CAIRNS ENTERTAINMENT PRECINCT

CIVIL ENGINEERING DESIGN REPORT TO SUPPORT THE DEVELOPMENT APPLICATION (STAGE 1)

Project Number: Q114012-001

Prepared for Cairns Regional Council

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TABLE OF CONTENTS

ANNEXURES:

CARDNO DRAWINGS:

1 INTRODUCTION

1.1 PURPOSE OF REPORT

This report supports a Development Application for Stage 1 of the Cairns Entertainment Precinct. The report provides an assessment of civil engineering infrastructure required for the development.

Ports North are the Assessment Manager for the Development Application and the development is governed by the Cairns Port Authority Land Use Plan. Cairns Regional Council and other relevant government agencies will be Concurrent Agencies for the Development Application approval process.

The Cairns Entertainment Precinct is situated on 1.5ha of Ports land fronting Wharf Street. The development is located within the Port of Cairns, situated directly to the west of Cairns CBD. Stage 1 of the development comprises a Performing Arts Centre, Public Plaza, car parking and restoring Whites Shed. Future stages of the precinct are proposed to include a museum and an additional 450 seat theatre venue.

1.2 MATTERS ADDRESSED IN THIS REPORT

This report addresses the following civil engineering aspects of the proposed development;

- Responses to Code Criteria relating to Civil Works
- Flooding
- Roadworks & Car Parking
- Stormwater Drainage
- Sewerage
- Water Supply and Water Recycling
- Gas
- Construction Management of Civil Works
- Geotechnical Overview
- Bulk Earthworks

The *Reponses to Code Criteria* noted above relates to the Cairns Port Authority Code, including Section 2.2 (Development of Flood Prone Land Code) and Section 2.12 (Works, Services and Infrastructure Code), and the Cairns Port Authority Seaport LAP Code, Section 5.1.

Preliminary Design Drawings attached to this report are as follows;

- DA-C00 Existing Services Plan
- DA-C01 Overall Roadworks Plan
- DA-C02 Proposed Southern Access Road Plan
- DA-C03 Proposed Port Road Plan
- DA-C04 Wharf Street Roadworks Plan
- DA-C05 Overall Stormwater Drainage Layout Plan
- DA-C06 Stormwater Drainage Details Plan
- DA-C07 Stormwater Drainage Pit Details

- DA-C08 Overall Water Reticulation Layout Plan
- DA-C09 Overall Sewerage Reticulation Layout Plan
- DA-C10 Continuation of Sewerage Reticulation Layout Plan

1.3 OTHER REPORTS BY OTHER CONSULTANTS

Other documents by other consultants which are relied upon in this report and/or provide detailed information on other specialist issues include the following;

- Architectural Plans by Cox Rayner
- Landscape Plans by Tract
- Traffic Report by Arup
- Hydraulic Report by SPP
- Electrical & Communications Report by Steensen Varming
- Acoustic Report by Acoustic Studio
- Maritime Report by Cardno

1.4 MEETINGS HELD WITH COUNCIL AND PORTS NORTH

Agency	Date	Officers	Issue
Cairns Regional Council	9/05/11	Tim Smith	Flooding and stormwater issues.
Cairns Regional Council	8/06/11	Tim Smith (J. Jentz – Maunsells)	Proposed stormwater upgrades for the CBD, and previous work undertaken by Maunsells.
Cairns Regional Council (Water & Waste)	24/06/11	Jon Turner, Ricky Hewitt, Ben Millar, Rebecca Smith	Outline of water and sewerage proposals for the Precinct. Initial considerations from Council for services provision.
Cairns Regional Council (Water & Waste)	16/11/11	Ricky Hewitt, G. Asoka	Update on sewerage design and options for connection to existing infrastructure.
Cairns Regional Council	8/12/11	Tim Smith	Update on stormwater design and lessons learnt on the lake street drainage construction.
Ports North	12/12/11	Michael Colleton Michael Martin,	Existing and proposed services locations and relocations, and other proposed civil works (minutes of meeting, Appendix B)
Cairns Regional Council	01/03/12	Ricky Hewitt, Grahame Dunstan	Update on proposed CEP sewerage design and planned upgrade works by Council.

2 RESPONSES TO PORTS CODE CRITERIA

Ports Code Criteria are outlined in the Cairns Port Authority (CPA) Code. The Code sections relevant to Civil Works and covered in the below subsections, are; Section 2.1 (assessment and management of Acid Sulphate Soils), Section 2.2 (Development of Flood Prone Land Code), Section 2.3 (Environmental Protection code) and Section 2.12 (Works, Services and Infrastructure Code), and the Cairns Port Authority Seaport LAP Code, Section 5.1.

To assist with interpreting the below responses, further details of the various civil infrastructure proposals are contained in subsequent sections of this report, including Section 3 roadworks, Section 5 stormwater drainage, Section 6 sewerage and Section 7 water.

2.1 GENERAL CODE SECTION 2.1 (ACID SULPHATE SOILS)

Refer attached Table of Elements of the Code / Development Principles in Annexure D.

Performance Criteria	Proposed Solution
P1 The release of acid and associated metal contaminants into the environment is avoided.	Acid Sulphate Soils (ASS) are likely to be exposed and disturbed during excavation of the basement and services trenching. Likely strata/materials are as described in the Geotechnical Desktop study by Golder Associates. It is proposed that all Potential Acid Sulphate Soils (PASS) will be treated on site or removed to a safe disposal area within suitable time constraints to minimise the risk of oxidation.
P2 Prior to any site works, the likelihood of AASS or PASS and the associated environmental impacts are determined. P3 Where in an area of PASS or AASS, development is managed in a manner that ensures the environmental values including receiving water quality are not adversely impacted and that assets are not subject to accelerated corrosion.	A detailed sampling, analysis and investigation will be conducted by a Geotechnical Consultant who will then prepare a suitable ASS and PASS Management Plan. This Plan will at the least detail the issues set out in the Code A3.1 All development will be undertaken in accordance with the ASS and PASS Management Plan.

2.2 CODE SECTION 2.2 (DEVELOPMENT OF FLOOD PRONE CODE)

Refer attached Table of Elements of the Code / Development Principles in Annexure D.

Performance Criteria	Proposed Solution
P1 Any development involving the excavation or filling of land is carried out so as not to have a "worsening" effect on flood water levels or flow results either upstream or downstream of the development site.	The current site is generally level and varies from about RL 1.8 to RL 2.0AHD which is significantly below the accepted flood levels. The adopted Q100 level for the proposed commercial building areas is RL 2.7AHD for a planning period to 2050 whereas the Performing Arts building has a planning period to 2100 and a commensurate Q100 flood level of RL 3.2AHD. The difference is due to increased sea level predictions between 2050 and 2100. It should be noted that White's Shed which will be retained on site has a floor level of RL 2.7AHD. The site is affected by inundation in three ways:- (i) Rainfall occurring on the site (ii) Floodwaters from the sea (iii) Floodwaters from the CBD (i) – Rainfall over the site will actually have a reduced effect on adjacent properties as the site will have a significant rainwater harvesting storage with some detention capability and all roof water will be collected directly into this system. At present the site is poorly served with drainage collection points and the main discharge system is in fact collecting all the water from the CBD Grafton street catchment. This system will be disconnected from the CBD and be used solely for the CEP outflows. Excess rainfall or rainfall not captured by the new drainage system will flow to adjacent ground areas as presently existing. However this will be less than at present due to the greater volume of outflows directed to the new drainage system and thence directly to the outfall to the sea. (ii) – When the site is affected by floodwaters from the sea, inundation to adjacent properties will be affected to the same extent as the site as flood levels will be mostly uniform depending on location of inflow through the sea wall, drainage pits without tide gates and overland flow from either end of the wharf. (iii) – At present overflows external to the site from the

	CBD can occur across the site at low points in Wharf Street (about RL 1.8) and at the Southern Access Road (about RL 1.9) initially and then at higher levels across the Wharf Street boundary generally. Behind White's Shed and to the north, the site is protected by a levee to at least RL 2.43 whilst the ground levels along the CEP boundary are at about RL 2.2. In the Cairns CBD Drainage Upgrade report of May 2006 various storm events for ARIs from 1 to 100 years were modelled for a fully developed drainage scheme. In general no overflows are indicated for all events in the area of the site. However for sea levels at MHWS (RL 0.93) some overflow from surcharging of the underground stormwater system in Wharf Street might just occur in the 50 and 100 year events. If sea level is at HAT then overflow is likely to occur in events greater than a 10 year event. In both cases though, overflows would not be great as the pipe involved is only 375mm dia. assuming main pit covers are bolted down. At present the CBD drainage passes through the site in two 900mm dia. pipes. Pits connect to this system in the Port land and are able to surcharge the site and adjacent roads. Once the building occurs and the pipes are relocated this will no longer occur and the existing pipes will in fact be able to reduce the level of ponding in the area by discharging greater volumes to the sea directly. With development of the site the area available for ponding and flood storage will be significantly reduced at the Performing Arts building and also the museum in the later stages of the project. However it is considered that the change in CBD drainage and the increased discharge capacity from the site including some detention capability will ameliorate this loss.
P2 All buildings and uses have a reasonable level of flood immunity.	This element has been addressed in the Cardno report – Flooding and Storm Surge Report dated 12 May 2011 and is appended to this report. As per the application drawings, new floor levels have been set to satisfy the recommendations of the report. The existing White's Shed however is at the same level as the design Q100 level for commercial activities and therefore has no free board to that event.

2.3 CODE SECTION 2.4 (ENVIRONMENTAL PROTECTION CODE)

Refer attached Table of Elements of the Code / Development Principles in Annexure D. Code element responses to P2, P3, P6 and P7 follow. Other performance criteria are addressed by other consultants.

Performance Criteria	Proposed Solution
P2 The environmental values of adjoining waterways and wetlands are maintained and protected.	The development of the Cairns Entertainment Precinct will basically involve 100% coverage of the site. As such only relatively clean water will be discharged from the site. The roofs will collect all rain water into a harvesting tank as detailed on the Hydraulic Consultant drawings from where it will discharge to existing underground stormwater drains and thence to the Inlet. Areas not roofed such as paths and plazas will only be collecting rainwater from pedestrian activities which will be collected and discharged into either existing or new underground stormwater pipes which will in turn discharge to the Inlet. Loading areas for delivery and unloading locations will all be provided with water quality treatment devices to remove pollutants as required by current FNQROC guidelines. Refer also to the Hydraulic Consultant's report on water quality which in particular describes the use of quality devices in conjunction with the water harvesting arrangements.
P3 During the construction and operational phases effective site management practices are adopted to ensure there are no adverse impacts on the ecological values of the adjoining areas.	Refer to Section 12 on Bulk Earthworks for a description of solutions to water quality control during the construction phase. During the operational phase it is not expected that there will be any particular requirements from a civil perspective other than normal maintenance activities for protection of ecological values.
P6 Land management including construction and ongoing operations are conducted in a manner that prevents pollutant emissions to waterways.	An EMP will be required for the Construction phase. It will also include the ASS and PASS management plans formulated for the treatment of any acid sulphate soils. Refer also sections above.
P7 Stormwater is of a standard that prevents contamination of surface and or groundwater.	Stormwater runoff will actually contain fewer pollutants than existing as most of the site will be covered with

	either roof or paths and gardens. Any run off from loading and unloading bays will have water quality devices installed to minimise pollutant runoff. Refer also to the Hydraulic Consultant's report

2.4 CODE SECTION 2.12 (WORKS, SERVICES & INFRASTRUCTURE CODE)

Refer attached Table of Elements of the Code / Development Principles in Annexure D.

In general, water supply will be connected directly to Council's reticulation, sewerage will be connected directly into Council's gravity sewer reticulation, gas will be connected to Origin existing gas pipeline and stormwater will be partially collected by a rainwater harvesting system as documented by the Hydraulics Consultant. All other stormwater generated by the site is proposed to be discharged directly to the sea using existing underground stormwater pipes.

In addition, it is proposed to construct two new outlets at the sea wall to carry stormwater from the Grafton and Wharf Streets CBD catchments. There are two (2) 1650mm dia. concrete pipes already installed under Wharf Street which will be extended across the site to discharge through the sea wall in the vicinity of the northern wharf ramp opposite the southern end of White's Shed. The construction will be similar to that already completed by the Council at the end of Lake Street. Council has discussed proposals to eventually upgrade its upstream drainage system and also connect pumps to the twin pipes to improve drainage in that part of the CBD although there is no time frame at this stage.

Performance Criteria	**Proposed Solution**
P1 Land is adequately serviced with water, waste disposal, telecommunications and energy.	Refer application drawings and Cardno report
P2 Land is provided with internal and external drainage to an appropriate standard to minimise runoff and impacts on receiving waters	Refer application drawings indicating roof water collection to rain harvesting systems. All other roof and pedestrian areas will be drained to FNQROC requirements. Loading dock and waste removal areas will have water quality devices installed into stormwater lines discharging to the sea.
P3 Engineering standards for land based development components meet or exceed those standards set out in the FNQROC Development Manual	Engineering infrastructure and services will be designed in accordance with FNQROC and Ports North's requirements.

2.5 CPA SEAPORT LOCAL AREA PLAN CODE SECTION 5.1

Refer attached Table of Elements of the Code / Development Principles in Annexure D. Code Element responses to P6 to P9 are as follows:-

Performance Criteria	Proposed Solution
P6 The design and location of any future uses minimises any potential impact on the environmental values of Trinity Inlet or Smith's Creek.	As the project is set back from the sea front the only direct impact will be from discharge of stormwater as described previously. Where appropriate, all civil works will be undertaken in accordance with FNQROC and relevant environmental requirements. It is expected that construction of the new main twin pipe outfalls from the CBD drainage will be in accordance with the Environmental Management Plan (EMP) to be provided by the Contractor and approved prior to any on site work.
P7 Major industrial development, or development constituting a potential safety risk or hazard, demonstrates it can meet acceptable safety standards.	Not applicable.
P8 Development is designed and located such that an acceptable level of flood immunity is provided.	Refer Section 2.2.
P9 The disturbance of acid sulphate soils or potential acid sulphate soils is avoided or minimised.	Refer Section 2.1.

3 RESPONSES TO STATE PLANNING POLICY PROVISIONS

Various State Planning Policies are applicable to the Cairns Entertainment Precinct project and those relevant to Civil matters are addressed in the following:

State Planning Policy	Proposed Solution
SPP 2/02-Planning and Managing Development involving Acid Sulfate Soils.	Refer Section 2.1 above.
SPP 1/03-Mitigating the adverse impacts of flood, bushfire and landslide.	Bushfire and landslide are not applicable. Refer to Section 2.2 for a response to dealing with flooding impacts.
SPP 4/11-Protecting wetlands of high ecological significance in Great Barrier Reef Catchments.	Refer to Section 2.3 above.
SPP 4/10-Healthy Waters.	Refer to Section 2.3 above.
State Coastal Plan	The new state Coastal Plan and associated planning policies are due to be adopted by the Government in the near future. In particular the Coastal plan will affect deliberations in relation to storm surge and more particularly sea level rise due to climate change. These matters have been addressed specifically in the earlier report by Cardno in its Flooding and Storm Surge report dated 12 May 2011 and which is incorporated into this report at Annexure A.

4 ROADWORKS

Traffic issues are being covered by Arup Traffic for the project. Supporting this work, we provide the below information with respect to roads.

The CEP site is bounded by one Council road (Wharf Street) along its western boundary. The southern and eastern boundaries are bordered by Ports North controlled roads, referred to as Port Road along the eastern boundary and the Southern Access Road along the southern boundary. Port Road links the site to the south to another Council road (Dutton Street) and intersects the Southern Access Road near the south-east corner of the CEP site.

Refer attached Cardno Drawings relating to proposed roadworks as follows;

DA-C01	Overall Roadworks Plan
DA-C02	Proposed Southern Access Road Plan
DA-C03	Proposed Port Road Plan
DA-C04	Wharf Street Roadworks Plan

The proposed works for the CEP, as shown on the enclosed plans, show proposed works on Wharf Street consisting of a pedestrian crossing across Wharf Street, a vehicle drop off and parking to the Performing Arts entrance area to the northern end of the site and realigned kerbing at the basement car park entrance and further to the Southern Access Road. Changes to the western side of Wharf Street are also proposed to accommodate separation for taxi zones from carparking together with associated kerbing changes. Stormwater drainage will need to be altered to suit. As a result of the changes there will be a loss of existing on-street parallel car parks along the Wharf Street.

In order to provide better stormwater immunity to the main entrance and associated footpath along Wharf Street it is proposed to reconstruct the drop off and parking lane to crossfall to an invert along the through lane and collect the stormwater in grated kerb inlet pits at the kerb on either side of the pedestrian crossing which occurs at the low point in Wharf Street. It is further proposed that the crossing be at kerb level and form a traffic management device similar to the crossing further to the North. Such an arrangement will keep all foot traffic out of the water flows in the kerb and invert channels. This will be relevant on both sides of Wharf Street.

The predominant road works for the project are the realignment and alteration of the Port Road to accommodate the proposed building, the loading dock, relocated services along the eastern boundary of the CEP site and a queuing lane for wharf traffic, and the slight realignment of the Southern Access Road to accommodate the 450 seat performance space, primarily and to also accommodate the back of house vehicle turning movements.. The nominated roadworks will be upgraded to a standard as discussed in the Traffic Report by Arup. It is proposed that both Port Road and Southern Access Road will have one way crossfalls to suit the drainage requirements and also the required floor levels of the CEP works.

As indicated on the attached plans the existing Port Road along part of the eastern adjoining boundary of the CEP site will have the kerb and channel extended south from White's shed within the CEP site boundary and then will be relocated several metres to the east near the intersection of the southern access road with a proposed width of 10.5m and one-way crossfall towards the CEP site with kerb / gutter and side entry pits to collect the road drainage. New drainage will be required and the existing railway lines will be buried as a result of the roadway being raised for a section of Port Road to accommodate access to the existing ramp to Wharf 5/6. It is noted that the Heritage report suggests that the railway lines be maintained even if built over.

Levels along the new road works are governed largely by stormwater considerations (refer Section 5) and suitable grades at the intersection of the southern access road and the existing ramp at Wharf 5/6).

The Southern Access Road will be realigned to the south to accommodate the new building works as mentioned above but will maintain the existing carriageway width of 8m. This will result in some encroachment onto the existing Port land at their workshop site near the intersection with Wharf Street. In conjunction with the realignment it will be necessary to increase the width of a portion of the southern alignment in the Quicksilver area to accommodate turning movements for vehicles exiting the loading dock. These arrangements will then cater for all normal vehicle movements servicing the CEP back of house. Refer also to the Cardno Maritime report.

However in the circumstance of a security level 2 shut down in the Port when the Southern Access Road would be closed at Wharf Street and access is only available from Dutton Street, it would be necessary for articulated vehicles to do a reverse manoeuvre to access the loading dock. This is a very unlikely scenario and is discussed further in the Cardno Maritime report.

5 FLOODING AND STORM SURGE

Cardno prepared a Flooding& Storm Surge report issued on 12 May 2011 for the CEP project. A copy is included as Appendix A of this report. The main intent of the Flood & Storm Surge report was to provide conclusions for flood advice and establish minimum floor levels and other operating levels for various aspects of the proposed works.

The recommendations made and subsequently endorsed by Council were minimum floor levels as follows;

- 3.35m Australian Height Datum (AHD) for the Performing Arts building that requires an ARI 100 year immunity. Note, this adopts a planning period to year 2100 for determining sea level rise, and adopts the “desirable” minimum freeboard of 0.15m as per Council requirements.
- 2.85m AHD for other commercial buildings or facilities including retail that requires an ARI 100 year immunity. Note, this adopts a planning period to year 2050 for determining sea level rise, and adopts the “desirable” minimum freeboard of 0.15m as per Council requirements. For some retail uses, it may be reasonable to adopt the “absolute” minimum freeboard of zero, thus reducing the minimum floor level to 2.7m AHD.
- 3.95m AHD for parts of the Museum building that stores collections or archives. This adopts the average of the range of ARI 200 year values from the publications reviewed in this report as summarised in Section 3, and is based on a planning period to year 2100 for determining sea level rise and using a 0.15m freeboard.

In relation to car parking, the following recommendations are provided;

- 2.1m AHD as a minimum surface level for any above ground car parks for ARI 20 immunity. This adopts a planning period to year 2050 for determining sea level rise.
- 3.35m AHD for the bund level protecting an underground car park forming a basement to the Performing Arts building. This includes a 0.15m freeboard above the ARI 100 year level.

6 STORMWATER DRAINAGE

6.1 GENERAL

This section provides a summary of the key components and issues of the stormwater system that impact the Cairns Entertainment Precinct (CEP) project

Refer attached Cardno Drawings;

DA-C05	Overall Stormwater Drainage Layout Plan
DA-C06	Stormwater Drainage Details Plan
DA-C07	Major Stormwater Drainage Pit Details

Reference is also made to the Flood & Storm Surge report issued on 12 May 2011 for the CEP project which included a brief discussion on proposed Cairns Business District (CBD) drainage upgrade works.

Of particular importance is the modelling of the existing drainage system and proposed upgraded systems for improving CBD drainage as per the Cairns CBD Drainage Upgrade reports by Maunsell in 2006 and 2007 which are referred to herein.

6.2 EXISTING STORMWATER SYSTEM

The existing stormwater system is shown on the attached Cardno Drawings DA-C00, DA-C05 and Figure 1- Existing Pipe Network from the CBD 2006 drainage report shown as Fig 1 below.

The key components of the existing system are as follows;

- Low point in Wharf Street on both sides of the road and associated underground drainage opposite the main entrance steps to the complex.
- Existing 2x 900mm dia. pipes running W to E through the CEP site and out letting to the Inlet through the Ports North sea wall.
- Existing 2x 1650mm dia. pipes under Wharf Street only and installed some years ago to accommodate future infrastructure (currently blanked off, not in use).

Stormwater runoff from the external catchment to the low point in Wharf Street is collected within side entry sag pits on either side of the road then discharged eventually to Trinity Inlet through existing 2x900mm dia. pipes running through the CEP site. The level of the invert at these pits is only IL 1.6. The overflow path from the low point in Wharf Street adjacent to the site extends across Ports land through the CEP site and into the Ports drainage system before discharging into Trinity Inlet. In flood events there is considerable standing water over Ports land including the CEP site due to capacity limitations of the existing drainage system and also the low lying nature of the land and its surrounds being below Highest Astronomical Tide (HAT) level in some places.

The flood modelling undertaken in the CBD drainage Upgrade reports found that for all the upgrade options there is no general overflow from the external catchment in the ARI 100 year event for sea levels up to highest astronomical tide (HAT) of RL 1.78. Fig. 2 shows the maps of inundation taken from the CBD report for the various upgrade options for HAT sea levels which indicates the only overflow to be in the vicinity of the Hilton hotel.

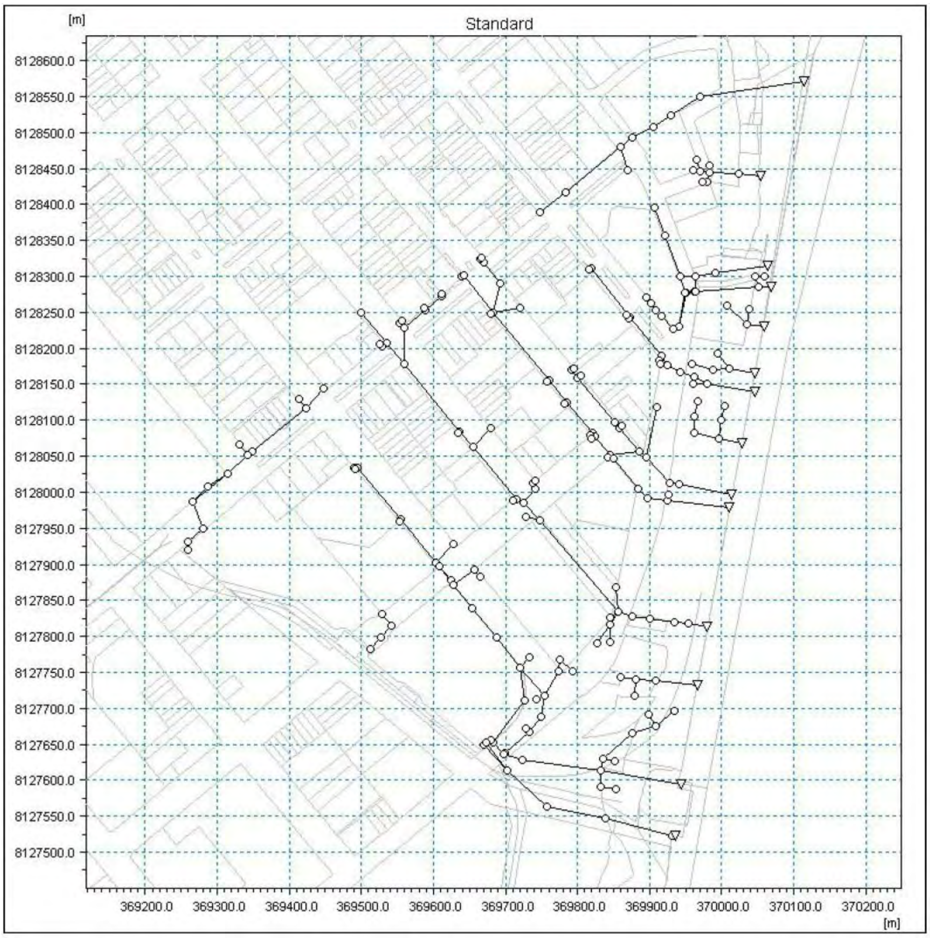
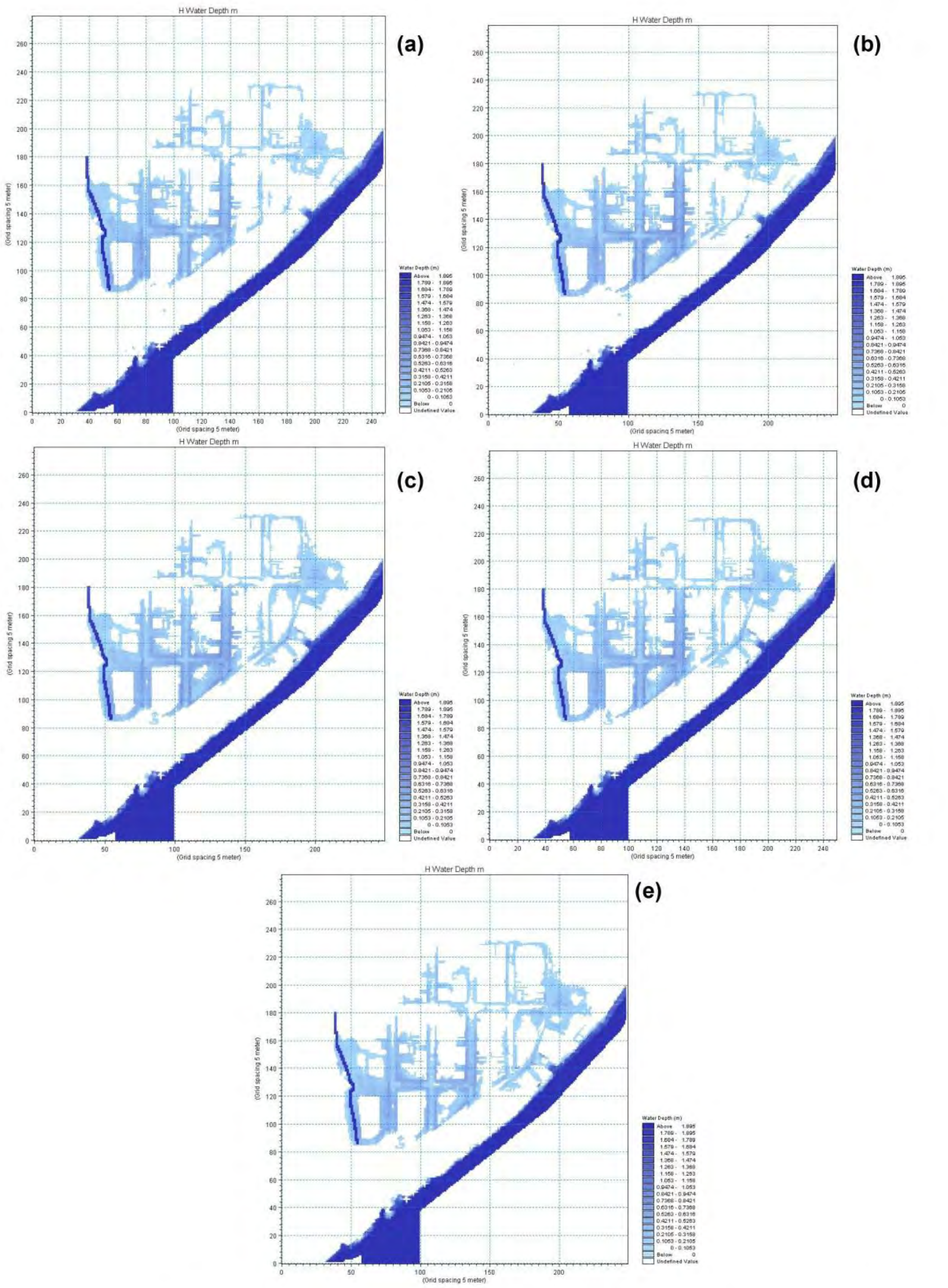


FIG. 1

The report also found that for the existing drainage system water levels in Grafton Street at the Wharf Street intersection are lower than the kerb levels at the median in wharf Street for all events for sea levels at MHWS and also for sea levels up to the maximum HAT. Thus overflows from Wharf Street through the site would only be due to high water levels in the pipe system surcharging the pits on the eastern side of Wharf Street or by blockage of the inlet pits. As the inlet pits are grated sag kerb inlets the likelihood of blockage is remote. Depending on the rearrangement of pipework for the existing and new pits on Wharf Street tide gates used to prevent tidal intrusion may also prevent surcharging from the western side of Wharf Street. It should be noted that at times of high rainfall and associated HAT sea level, water levels in the kerb and channelling at the entrance to the site will be significantly above top of kerb due to the low invert levels existing.

There is a further low point pit along Wharf Street near the southern end of the site which overflows around the corner and along the Southern Access Road. There would be no change to this situation except that with the realignment of the kerb and channel overflow would occur at a higher level thus providing better immunity to the Port area from CBD flooding.

Within Port land, there is a low point midway along the Southern Access Road. This water is collected in an underground pipe and directed to the sea together with inflows from some other connected pits on Port land nearby. It is unclear whether there is a flood gate on this system and no record of the outlet pipe size is available at this point in time. There is no defined overland flow path at this low point, therefore during larger



Cairns CBD Drainage Improvements –100 Year ARI, Highest Astronomical Tide
(a) combined pump and gravity, (b) gravity only, (c) Grafton Street system only, (d) Lake Street system only, (e)combined Lake and Grafton Street systems

Cairns CBD Drainage Upgrade
Drainage Modelling
Appendix A

FIG.2

rainfall events stormwater ponds before flowing back along the road towards Trinity Inlet then south along the rail tracks to a sag point along the Port road.

The Port Road running parallel to the wharf along the eastern boundary of the CEP site is effectively an overland flow path for stormwater through Port land and thus needs to be maintained at existing levels and grade. There are some pits servicing this road although not significant. White's shed has no gutters and roof water runs directly onto the ground. The water from the eastern side of the shed is collected by pits along Port road. However roof water from the western side is partially collected by ground level grated inlet pits which connect to the same pipe system from the Grafton Street CBD system. The balance runs overland through the site and eventually onto Port Road.

6.3 CBD PROPOSED DRAINAGE UPGRADE

The CBD Drainage Upgrade report (2007) prepared for Council developed preliminary designs for the final scheme arrangements, including;

- *Upgraded gravity schemes in Grafton Street to convey a Q10 event for a tail water level equivalent to MHWS (Mean High Water Springs);*
- *Pump station associated with upgraded gravity system to provide a Q100 system via the upgraded pipe system.*

The Lake Street system including pumps has been completed in its entirety and Stage 1 of the Grafton Street works has also been completed which included the construction of the pipe crossing (2x 1650mm dia. pipes) as part of the Wharf Street upgrade works.

The report identifies the balance of works in the following staging;

- Stage 2B(a) (now part of Stage 5): Construct the pipes from the existing pipes under Wharf Street through to the *outlet, including the outlet, for the Grafton Street system. Construct the upgraded drainage system in Hartley Street associated with the Lake Street system and connect to the existing Grafton Street pipework.*
- Stage 4 (now part of Stage 5)*: Complete the remaining pipe system for the Grafton Street system including the pumps and the connection of the existing new pipes from stage 2 to the new pipes in Grafton Street. The performance of the combined system utilising the Lake Street pump station should be monitored. If the system does not perform satisfactorily, then the pumps should be installed in the Grafton Street pump station.*

However, the staging strategy has since been modified as reflected on the latest Staged Implementation Plan (refer attached). This now includes all works associated with the Grafton Street drainage upgrade incorporated as Stage 5.

The proposed Grafton Street system works is shown in the CBD Drainage Upgrade report (2007) (refer plan attached CCC CBD South Drainage Study, Stormwater Drainage Plan, Grafton Street System - 2005C4N1).

The key impact of the proposed CBD upgrade works on the CEP project is the extension of the existing 2x1650 mm dia. pipes under Wharf Street through the CEP site within a designated services corridor to the Trinity Inlet. The CEP is proposing to build over this services corridor thus making it impractical to build the pipes at a later stage.

6.4 KEY COMPONENTS OF PROPOSED WORKS

The key components of the stormwater infrastructure can be divided into two groups, the proposed CBD Drainage Upgrade works and the proposed CEP project drainage works.

CBD Drainage Upgrade Works

The CBD Drainage Upgrade works are outlined in the above section and notably considers a staging upgrade option which includes two levels of immunity, one at Q10 and the other at Q100. Both options require extensive modifications to the existing stormwater drainage infrastructure and the extension of the existing 2 x 1650 mm dia. pipes from Wharf Street to Trinity Inlet through the CEP site. Associated with the upgrading would be alteration of the pipework connecting the pits in Wharf Street to be directed to the pump station.

The proposed pump station location is in the Grafton Street road reserve adjacent to the CPA site. Access to the pump station can be gained via Grafton Street. The drainage upgrade utilises the existing drainage system upstream as well as new infrastructure. The location of the Pump Station has some flexibility and will require further collaboration with stakeholders to determine the most favourable location including consideration to pedestrian links, visual screening and drainage efficiencies.

Tide gates are proposed to be installed in the pump station to the outfall line from Grafton Street in the future upgraded system. Tide flex rubber check valves are proposed in the design plans as installed by Council in the Lake Street pump station. If the Grafton Street pump station is constructed the valves proposed in these works could be relocated to the pump station if necessary.

As indicated on the drawings there are two options for the location of the valves. Option 1 is to install them in the junction pit on Wharf Street and the existing drainage pipes joining the twin 900mm dia. pipes would be redirected to join the new 1650mm dia. pipes on the western side of Wharf Street. In Option 2, the instance where the existing twin 900mm dia. pipes crossing Wharf Street are redirected to the new 1650mm dia. pipes, the valves would need to be installed in the pits at the sea wall. Ports North have advised that this would not be their preference.

CEP Drainage Works

The proposed key CEP Drainage Works are as follows;

- The existing overland flow path for larger flood events until the Q100 pumps are constructed is effectively along Wharf Street bordering the site, but initially any overland flow would be at the low point in Wharf Street near the main entrance to the CEP site. The proposed overland flow path will be initially ponding in Wharf Street then along Wharf Street in both the south and north directions. Note the overland flow will occur less frequently because the existing 2x900mm dia, outlet pipes are being replaced by 2x1650mm dia. outlet pipes.
- Removing the 2x 900mm dia. pipes within the CEP site, but using the existing outlet for these pipes for internal drainage connection and discharge to Trinity Inlet. A Stormwater Quality Improvement Device (or other approved water quality control device) is proposed on existing outlets used for the project. Note that the existing pipe location may or may not suit the final internal hydraulics design in which case the outlet may need to be relocated. Also the device(s) may be located within the building rather than at ground level external to it.

- Construct 2x 1650mm dia. pipes through the CEP site to accommodate the CBD drainage upgrade works and replace the removal of the 2x 900mm dia. pipes through the site.
- Accommodate the overflow path and drainage outlets along Port Road at current levels and grades, however construct kerb & gutter with associated drainage pits along the common Port Road and CEP boundary.
- Relocate drainage within the Southern Access Road to accommodate the proposed realignment of this road and a tidal gate on the existing outlet. In order to accommodate the existing overland flow paths along Port Road to the south, it is proposed to maintain levels on the Southern Access Road to allow overflows to be directed around the intersection and cross the Southern Access Road slightly to the west of the intersection of Port Road as indicated on the drawings.
- As raised in our Flood Report for the CEP project, consideration was given to flood and storm tide immunity for car parking. For underground car parking the bund level protecting access into the basement should provide a 0.15m freeboard (instead of 0.3m as per the Flood Report) above the ARI 100 year level as required by Council's Drainage Management Plan. Therefore 3.35m AHD is recommended for the bund level protecting the underground car park forming a basement to the Performing Arts building. Council's Drainage Management Plan provides the opportunity for Council to accept an "*alternative protection measure*" if the underground car parks are for visitor parking and on a constrained site which is the case for the CEP project. Whilst it is currently proposed to provide a ramp at the recommended level an alternative protection measure for the basement car park instead of a ramp at trafficable grade is a suitable floodgate system. It should be noted that all ventilations and other penetrations of the basement will need to be above the recommended flood protection level of 3.35m AHD.

Another consideration for the project in relation to stormwater is the requirement of the Cityport Infrastructure Agreement between Ports North and Council which requires *the provision of an overland flow path on the extension of Grafton Street, along the access corridor, as part of the road. A crest level of 2.45m AHD will be built into this overland flow path.* As we understand from Ports North, the Agreement was established to protect the CBD land from Trinity Inlet Storm Surge. In relation to the CEP Project, the Agreement only requires the crest level along the overland flow path at the extension of Grafton Street, and therefore does not extend to the Southern Access Road off Wharf Street or the boundary area to the North of the Grafton Street extension. Construction of the CEP buildings will mostly automatically create a wall above the RL 2.45 level. However at the extension of Grafton Street where the main access stairs will be built up to the plaza it would be possible to construct an overflow path at RL 2.45 (or lower)if required.

6.5 ENVIRONMENTALLY SUSTAINABLE DESIGN (ESD) MATTERS

As the CEP project is within100m of Trinity Inlet, it is considered by the GBCA to be a wetland of low ecological value. In order to obtain a rating, one of the requirements is that the post-development peak discharge from the project in a 1.5 year ARI (average return interval) event does not exceed the pre-development peak 1.5 year ARI event discharge. As the site runoff water will mostly be collected via roof runoff into a water harvesting tank as described in the Hydraulics report a small detention system will be added to the outlet of the harvesting tank to detain the runoff to the required amount. The 1.5 year ARI event does not result in a large discharge and preliminary calculations indicate that a 10m^3 volume tank will be sufficient for control of the whole site. This size tank has been included in the plans presented by the Hydraulics Consultant.

Other requirements to be met relate to water quality and these have been addressed in the section on response to State Planning Policy issues. In particular the Hydraulic consultant has advised that guidelines for reductions in Total Suspended solids, Total Phosphorous and Total Nitrogen (TSS/TP/TN) of 80/65/40 based on a Wet Tropics region will be met.

This section relates particularly to stormwater as part of the Civil Engineering Consultancy. Reference should also be made to the reports prepared by the ESD Consultant, Cundell Johnstone and Partners, and the Hydraulics consultant, SPP Group.

6.6 OTHER ISSUES AND RECOMMENDATIONS

The following issues and recommendations are provided relating to stormwater;

a) <u>Responsibilities for implementing various infrastructure works</u>.

We consider that the CEP project is obligated to replace the equivalent capacity of the 2x 900mm dia. pipes which are being disconnected and removed from the site. The balance of drainage works are a Council responsibility since the proposed CBD drainage upgrade works have been proposed to improve existing deficiencies within the CBD drainage system which are external to the CEP site and that the proposed CEP internal drainage is not connecting into the CBD system instead proposing to connect to existing drainage outlets within Ports land.

The CEP project will be reliant on the CBD drainage works being built in order to provide a desirable immunity for the project. Also, the CEP project is proposing to build over the 2 x 1650mm dia. pipe extension thus making it impractical to build these pipes at a later stage. The scope to design and build the 2 x 1650mm dia.is therefore proposed to be undertaken as part of the CEP project whereas the balance of the CBD Drainage Upgrade Works extending along Grafton and Hartley Streets could be undertaken independent to the CEP project.

If Q10 immunity to the CEP is accepted, then the Pump Station and other associated Q100 immunity works can be implemented in the future.

The existing road levels in Wharf Street in front of the CEP site at the proposed services corridor will experience inundation at high tides combined with rainfall unless protected by tide gates and pumping. Even with the proposed tide gates heavy rain may still cause some inundation.

b) Staging of the proposed Grafton Street drainage upgrade.

The two options for consideration are;

- Upgraded gravity schemes in Grafton Street to convey a Q10 event for a tail water level equivalent to Mean High Water Springs tide;
- Pump station associated with the upgraded gravity system to provide a Q100 system via the upgraded pipe system.

As indicated in the previous section on drainage there is no general overflow of Wharf Street into Port's land. However depending on the final arrangement of the underground drainage surcharging of the pipes systems may result in overflows. We consider that by constructing the Q100 system, the overland flow path through the services corridor is not required as surcharging flows would be small and if the ground levels were raised to prevent overflows at the CEP entrance, any excess of Q100 will flow along the Southern Access Road albeit at significant depths of water and inundation at kerb locations.

If the Q10 upgrade is constructed only as an initial stage, then until the Q100 infrastructure is constructed, any stormwater flow beyond the capacity of the new 2 x 1650 discharge pipes will pond then traverse along Wharf Street. Some reduction in water depth problems along the eastern side of Wharf Street may be obtained if the pits are disconnected from the CBD drainage system although inundation would still occur at high tides combined with heavy rainfall.

c) A review of the proposed works and funding options of the Grafton Street CBD Drainage Upgrade if Council consider it warranted.

d) Whether providing a high level overland flow path on the extension of Grafton Street with a crest level at 2.45m AHD is required as per the City/Port Infrastructure Agreement. The Agreement only requires this crest level along the overland flow path at the extension of Grafton Street and as we understand was established to protect the CBD land from Storm Surge.

e) Adopting a floodgate solution to protect the basement car park as an alternative protection measure instead of the traditional ramping up. Due to difficulties in site access and levels, a compromise might be considered where a minimum immunity level is set based on say a 50 year planning period and flood gates installed for any higher level flooding. As the difference in proposed flood levels between the 50 and 100 year planning periods is due to increased sea levels due to climate change rather than increased predicted rain events this could be considered to be a reasonable proposition. Increased pedestrian exits may be required to compensate.

The current proposal is to ramp up the basement entry to provide the required flood immunity.

7 SEWERAGE INFRASTRUCTURE

7.1 PROPOSED SEWERAGE RETICULATION

Refer attached Cardno Drawings relating to proposed sewerage works as follows;
DA-C09 Overall Sewerage Reticulation Layout Plan,
DA-C10 Continuation of Sewerage Reticulation Layout Plan

The proposed sewerage infrastructure for the Stage 1 development while accommodating the ultimate development, are as follows;

- Relocate the existing sewer pipe currently aligned East West through the site within the proposed building envelope. Due to the proposed basement carpark and performing arts building, it is proposed to relocate the sewer pipe to the services corridor immediately south of White's Shed between Port Road and Wharf Street, and on the southern side of the new Stormwater pipes located in the same services corridor.

- A service will need to be provided across the stormwater pipes to the proposed future Museum building. This service will be constructed in Stage 1 and plugged at the manhole for future connection.

- Since the existing 150mm dia. sewer pipe along Grafton Street is located underneath the Convention Centre building ramp and therefore cannot be reconstructed to the required depth to service the realigned Port sewer, a new 150mm dia. sewer pipe along Grafton Street is proposed. The new 150mm dia. sewer pipe will accommodate the existing upstream developments on Port land and the proposed ultimate Entertainment Precinct. Determination of the existing upstream Port sewage loadings are outlined in the following subsection.

- Extend and realign the existing 150mm dia sewer pipe running along the eastern side of Wharf Street. This sewer pipe is proposed to provide direct connection to the CEP Performing Arts building. The existing pipe is close (approximately 1.5m) to the CEP basement, therefore a written application to Council for "Building over or near a sewer" will be required during the design phase. Requirements of Council for building near an existing sewer will likely require this line to be upgraded to a SN8 pipe material.

- Connect the existing sewer adjacent to the Convention Centre at manhole G8/3 to the new sewer at proposed manhole 4/1.

- Owing to the location and level of the two 1650mm dia. stormwater pipes under Wharf Street, there is only one option for the new 150mm dia. pipe along Grafton Street which has been shown on the sewerage plans.

- The relocated sewer pipe within the site and the new pipe along Grafton Street are very constrained in vertical grade as the proposed pipe realignment will traverse a longer distance to the existing pipe alignment. Our calculations have determined that the realigned and new 150mm dia. pipe constructed at minimum desirable grade as per FNQROC will just reach the 225mm dia. connection pipe in Hartley Street.

- The 225mm dia. pipe in Hartley Street feeds into Pump Station PSG. Council have indicated future upgrade works to Pump Station PSG and the rising main based on the Northern WWTP Sewerage Catchment Planning Report to accommodate future loadings. The Planning Report has estimated the future population density of the Entertainment Precinct site to be a combination of 35-50 and 0-15 EDU/ha across the site, which is less than the proposed peak usage of the Entertainment Precinct, however the peak usage of the Entertainment Precinct will typically occur outside of the peak CBD usage. Sewage generation for the Entertainment Precinct is covered in the following subsection.

- The existing sewerage pipe along the Port Road will be retained and utilised to service the existing Ports services points to the south east and south of the site. This pipe will be connected to the proposed relocated 150mm dia. pipe through the services corridor adjacent to Whites Shed. Refer Annexure C which shows the existing sewerage catchment boundaries.

Council advised that they will be undertaking upgrade works in the near future to increase the capacity of the existing sewerage pressure system including the Sewerage Pump Station PSG in Hartley Street and the connecting rising main as per the first phase of the proposed augmentation works. Council indicated they would like to understand the sewage loadings for the Entertainment Precinct to determine whether this will have any impact on the proposed upgrade works to the existing system.

The Hydraulic Engineer has determined the sewage loadings for the Entertainment Precinct development which are contained within a separate report, copy attached in Appendix F of this report. These sewage loadings have been used to establish the proposed external sewerage works required to service the development as determined below.

7.2 SEWAGE GENERATION

7.2.1 Sewage Generation from Premises Upstream of the CEP

Sewage generation from premises upstream of the Cairns Entertainment Precinct which enters the existing sewer line is as follows;

The area of land which is / could possibly be serviced by the existing sewer along the wharf frontage is shown in Annexure C(Figure 1 (highlighted in blue) and Figure 2).

Based on Department of Natural Resources & Mines – Planning Guidelines for Water Supply and Sewerage (Chapter 5, Table A) Indicative Average Flows from Commercial/Institutional Developments:

Heavy / light industry development ADWF= 10,000 to 13,500 L/d/ha

Area of land = approx 0.5 ha
ADWF = 5,000 to 6,750 L/d (Adopt 6,750L/d to be conservative)

The FNQROC Development Manual specifies;
PWWF = 5 x ADWF = 33,750 L/d = 0.39 L/s

7.2.2 Sewage Generation from Stage 1 of the CEP

Sewage generation from Stage 1 of the Cairns Entertainment Precinct (Performance Space 1 & carparks, White's Shed & public domain spaces), is as follows;

Sewerage generation from the ultimate development of the Entertainment Precinct is based on the Hydraulic Consultant's Water and Waste Water Demand Assessment Report dated 9/12/03 (refer Appendix F).

The Hydraulic Consultant calculated sewage generation based on two different approaches, namely:

1. In terms of an Equivalent Population (EP) in accordance with Cairns Regional Council Trunk Infrastructure Planning Scheme Policy which is based on Gross Floor Area for Defined Land Uses; and

2. In terms of actual projected waste water generation based on the population expected to be working, performing and visiting the site.

However the report advises that actual projected demands based on uses is deemed to be the more accurate assessment.

Approach 1

Equivalent Population (year 2016) = 267 EP
ADWF = EP x 270L/d = 72,090L/d
PWWF = 5 x ADWF = 360,450 L/day = 4.17 L/s

Approach 2

The Hydraulics Consultant, SSP Group, state a peak waste water demand (spike) of 3.2 L/s in their report. This has been taken to be equivalent to the Peak Wet Weather Flow (PWWF).

PWWF = 3.2 L/s

<u>Total Sewage generation for existing and Stage 1</u>

Using figures of Approach 1

PWWF = 0.39 L/s + 4.17 L/s = 4.56 L/s = 393,984 L/day
ADWF = PWWF/5 = 78,797 L/day
From FNQROC Development manual;
ADWF = 270 L/EP/day
Therefore, Equivalent Population = 78,797/270 = 291.8 EP

Based on FNQROC Development Manual there are 2.8 Equivalent Persons / Equivalent Domestic Connection (EP/EDC), therefore;

EDC = 291.8 / 2.8 = 104

Using figures of Approach 2

PWWF = 0.39 L/s + 3.2 L/s = 3.59 L/s = 310,176 L/day
ADWF = PWWF/5 = 62,035 L/day
From FNQROC Development manual;
ADWF = 270 L/EP/day
Therefore, Equivalent Population = 62,035/270 = 229.8 EP

Based on FNQROC Development Manual there are 2.8 Equivalent Persons / Equivalent Domestic Connection (EP/EDC), therefore
EDC = 229.8 / 2.8 = 82

For a 150mm dia. sewer pipeline at 1:150 grade, the maximum EDC allowable in accordance with FNQROC is 259 EDC.

7.2.3 Sewage Generation from the Ultimate Development (Stages 1, 2 & 3)

Sewerage generation from the ultimate development of the Entertainment Precinct is based on the Hydraulic Consultant, SPP Group's Water and Waste Water Demand Assessment Report dated 9/12/03.

The Hydraulic Consultant calculated sewage generation based on two different approaches, namely:

1. In terms of an Equivalent Population (EP) in accordance with Cairns Regional Council Trunk Infrastructure Planning Scheme Policy which is based on Gross Floor Area for Defined Land Uses; and

2. In terms of actual projected waste water generation based on the population expected to be working, performing and visiting the site.

Approach 1

Equivalent Population (year 2016) = 267 EP (stage 1) + 23 EP (Stage 2) + 49 EP (Stage 3) =339 EP
ADWF = EP x 270L/d = 91,530L/d
PWWF = 5 x ADWF = 457,650 L/day = 5.3 L/s

Approach 2

Based on the Hydraulic Consultant's peak waste water demand (spike) in their report, this has been taken to be equivalent to the Peak Wet Weather Flow (PWWF).

PWWF = 3.2 L/s (Stage 1) + 1.1 L/s (Stage 2) + 0.85 L/s (Stage 3) = 5.15 L/s

<u>Total sewage generation for existing and Ultimate Development</u>

Using figures of Approach 1

PWWF = 0.39 L/s + 5.3 L/s = 5.69 L/s = 491,616 L/day

ADWF = PWWF/5 = 98,323 L/day
From FNQROC Development manual;
ADWF = 270 L/EP/day
Therefore, Equivalent Population = 98,323/270 = 364.2 EP

Based on FNQROC Development Manual there are 2.8 Equivalent Persons / Equivalent Domestic Connection (EP/EDC), therefore;
EDC = 291.8 / 2.8 = 130

Using figures of Approach 2

PWWF = 0.39 L/s + 5.15 L/s = 5.54 L/s = 478,656 L/day
ADWF = PWWF/5 = 95,731 L/day
From FNQROC Development manual;
ADWF = 270 L/EP/day
Therefore, Equivalent Population = 95731/270 = 355 EP

Based on FNQROC Development Manual there are 2.8 Equivalent Persons / Equivalent Domestic Connection (EP/EDC), therefore;
EDC = 355 / 2.8 = 127

<u>Total Future Sewage Generation for the Ultimate Development</u>

The SPP Group report advises increased sewage generation over future years based on a 2% average increase in visitation as outlined in the Business Case Study as follows:

	2016	2020	2025	2030	2040
Factor	1	1.082	1.195	1.318	1.607
Total EDC Approach 1	130	140	155	171	209
Total EDC Approach 2	127	137	152	167	204

For a 150mm dia. sewer pipeline at 1:150 grade, the max EDC allowable in accordance with FNQROC is 259 EDC.

Therefore a 150mm dia. sewer pipeline to service the ultimate development of the entertainment precinct (Stages 1, 2 and 3) will meet this criterion to the year 2040 and beyond.

8 WATER SUPPLY & WATER RECYCLING RETICULATION

Refer attached Cardno Drawing:DA-C08 Overall Water Reticulation Layout Plan

An existing 225mm dia. water main runs along Wharf Street adjacent to the CEP site. It is proposed to connect into this system and provide a metering point within the boundary to the Performing Arts building, and a future separate metering point to the Museum building.

A fire water booster assembly will likely be required to service the Precinct. A fire pump is unlikely to be required as the pressure on Wharf Street appears to be adequate, however Council will require confirmation of this once reviewing the water demand as estimated by the Hydraulics Consultant and updating Council's water model of the CBD to confirm pressure and flow capacity requirements.

Council have requested that water recycling infrastructure be accommodated in the project with provision for future connection to external water recycling pipes yet to be constructed by Council.

The Hydraulics Consultant has determined the water demands for the CEP development in a report titled Water and Wastewater Demand Assessment, and these have been submitted to Council in order for Council to insert into the CBD water model and confirm pressures and flows (refer Appendix F for copy of report by Hydraulics Consultant). A meeting was held with Council's Water and Waste personnel to discuss the project relating to water reticulation and expectations moving forward. While there is comfort in the proposal as put forward with respect to flows and pressures at the external water connection points, Council require confirmation of site water demands, the proposed works to support the project and the subsequent impacts on the external water reticulation.

The existing water main along the edge of the Port Road will need to be relocated outside the CEP boundary as proposed in the attached proposed water reticulation drawing. Also the existing water main through the CEP site will be relocated to the services corridor adjacent to White's Shed between Port Road and Wharf Street.

9 GAS SERVICE

There is an existing gas pipeline adjacent to the CEP site along the western side of Wharf Street. Origin has confirmed that the option to use gas is viable. The location of the service connection point will be determined during the Detailed Design Phase.

Provision of the service to the site will require a road crossing from the existing main located on the western side of Wharf Street. Origin require confirmation of what appliances (e.g. cooking appliances at the commercial kitchen, hot water, etc...) will be used by the project to determine if they would cover the cost of the new service to the site boundary. They will also require this information to provide a design of the service.

10 CONSTRUCTION MANAGEMENT OF CIVIL WORKS

There are several important issues that will impact on the construction management of the civil works. These are listed below and will require appropriate specification in the construction contract to ensure construction management achieves desirable outcomes during the construction phase.

The following construction management issues are outlined for consideration;

- The existing 'live' services that are proposed to be relocated will need to remain in operation until the new services are constructed, tested and connected.
- The Port Road construction will require appropriate management to ensure road access is maintained for Port traffic during construction. This will be particularly challenging for the raised section of road at the intersection with the realigned Southern Access Road. One option for consideration is to utilise the Wharf as an access corridor connecting back to the Port Road via the existing ramps just south of White's Shed. The construction management of these works will need to be approved by Ports North.
- The construction of the 2 x 1650mm dia. stormwater pipes, pits and outlet will require excavating below the water table and below the tide level. This will require implementation of safe work methods by the Contractor. It is recommended that these works are constructed during the Dry Season when the water table is relatively low and when there is lower chance of storm inundation of the site.
- Construction of the 2 x 1650mm dia. stormwater outlet will require the partial or total reconstruction of the northern most wharf ramp adjacent to the CEP site. As this ramp is an important access to the wharf and separated from the wharf ramp immediately to the south by a security fence on the wharf, the construction management of this work will require consultation with Ports North to ensure satisfactory temporary operation. One option if possible is to construct the outlet and rebuild the ramp outside of cruise ship days.
- Construction of the 2 x 1650mm dia. stormwater outlet through the Seawall piers which are not currently surveyed and do not line up with the exposed Wharf piers.
- Programming of certain service relocations to allow other early works to be undertaken. For example, the existing communication services adjacent to Whites Shed will need to be relocated prior to the trench excavation of the 2 x 1650mm dia. pipes along the services corridor.
- Construction of the realigned Southern Access Road will require temporary alternative access and appropriate traffic control. This can be achieved by utilising the existing Southern Access Road except for where the existing and realigned sections overlap in which case the back Port Road could be used as the sole access.
- The construction of the car park basement will require excavating below the water table. This will require implementation of safe work methods by the Contractor to provide a safe work environment. It is recommended that these works are constructed during the Dry Season when the water table is relatively low and when there is lower chance of storm inundation of the site.
- Construction works on Wharf Street will require appropriate traffic control to manage continuation of traffic operations. This is deemed achievable without major interruption by leaving at least one lane of traffic open with approved traffic controls.

11 GEOTECHNICAL OVERVIEW

A Geotechnical Desktop Study by Golders has been undertaken as part of the Concept Design Phase for the CEP project as follows;

Golder Associates “Geotechnical Desktop Study” (Ref 117672026-001 dated June 2011)
The study provides preliminary information including comments on foundation options, site preparation and earthworks, potential settlements, basement excavation and Acid Sulphate Soils.

Further geotechnical field investigation will be required in order to provide more comprehensive coverage of the subsurface soil strength parameters and acid sulphate management.

12 BULK EARTHWORKS

12.1 CONSTRAINTS ON PROCEDURES FOR PERFORMING GROUNDWORKS

There are several environmental and engineering issues which will constrain the bulk earthworks excavation.

Salient among these issues are the following:

1) The essential requirement to impose minimal impact on the external waters in performing ground works.
2) Management of acid sulphate soils by Geotechnical Engineer.
3) Method of excavation below ground water level.
4) The need to dewater excavations which extend to below ground water level.
5) Control of quality of water discharged to the environment during bulk earthworks.
6) Minimisation of groundwater drawdown.

12.2 MINIMISATION OF IMPACT ON EXTERNAL WATERS

It is proposed that impact of the ground works on the external waters of Trinity Inlet will be minimised by the following systems:

- A barrier of ground will be constantly maintained between the ground works and Trinity Inlet throughout the performance of the ground works.
- Construction of the relatively minor structural works for the stormwater outlets will be performed with appropriate erosion and sediment controls to control disposal of material in tidal water.

Early Contractor involvement is proposed to evaluate construction management of the site to confirm the above approach.

12.3 MANAGEMENT OF ACID SULPHATE SOILS

The materials expected to be encountered during excavation are described in the Geotechnical Desktop Study by Golders.

It is proposed that all excavated Actual and Potential Acid Sulphate Soils will be lime neutralised prior to their incorporation in the fill body, or, in the case of surplus materials if any, disposal off site.

A detailed Acid Sulphate Soils Management Plan for the project will need to be prepared by a Geotechnical Consultant during the Design Phase of the project.

12.4 METHOD OF EXCAVATION BELOW GROUND WATER LEVEL

It is expected that given the nature of the materials present across the site and based on advice by the Structural Engineering Consultant, the majority of the building works will be piled below the base of the building. However, the basement car park extends below existing ground surface level and will therefore require appropriate management of construction below the ground water level. It is therefore best that construction of the bulk earthworks, in particular works below the existing ground level, takes place during the dry season to minimise construction issues and costs relating to ground water management.

Other works including services trenching may require dewatering to ensure equipment access.

The rate of dewatering will be dependent on the perimeter of the dewatered area as well as the hydraulic conductivity of the subsurface soils.

The rates of dewatering are proposed to be controlled by measures such as the following.

- The areas of bulk excavations below ground water level being undertaken at a given time should be minimised.
- Should excavation to below ground water level be necessary, the excavation and construction should be undertaken in short lengths which should be individually dewatered to the minimum extent which will permit construction.

Early Contractor involvement is proposed to evaluate construction management of the site and methodology for excavation below the ground water level.

12.5 CONTROL OF QUALITY OF WATER DISCHARGED TO THE ENVIRONMENT

Groundwater will be discharged from bulk earthworks excavations in the following circumstances:

- Local dewatering for construction of basement and associated works;
- Local dewatering for construction of services trenching;
- Local dewatering for construction of stormwater outfalls;

In the case of dewatering for excavation of the car park basement or draining from the excavated material water could be discharged to sediment ponds on site.

The turbidity and pH and other parameters of the detained water should be monitored. The pH could be controlled by addition of hydrated lime or other approved chemical. The water should be detained in the ponds until its turbidity, pH and other parameters are acceptable for discharge to the external environment, and should discharge to the external environment be desirable. The acceptability of the water quality will be confirmed by testing immediately prior to its discharge to receiving waters.

Early Contractor involvement is proposed to evaluate construction management of the site and methodology for controlling water quality.

Details of proposed procedures for controlling the quality of water associated with bulk ground works should be included in the Acid Sulphate Soils Management Plan prepared by the Geotechnical Engineering Consultant.

12.6 MINIMISATION OF GROUNDWATER DRAWDOWN

It will be necessary to minimise the drawdown of groundwater levels outside the local excavations in order that PASS materials within the drawdown zone do not become partially oxidised and generate acidity.

Groundwater levels outside the excavations could be monitored by using groundwater monitoring wells as dewatering and excavation proceed if deemed necessary by the Geotechnical Engineering Consultant. Construction methodology can also influence the groundwater drawdown extent and duration, therefore involvement of the Contractor will be required as part of this assessment.

ANNEXURE A

Flooding and Storm Surge Report

Cardno
Shaping the Future

Cairns Entertainment Precinct

Flooding and Storm Surge Report

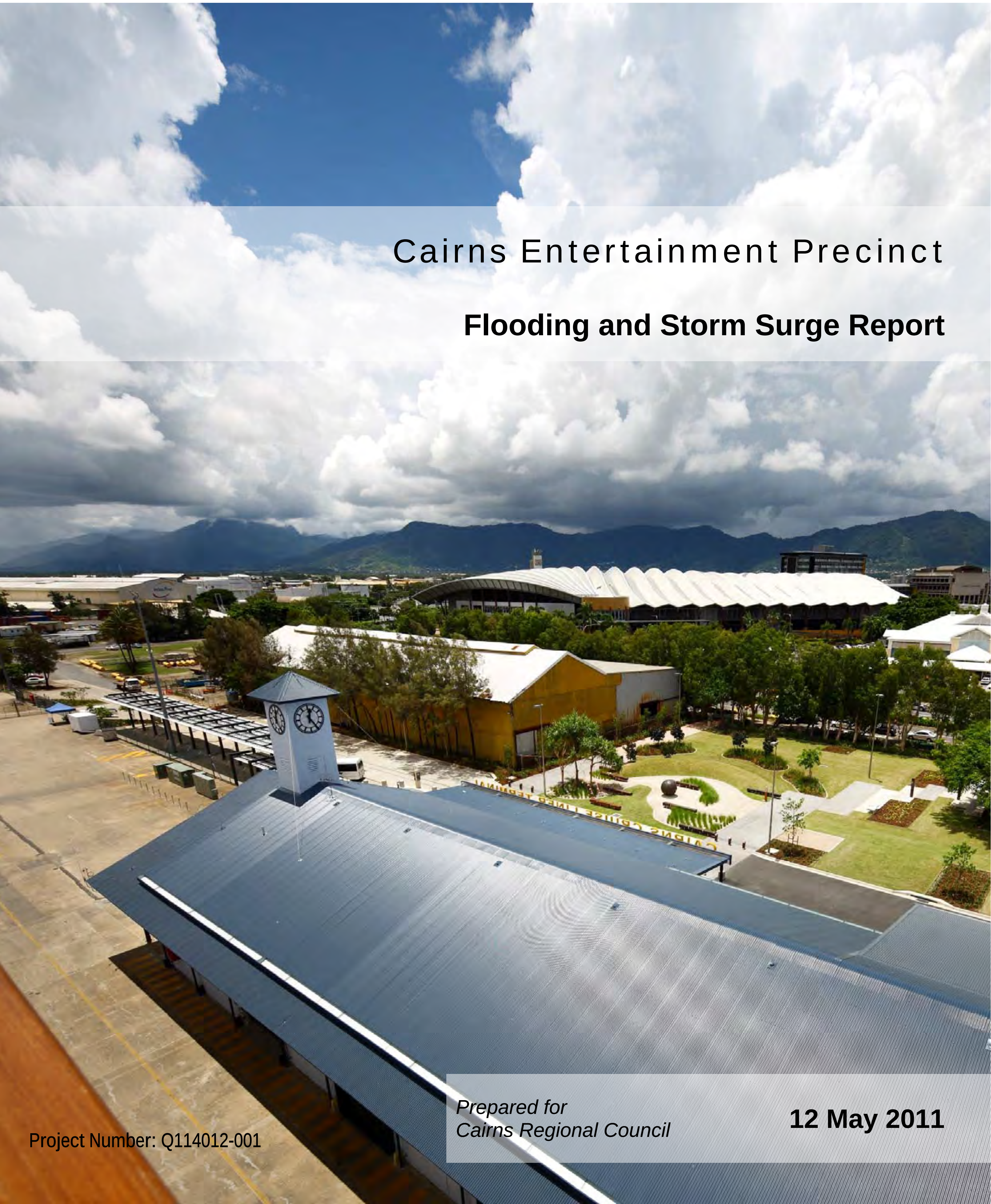


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TABLE OF CONTENTS

APPENDICES:

1 PURPOSE OF REPORT

The investigation of flood and storm surge levels in the area of a proposed site of the Cairns Entertainment Precinct (CEP) is required for the project in order to determine the floor level of the proposed buildings and car parks in accordance with a rational basis to minimise or avoid inundation.

The methodology involved has been to research the latest relevant documents which have investigated the height of sea levels in the Cairns area resulting from cyclonic activity, storm surge, green house effects and wave set up, assess the recommended minimum floor levels and review the latest reports used by the Council and other Agencies as relevant to this topic.

2 REVIEW OF EXISTING DOCUMENATION

1) CairnsPlan – Cairns Regional Council

The following items in CairnsPlan are relevant to flooding and storm tide;

a) CairnsPlan (Section 4.5.13 Cityport South Planning Area Code) – This Code specifically refers to the various Precincts within the Cityport South area, but nothing specific in relation to flooding.

b) CairnsPlan Amendment 2007 (Section 4.6.3 Flood Management Code) – Table 1 refers to "Community Uses involving access by the public" to have;
   i) fill level of immunity to 1 in 100 year ARI Flood (note, the Storm Tide Event wording is crossed out as an amendment from CairnsPlan 2005), and
   ii) floor level of immunity 1 in 100 year ARI Flood Event. No guidance is given for community services requiring post-disaster functions.

c) Included within the CairnsPlan is a Flood Inundation (ARI 100 year) overlay. The overlay indicates submergence of the surrounding area of the proposed CEP site for the ARI 100 year event.

2) State Planning Policy 1/03 : Mitigating the Adverse Impacts of Flood, Bushfire and Landslide

The State Planning Policy (SPP) sets out the State's interest in ensuring that the natural hazards of flood, bushfire and landslide are adequately considered when making decisions.

Outcome 3 of the SPP states that "wherever practicable, community infrastructure to which the SPP applies is located and designed to function effectively during and immediately after natural hazard events commensurate with a specified level of risk".

A natural hazard management area (flood) is land inundated by a Defined Flood Event (DFE) and identified in a planning scheme. The Queensland Government's position is that, generally, the appropriate flood event for determining a natural hazard management area (flood) is the 1% Annual Exceedance Probability (AEP) flood or average return interval (ARI) 100 year flood event.

The SPP defines community infrastructure as including, amongst many other things, Stores of valuable records or items of historic or cultural significance (eg galleries and libraries). Under the SPP 1/03, Cairns Regional Council is obliged to consider the risk to community infrastructure.

Appendix 9 of the SPP 1/03 recommends a solution for the specific outcome 3 for Stores of valuable items etc as having an immunity to a flood level of 0.5% AEP i.e. ARI 200.

3) Cairns CBD and Environs Drainage Management Plan – Phase 1 & Phase 2 Reports

These reports were commissioned for use by the Cairns Regional Council, revision 3 dated 18/01/00. The reports prepared by WBM Oceanics Australia are based on computer modelling of the hydrologic and hydraulic processes involved in determining the volume of stormwater run-off and the magnitude and distribution of flooding.

The computer modelling used the following as its basis for the sea level into which overland flood flows would discharge thus setting the lowest level of flooding. *"Hydrologic and hydraulic models of the catchment have been produced to model storm events and a set of criteria adopted for design purposes. A 100 year flow combined with tidal water levels, consisting of a Mean High Water Spring (MHWS) tide superimposed upon a storm surge, to produce a maximum peak of 2.4 AHD, was modelled to provide development control levels within the Chinaman Creek, Fearnley Street Drain, Saltwater Creek and CBD catchments.*

The storm tide peak of 2.4 AHD was determined in consultation with Council Officers and consists of a 2.1 AHD 100 year ocean storm tide level (JCV 1979, BPA 1984 and JCU 1992) plus an allowance of 0.3m for Greenhouse effects, wave setup (Saltwater Creek Entrance) and tidal amplification in Trinity Inlet and Smiths Creek".

The Phase 1 report states that "the storm tide peak was phased to coincide with the peak of the rainfall rather than the peak run-off which would be more conservative. It further states that combining a 100 year storm tide event with a 100 year rainfall event would give a lower probability event and is therefore conservative in that respect. The report goes on to state that as yet there is no definitive rule for combining storm tides and rainfall events, other than it is unlikely that one would occur without the other.

It is noted however that within the tidal reaches, the level of the ocean tide and the presence of a storm surge can have a major influence on flood levels.

The report provides a map of the area with calculated flood levels for various ARI events. The Q100 event based on a 2.4m AHD storm tide with the peak of the storm tide coinciding with the peak of rainfall. A plan of the ARI 100 flood levels is included in the Phase 2 report, and a copy attached in Appendix A.

In addition to determining current flood levels the report also investigated the effect of filling in the flood plain and other mitigation measures such as improving drainage capacities particularly at constrictions at road crossings.

In Appendix G to the report the Esplanade area of Cairns City was given special consideration owing to its proximity to the sea. As part of its scope the report assessed the likely level of wave set-up as 0.3m.

The report also provided the following information on anticipated future sea level rise due to climate change as follows:-

Anticipated future sea level rise (metres) relative to 1990

YEAR	LOW	BEST ESTIMATE	HIGH
2020	0.05	0.1	0.2
2050	0.10	0.2	0.4
2100	0.15	0.5	0.95

The Phase 2 Report provides the following relevant recommendations;

i) A flood immunity of ARI 100 be adopted for building floor levels with freeboard appropriate for the use. Refer Table 4.1 reproduced below.

ARI Freeboard by Land Use

	Minimum Freeboard (mm)	
	Desirable	Absolute
Residential	300	150
Commercial	150	0
Industrial	150	0
Permanent Residential Parking	0	0

ii) A plan of the ARI 100 flood levels (refer Appendix A attached), which for the CEP site shows the ARI 100 Flood Level as 2.6m AHD. This level includes the following components;

- Ocean storm tide level 2.1m AHD,
- Wave set-up 0.3m
- Mean sea level rise 0.2m

iii) Advice on immunity for underground car parking which states, *"Underground carparks will be permitted but they shall be built as tank (waterproof) structures with an effective weir height at least 300mm above ARI 100 flood level. Where this is not practical for holiday and visitor parking (for example on the entry ramp on small sites) Council may accept alternative protection measures."*

4) CBD South Drainage Upgrade (Staged Implementation Plan) – Cairns Regional Council

Council have commenced upgrade works as part of a staged implementation to the CBD drainage upgrade which includes measures to improve flood immunity of the city. These upgrade works are summarised in the plan titled CBD South Drainage Upgrade Stage Implement Plan, a copy of which is included in Appendix C. Of the 5 stages shown in this plan, Stages 1 and 2 (including 2A, 2B, 2C) have already been constructed, Stages 3 & 4 are programmed to be constructed within the next two years, and Stage 5 identified as future works.

It is noted that the proposed Stage 5 works include a drainage line through the CEP site and a pump station at the end of Grafton Street adjacent to the Convention Centre, which will need to be allowed for in the planning of the CEP project. It is understood that the future Stage 5 drainage infrastructure as shown on this Plan will accommodate the ARI 100 flow, thus this work will need to be constructed before or concurrently with the CEP development if the overland flow path through the CEP site at this location is compromised.

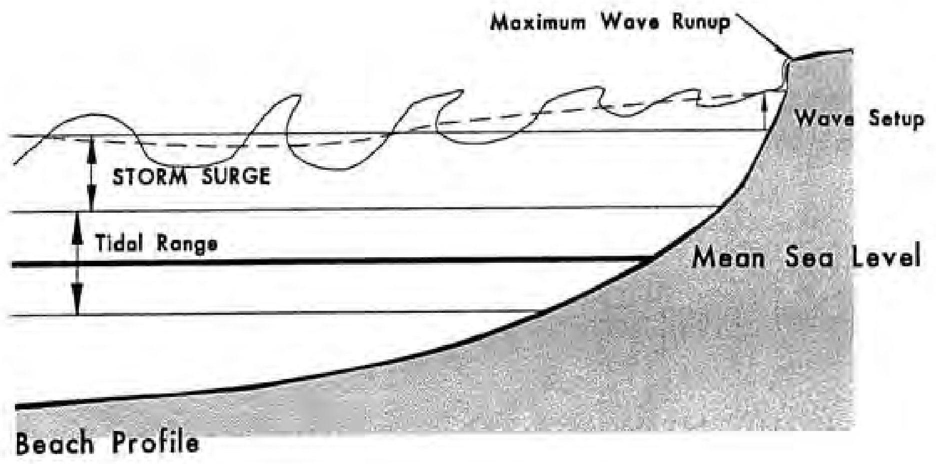
5) Storm Tide Threat in Queensland : History, prediction and relative risks

This report was authored by B. Harper of the Queensland Department of Environment and Heritage in January 1999.

Harper provides useful definitions as follows:-

HAT in the Cairns area is RL 1.78 and HAT. A storm tide is the effect on coastal water levels of a storm surge combining with the normally occurring astronomical tide. The storm surge is an atmospherically forced ocean response caused by extreme surface winds and low surface pressures associated with severe and/or persistent offshore weather systems. At exposed beachside areas, additional localised increases in water level can occur due to the effects of breaking wave set up.

These effects are indicated below.



The Harper report summarises all available reports up to the 1999 publication date and assesses the methods, risks and predictions possible from the various reports. At the time of the report all of the existing studies assumed a static mean sea level based on the present climate conditions with the exception of the JCU work by Hardy et al., 1987a where early climate change scenarios were considered in the discussion. No information was presented to indicate the extent of the allowance for climate change.

The result of Harper's report for Cairns based on Hardy et al., 1987a is as follows:-

	Storm Tide Relating to AHD (m)					Extra Wave Set-Up Allowance (m)
ARI	50	100	500	1000	10,000	
	2.2	2.5	3.2	3.5	4.5	0.5

6) Queensland Coastal Plan – March 2011

This is a new document prepared by the Queensland Government released recently but does not take legal effect until some unspecified date in mid 2011. The "Coastal Zone" is the area where the policies of the Queensland Coastal Plan apply. The coastal zone includes Queensland's coastal waters, islands and land below 10 m Australian Height Datum (or mid-tide level) or 5 km from the coast (whichever is greater).

The Qld Coastal Plan includes a 'State Planning Policy for Coastal Protection' (SPP). Needless to say, this is a complex document that may require further review and advice from a Planner. However a couple of key points to note:

- A development commitment is subject to the 'defined storm tide event' provisions of the SPP (Annex 3), attached in Appendix B. This in turn establishes the 'coastal hazard area', and development is not to occur in a coastal hazard area unless consistent with an 'adaptation strategy' prepared by the local government, or where no adaptation strategy exists, with a 'risk assessment' that indicates the development is acceptable (PO16 to PO21 of Annex 2).
- Part D of the SPP recognises acceptable circumstances for not fully achieving the policy outcomes. This includes 'overriding need in the public interest, a 'development commitment' (as referred to above) or a 'public benefit asset' (transport and other infrastructure, etc). 'Overriding need in the public interest' is broadly similar in concept, but differently defined, to the term used in the FNQ Regional Plan regulatory provisions.

The summary of salient issues are as follows;

- The site is within the coastal zone applicable to the Queensland Coastal Plan (QCP).
- The QCP has adopted an updated sea-level rise figure of 800mm by 2100.
- Previously DERM used a sea-level rise figure of 300mm by 2050.
- The storm tide event for various community services and the projected sea level rise for the year of the end of the asset life is detailed in Annex 3 of the QCP (refer Appendix B for the Queensland Coastal Plan Annex 3 Storm Tide Inundation).

7) Queensland Reconstruction Authority – Part 1 Rebuilding in Storm Tide Prone Area (Tully Heads and Hull Heads) - Draft

This Draft document is expected to be finalised mid 2011 and has been developed to support a better rebuild of homes to improve storm tide resilience. Whilst not specific to community buildings, there is some information worth considering for the CEP. The summary of salient issues are as follows;

- It mentions that the Queensland Government now requires that land use planning schemes allow for a sea level rise due to climate change of 0.8m by the year 2100 (as per Item 6 above in the Queensland Coastal Plan).
- Provides an understanding of storm surges and storm tides, including that Storm Surge + Normal Tide = Storm Tide.
- The storm surge during Cyclone Yasi raised the ocean level to more than five metres above the normal tide at Cardwell and up to three metres higher at Clump Point.
- The probability of reoccurrence is less than that adopted in the housing design criteria for cyclonic winds which is a 10% chance of occurrence within any 50 year period.

8) Cityport Infrastructure Agreement (between CRC and Ports North)

The relevant part of this Agreement in relation to flooding is to provide the following overland flow paths;

- On the extension of Grafton St, along the access corridor, as part of the road. A crest level of 2.45m AHD will be built into this overland flow path;
- On the extension of Lake St, along the access corridor, as part of the road/plaza. A crest level of 2.45m AHD will be built into this overland flow path.

It is understood that the primary intent of the crest is to provide a level of protection to the CBD from storm tide influences.

9) Impact of Sea-level Rise and Storm Surges on Coastal Resorts

This report for CSIRO Tourism research dated January 2000 is by K. M. McInnes, K.J.E. Walsh and A.B. Pittock of CSIRO Atmospheric Research.

The report investigates storm surge effects for the current climate and also a scenario of climate change due to global warming. In the latter case the calculated storm tides are adjusted by the mid range estimates for sea-level rise of 0.2m by the year 2050. Upper and lower estimates of 0.4m and 0.1m have been incorporated into the statistical range for return periods.

The predicted storm tide levels take into account the topography of the Cairns area, the tracking of cyclones, cyclone size, intensity and frequency and tides. The figures also include an allowance for wave set up.

In assessing the affect on storm tides by climate change, the authors have considered changes in cyclone intensity and frequency and sea-level rise.

The calculations are a result of a “state-of-the-art” model for storm surge. One thousand storm surge simulations were performed representing 5000 years of cyclone occurrence. Sea-level heights for various return periods under present and enhanced greenhouse climate conditions (about 2050) were obtained and are shown in the following table.

Return Period (Years)	Sea Level Height (metres)		
	Control Climate	Enhanced Greenhouse Climate (Cyclone intensity changes only)	Enhanced Greenhouse Climate (Cyclone intensity and sea-level rise)
1000	3.4 ± 0.2	3.9 ± 0.25	4.2 (+0.5/-0.4)
500	3.0 ± 0.2	3.5 ± 0.20	3.8 (+0.4/-0.3)
200	2.6 ± 0.2	3.0 ± 0.2	3.2 (+0.4/-0.3)
100	2.3 ± 0.1	2.6 ± 0.1	2.8 (+0.3/-0.2)
50	2.0 ± 0.1	2.2 ± 0.1	2.4 (+0.3/-0.2)

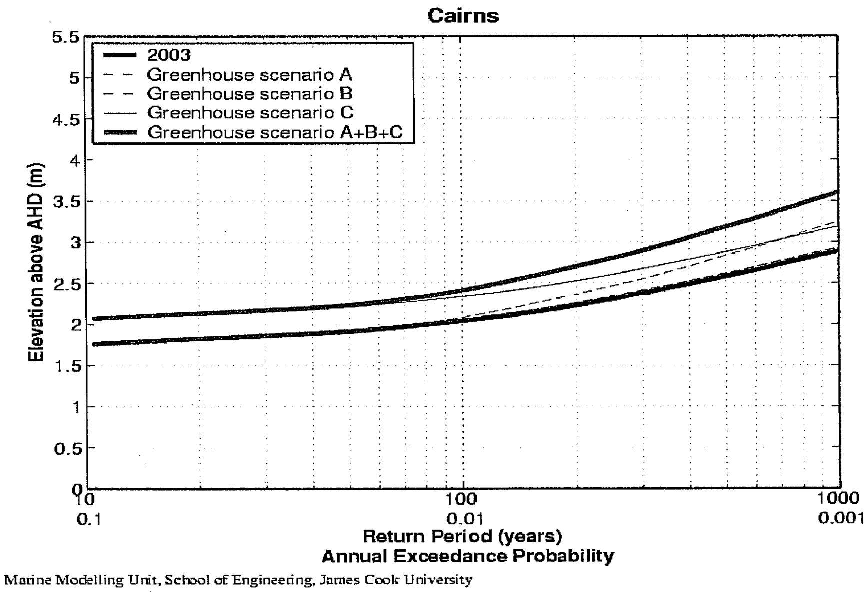
10) The Frequency of Surge Plus Tide During Tropical Cyclones for Selected Open Coast Locations along the Queensland East Coast

This study is the third in a serious of studies under the heading the *Queensland Climate Change and Community Vulnerability to Tropical Cyclones* project. The study was commissioned by the Australian Bureau of Meteorology in conjunction with the Queensland Environmental Protection Agency and was carried out by the *Marine Modelling Unit* of the School of Engineering at James Cook University.

Using a very large ensemble of synthetic tropical cyclones representing 3000 years of storms, statistics (return period) of total water level at open coast locations (i.e. overland flooding was not considered) were generated.

In addition the effect of greenhouse – induced sea-level rise, and tropical cyclone frequency and intensity changes was incorporated. Wave set-up was not included, nor was run up overtopping and overland flooding. Return period curves for storm surge plus astronomical tide for return periods between 10 and 7000 years were produced together with curves which include various greenhouse scenarios.

The curves for Cairns are reproduced below.



The effect of greenhouse climate change was investigated by testing three scenarios. These were:

(a) combined effect for an increase in maximum intensity by 10% and a poleward shift of 1.3^0;

(b) increase in frequency of tropical cyclones of 10%; and

(c) mean sea level rise of 300mm.

Thus the ARI 100 storm tide level is RL 2.1m AHD and with 0.3m greenhouse sea level rise is RL 2.4m AHD.

In general, (c) the mean sea level rise is the most important and (b) is insignificant. (a) is more significant with larger return periods. Unfortunately no information is presented as to the selection of 0.3m mean sea level rise nor the time frame involved.

The report notes that the largest storm surges predicted are not the largest possible. The probable maximum water level at a given location would be caused by a tropical cyclone of very severe coastal pressure, a large radius, a landfall point at a distance equal to the radius of the maximum winds to the North, a forward speed of the eye equal to the short wave speed offshore and the shallow water wave speed over the shelf and a tide level close to HAT.

3 SUMMARY AND COMMENTS

The below discussion should be read with consideration to the multiple building immunities that are applicable to the project. Specifically to provide an ARI 100 immunity for the Performing Arts or other commercial buildings, and an ARI 200 immunity for the Museum building.

The Queensland Coastal Plan comes into effect mid-2011 and is a legislative document. Based on this and with consideration to the type of development and planning period for each asset on the site, we consider that the requirement for a 0.8m rise in sea level to year 2100 is appropriate for the Performing Arts and Museum buildings. With regard to other commercial buildings including retail that may be located on the site, the Queensland Coastal Plan provides guidance that a 40 year planning period is suitable for this type of development. Based on this we consider that a planning period to year 2050 is appropriate for any commercial or retails buildings which corresponds to a 0.3m rise in sea level.

Of the four references reviewed on predictions of storm tide levels in Cairns, the adjusted predicted ARI 100 levels based on using the 0.8m rise in sea level from the Queensland Coastal Plan, are as follows:-

Publication Author	Storm Tide (m AHD)	Wave Set-up (m)	Greenhouse (sea level rise) (m)	Total ARI 100 (m AHD)
Harper	2.5	0.5	0.8	3.8
CSIRO	2.6	incl	0.8	3.4
JCU	2.1	0.3	0.8	3.2
CRC	2.1	0.3	0.8	3.2

The Council CBD and Environs Drainage Management Plan advises an ARI 100 level at the project site of 2.6m AHD which allows for a sea level rise of 0.2m, as compared to the 0.8m prediction in the Queensland Coastal Plan by year 2100. As the sea level at the outlets to the various drains has a direct affect on flood levels the adopted ARI 100 flood levels for Cairns should be increased by the difference, i.e. 0.6m. In relation to the wave set-up between the various publications, adopting the lesser wave height of 0.3m is considered appropriate as there will be some protection from the wharf. Therefore, by adopting the Council level in the above table which matches the JCU publication, the predicted ARI 100 level at the site would be 3.2m AHD.

The above studies and Council's requirements are all based on an immunity level with freeboard of 0.0m to 0.3m above a flood level of ARI 100 years. For the Performing Arts building the ARI 100 plus a freeboard level of 0.15m is recommended, thus giving a minimum floor level of RL 3.35m AHD. However, the State Government Planning Policy requires museums to have immunity to the ARI 200 year event.

Harper doesn't quote storm tide levels for the 200 year event, but it can be interpolated to about RL2.9m AHD. The CSIRO paper provides an ARI 200 year level of 3.2m +0.4/-0.3 based on 0.2m climate change and JCU suggest a level of 2.7m AHD based on 0.3m climate change but excluding wave set up or 3.0m AHD with a 0.3 wave set up as suggested by Harper. Using the 0.8m sea level rise by 2100 in the Queensland Coastal Plan, the difference in level for this criterion should be used to adjust the above flood levels. The following table summarises these levels for the various publications.

Publication Author	Storm Tide (m AHD)	Wave Set-up (m)	Greenhouse (sea level rise) (m)	Total ARI 200 (m AHD)
Harper	2.9	0.5	0.8	4.2
CSIRO	3.4	incl	0.8	4.2
JCU	2.4	0.3	0.8	3.5
CRC	2.3	0.3	0.8	3.4

The Australian Standard Code AS 1170 Structural Design Actions : Part O : General Principles suggests most buildings which contain contents of high value to the community be designed for an ARI 1000 wind event. If this return period was adopted, the likely ARI 1000 flood level could be about 3.9 AHD excluding sea level rise. Clearly such a level would result in high levels of submergence of much of Cairns City and presumably significant destruction due to wave action if not by the very severe effect of such an extreme cyclonic event. This should be given further consideration as to whether it would be appropriate for the Museum building for the CEP project.

The recent Cyclone Yasi event raised the ocean level to above RL 5.0m AHD on the coastline near Cardwell. The recurrence interval of this cyclone has not been confirmed and published at this stage, however the event was an extreme event and as advised in the Queensland Reconstruction Authority draft document, the probability of reoccurrence is less than that adopted in the housing design criteria for cyclonic winds which is a 10% chance of occurrence within any 50 year period. In assessing the risks and probabilities of such an event, it's not only the probability of occurrence but also the probability of occurrence at a particular location. In considering the likelihood and consequences of an event the size of Cyclone Yasi or larger reoccurring and passing through Cairns, we suggest consideration be given as to whether further assessment of this issue is required.

Regarding flood and storm tide immunity for car parking, the following advice is provided for above ground and basement parking. For above ground car parking Council requires an ARI 20 year immunity. For underground car parking the bund level protecting access into the basement shall provide a 0.3m freeboard above the ARI 100 year level as required by the Council in their drainage management plan (refer Section 2 (3) above). The same document provides the opportunity for Council to accept an "*alternative protection measure*" if the underground car parks are for visitor parking and on a constrained site which in this case applies to the CEP project, however it does not specify what alternative protection measures are acceptable nor if a lower freeboard is acceptable. We suggest further discussion with Council and the CEP Team may be required on this issue.

4 RECOMMENDATIONS

It is recommended that, based on available information as referenced in this report, a minimum floor level be adopted as follows;

- RL 3.35m AHD for the Performing Arts building that requires an ARI 100 year immunity. Note, this adopts a planning period to year 2100 for determining sea level rise, and adopts the "desirable" minimum freeboard of 0.15m as per Council requirements.
- RL 2.85m AHD for other commercial buildings or facilities including retail that requires an ARI 100 year immunity. Note, this adopts a planning period to year 2050 for determining sea level rise, and adopts the "desirable" minimum freeboard of 0.15m as per Council requirements. For some retail uses, it may be reasonable to adopt the "absolute" minimum freeboard of zero, thus reducing the minimum floor level to RL 2.7m AHD.
- RL 3.95m AHD for parts of the Museum building that stores collections or archives. This adopts the average of the range of ARI 200 year values from the publications reviewed in this report as summarised in Section 3, and is based on a planning period to year 2100 for determining sea level rise and using a 0.15m freeboard.

The planning period assumption for the Performing Arts and Museum buildings to year 2100 is an important criterion in selecting the required predicted sea level rise, and could be consider further by Council and the CEP Team as to whether a lower anticipated asset life may be appropriate. For example, if a planning period to year 2090 was adopted instead, then there would be a decrease of 0.1m in the predicted sea level rise, which lowers the minimum floor level recommendations to the Performing Arts and Museum buildings (and the bund level protection to the basement car park) by the same amount.

In relation to car parking, the following recommendations are provided;

- RL 2.1m AHD as a minimum surface level for any above ground car parks. This adopts a planning period to year 2050 for determining sea level rise.
- RL 3.5m AHD for the bund level protecting an underground car park forming a basement to the Performing Arts building. This includes a 0.3m freeboard above the ARI 100 year level as required by Council and adopts a planning period to year 2100 for determining sea level rise since the basement is part of the Performing Arts building.

In relation to parks and open space, the Council requires an immunity of ARI 5 years. The existing surface levels over the site are above the ARI 5 year flood level, therefore it is acceptable for any parks and open space to be at existing ground levels.

REFERENCES

1. Hardy, T.A., Mason, L., Astorquia, A., August 2004
   The Frequency of Surge Plus Tide During Tropical Cyclones for Selected Open Coast Locations Along The Queensland East Coast.

2. Harper, B., Queensland Department of Environments Heritage January 1999.
   Storm Tide Threat In Queensland: History, Prediction and Relative Risks.

3. Lawson & Treloar, March 2003.
   Report on Proposed Lot & Floor Levels For Cyclonic Surge/Tide/Set-Up/Run-Up. Lots 1&2 on RP 732379 and Part of Lots 4& 5 on RP 745129, Palm Cove, Cairns.

4. WBM Oceanics Australia, April 2000.
   Cairns CBD and Environs Drainage Management Plan Phase 1 – Final Report.

5. Sinclair Knight Merz, WBM Oceanics Australia, April 2000.
   Cairns CBD and Environs Drainage Management Plan Phase 2 – Report Rev 8.

6. Lawson and Treloar, March 2001.
   Cairns CBD and Environs Drainage Management Plan – Peer Review.

7. Queensland Government. Queensland Coastal Plan (Draft), April 2011.

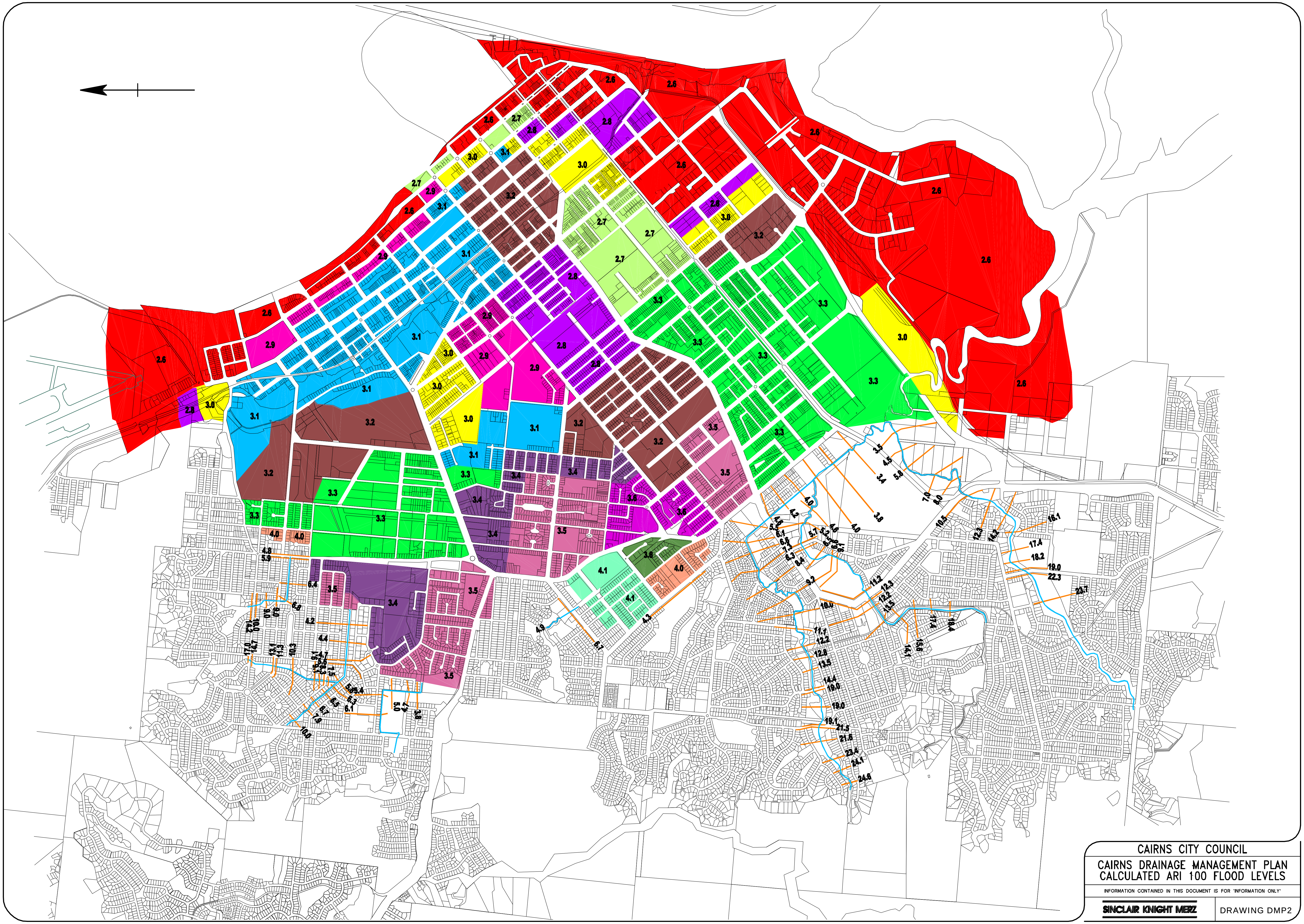
8. Queensland Government. State Planning Policy Guideline 1/03– Mitigating the Adverse Impacts of Flood, Bushfire and Landslide, June 2003.

9. Queensland Reconstruction Authority. Planning for a stronger, more resilient North Queensland – Part 1 Rebuilding in Storm Tide Prone Areas: Tully Heads and Hull Heads, April 2011 (Draft).

10. K.M. McInnes, K.J.E. Walsh and A.B. Pittock for CSIRO, January 2000.
    Impact of Sea-level Rise and Storm Surges on Coastal Resorts.

Appendix A

PLAN DMP2 OF CAIRNS CBD AND ENVIRONS DRAINAGE MANAGEMENT PLAN – PHASE 2



CAIRNS CITY COUNCIL

CAIRNS DRAINAGE MANAGEMENT PLAN
CALCULATED ARI 100 FLOOD LEVELS

INFORMATION CONTAINED IN THIS DOCUMENT IS FOR 'INFORMATION ONLY'

SINCLAIR KNIGHT MERZ

DRAWING DMP2

0 1 2 3 4 5 6 7 8 9 10 cm
FULL SIZE ON ORIGINAL

A1

Appendix B

QUEENSLAND COASTAL PLAN - ANNEX 3 STORM TIDE INUNDATION

Annex 3 – Storm-tide inundation areas

Determining storm tide areas

A3.1 The storm-tide inundation area is the area of coast inundated by the defined storm tide event (DSTE) as determined by applying:

a) For a development commitment, the minimum assessment factors outlined in table 3-1, column 1

or

b) For any other development, the assessment factors outlined in table 3-1, column 2.

Table 3-1 Assessment factors for determining erosion prone areas and storm-tide inundation areas.

Column 1	Column 2
For development subject to a development commitment	**For development not subject to a development commitment**
• Planning period equivalent to expected asset life of the development as outlined in table 3-2 • Projected sea level rise of amount outlined in table 3-3, based on expected asset life • Adoption of the 100-year average recurrence interval extreme storm event or water level • Increase in cyclone intensity by 10% (relative to maximum potential intensity) due to climate change.	• Planning period: 90 years + • Projected sea level rise of 0.8 metres by 2100 due to climate change (relative to 1990 value) • Adoption of the 100-year average recurrence interval extreme storm event or water level • Increase in cyclone intensity by 10% (relative to maximum potential intensity) due to climate change.

Table 3-2 Planning period for development subject to development commitment

Type of development	Planning period (based on anticipated asset life)
Short-term tourist accommodation	40 years
Residential dwelling, excluding unit blocks of 7+	50 years
Residential dwelling unit blocks of 7+	60 years
Industrial building	40 Years
Commercial building (retail)	40 Years
Commercial building (multiple storeys)	60 years

Table 3-3 Projected sea level rise for the year of the end of asset life as per table 3-2

Year of end of planning period	Projected sea level rise
Year 2050	0.3 metres
Year 2060	0.4 metres
Year 2070	0.5 metres
Year 2080	0.6 metres
Year 2090	0.7 metres
Year 2100	0.8 metres

A3.2 A registered professional engineer Queensland, with expertise in physical coastal processes may determine the coastal hazard area relevant to a proposed development by undertaking a storm-tide inundation assessment consistent with A3.1 and the methodology described in the coastal hazards guideline. The guideline also provides information on how a storm-tide inundation assessment may be modified to be consistent with A3.1.

A3.3 Where a relevant storm-tide inundation assessment referred to in section A3.2 has not been completed in relation to a proposed development, the coastal hazard area is taken to be all land between high water mark and a minimum default DSTE level of:

- 1.5 metres above the level of HAT for all development in South East Queensland

  or

- 2 metres above the level of HAT in the rest of Queensland for development that is not a development commitment.

Recommended storm-tide event levels for essential community service infrastructure

Table 3-4 lists recommended storm-tide event levels for essential community infrastructure (included in Community Infrastructure from Schedule 2 of the Sustainable Planning Regulation 2009).

Table 3-4

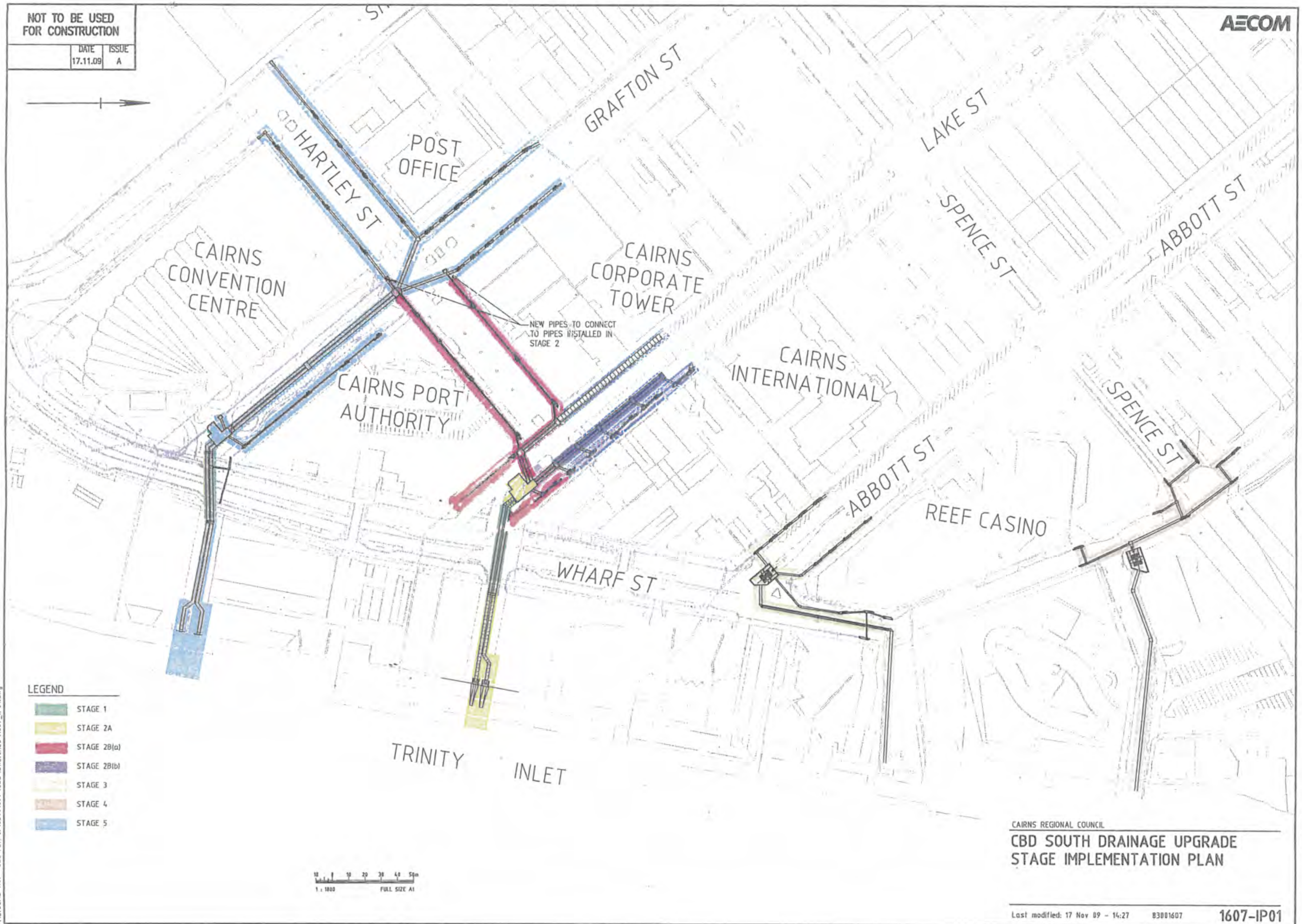
Type of infrastructure	Recommended storm-tide event level (RSTEL)
Emergency services *	0.2 % annual exceedance probability (AEP)
Emergency shelters	see reference 1*
Hospitals and associated facilities	0.2 % AEP
Major switch yards and substations *	0.5 % AEP
Police facilities *	0.5 % AEP
Power stations	0.2 % AEP
Sewerage treatment plants*	Storm-tide inundation area
School facilities	0.5 % AEP
Stores of valuable records or items of historic or cultural significance (e.g. galleries and libraries).	0.5 % AEP
Water treatment plants *	0.5 % AEP
• State controlled roads, railway lines, stations and associated facilities • Aeronautical facilities • Works of an electricity entity not otherwise listed in this table • Communication network facilities	No specific recommended storm-tide event level but development proponents should ensure that the infrastructure is optimally located and designed to achieve suitable levels of service, having regard to the processes and policies of the administering government agency.

* The RSTEL applies only to electrical and other equipment that, if damaged by floodwater or debris, would prevent the infrastructure from functioning. This equipment should either be protected from damage or designed to withstand inundation. Also some police and emergency services facilities (e.g. water police and search and rescue operations) are dependent on direct water access. The RSTELs do not apply to these aspects but other operational areas should be located above the RSTEL to the greatest extent feasible.

Reference 1* : Design guidelines for Queensland public cyclone shelter posted at ‹www.distaster.qld.gov.au›.

Appendix C

CBD SOUTH DRAINAGE UPGRADE - STAGE IMPLEMENTATION PLAN



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CAIRNS REGIONAL COUNCIL

CBD SOUTH DRAINAGE UPGRADE
STAGE IMPLEMENTATION PLAN

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Appendix D

GLOSSARY OF TERMS – EXTRACT FROM STORM TIDE THREAT IN QUEENSLAND BY HARPER

Glossary

AHD (Australian Height Datum)
This datum has been adopted by the National Mapping Council as the datum to which all vertical control for mapping is to be referred. It is approximately equivalent to Mean Sea Level (MSL).

Ambient pressure
The MSL atmospheric pressure surrounding, but not affected by, a tropical cyclone.

Astronomical tide
The periodic rising and falling of the oceans, resulting from the gravitational attraction of the moon, sun and other astronomical bodies acting upon the rotating Earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the 'tide', it is preferable to designate the latter as the tidal current or stream, reserving the name astronomical tide for the vertical movement.

Bathymetry
The measurement of depths of water in oceans, seas and lakes; also information derived from such measurements.

Continental shelf
The zone bordering a continent and extending from the tidal low water mark to a depth where there is a marked or rather steep descent toward greater depths.

Coriolis effect
The influence of the Earth's rotation that causes winds to circulate in a clockwise direction around low pressure systems in the southern hemisphere.

El Niño — southern oscillation
Large-scale natural fluctation in the global climate system that occurs irregularly and involves a close coupling of the oceans and atmosphere in the Pacific basin.

HAT (Highest Astronomical Tide)
The highest tide level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. These levels will not be reached every year, HAT generally occurring at any one location once every 18.6 years.

Inverse barometer effect
The proportional rise in water level due to the hydrostatic pressure deficit beneath a tropical cyclone or other intense weather system. The pressure deficit is the difference between the MSL ambient pressure and the MSL pressure at the centre of the tropical cyclone. The local magnitude of the rise in elevation is approximately 10mm per 1hPa of pressure deficit.

Long-wave motion
A class of surface disturbances of the sea surface whose characteristic wavelength (distance between consecutive peaks or troughs) is such that the resulting motion can be considered as nearly-horizontal in form. Long waves include the astronomical tide, storm surge and tsunamis.

Radius of maximum winds
The distance from the centre of a tropical cyclone, where winds are calm, to the point where the surface wind speeds are greatest (at the position of maximum radial pressure gradient).

Return period
Also known as average recurrence interval or ARI. The return period of an event, normally expressed in years, is the average time between successive events of equal or greater magnitude. The actual time between such events may be greater or less than this period due to the randomness of the process. The inverse of the return period is the average annual probability of exceedance, which remains constant from one year to the next, regardless of whether a given event has or has not occurred.

Sea
That portion of wave motions on the sea surface that are generated by local winds and are still in a state of absorbing the energy of the wind, which leads to a growth in wave energy.

Spring tidal range
The difference in height between MHWS (mean high water springs) and MLWS (mean low water springs). MHWS is the long term average of the heights of two successive high waters during those periods of 24 hours (approximately once per fortnight) when the range of tide is greatest, at full and new moon. MLWS is the long-term average value of two successive low waters over the same period as defined for MHWS.

Storm surge
A rise above normal water level on the open coast due to the combined effects of surface wind stress and atmospheric pressure fluctuations caused by severe weather events (e.g. tropical cyclones).

Storm tide
The combined action of storm surge and astronomical tide.

Swell
That portion of wave motions on the sea surface that have travelled away from the area of wave generation and become characteristically more regular, of longer period and with flatter crests.

Tropical cyclone
Also known as a hurricane or typhoon. An intense, large-scale low-pressure storm system of tropical origin with cyclonically rotating mean winds at the sea surface (clockwise in the southern hemisphere) in excess of gale force (63km/hr, 34kt, or 17.5m/s).

Tsunami
Japanese for "harbour wave". A transient long-period wave typically caused by an underwater disturbance such as an earthquake, volcanic eruption or landslide. Tsunami can travel very long distances across oceans and affect remote coasts, often being amplified as they enter shallow waters and are capable of causing significant inundation. Tsunami are sometimes incorrectly termed tidal waves.

Wave runup
The rush of water up against a structure or beach on the breaking of a wave. The amount of runup is the vertical height above still-water level to which the rush of water reaches. In the present report, runup is measured from the quasi-steady wave setup level.

Wave setup
A quasi-steady super-elevation of the water surface due to the onshore mass transport of water caused entirely by the action of breaking waves. Wave setup is sometimes included in calculations of wave runup.

ANNEXURE B

Minutes of Meeting 12/12/11 with Ports North - Services

MINUTES OF MEETING

Project Title	Cairns Entertainment Precinct	**Project No.**	Q114012
Meeting Place	Ports North Office (2.00pm)	**Date**	12/12/11
Recorded by	Bevan Clayton / Mark Perry	**Sheet** 1	**Of** 1
Purpose of Meeting	CEP Services	**Meeting No.**	

Attendees

Mark Perry (MP) – Cardno
Bevan Clayton (BNC) – Cardno
Michael Colleton (MC) – Ports North
Michael Martin (MM) – Ports North
Rezan (R) - GHD

Item	Description	Action By	Date Reqd
1.0	(MP) Outline of CEP services proposal for water, sewerage, road, stormwater, including relocation of existing PN services.		
2.0	(MP) Outline of CEP proposal of roadworks for Southern Access Road (realignment), Port Road and ramped intersection. Proposal for 8m wide pavement for Port Road and 7.5m wide for Southern Access Road. MM noted that roadway needs to accommodate trucks passing. (Also note item 12 below)	MP	
3.0	Sewerage – MC – PN would probably prefer separate sewer to CEP	Note	
4.0	CEP has a lease over PN land so no need for easements. Therefore can include any services access or other requirements in lease agreement.	Note	
5.0	(R) A discussion of electrical issues, relocation of communication services through the services corridor, and street lighting.	Note	
6.0	Check sewer depths	BNC/MP	
7.0	Check seawall drawings for pile locations and resolve pipe location. Lake Street doesn't have a grate	BNC	
8.0	2/900 dia join into 1 pipe. MM will check files for diameter	MM	
9.0	MM to provide photos of how Lake Street outlet is working. He indicated some scour issues at the outlet.	MM	
10.0	MM advised that some current underground pipes aren't flood gated.	MM	
11.0	MC noted that loss of flood storage due to the CEP building will cause longer inundation of Port Road. Continuity of access required during cruise ships which will need to be managed during the re-construction of this ramp.	MC	
12.0	MM noted access to northern ramp is important and is separated by security fence from the adjacent ramp to the south, therefore need to consider access continuity during ramp reconstruction. Will need ARUP to confirm turning circles to check truck movements between the new Port Road alignment and the wharf ramps.	ARUP	
13.0	Council drove RL2.45m Crest requirement and no one seems to know reason for that level. PN doesn't have any requirement. The CEP is proposing to direct overland flow through the CEP site (services corridor) at least until the Grafton St Q100 Drainage Pumps are built.	Note	
14.0	Contact Tecoma Plumbing – Trevor regarding location of store sewerage connections – 0407 969 505	BNC/MP	

ANNEXURE C

Figures to Support the Upstream Sewage Generation Calculations

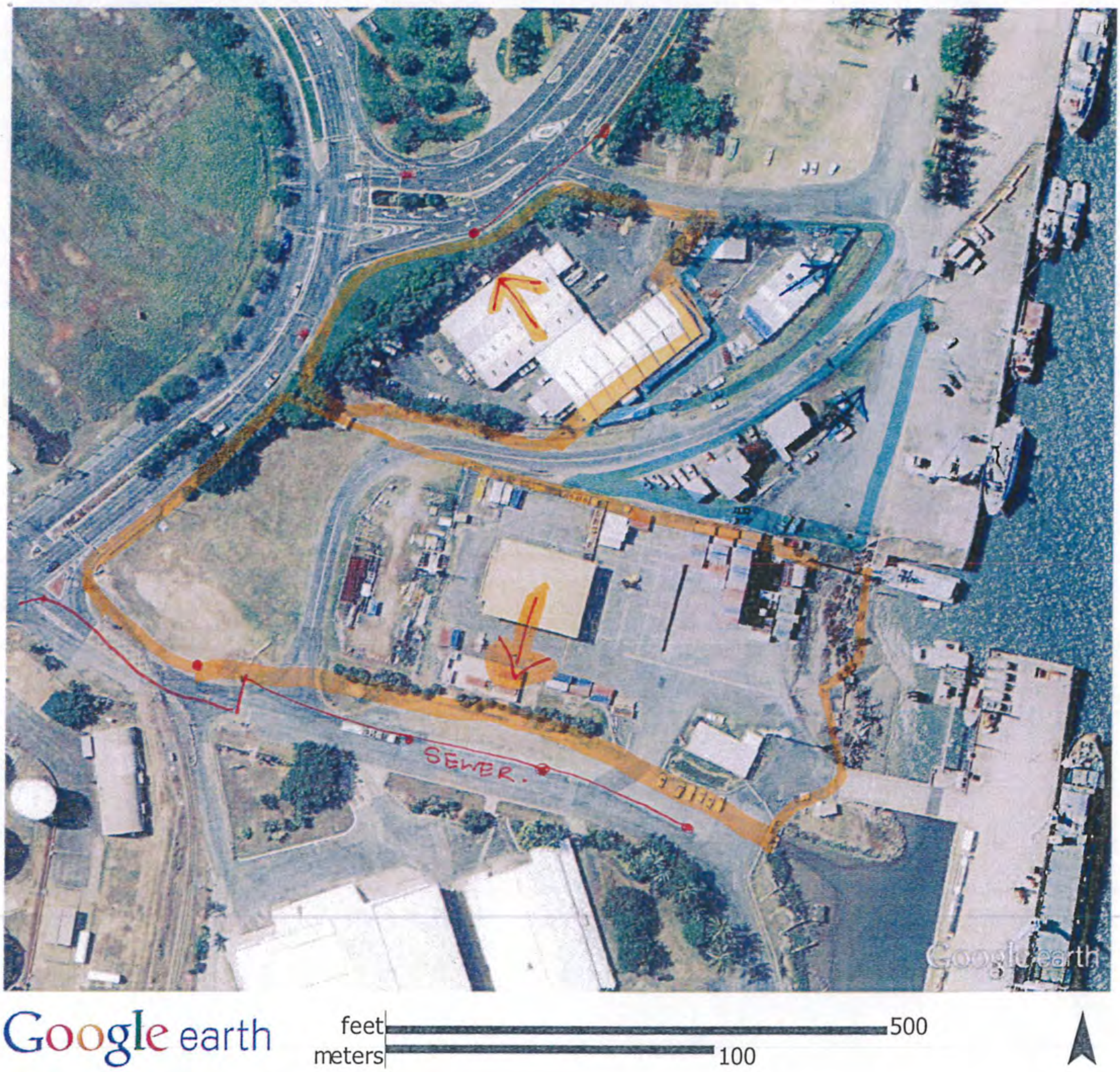
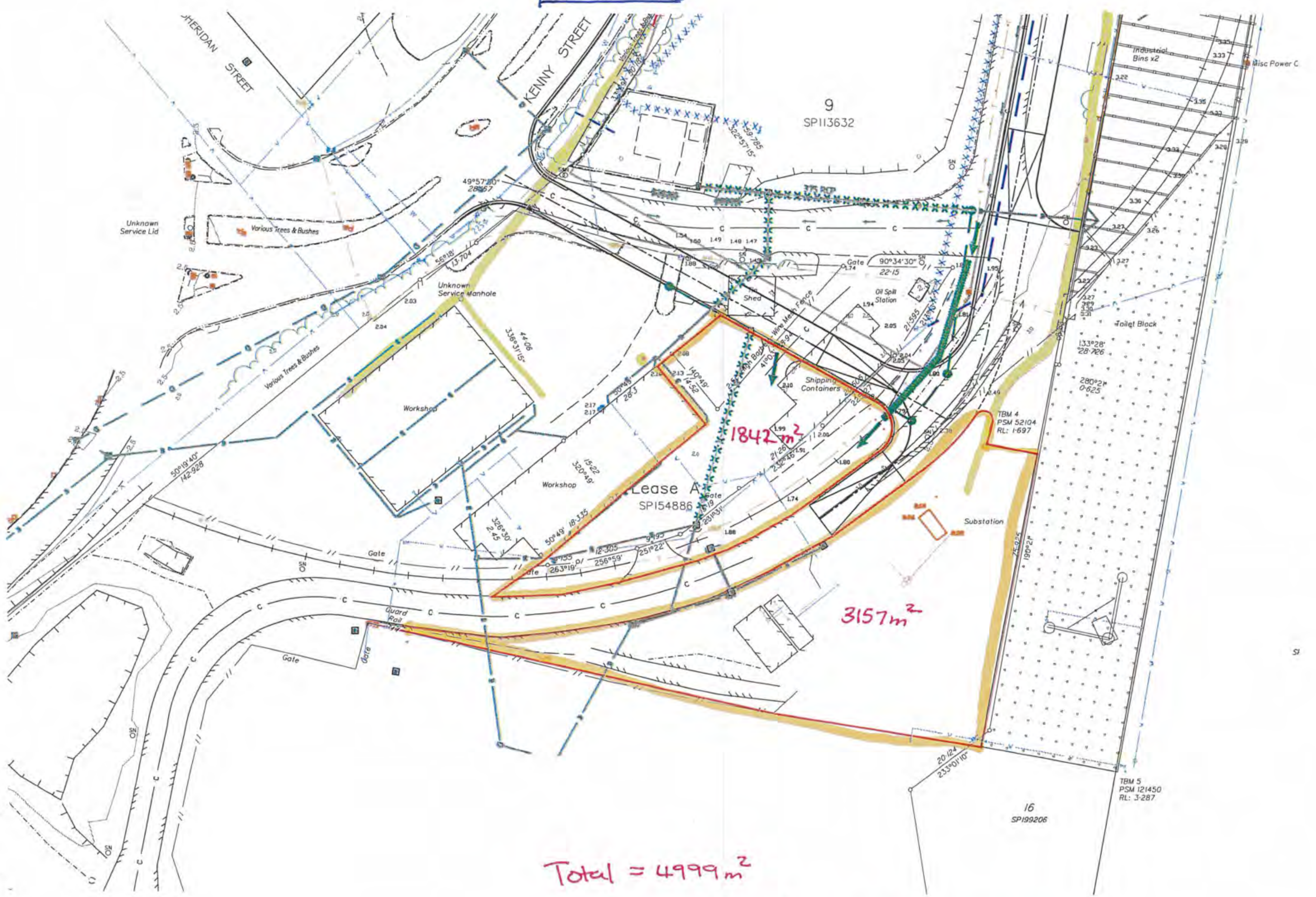


FIGURE 1

FIGURE 2



Total = 4999m²

for land serviced by sewer along wharf

ANNEXURE D

Cairns Ports Authority General Code Requirements

2.0 General Codes

2.1 Assessment & Management of Acid Sulphate Soils Code

Intent

The purpose of this code is to —

- ensure the environmental values and ecological health of receiving waters are maintained and protected; and
- identify, assess, contain and/or manage Potential Acid Sulphate Soils (PASS) and Actual Acid Sulphate Soils (AASS).

Applicability

This code applies to development within the Cityport, Seaport or Airport LAPS that —

- is exempt or assessable development;
- includes land, soil and sediment at or below 5 metres Australian Height Datum (AHD) where the natural ground level is less than 20 metres AHD;
- involves the following activities –
  - excavating or otherwise removing $5m^3$ or more of soil or sediment; or
  - filling of land involving $500m^3$ or more of material with an average depth of 0.5 metres or greater.

This code should be read in conjunction with the **Environmental Protection Code** and the **Landscape Design Code**.

Elements of the Code

Development Principles

PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
General	
P1 The release of acid and associated metal contaminants into the environment is avoided.	A1 Acid sulphate soils are not disturbed when excavating or otherwise removing soil or sediment, extracting groundwater or filling land. OR If acid sulphate soils are disturbed, they are treated and, if required, ongoing management of any disturbed acid sulphate soils and drainage waters is undertaken.

PERFORMANCE CRITERIA		ACCEPTABLE SOLUTIONS	
P2	Prior to any site works, the likelihood of AASS or PASS and the associated environmental impacts are determined.	A2.1	Sampling and analysis is carried out in accordance with the procedures described in **The Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (AASS) in Queensland** produced by the Department of Natural Resources, Mines & Water.
		A2.2	An Acid Sulphate Soil Investigation Report is submitted to and approved by the assessment manager prior to any approval. This report is to include at least the following – • the testing results; • sampling methods; • an assessment of the potential for acid sulphate soils to be disturbed either through drainage or excavation; and • potential impacts on adjoining areas. The level of testing should be commensurate with the level of risk.
P3	Where in an area of PASS or AASS, development is managed in a manner that ensures the environmental values including receiving water quality are not adversely impacted and that assets are not subject to accelerated corrosion.	A3.1	Where AASS or PASS is identified, an Acid Sulphate Soils Environmental Management Plan is prepared. The EMP is to detail at least the following – • the sampling & analysis procedures to be adopted; • the methods of treating/managing soils; • details of monitoring procedures; and • details of contingency procedures.
		A3.2	All development is to be carried out in accordance with the approved Environmental Management Plan.

2.2 Development of Flood Prone Land Code

Intent

The purpose of this code is to ensure that all development has an acceptable level of flood immunity.

Applicability

This code applies to development that is —

- exempt or assessable development; and
- in the Cityport, Seaport or Airport LAP areas.

This code should be read in conjunction with the Assessment **and Management of Acid Sulphate Soils Code** and **Landscape Design Code**.

Elements of the Code

Development Principles

PERFORMANCE CRITERIA		ACCEPTABLE SOLUTIONS	
General			
P1	Any developing involving the excavation or filling of land is carried out so as not to have a "worsening" effect on flood water levels or flow results either upstream or downstream of the development site.	A1.1	Development does not significantly alter the levels of the site AND/OR Development does not impact on downstream properties AND/OR Where sites levels are to be altered, adequate retention and retardation mechanisms are provided to ensure the quantity of water leaving the site is not increased above present volumes and flow rates.
		A1.2	Water quality measures are established to ensure the quality of water (surface and sub-surface) is of an equivalent or higher standard than presently exists.
		A1.3	A water quality monitoring program is implemented.

PERFORMANCE CRITERIA		ACCEPTABLE SOLUTIONS	
P2	All buildings and uses have a reasonable level of flood immunity.	A2	The floor level of all buildings and structures is located above Q100 flood heights. OR Where a lower level of flood immunity is required for the intended use, an appropriate floor level is provided for the use. In these circumstances, appropriate mechanisms should also be developed to manage flood events.

2.12 Works, Services & Infrastructure Code

Intent

This code is intended to ensure an appropriate level of engineering infrastructure servicing is provided to all development.

Applicability

This code applies to development that is —

- exempt or assessable development; and
- in the Cityport, Seaport or Airport LAP areas.

Elements of the Code

Development Principles

PERFORMANCE CRITERIA		ACCEPTABLE SOLUTIONS	
General			
P1	Land is adequately serviced with water, waste disposal, telecommunications and energy.	A1	All land is provided with reticulated water, sewerage, electricity and telephone services and gas services where applicable.
P2	Land is provided with internal and external drainage to an appropriate standard to minimise runoff and impacts on receiving waters.	A2.1	Internal and external stormwater management is designed in accordance with the FNQROC Development Manual and is to be consistent with the requirements of Cairns Port Authority.
		A2.2	Open paved areas for the storage or operation of mobile equipment incorporates a system to prevent contaminants or spillage entering the stormwater system.
P3	Engineering standards for land based development components meet or exceed those standards set in the FNQROC Development Manual.	A3.1	Engineering infrastructure & services are designed and constructed in accordance with the FNQROC Development Manual as required by Cairns Port Authority.
		A3.2	The relevant service authority is contacted to ascertain standards applicable to the provision of power and telecommunications.
		A3.3	The standards adopted for aviation and marine based components and infrastructure is consistent with the requirements of Cairns Port Authority.

5.0 General Seaport Codes

5.1 Seaport LAP Code

The purpose of this code is to facilitate the achievement of the following desired development outcomes for Seaport —

- ensure the safe and efficient operation of the Seaport;
- maintain acceptable levels of impact from port activities on adjoining non-industrial areas;
- ensure the waterfront development areas are utilised efficiently;
- ensure the amenity of the Seaport is maintained and enhanced; and
- ensure development balances economic, social and environmental factors to minimise adverse impacts on the community and the environment.

Applicability

These development principles apply to development that is —

- exempt or assessable development; and
- in the Seaport LAP area.

Elements of the Code

Development Principles

PERFORMANCE CRITERIA		ACCEPTABLE SOLUTIONS	
General			
P1	Planning areas adjoining the waterfront and wharfage areas are utilised primarily for port related activities.	A1	No acceptable solution provided. The applicant is to provide a solution which achieves the Performance Criteria.
P2	Public access to the Inlet and Smiths Creek is provided only where it does not impact on the operation of the port, and where it does not present a risk to personal safety.	A2	No acceptable solution provided. The applicant is to provide a solution which achieves the Performance Criteria.
P3	Development is to be designed and constructed to an engineering standard acceptable to Cairns Port Authority.	A3	Development complies with the **Works, Services & Infrastructure Code**.
P4	Development is located and carried out in a manner that separates and where necessary, provides a physical buffer to incompatible land uses.	A4	No acceptable solution provided. The applicant is to provide a solution which achieves the Performance Criteria.
P5	Development affecting land below high water mark (such as landings, ramps, berthing facilities and retaining walls) is designed and constructed according to relevant standards.	A5	Design and construction is in accordance with the requirements of the *Fisheries Act 1994*, the *Harbours Act 1955* and the *Transport Infrastructure Act 1994*.

PERFORMANCE CRITERIA		ACCEPTABLE SOLUTIONS	
Environmental & Risk Management			
P6	The design and location of any future uses minimises any potential impact on the environmental values of Trinity Inlet or Smith's Creek.	A6.1	Development complies with water quality, air quality and noise standards administered through the *Environmental Protection Act 1994*.
		A6.2	Development is undertaken in accordance with the **Environmental Protection Code**.
		A6.3	Where any use has the potential to impact on the environment, the necessary Environmental Management Plans will be prepared and approved prior to any on-site works or commencing the use.
		A6.4	Where necessary, all construction and on-site works are undertaken in accordance with an approved Environmental Management Plan for Acid Sulphate Soils.
P7	Major industrial development, or development constituting a potential safety risk or hazard, demonstrates it can meet acceptable safety standards.	A7.1	Development compiles with the **Industrial Development Code**.
		A7.2	Development complies with State Planning Policy 1/02 – Development in the Vicinity of Certain Airports and Aviation Facilities.
P8	Development is designed and located such that an acceptable level of flood immunity is provided.	A8.1	Development complies with the Development **of Flood Prone Land Code** where applicable.
P9	The disturbance of acid sulphate soils or potential acid sulphate soils is avoided or minimised.	A9.1	Development does not involve excavation works where there is potential or actual acid sulphate soils; or
		A9.2	Development complies with the **Assessment & Management of Acid Sulfate Soils Code**.
Landscaping			
P10	On-site landscaping assists in creating an attractive environment and enhancing the amenity of the area.	A10	Development complies with the **Landscaping Code**.
P11	Landscaping provides a buffer between industrial uses and non-industrial uses.	A11	Development complies with the **Landscaping Code**. Development complies with the **Industrial Development Code**.

PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Car Parking & Access	
P12 Parking facilities provide – • sufficient car parking spaces for the amount and type of vehicle traffic likely to be generated and terminated; • convenient location, easily assessable, attractive and safe to use; • appropriate design so access points are located to operate efficiently and safely and minimise conflict; and • car parking spaces are of a suitable size and dimension to meet user requirements.	A12.1 Development complies with the **Parking Code**. A12.2 No parking is located on the public road system.
P13 Premises include adequate provision for service vehicles, to cater for generated demand. Loading areas for services vehicles are designed to – • be accommodated on-site; • maximise safely and efficiency of loading; and • protect the visual and acoustic amenity of the premises and adjoining premises.	A13 Loading facilities – • are contained wholly within the premises; • are located at the rear of side of the building • are not located adjacent to residential areas; and • are provided with parking bays and manoeuvring areas for service vehicles in accordance with AS2890.2 – Parking Facilities (Off-Street Parking) Commercial Vehicle Facilities
P14 Vehicle manoeuvring areas and designed to be operationally safe and functional.	A14.1 Vehicle parking and manoeuvring areas – • are designed in accordance wit AS28901 – Car Parking Facilities (Off-Street Parking); and • provide turning circles designed in accordance with AP34/95 (Austroads 1995) Design Vehicles and Turing Path Templates. A14.2 The parking set down and manoeuvring areas are in accordance with the Traffic and Access Planning Code.

ANNEXURE E

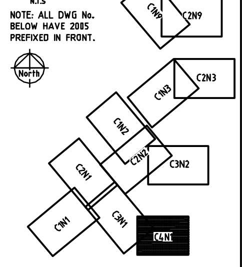
CBD South Drainage Study (2007 report) Drawing 2005C4N1 - Stormwater Drainage Plan Grafton Street System

THE LOCATIONS OF UNDERGROUND SERVICES HAVE BEEN APPROXIMATED FROM THE KNOWN POSITIONS OF VALVES, MANHOLES ETC, AND INFORMATION SUPPLIED BY THE SERVICE AUTHORITIES, AND NO RESPONSIBILITY IS TAKEN FOR THE COMPLETENESS OF THE INFORMATION SUPPLIED.

SERVICE RELOCATIONS OR NEW SERVICE INSTALLATIONS MAY OR MAY NOT BE COMPLETED AT TIME OF CONSTRUCTION AND FOR FURTHER DETAILS, REFER THE RELEVANT AUTHORITY.

POSSIBLE SERVICE CONFLICTS ARE SHOWN THUS: (E) ELECTRICAL (W) WATER (T) TELECOMS. (G) GAS (S) SEWER
NOT ALL CONFLICTS HAVE NECESSARILY BEEN SHOWN.
CONTRACTOR TO CONFIRM SERVICES ON SITE PRIOR TO EXCAVATION.

KEYPLAN
N.T.S
NOTE: ALL DWG No. BELOW HAVE 2005 PREFIXED IN FRONT.



CONTRACTOR MUST VERIFY DIMENSIONS AND EXISTING LEVELS ON SITE PRIOR TO COMMENCEMENT OF WORKS. ANY DISCREPANCIES TO BE REPORTED TO THE ENGINEER.

FOR NOTES AND LEGEND REFER TO DRAWING No. 2005LP01 AND 2005CS01.

NOT TO BE USED FOR CONSTRUCTION

DATE	ISSUE
29.03.07	1

MAUNSELL | AECOM
Maunsell Australia Pty Ltd
ABN 20 093 846 925
Consulting Engineers, Planners, Environmental Scientists & Project Managers

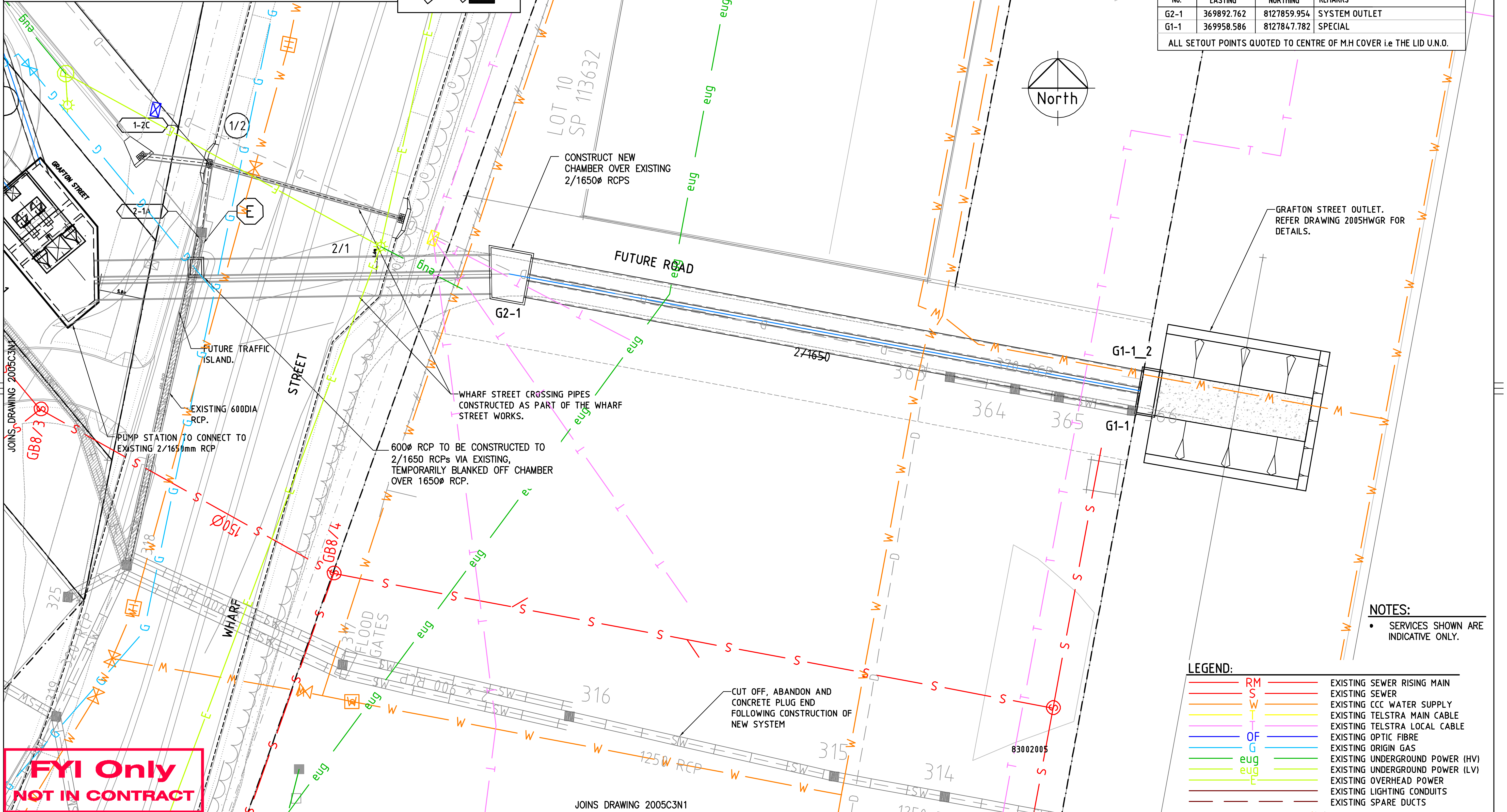
THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE MAUNSELL AUSTRALIA PTY LTD QUALITY ASSURANCE SYSTEM CERTIFIED TO AS/NZS ISO 9001-1994

	PREPARED	CHECKED	Original Signed By:	MAUNSELL JOB NUMBER
DESIGN			PASSED	83002005
DRAFTING			DATE	* DENOTES SIGNATURE ON ORIGINAL DRAWING ONLY

STORMWATER PIPE SETOUT SCHEDULE

PIT No.	EASTING	NORTHING	REMARKS
G2-1	369892.762	8127859.954	SYSTEM OUTLET
G1-1	369958.586	8127847.782	SPECIAL

ALL SETOUT POINTS QUOTED TO CENTRE OF M.H COVER i.e THE LID U.N.O.



NOTES:
- SERVICES SHOWN ARE INDICATIVE ONLY.

LEGEND:

RM	EXISTING SEWER RISING MAIN
S	EXISTING SEWER
W	EXISTING CCC WATER SUPPLY
T	EXISTING TELSTRA MAIN CABLE
T	EXISTING TELSTRA LOCAL CABLE
OF	EXISTING OPTIC FIBRE
G	EXISTING ORIGIN GAS
eug	EXISTING UNDERGROUND POWER (HV)
eug	EXISTING UNDERGROUND POWER (LV)
E	EXISTING OVERHEAD POWER
	EXISTING LIGHTING CONDUITS
	EXISTING SPARE DUCTS

FYI Only
NOT IN CONTRACT

REVISIONS

No.	DESCRIPTION	DATE	SIGN
A	ORIGINAL ISSUE		

SCALE 1:200
0 4 8 12 16 20 m
DO NOT SCALE

SURVEYED		Reviewed by Pre-Construction for compliance with client approved scope of work and budget CO-ORDINATING ENGINEER (PRE CONSTRUCTION)
DRAWN	MGC / AS	Approved for Project Delivery phase on behalf of client MANAGER PROJECT SERVICES
DESIGNED	A.S	RECOMMENDED FOR CONSTRUCTION ☐ MANAGER INFRASTRUCTURE MANAGEMENT ☐ MANAGER PRECINCTS & FACILITIES ☐ OTHER
CHECKED		
DATE		APPROVED FOR CONSTRUCTION GENERAL MANAGER CITY WORKS AND SERVICES

Initial | Date

CAIRNS CITY COUNCIL

CBD SOUTH DRAINAGE STUDY
STORM WATER DRAINAGE PLAN
GRAFTON STREET SYSTEM

NUMBER 5 OF 30 PLANS
REV.
DRAWING NUMBER / ACAD FILE No.
2005C4N1
PROJECT No. 83002005

30 Mar 07 - 09:32
2005_C4N1.DWG

ANNEXURE F

Water and Wastewater Demand Assessment Report (by SPP Group)

SPP GROUP

Hydraulic Fire Environmental

Cairns Entertainment Precinct

Wharf Street, Cairns

Water & Waste Water Demand Assessment Report

Prepared By:
SPP Group
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BRISBANE QLD 4000
Telephone: 07 3846 3077
Facsimile: 07 3844 4665
Email: brisbane@sppgroup.com.au

REPORT AUTHORISATION
PROJECT: Cairns Entertainment Precinct

Report No: BN110080

Date	Rev.	Comment	Report Prepared by	Report Checked by	Authorised by
11 Nov	01	Issue for Review	TK	DC	TK
2 Dec	02	Issue to Review	TK	DC	TK
9 Dec	03	Issue for Council Review	TK	DC	TK

This document contains commercial information which has been prepared for the attention of the Client on this project. It is confidential and no information contained in this document shall be released in part or whole to any third party without the approval of SPP Group.

Reviewed & Approved for Issue

Troy Kassulke
Director

CONTENTS

1. INTRODUCTION

1.1 General

This report, prepared by SPP Group, provides an assessment of the Water Demand and Waste Water requirements for the proposed Cairns Entertainment Precinct (CEP) – Wharf Street, Cairns.

The report has been prepared to assist the Civil Engineer in providing an assessment to Cairns Regional Council of the projected impact on the existing water and sewer loadings that the new Entertainment Precinct will impose on the proposed new system upgrades.

This report excludes any water demands for Fire Fighting Purposes. Or any demands from the existing Ports Facilities

The desktop assessment of the proposed development Water and Waste water as outlined in this report is based on the following considerations in line with the Business Case Study:

Stage 1

Performance Space 1 and Car Parks, Whites Shed, and Public Domain Spaces

Stage 2

Performance Space 2 addition

Stage 3

Museum Addition

1.2 Report Format

1.2.1 General

The report has been presented in two formats.

1. In terms of an Equivalent Population (EP) in accordance with Cairns Regional Council and Far North Queensland Regional Organisation of Councils Planning Trunk Infrastructure Guidelines which identify First Principle EDU / EP based on GFA for the development.

2. In terms of actual projected water and waste water usage based on specific assessment criteria of uses and population expected to be working, performing or visiting the site from the initial commencement of operation with an expected average annual increase of patronage of 2% in accordance with the Business Case Study.

   This section of the assessment shall:

   - Identify the average daily water demand (AD)
   - Identify the mean monthly water demand (MDMM)
   - Identify the peak flow demand in litres / second
   - Identify the Average daily sewer discharge (AD)
   - Identify the mean monthly sewer discharge (MDMM)
   - Identify the peak sewer discharge in litres/second

The report shall generally focus on the actual projected demands based on the uses as this is deemed to be a more accurate assessment.

1.3 Assessment Criteria

1.3.1 Cairns Regional Council (CRC)

The report has adopted the following CRC first principle basis points.

- Defined Land Use : Place of Assembly
- Unit of Measure: 275 sqm GFA
- Water Supply Demand: 1.0 (EDU) / Unit of Measure
- Waste Water Demand: 1.0 (EDU) / Unit of Measure
- 1 EDU: Equates to 2.8 EP's

1.3.2 Far North Queensland Regional Organisation of Council (FNQROC)

The report has adopted the following FNQROC first principle basis points.

Water Reticulation

- Aver Daily Consumption (AD) : 500l / person / day
- Mean day Max Month MDMM: 1.5 x AD
- Peak Day: 2.25 x AD
- Peak Hour: 1/12 x AD

Sewerage System

- Aver Dry Weather Flow (ADWF) : 270l / EP / day
- Peak Wet Weather Flow (PWWF) : 5 x ADWF
- Peak Dry Weather Flow (PDWF) : C2 x ADWF

1.3.3 Site Specific Demand Principles

Water is utilised and sewer discharge generated by the following processes within the proposed development:

- Potable Requirements for onsite personnel use – The use of water for potable water purposes i.e. water closet flushing, drinking, personal hygiene and general personnel hygiene cleaning requirements and the associated wastewater generated by these processes;
- Food Process Requirements – The use of water in the cooking and cleaning and waste water generated by these processes.
- Mechanical Plant Cooling Waters and the associated waste waters.

Demand for relevant / specific uses and anticipated population numbers are as follows:

Stage 1 - Performance Arts Venue (PAV Space 1), Whites Shed, Public Domain Spaces.

Full Time Staff Numbers and Hours of Operation for PAV Space 1:

- 34 persons

Average Performer Numbers:

- Average 75 performers
- Average Musicians 25 person
- Average 25 Stage and BOH support crew

Stage 1 PAV Patron Numbers:

- Performance Space 1 - 1,000 Seat Venue
- Annual Visitation of Performing Arts Venue - 130,000 persons (2016)
- Annual Visitation of Whites Shed - 115,000 persons (2016)

Stage 2 - Performance Arts Venue (Space 2)

Stage 2 PAV Patron Numbers:

- Performance Space 2 - Additional 450 Seat Venue
- Annual Visitation of Performing Arts Venue - Additional 70,000 persons

Average Performer numbers generally for PAV:

- Average 25 performers
- Average 10 Stage and BOH support crew

Stage 3 Museum

Full Time Staff Numbers and Hours of Operation for PAC:

- 10 persons
- Annual Visitation of Museum - 300,000 persons

2. WATER SERVICES DEMAND

2.4 Water Demand Based on Authority Planning Guidelines

Based on technical requirements form the Cairns Regional Council trunk Infrastructure Planning Scheme Policy and FNQROC Development Manuals for Water Reticulation the potable water demand has been expressed as an Equivalent Population (EP) assessed by the Gross Floor Area (GFA) for Defined Land Uses (DFU) and the corresponding Water Supply Demand (WSD) for the development which has been determined as follows;

2.4.1 Stage 1

Performance Space 1 and Car Parks, Whites Shed, Public Domain Spaces.

DFU	GFA	Unit of Measure / WSD	Equivalent Demand Units	Equivalent Population
PAV Stage 1	21,400 m2	@ 1.0 / 275m2	78 EDU	218 EP
Whites Shed	1,500m2	@ 1.0 / 275m2	5.5 EDU	15 EP
Public Spaces	3,350m2	@ 1.0 / 275m2	12 EDU	34 EP
Totals	**26,250m2**	**@ 1.0 / 275m2**	**94.5 EDU**	**267 EP**

2.4.2 Stage 1 Average Daily Water Demand (AD)

Average Daily Water Demand (AD) = EP x 500l / person

= 267 x 500l / person = 133,500 L / day

2.4.3 Stage 1 Mean Day Maximum Month (MDMM)

Mean Day Maximum Month (MDMM) 1.5 x AD = 200,250 L / day

2.4.4 Stage 1 Peak Day (PD)

Peak Day (PD) 2.25 x AD = 300,375 L / day

2.4.5 Stage 1 Peak Hour (PH)

Peak Hour (PH) 1/12 x AD = 11,125 L / hr

2.4.6 Stage 2

Performance Space 2 addition

DFU	GFA	Unit of Measure / WSD	Equivalent Demand Units	Equivalent Population
PAV Stage 2	2,000 m2	@ 1.0 / 275m2	7.2 EDU	23 EP

2.4.7 Stage 2 Average Daily Water Demand (AD)

Average Daily Water Demand (AD) = EP x 500l / person

= 23 x 500l / person = 11,500 L / day

2.4.8 Stage 2 Mean Day Maximum Month (MDMM)

Mean Day Maximum Month (MDMM) 1.5 x AD = 17,250 L / day

2.4.9 Stage 2 Peak Day (PD)

Peak Day (PD) 2.25 x AD = 25,875 L / day

2.4.10 Stage 2 Peak Hour (PH)

Peak Hour (PH) 1/12 x AD = 960 L / hr

2.4.11 Stage 3

Museum

DFU	GFA	Unit of Measure / WSD	Equivalent Demand Units	Equivalent Population
Museum	4,385 m2	@ 1.0 / 275m2	15.9 EDU	49 EP

2.4.1 Stage 3 Average Daily Water Demand (AD)

Average Daily Water Demand (AD) = EP x 500l / person

= 49 x 500l / person = 24,500 L / day

2.4.2 Stage 3 Mean Day Maximum Month (MDMM)

Mean Day Maximum Month (MDMM) 1.5 x AD = 36,750 L / day

2.4.3 Stage 3 Peak Day (PD)

Peak Day (PD) 2.25 x AD = 55,125 L / day

2.4.4 Stage 3 Peak Hour (PH)

Peak Hour (PH) 1/12 x AD = 2041 L / hr

2.4.5 Projected Forecast for Stage 1

Based on a 2% average increase in visitation to the precinct as outlined in the business case study the Performance Space 1 and Car Parks, Whites Shed, and Public Domain Spaces could expect the follow EP demands.

Total Equivalent Population at 2016	2020	2025	2030	2040
267 EP	289 EP	319 EP	352 EP	429 EP

2.4.1 Projected Stage 1 Average Daily Water Demand (AD)

Average Daily Water Demand (AD) 2020 = 289 x 500l / person = 144,500 L / day

Average Daily Water Demand (AD) 2025 = 319 x 500l / person = 159,500 L / day

Average Daily Water Demand (AD) 2030 = 352 x 500l / person = 176,000 L / day

Average Daily Water Demand (AD) 2040 = 429 x 500l / person = 214,500 L / day

2.4.2 Projected Stage 1 Mean Day Maximum Month (MDMM)

Mean Day Maximum Month (MDMM) 2020 1.5 x AD = 216,750 L / day

Mean Day Maximum Month (MDMM) 2025 1.5 x AD = 239,250 L / day

Mean Day Maximum Month (MDMM) 2030 1.5 x AD = 264,000 L / day

Mean Day Maximum Month (MDMM) 2040 1.5 x AD = 321,750 L / day

2.4.3 Projected Stage 1 Peak Day (PD)

Peak Day (PD) 2020 2.25 x AD = 325,125 L / day

Peak Day (PD) 2025 2.25 x AD = 358,875 L / day

Peak Day (PD) 2030 2.25 x AD = 396,000 L / day

Peak Day (PD) 2040 2.25 x AD = 482,625 L / day

2.4.4 Projected Stage 1 Peak Hour (PH)

Peak Hour (PH) 2020 1/12 x AD = 12,040 L / hr

Peak Hour (PH) 2020 1/12 x AD = 13,290 L / hr

Peak Hour (PH) 2020 1/12 x AD = 14,666 L / hr

Peak Hour (PH) 2020 1/12 x AD = 17,875 L / hr

2.5 Water Demand Based on Specific Project Assessment Criteria

The potable water demand is assessed by the number of full time persons and Guests expected to visit the complex on average, the volumes of water each person uses on average, the equipment utilised for the production of meals and the cleaning of same, and the general daily cleaning parameters carried out to maintain the facility.

The development has been provided with a 350KL rainwater storage tank as required under the QDC Requirements for Toilet flushing and Wash down purposes. This tank when factored in to calculations, effectively removes the peak water demand brought on by Patrons and performer uses during large events. The daily volume for toilet flushing and wash down however is still included in calculations as the rainwater will not be available all year round and shall be topped up off the potable towns mains supply during dryer months.

2.6 Stage 1 Average Daily Water Demand (AD)

2.6.1 PAV - Patron Daily Water Demand

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 360 persons / Guests has been determined.

The Total Daily Potable Water Demand for Patron Drinking / Food Prep and Toilet flushing is determined to be 25 litres / Person / Day.

Therefore daily Patron use is as follows: 360 x 25l / person = **9,000 L / day**

2.6.2 PAV – Performer and Support Personnel Daily Water Demand

The average daily performer and support personnel expectancy of 125 persons has been determined.

The Total Daily Potable Water Demand for Performers and support Crew for Drinking / Food Prep / Personal Hygiene and Toilet flushing is determined to be 25-45 litres / Person / Day.

Therefore daily Performer and Support Personnel use is as follows:

Performers	75 x 45l / person = 3,375 L / day
Support Personnel	50 x 25l / person = 1250 L / day
Total	= **4,625 L / day**

2.6.3 PAV - Full Time Staff Daily Water Demand

Full Time Staff of 34 persons has been determined in the Business Case Study.

The Total Daily Potable Water Demand for Full Time Administration and Maintenance Staff for drinking / food prep and toilet flushing is determined to be 25 litres / Person / Day.

Therefore daily full time Admin and Maintenance Staff use is as follows:

34 x 25l / person = **850 L / day**

2.6.4 PAV - General Cleaning Water Demand

Based on a weekly cleaning regime with expected work patterns during daily shifts it has been determined that the Average Daily Water Demand for General Cleaning to be:

= 1500 L / day

2.6.5 PAV- Cooking Water Demand

Water use for patrons, performers and staff drinking and food preparation has been incorporated into the per person rate in other sections.

2.6.6 PAV- Cooling Tower Water Demand

Water use for Mechanical Plant and Equipment used for the conditioning of room temperatures has been estimated to be:

= 4,500 L / day

2.6.7 Whites Shed - Patron Daily Water Demand

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 300 persons has been determined.

The Total Daily Potable Water Demand for Patron drinking / cooking and toilet flushing is determined to be 15 litres / Person / Day.

Therefore daily Patron use is as follows:

300 x 25l / person = **7,500 L / day**

Note: Provision for new fixtures have not been incorporated into the Whites Shed Refurbishment due to Heritage listing constraints. The area will be serviced from facilities in the Lower Plaza Area.

2.6.8 Whites Shed - Full Time Staff Daily Water Demand

Full Time Staff for Whites Shed has been incorporated in to the PAV calculations.

2.6.9 Whites Shed - General Cleaning Water Demand

Based on a weekly cleaning regime with expected work patterns during daily shifts it has been determined that the Average Daily Water Demand for General Cleaning to be:

= **450 L / day**

2.6.10 Public Space - General Cleaning Water Demand

Based on a weekly cleaning regime with expected work patterns during daily shifts it has been determined that the Average Daily Water Demand for General Cleaning to be:

= **750 L / day**

Note: Provisions for Irrigation demand have not been incorporated into the Public Space Areas as all irrigation shall be provided by Rainwater Harvesting and storage. Potable water shall not be used for top up.

2.6.11 Stage 1 - Total Average Daily Water Demand (AD)

User	PAV	Whites Shed	Public Spaces
Patron	9,000 L	7,500 L	NA
Performers	4,625 L	NA	NA
Full Time Staff	850 L	NA	NA
General Cleaning	1500 L	750 L	450 L
Cooling Towers	4,500 L	NA	NA
Sub- Totals	**20,475 L**	**8,250 L**	**450 L**
Totals (AD)	**29,175 L / Day**		

2.6.12 Stage 1 - Projected Forecast

Based on a 2% average increase in visitation to the precinct as outlined in the business case study the Performance Space 1 and Car Parks, Whites Shed, and Public Domain Spaces could expect the follow increase in average Daily Water Demands. (AD)

Daily Average water Demand 2016	2020	2025	2030	2040
29,175 L	31,580 L	34,870 L	38,500 L	46,950 L

2.7 Stage 1- Average Continuous Water Demand

Based on the above considerations the continuous rate of water flow to be expected based on the average daily demand can be expressed as follows:

:

$$Q(l/s) = \frac{\text{Average Daily Demand x 1.5(Demand Factor)}}{\text{10 hrs x 3600}}$$

$$= \frac{439763}{36000}$$

$$= 1.22\ l/s$$

It can therefore be determined that the average continuous rate of flow for potable water is **1.2 litres / second.**

2.8 Stage 1- Maximum Peak Water Demand

Based on the above considerations the peak rate of water flow to be expected based on the average daily demand can be expressed as follows:

$$Q(l/s) = \frac{\text{Average Daily Demand x 4.22(Peak Factor)}}{\text{10hr x 3600}}$$

$$= \frac{123120}{36000}$$

$$= 3.4 \text{ l/s}$$

It can therefore be determined that the maximum continuous peak rate of flow for potable water is **3.4 litres / second.**

Note As previously noted the development has been provided with a large rainwater storage tank as required under the QDC Requirements for Toilet flushing and Wash down purposes. This tank when factored in to calculations, effectively provides a buffer tank and removes the spikes in water demand brought on by Patron and Performer Toilet Flushing during large events.

2.9 Stage 2 - Average Daily Water Demand (AD)

2.9.1 PAV Performance Space 2 - Patron Daily Water Demand

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 200 persons has been determined.

The Total Daily Potable Water Demand for Patron drinking / Food Prep and Toilet flushing is determined to be 15 litres / Person / Day.

Therefore daily Patron use is as follows: 200 x 25l / person = **5,000 L / day**

2.9.2 PAV Performance Space 2 - Performer & Support Personnel Daily Water Demand

The average daily performer and support personnel expectancy of persons has been determined.

The Total Daily Potable Water Demand for Performers and support Crew for Drinking / Food Prep / Personal Hygiene and Toilet flushing is determined to be 25-45 litres / Person / Day.

Therefore daily Performer and Support Personnel use is as follows:

Performers	25 x 45l / person = 1,125 L / day
Support Personnel	10 x 25l / person = 250 L / day
Total	= **1,375 L / day**

2.9.3 PAV Space 2 - Cooling Tower Water Demand

Water use for Mechanical Plant and Equipment used for the conditioning of room temperatures has been estimated to be:

= **1,500 L / day**

2.9.4 Stage 2 - Total Average Daily Water Demand (AD)

User	PAV Space 2
Patron	5,000 L
Performers	1,375 L
Cooling Towers	1,500 L
Totals	**7,875 L / Day**

2.10 Stage 2- Average Continuous Water Demand

Based on the above considerations the continuous rate of water flow to be expected based on the average daily demand can be expressed as follows:

: $$Q(l/s) = \frac{\text{Average Daily Demand x 1.5(Peak Factor)}}{\text{10hr x 3,600}}$$

$$= \frac{11812}{36,000}$$

$$= 0.33\ l/s$$

It can therefore be determined that the maximum continuous peak rate of flow for potable water is **0.35 litres / second.**

2.11 Stage 2 - Maximum Peak Water Demand

Based on the above considerations the max peak rate of water flow to be expected based on the average daily demand can be expressed as follows:

: $$Q(l/s) = \frac{\text{Average Daily Demand x 4.22(Peak Factor)}}{\text{10 x 3,600}}$$

$$= \frac{33,232}{36,000}$$

$$= 0.92\ l/s$$

It can therefore be determined that the maximum continuous peak rate of flow for potable water is **0.95 litres / second.**

2.12 Stage 1 and 2 – Combined Average Continuous Water Demand

Based on the above considerations for the combined Stage 1 and 2 developments the maximum continuous peak rate of flow for potable water is **1.55 litres / second.**

2.13 Stage 1 and 2 – Combined Maximum Peak Water Demand

Based on the above considerations for the combined Stage 1 and 2 developments the maximum peak rate of flow for potable water is **4.40 litres / second.**

2.14 Stage 3 - Average Daily Water Demand (AD)

2.14.1 Museum - Patron Daily Water Demand

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 850 persons has been determined.

The Total Daily Potable Water Demand for Patron drinking and Toilet flushing is determined to be 4.5 litres / Person / Day.

Therefore daily Patron use is as follows: 850 x 4.5l / person = **3,850 L / day**

2.14.2 Museum - Full Time Staff Daily Water Demand

Full Time Staff of 7 persons has been utilised for this Study.

The Total Daily Potable Water Demand for Full Time Administration and Maintenance Staff for drinking / food prep and toilet flushing is determined to be 25 litres / Person / Day.

Therefore daily full time Admin and Maintenance Staff use is as follows:

7 x 25l / person = **175 L / day**

2.14.3 Museum - General Cleaning Water Demand

Based on a weekly cleaning regime with expected work patterns during daily shifts it has been determined that the Average Daily Water Demand for General Cleaning to be:

= **500 L / day**

2.14.4 Museum - Cooling Tower Water Demand

Water use for Mechanical Plant and Equipment used for the conditioning of room temperatures has been estimated to be:

= **3,000 L / day**

2.14.5 Museum – Total Daily Water Demand

User	PAV Space 2
Patron	3,850 L
Staff	175 L
General Cleaning	500 L
Cooling Towers	3,000 L
Totals	**7,525 L / Day**

2.15 Stage 3 – Average Continuous Water Demand

Based on the above considerations the average continuous rate of water flow to be expected based on the average daily demand can be expressed as follows:

$$Q(l/s) = \frac{\text{Average Daily Demand} \times 1.5(PF)}{10 \times 3{,}600}$$

$$= \frac{11{,}287}{36{,}000}$$

$$= 0.31 \text{ l/s}$$

It can therefore be determined that the anticipated maximum continuous peak rate of flow for potable water is **0.30 litres / second.**

2.16 Stage 3 - Maximum Peak Water Demand

Based on the above considerations the peak rate of water flow to be expected based on the average daily demand can be expressed as follows:

$$Q(l/s) = \frac{\text{Average Daily Demand} \times 4.22(PF)}{10 \times 3{,}600}$$

$$= \frac{31{,}755}{36{,}000}$$

$$= 0.88 \text{ l/s}$$

It can therefore be determined that the anticipated maximum continuous peak rate of flow for potable water is **0.90 litres / second.**

2.17 Stage 1, 2 and 3 – Combined Average Continuous Water Demand

Based on the above considerations for the combined Stage 1, 2 and 3 developments the maximum continuous peak rate of flow for potable water is : **1.85 litres / second.**

2.18 Stage 1, 2 and 3 – Combined Maximum Peak Water Demand

Based on the above considerations for the combined Stage 1, 2 and 3 developments the maximum peak rate of flow for potable water is : **5.3 litres / second.**

Note 1: As previously noted the development has been provided with a large rainwater storage tank as required under the QDC Requirements for Toilet flushing and Wash down purposes. This tank when factored in to calculations, effectively provides a buffer tank and removes the spikes in water demand brought on by Patron and Performer Toilet Flushing during large events

Note 2: As previously noted Provisions for Irrigation demand have not been incorporated as all irrigation shall be provided by Rainwater Harvesting and storage. Potable water shall not be used for top up.

2.19 Stage 1 - Mean Potable Water Monthly Demand (MDMM)

2.19.1 Stage 1 - Average Monthly Water Demand

Based on the above considerations the Mean Monthly Water Demand (MDMM) during the initial year of commencement can be expressed as follows:

Q = Av. Daily Water Demand x 30 days / month

= 29,175 x 30

= 875,250 litres / month

It can therefore be determined that the Mean Monthly Water Demand is **875 KL / month.**

2.19.2 Stage 1 – Projected Average Monthly Water Demand

Monthly Average water Demand 2016	2020	2025	2030	2040
875 KL	947 KL	1045 KL	1154 KL	1407 KL

2.20 Stage 2 - Mean Potable Water Monthly Demand (MDMM)

2.20.1 Stage 2 - Average Monthly Water Demand

Based on the above considerations the Mean Monthly Water Demand (MDMM) during the initial year of commencement can be expressed as follows:

Q = Av. Daily Water Demand x 30 days / month

= 7,875 x 30

= 236,250 litres / month

It can therefore be determined that the Mean Monthly Water Demand is **236 KL / month.**

2.21 Stage 3 - Mean Potable Water Monthly Demand (MDMM)

2.21.1 Stage 3 - Average Monthly Water Demand

Based on the above considerations the Mean Monthly Water Demand (MDMM) during the initial year of commencement can be expressed as follows:

Q = Av. Daily Water Demand x 30 days / month

= 7,525 x 30

= 225,750 litres / month

It can therefore be determined that the Mean Monthly Water Demand is **226 KL / month.**

3. WASTEWATER SERVICES

3.22 Waste Water Flow Based on Authority Planning Guidelines

Based on technical requirements form the Cairns Regional Council trunk Infrastructure Planning Scheme Policy and FNQROC Development Manuals for Sewer Reticulation the waste water flow has been expressed as an Equivalent Population (EP) assessed by the Gross Floor Area (GFA) for Defined Land Uses (DFU) and the corresponding Waste Water Flow (WWF) for the development which has been determined as follows;

3.22.1 Stage 1

Performance Space 1 and Car Parks, Whites Shed, Public Domain Spaces.

DFU	GFA	Unit of Measure	Equivalent Demand Units	Equivalent Population
PAV Stage 1	21,400 m2	@ 1.0 / 275m2	78 EDU	218 EP
Whites Shed	1,500m2	@ 1.0 / 275m2	5.5 EDU	15 EP
Public Spaces	3,350m2	@ 1.0 / 275m2	12 EDU	34 EP
Totals	**26,250m2**	**@ 1.0 / 275m2**	**94.5 EDU**	**267 EP**

3.22.2 Stage 1 Average Dry Weather Flow (ADWF)

Average Daily Waste Water Flow = EP x 270l / person

= 267 x 270l / person = 72,090 L / day

3.22.3 Stage 1 Peak Wet Weather Flow (PWWF)

Peak Wet Weather Flow 5 x ADWF = 360,450 L / day

3.22.4 Stage 2

Performance Space 2 addition

DFU	GFA	Unit of Measure	Equivalent Demand Units	Equivalent Population
PAV Stage 2	2,000 m2	@ 1.0 / 275m2	7.2 EDU	23 EP

3.22.1 Stage 2 Average Dry Weather Flow (ADWF)

Average Daily Waste Water Flow = EP x 270l / person

= 23 x 270l / person = 6,210 L / day

3.22.2 Stage 2 Peak Wet Weather Flow (PWWF)

Peak Wet Weather Flow 5 x ADWF = 31,050 L / day

3.22.3 Stage 3

Museum

DFU	GFA	Unit of Measure	Equivalent Demand Units	Equivalent Population
Museum	4,385 m2	@ 1.0 / 275m2	15.9 EDU	49 EP

3.22.4 Stage 3 Average Dry Weather Flow (ADWF)

Average Daily Waste Water Flow = EP x 270l / person

= 49 x 270l / person = 13,230 L / day

3.22.5 Stage 3 Peak Wet Weather Flow (PWWF)

Peak Wet Weather Flow 5 x ADWF = 66,150 L / day

3.22.6 Projected Forecast for Stage 1

Based on a 2% average increase in visitation to the precinct as outlined in the business case study the Performance Space 1 and Car Parks, Whites Shed, and Public Domain Spaces could expect the follow EP demands.

Total Equivalent Population at 2016	2020	2025	2030	2040
267 EP	289 EP	319 EP	352 EP	429 EP

3.22.7 Projected Stage 1 Average Daily Waste Water Flow (ADWF)

Average Daily Waste Water Flow (ADWF) 2020 = 289 x 270l / person = 78,030 L / day

Average Daily Waste Water Flow (ADWF) 2025 = 319 x 270l / person = 86,130 L / day

Average Daily Waste Water Flow (ADWF) 2030 = 352 x 270l / person = 95,040 L / day

Average Daily Waste Water Flow (ADWF) 2040 = 429 x 270l / person = 115,830 L / day

3.22.8 Projected Stage 1 Peak Wet Weather Flow (PWWF)

Peak Wet Weather Flow (PWWF) 2020 5 x ADWF = 390,150 L / day

Peak Wet Weather Flow (PWWF) 2025 5 x ADWF = 430,650 L / day

Peak Wet Weather Flow (PWWF) 2030 5 x ADWF = 475,200 L / day

Peak Wet Weather Flow (PWWF) 2040 5 x ADWF = 579,150 L / day

3.23 Waste Water Flow Based on Assessment Criteria

The waste water flow is assessed by the number of persons in the building and the volumes of waste water each person uses on average, the equipment utilised for the production of meals and the cleaning of same, and the general daily operational and cleaning parameters carried out to maintain the facility.

The calculation takes in to consideration a percentage of water use which shall be lost through the following uses:

- Drinking Water
- Cooking
- General Cleaning
- Evaporation at Cooling Towers

3.24 Stage 1 Average Daily Waste Water Flow (AD)

3.24.1 PAV - Patron Daily Waste Water Flow

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 360 persons has been determined.

The Total Daily Waste Water Demand for Food Prep and Toilet flushing is determined to be 12.5 litres / Person / Day.

Therefore daily Patron use is as follows: 360 x 20l / person = **7,200 L / day**

3.24.2 PAV – Performer and Support Personnel Daily Waste Water Flow

The average daily performer and support personnel expectancy of 125 persons has been determined.

The Total Daily Waste Water Demand for Performers and support Crew for Food Prep / Personal Hygiene and Toilet flushing is determined to be 20- 42.5 litres / Person / Day

Therefore daily Performer and Support Personnel use is as follows:

Performers	75 x 42.5l / person = 3,188 L / day
Support Personnel	50 x 20l / person = 1000 L / day
Total	= **4,188 L / day**

3.24.3 PAV - Full Time Staff Daily Waste Water Flow

Full Time Staff of 34 persons has been determined in the Business Case Study.

The Total Daily Waste Water Demand for Full Time Administration and Maintenance Staff for food prep and toilet flushing is determined to be 22.5 litres / Person / Day.

Therefore daily full time Admin and Maintenance Staff use is as follows:

34 x 22.5l / person = **765 L / day**

3.24.4 PAV - General Cleaning Waste Water Flow

Based on a weekly cleaning regime with expected work patterns during daily shifts it has been determined that the Average Daily Waste Water Demand for General Cleaning to be:

= 750 L / day

3.24.5 PAV- Cooking Waste Water Flow

Waste Water discharged for patrons, performers and food preparation has been incorporated into the per person rate in other sections.

3.24.6 PAV- Cooling Tower Waste Water Flow

Waste Water use for Mechanical Plant and Equipment used for the conditioning of room temperatures has been estimated to be:

= 3,000 L / day

3.24.7 Whites Shed - Patron Daily Waste Water Flow

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 300 persons has been determined.

The Total Daily Waste Water Demand for Patron cooking and toilet flushing is determined to be 15 litres / Person / Day.

Therefore daily Patron use is as follows:

300 x20l / person = **6,000 L / day**

Note: Provision for new fixtures have not been incorporated into the Whites Shed Refurbishment due to Heritage listing constraints; however the area will be serviced from facilities in the Lower Plaza Area.

3.24.8 Whites Shed - Full Time Staff Daily Waste Water Flow

Full Time Staff for Whites Shed has been incorporated in to the PAV calculations.

3.24.9 Stage 1 - Total Average Daily Waste Water Flow (ADWF)

User	PAV	Whites Shed	Public Spaces
Patron	7,200 L	6,000 L	NA
Performers	4,188 L	NA	NA
Full Time Staff	765 L	NA	NA
General Cleaning	750 L	450 L	NA
Cooling Towers	3,000 L	NA	NA
Sub- Totals	**15,903 L**	**6,450 L**	**NA**
Totals	**22,353 L / Day**		

3.24.10 Stage 1 - Projected Forecast Waste Water Flow

Based on a 2% average increase in visitation to the precinct as outlined in the business case study the Performance Space 1 and Car Parks, Whites Shed, and Public Domain Spaces could expect the follow increase in average Daily Waste Water Flow. (ADWF)

Daily Average Waste Water Flow 2016	2020	2025	2030	2040
22,350 L	24,200 L	26,720 L	29,500 L	35,960 L

3.25 Stage 1- Estimated Continuous Waste Water Flow

Based on the above considerations the estimated continuous rate of waste water flow to be expected based on the average daily demand can be expressed as follows:

:

$$Q(l/s) = \frac{\text{Average Daily Flow x 1.5(PF)}}{\text{10hr x 3,600}}$$

$$= \frac{33{,}530}{36{,}000}$$

$$= 0.93 \text{ l/s}$$

It can therefore be determined that the Average continuous rate of flow for Waste water is **1.0 litre / second.**

3.26 Stage 1- Estimated Spike / Peak Waste Water Demand

The operational nature of the completed CEP will create regular spikes in waste water demand during major events.

Internal House Drainage lines shall be sized to accommodate the spike discharges created by toilet and urinal waste streams associated with interval and end of event use.

Allowing for peak occupancy numbers and diversity of operation, and drain time for waste streams to accumulate in internal house drainage networks prior to discharge at the sewer connection the estimated flows when the facility is at peak demand shall be:

Performance Space 1 Spike Waste Water Flow: **3.2 litres / second.**

This spike in estimated waste water demand and shall occur for approximately 20-30 minutes and is based on worst case scenario of a full venue with 65% of patrons using the amenities during intervals and or at the end of events. The Performance Space and Whites shed would not necessarily expect spike loads in the same manner hence only worst case venue being the performance space has been included.

3.27 Stage 2 - Average Daily Waste Water Flow (ADWF)

3.27.1 PAV Performance Space 2 - Patron Daily Waste Water Flow

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 200 persons has been determined.

The Total Daily Waste Water Demand for Patron Food Prep and Toilet flushing is determined to be 12.5 litres / Person / Day.

Therefore daily Patron use is as follows: 200 x 20 l / person = **4,000 L / day**

3.27.2 PAV Performance Space 2 - Performer & Support Personnel Daily Waste Water Flow

The average daily performer and support personnel expectancy of persons has been determined.

The Total Daily Waste Water Demand for Performers and support Crew for Drinking / Food Prep / Personal Hygiene and Toilet flushing is determined to be 20 - 42.5 litres / Person / Day.

Therefore daily Performer and Support Personnel use is as follows:

Performers 25 x 42.5l / person = 1063 L / day

Support Personnel 10 x 20 l / person = 200 L / day

Total = **1,188 L / day**

3.27.3 PAV Space 2 - Cooling Tower Waste Water Demand

Waste Water flow for Mechanical Plant and Equipment used for the conditioning of room temperatures has been estimated to be:

= 1,000 L / day

3.27.4 Stage 2 - Total Average Daily Waste Water Demand (AD)

User	PAV Space 2
Patron	4,000 L
Performers	1,263 L
Cooling Towers	1,000 L
Totals	**6,263 L / Day**

3.28 Stage 2- Estimated Continuous Waste Water Flow

Based on the above considerations the estimated continuous rate of waste water flow to be expected based on the average daily demand can be expressed as follows:

$$Q(l/s) = \frac{\text{Average Daily Flow x 1.5(PF)}}{\text{10hr x 3,600}}$$

$$= \frac{9394}{36,000}$$

$$= 0.26 \text{ l/s}$$

It can therefore be determined that the Average continuous rate of flow for Waste water is **0.3 litres / second.**

3.29 Stage 2- Estimated Spike / Peak Waste Water Demand

The operational nature of the completed CEP will create regular spikes in waste water demand during major events.

Internal House Drainage lines shall be sized to accommodate the spike discharges created by toilet and urinal waste streams associated with interval and end of event use.

Allowing for peak occupancy numbers and diversity of operation, and drain time for waste streams to accumulate in internal house drainage networks prior to discharge at the sewer connection the estimated flows when the facility is at peak demand shall be:

Performance Space 2 Spike Waste Water Flow: **1.1 litres / second.**

3.30 Stage 1 and 2 – Combined Average Waste Water Flow

Based on the above considerations for the combined Stage 1 and 2 developments the Average continuous rate of flow for Waste water is **1.3 litres / second.**

3.31 Stage 1 and 2 – Combined Peak Waste Water Flow

Based on the above considerations for the combined Stage 1 and 2 developments the maximum continuous peak rate of flow for Waste water is **4.3 litres / second.**

3.32 Stage 3 Average Daily Waste Water Flow

3.32.1 Museum - Patron Daily Waste Water Flow

Based on the annual expected visitation in the initial year of operation, an average daily patron expectancy of 850 persons has been determined.

The Total Daily Waste Water Flow for Patron Toilet flushing is determined to be 3.0 litres / Person / Day.

Therefore daily Patron Waste Water is as follows: 850 x 3.0l / person = **2,550 L / day**

3.32.2 Museum - Full Time Staff Daily Waste Water Flow

Full Time Staff of 7 persons has been utilised for this Study.

The Total Daily Waste Water Flow for Full Time Administration and Maintenance Staff for food prep and toilet flushing is determined to be 22.5 litres / Person / Day.

Therefore daily full time Admin and Maintenance Staff Waste Water is as follows:

7 x 22.5l / person = **158 L / day**

3.32.3 Museum - General Cleaning Water Flow

Based on a weekly cleaning regime with expected work patterns during daily shifts it has been determined that the Average Daily Waste Water Demand for General Cleaning to be:

= **400 L / day**

3.32.4 Museum - Cooling Tower Water Flow

Waste Water for Mechanical Plant and Equipment used for the conditioning of room temperatures has been estimated to be:

= 1 980 L / day

3.32.5 Museum – Total Daily Water Flow

User	**Museum**
Patron	2,550 L
Staff	158 L
General Cleaning	400 L
Cooling Towers	1,980 L
Totals	**5,088 L / Day**

3.33 Stage 3 – Estimated Continuous Waste Water Flow

Based on the above considerations the average continuous rate of waste water flow to be expected based on the average daily flow can be expressed as follows:

:

$$Q(l/s) = \frac{\text{Average Daily Flow x 1.5(AD)}}{10 \times 3{,}600}$$

$$= \frac{21{,}471}{36{,}000}$$

$$= 0.212 \text{ l/s}$$

It can therefore be determined that the anticipated maximum continuous average rate of flow for Waste water is **0.23 litres / second.**

3.34 Stage 1, 2 and 3 – Combined Continuous Waste Water Flow

Based on the above considerations for the combined Stage 1, 2 and 3 developments the average continuous rate of flow for waste water is **1 .53 litres / second.**

3.35 Stage 1 - Mean Waste Water Monthly Flow (MWWMF)

3.35.1 Stage 1 - Average Monthly Waste Water Flow

Based on the above considerations the Mean Monthly Waste Water Flow (MWWMF) during the initial year of commencement can be expressed as follows:

Q = Av. Daily Waste Water Flow x 30 days / month

= 22,350 x 30

= 670,500 litres / month

It can therefore be determined that the Mean Monthly Water Demand is **670 KL** / **month**.

3.35.2 Stage 1 – Projected Average Monthly Waste Water Demand

Monthly Average water Demand 2016	2020	2025	2030	2040
670 KL	725 KL	800 KL	883 KL	1077 KL

3.36 Stage 2 - Mean Waste Water Monthly Flow (MWWMF)

3.36.1 Stage 2 - Average Monthly Waste Water Flow

Based on the above considerations the Mean Monthly Waste Water Flow (MWWMF) during the initial year of commencement can be expressed as follows:

Q = Av. Daily Water Demand x 30 days / month

= 6,263 x 30

= 187,890 litres / month

Therefore the Estimated Mean Monthly Waste Water Flow is **188 KL** / **month**.

3.37 Stage 3 - Mean Monthly Waste Water Flow (MWWMF))

3.37.1 Stage 3 - Average Monthly Waste Water Flow

Based on the above considerations the Mean Monthly Waste Water Flow (MWWMF) during the initial year of commencement can be expressed as follows:

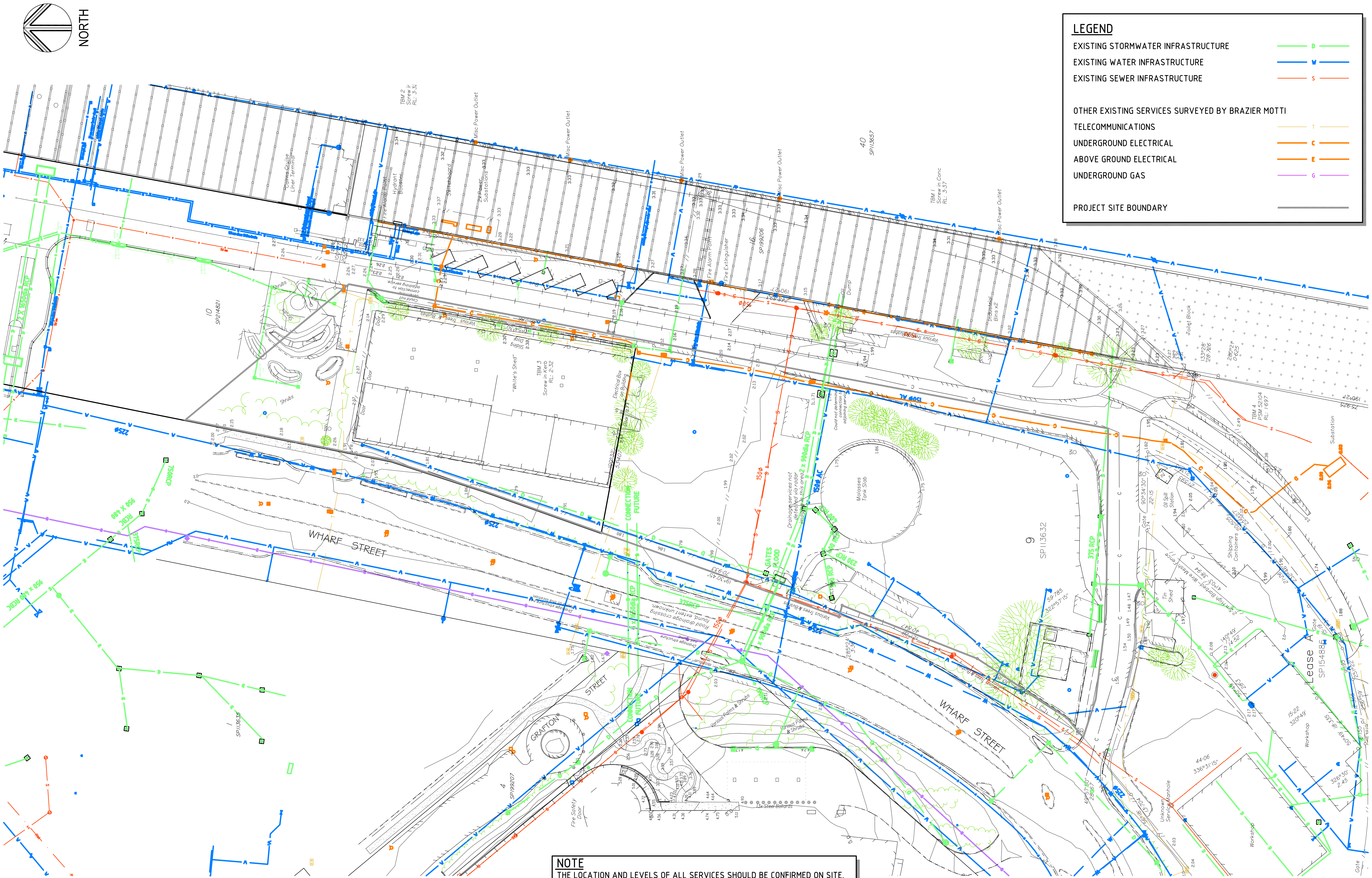
Q = Av. Daily Waste Water Demand x 30 days / month

= 5,088 x 30

= 152,640 litres / month

Therefore the Estimated Mean Monthly Waste Water Flow is **153 KL** / **month**.

CARDNO DRAWINGS



LEGEND

EXISTING STORMWATER INFRASTRUCTURE	D
EXISTING WATER INFRASTRUCTURE	W
EXISTING SEWER INFRASTRUCTURE	S
OTHER EXISTING SERVICES SURVEYED BY BRAZIER MOTTI	
TELECOMMUNICATIONS	T
UNDERGROUND ELECTRICAL	C
ABOVE GROUND ELECTRICAL	E
UNDERGROUND GAS	G
PROJECT SITE BOUNDARY	

NOTE
THE LOCATION AND LEVELS OF ALL SERVICES SHOULD BE CONFIRMED ON SITE.
CONTACT LOCAL AND UTILITY AUTHORITIES PRIOR TO COMMENCING ANY WORKS.

NOT FOR CONSTRUCTION

10 5 0 10 20 30 40m
SCALE: 1:500 AT A1, 1:1000 AT A3

CAD FILE :H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C00-03.dwg Mar 07, 2012 - 1:42pm XREF's: x Base DD 114012-001; x CCLT Services Base 114012-001; x CCLT As Con Services; x Survey 114012-001; x Arch Base DD 114012-001

ISSUE	DATE	DESCRIPTION / APPROVED USE	REV'D	APP'D
03	29.02.12	RE-ISSUED WITH ENGINEERING REPORT	MAP	MAP
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01	16.01.12	PRELIMINARY ISSUE	MAP	MAP

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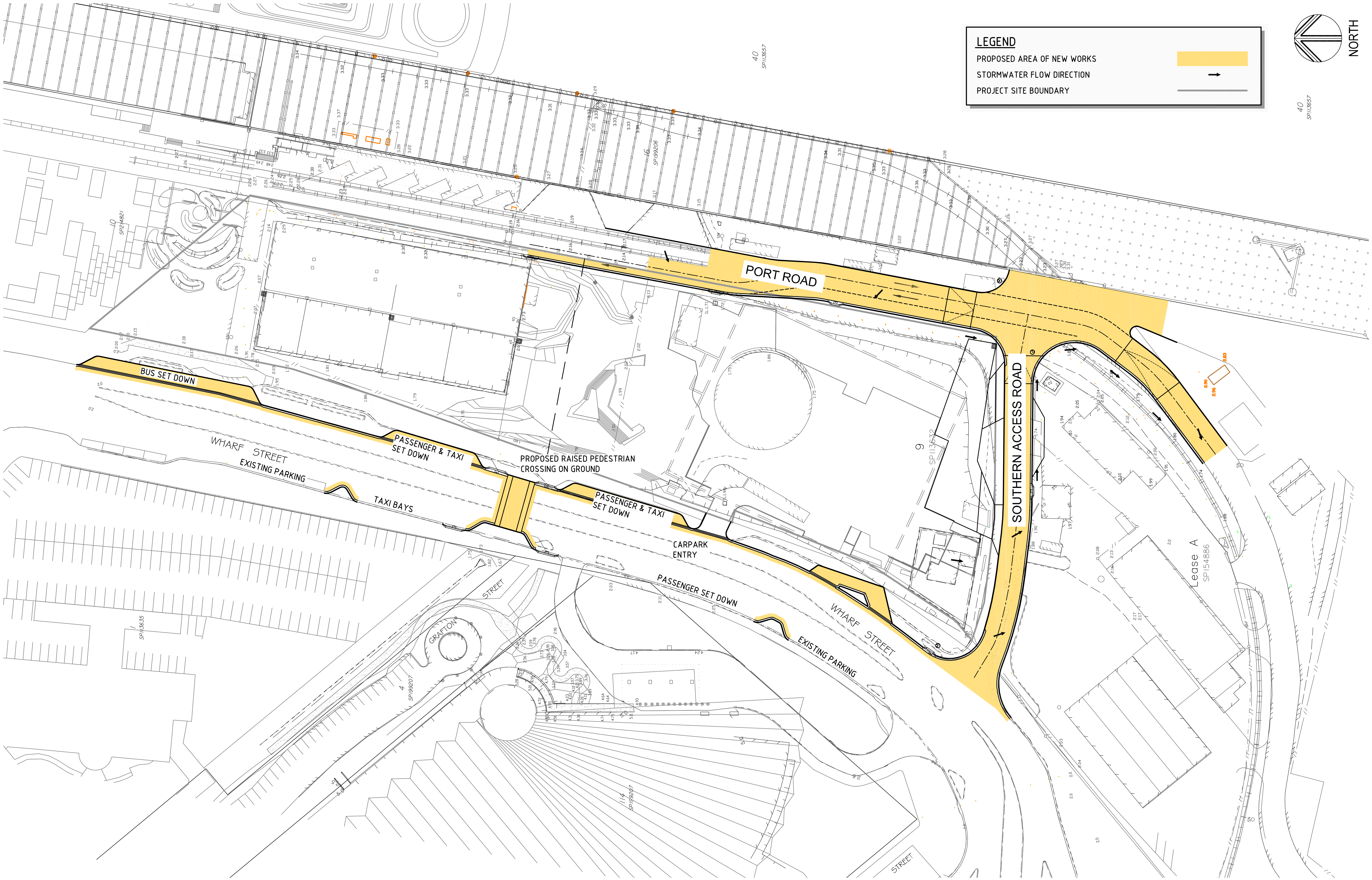
PROJECT CAIRNS ENTERTAINMENT PRECINCT, WHARF STREET, CAIRNS
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)
TITLE EXISTING SERVICES PLAN

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C00	03



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SCALE: 1:500 AT A1, 1:1000 AT A3

CAD FILE :H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C01-04.dwg Mar 14, 2012 - 3:10pm XREF's x Base DD 114012-001 x CCLT Services Base 114012-001 x CCLT As Con Services x Survey 114012-001 x Arch Base DD 114012-001

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CAIRNS ENTERTAINMENT PRECINCT, WHARF STREET, CAIRNS
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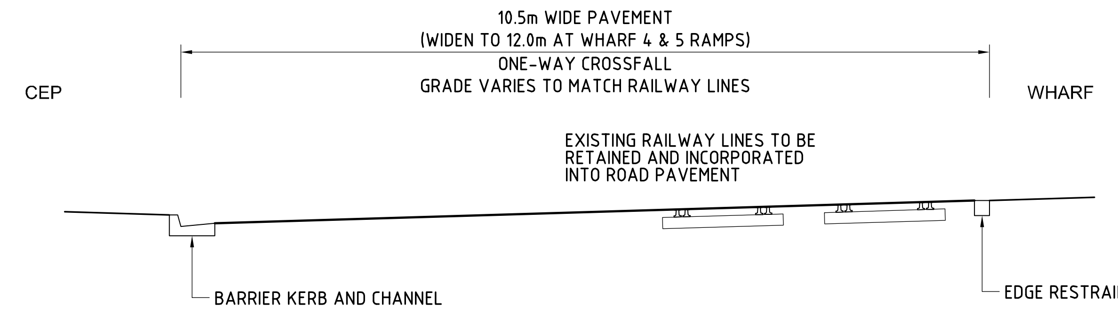
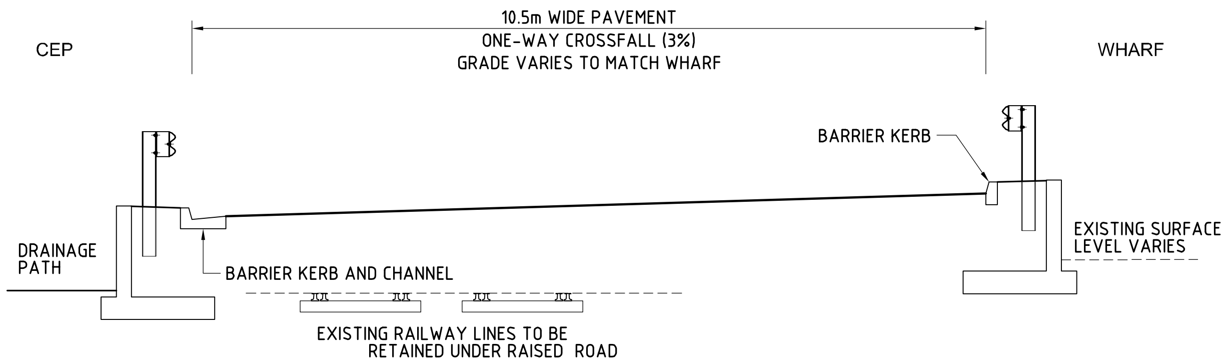
TITLE OVERALL ROADWORKS PLAN

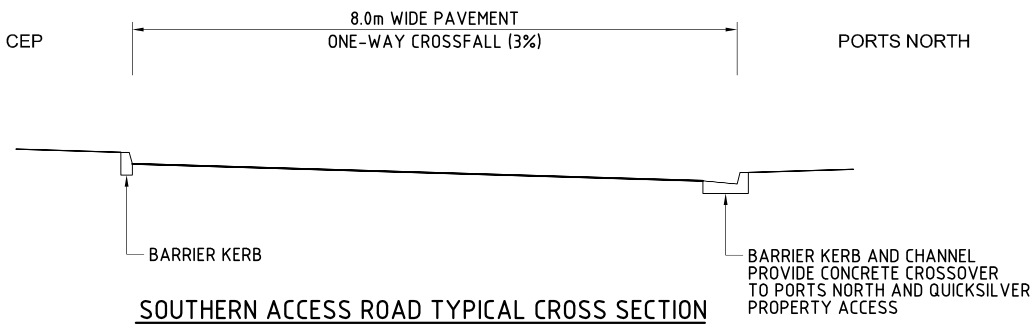
ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C01	04



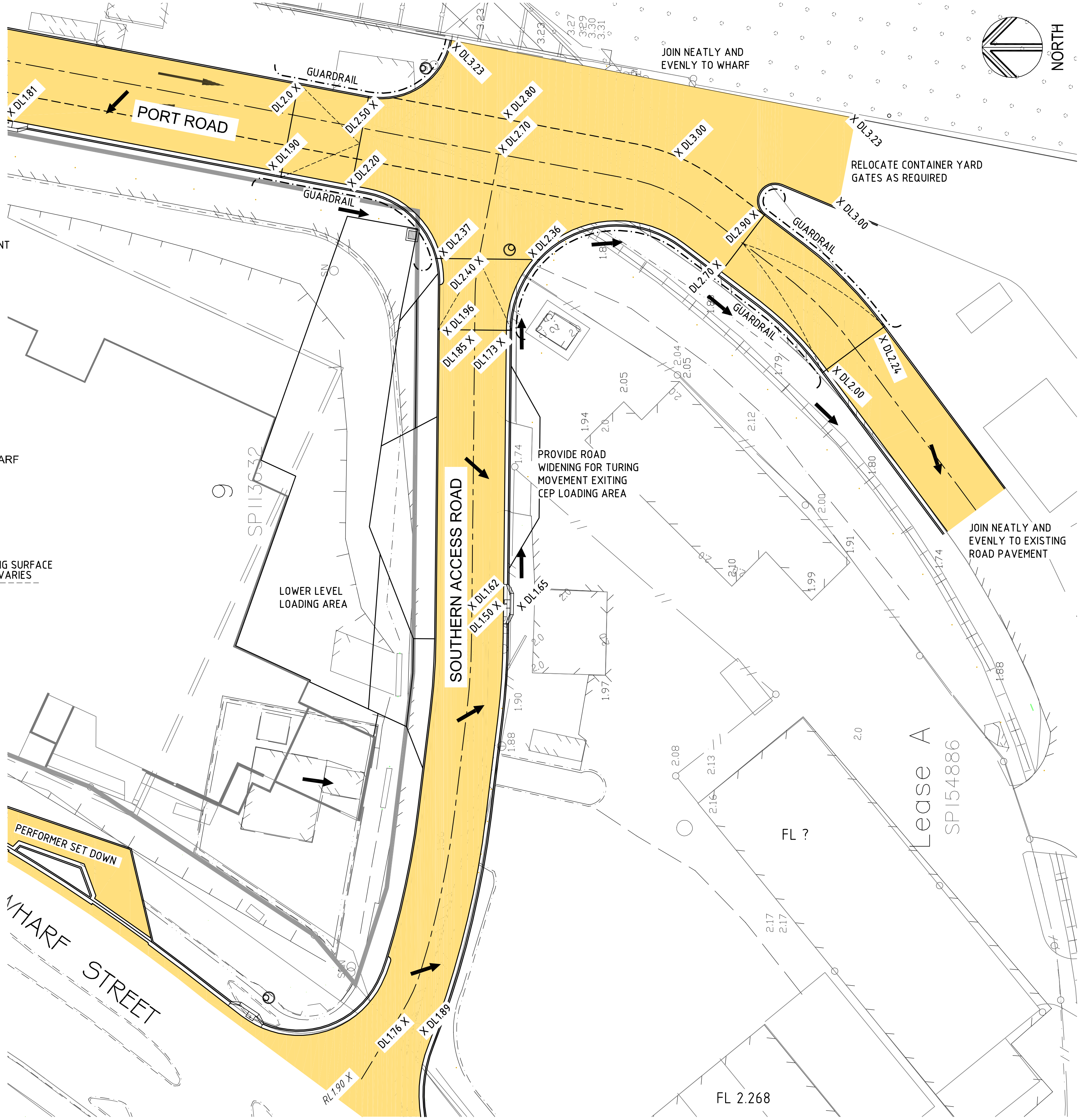
PORT ROAD TYPICAL CROSS SECTION 1
1:100



PORT ROAD TYPICAL CROSS SECTION 2 (RAMP AND ELEVATED AREA)
1:100



SOUTHERN ACCESS ROAD TYPICAL CROSS SECTION
1:100



LEGEND

PROPOSED AREA OF NEW WORKS	
STORMWATER FLOW DIRECTION	→
PROJECT SITE BOUNDARY	

NOT FOR CONSTRUCTION

1 0.5 0 1 2 3 4m
SCALE: 1:50 AT A1, 1:100 AT A3

10 5 0 10m 20m
SCALE: 1:250 AT A1, 1:500 AT A3

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TITLE PROPOSED SOUTHERN ACCESS ROAD PLAN

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C02	04

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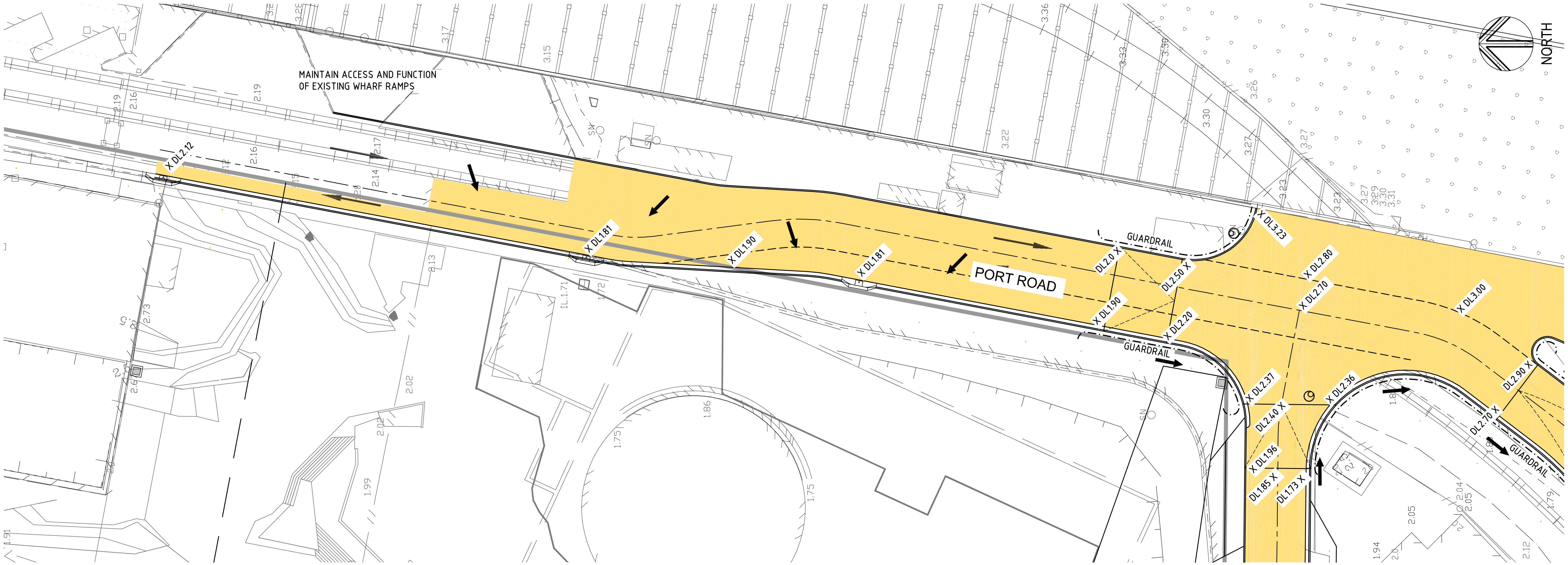
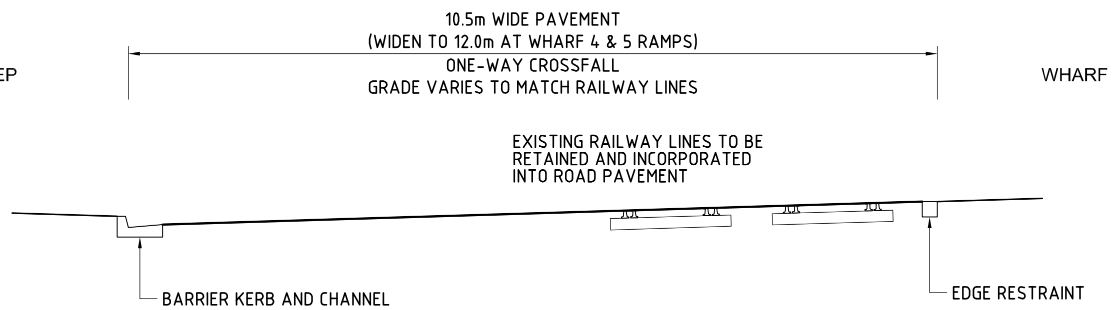
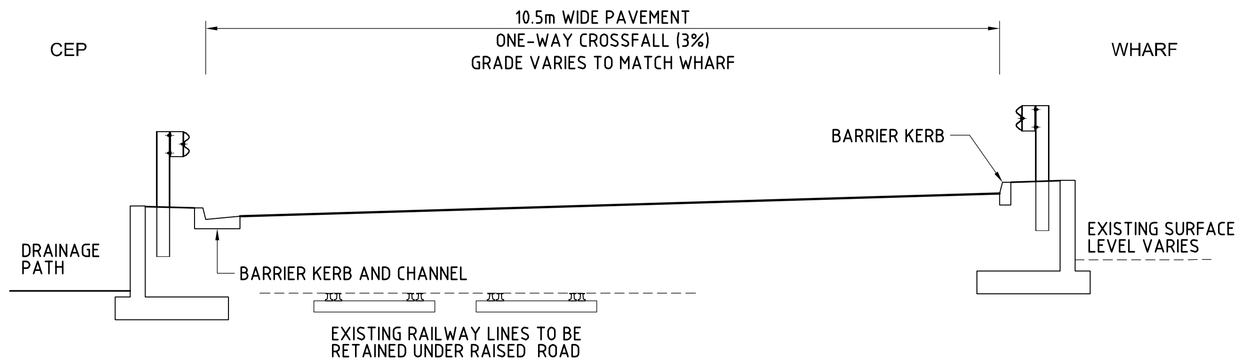


LEGEND

PROPOSED AREA OF NEW WORKS	
STORMWATER FLOW DIRECTION	
PROJECT SITE BOUNDARY	



PORT ROAD TYPICAL CROSS SECTION 1
1:100



PORT ROAD TYPICAL CROSS SECTION 2 (RAMP AND ELEVATED AREA)
1:100

NOT FOR CONSTRUCTION

SCALE: 1:50 AT A1, 1:100 AT A3

SCALE: 1:250 AT A1, 1:500 AT A3

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01	16.01.12	PRELIMINARY ISSUE	MAP	MAP

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APPROVED PROJECT DIRECTOR: B.N.CLAYTON - 14.03.12

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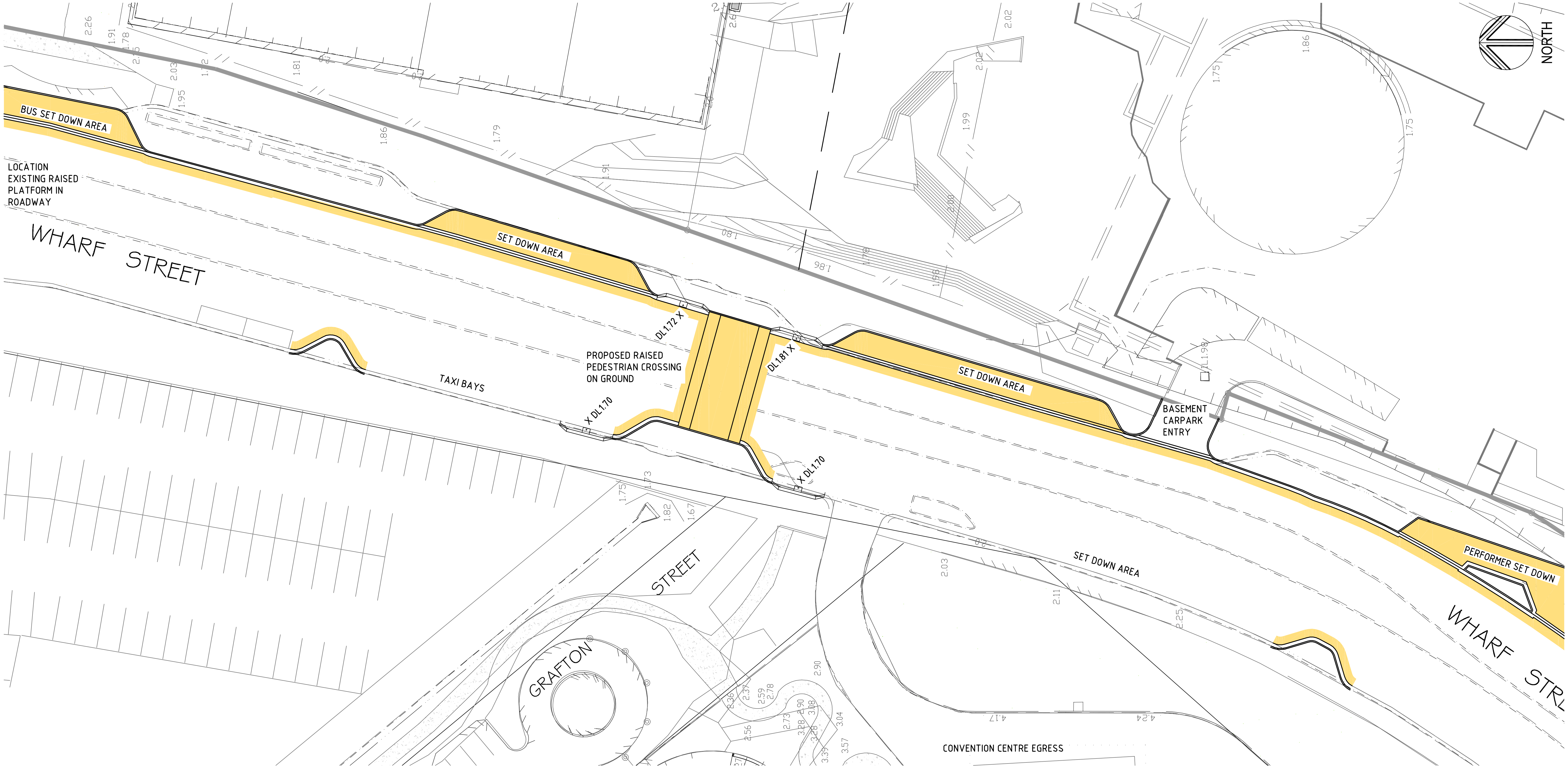
PROJECT: CAIRNS Entertainment Precinct
CAIRNS ENTERTAINMENT PRECINCT, WHARF STREET, CAIRNS
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)

TITLE: PROPOSED PORT ROAD PLAN

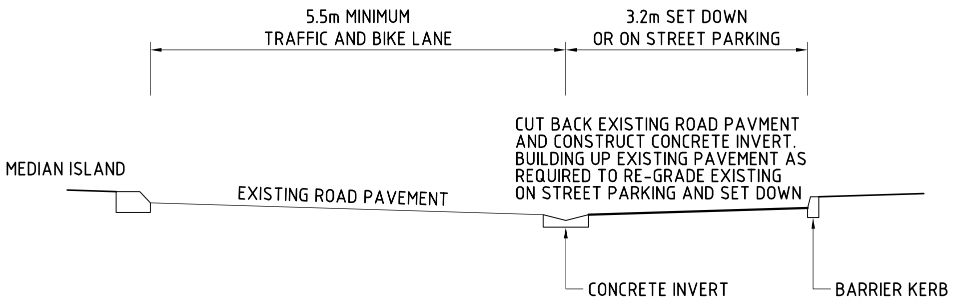
ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C03	04

CAD FILE :H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C02-C04-04.dwg Mar 14, 2012 - 3:15pm XREF's: x Base DD 114012-001.x Base DD 114012-001.x CCLT Services Base 114012-001.x CCLT As Con Services.x Survey 114012-001.x Arch Base DD 114012-001

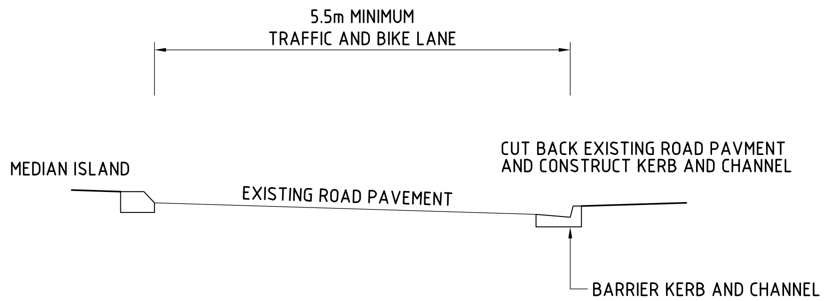


LEGEND

PROPOSED AREA OF NEW WORKS	(yellow fill)
STORMWATER FLOW DIRECTION	→
PROJECT SITE BOUNDARY	(line)



WHARF STREET TYPICAL CROSS SECTION 1
1:100



WHARF STREET TYPICAL CROSS SECTION 2
1:100

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SCALE: 1:50 AT A1, 1:100 AT A3

SCALE: 1:250 AT A1, 1:500 AT A3

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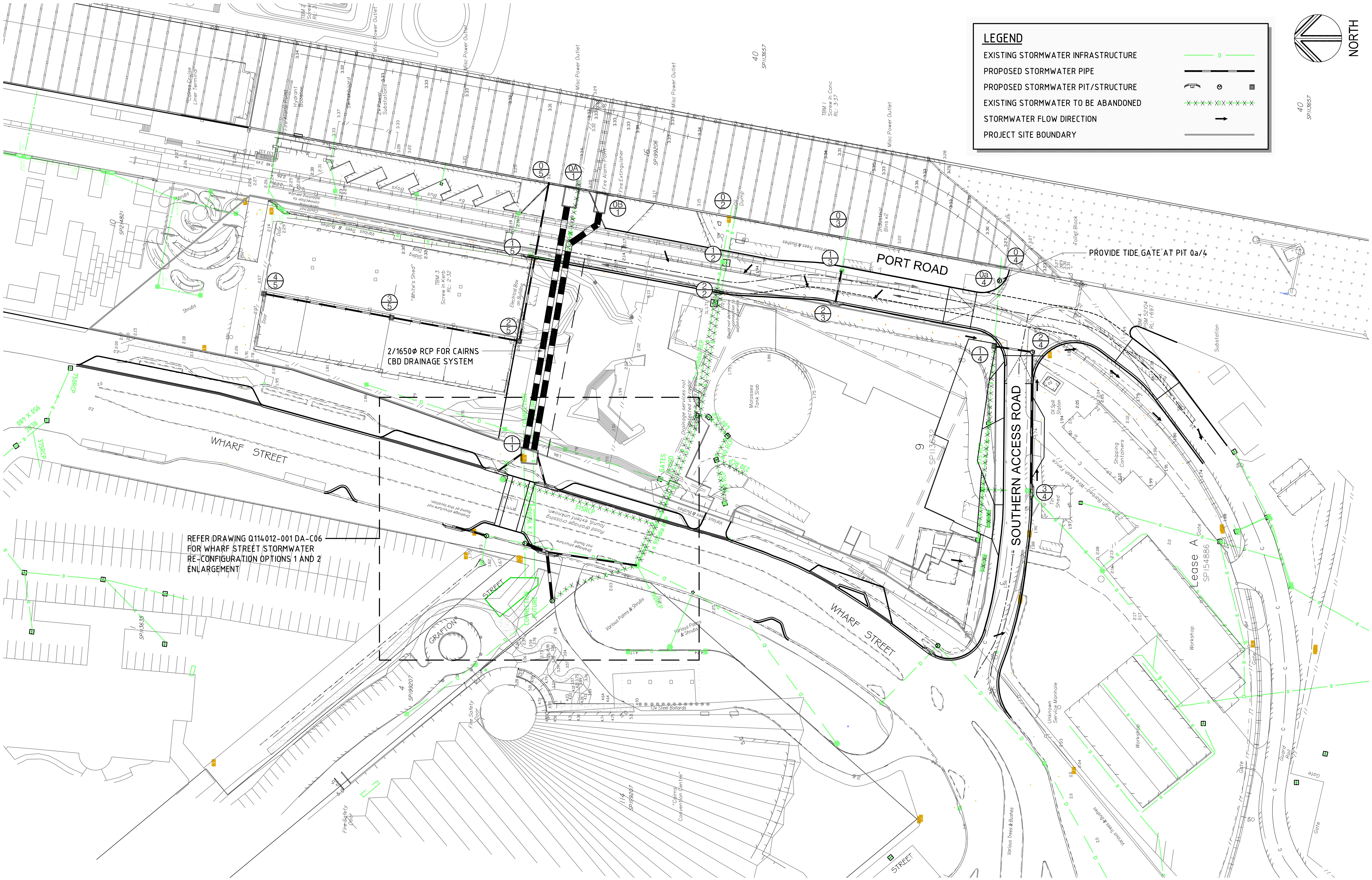
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)

TITLE: WHARF STREET ROADWORKS PLAN

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C04	03



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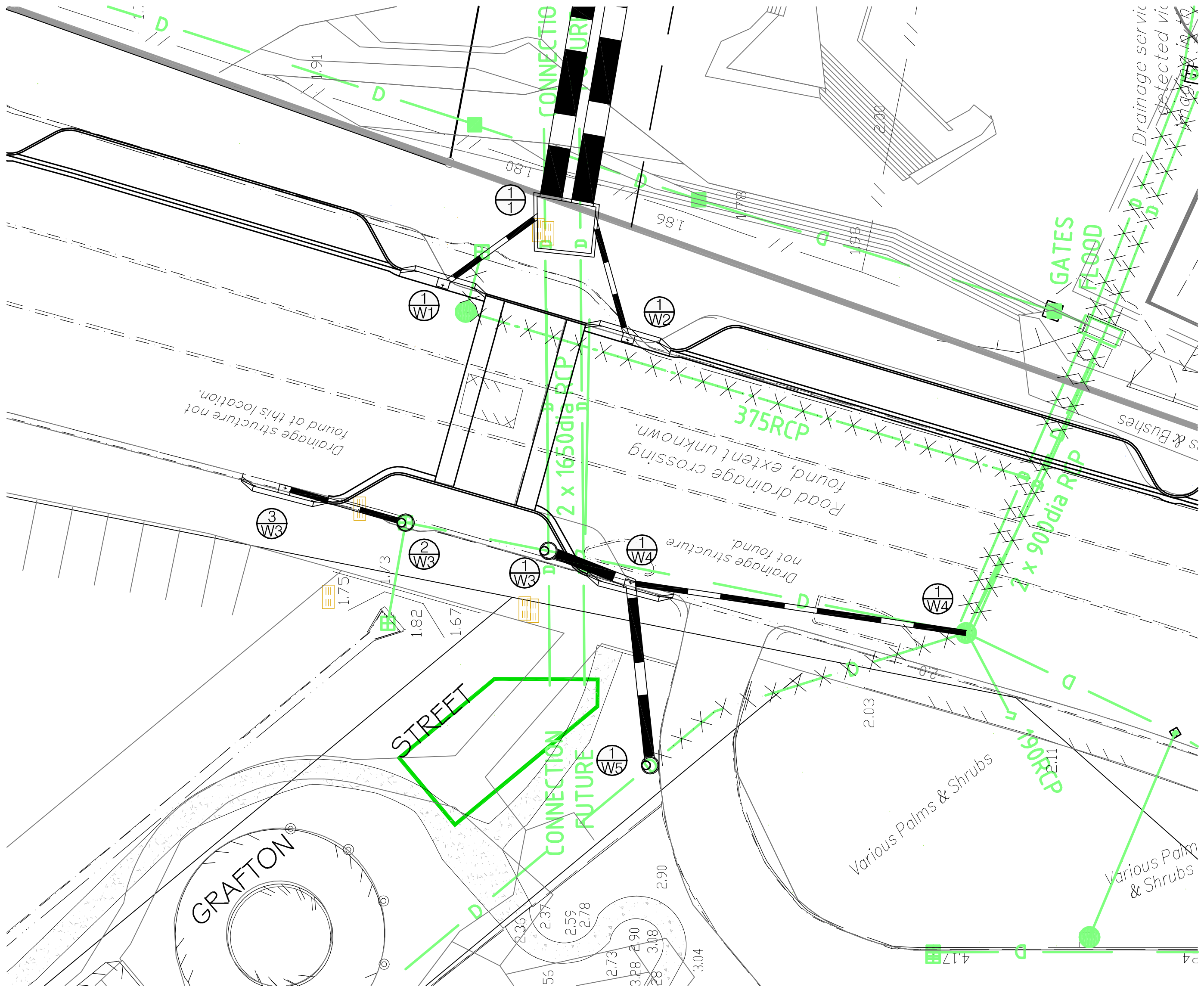
PROJECT CAIRNS ENTERTAINMENT PRECINCT, WHARF STREET, CAIRNS
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)

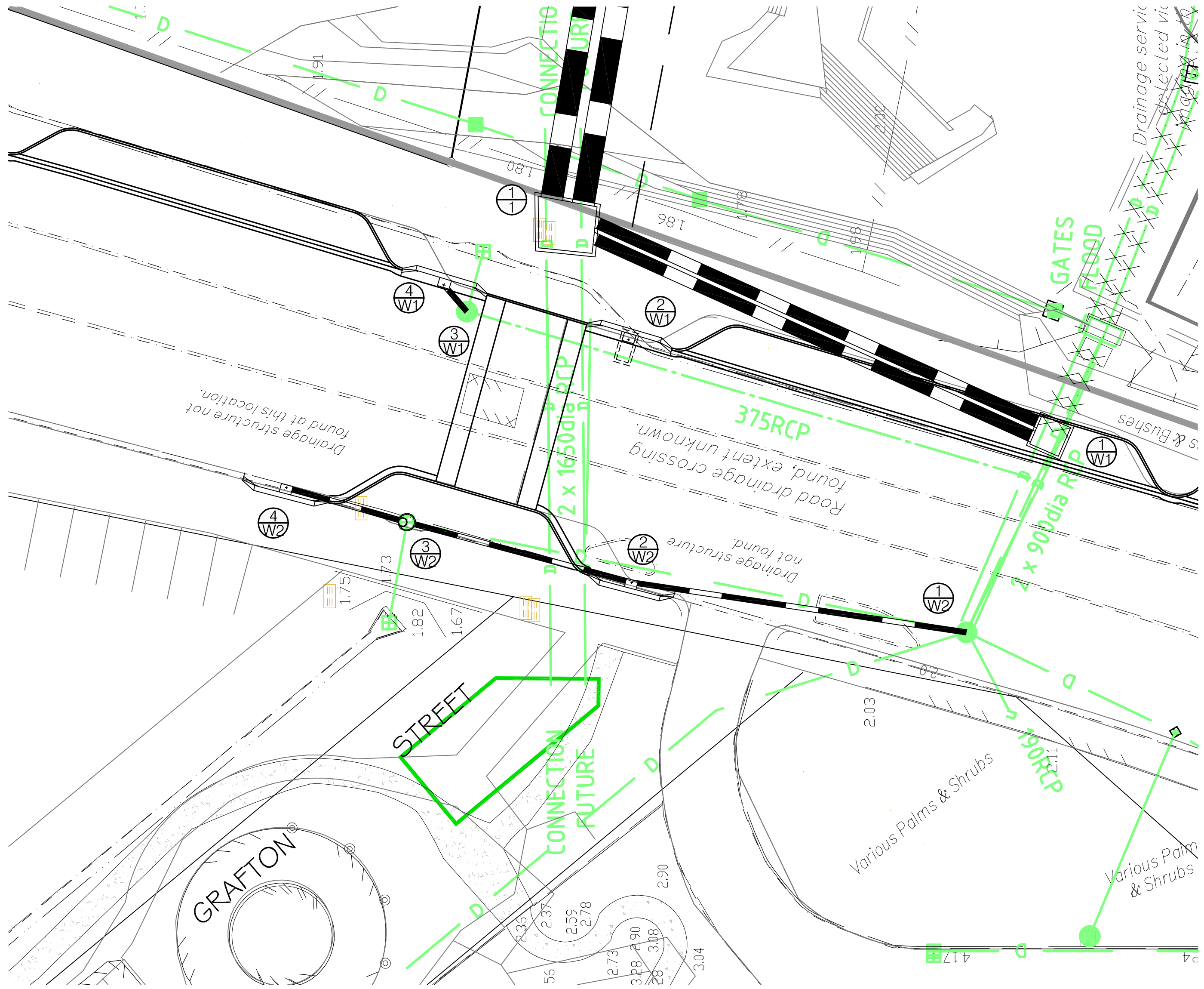
TITLE OVERALL STORMWATER DRAINAGE LAYOUT PLAN

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C05	04



WHARF STREET STORMWATER RE-CONFIGURATION - OPTION 1

1:250



WHARF STREET STORMWATER RE-CONFIGURATION - OPTION 2

1:250

LEGEND

- EXISTING STORMWATER INFRASTRUCTURE
- PROPOSED STORMWATER PIPE
- PROPOSED STORMWATER PIT/STRUCTURE
- EXISTING STORMWATER TO BE ABANDONED
- STORMWATER FLOW DIRECTION
- PROJECT SITE BOUNDARY

NOT FOR CONSTRUCTION

10 5 0 10m 20m

SCALE 1:250 AT ORIGINAL SHEET SIZE

CAD FILE :H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C06-03.dwg Mar 07, 2012 - 1:46pm XREF's: x Base DD 114012-001; x CCLT Services Base 114012-001; x CCLT As Con Services; x Survey 114012-001; x Arch Base DD 114012-001

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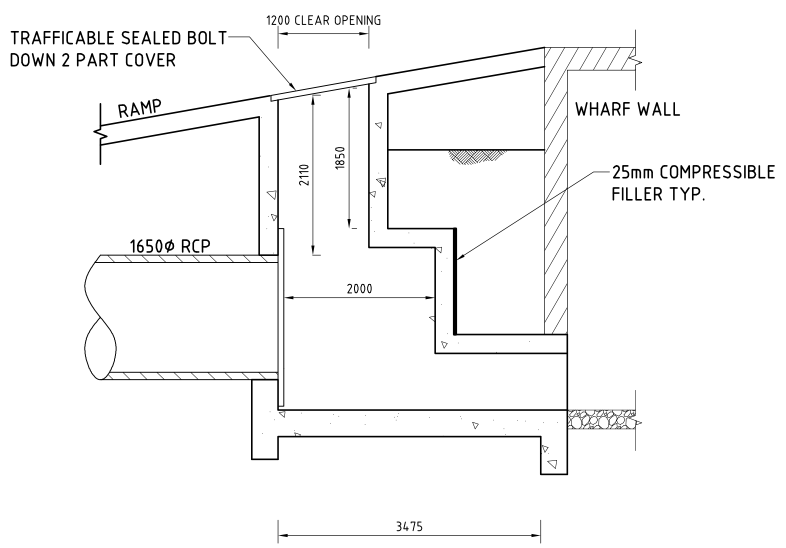
CLIENT CAIRNS REGIONAL COUNCIL

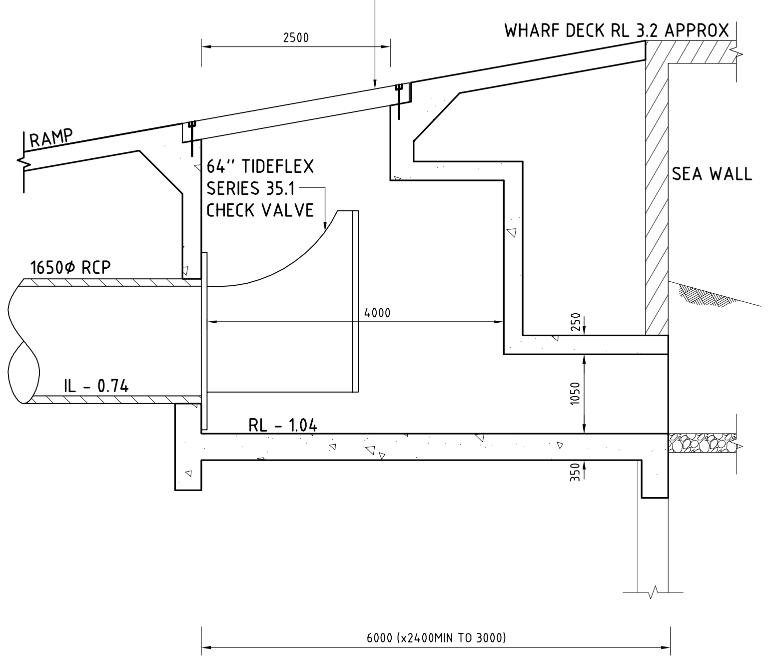
PROJECT CAIRNS Entertainment Precinct
CAIRNS ENTERTAINMENT PRECINCT, WHARF STREET, CAIRNS
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)

TITLE STORMWATER DRAINAGE DETAILS PLANS

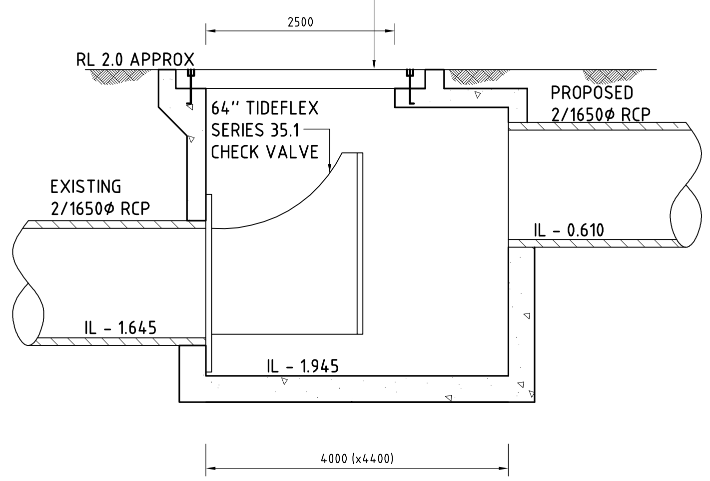
ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C06	03



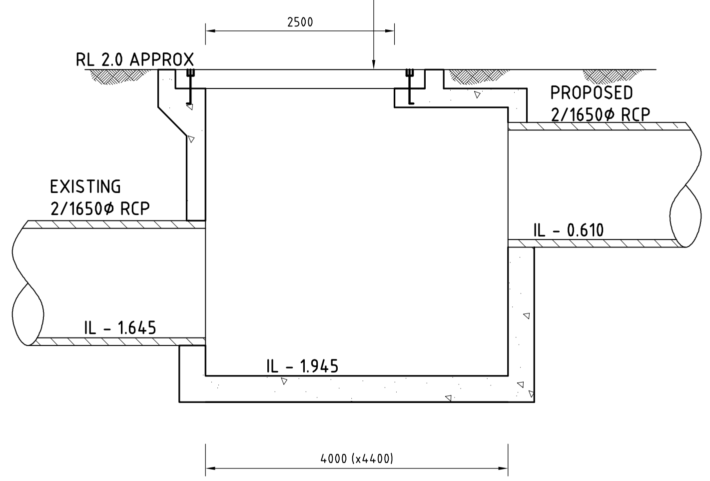
DRAINAGE OUTLET STRUCTURE 0/1 WITHOUT FLOODGATES – OPTION 1 (RECOMMENDED)
1:50



DRAINAGE OUTLET STRUCTURE 0/1 WITH FLOODGATES – OPTION 2
1:50



DRAINAGE MANHOLE 1/1 WITH FLOODGATES – OPTION 1 (RECOMMENDED)
1:50



DRAINAGE MANHOLE 1/1 WITHOUT FLOODGATES – OPTION 2
1:50

NOT FOR CONSTRUCTION

1 0.5 0 1 2 3 4m
SCALE: 1:50 AT A1, 1:100 AT A3

CAD FILE: H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C07-03.dwg Mar 07, 2012 - 1:47pm XREF's:

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03	29.02.12	RE-ISSUED WITH ENGINEERING REPORT	MAP	MAP
02	02.02.12	ISSUED WITH ENGINEERING REPORT	MAP	MAP
01	16.01.12	PRELIMINARY ISSUE	MAP	MAP

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DESIGNED NLL 29.02.12
CHECKED / PROJECT M'GR MAP 29.02.12
APPROVED PROJECT DIRECTOR B.N.CLAYTON - 29.02.12

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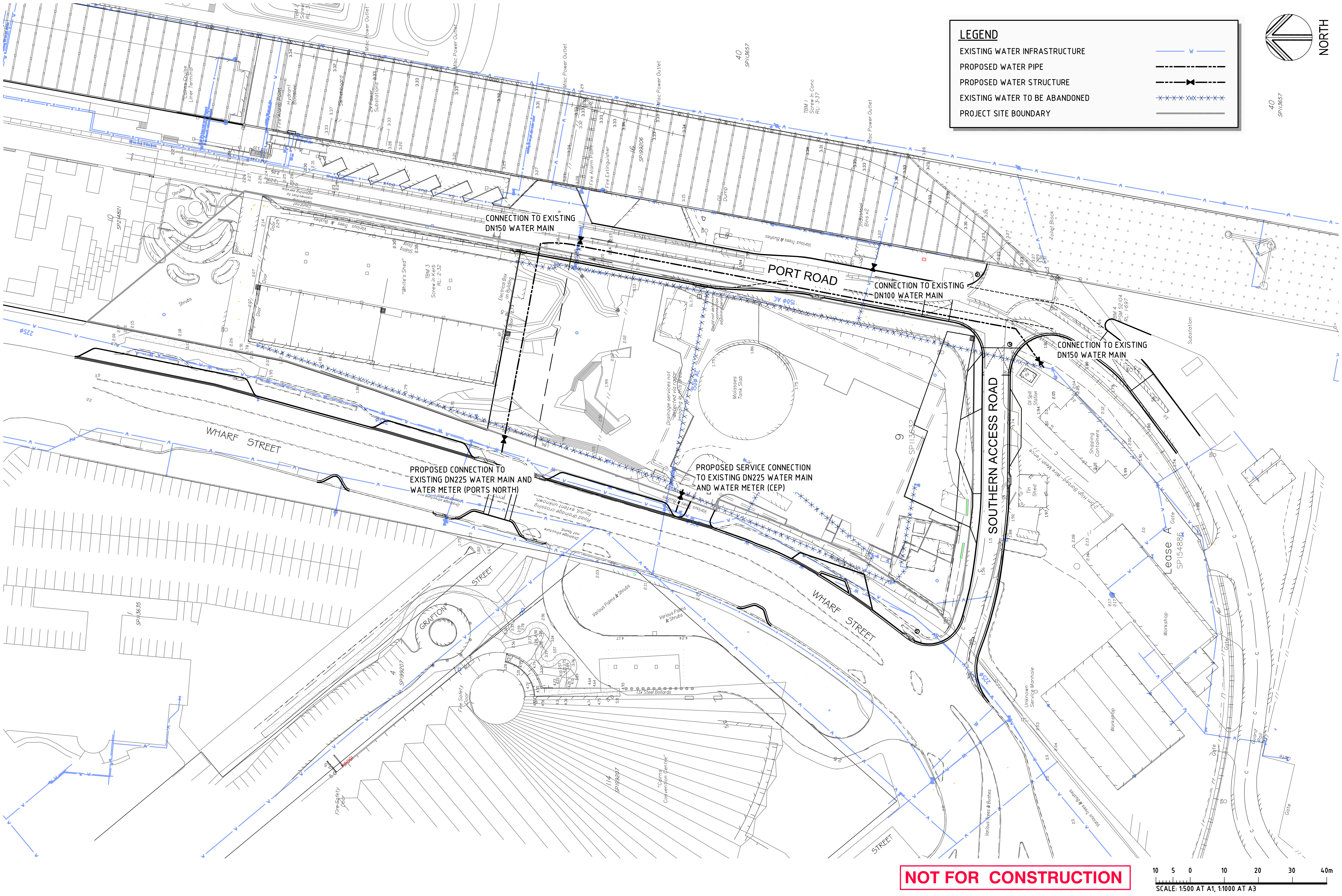
Cairns Regional Council

CLIENT CAIRNS REGIONAL COUNCIL
PROJECT CAIRNS Entertainment Precinct
CAIRNS ENTERTAINMENT PRECINCT, WHARF STREET, CAIRNS
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)

TITLE MAJOR STORMWATER DRAINAGE PIT DETAILS

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C07	03



CAD FILE :H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C08-04.dwg Mar 14, 2012 - 3:14pm XREF's: x Base DD 114012-001; x CCLT Services Base 114012-001; x CCLT As Con Services; x Survey 114012-001; x Arch Base DD 114012-001

ISSUE	DATE	DESCRIPTION / APPROVED USE	REV'D	APP'D
04	14.03.12	RE-ISSUED WITH ENGINEERING REPORT	MAP	MAP
03	29.02.12	RE-ISSUED WITH ENGINEERING REPORT	MAP	MAP
02	02.02.12	ISSUED WITH ENGINEERING REPORT	MAP	MAP
01	16.01.12	PRELIMINARY ISSUE	MAP	MAP

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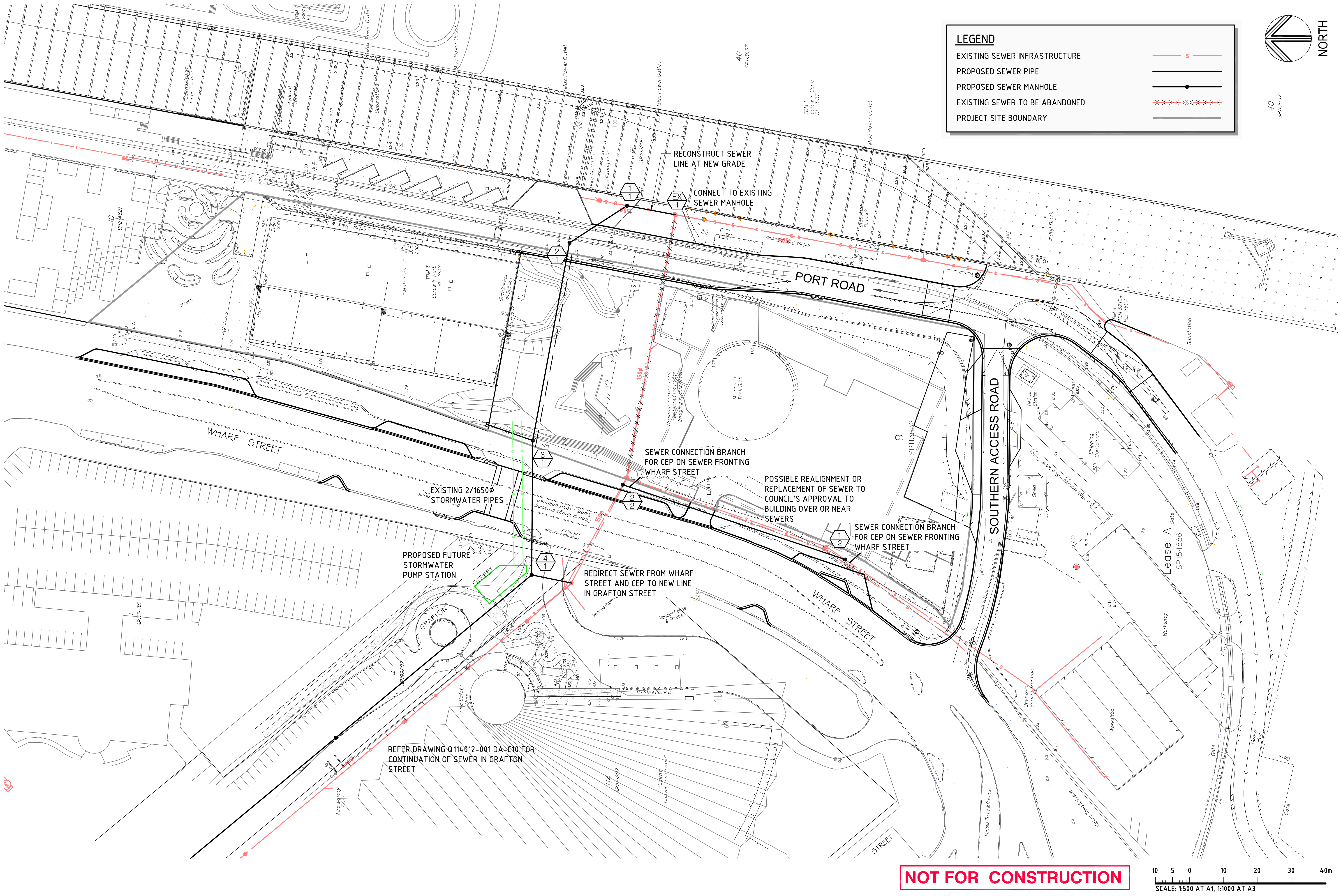
CLIENT: CAIRNS REGIONAL COUNCIL

PROJECT: Cairns Entertainment Precinct
CAIRNS ENTERTAINMENT PRECINCT, WHARF STREET, CAIRNS
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)

TITLE: WATER RETICULATION LAYOUT PLAN

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C08	04



CAD FILE :H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C09-04.dwg Mar 14, 2012 - 3:09pm XREF's x Base DD 114012-001 x CCLT Services Base 114012-001 x CCLT As Con Services x Survey 114012-001 x Arch Base DD 114012-001

ISSUE	DATE	DESCRIPTION / APPROVED USE	REV'D	APP'D
04	14.03.12	RE-ISSUED WITH ENGINEERING REPORT	MAP	MAP
03	29.02.12	RE-ISSUED WITH ENGINEERING REPORT	MAP	MAP
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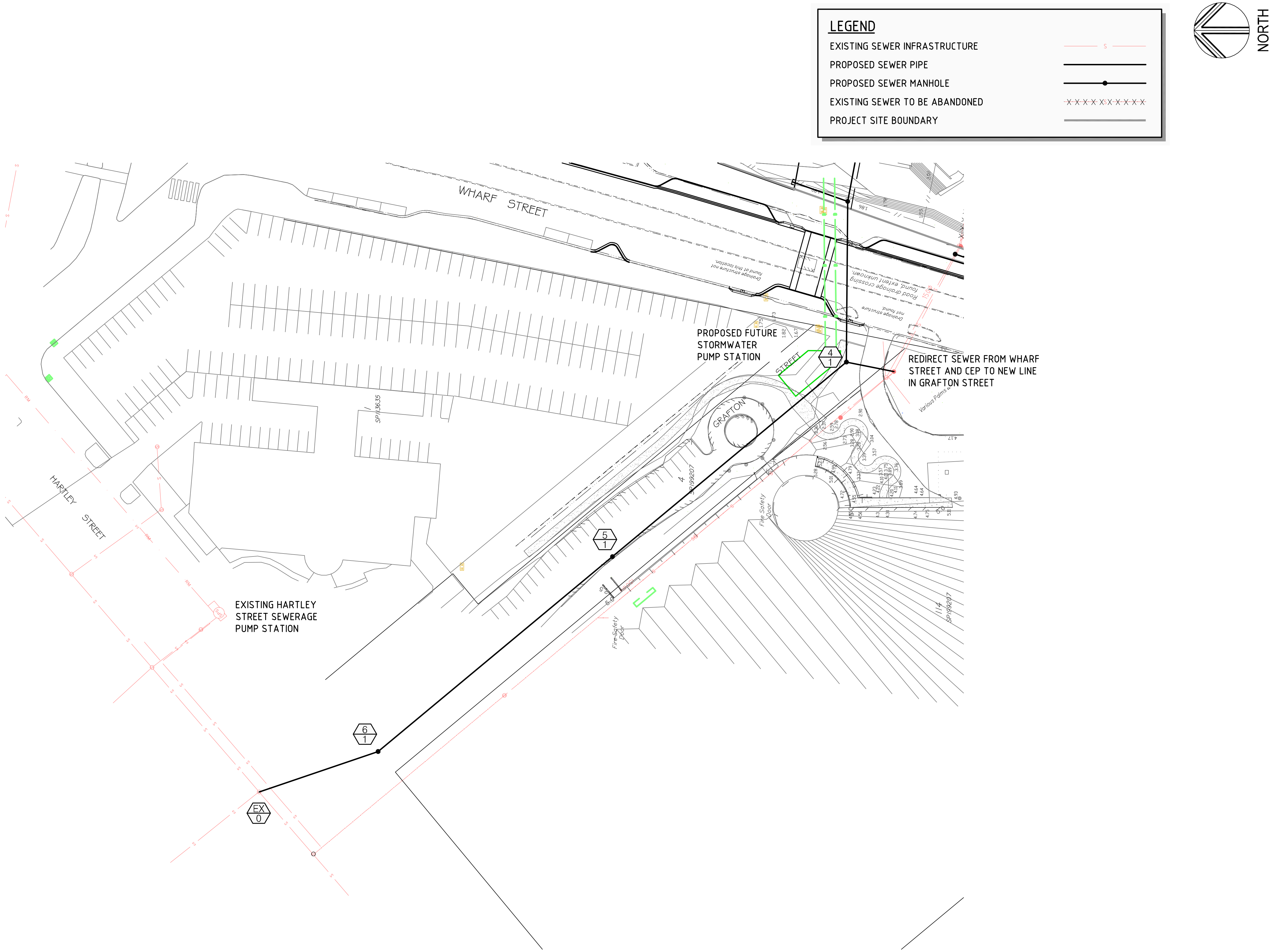
PHASE 2 - DEVELOPMENT APPLICATION (STAGE 1)

TITLE SEWERAGE RETICULATION LAYOUT PLAN

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C09	04



NOT FOR CONSTRUCTION

SCALE: 1:500 AT A1, 1:1000 AT A3 (10 5 0 10 20 30 40m)

ISSUE	DATE	DESCRIPTION / APPROVED USE	REV'D	APP'D
03	29.02.12	RE-ISSUED WITH ENGINEERING REPORT	MAP	MAP
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01	16.01.12	PRELIMINARY ISSUE	MAP	MAP

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TITLE CONTINUATION OF SEWERAGE RETICULATION LAYOUT PLAN

ORIGINAL SHEET SIZE	PROJECT No.	DRAWING No.	ISSUE
A3	Q114012-001	DA-C10	03

CAD FILE :H:\2011\114012-001\Detail Design Phase\Design\Acad\DA-C10-03.dwg Mar 07, 2012 - 1:49pm XREF's x Base DD 114012-001 x CCLT Services Base 114012-001 x CCLT As Con Services x Survey 114012-001 x Arch Base DD 114012-001