ENGINEERING REPORT

LIFE CITY WOLLONGONG

HI-TECH HOLISTIC CANCER & MEDICAL HOSPITAL

FACILITY, WARWICK ST, BERKELEY

Rev 3

PN00864.R01

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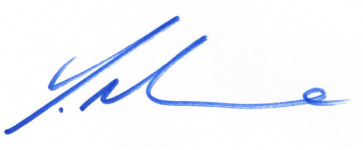

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1. INTRODUCTION

1.1 Context of the Report

C&M Consulting Engineers has been commissioned to undertake an engineering investigation and assessment report for the proposed Life City – Wollongong at Berkeley. The proposed development is defined as a Major Project (Critical Infrastructure) under Part 3A of the Environmental Planning and Assessment Act 1979. It is a requirement of the Director General of the Department of Planning (DoP) that an Environmental Assessment (EA) be carried out for the development.

This engineering report will be a part of the EA, which addresses constraints and opportunities associated with roads, earthworks, stormwater, water sensitive urban design and utility services.

The report addresses the following:

- Road Network,
- Pedestrian Access,
- Stormwater Quantity,
- Stormwater Quality,
- Water harvesting, and
- Utility Services.

The Report describes the principles and operation of the proposed infrastructure system as well as the primary components of each system. As the assessment is of an Environmental Assessment nature, the proposed measures may have to be revisited and refined in conjunction with any modifications to the final form of layout and along with other comments from Department Planning and/or Wollongong City Council. Detailed design of the final form will be provided as part of the Construction Certificate submission.

1.2 The Site

The subject site is located in a southern Wollongong suburb of Berkeley, approximately 11km south of the Wollongong CBD. It is bounded by the F6 Southern Freeway to the west, Nolan Street to the east, Hopeman Cres to the north and Nottingham St to the south. The access to the site is via Warwick Street to the north of the site.

The site comprises an area of 16.88 hectares consisting of three (3) separate allotments: Lot 4 DP 258635, Warwick Street; Lot 2 DP 534116, Nottingham Street; Lot 2 DP 249814, York Street. Along the southern boundaries there is a 24 metre wide easement for transmission lines. The majority of the site is zoned E3 (Environmental Management) but there is an area that is zoned R2 (residential) under the Wollongong Local Environmental Plan 1990.

The site has a dominant ridge running in an east-westerly direction accommodating reasonably steep slopes (gradients are generally 20- 30%) to the south and a gently rolling slope (gradients are generally 5-10%) towards the F6 Southern Freeway to the north-west.
The site is currently vacant with natural bushland to the south of the ridge and open pastured land to the north of the ridge.

The character of the immediate locality is mixed with residential to the east of F6 Southern Freeway and industrial development to the west of the Freeway. Full context of the site as well as current planning instruments are described comprehensively in the Environmental Assessment Report.

Figure 1 – Site Layout

1.3 The Development

Life City Wollongong will be a Hi-tech Holistic Inpatient Hospital Facility providing inpatient cancer treatments and medical services and healthcare services, including:

- 320 beds hi-tech holistic cancer and medical hospital facility
- Holistic health course for Yoga, Reiki and Laughter Therapy, Meditation, Auras, and Panic Healing,
- Day surgery and Specialist rooms,
- Senior living development,
- Ancillary accommodation for employees including doctors, nurses, medical students and patients seeking outpatient services,
- A Library, Lecture Theatre, Auditorium & Conference Facilities and amphitheatre,
- Wollongong Healthcare Technical High School.

Full details of the development is in the Environmental Assessment Report.

1.4 Engineering Objectives

The engineering objectives are to create a well linked and highly accessible layout to provide a development that responds to the topography and site constraints, and to provide a safe and environmentally friendly development. In particular:

- To ensure that transport networks are able to support the proposed development in a manner that maintains safe levels of service.
- Provide adequate and safe vehicular access to sites without compromising streetscape qualities.
- To ensure that premises are accessible to a person with a disability without discrimination
- To control stormwater runoff and minimise discharge impacts on adjoining properties and into the natural drainage system before, during and after construction.
- To ensure that the proposed development does not adversely affect the operational capacity of the downstream stormwater system.
- To ensure that the development does not impact on the water quality of adjacent properties or creeks.
- To provide for the disposal of stormwater from the site in an efficient, equitable and environmentally sensible way.
- To ensure that biodiversity and the integrity of ecological processes are not compromised by the development.
- To encourage reuse, recycling and harvesting of stormwater to reduce the reliance on potable water and wastage of water.

1.5 Engineering Principles

The following principles underpin the design:

- Provision of safe access links to the adjoining neighborhood – integration with Warwick Street as well as Nolan Street,
- Adopt a simple yet safe connective access system,
- Sympathetic to the terrain and landform and responsive to the existing environmental constraints,
- Develop a high quality infrastructure that integrates well with landform and drainage system
- Respond to the existing drainage system under F6 Freeway,
- Adopt water sensitive urban design principles and improve stormwater runoff quality discharging from the site to Lake Illawarra, and
- Meet triple bottom line benchmarks encompassing social, ecological, and economic factors.

2. RELEVANT GUIDELINES

2.1 Roads and Access Guidelines

Austroads – Guide to Road Design was generally used to determine the appropriate technical design criteria for the roads including cross- section configuration, alignments, dimensions, safety requirements, linemarking and sign posting.

Other guidelines and regulations that are applicable to the development are;

- Chapter B2: Residential Subdivision of the Wollongong Development Control Plan, 2009 (DCP)
- AS 2890.1 Off Street Car Parking
- AS 2890.2 Commercial Parking Facilities
- AS 1428 Design for Access and Mobility
- AS 1742 Manual of Uniform Traffic Control Devices
- New South Wales Roads & Maritime Services (Formerly RTA) Traffic Control at Worksites manual
- Austroads – Guide to Road Design
- Austroads – Pavement Design for Light Traffic: Supplement to Austroads Pavement Design Guide

2.2 Water Sensitive Design guidelines

Water Sensitive Urban Design (WSUD) is the term used to describe the current approach to urban planning and design that offers sustainable solutions for integrating land development with the natural water cycle. WSUD emphasises a more decentralised approach, water management that is more in tune with natural environmental processes, and the restoration of the natural water cycle in terms of surface runoff, groundwater, and evapo-transpiration. It involves integrating the potable water, stormwater and wastewater streams to mitigate the increased runoff from urban areas, decrease the volume of polluted water entering our waterways, sustain biodiversity and the integrity of ecological processes and reduce the strain on drinking water reserves.

For stormwater runoff control requirements of the WSUD, Chapter E14: Stormwater Management of the Wollongong Development Control Plan, 2009 (DCP), which outlines the objectives and standards to ensure the runoff from the development is controlled and safely conveyed to the downstream waterways.

WSUD elements are to be designed and constructed in accordance with Chapter E15: Water Sensitive Urban Design of the DCP which outlines the objectives and standards to ensure the development incorporates the principles of Ecological Sustainable Development.

In addition to above, Wollongong City Council's On-site Stormwater Detention Code, June 2006 and Council's Urban Drainage Design Manual are to be used for the technical design guideline.

2.2.1 Water Quantity

Drainage systems are to be designed and constructed in accordance with the DCP and Council Code specified above in conjunction with "Australian Rainfall and Runoff" published by the Institution of Engineers, Australia (1987)

In general, these standards and guides state a requirement that development must not result in downstream drainage nuisance. This, consistent with the Council Standard, means that the peak flows for a range of storm events should not increase except where regional planning has been provided for the future developments. The latter is applicable to the existing residential zoning land within the site. Where mimicking of natural flows are required, on-site detention systems are to be provided to the requirements of Council Standard.

2.2.2 Water Quality

The stormwater quality management strategy should be based on the current best practice to achieve pollutant load reduction targets set in Chapter 15: Water Sensitive Urban Design of the DCP.

The reduction targets applicable to this site (Industrial/Commercial) are:

Table 1 – Water Quality Criteria

Parameters	Reduction Note 1
Gross Pollutants	90%.
Total Suspended Soilds	80%
Total Phosphorus	55%
Total Nitrogen	40%

Reductions in loads are relative to the pollution generated from the development without treatment

2.2.3 Stormwater Harvesting and Reuse

For stormwater harvesting and reuse, there are no set criteria in the DCP but is generally designed on a case by case basis. To determine the most efficient size of rainwater tanks, water demand and supply (catchment area and rainfall) must be optimally balanced.

Based on a number of published documents including WSUD Guidelines for Western Sydney the average water usage for toilet flushing is 50L/day/person and irrigation rate of 1mm depth per day.

The industrial standard for acceptable rainwater replacement with potable water is 80%.

2.3 Compliance with DGR

This engineering report together with the Drawings generally satisfies the Director General's Requirements (DGR) issued on 26 October 2010 for the particular conditions:

Condition 4 - Transport and Accessibility Impacts – For general traffic impacts, *Traffic and Transportation Report* by GHD should be referred. In this report we have adequately addressed the accessibility of the site.

Conditions 12 - Water Quality and Drainage

In addition to above conditions, the drawing includes Stormwater Concept Plan required under 'Plan and Documents to Accompany the Application'.

3. SITE WORKS

3.1 Earthworks

The proposed development is sympathetic to the site topography to overcome the slopes and minimised excessive cut and fill to meet the engineering objectives. However, it is inevitable that some areas need extensive excavation and filling. Based on the preliminary grading of the roads, maximum cut/fill of +/-4m is proposed. This cut/fill does not include building excavations.

Drawing 00864_SK07 included in Appendix A shows preliminary cut and fill.

The site work will be carried out under a strict supervision of a Geotechnical Engineer to the requirement of AS 3798.

3.2 Land Slip Management

A preliminary geotechnical investigation by Coffey Partners indicates some areas of the site are potentially at risk of landslide.

The development will be proceeded with good hillside construction practice techniques recommended by *Australian Geomechanics Society's* Landslide Risk Management 2007.

Where the risks are high, the top clay layer will either be removed or replaced with granular materials excavated on site. Subsurface drains will be provided to minimize seepage flows.

Typical section showing the construction method is provided below.

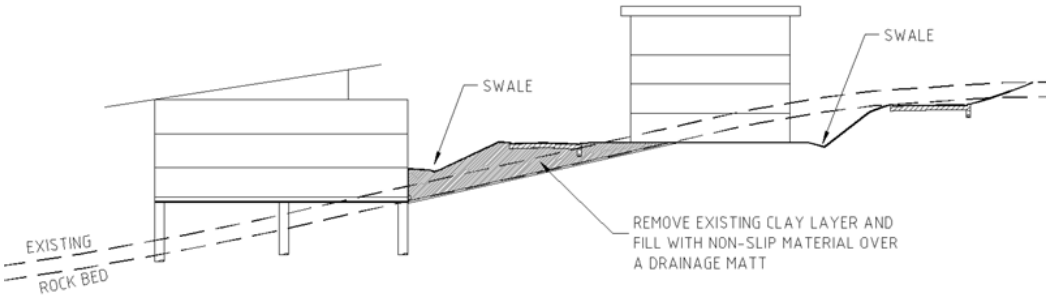

Figure 2 – Typical Section showing the Construction Method

3.3 Batters and Retaining Walls

Given the topography of the site, battered earth, retaining wall structures or a combination of these will be required to safely support the roads and buildings.

Where possible, the use of retaining wall will be limited by landscaped batters. Where retaining walls are inevitably required, high walls will be limited by combining low retaining walls with

landscaped batters. This type of treatment will be aesthetically pleasing and will provide improved visual integration of natural form consistent with the surrounding environment.

The type of wall will be incorporated into the detailed landscape drawings and will be constructed of durable materials.

4. ROADS AND TRANSPORTATION

4.1 Road Planning

Traffic report prepared by GHD is included in the EA Submission. Issues relating to traffic should refer to that report including the proposed roundabout in Nolan Street. This Section addresses issues relating to the internal road works in the aspects of civil engineering works either identified in the traffic report or are deemed necessary relate to this type of development.

The proposed hierarchy of the road system is shown on Drawing 00864_SK01 in Appendix A. Table 2 below summarises road widths proposed.

Table 2: Characteristics of road types

Road Number	Road Type	Carriageway Width (m)	Kerbside Parking	Equivalent Council Standard
1	Entry Road	9	No	Local Street with AADT between 1000-3000. Note1
2, 3 and 4	Main Circular Roads	7	No	Local Street with AADT between 300-1000. Note2
5, 6 and 7	Resident Access Street or Parking Entry	6	No	Local Street with AADT < 300. Note3
8	Service Access	3	No	

Note 1 – Council standard is 9.5m but allows kerbside parking.
Note 2 – Council standard is 7.5m but allows kerbside parking.
Note 3 – Council standard is 6.5m but allows kerbside parking on one side.

The main philosophy of the road hierarchy system proposed is to provide good level of services and yet sympathetic to the topographic constraints. In comparison with Council's DCP, we believe the road widths proposed comply with the Council road system of similar roads.

All roads will have concrete kerb and gutter and carriageway surface finished with asphaltic concrete or other surfaces that are safe and durable.

Drawing 00864_SK02 in Appendix A shows typical cross-section of the roads.

4.2 Road Alignments

The proposed road alignments generally meet the Austroads requirement. It is acknowledged that the topography is the main constraint on site, which requires a good engineering judgement to overcome the potential unsafe road alignments.

The proposed road layout incorporates the best practice for both horizontal and vertical alignments with empathise on terrain and landform. Priority has been given in the design for the safety of vehicles and pedestrians.

Where the horizontal deflection angle is greater than 70 degrees, a localised widening of the pavement has been proposed to enable larger vehicles to turn without engaging the full width of the road.

Vertical alignment, or grading, is an important factor to be considered in this development due to the terrain. Special consideration has been given to meet the sight distance requirements as well as easy access to driveways. Given the terrain it was not practical to design the road system to the desirable grade throughout the site without excessive earthworks. It is therefore, envisaged that there will be areas where vertical grades will reach up to 15% but will generally maintain to 10%.

Drawings 00864_SK03 to 00864_SK06 in Appendix A show vertical grades of the roads.

4.3 Roundabouts

The geometric layout for the roundabout has been designed in accordance with the Austroads - Guide to Road Design. All roundabouts within the development are single-lane roundabout with central annulus and lane width to suit circulation of an articulated vehicle.

The determination of return radii in the roundabout was based on the turning movement of such vehicles, which has been simulated using the *AutoTurn* computer simulator. Pedestrian access through the roundabout will be provided off-road to comply with the Austroads design guidelines.

4.4 Sight Distance Requirements

One of the most important elements in road design is to provide an adequate sight distance on both the horizontal and vertical planes. The geometry of the road, location of the intersection, clearances, boundary splays, and the extent of vegetation will affect the sight distance requirements.

Based on the AustRoads, the stopping sight distance (SSD) for cars operating speed of 50kph and reaction time of 2.5 second is 60m for an urban setting, including additional length for the grade correction.

The proposed road design generally meets the SSD but the final sight distance provisions for different conditions will be determined at the detail design stage of the roads in consideration with the final building form.

4.5 Traffic Management

The objective is to provide safe roads for pedestrians, cyclists and motorists without compromising aesthetics and traffic flows. To meet this objective, measures to control vehicular speed will be implemented. To control traffic speeds, slow point devices in a form of surface textures, curves, intersections and roundabouts are strategically located to minimise the long straight leg lengths.

4.6 Car parks

Off road car parks have been designed to comply with the requirements of Council DCP, AS2890.1 Off Street Parking Facilities and AS2890.2 Commercial Parking Facilities.

4.7 Nolan and Warwick St Intersections

The development, as proposed, includes two (2) exit/entry points. One at the western end of Warwick Street located to the north of the site and the other from Nolan Street via Council owned Environmental Area.

Interface at the Warwick Street entry will be designed to comply with Council's standards with an entry feature that delineates between public road and private road.

The Nolan Street entry will be the main entry and the intersection treatment at Nolan Street will be dealt in the traffic report by GHD. The design of the intersection treatment will be to Council's and RMS standards.

5. STORMWATER MANAGEMENT

5.1 Introduction

5.1.1 Background

The objective is to provide stormwater controls, which ensure that the proposed development does not adversely impact on the stormwater flows and water quality of waterways within, adjacent and downstream of the site.

The principles and operation of the proposed stormwater system, the primary components of the drainage system, and their sizes and locations on the site are described below. Detailed design of the drainage system will be provided as part of the detail design submission.

Increased impervious surfaces and alteration of the natural topography due to the land development have the potential to increase the flows and tend to concentrate the flows. This has the potential to impact on flood levels and erosion of the downstream drainage system. To avoid any adverse impact on the downstream drainage system, the site stormwater system is required to be planned to ensure safe conveyancing of flows through the site and within the capacity of the downstream drainage system.

The proposed drainage system including water quality is shown on Drawings 00864_SK08 and 00864_SK09 in Appendix A.

5.1.2 Key Issues

The key issues and the mitigating measures to be employed within the proposed development site are:

- **Stormwater Flow** - Increased impervious surfaces (such as roads, roofs, carparks, etc) have the potential to increase the stormwater flows from the site during storm events. To avoid impacting on the downstream drainage system, the site stormwater system has been designed to safely convey the flows through the site and within the capacity of the downstream system. The design and operation of the proposed system is described in Section 5.2.

- **Water Quality** - Urban developments have the potential to increase gross pollutants, sediments and nutrient concentrations in stormwater runoff. To limit impact on the downstream water quality, gross pollutant traps will be provided at each stormwater outlet prior to discharging to a bioretention basin. Further, the bioretention basins will further furbish the water quality prior to discharge to the receiving downstream watercourses. The design and operation of the proposed system is described in Section 5.3.

5.2 Runoff Control

5.2.1 Catchments and Existing Drainage System

The site is divided into two (2) major catchments: north bound and south bound. The North Bound catchment drains to the existing stormwater system provided for Berkeley Residential Development including a culvert under F6 Southern Freeway. 4.7 hectare of this catchment is zoned R2 (residential) under the Wollongong Local Environmental Plan 1990. According to the Council DCP (Chapter E14: Stormwater Management), this catchment is exempted from the on-site detention requirement as it is controlled by regional detention basin. However, since this development has not been considered in the design of the regional stormwater system, a local detention system is required to control the flows to the planned residential development condition.

The South Bound catchment which is zoned E3 (Environmental Management) under the Wollongong LEP, drains to the existing properties via designated stormwater system. Detention system is required in this catchment to control the flows to the existing condition.

Each catchment can be further divided into seven (7) sub-catchments based on the discharge points as shown below and described in Table 3.

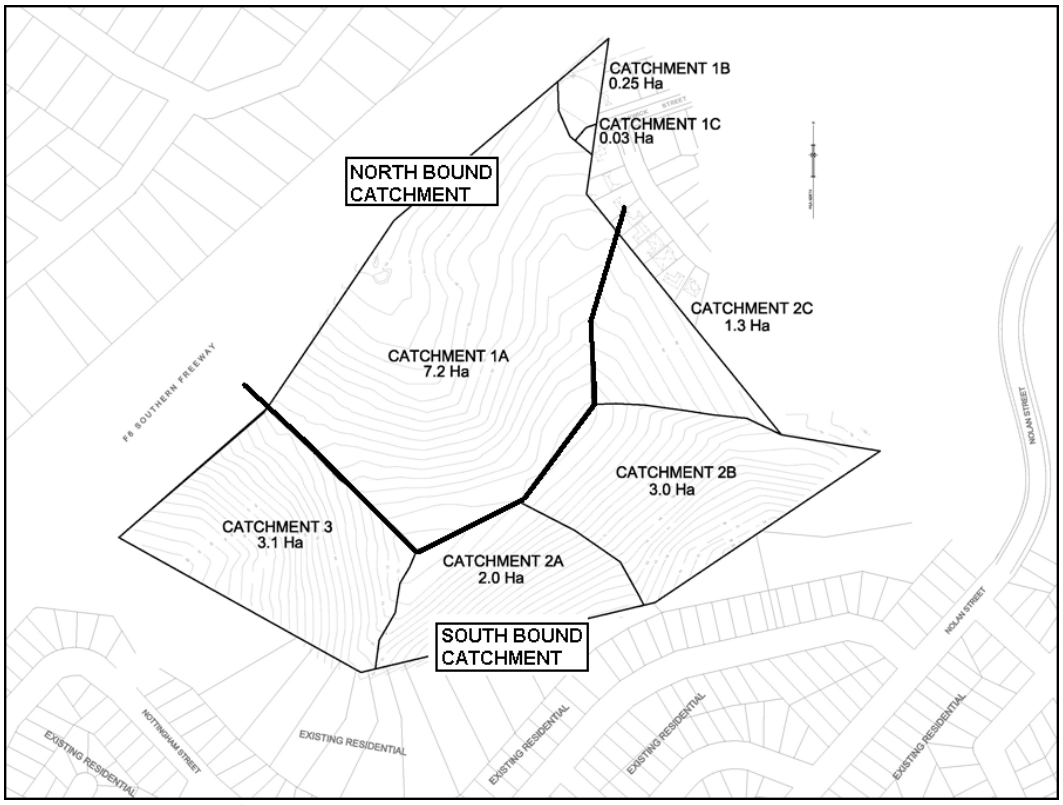

Figure 3 – Existing Catchments

Table 3 – Existing Catchment Description

Catchment	Area (Ha)	Description
1A	7.2	This subcatchment drains to the existing 1200mm diameter culvert under F6 Southern Freeway.
1B	0.25	This is a small subcatchment that drains to the reserve at the back of residential houses on the northern side of Warwick St, which then drains to the existing 1500mm diameter culvert under the F6 near Newcombe Street.
1C	0.03	This small subcatchment drains to Warwick Street stormwater system.
2A	2.0	This subcatchment discharges to the existing residential houses in Nottingham Street. Runoff from the roofs and hard surface areas will be directed to subcatchment 2B.
2B	3.0	This subcatchment discharges to the existing residential houses in Nottingham Street. There is a 450mm diameter pipe that collects runoff from the site.
2C	1.3	This subcatchment discharges to the existing residential houses in Hopman Crescent and to Nolan Street. Runoff from the development in this subcatchment will be directed to Nolan Street.
3	3.1	This subcatchment discharges to the back of the existing residential houses in York Street. There is no formal discharge point for the subcatchment. Runoff from the roofs and hard surface areas will be directed to subcatchment 1A.
Total	**16.88**	

5.2.2 Proposed Drainage System

The drainage system for the development will be designed to collect all surface runoff flows from impermeable surfaces such as roads, buildings and hard surface areas to the designated conveyancing system to the downstream drainage system in a safe manner.

The drainage system proposed for the development includes:

- A piped system to collect minor storm runoff from the developed areas,
- Grass lined swales off the edges of car parks,
- Gross pollutant traps at each minor storm outlet point;
- Rainwater tanks for each building,
- Bio-retention/Detention basins to reduce nutrient runoff and peak flows to pre-development levels.

The development of the above infrastructure will be provided on an “as needs” basis and will be constructed in stages. Drawing No PN-00864_SK08 shows the conceptual layout of the drainage system.

5.2.3 Preliminary Drainage Investigation

In according to Council record, the site is located within 'uncategorised flood precinct'. Given the topography of the site, it is unlikely the site is in any affectation from flooding other than from the local runoff, which will be safely mitigated. Details of the mitigation works have been addressed in this report.

A preliminary assessment of the drainage systems has been carried out using Council's Urban Drainage Design Manual and On-site Detention (OSD) calculation set in Council's On-Site Stormwater Detention Code, June 2006.

Although watershed boundaries should not be altered during the development, it was inevitable that some minor modification is necessary. Figure 4 below shows revised catchment upon development of the site.

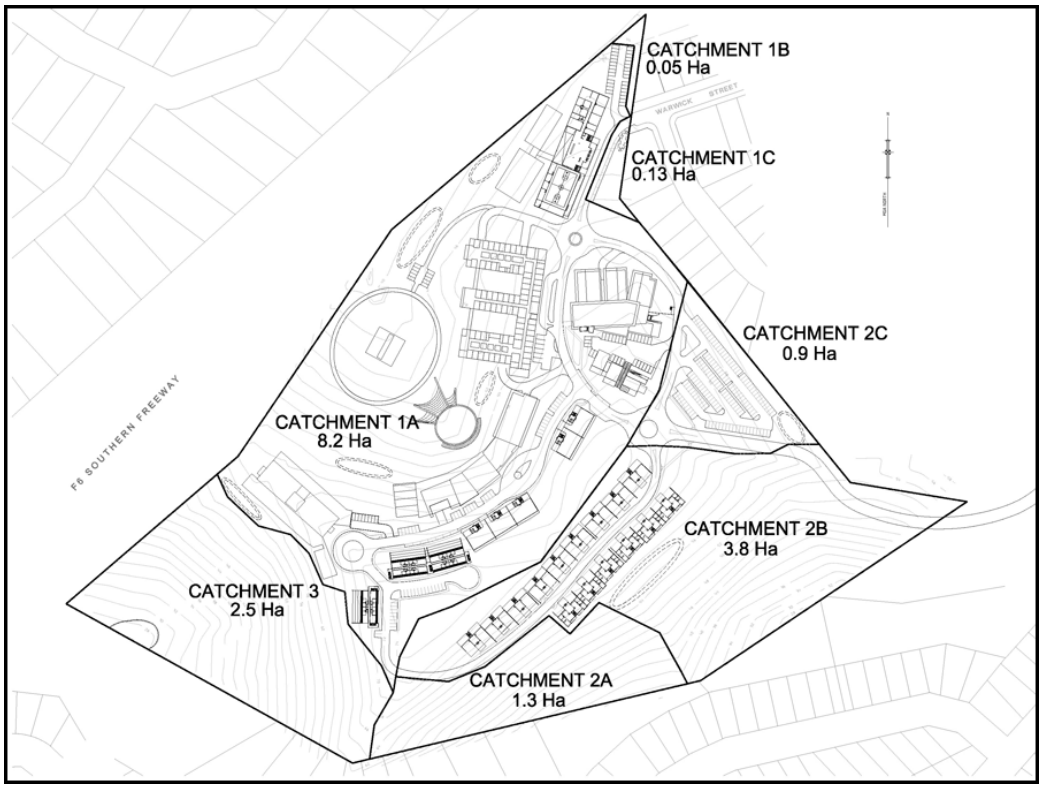

Figure 4 – Revised Catchments

As mentioned above, catchments 2A and 3 have no legal point of discharge. Therefore any development within these areas has to be re-directed to the adjacent catchments. The additional flows due to these areas will be compensated for in the On-site Detention (OSD) system.

The table below shows comparison between existing and post developed catchments.

Table 4 – Comparison of Existing and Developed Catchments

Subcatchment No.	Existing Catchments		Post Dev Catchment	
	Area (Ha)	% Imp	Area (Ha)	% Imp
1A	7.2	24[Note1]	8.2	70
1B	0.25	40[Note2]	0.05	0
1C	0.03	40[Note2]	0.13	40
2A	2.0	0	1.3	0
2B	3.0	0	3.8	30
2C	1.3	0	0.9	90
3	3.1	0	2.5	0

Note 1 – From Council's Urban Drainage Design Manual. 40% of 4.4ha of R2 over 7.2ha = 24%
Note 2 – From Council's Urban Drainage Design Manual.

Using Council's OSD calculation method the table below shows the Permissible Site Discharge (PSD) and Site Storage Requirements (SSR) for the 5 year ARI and 100 year ARI for each subcatchment.

Table 5 – OSD Requirements

Subcatchment No.	5 Year ARI Requirements		100yr ARI Requirements	
	PSD (m^3/s)	SSR (m^3)	PSD (m^3/s)	SSR (m^3)
1A	5.2	1,425	9.04	2,475
1B	OSD Not Required [Note1]			
1C	0.037	5.1	0.065	9.0
2A	OSD Not Required [Note2]			
2B	0.99	261	1.75	463
2C	0.23	95	0.4	168
3	OSD Not Required [Note2]			

Note 1 – The catchment has reduced from 0.25ha of 40% impervious to 0.05ha of no impervious area.
Note 2 – The catchment area has been reduced with no impervious area.

The bio-retention basins proposed on site will have additional storage for the OSD requirements. Drawing PN-00864_SK08 shows indicative locations of the Bio-retention/OSD basins.

This investigation shows, in principle, that the proposed drainage system can achieve its main function of safe conveyancing through the site without any adverse impact both on site and downstream site. The detail design of the drainage system will be submitted with the detailed engineering design.

5.3 Water Quality Control

5.3.1 Introduction

The quality of runoff from a catchment depends upon many factors such as land use, degree of urbanisation, population density, sanitation and waste disposal practices, landform, soil types, and climate. Pollutants typically transported by runoff include litter, sediment, nutrients, oil, grease, and heavy metals. Whilst these pollutants have deterious impact on receiving water quality, the suspended solids and nutrients are the most detrimental impact on the environment. Litter, oils, and other surfactants have an aesthetic impact.

Activity within a catchment during urbanisation includes the disturbance of vegetation, removal of topsoil, landshaping, road construction, installation of services, and building works. It is during this phase that the sediment movement is greatest and is estimated that the sediment production levels may be up to 6 times higher than under the existing conditions. However, once development is completed, the sediment loading may return to the existing level or remain at a higher level depending on land management practices.

This section of the report addresses the long term impacts of the development on water quality. For short term effects (i.e. during the construction phase) water quality control is achieved by implementing the requirements set in the Soil and Water Management Plan (Appendix F) and site specific Sedimentation & Erosion Control Plans prepared for each Stage of the construction.

5.3.2 Water Quality Control Measures

There are number of measures that can reduce pollutant loadings. Such measures may include:

- Litter baskets
- Gross Pollutant Traps (GPT)
- Grease and Silt Arrestors
- Grassed swales
- Vegetation Buffers
- Natural Streams
- Bioretention basins
- Wetlands
- Rainwater Tanks

Whilst all of the above are effective in reducing pollutant loadings to some degree, by far the most effective control system is a combination of two or more of the above measures in a conveyancing system, known as Treatment Train. This is because each one of the measures has a varying effectiveness for different types of pollutants.

The most effective treatment train consists of a gross pollutant trap (GPT), vegetation buffers, and either a bioretention basin or wetland. The GPT will intercept the majority of gross pollutants greater than 3mm then the vegetation buffer would filter coarse sediments before the final polishing of runoff by bioretention or a wetland.

It is proposed that this type of Treatment Train will be provided in the proposed Life City Wollongong development.

Each measure is described below:

Gross Pollutant Trap

As the name implies, this device is provided to trap gross pollutants including litter and sediments. The design of GPTs is site specific depending on the intended use. GPTs are generally sized to treat 50% of the 1 in 1 year storm with a pollutant holding capacity equal to a third of the annual load. In this investigation we have assumed that litter baskets will be installed within the kerb inlet pits along the proposed internal roads.

Vegetation Buffer

A buffer strip is a vegetated area of land which filters coarse to medium sediments by vegetation in un-channeled overland flow. It is necessarily located well upstream in a treatment train, before the flow has become concentrated into channels. It may be a physically identifiable strip of land, such as between a road and a parallel watercourse, but the buffer concept may also be used in a more notional way to model the effect of unconnected impervious areas on runoff water quality.

Vegetated Swale

A swale is a shallow vegetated ephemeral channel. The vegetation is often grass, but other types of vegetation may also be appropriate. Swales are typically located well upstream in a treatment train, where flows are intermittent and volumes are manageable. The standard swale in this study is based on a 1 m base width, 3 m top width, 0.3 m depth, and 50 mm high grass cover, with the length adjusted to alter the area ratio. These swales are located along the edges of on-grade carparks.

Rainwater Tanks

Rainwater tanks are an effective measure of removing the nutrients at source. The nutrient removal process is done by physically removing of water body thereby limiting the nutrients discharging to the waterways. Rainwater tanks are proposed throughout the development – Refer Section 5.4.

Bioretention

A bioretention system is a vertical filtration system that filters stormwater through a prescribed media (e.g. sandy loam) before being collected by an underlying perforated pipe for subsequent discharge to the receiving water.

The filtration media should have a permeability of at least one order of magnitude higher that the surrounding soils to ensure that the pathways of stormwater through the system is well-defined and directed at the perforated pipe underlain.

Filter effectiveness depends on both the surface area of the filter medium and the detention time in the filter, but is more sensitive to detention time. A coarser filter is less prone to clogging, but lower surface area and shorter detention times both reduce the treatment effectiveness. The standard bioretention basin in this study has an average retention depth of 300mm.

5.3.3 Water Quality Modelling

Water quality modelling relies on numerous factors and assumptions. There is a lack of calibrated data available within Australia, which places limits on the accuracy of water quality modelling.

The water quality model adopted for this project is the MUSIC (Model for Urban Stormwater Improvement Conceptualisation) water quality numerical model developed by the eWater. MUSIC is an event basis model, and will simulate the performance of a group of stormwater management measures, configured in series or in parallel to form a "treatment train".

The MUSIC model was generated using the historical 6-minute rainfall and available monthly evapotranspiration data for Port Kembla (BOM Station No. 67035) for a period of 10 years from 1997 to 2006. Catchment characteristics were defined using a combination of rural and urban catchments with varying imperviousness ratio to replicate the catchment for the post-development condition.

The MUSIC model layout is shown in Appendix C of this report.

The MUSIC model parameters used for the nutrient removal analysis for each treatment measure are default values set in the model.

5.3.4 Event Mean Concentration

MUSIC uses different event mean concentrations (EMC) to determine the pollutant loads generated by different land uses. The standard EMCs adopted within MUSIC were based on research undertaken by Duncan (1999) through the CRCCH and the results are reproduced in Australian Runoff Quality – A Guide to Water Sensitive Urban Design (ARQ).

The EMC values used in the MUSIC models for this project were obtained from ARQ. Table 6 summarises the parameters used for an industrial site.

Table 6 – EMC Parameters

Land Use	Mean Base Flow Concentration Parameters Log_{10} (mg/l)			Mean Storm flow Concentration Parameters Log_{10} (mg/l)		
	TSS	TP	TN	TSS	TP	TN
Development Area	1.100	-0.820	0.320	2.200	-0.450	0.420

5.3.5 Configuration

Figure 5 below shows catchment associated with each basin. The catchments generally conform with the watershed boundaries of Figure 3 in Section 5.2.3.

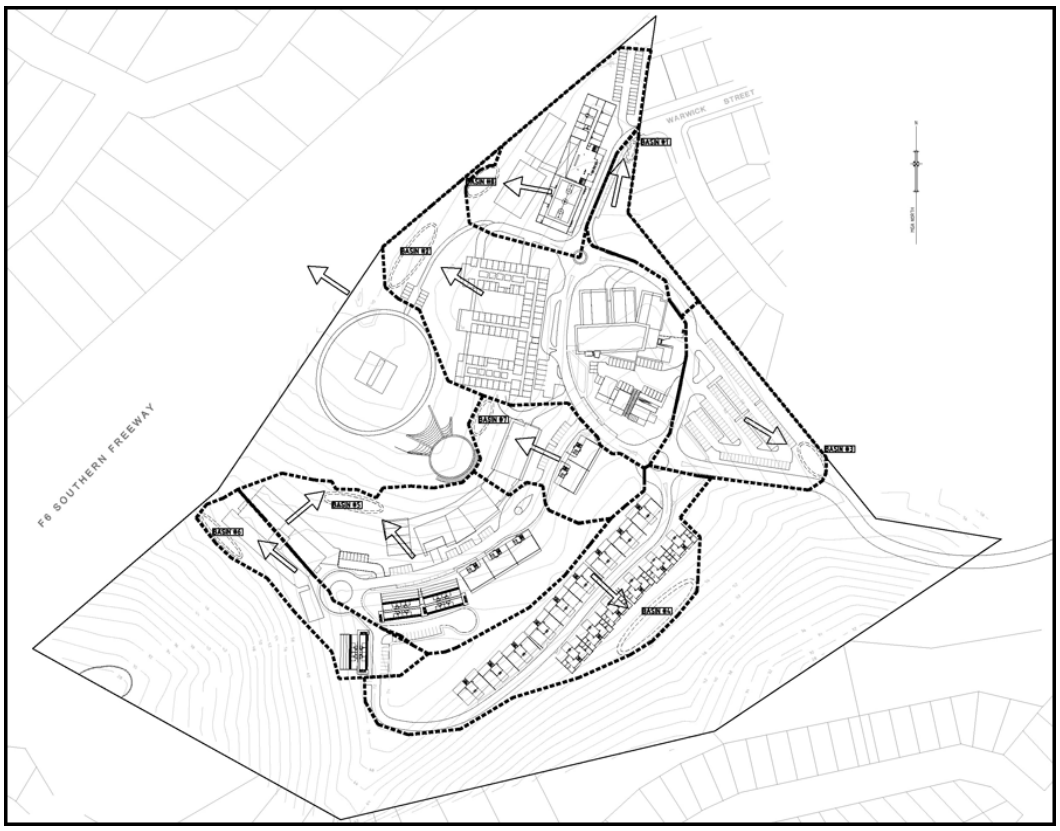

Figure 5 – MUSIC Catchments

Table 7 below provides the areas of catchment and basin used in the MUSIC model. As noted in Section 5.2.3, these bio-retention basins will be utilised as OSD basins for the catchment.

Table 7 – Water Quality Control Measures

Basin No	Catchment Area (ha)	Bioretention Area
1	0.288	45
2	2.08	535
3	1.10	245
4	1.45	750
5	2	300
6	0.28	200
7	0.735	175
8	0.95	250

5.3.6 Results of Modelling

The results of the MUSIC modelling are summarised in Table 8 below.

The total pollutant loads from the development are expressed in kilograms per year. The reduction rate is expressed as a percentage and compares the resulting pollution from the post developed site to that of the existing developed state of the site.

Table 8 – Summary of MUSIC Model Results

Parameter	Existing Site Load (Kg/Yr)	Developed Site Load with Treatment (Kg/Yr)	Reduction (%)	Target Achieved
GP	1,480	0	100	Yes
TSS	7,780	619	92	Yes
TP	17.8	3.99	77.6	Yes
TN	136	65	52	Yes

Notes:
GP = Gross Pollutants
TSS = Total Suspended Solids
TP = Total Phosphorus
TN = Total Nitrogen

In all instances, the proposed water quality control measures enabled the reduction targets to be achieved for all key stormwater pollutants.

Therefore, by implementing the proposed treatment measures within the proposed development there will be no detrimental effect on the quality of stormwater running off from the site.

5.4 Rainwater Harvesting and Reuse

A number of the water sensitive design measures to be adopted on the site will serve to integrate elements of the water cycle to reduce the loading placed on water and wastewater infrastructure, when compared with a business as usual approach.

For the purpose of this preliminary assessment, being an initial investigation into the potential for water sensitive design, opportunities to reduce demand on potable water and to reduce wastewater exported from the development will be explored through potential use of rainwater tanks to supplement water supply and installation of AAA fittings to reduce consumption of potable water.

It is important to note that the information in this report has been compiled to show what levels of reduction in potable water demand can be achieved and some of these measures may or may not be adopted in the final design for the project.

For the purposes of this report, a water balancing study has been undertaken to determine an approximate rainwater tank capacity requirement for the development. It is important to note that the proposed development will also be assessed under the BASIX legislation and this assessment will be used to determine final rainwater tank volumes and uses for the harvested rainwater.

The capacity of the rainwater tanks is a function of the local rainfall data, the catchment areas, and the water demand (irrigation, toilet flushing) placed upon the tanks. The rainfall data, which encompasses daily rainfall for the last 10 years, was obtained from the nearby Port Kembla rainfall station recorded by the Bureau of Meteorology. The modelling is done on a building by building basis as the roof area, tank size, water demand, and irrigation areas vary from building to building.

The water balance modelling was to determine what order of potable water demand reduction could be achieved by using harvested rainwater for various uses within the development.

5.4.1 Modelling

The model is a daily urban water balance model which has been developed to simulate the water cycle as an integrated whole and provide a tool for investigating the use of locally generated stormwater as a substitute for potable water.

Optimised tank size generally refers to the size that gives the minimum number of days the tank to dry or surcharge for a given roof area.

For the purposes of the model, it was assumed that the captured rainwater could be used for toilet flushing and irrigational uses except the hospital building where irrigation only proposed. The daily water demand for toilet flushing in the model is 50L/day per occupant as explained in Section 2.2.3. Likewise, the water demand for the irrigation has been derived based on an average usage of 7mm of water per week.

A summary of results is provided in Table 9 and corresponding Buildings/Stages are shown in Figure 6.

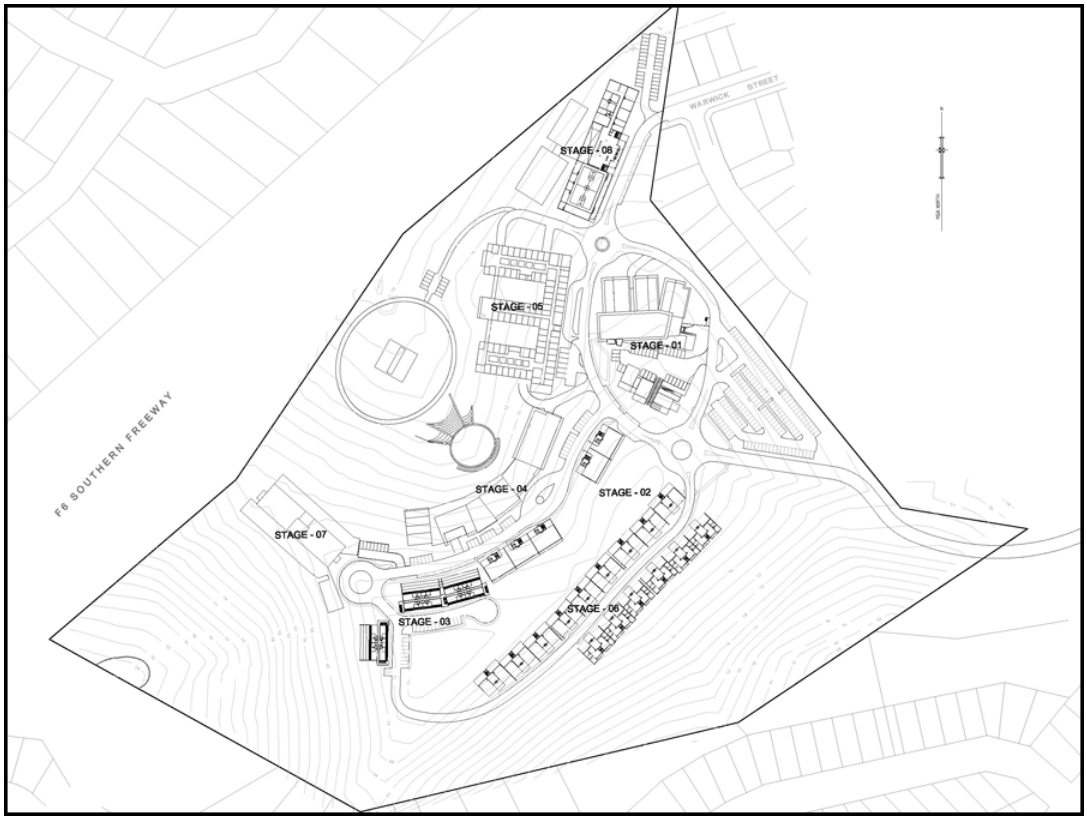

Figure 6 – Building/Stage layout

Table 9 – Summary of Water Balance Model Results

Building /Stage	Roof Area Connected (m2)	No of Occupants	Irrigation area (ha)	Rainwater Tank Size (KL)	Total Water Demand (kL/yr)	Total Rainwater Used (Kl/Yr)	% Potable Water Reuse
1	2000	50	0.3	250	1761	1403	80
2	No building. Landscaped area will be irrigated from Stage 3 buildings						
3	2500	75	0.4	200	1952	1530	79
4	2000	100	0.3	200	1660	1320	80
5	2000	-	0.25	50	700	580	82
6	2500	200	0.1	300	2500	1850	75
7	1500	160	0.1	300	2040	1270	60
8	2500	380	0.2	300	2320	1790	78

The above water balance modelling shows that a reduction in potable water demand of up to 80% can be achieved. In addition to the above, AAA fittings and appliances can reduce the potable water consumption by a further 10 to 15%.

Adoption of the rainwater tanks will provide an integrated, sustainable approach to water cycle management on the site by meeting the objectives set. These particular strategies are being adopted in other areas demonstrating their practicability which should be applicable to the Life City Wollongong development.

6. UTILITY SERVICES

6.1 Sewer

There is a DN150 sewermain in Warwick Street which we assume is for the future residential development of the site. Based on our flow calculation this main does not have capacity to service the Life City development. There is however a DN300 under the F6 Freeway which can be accessed via a public reserve at the back of residential houses on the northern side of Warwick Street.

The Feasibility Study from Sydney Water Corporation did not indicate any restrictions to the proposed development. However they have indicated that the existing sewermain may have to be extended and/or amplified to serve the development.

Sewer flow calculation for the development is included in Appendix D and the Feasibility Study from Sydney Water Corporation is in Appendix E.

6.2 Water

There are DN150 watermain in Nolan Street and DN100 watermain Warwick Street. It is likely that the site will be serviced by both mains. The Feasibility Study from Sydney Water Corporation did not indicate any restrictions to the proposed development. However they have indicated that the existing watermain may have to be extended and/or amplified to serve the development.

Water demand calculation for the development is included in Appendix D and the Feasibility Study from Sydney Water Corporation is in Appendix E.

6.3 Electricity and Telecommunications

Electricity and telecommunications (Telstra) services are all readily available adjacent to the site from Warwick Street and Nolan Street, and should not present any restrictions to the proposed development. All power, telecommunication and gas services within the development will be provided as underground services.

REFERENCES

- Wollongong DCP - Chapter B2: Residential Subdivision
- Wollongong DCP - Chapter E14: Stormwater Management
- Wollongong DCP - Chapter E15: Water Sensitive Urban Design
- Wollongong City Council - On-site Stormwater Detention Code
- Wollongong City Council - Urban Drainage Design Manual
- Coffey Geotechnics – Preliminary Geotechnical Assessment – Proposed Life City Wollongong, February 2013
- Institute of Engineers, Aust - *Australian Rainfall and Runoff*, 1987, 3rd edition.
- Institute of Engineers, Aust - – *Australian Rainfall Quality*, 2005
- eWater - *MUSIC Software Version 5.01*
- Austroads – Guide to Road Design, August 2009
- FAWB – Stormwater Biofiltration Systems, June 2009
- AS 2890.1 Off Street Car Parking
- AS 2890.2 Commercial Parking Facilities
- AS 1428 Design for Access and Mobility
- AS 1742 Manual of Uniform Traffic Control Devices
- New South Wales RTA - Traffic Control at Worksites manual
- Austroads – Guide to Road Design
- Austroads – Guide to Pavement Technology

APPENDIX A

CONCEPT ENGINEERING PLANS

A1

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P1	W.M.	02/11/12	E.S.	02/11/12	PRELIMINARY ISSUE

CLIENT

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ABN 21 118 134 240

C&M CONSULTING ENGINEERS

DESIGNED	J. WANG	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	J. WANG	SCALE @ A1	1:1000

LIFE CITY WOLLONGONG

GENERAL ARRANGEMENT PLAN

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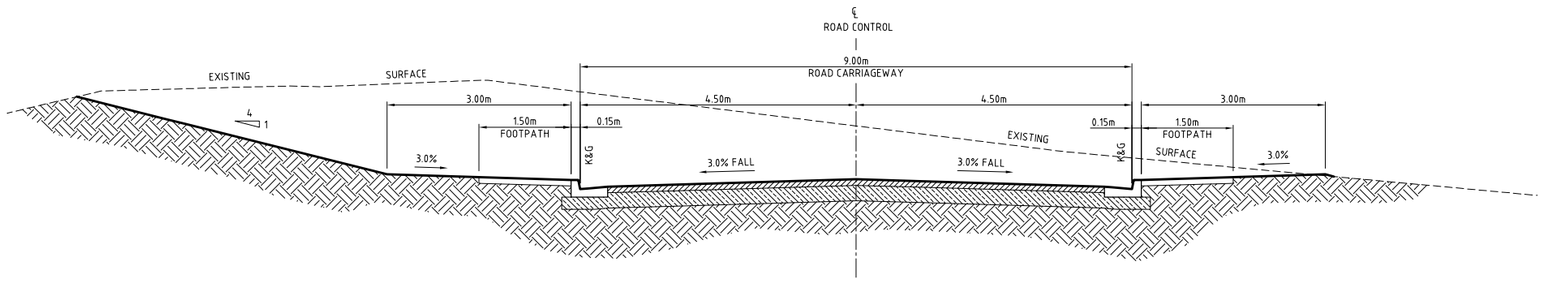

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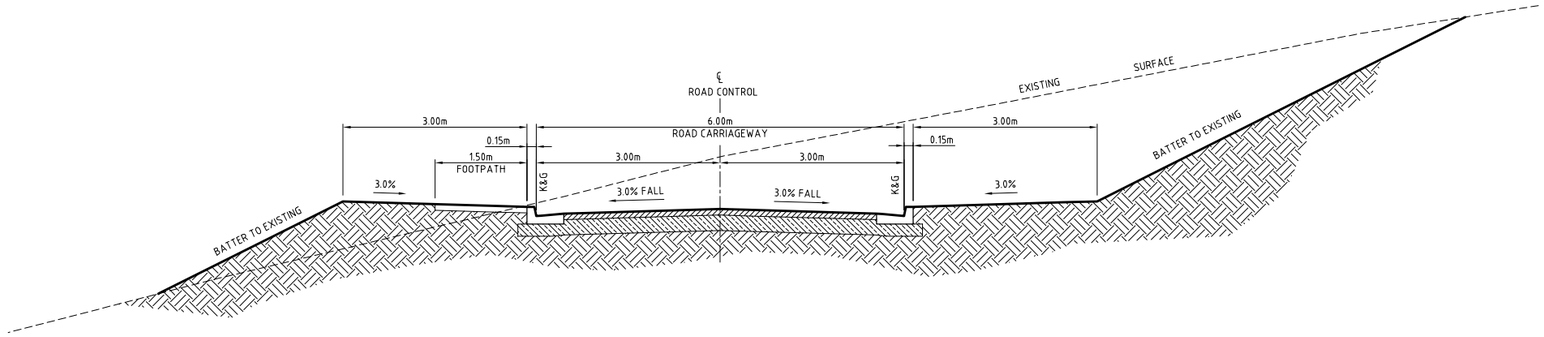

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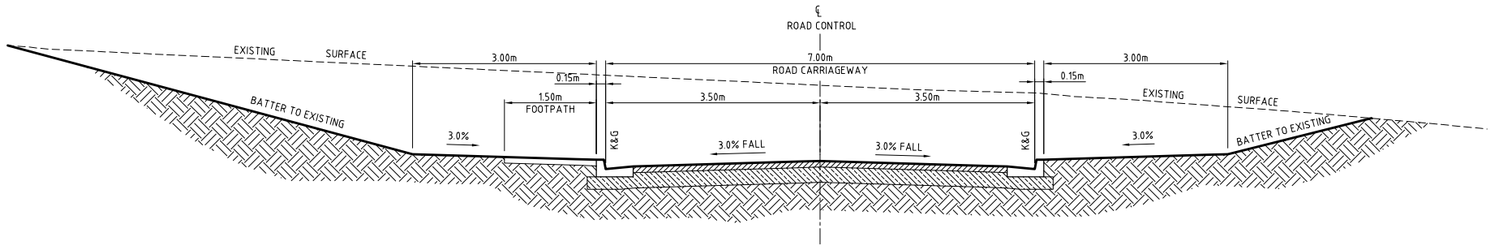

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1000 500
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VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	J. WANG	SCALE @ A1	AS NOTED

LIFE CITY WOLLONGONG

TYPICAL ROAD SECTIONS

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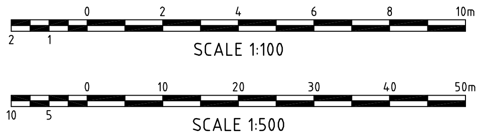

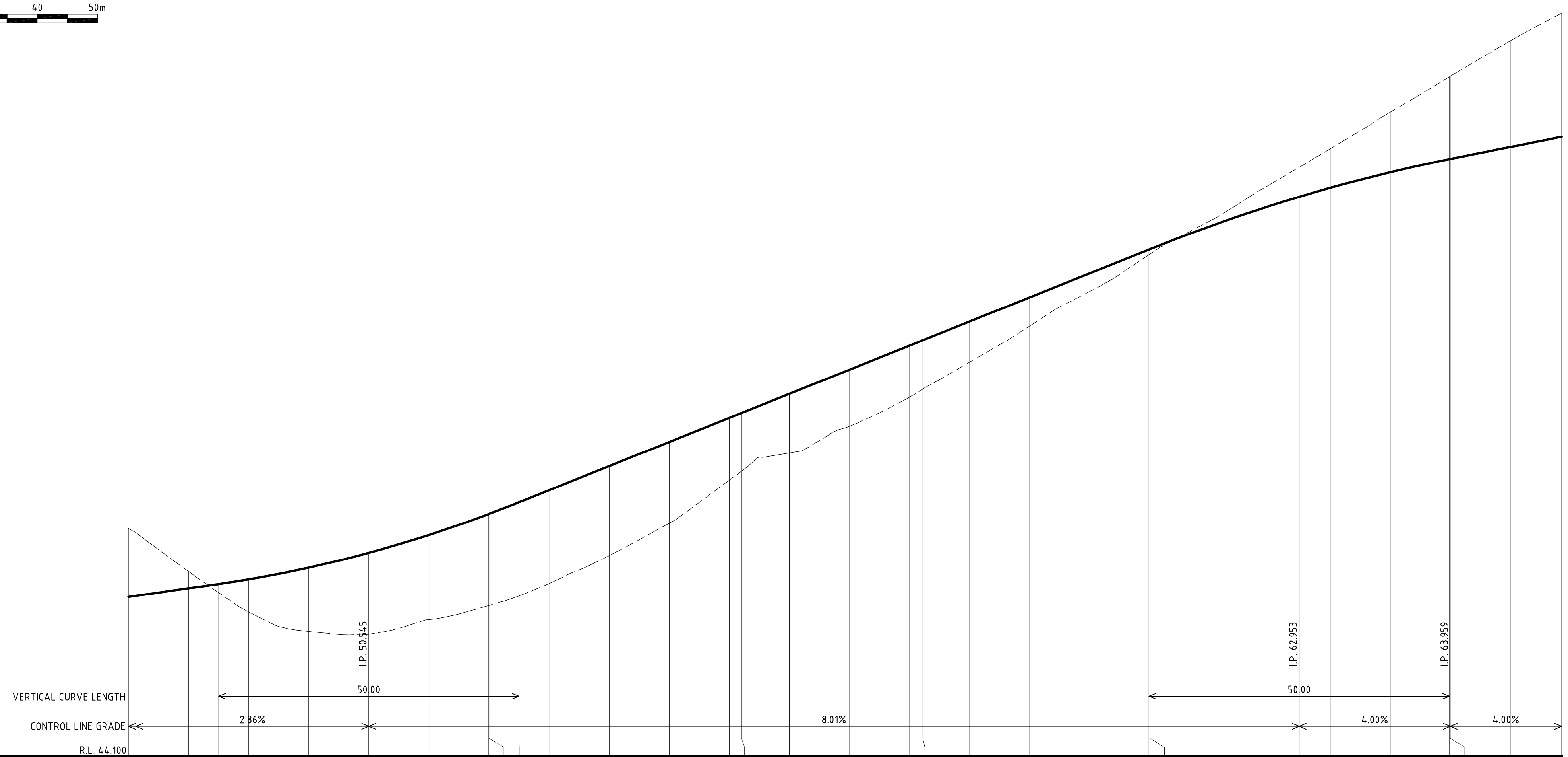

CUT / FILL DEPTHS ALONG CONTROL LINE	-2.275	-0.558	+0.287	+1.081	+2.124	+2.712	+2.813	+3.042	+3.043	+3.111	+3.104	+2.976	+2.842	+2.699	+2.071	+1.934	+1.968
DESIGN SURFACE LEVEL ALONG CONTROL LINE	49.401	49.687	49.830	49.985	50.375	50.867	51.462	52.157	52.160	52.548	52.949	53.750	54.173	54.551	55.353	55.515	56.154
EXISTING SURFACE LEVEL ALONG CONTROL LINE	51.675	50.245	49.542	48.904	48.251	48.155	48.649	49.115	49.117	49.437	49.844	50.774	51.331	51.852	53.281	53.581	54.186
CHAINAGE ALONG CONTROL LINE	190.000	200.000	205.000	210.000	220.000	230.000	240.000	249.958	250.000	255.000	260.000	270.000	275.279	280.000	290.000	292.028	300.000

CUT / FILL DEPTHS ALONG CONTROL LINE	+1.883	+1.710	+1.623	+1.351	+0.950	+0.603	+0.171	+0.163	-0.181	-0.713		-1.297	-1.997	-2.741	-2.754	-3.530	-4.110
DESIGN SURFACE LEVEL ALONG CONTROL LINE	56.955	57.757	57.932	58.558	59.359	60.160	60.950	60.962	61.722	62.401	62.702	63.001	63.520	63.953	63.959	64.359	64.700
EXISTING SURFACE LEVEL ALONG CONTROL LINE	55.073	56.046	56.310	57.207	58.409	59.558	60.779	60.799	61.903	63.114		64.298	65.517	66.694	66.713	67.889	68.810
CHAINAGE ALONG CONTROL LINE	310.000	320.000	322.195	330.000	340.000	350.000	359.850	360.000	370.000	380.000	384.850	390.000	400.000	409.850	410.000	420.000	428.523

LONGITUDINAL SECTION ALONG ROAD No.1

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DESIGNED	W.MARTIN	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	W.MARTIN	SCALE @ A1	1:1000

LIFE CITY WOLLONGONG

ROAD LONGITUDINAL SECTIONS
SHEET 1 of 5

STATUS MASTERPLANNING | DRAWING No. 00864_SK03 | REVISION P2

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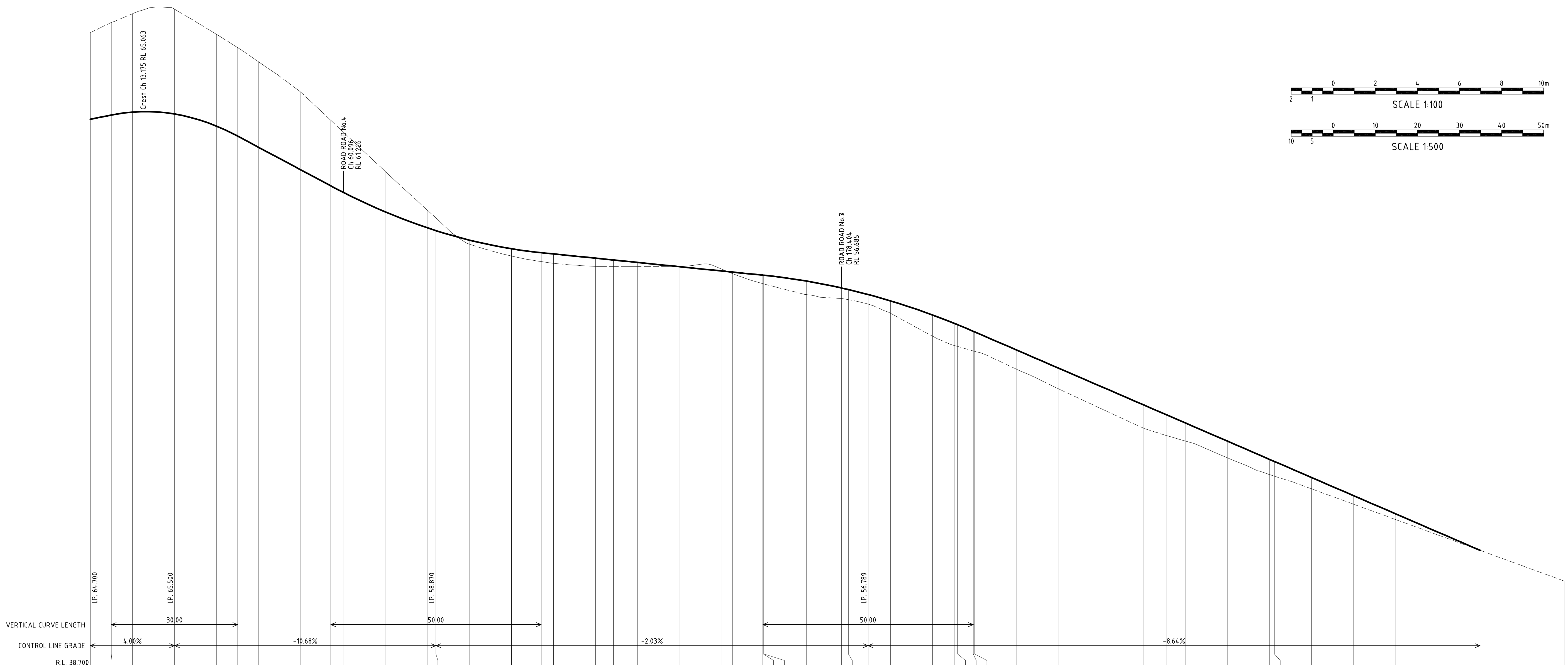

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0.000	-4.110	64.700	68.810
5.000	-4.396	64.900	69.296
10.000	-4.671	65.039	69.710
20.000	-4.979	64.950	69.928
30.000	-4.356	64.371	68.727
35.000	-4.205	63.898	68.103
40.000	-4.061	63.364	67.425
50.000	-3.687	62.296	65.984
57.078	-3.116	61.540	64.657
60.000	-2.869	61.236	64.105
70.000	-1.923	60.305	62.228
80.000	-0.842	59.547	60.389
82.078		59.411	
90.000	+0.193	58.962	58.769
100.000	+0.346	58.550	58.204
107.078	+0.424	58.363	57.939
110.000	+0.443	58.304	57.861
120.000	+0.387	58.101	57.714
124.233	+0.309	58.015	57.706
130.000	+0.188	57.898	57.710
140.000	-0.022	57.696	57.718
150.000	-0.083	57.493	57.576
152.535	+0.072	57.441	57.369
159.694	+0.405	57.296	56.891
159.809	+0.409	57.294	56.885
160.000	+0.415	57.290	56.875
170.000	+0.643	57.017	56.374
178.404	+0.495	56.685	56.191
180.000	+0.480	56.612	56.132
184.694		56.376	
190.000	+0.584	56.074	55.490
196.497	+0.881	55.654	54.773
200.000	+1.004	55.404	54.400
205.262	+1.047	54.998	53.951
205.955	+1.031	54.942	53.911
209.694	+0.934	54.628	53.694
210.000	+0.926	54.602	53.676
220.000	+0.913	53.737	52.824
230.000	+0.983	52.873	51.890
240.000	+1.051	52.009	50.957
250.000	+1.108	51.144	50.036
255.489	+0.984	50.670	49.685
260.000	+0.862	50.280	49.418
270.000	+0.791	49.415	48.624
280.000	+0.724	48.551	47.827
281.187	+0.700	48.448	47.748
290.000	+0.539	47.686	47.148
300.000	+0.404	46.822	46.418
310.000	+0.269	45.958	45.688
320.000	+0.135	45.093	44.959
330.000	+0.000	44.229	44.229
340.000			43.499
350.000			42.769

LONGITUDINAL SECTION ALONG ROAD No.2

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P1	W.M.	02/11/12	E.S.	02/11/12	PRELIMINARY ISSUE

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DESIGNED	W.MARTIN	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	W.MARTIN	SCALE @ A1	1:1000

LIFE CITY WOLLONGONG

ROAD LONGITUDINAL SECTIONS
SHEET 2 of 5

STATUS: MASTERPLANNING | DRAWING No. 00864_SK04 | REVISION P2

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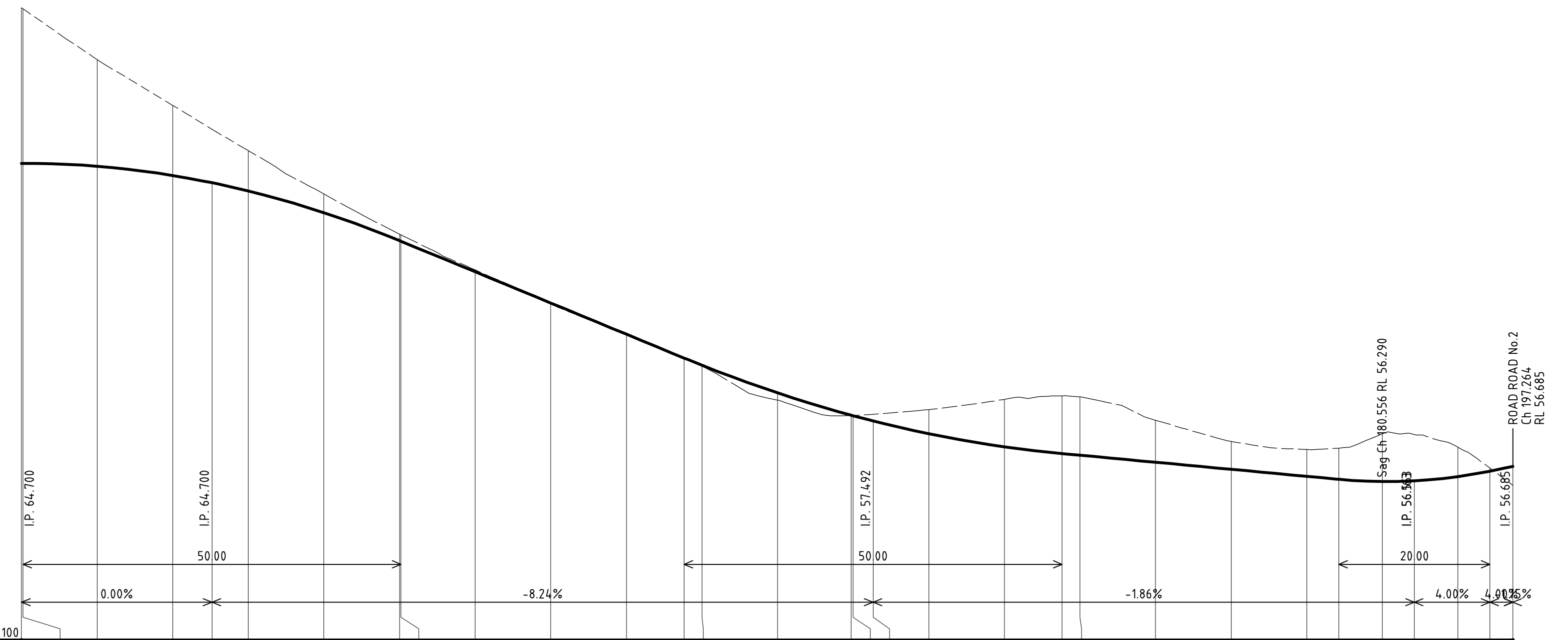

CHAINAGE ALONG CONTROL LINE	CUT / FILL DEPTHS ALONG CONTROL LINE	DESIGN SURFACE LEVEL ALONG CONTROL LINE	EXISTING SURFACE LEVEL ALONG CONTROL LINE
0.000	-4.110	64.700	68.810
0.196	-4.083	64.700	68.783
10.000	-2.821	64.621	67.442
20.000	-1.855	64.377	66.231
25.196		64.185	
30.000	-1.065	63.968	65.033
40.000	-0.495	63.394	63.889
50.000	-0.173	62.655	62.828
50.196	-0.170	62.639	62.809
60.000	-0.051	61.831	61.882
70.000	+0.007	61.007	61.000
80.000	-0.008	60.183	60.191
87.643	-0.011	59.553	59.564
90.000	+0.025	59.362	59.337
100.000	+0.190	58.632	58.441
109.730	+0.012	58.044	58.032
110.000	-0.005	58.029	58.034
112.643		57.891	
120.000	-0.636	57.554	58.190
130.000	-1.255	57.207	58.462
137.643	-1.527	57.028	58.554
140.000	-1.540	56.984	58.524
150.000	-1.111	56.798	57.910
160.000	-0.733	56.613	57.345
170.000	-0.707	56.427	57.134
174.219	-0.824	56.349	57.173
180.000	-1.261	56.290	57.551
184.219		56.309	
190.000	-0.777	56.420	57.197
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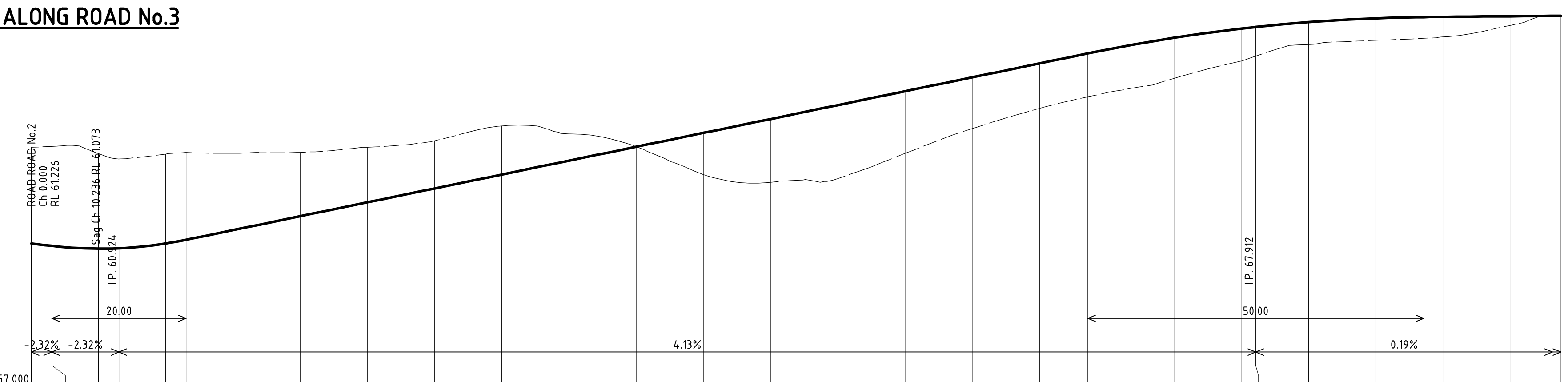
197.264	+0.495	56.685	56.191

LONGITUDINAL SECTION ALONG ROAD No.3



CHAINAGE ALONG CONTROL LINE	CUT / FILL DEPTHS ALONG CONTROL LINE	DESIGN SURFACE LEVEL ALONG CONTROL LINE	EXISTING SURFACE LEVEL ALONG CONTROL LINE
0.000	-2.860	61.226	64.086
3.052	-2.958	61.156	64.114
10.000	-2.828	61.073	63.900
13.052		61.085	
20.000	-2.660	61.226	63.887
23.052	-2.596	61.337	63.934
30.000	-2.284	61.624	63.909
40.000	-1.898	62.038	63.935
50.000	-1.640	62.451	64.091
60.000	-1.415	62.864	64.279
70.000	-1.449	63.277	64.726
80.000	-0.798	63.690	64.489
90.000	-0.003	64.104	64.107
100.000	+1.240	64.517	63.277
110.000	+1.881	64.930	63.049
120.000	+2.185	65.343	63.158
130.000	+1.850	65.756	63.906
140.000	+1.524	66.170	64.646
150.000	+1.336	66.583	65.247
157.159	+1.288	66.879	65.591
160.000	+1.283	66.993	65.710
170.000	+1.205	67.344	66.140
180.000	+0.965	67.617	66.652
182.159		67.666	
190.000	+0.665	67.811	67.146
200.000	+0.658	67.926	67.268
207.159	+0.632	67.960	67.328
210.000	+0.596	67.966	67.370
220.000	+0.271	67.985	67.714
227.550	-0.013	68.000	68.013

LONGITUDINAL SECTION ALONG ROAD No.4

SCALE 1:100

SCALE 1:500

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REV.	DES.	DATE	VER.	DATE	DESCRIPTION
P2	W.M.	21/11/12	E.S.	21/11/12	ISSUE FOR EA SUBMISSION
P1	W.M.	02/11/12	E.S.	02/11/12	PRELIMINARY ISSUE

CLIENT

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FAX: (02) 9687 9393
ABN 21 118 134 240

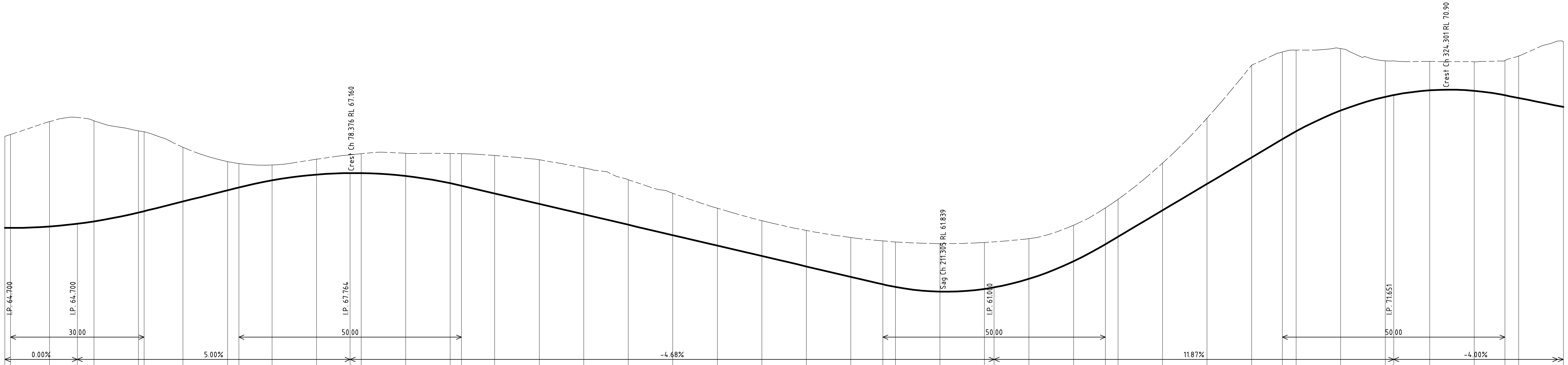
DESIGNED	W.MARTIN	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	W.MARTIN	SCALE @ A1	1:1000

LIFE CITY WOLLONGONG

ROAD LONGITUDINAL SECTIONS SHEET 3 of 5

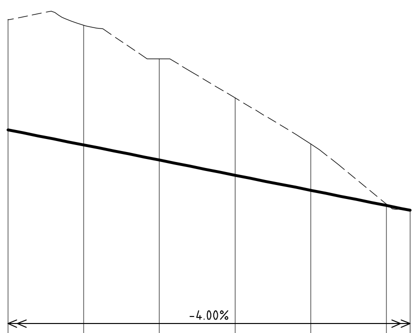
STATUS MASTERPLANNING | DRAWING No. 00864_SK05 | REVISION P2

A1



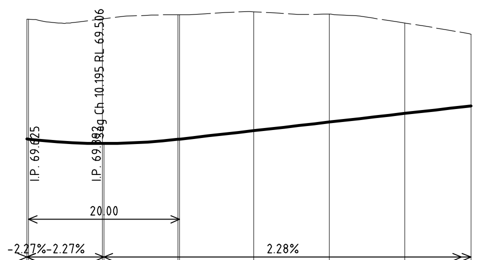
CHAINAGE ALONG CONTROL LINE	CUT / FILL DEPTHS ALONG CONTROL LINE	DESIGN SURFACE LEVEL ALONG CONTROL LINE	EXISTING SURFACE LEVEL ALONG CONTROL LINE
0.000	-4.110	64.700	68.810
1.261	-4.191	64.700	68.891
10.000	-4.701	64.764	69.465
16.261		64.888	
20.000	-4.513	64.993	69.506
30.000	-3.666	65.388	69.054
31.261	-3.563	65.450	69.013
40.000	-2.430	65.887	68.317
50.000	-1.287	66.387	67.674
52.541	-1.073	66.514	67.587
60.000	-0.687	66.833	67.520
70.000	-0.692	67.092	67.784
77.541		67.159	
80.000	-0.876	67.157	68.033
90.000	-1.019	67.029	68.048
100.000	-1.334	66.707	68.041
102.541	-1.439	66.595	68.034
110.000	-1.707	66.246	67.953
120.000	-1.981	65.778	67.760
130.000	-2.086	65.311	67.396
140.000	-2.022	64.843	66.865
150.000	-1.881	64.375	66.256
160.000	-1.675	63.908	65.582
170.000	-1.585	63.440	65.025
180.000	-1.614	62.972	64.586
190.000	-1.764	62.505	64.268
197.172	-1.947	62.169	64.116
200.000	-2.022	62.050	64.072
210.000	-2.153	61.842	63.995
220.000	-2.081	61.964	64.045
222.172		62.034	
230.000	-1.802	62.417	64.219
240.000	-1.619	63.201	64.820
247.172	-1.633	63.967	65.600
250.000	-1.681	64.303	65.984
260.000	-2.115	65.490	67.605
270.000	-2.948	66.677	69.624
280.000	-4.138	67.864	72.002
286.914	-3.906	68.684	72.590
290.000	-3.641	69.035	72.677
300.000	-2.782	69.966	72.747
310.000	-1.614	70.578	72.192
311.914		70.659	
320.000	-1.293	70.874	72.167
330.000	-1.305	70.851	72.156
336.914	-1.563	70.650	72.213
340.000	-1.886	70.527	72.412
350.000	-2.919	70.126	73.046

LONGITUDINAL SECTION ALONG ROAD No.5



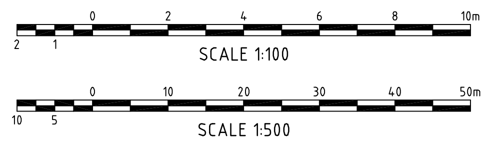
CUT / FILL DEPTHS ALONG CONTROL LINE	-2.919	-3.165	-2.676	-2.045	-1.227	-0.036	-0.013
DESIGN SURFACE LEVEL ALONG CONTROL LINE	70.126	69.726	69.326	68.925	68.525	68.124	68.000
EXISTING SURFACE LEVEL ALONG CONTROL LINE	73.046	72.891	72.001	70.970	69.752	68.161	68.013
CHAINAGE ALONG CONTROL LINE	350.000	360.000	370.000	380.000	390.000	400.000	403.107

LONGITUDINAL SECTION ALONG ROAD No.5



CUT / FILL DEPTHS ALONG CONTROL LINE	-3.170	-3.171	-3.296		-3.298	-3.293	-3.146	-2.852	-2.394	-1.897
DESIGN SURFACE LEVEL ALONG CONTROL LINE	69.625	69.620	69.506	69.506	69.616	69.621	69.844	70.072	70.300	70.500
EXISTING SURFACE LEVEL ALONG CONTROL LINE	72.795	72.791	72.802		72.913	72.913	72.990	72.924	72.694	72.397
CHAINAGE ALONG CONTROL LINE	0.000	0.214	10.000	10.214	20.000	20.214	30.000	40.000	50.000	58.743

LONGITUDINAL SECTION ALONG ROAD No.6



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REV.	DES.	DATE	VER.	DATE	DESCRIPTION
P2	W.M.	21/11/12	E.S.	21/11/12	ISSUE FOR EA SUBMISSION
P1	W.M.	02/11/12	E.S.	02/11/12	PRELIMINARY ISSUE

CLIENT

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FAX: (02) 9687 9393
ABN 21 118 134 240

DESIGNED	W.MARTIN	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	W.MARTIN	SCALE @ A1	1:1000

LIFE CITY WOLLONGONG

ROAD LONGITUDINAL SECTIONS
SHEET 4 of 5

STATUS: MASTERPLANNING | DRAWING No. 00864_SK06 | REVISION P2

A1

0 20 40 60 80 100m
20 10
SCALE 1:1000

CUT/FILL CHART

No.	Min. Depth	Max. Depth	Shade
1	-	-4.000	
2	-4.000	-2.000	
3	-2.000	0.000	
4	0.000	2.000	
5	2.000	4.000	
6	4.000	-	

CAD FILENAME: D:\C&M\Projects\PN-00864 - Life City Berkeley\ACAD\00864_SK07.dwg

REV.	DES.	DATE	VER.	DATE	DESCRIPTION
P2	W.M.	21/11/12	E.S.	21/11/12	ISSUE FOR EA SUBMISSION
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CLIENT

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ABN 21 118 134 240

DESIGNED	J. WANG	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	J. WANG	SCALE @ A1	1:1000

LIFE CITY WOLLONGONG

PRELIMINARY BULK EARTHWORKS

STATUS	DRAWING No.	REVISION
MASTERPLANNING	00864_SK07	P2

A1

CAD FILENAME: D:\C&M\Projects\PN-00864 - Life City Berkeley\ACAD\00864_SK08.dwg

REV.	DES.	DATE	VER.	DATE	DESCRIPTION
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P1	W.M.	02/11/12	E.S.	02/11/12	PRELIMINARY ISSUE

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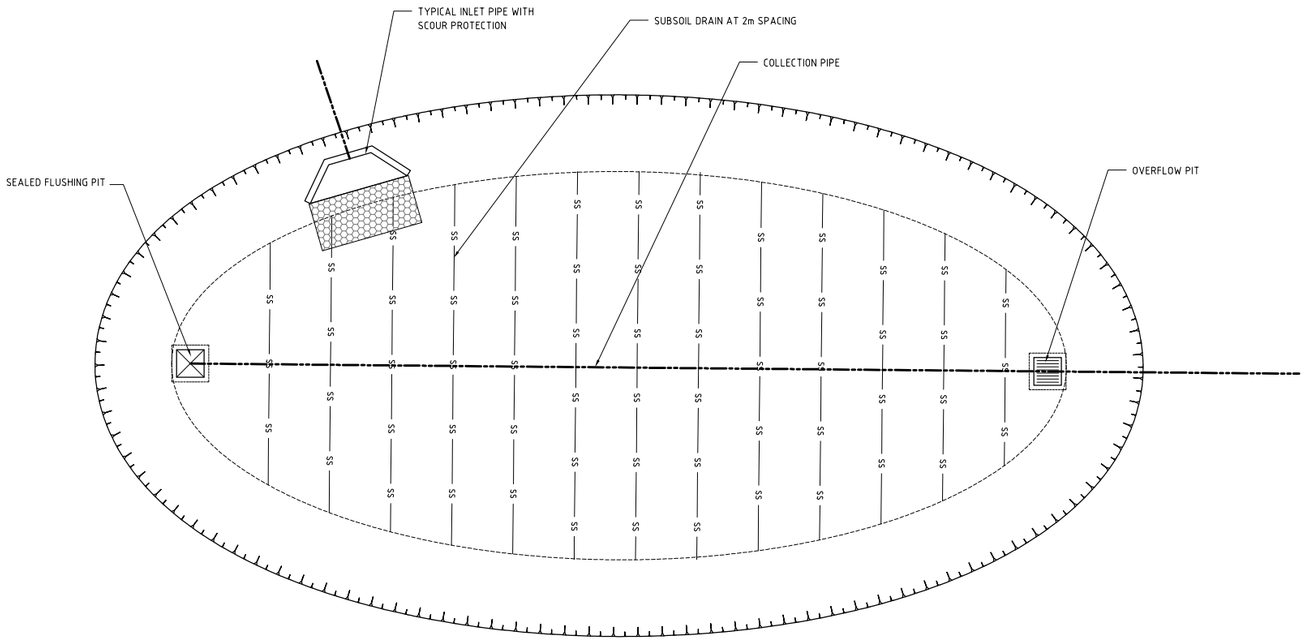
DESIGNED	W.MARTIN	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	W.MARTIN	SCALE @ A1	1:1000

LIFE CITY WOLLONGONG

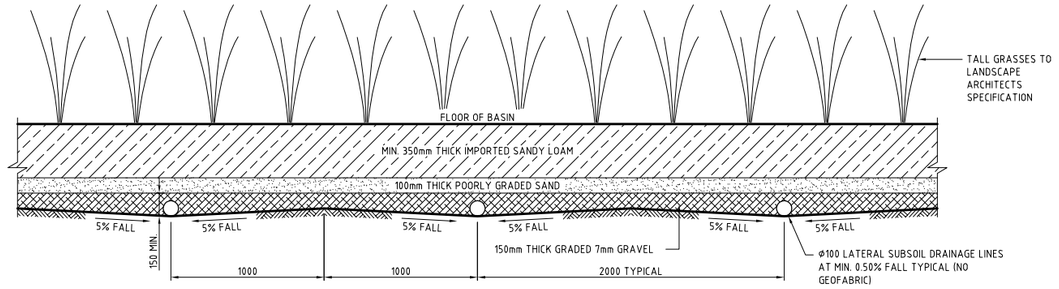
CONCEPT STORMWATER PLAN

STATUS	DRAWING No.	REVISION
MASTERPLANNING	00864_SK08	P2

A1



TYPICAL BIORETENTION PLAN
SCALE 1:100



TYPICAL BIO-RETENTION PROFILE PERPENDICULAR TO LATERAL SUBSOILS
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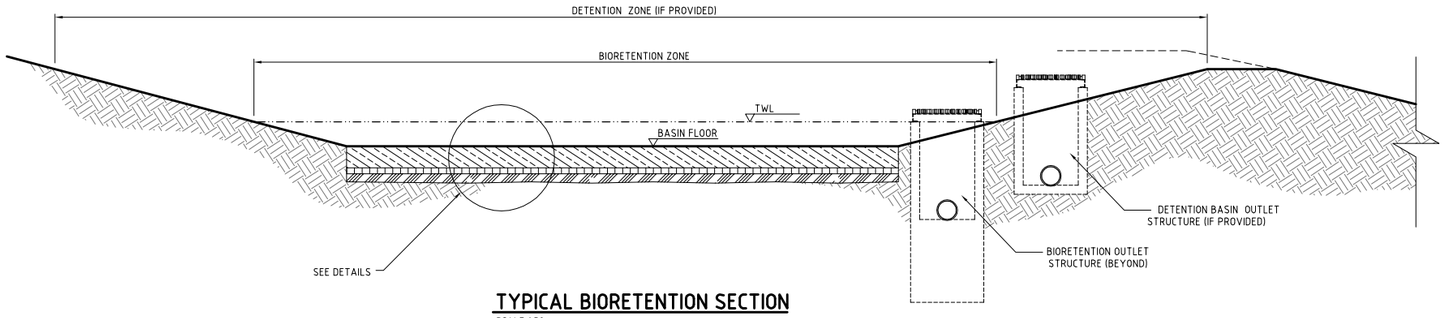

TYPICAL BIORETENTION SECTION
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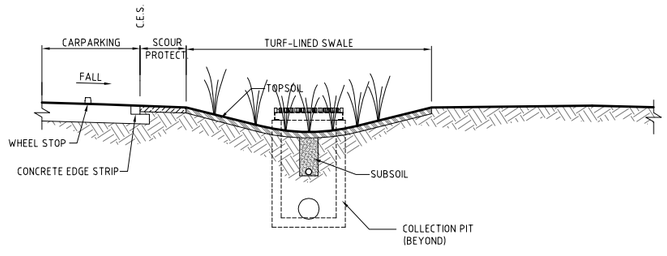

TYPICAL BIO-SWALE SECTION
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REV.	DES.	DATE	VER.	DATE	DESCRIPTION
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P1	W.M.	02/11/12	E.S.	02/11/12	PRELIMINARY ISSUE

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DESIGNED	W.MARTIN	DATE	24/09/12
VERIFIED	E. SHIN	DATE	24/08/12
DRAWN	W.MARTIN	SCALE @ A1	AS NOTED

LIFE CITY WOLLONGONG

CONCEPT STORMWATER TYPICAL SECTIONS

STATUS	DRAWING No.	REVISION
MASTERPLANNING	00864_SK09	P2

APPENDIX B

OSD CALCULATION SHEETS

WOLLONGONG CITY COUNCIL OSD DESIGN SHEET

Catchment: 1A

AREA	82000	m2	Total Site Area
AREA_Trib	82000	m2	Tributary area to OSD
AREA_Imp (Trib)	57400	m2	Imp Area within Trib
Imp_Exist	21.5	%	
Imp_Post	70.0	%	
I_1 (50)	95	mm/hr	1 hour 50year ARI Intensity (App A2)
F1(5)	1.06551625		
F1(100)	1.05763135		
F2	2.35		
F3	0.17		
F4	1.69		

RESULTS

PSD (5)	5205.8	L/s
SSR (5)	1425.3	m3
PSD (100)	9038.0	L/s
SSR (100)	2474.5	m3

WOLLONGONG CITY COUNCIL OSD DESIGN SHEET

Catchment: 1C

AREA	1300	m2	Total Site Area
AREA_Trib	1300	m2	Tributary area to OSD
AREA_Imp (Trib)	520	m2	Imp Area within Trib
Imp_Exist	9.2	%	
Imp_Post	40.0	%	
I_1 (50)	95	mm/hr	1 hour 50year ARI Intensity (App A2)
F1(5)	1.0182904		
F1(100)	1.022856544		
F2	1.11		
F3	0.11		
F4	0.60		

RESULTS

PSD (5)	37.3	L/s
SSR (5)	5.1	m3
PSD (100)	65.4	L/s
SSR (100)	8.9	m3

WOLLONGONG CITY COUNCIL OSD DESIGN SHEET

Catchment: 2B

AREA	38000	m2	Total Site Area
AREA_Trib	38000	m2	Tributary area to OSD
AREA_Imp (Trib)	11400	m2	Imp Area within Trib
Imp_Exist	0	%	
Imp_Post	30.0	%	
I_1 (50)	95	mm/hr	1 hour 50year ARI Intensity (App A2)
F1(5)	0.98		
F1(100)	0.9938		
F2	1.05		
F3	0.09		
F4	1.40		

RESULTS

PSD (5)	988.6	L/s
SSR (5)	261.0	m3
PSD (100)	1753.5	L/s
SSR (100)	463.0	m3

WOLLONGONG CITY COUNCIL OSD DESIGN SHEET

Catchment: 2C

AREA	9000	m2	Total Site Area
AREA_Trib	9000	m2	Tributary area to OSD
AREA_Imp (Trib)	8100	m2	Imp Area within Trib
Imp_Exist	0	%	
Imp_Post	90.0	%	
I_1 (50)	95	mm/hr	1 hour 50year ARI Intensity (App A2)
F1(5)	0.98		
F1(100)	0.9938		
F2	1.01		
F3	0.19		
F4	0.97		

RESULTS

PSD (5)	225.9	L/s
SSR (5)	94.9	m3
PSD (100)	400.6	L/s
SSR (100)	168.3	m3

APPENDIX C

RAINWATER BALANCE MODEL

PROJECT:	**LIFE CITY WOLLONGONG**
RAINFALL DATA:	**PORT KEMBLA FROM 1996 TO 2005**
DESIGNER	**ES**
DATE:	

ROOF AREA (Ha)	0.2
NON-ROOF AREA (Ha)	0
FRACTION IMPERVIOUS	0
PERVIOUS LOSS COEFF	0.3
Max Tank/pond Capacity (m3)	250
Average Surface Area (m2)	0
Pond base area (m2)	0
Average Infiltration rate (mm/hr)	0
Porosity of soil (%)	0%
Usage:	
Total Number of occupants	50
Toilet Flushing (l/d/person)	50
Laundary (l/d/person)	0
Other usage (l/d/person)	0
Total Domestic Usage (m3/d)	2.50
Irrigation Area (m2)	3000
Max Irrigation Rate (mm/day)	1
No irrigation if rainfall > (mm)	1
Max Irrigation Usage (m3/d)	3
Daily Infiltration (m3)	0.00
% Irrigation water re-collected	0

SUMMARY RESULTS

Average Annual Rainfall (mm)	947

Total No. Days:	3653
Total # days with empty tank	628
Percentage:	17.2%
Total # days with overflow/full tank	107
Percentage:	2.9%

Total Annual Runoff Collected (KL)	1894
Average Annual Rainwater Usage (KL)	1403
% Reuse	74.1%
Total Average Annual Water Demand (KL)	1761
Average Annual Potable Water Required (KL)	358
Potable Water Usage (%)	20.3%

APPENDIX D

SEWER FLOWS AND WATER DEMANDS CALCULATIONS

SEWER DISCHARGE

Stage	Description	Unit				EP/Unit	Total EP	
		Building GFA (m2)	Dwelling	Beds	Person			
1	**Day surgery & Specialist Rooms**; Medical Centre, Child Care Centre, Respite care Centre and the initial structural works and major tree planting for Precinct B.	4800				0.0075	36	Assumed Local Commercial
2	**Holistic Health Course** including Yoga, Reiki, Laughter Therapy, Meditation, Auras and Pranic Healing and outdoor structures for these activities.	-					0	
3	**Serviced Apartment** for attendants of patients and patients seeking outpatients services.			75		2.5	187.5	Single occupancy high density dwelling units
4	**Educational & Research**; Library + Lecture theatre Auditorium + Research & Development facility	3000				0.0075	22.5	Assumed Local Commercial
	Ancillary Accommodation for doctors, nurses and students.		30			2.5	75	Single occupancy high density dwelling units
5	**High-Tech Holistic Cancer & Medical Hospital** (Tertiary referral hospital) including Oncology and Holistic, Medical and Rehabilitation, Dementia and Psychiatric wings.			320		3.4	1088	Hospitals and Nursing Homes
6	**Seniors Living,** further detail landscaping to the eastern edge of Precinct B and rainforest restoration.		100			3	300	Assumed Medium Density Group Housing
7	**Residential Care Facility and Hostel** with total 160 beds		160			3.4	544	Hospitals and Nursing Homes
8	**Wollongong Healthcare Technical High school** for 350 Students and the Oval				350	0.2	70	Educational Institutions

TOTAL	2323	EP
FLOW	4.88	L/s
	421	KL/d

WATER DEMAND

Stages	Zoning	Unit				Kl/d/Unit	Max Kl/d	Ratio Max/Ave	Average KL/d
		Building GFA (ha)	Units/beds	Beds	Person				
1,4	Suburban commercial	0.78				41	32	2	16
5	District Hospital			320		0.77	246	2	123
3,4,6 & 7	>140 dwellings per net ha		365			0.8	292	1.9	146
8	School - Secondary				350	0.18	63	2	32
	TOTAL								**317**

APPENDIX E

FEASIBILITY STUDY FROM SYDNEY WATER

Case Number: **130509**

1 November 2012

LIFE CITY WOLLONGONG
C/- Simply Water and Sewer Pty Ltd

FEASIBILITY LETTER

Developer:	**LIFE CITY WOLLONGONG**
Your reference:	**203701**
Development:	**Lot 2 DP 249814, Lot 2 DP 534116 and Lot 4 DP 258635 Nottingham Street, Berkeley**
Development Description:	**Proposed "Hi tech holistic cancer and medical hospital facility" comprised of day surgery and specialist rooms, self-care seniors housing, cancer and medical hospital, serviced apartments, residential care facility and hostel, ancillary accommodation and research and a high school. See attached paperwork for specific details and hydraulic calculations.**
Your application date:	**17 October 2012**

Dear Applicant,

This Feasibility Letter (Letter) is a guide only. It provides general information about what Sydney Water's requirements could be if you applied to us for a Section 73 Certificate (Certificate) for your proposed development. **The information is accurate at today's date only.**

If you obtain development consent for that development from your consent authority (this is usually your local Council) they will require you to apply to us for a Section 73 Certificate. You will need to submit a new application (and pay another application fee) to us for that Certificate by using your current or another Water Servicing Coordinator (Coordinator).

Sydney Water will then send you either a:

- Notice of Requirements (Notice) and Developer Works Deed (Deed) or
- Certificate.

These documents will be the definitive statement of Sydney Water's requirements.

There may be changes in Sydney Water's requirements between the issue dates of this Letter and the Notice or Certificate. The changes may be:

- if you change your proposed development eg the development description or the plan/ site layout, after today, the requirements in this Letter could change when you submit your new application; and

- if you decide to do your development in stages then you must submit a new application (and pay another application fee) for each stage.

You have made an application for specific information. Sydney Water's possible requirements are set out on the following pages:

What You Must Do To Get A Section 73 Certificate In The Future

To get a Section 73 Certificate you must do the following things. You can also find out about this process by visiting www.sydneywater.com.au > Building and Developing > Developing Your Land.

1. **Obtain Development Consent from the consent authority for your development proposal.**

2. **Engage a Water Servicing Coordinator (Coordinator).**

   You must engage your current or another authorised Coordinator to manage the design and construction of works that you must provide, at your cost, to service your development. If you wish to engage another Coordinator (at any point in this process) you must write and tell Sydney Water.

   For a list of authorised Coordinators, either visit www.sydneywater.com.au > Building and Developing > Developing Your Land or call **13 20 92.**

   The Coordinator will be your point of contact with Sydney Water. They can answer most questions that you might have about the process and developer charges and can give you a quote or information about costs for services/works (including Sydney Water costs).

3. **Developer Works Deed**

   After the Coordinator has submitted your new application, they will receive the Sydney Water Notice and Developer Works Deed. You and your accredited Developer Infrastructure Providers (Providers) will need to sign and lodge both copies of the Deed with your nominated Coordinator. After Sydney Water has signed the documents, one copy will be returned to the Coordinator.

   The Deed sets out for this project:

   - your responsibilities;
   - Sydney Water's responsibilities; and
   - the Provider's responsibilities.

   You must do all the things that we ask you to do in that Deed. This is because your development does not have water and sewer services and you must construct and pay for the following works extensions under this Deed to provide these services.

   Note: The Coordinator must be fully authorised by us for the whole time of the agreement.

4. **Water and Sewer Works**

   4.1 **Water**

   Your development must have a frontage to a water main that is the right size and can be used for connection.

Sydney Water has assessed your application and found that:

- The proposed development site has to possible connection points the existing water supply system:
    - DN100 main on the eastern side of Warwick Street.
    - DN150 main on the western side of Nolan Street.
- Based on a peak instantaneous demand of 7 l/s the water supply system has adequate capacity to service the proposed development.
- You will need to provide peak water supply demands and identify proposed connection points at the Section 73 Application phase to enable Sydney Water to determine detailed water supply requirements.

- **You may need to construct water main extensions and/or amplify the existing system to serve your development**. These works must be constructed by a constructor with the appropriate capability. Your Coordinator will be able to provide further advice about this.

4.2 Sewer

Your development must have a sewer main that is the right size and can be used for connection. That sewer must also have a connection point within your development's boundaries.

Sydney Water has assessed your application and found that:

§ The proposed development site has multiple DN150 sewer mains from which extensions and or amplification would be required to service the site.
§ At the Section 73 Application phase, you must provide the proposed wastewater servicing scheme for the site identifying proposed connection points and wastewater flows. The scheme plan can be in the form of a catchment plan and flow schedule showing connection to the existing system. Sydney Water will review the proposed servicing scheme and provide detailed wastewater requirements.

- **You may need to construct a waste water main extension, and/or amplify the existing sewer system to serve your development**. The terms of the Deed define these works as ‘Major Works’.

5. Ancillary Matters

5.1 Asset adjustments

After Sydney Water issues this Notice (and more detailed designs are available), Sydney Water may require that the water main/sewer main/stormwater located in the footway/your property needs to be adjusted/deviated. If this happens, you will need to do this work as well as the extension we have detailed above at your cost. The work must meet the conditions of

this Notice and you will need to complete it **before we can issue the Certificate**. Sydney Water will need to see the completed designs for the work and we will require you to lodge a security. The security will be refunded once the work is completed.

5.2 **Entry onto neighbouring property**

If you need to enter a neighbouring property, you must have the written permission of the relevant property owners and tenants. You must use Sydney Water's **Permission to Enter** form(s) for this. You can get copies of these forms from your Coordinator or the Sydney Water website. Your Coordinator can also negotiate on your behalf. Please make sure that you address all the items on the form(s) including payment of compensation and whether there are other ways of designing and constructing that could avoid or reduce their impacts. You will be responsible for all costs of mediation involved in resolving any disputes. Please allow enough time for entry issues to be resolved.

5.3 **Costs**

Construction of these **future** works will require you to pay project management, survey, design and construction costs **directly to your suppliers**. Additional costs payable to Sydney Water may include:

- water main shutdown and disinfection;
- connection of new water mains to Sydney Water system(s);
- design and construction audit fees;
- contract administration, Operations Area Charge & Customer Redress prior to project finalisation;
- creation or alteration of easements etc; and
- water usage charges where water has been supplied for building activity purposes prior to disinfection of a newly constructed water main.

Note: Payment for any Goods and Services (including Customer Redress) provided by Sydney Water will be required prior to the issue of the Section 73 Certificate or release of the Bank Guarantee or Cash Bond.

Your Coordinator can tell you about these costs.

OTHER THINGS YOU MAY NEED TO DO

Shown below are other things you need to do that are NOT a requirement for the Certificate. They may well be a requirement of Sydney Water in the future because of the impact of your development on our assets. You must read them before you go any further.

Stamping and approval of your building plans

Please note that the building plans must be stamped and approved when each lot is developed. This can be done at a Quick Check agency. For an agency list visit www.sydneywater.com.au > Building and Developing > Quick Check or call 13 20 92).

Please note that your building plans must be stamped and approved. This can be done at a Quick Check agency. For an agency list visit www.sydneywater.com.au > Building and Developing > Quick Check or call 13 20 92.

This is not a requirement of the Certificate but the approval is needed because construction/ building works may impact on existing Sydney Water assets (e.g. water and sewer mains). In any case, these works MUST NOT commence until Sydney Water has granted approval. Your Coordinator can tell you about the approval process including:

- Possible requirements;
- Costs; and
- Timeframes.

Note: You must obtain our written approval before you do any work on Sydney Water's systems. Sydney Water will take action to have work stopped on the site if you do not have that approval. We will apply Section 44 of the *Sydney Water Act 1994.*

Disused Sewerage Service Sealing

Please do not forget that you must pay to disconnect all disused private sewerage services and seal them at the point of connection to a Sydney Water sewer main. This work must meet Sydney Water's standards in the NSW Code of Practice for Plumbing and Drainage (the Code) and be done by a licensed drainer. The licensed drainer must arrange for an inspection of the work by a NSW Fair Trading Plumbing Inspection Assurance Services (PIAS) officer. After that officer has looked at the work, the drainer can issue the Certificate of Compliance. The Code requires this.

Soffit Requirements

Please be aware that floor levels must be able to meet Sydney Water's soffit requirements for property connection and drainage.

Requirements for Business Customers for Commercial and Industrial Property Developments

If this property is to be developed for Industrial or Commercial operations, it may need to meet the following requirements:

Trade Wastewater Requirements

If this development is going to generate trade wastewater, the property owner must submit an application requesting permission to discharge trade wastewater to Sydney Water's sewerage system. You must wait for approval of this permit before any business activities can commence.

The permit application should be emailed to Sydney Water's Business Customer Services at businesscustomers@sydneywater.com.au

It is illegal to discharge Trade Wastewater into the Sydney Water sewerage system without permission.

A **Boundary Trap** is required for all developments that discharge trade wastewater where arrestors and special units are installed for trade wastewater pre-treatment.

If the property development is for Industrial operations, the wastewater may discharge into a sewerage area that is subject to wastewater reuse. Find out from Business Customer Services if this is applicable to your development.

Backflow Prevention Requirements
Backflow is when there is unintentional flow of water in the wrong direction from a potentially polluted source into the drinking water supply.

All properties connected to Sydney Water's supply must install a testable **Backflow Prevention Containment Device** appropriate to the property's hazard rating. Property with a high or medium hazard rating must have the backflow prevention containment device tested annually. Properties identified as having a low hazard rating must install a non-testable device, as a minimum.

Separate hydrant and sprinkler fire services on non-residential properties, require the installation of a testable double check detector assembly. The device is to be located at the boundary of the property.

Before you install a backflow prevention device:

1. Get your hydraulic consultant or plumber to check the available water pressure versus the property's required pressure and flow requirements.
2. Conduct a site assessment to confirm the hazard rating of the property and its services. Contact PIAS at NSW Fair Trading on **1300 889 099**.

For installation you will need to engage a licensed plumber with backflow accreditation who can be found on the Sydney Water website:
http://www.sydneywater.com.au/Plumbing/BackflowPrevention/

Water Efficiency Recommendations

Water is our most precious resource and every customer can play a role in its conservation. By working together with Sydney Water, business customers are able to reduce their water consumption. This will help your business save money, improve productivity and protect the environment.

Some water efficiency measures that can be easily implemented in your business are:

- Install water efficiency fixtures to help increase your water efficiency, refer to WELS (Water Efficiency Labelling and Standards (WELS) Scheme, http:// www.waterrating.gov.au/
- Consider installing rainwater tanks to capture rainwater runoff, and reusing it, where cost effective. Refer to http://www.sydneywater.com.au/Water4Life/InYourBusiness/ RWTCalculator.cfm
- Install water-monitoring devices on your meter to identify water usage patterns and leaks.
- Develop a water efficiency plan for your business.

It is cheaper to install water efficiency appliances while you are developing than retrofitting them later.

Contingency Plan Recommendations
Under Sydney Water's customer contract Sydney Water aims to provide Business Customers with a continuous supply of clean water at a minimum pressure of 15meters head at the main tap. This is equivalent to 146.8kpa or 21.29psi to meet reasonable business usage needs.

Sometimes Sydney Water may need to interrupt, postpone or limit the supply of water services to your property for maintenance or other reasons. These interruptions can be planned or unplanned.

Water supply is critical to some businesses and Sydney Water will treat vulnerable customers, such as hospitals, as a high priority.

Have you thought about a **contingency plan** for your business? Your Business Customer Representative will help you to develop a plan that is tailored to your business and minimises productivity losses in the event of a water service disruption.

For further information please visit the Sydney Water website at: http:// www.sydneywater.com.au/OurSystemsandOperations/TradeWaste/ or contact Business Customer Services on **1300 985 227** or businesscustomers@sydneywater.com.au

Fire Fighting

Definition of fire fighting systems is the responsibility of the developer and is not part of the Section 73 process. It is recommended that a consultant should advise the developer regarding the fire fighting flow of the development and the ability of Sydney Water's system to provide that flow in an emergency. Sydney Water's Operating Licence directs that Sydney Water's mains are only required to provide domestic supply at a minimum pressure of 15 m head.

A report supplying modelled pressures called the Statement of Available pressure can be purchased through any Quickcheck agent and may be of some assistance when defining the fire fighting system. The Statement of Available pressure, may advise flow limits that relate to system capacity or diameter of the main and pressure limits according to pressure management initiatives. If mains are required for fire fighting purposes, the mains shall be arranged through the water main extension process and not the Section 73 process.

Large Water Service Connection

A water main will be available, once you have completed your drinking water main construction to provide your development with a domestic supply. The size of your development means that you will need a connection larger than the standard domestic 20 mm size.

To get approval for your connection, you will need to lodge an application with a Quick Check Agent. You, or your hydraulic consultant, may need to supply the following:

- A plan of the hydraulic layout;

- A list of all the fixtures/fittings within the property;
- A copy of the fireflow pressure inquiry issued by Sydney Water;
- A pump application form (if a pump is required);
- All pump details (if a pump is required).

You will have to pay an application fee.

Sydney Water does not consider whether a water main is adequate for fire fighting purposes for your development. We cannot guarantee that this water supply will meet your Council's fire fighting requirements. The Council and your hydraulic consultant can help.

Disused Water Service Sealing

You must pay to disconnect all disused private water services and seal them at the point of connection to a Sydney Water water main. This work must meet Sydney Water's standards in the NSW Code of Practice for Plumbing and Drainage (the Code) and be done by a licensed plumber. The licensed plumber must arrange for an inspection of the work by a NSW Fair Trading Plumbing Inspection Assurance Services (PIAS) officer. After that officer has looked at the work, the drainer can issue the Certificate of Compliance. The Code requires this.

Private Water Services Connection and Metering

To provide domestic water to the total development you will need to connect to the Sydney Water main. This connection must comply with the *National Plumbing and Drainage Code AS 3500* and *NSW Code of Practice for Plumbing and Drainage*. You may have to include isolation valves on either side of the connection(s) to the Sydney Water main.

Visit www.sydneywater.com.au > Plumbing > Meters > Diagrams to help position meters correctly.

For a vertical commercial/residential building, the meter servicing the residential area generally must be located in the commercial area and after all commercial off-takes.

Sydney Water will supply enough meters to meet the above guidelines but will not provide check meters. All meters **must** be placed in an accessible area that should be either:

- no more than one metre inside the property boundary **or**
- in a location acceptable to Sydney Water eg in the commercial area after all commercial off-takes.

Other fees and requirements

The requirements in this Notice relate to your Certificate application only. Sydney Water may be involved with other aspects of your development and there may be other fees or requirements. These include:

- plumbing and drainage inspection costs;
- the installation of backflow prevention devices;
- trade waste requirements;

- large water connections and
- Council fire fighting requirements. (It will help you to know what the fire fighting requirements are for your development as soon as possible. Your Hydraulic Consultant can help you here.)

No warranties or assurances can be given about the suitability of this document or any of its provisions for any specific transaction. It does not constitute an approval from Sydney Water and to the extent that it is able, Sydney Water limits its liability to the reissue of this Letter or the return of your application fee. You should rely on your own independent professional advice.

END

APPENDIX F

SOIL AND WATER MANAGEMENT PLAN

SOIL & WATER MANAGEMENT PLAN

LIFE CITY - WOLLONGONG

REPORT NO. R00864-S&WMP

REVISION A

NOVEMBER 2012

C&M Consulting Engineers Pty Ltd
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PROJECT DETAILS

Property Address: Warwick Street Berkeley

Development Proposal: Life City Wollongong

REPORT CERTIFICATION

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DISCLAIMER

C & M Consulting Engineers Pty Ltd should be consulted to ascertain the suitability of the information contained herein if any third party wishes to utilise this report. C & M Consulting Engineers Pty Ltd accepts no responsibility for the application of the contents of this report by other than the instructing party who has not verified the use of this report for their purposes.

DOCUMENT CONTROL

REVISION	ISSUE DATE	ISSUED TO	ISSUED FOR
A	November 2012	TCG	EA Submission

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Preface

This Soil and Water Management Plan (SWMP) has been prepared to supplement the Environmental Assessment (EA) for the Life City Wollongong development at Berkeley.

This SWMP has been written in accordance with the requirements of "Managing Urban Stormwater – Soils and Construction, 4th Edition (2004)" by Landcom. This SWMP shall be applied to the construction activities carried out for the development site.

Measures outlined in this Soil and Water Management Plan must be implemented prior to and maintained during and after the construction works.

It is the Contractor's responsibility to design the sedimentation and erosion control plan for the site such that it is accordance with this Soil and Water Management Plan and the Civil Works Specification.

General Instructions

1. The Soil and Water Management Plan (SWMP) is to be read in conjunction with the engineering plans, and any other plans or specifications that may be issued in relation to the Project.

2. Contractors shall ensure that all soil and water management works are undertaken as instructed in this specification and constructed following the guidelines stated in "Managing Urban Stormwater – Soils and Construction, 4th Edition (2004)" by Landcom.

3. The Contractor shall ensure that all subcontractors are informed of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas.

Site Constraints and Characteristics

1. The following design parameters have been assessed for the site :

Constraint	**Value**	**(Source)***
Rainfall Erosivity (R-factor)	4500	(Appendix B - Map 11)
Soil Erodibility (K-factor)	0.022	(Table C21 – Berkeley)
Length/Slope Gradient Factor, LS	3.27	Table A1
Erosion Control Practice Factor (P-Factor)	1.3 (Compacted)	Table A2
Cover Factor (C-Factor)	1.0 (During Earthworks) 0.1 (Temporary Seeding – Post-Earthworks Operation)	Table A3
Calculated Soil Loss, A (RUSLE equation)	421 t/Ha/yr (During Earthworks) 42 t/Ha/yr (Post-Earthworks)	A = R K LS P C
Soil Loss Class	4 – Moderate	(Table 4.2)
Soil Hydrologic Group	C	(Table C21)
75th Percentile 5-day Rainfall Event	25.4mm (Wollongong)	(Table 6.3a)
Volumetric Runoff Coefficient, Cv	0.35	(Table F2)

* (NSW Landcom Managing Urban Stormwater Manual Reference)

2. The sediment basin sizing has been conducted on a rate per hectare of disturbed area basis and has been sized in accordance with the requirements of the Landcom manual "Managing Urban Stormwater - Soils and Construction", for Type D soils. The disturbed area within this catchment at any one time should be limited to an area for which each sediment basin can handle.

Sediment Basin Sizing Calculation for Type D Soil*:

	TOTAL
Volumetric Runoff Coefficient, Cv	0.35 (Table F2)
75th percentile 5 Day total rainfall depth	25.4mm
Catchment Area (A_c)	1.0 (i.e. per hectare of disturbed area)
Settling Zone Volume (per hectare), V_{sett} = 10 x Cv x A_c x R75th	89 m^3/ha
Disturbed Catchment Area (A_d)	1.0 (i.e. per hectare of disturbed area)
R K LS P C	421 t/ha/yr
Sediment Zone Volume, V_{sed} (0.17 A_d (R K LS P C) / 1.3 V_{sed} should be >30% of V_{sett}	55 m^3/ha
Total Sediment Basin Volume Required:	**144 m^3/ha of disturbed area**

*(NSW Landcom Managing Urban Stormwater Manual Reference)

3. The basins have been sized to accommodate the 75th percentile of 5 day continuous storm. The total volume of the basins required is given in m^3 per hectare of disturbed area.

4. Stormwater runoff from the non-disturbed portion of the catchment outside of operating area is to be bypassed around the basins by physical means such as catch drains.

Basin Management

1. The captured stormwater in the settling zone should be drained to meet the minimum storage capacity required within a five (5) day period following rainfall, provided the acceptable water quality (NFR) and turbidity have been achieved.

2. Chemical flocculent such as gypsum may be dosed to aid settling within 24 hours of conclusion of each storm. The applied dosing rates should achieve the target quality within 36 to 72 hours of the storm event.

Land Disturbance Conditions

1. Where practicable, the soil erosion hazard shall be kept as low as possible. Limitations to access are to be in accordance with the following table:

Land use	Limitation
Access Areas	Access is to be limited to the designated work zones.
Truck Cleaning Areas	Any truck exiting out of the site shall be thoroughly cleaned and limit the exportation of soil and sediment on public roads.
Remaining Lands (Undisturbed Areas)	Entry is prohibited to remaining lands. Access is only permitted with permission from the Project Manager and/or Superintendent, to allow for thinning of growth in the interests of fire protection and/or flora and fauna management.

Construction Sequence

Works shall be undertaken in the following sequence:

1. Install sediment fencing and cut drains to meet the requirements of the SWMP. Waste collection bins shall be installed adjacent to site office.

2. Construct stabilised site access in location nominated by the Contractor and in accordance with the Specification.

3. Install sediment control protection measures at all natural and man-made drainage structures. Maintain until all the disturbed areas are stabilised.

4. Redirect clean water around the construction site (earthworks areas).

5. Construct sediment basin(s) for disturbed areas in accordance with the rate per hectare provided in the SWMP. Install risers and two pegs in the floor of the basin and have them marked to show the top of the sediment storage zone. Ensure the basin is cleared of sediment once the design capacity is reached.

6. Clear and strip the work areas. Minimise the damage to the grass and low ground cover of non-disturbed areas.

7. Any disturbed areas, other than grading areas, shall immediately be covered with site topsoil within 7 days of clearing. Re-graded areas shall be covered with bitumen emulsion as specified.

8. Apply permanent stabilisation to the site if necessary.

Erosion Control Requirements

1. Clearly visible barrier fencing shall be installed at the discretion of the site superintendent to ensure traffic control and prohibit unnecessary site disturbance. Vehicular access to the site shall be limited to only that essential for construction work and shall enter the site only through the stabilised access points.

2. All disturbed areas are to be stabilised within 14 working days of the completion of land shaping. All disturbed areas are to be protected so that the land is permanently stabilised within six months. Topsoil shall be respread over the site, other than re-grading areas, to a minimum depth of 100mm on bare but tyned soil surfaces and the site shall be revegetated in accordance with the following:

Sowing season	**Seed mix**
Autumn/Winter	oats@40kg/ha + Japanese millet@10kg/ha
Spring/Summer	oats@20kg/ha + Japanese millet@20kg/ha

Note : These plant species are for temporary revegetation only. They will only provide protection from erosion for six months. Where the lots are to be left undeveloped for a longer period, the Contractor shall seek advice from the site superintendent as to more appropriate revegetation methods.

Revegetation in accordance with the above table will be enhanced by adding lime at a rate of 4kg/tonne of topsoil and 7.5kg/tonne of subsoil.

3. The long term ground cover factors for the construction works is not to exceed the following limits :

Land	**Maximum C-factor**	**Remarks**
Waterways and other areas of concentrated flows, post construction	0.05	Applies after 10 working days of completion of formation and before concentrated flows are applied. Foot and vehicular traffic is prohibited in this area and 70% ground cover is required.
Stockpiles, post construction	0.10	Applies after 10 working days from completion of formation. 60% ground cover is required.
All lands, including waterways and stockpiles, during construction.	0.15	Applies after 20 days of inactivity, even though works may be incomplete. 50% ground cover is required.

Sediment Control Conditions

1. Proprietary silt fencing shall be installed by the Contractor in accordance with their approved Sediment and Erosion Control Plan and elsewhere at the discretion of the site superintendent to contain coarser sediment fractions as near as possible to their source.

2. Sediment removed from any trapping device shall be relocated where further pollution to downslope lands and waterways cannot occur.

3. Stockpiles shall be located by the Contractor in accordance with their approved Sediment and Erosion Control Plan and elsewhere at the discretion of the Project Manager and/or Superintendent. Where stockpiles are to be in place longer than 30 days they shall be stabilised by covering with mulch or with temporary vegetation.

4. Water shall be prevented from entering the permanent drainage system unless it is sediment free. Drainage pits are to be protected in accordance with the Contractor's approved Sediment and Erosion Control Plan.

5. Temporary sediment traps at pits shall be retained until after lands they are protecting are completely rehabilitated.

Site Maintenance Requirements

1. Waste bins are to be provided for all construction refuse. They are to be emptied at least weekly and refuse is to be disposed in accordance with the site manager's recommendations.

2. The site manager shall inspect the site at least weekly and shall;

    a. Ensure that all drains are operating effectively and shall make any necessary repairs;

    b. Remove any spilled material from area subject to runoff or concentrated flow;

    c. Remove trapped sediment where the capacity of the trapping device falls below 60%;

    d. Inspect the sediment basins after each rainfall event and/or weekly. Ensure that all sediment is removed once the sediment storage zone is full (refer to pegs installed in basins in accordance with the SWMP). Ensure that outlet and emergency spillway works are maintained in a fully operational condition at all times.

    e. Ensure rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate;

f. Construct additional erosion or sediment control works as may be appropriate to ensure the protection of downslope lands and waterways;

g. Maintain erosion and sediment control measures in a fully functioning condition at all times until the site is rehabilitated;

h. Ensure that the revegetation scheme is adhered to and that the all grass covers are kept healthy, including watering and mowing;

i. Remove temporary soil conservation structures as the last activity in the rehabilitation program.