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ORIGINAL
WATER & ENVIRONMENT

Jumping Creek Deferred Area Urban Capability Study
Report

COMMERCIAL IN CONFIDENCE

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1 EXECUTIVE SUMMARY

Calibre Consulting has been engaged by CIC Australia to prepare an Urban Capability Study for the area within Jumping Creek Residential Estate which was deferred from rezoning in the Queanbeyan Local Environment Plan 2012. This portion of the site is shown on the zoning map as “Deferred Matter” (Deferred Area), see Figure 4-1.

Queanbeyan City Council (QCC), NSW Department of Planning and Environment (DPE), and the NSW Office of Environment and Heritage (OEH) have requested advice confirming the suitability of the Deferred Area for residential development based on a detailed assessment of slope, soil stability, stormwater quantity, water quality, sediment control and biodiversity considerations.

This report addresses site slope (vehicular access), stormwater quantity, water quality, and sediment control for the Deferred Area to inform a Planning Proposal which will seek to rezone the Deferred Area.

The Water Quality Strategy in this report has been undertaken in accordance with a water quality methodology that was agreed with Mr Miles Boak (OEH) subsequent to receiving Dr Sandra Jones’s letter. The correspondence with Mr Miles Boak and Dr Sandra Jones are within Appendix A.

It was agreed with Mr Miles Boak that the water quality strategy for the area currently zoned as a Deferred Area will be developed using MUSIC modelling, and will demonstrate the performance of the proposed treatment in terms of reduction in average annual pollutant exports. The pollutants are gross pollutants, suspended solids, phosphorus and nitrogen.

This detailed assessment has found that a residential development within the currently zoned Deferred Area will have no adverse effects on the environment, with the management measures proposed in this report. These management measures include the control of sediment runoff during both civil and housing construction phases. The use of rainwater tanks, gross pollutant traps and bioretention basins for the treatment of stormwater runoff.

This assessment has also found that using the catchment wide approach for stormwater quantity control, a development within this area will have no impact on the 1 and 100 ARI storm event peak flows at the confluence of Jumping Creek and Queanbeyan River.

Access roads and services within the Deferred Area are able to meet the required standards as set by QCC.

It has been determined that a residential development within the Deferred Area is feasible, and can comply with the requirements of QCC, DPE and OEH with respect to slope, stormwater quantity, water quality and sediment control.

2 INTRODUCTION

Calibre Consulting has been engaged by CIC Australia to prepare an Urban Capability Study for the area within Jumping Creek Residential Estate which was deferred from rezoning in the Queanbeyan Local Environment Plan 2012. This portion of the site is shown on the zoning map as “Deferred Matter” (Deferred Area), see Figure 4-1.

CIC Australia and Calibre Consulting engaged actively with Queanbeyan City Council (QCC), NSW Department of Planning and Environment (DPE) and NSW Office of Environment and Heritage (OEH) prior to undertaking this capability study to ensure all outstanding issues with regards to the Deferred Area are adequately addressed, and to ensure a smooth rezoning of the Deferred Area.

During our extensive consultation process, QCC, DPE and OEH have requested additional advice confirming the suitability of the Deferred Area for residential development based on a detailed assessment of slope, soil stability, stormwater quantity, water quality, sediment control and biodiversity considerations.

This report addresses site slope (vehicular access to the Deferred Area), stormwater quantity, water quality, and sediment control on the Deferred Area to inform a Planning Proposal which will seek to rezone the Deferred Area. We note that soil stability will be addressed by Douglas Partners in a separate report.

The Water Quality Strategy in this report has been undertaken in accordance with a water quality methodology that was agreed with Mr Miles Boak (OEH) subsequent to receiving Dr Sandra Jones’s letter. The correspondence with Mr Miles Boak and Dr Sandra Jones are within Appendix A.

It was agreed with Mr Miles Boak that the water quality strategy for the area currently zoned as Deferred Area will be developed using MUSIC modelling, and will demonstrate the performance of the proposed treatment in terms of reduction in average annual pollutant exports. The pollutants are gross pollutants, suspended solids, phosphorus and nitrogen.

For clarity, the Deferred Area will also be referred to as “the site” in this report.

3 PURPOSE OF THIS REPORT

The purpose of this report is to:

- Undertake preliminary Water Quantity and Quality Management Strategies, including positioning and concept grading of principal stormwater quality improvement devices,
- Map the 100yr ARI flood extent for Queanbeyan River and Jumping Creek along the Deferred Area,
- Define the Riparian Corridor for Queanbeyan River and Jumping Creek along the Deferred Area,
- Develop a concept Erosion and Sediment Control Strategy for the period of construction,
- Refine the location and grading of the connecting road and subdivision edge roads to minimise the construction footprint and to provide a services corridor, and
- Refine the vehicular access to building envelopes for the large lots.

4 SITE CHARACTERISTICS

4.1 LOCATION

Jumping Creek Residential Estate is approximately 96.43ha in size, and is located approximately 3km south of the Queanbeyan City Centre. The Residential Estate is bounded by Queanbeyan River to the west and is crossed by Jumping Creek. The Deferred Area is located to the south of Jumping Creek, and to the east of Queanbeyan River. The total area of the Deferred Area is approximately 10.58ha.

Figure 4-1 shows the location of the site and Deferred Area.

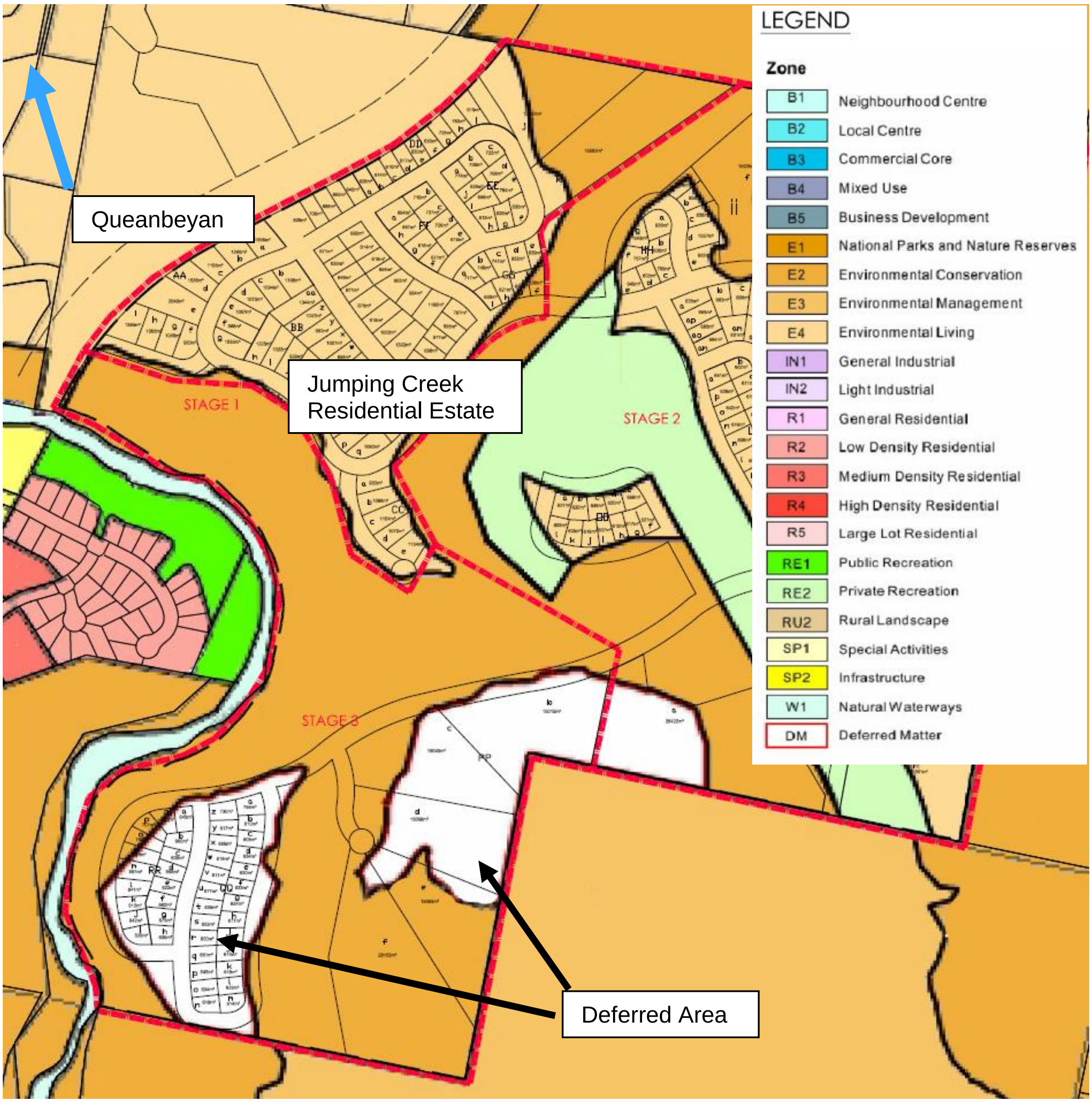

Figure 4-1: Jumping Creek Development – Location of the Deferred Area (Out of Date Layout)

4.2 EXISTING TOPOGRAPHY

The topography of the Deferred Area is relatively steep with slopes from zero to greater than 20%.Two ridges run north to south through the site, with an elevated relatively flat plain located south of Jumping Creek and east of Queanbeyan River. Jumping Creek and an unnamed tributary runs through the site.

Refer to Figure 4-2 for site topography and characteristics.

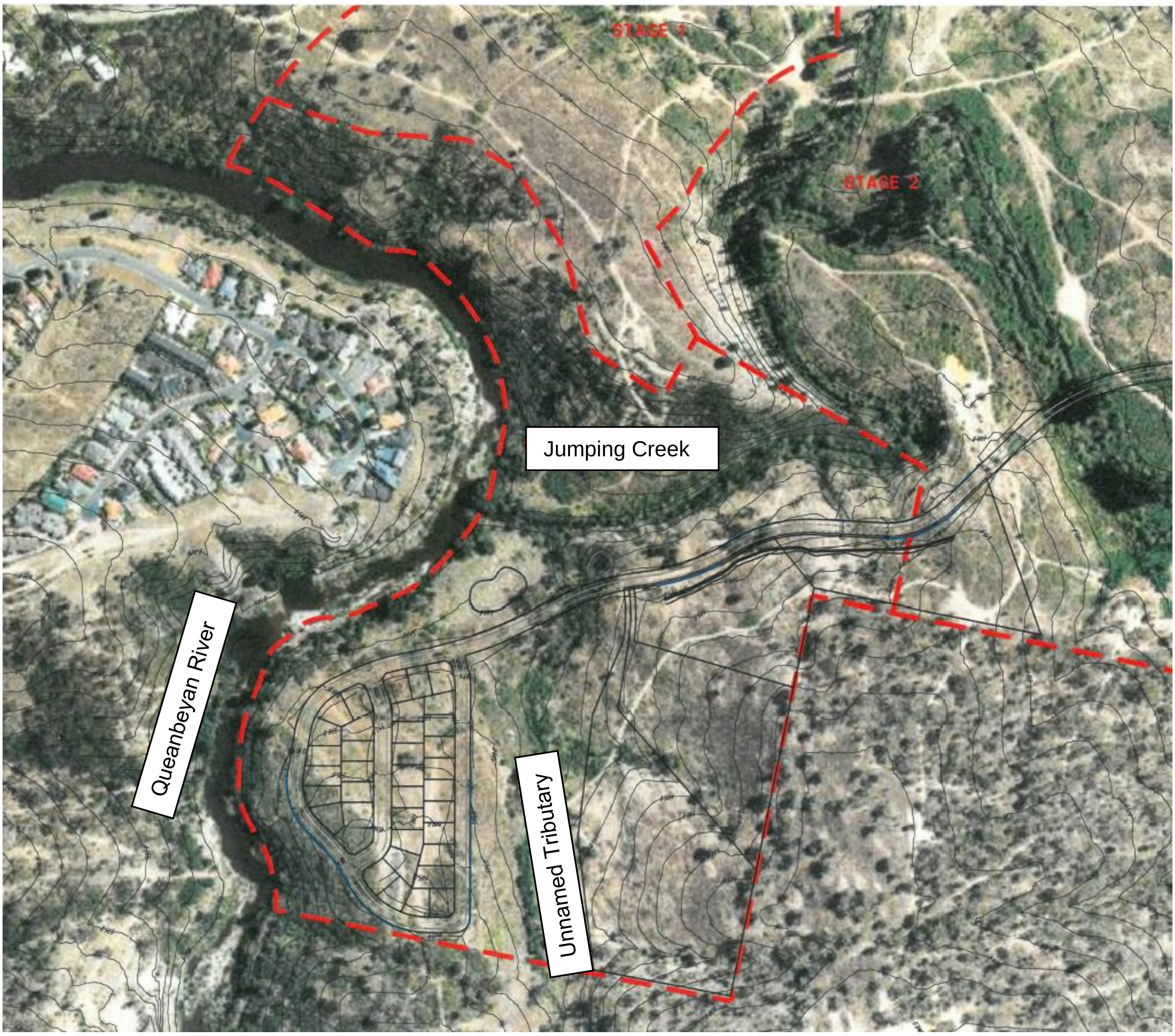

Figure 4-2: Deferred Area Topography and Characteristics.

5 STORMWATER QUANTITY

The stormwater quantity analysis presented in this report has been undertaken for the following:

- Determine existing peak flow rates at the confluence of Queanbeyan River and Jumping Creek for the 1 and 100 year Average Recurrence Interval (ARI) storm events;
- Determine the developed (unmitigated) peak flow rates at the confluence of Queanbeyan River and Jumping Creek for the 1 and 100 year ARI storm events;
- Determine peak flow mitigation strategies to ensure that the development of the Deferred Area has no adverse impact on peak flows at the confluence of Queanbeyan River and Jumping Creek; and
- Modelling of the peak flow mitigation strategies to determine the developed mitigated peak flow rates at the confluence of Queanbeyan River and Jumping Creek for the 1 and 100 year ARI storm events.

We note that low flow channel erosion in gullies and creeks are predominantly due to smaller more frequent flows, such as the 1 year ARI. Therefore, mitigating the 1 year ARI peak flows will ameliorate velocity changes in the low flow channels.

5.1 CATCHMENT WIDE APPROACH

Peak flow mitigation presented in this report has been undertaken for a catchment wide approach. The alternative to a catchment wide approach is a site based approached with stormwater quantity control basins downstream of developments within the catchment. Site based detention basins for a large range of ARI's may increase the catchment wide peak flows due to delaying site based peak flows to align with catchment wide peak flows.

The design objective was to ensure that the Post-Development peak discharge rates for the 1 year and the 100 year ARIs are not increased at the confluence of Queanbeyan River and Jumping Creek for the whole catchment.

A catchment based Rational Method calculation was undertaken for the existing scenario (i.e. pre-development catchment conditions) to verify the XP-RAFTS modelling parameters adopted.

The following two scenarios were modelled using XP-RAFTS:

- <u>Existing Scenario</u> – This scenario modelled peak flow at the confluence of Queanbeyan River and Jumping Creek for pre-development catchment conditions. Refer to section 5.3 for details. Existing XP-RAFTS peak flows have been verified against Rational Method calculations;
- <u>Deferred Area Developed Scenario</u> – This scenario modelled peak flow at the confluence of Queanbeyan River and Jumping Creek with the Deferred Area developed. One offline detention basin has been incorporated for peak flow mitigation. Refer to section 5.4 for details.

5.2 RATIONAL METHOD CALCULATION

The Rational Method calculation was undertaken for the existing undeveloped catchment in order to verify the XP-RAFTS model.

5.2.1 CATCHMENT

The Rational Method calculation was undertaken for the total catchment of 3,676ha. Refer to Drawing No C15776-001+ and C15776-002+ for the existing scenario catchment plan.

5.2.2 COEFFICIENT OF RUNOFF

Coefficient of Runoff (C_{10}) value of 0.4 was adopted in accordance with the *Australian Rainfall & Runoff (AR&R) Volume 1 & Volume 2* (1987):

This value has then been adjusted for the 1 year, and 100 year ARI events using *Equation 5.5* in AR*&R Volume 1* (1987, p. 99). These values are as follows:

- C_1 = 0.276
- C_{100} = 0.536

5.2.3 TIME OF CONCENTRATION

The Time of Concentration for this catchment was determined in accordance with the empirical formula for calculating the time of concentration in natural channels developed by the US Soil Conservation Services. This method was adopted due to the large catchment with dominant channel flow. A time of concentration value of 126 minutes was calculated.

5.2.4 RAINFALL DATA

The Intensity-Frequency-Duration (IFD) rainfall data was sourced from *Bureau of Metrology* for the Jumping Creek region. Refer to Appendix A for IFD details.

5.2.5 RESULTS

The peak flows calculated by the Rational Method for the 1 and the 100 year ARI events are outlined in Table 5-1. Refer to Appendix B for rational method calculation.

Table 5-1: Rational Method Peak Flows

ARI	Peak Flow (m^3/s)
1	29.4
100	164.7

5.3 XP-RAFTS EXISTING SCENARIO

An XP-RAFTS model has been built for the Jumping Creek catchment. The modelling parameter adopted are discussed within subsequent sections.

5.3.1 MODEL PARAMETERES

5.3.1.1 CATCHMENT DATA

The catchment delineation for the Existing Scenario follows the existing contours. A small section of contours is missing from the north eastern part of the catchment. Using aerial photography provided by *Six Maps,* the areas were adjusted around the creek lines shown. Refer to Drawing C15776-001+ and C15776-002+ within Appendix C for the Existing Scenario Catchment Plan. All catchments for the Existing Scenario have been modelled with 5% fraction impervious. The catchment input data is presented in Appendix D.

5.3.1.2 LOSSES

For the hydrological modelling of the Existing Scenario using XP-RAFTS, the ARBM loss method was used incorporating the infiltration parameters outlined in *Section 1.07* of the *Queanbeyan City Council – Handbook of Drainage Design Criteria*. These guidelines are the most locally relevant guidelines for the study area and the guidelines are based on years of continuous review. The ARBM loss method is able to model a range of ARI events with a single set of model parameters.

5.3.1.3 MANNINGS 'N' VALUES

The Manning's n value of 0.04 was used for pervious areas and 0.015 was used for impervious areas. These are in accordance with *Section 1.07* of the *Queanbeyan City Council – Handbook of Drainage Design Criteria.*

5.3.1.4 Bx

After various iterations and verification with the peak flows calculated by the Rational Method Calculation, a B_x Factor of 1.5 was used consistently for all XP-RAFTS modelling presented in this report.

5.3.1.5 ROUTING

Routing through sub-catchments was undertaken by applying lag time to the links. This lag time has been calculated as channel flow between nodes at a rate of 2m/s.

5.3.1.6 RAINFALL DATA

Table 5-2 presents the IDF data used for XP-RAFTS modelling. These values are consistent with the Bureau of Meteorology (BOM) values for the Jumping Creek Region (-35.378 S, 149.252 E). Refer to Appendix A for IFD details.

Table 5-2: XP-RAFTS Rainfall Data

${}^{50}I_1$ (mm/hr)	${}^{2}I_1$ (mm/hr)	${}^{50}I_{12}$ (mm/hr)	${}^{2}I_{12}$ (mm/hr)	${}^{50}I_{72}$ (mm/hr)	${}^{2}I_{72}$ (mm/hr)	Location Skew	F_2	F_{50}	AR&R zone
41.78	22.16	7.78	4.13	2.1	1.17	0.22	4.28	15.58	2

5.3.2 EXISTING PEAK FLOW RESULTS

Table 5-3 outlines peak 1 and 100 year ARI event flows at the confluence of Queanbeyan River and Jumping Creek. Refer to Drawing No. C15776-002+ in Appendix C for location.

Table 5-3: Existing Peak Flow

Location	1 year ARI XP-RAFTS Peak Flow (m^3/s)	100 year ARI XP-RAFTS Peak Flow (m^3/s)
Confluence of Queanbeyan River and Jumping Creek	31.62	157.01

5.3.3 PEAK FLOW VERIFICATION

Analysis was undertaken for the 1 and 100 year ARI storm events, with durations ranging from 15 minutes to 72 hours. Table 5-4 compares the XP-RAFTS peak flow to those calculated using the Rational Method for the whole catchment.

Table 5-4: XP-RAFTS Flow Verification

ARI	Rational Method Peak Flow (m^3/s)	XP-RAFTS Peak Flow (m^3/s)
1	29.37	31.62
100	164.69	157.01

As can be seen from the table above, XP-RAFTS produces flows similar to those calculated using the Rational Method calculation. This confirms the validity and the verification of the XP-RAFTS model.

5.4 XP-RAFTS DEVELOPED SCENARIO

An XP-RAFTS model was set up to represent the post-development Deferred Area discharging to Jumping Creek. The remaining Jumping Creek residential estate has been modelled as undeveloped.

5.4.1 MODEL SETUP

The XP-RAFTS model set up for the Deferred Area Developed Scenario was similar to the Existing Scenario, except where changes were made to the Deferred Area catchments discharging to Jumping Creek.

The following sub-subsections highlight the XP-RAFTS model parameters adopted for the Deferred Area Developed Scenario.

5.4.1.1 CATCHMENT DATA

To account for the Deferred Area development areas, the catchment data was updated as per Drawing No C15776-003+ and C15776-004+ within Appendix C. Refer to Appendix E for catchment input data. There is slight increase in the overall catchment size under the developed scenario due to the lot layout and final earthworks for the Deferred Area Development.

5.4.1.2 MANNING'S N

The Manning's n value of 0.04 was used for pervious areas and 0.015 was used for impervious areas. These are in accordance with *Section 1.07* of the *Queanbeyan City Council – Handbook of Drainage Design Criteria*.

5.4.1.3 BX FACTOR

The Bx Factor of 1.5 was used consistently for all XP-RAFTS modelling

5.4.1.4 RAINFALL DATA

The IFD rainfall data was as per the Existing Scenario in Table 5-2.

5.4.2 DEVELOPED DEFERRED AREA UNMITIGATED RESULTS

Table 5-5 outlines the 1 and 100 year ARI peak flows at the confluence of Queanbeyan River and Jumping Creek when the Deferred Area is developed.

Table 5-5: Jumping Creek Deferred Area Developed Unmitigated Peak Flow

Location	1 year ARI XP-RAFTS Peak Flow		100 year ARI XP-RAFTS Peak Flow	
	Existing (m^3/s)	Developed Scenario (m^3/s)	Existing (m^3/s)	Developed Scenario (m^3/s)
Confluence of Queanbeyan River and Jumping Creek	31.62	31.60	157.01	157.00

Table 5-5 shows that the difference between the Existing Scenario and Developed Scenario for the Deferred Area is insignificant. As a result, no peak flow attenuation is required for the development of the Deferred Area. This is not uncommon in large catchments with development in the downstream end of the catchment.

5.5 DISCUSSION

It can be seen that development of the Deferred Area will have no impact on the 1 and 100 year ARI peak flows at the confluence of Queanbeyan River and Jumping Creek. Therefore, no peak flow mitigation is required as part of developing the Deferred Area.

6 STORMWATER QUALITY

The Stormwater Quality analysis presented in this report is for development areas discharging to Jumping Creek. It is expected that if left unmitigated, the development will increase the stormwater pollutants that are exported to Jumping Creek and Queanbeyan River. A treatment train comprised of suitable Stormwater Quality Improvement Devices (SQIDs) is proposed to intercept and capture pollutants so that the potential impacts to receiving waters will be adequately mitigated and the development will achieve the required Water Quality Objectives (WQOs).

This section discusses:

- The WQOs identified for the catchment;
- Proposed measures to mitigate the increase in pollutant export; and
- Modelling of the proposed measures to confirm their effectiveness in meeting the WQOs.

6.1 WATER QUALITY OBJECTIVES

6.1.1 QUEANBEYAN CITY COUNCIL POLLUTANT REDUCTION TARGETS

Queanbeyan City Council's (QCC) *Development Design Specification – D7* titled *"Erosion Control and Stormwater Management"* (Version 1 June 2013) outlines the long-term water quality sustainability requirements for developments within Queanbeyan City Council.

The objective of long-term water quality sustainability is to protect the sensitive downstream aquatic ecosystems.

The biodiversity values of Jumping Creek and Queanbeyan River are also considered high, with a significant Platypus population in the area.

QCC's *Development Design Specification – D7* outlines the minimum level of pollutant load reductions for a development. These pollutant load reductions are defined in Table 6-1 below**.**

Table 6-1: Water Quality Objectives

Pollutant	Load Target Reduction
Total Suspended Solids (TSS)	80%
Total Phosphorus (TP)	65%
Total Nitrogen (TN)	65%

These pollutant reduction targets presented in Table 6-1 are higher than many standards and guidelines, particularly for TN. A 65% reduction in TN is significantly higher than the performance targets required under other guidelines. For example:

- NSW Council adopted Landcom draft *Water Sensitive Urban Design, Book 1, Policy* (2004) states 80% TSS, 60%TN and 45% TN reduction;

- Engineer's Australia *Australian Rainfall Quality* (2006) states a 80% TSS, 45% TP and 45% TN reduction;
- The ACT Planning & Land Authority's *Waterways: Water Sensitive Urban Design General Code* (ACT, 2008) states a catchment wide 85% TSS, 70% TP and 60% TN reduction; and
- The ACT Planning & Land Authority's *Waterways: Water Sensitive Urban Design General Code* (ACT, 2008) states a Subdivisional 60% TSS, 45% TSS and 40% TN reduction.

Therefore, achieving the pollutant reductions in accordance with Queanbeyan City Council's *Development Design Specification – D7* will provide an environmental outcome better than the developments in surrounding regions, particularly for TN.

6.1.2 NEUTRAL OR BENEFICIAL EFFECT ANALYSIS

In addition to achieving QCC water quality objectives, the existing scenario will also be modelled to ensure that the development pollutant loads are less than existing providing a Neutral or Beneficial Effect (NorBE) on water quality. In this case, the pollutant concentrations for TSS, TP and TN for the post-development case (including mitigation measures) must be equal to, or better compared to the pre-development case for between the 50th and 98th percentiles over the 10 year modelling period (1968 to 1977) when runoff occurs.

6.2 STORMWATER QUALITY MANAGEMENT STRATEGY

A treatment train of suitable SQIDs is proposed to mitigate the potential impact of developing the Deferred Area on the quality of stormwater runoff. A stormwater quality management strategy incorporating rainwater tanks and bioretention systems are proposed. Refer to Drawing No. C15776-005+ in Appendix C for the stormwater quality plan.

Given the site terrain it was determined that the ideal treatment train would consist of the following:

- Rainwater tanks to all the residential areas within all the catchments.
- End of line bioretention basins
- CDS Units.

The bioretention systems utilise a sandy loam soil based media to filter runoff. Sediment particle and suspended solids are trapped within vegetation and on the surface of the filter media while micro-organisms and vegetation remove dissolved nutrients (nitrogen and phosphorus) through biological uptake processes. Subsoil drainage provided below the filter media allows for the treated runoff to discharge from the bioretention systems.

6.3 MUSIC MODELLING METHODOLOGY

Water quality modelling of the Deferred Area development only has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 6.0.4, developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH). MUSIC enables the user to conceptualise the transfer of pollutants through a stormwater drainage system and provides an aid in quantifying the effectiveness of the proposed stormwater quality treatment train. MUSIC only provides quantitative modelling for Total Suspended Solids (TSS), Total Phosphorous (TP), Total Nitrogen (TN) and Gross Pollutants (GP).

The MUSIC model was setup in accordance with *Section B.2* from the ACT Planning & Land Authority's *Waterways: Water Sensitive Urban Design General Code* (ACT, 2008). Reference was made to Water by Design *MUSIC Modelling Guidelines* (2010) for any additional MUSIC setup guidelines. The subsequent sections discuss the model configurations adopted for the analysis.

6.3.1 METEOROLOGICAL DATA

Six minute pluviographic data was sourced from the eWater website for Canberra Airport Rainfall Station (Station No. 70014) as this was the nearest rainfall station to the site with a range of rainfall data. In accordance with *Section B.2* from the *Waterways: Water Sensitive Urban Design General Code,* the 10 year period from 1st January 1968 to 31st December 1977 was adopted for the rainfall duration. The six minute time step mean annual rainfall for this period is 655mm.

6.3.2 SOURCE NODES

The source nodes and their associated attributes are summarised in Table 6-2.

Table 6-2: Source Node Configuration

Source Node	Node Type	Adopted Fraction Impervious
Urban Residential Roof	Urban	100%
Urban Residential, including roads	Urban	70%
Connecting Road	Urban	75%

Base flow and Storm flow pollutant concentrations and soil properties were adopted from *Section B.2* from the ACT *Waterways: Water Sensitive Urban Design General Code,* being regionally relevant to Jumping Creek. Mean generation estimation has been adopted.

Refer to Figure 6-1 below for the MUSIC model layout for the Deferred Area.

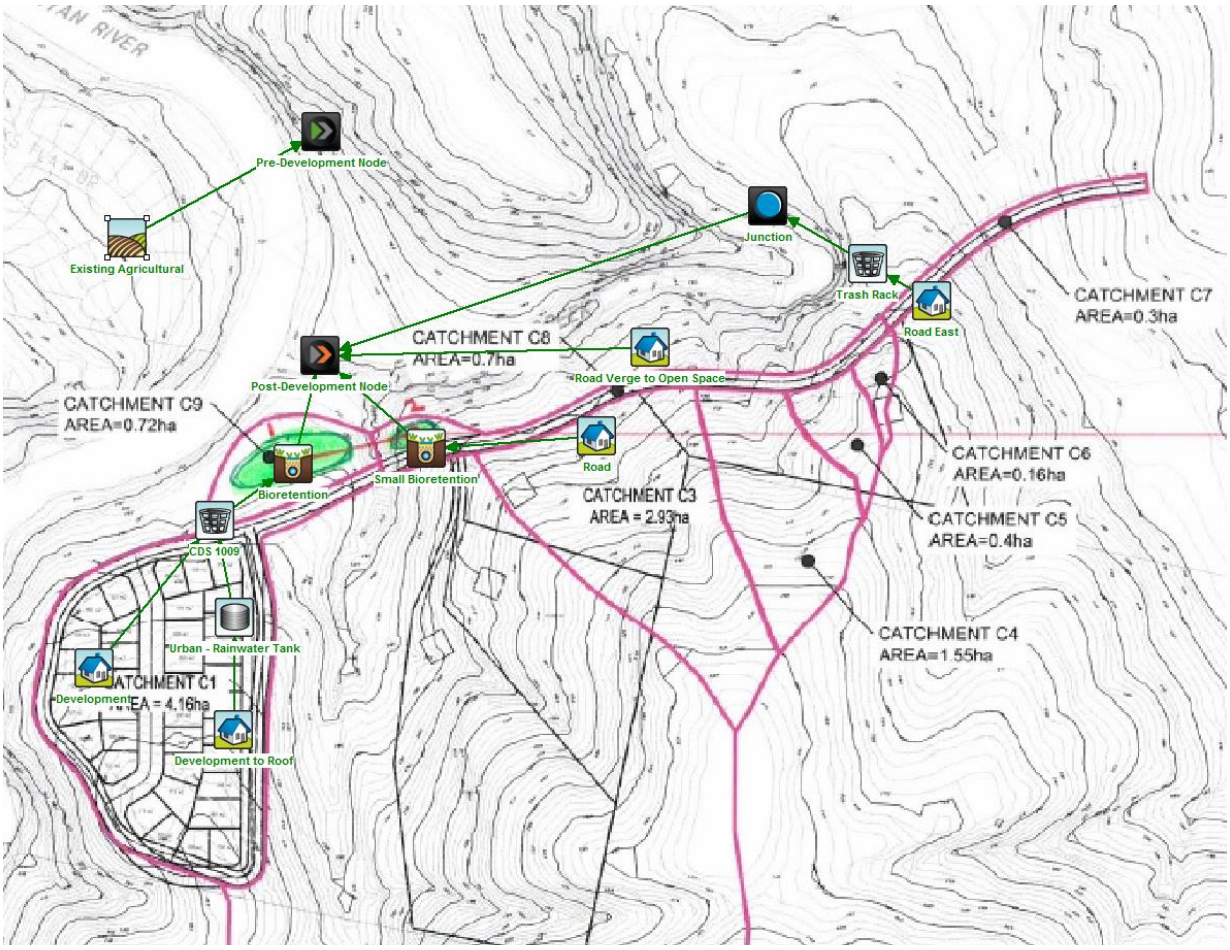

Figure 6-1: Pre- and post-development MUSIC Models

6.3.3 DRAINAGE LINKS

No routing was adopted for drainage links in accordance with *Section 4.17* of the *MUSIC Modelling Guidelines* (2010). This assumes flows and associated pollutants from all parts of the catchment arrive at the treatment nodes at the same time. This is conservative as it means that MUSIC may overestimate the overflow volumes.

6.3.4 TREATMENT NODES

6.3.4.1 RAINWATER TANKS

Rainwater tanks were adopted for all residential areas at a minimum of 2,000L per dwelling, for an average 3 bedroom house. Reuse has been taken as 0.15kL/day/dwelling.

Table 6-3: Rainwater Tank Parameters

Parameters per Tank	Value
Rainwater Tank Volume below overflow pipe per tank (kL)	2
Depth above Overflow per tank (m)	0.2
Adopted Surface Area per tank (m^2)[A]	2.5
Initial volume per tank (kL)	2
Overflow Pipe Diameter per tank (mm)	90
Daily Re-use per tank (L/day)[B]	150

[A]Surface area based on tank diameter of 1.8m
[B]Re-use rate based on a worst case scenario of external residential use e.g. gardens only. Taken from NSW *Using MUSIC in Sydney Drinking Water Catchment*

6.3.4.2 BIORETENTION

Bioretention systems are proposed to treat the entire Deferred Area development and the associated connecting road. End of line bioretention basin locations are shown on Drawing No. C15776-005+ in Appendix C.

Bioretention systems were modelled using MUSIC's Bioretention Treatment Node with the configurations outlined in Table 6-4. The Total Nitrogen content in filter media was adopted from Healthy Waterways *Interim MUSIC Bioretention Treatment Node* (2012) document. The Orthophosphate Content of the filter media modelled is slightly lower than the 50mg/kg stated in the Healthy Waterways *Interim MUSIC Bioretention Treatment Node* (2012) document, however laboratory testing from previous filter material supplied to various locations in Australia indicate that the Orthophosphate Contents filter media is generally in the order of 2 – 10mg/kg. Although less than the Healthy Waterways nominated 50mg/kg, modelling has adopted a conservative value of 30mg/kg, higher than the supplied material for the area.

Pre-treatment such as a Gross Pollutant Trap (GPT) has been modelled and will be required where the stormwater networks discharge into the proposed bioretention basins.

Table 6-4: Bioretention Node Parameters

Parameters	Bioretention Systems
Extended Detention Depth (mm)	500
Filter Depth (mm)	400
Drainage Layer Depth (mm)	150
Filter Type	Sandy Loam
Filter Area (m^2)	1% of contributing catchment area

Parameters	Bioretention Systems
Surface Area (m^2)	2.5% of contributing catchment area
Saturated Hydraulic Conductivity (mm/hr)	180
Filter Median Particle Diameter (mm)	0.45
Orthophosphate Content of Filter Media (mg/kg)	30
Overflow Weir (m)	10% filter area

6.4 MUSIC MODELLING RESULTS

Results of the proposed stormwater quality management strategy are presented in Table 6.5, Table 6.6, Figure 6.2 and Figure 6.3 below. The MUSIC model for the proposed development on the Deferred Area is shown in Figure 6.1.

The treatment train includes:

- End of line bioretention basins,
- Gross Pollutant Traps, and
- Rainwater tanks for residential lots

The results in Table 6.5 represent the pollutant reductions for the proposed development on the Deferred Area, discharging to the confluence of Queanbeyan River and Jumping Creek.

Table 6-5: MUSIC QCC Load Reduction Results

Description	Target Pollutant			
	TSS	TP	TN	GP
QCC WQO	80%	65%	65%	100%
Load Reduction Achieved	90%	82%	72%	100%
Load Reduction Achieved > WQO?	YES	YES	YES	YES

The above results indicate that the Queanbeyan City Council's Water Quality Objectives can be achieved for the proposed development on the Deferred Area. This includes chainage 0 to 100m along the Connecting Road draining directly to Jumping Creek.

The results in Table 6.6 represent the annual pollutant loads for the proposed development on the Deferred Area, discharging to the confluence of Queanbeyan River and Jumping Creek.

Table 6-6: MUSIC Model Annual Pollutant Loading (kg/yr) Results

Description	Annual Pollutant Loading (kg/yr)		
	TSS	TP	TN
Pre-development (1)	1260	1.43	24.7
Post-development with measures (2)	584	0.94	20.2
Difference (3) = (1) - (2)	676	0.49	4.5
% Improvement = (3) / (1) * 100	53.6	34.3	18.2
Neutral or Beneficial Effect? (Y/N)	Y	Y	Y

The above results show that the modelled post-development total suspended solids, total phosphorus and total nitrogen loads with the proposed stormwater management measures in place provides between 18 to 54% improvement compared to the pre-development conditions.

The comparative cumulative frequency curves for pollutant concentrations for phosphorus, nitrogen and total suspended solids are provided in Figure 6-2, Figure 6-3 and Figure 6-4 below.

To meet Neutral or Beneficial Effect (NorBE) the concentration of pollutants for the post-development scenario should always be equal to or less than the concentration for the pre-development scenario. This is impractical for a risk based approach and the natural variability of rain events. As a result, the "Using MUSIC in Sydney's Drinking Water Catchment - A Sydney Catchment Authority Standard" specifies that NorBE will be deemed to be met if the post-development scenario pollutant concentrations are equal to or less than the pre-development scenario concentrations between the 50th and 98th frequency percentiles when runoff occurs.

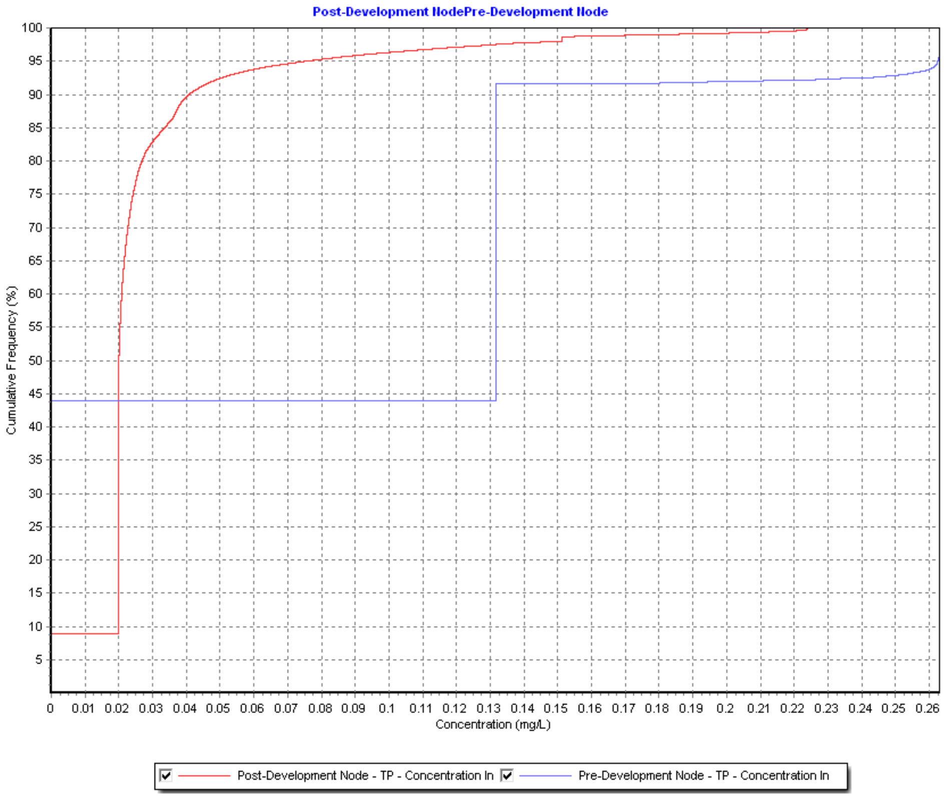

Figure 6-2: Pre- and post-development cumulative frequency graphs for total phosphorus concentrations.

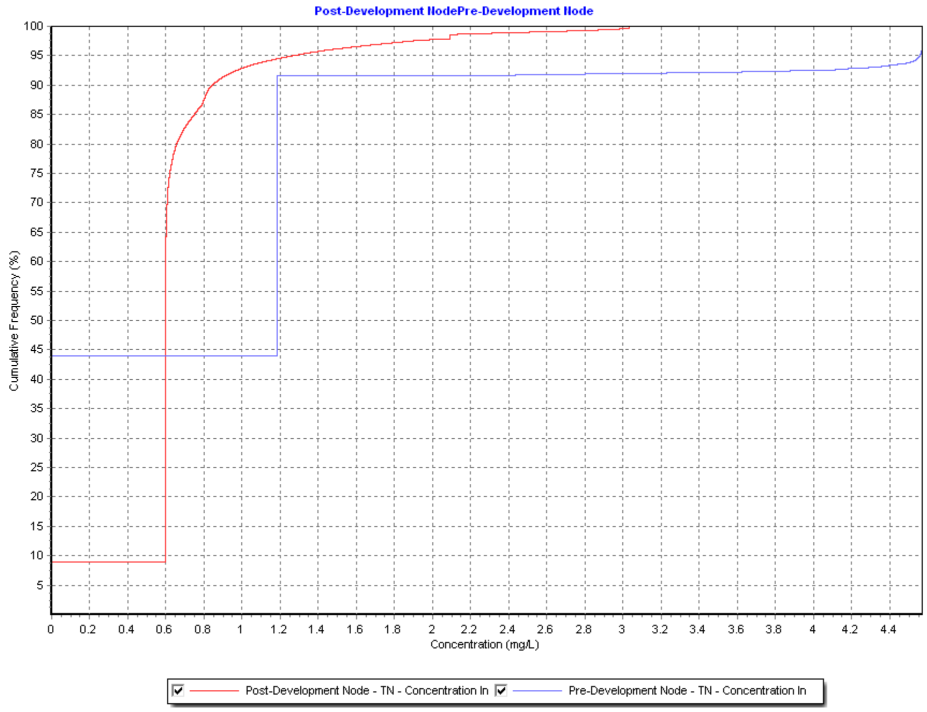

Figure 6-3: Pre- and post-development cumulative frequency graphs for total nitrogen concentrations.

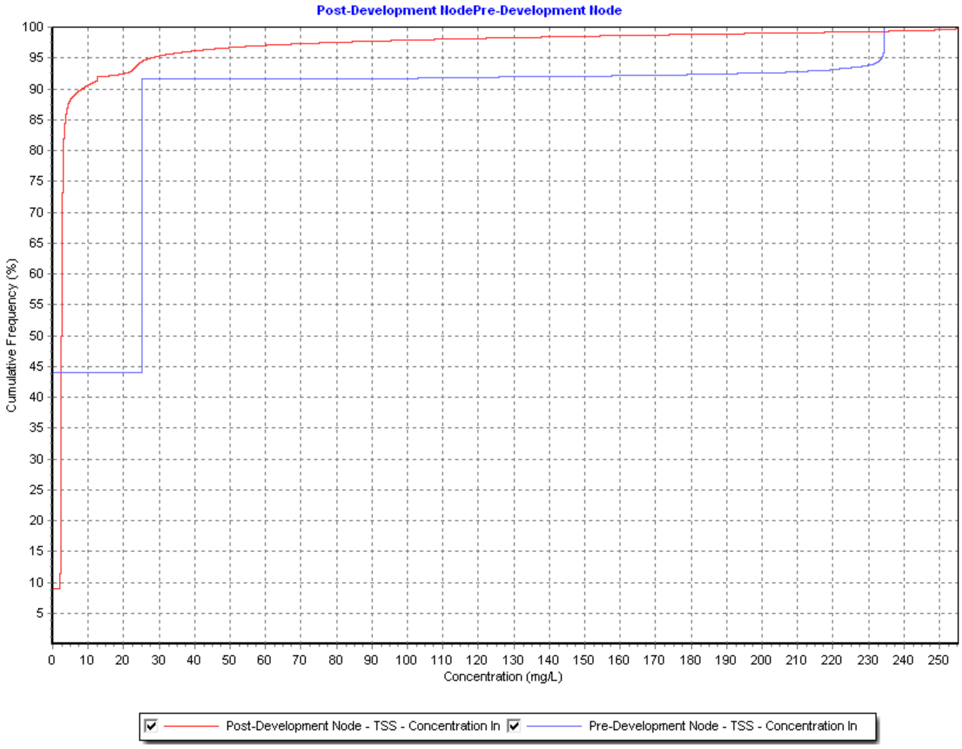

Figure 6-4: Pre- and post-development cumulative frequency graphs for total suspended solid concentrations.

The above results show that the total suspended solids, total phosphorus and total nitrogen runoff concentrations for the post-development scenario are lower than the predevelopment conditions between the 50th and 98th percentiles.

6.5 DISCUSSION

The MUSIC model results have conceptually shown that the Queanbeyan City Council's Water Quality Objectives can be achieved for the proposed development on the Deferred Area. This includes chainage 0 to 100m along the Connecting Road draining directly to Jumping Creek.

The results have also shown that NorBE would be achieved for the proposed development on the Deferred Area with the proposed management measures.

Given that our surface runoff water quality modelling shows that the quality of the stormwater runoff from the Deferred Area would improve post development, it is considered that the ambient water quality within the Queanbeyan River and Jumping Creek will not deteriorate due the proposed development on the Deferred Area with the proposed stormwater quality improvement management measures.

The sustainable achievement of NorBE will require stormwater management measures consisting of:

- 2000 L rainwater tanks (min) and plumbing of roofs to capture 50% of runoff into the tanks on each lot. Assumes a roof area of 350m^2. Roof area adopted from Googong with similar lot sizes.
- Rainwater re-use for external use only. Adding toilets and laundry will improve the MUSIC model results,
- Gross Pollutant Traps, and
- End of line bio-retention basins.

7 DISCHARGING INTO JUMPING CREEK

Integration of the proposed water quality treatment devices with Jumping Creek is important. The design and construction of stormwater outlets should aim to be natural, yet provide a stable transition from a constructed drainage system to the natural environment. It is recommended that the following be integrated in the final design with respect to outlet structures and scour protection:

- Employ ecological engineering solutions for scour and erosion control, to meander the discharging water to the Creek.
- Only use engineered solutions (e.g., stone pitching, concrete lined batters, and concrete structures) where necessary.

Appropriate rehabilitation of disturbed areas following the installation of outlet structures should adequately restore the integrity of the riparian corridor.

8 FLOOD MAPPING (100 YEAR ARI)

Mapping of the 100 year flood extents for Jumping Creek and Queanbeyan River at the site is based on the 2008 Queanbeyan Flood and Floodplain Risk Management Study and Plan (Lyell and Associates). The Queanbeyan Flood and Floodplain Risk Management Study and Plan identifies the 100 year ARI flood level at the confluence of Jumping Creek and Queanbeyan River to be 579.5m AHD.

The Deferred Area surface levels varies between 580 m AHD and 605m AHD, which is well above the 100 year flood level. Refer to C15776-005+ for 100yr ARI flood extents along the Deferred Area.

9 RECOMMENDED RIPARIAN CORRIDOR WIDTHS

LandData Surveys has undertaken a survey along Queanbeyan River corridor to define the highest bank on the eastern side of Queanbeyan River along the Deferred Area. LandData Surveys report is presented within Appendix G.

Queanbeyan River and Jumping Creek are defined as 4th order or greater watercourses in accordance with the Strahler System. The unnamed tributary through the site is a 2nd order stream. The *NSW Office of Water Guidelines for Riparian Corridors on Waterfront Land specifies* that for a 4th order watercourse, the width of the vegetated riparian zone (VRZ) is 40 metres measured from the top of the highest bank on both sides of the watercourse. For a 2nd order watercourse, the width of the vegetated riparian zone (VRZ) is 20 metres measured from the top of the highest bank on both sides of the watercourse. The riparian corridors for Queanbeyan River and Jumping Creek are shown in C15776-005+ in Appendix D.

10 SOIL AND WATER MANAGEMENT STRATEGY

10.1 BACKGROUND

The Jumping Creek Deferred area is located along both Jumping Creek and Queanbeyan River, which is a highly sensitive ecosystem. During the land disturbance phase of a development, a large amount of soil can be eroded and deposited onto nearby lands or downstream waterways. To mitigate the impacts of land disturbances from developments, the NSW Government has developed the *Managing Urban Stormwater: Soils and Construction Guidelines*, also known as the *NSW Blue Book*. This guideline has been applied for the Soil and Water Management Strategy.

10.2 OBJECTIVE

The objective is to provide a high level Soil and Water Management Strategy for the Jumping Creek Deferred Area. Due to the highly sensitive nature of the downstream environment the aim of this strategy is to not only meet *NSW Blue Book* requirements but to exceed it where site constraints allow. Also, the principle of minimum disturbance is to be observed.

10.3 METHODOLOGY

10.3.1 CLEAR WATER DIVERSION

Clear water diversion bunds are to be located upstream of the earthworks areas to divert clean water around any construction works.

10.3.2 DIRTY WATER DIVERSION

Dirty water diversion bunds are to be located on the low side the earthworks areas, to carry dirty water to the proposed sediment control basins. Where required, the use of rock check dams may be used in the channels to minimise scouring.

10.3.3 OTHER TREATMENT MEASURES

Sediment fences, straw bale sediment traps and geotextile surface protection is to be constructed at strategic locations where required.

Any temporary culverts installed must have appropriate outlet protection installed after pipe laying without delay.

10.3.4 SEDIMENT BASINS

10.3.4.1 LOCATION OF SEDIMENT CONTROL BASINS

The Stormwater Quality Improvement Devices (SQIDs) outlined in this report will also be utilised as end of line sediment control basins during both civil construction and housing construction phases.

10.3.4.2 SIZING OF SEDIMENT CONTROL BASINS

The sediment basins for this study have been sized in accordance with the guidelines set out by the *NSW Blue Book*, *Managing Urban Stormwater: Soils and Construction* (2004). An assessment of the soil types provided in the Geotechnical Report *(Geotechnical Terrain Assessment for the Proposed South Queanbeyan Rural-Residential Development NSW,* February 1988*)* prepared by Coffey & Partners has been carried out. The soil types were compared against the soil type descriptions provided in the NSW Blue Book. Based on this assessment, a 'Type D' dispersible soil was adopted in the design. A 'Type D' soil also yields a worst case dispersive soil sediment basin size. The total volume of a 'Type D' sediment basin is the sum of the following two components:

- A settling zone, within which water is stored allowing the settlement of suspended sediment, and
- A sediment storage zone, where deposited sediment is stored until the basin is cleaned out.

The settling zone is determined from a predefined y-percentile, 5-day rainfall depth as set in the *NSW Blue Book*.

Due to the developments proximity to Queanbeyan River and Jumping Creek, and the sensitive nature of the downstream environment, the minimum rainfall event as stated in *Section 6.3.4(f)(ii)* of the *NSW Blue Book* is an 85th percentile 5 day event (pg. 6-21). This gives a design rainfall depth for Queanbeyan of 25.8mm over a 5 day period.

The sediment storage zone is taken as the greater of:

- 0.5 x the settling zone capacity, or
- Two months soil loss as calculated with the Revised Universal Soil Loss Equation (RUSLE).

It was found that *0.5 x the settling zone capacity* yields a larger storage volume for each basin and was therefore adopted for calculating the total sediment storage volume. Refer to Appendix F for sediment basin volume calculations.

10.3.4.3 REQUIRED SEDIMENT BASIN SIZES

Table 10-1 below shows the required sediment basin volumes for the developed catchments to Jumping Creek. It can be seen that the end of line Water Quality Improvement Devices proposed in Section 6 will have sufficient capacity to meet the required sediment basin volumes when excavated to the base of the filter component. Refer to Appendix D and Drawing C15776-006+ for the Soil and Water Concept Management Plan.

Table 10-1: Summary of Sediment Basin Volumes

Catchment	Area (ha)	[1] Required Sediment Volume (m^3)	[2] End of Line SQID Volume (m^3)
D_C1 (Urban Area)	4.17	905	1,023
D_C8 (Road Catchment)	0.98	213	240

[1] This is the volume of the sediment basin required by the NSW Blue Book for 85th percentile 5-day event capture for Queanbeyan.
[2] This is the volume of the end of line Bio Retention Basin measured to the boxing level.

The above table shows that the minimum required 5-day 85th percentile volume can be provided. The final sediment basin volumes are subject to detailed design.

10.4 CONSTRUCTION AND ESTABLISHMENT OF BIORETENTION BASINS USED AS SEDIMENT CONTROL BASINS

The following information outlines a staged construction and establishment methodology for bioretention basins utilised as sediment control basins during civil construction. There are a number of challenges that must be appropriately considered to ensure successful construction and establishment of bioretention basins. These challenges are best described in the context of the typical phases in the development of a Greenfield development, namely the Civil Construction Phase and the Housing Construction Phase.

10.4.1 CIVIL CONSTRUCTION PHASE CHALLENGES

The Civil Construction Phase involves the civil works required to create the landforms associated with a development and install the related services (roads, water, sewerage, power, etc.) followed by the landscape works to create the softscape, streetscape and parkscape features.

The risks to the successful construction and establishment of bioretention basins during this phase of work have generally been related to the following:

- Construction activities which can generate large sediment loads in runoff which can smother vegetation and clog bioretention filter media or plants, and
- Construction traffic and other works can result in damage to the bioretention basins. It is important to note that all works undertaken during civil construction are 'controlled' through the principle contractor and superintendent. This means the risks described above can be readily managed through appropriate guidance and supervision.

10.4.2 HOUSING CONSTRUCTION PHASE CHALLENGES

Once the Civil Construction works are complete the Housing Construction Phase can commence. This phase of development is effectively 'uncontrolled' due to the number of building contractors and sub-contractors present on any given block on any given day. For this reason the Housing Construction Phase represents the greatest risk to the successful establishment of bioretention basins.

10.5 STAGED CONSTRUCTION AND ESTABLISHMENT METHOD

To overcome the challenges associated within delivering bioretention basins a Staged Construction and Establishment Method should be adopted, see Figure 10-1 below.

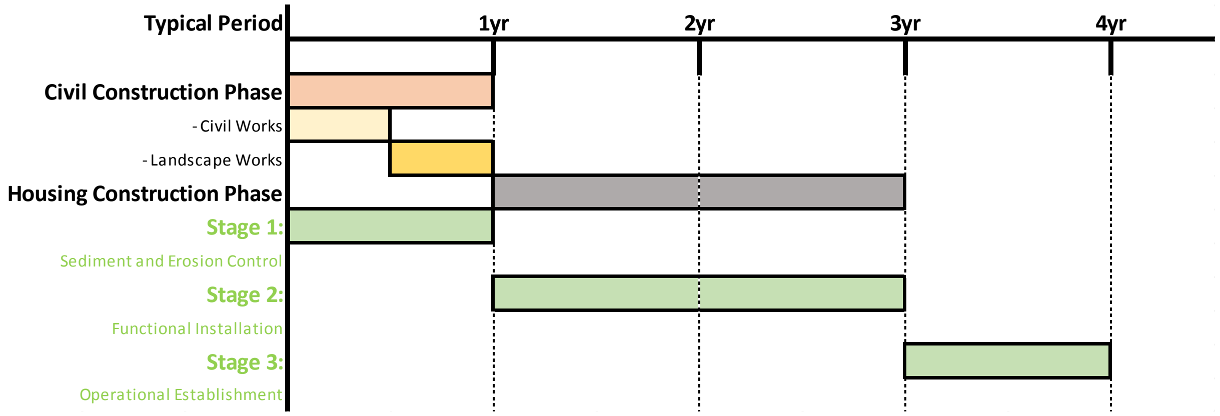

Figure 10-1: Staged Construction and Establishment Method

10.5.1 STAGE 1: SEDIMENT AND EROSION CONTROL

During the civil construction phase no elements of the future bioretention basins should be established. The bioretention basins should only be constructed to the base of the filtration component to achieve the highest possible sediment storage volumes, and must be constructed as per the *NSW Blue Book* Guidelines.

10.5.2 STAGE 2: FUNCTIONAL INSTALLATION

Construction of the functional elements of a bioretention basin can be installed along with temporary protective measures. This involves:

- Bulking out and trimming;
- Installation of the outlet structures;
- Placement of liner and installation of drainage layer (i.e. under-drains and drainage layer);
- Placement of filter media;
- Placement of a temporary protective layer by covering the surface of the filtration media with geofabric and placement of 25mm topsoil and turf over the geofabric. This temporary geofabric and turf layer will protect the bioretention basin during the housing construction phase ensuring sediment/litter laden water does not enter the filter media causing clogging;
- Place silt fences around the boundary of the bioretention basins to exclude silt and restrict access.

10.5.3 STAGE 3: OPERATIONAL ESTABLISHMENT

At the completion of the Housing Construction Phase (approximately 2 years post-civil construction), the temporary measures (i.e. geofabric and turf) are removed with all accumulated sediment, and the bioretention system can be re-profiled and planted in accordance with the proposed landscape design.

Establishment of the vegetation to design condition can require more than two growing seasons, depending on the vegetation types, during which regular watering and removal of weeds will be required for all bioretention basins.

11 CONNECTING ROAD AND SUBDIVISION EDGE ROADS

11.1 GENERAL

Portions of the Deferred Area along the connecting road alignment consist of steep terrain with site slopes up to 20%. The location and grading of the connecting road and subdivision edge roads have been refined from the previous Master Plan Layout to better allow for this steep terrain, to minimise the construction footprint and environmental impacts. See Appendix D for road design drawings.

Special consideration was also given to future maintenance of the road corridors. Sufficient verge widths have been provided to facilitate maintenance of the grassed verges along the gully edges.

The road corridors will also serve as a service corridor to service the proposed residential lots. The typical road cross section on Drawing C15776-008+ in Appendix D shows that the connecting road corridor has ample room to provide water, stormwater, sewerage, power and telecommunication services to the proposed development on the Deferred Area.

11.2 ROAD DESIGN CRITERIA

The design criteria adopted for the connecting road and subdivision edge roads are compiled from Queanbeyan City Council's Development Design Specification D1 – Geometric Road Design.

The connecting road and subdivision edge roads have been designed as a Local Street. Table 11-1: outlines the key criteria.

Table 11-1: Key criteria for road design

Criterion	Value
Design Speed	40km/hr
Minimum Radii of Horizontal Curves	40m
Minimum Radii of Vertical Curves	25m
Minimum K Value (Crest)	5.3
Maximum Longitudinal Grade	16%
Kerb Type	Kerb and Gutter
Carriageway Width	6m

11.3 TYPICAL CROSS SECTIONS

11.3.1 CONNECTING ROAD

The main features of the Connecting Road cross section are as follows (see Typical Cross Section, Drawing C15776-008 within Appendix D):

- 6m wide carriageway to allow for two 3m wide traffic lanes;
- 5m wide verge to accommodate street lighting and other services;
- 2m wide verge along the connecting road to reduce the extent of cut;
- The total width of the road reserve is 13m;
- Verges along the gullies will have uniform cross fall of 2% away from the kerb;
- Fill batter slopes shall be 1v:4h or flatter;
- Cut batter slopes shall be 1v:2h or flatter; and
- Normal pavement cross fall is 3%.

11.3.2 SUBDIVISION EDGE ROADS

The main features of the Subdivision Edge Road cross section are as follows (see Typical Cross Section, Drawing C15776-008+ within Appendix D):

- 6m wide carriageway to allow for two 3m wide traffic lanes;
- 5m wide verge to accommodate street lighting and other services;
- 2m wide verge along the subdivision edge roads to reduce fill into the riparian corridor;
- The total width of the road reserve is 13m;
- Verges along the gullies will have uniform cross fall of 2% away from the kerb;
- Fill batter slopes shall be 1v:4h or flatter;
- Cut batter slopes shall be 1v:2h or flatter; and
- Normal pavement one-way cross fall away from blocks is 3%.

11.4 DISCUSSION

The above sections 11.2 and 0 with drawings in Appendix D show that the connecting road and subdivision edge roads can be designed and constructed to comply with Queanbeyan City Council's Development Design Specification D1 – Geometric Road Design.

A 6m wide carriage for the connecting road and subdivision edge roads has been adopted from Googong for this study. The carriageway width can be adjusted at DA stage should Queanbeyan City Council request a differed width. We note that changing the carriageway width will not change the result of this study.

12 VEHICULAR ACCESS

Queanbeyan City Council aims to provide appropriate and safe access to all lots for pedestrian, vehicles and cyclists.

Queanbeyan City Council's Development Design Specification D13 – Vehicular Access Design specifies that the gradients of residential driveways within a lot shall not exceed 1v:6h for driveways which fall away from the property boundary.

The vehicular accesses off the Connecting Road to the building envelopes on the large lots have been graded at a maximum of 1v:6h. See drawing C15776-016 within Appendix D for the vehicular access locations and long sections.

13 CONCLUSION

Calibre Consulting has completed a detailed assessment of the urban capability of the portion of the Jumping Creek Residential Estate currently zoned as Deferred Area. The detailed assessment specifically looked at site slope (vehicular access to the Deferred Area), stormwater quality and quantity post development of the Deferred Area, and erosion and sediment control for the period of construction on the Deferred Area.

This detailed assessment has found that a residential development on the Deferred Area will have no adverse effects on the environment, with the management measures proposed in this report. These management measures include the control of sediment runoff during both civil and housing construction phases. The use of rainwater tanks, gross pollutant traps and bioretention basins for the treatment of stormwater runoff.

The water quality modelling results have also shown that a Beneficial Effect would be achieved for the proposed development on the Deferred Area. This assessment has also found that using the catchment wide approach for stormwater quantity control, a development within this area will have no impact on the 1 and 100 ARI storm event Peak flows.

Access roads and services within the Deferred Area are able to meet the required standards as set by QCC.

It has been determined that the a residential development within the Deferred Area is feasible, and can comply with the requirements of QCC, DPE and OEH with respect to slope, stormwater quantity, water quality and sediment control.

14 REFERENCES

- ACT Planning & Land Authority (2008), Waterways: Water Sensitive Urban Design General Code.
- Coffey & Partners (1988), Geotechnical Terrain Assessment for the Proposed South Queanbeyan Rural-Residential Development N.S.W.
- Engineers Australia (2006), Australian Rainfall Quality: A Guide to Water Sensitive Urban Design.
- A Sydney Catchment Authority Standard (2012), Using MUSIC in Sydney's Drinking Water Catchment
- LandData Surveys (2015), Jumping Creek Development Definition of Highest Bank of the Queanbeyan River.
- Lyall & Associates (2008), Queanbeyan Flood and Floodplain Risk Management Study and Plan.
- NSW Department of Primary Industries (2012), Guidelines for Outlet Structures on Waterfront Land.
- NSW Department of Primary Industries (2012), Guidelines for Riparian Corridors on Waterfront Land.
- NSW Office of Water & Heritage (2004), Managing Urban Stormwater: Soils and Construction – Volume 1.
- Parsons Brinckerhoff Australia (2008), Jumping Creek – Planning Submission to Queanbeyan City Council.
- Queanbeyan City Council (2011), Development Design Specification D5 Stormwater Drainage Design.
- Queanbeyan City Council (2011), Development Design Specification – D7 Erosion Control and Stormwater Management.

APPENDICES

APPENDIX A CORRESPONDANCE WITH MR MILES BOAK AND DR SANDRA JONES

ATTACHMENT 1

BROWN
Smart Consulting

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e. Mark.Kelly@brownconsulting.com.au
Level 6,121 Marcus Clarke Street, Canberra City, ACT, 2601
GPO Box 261, Canberra, ACT, 2601
www.brownconsulting.com.au

From: Miles Boak [mailto:Miles.Boak@environment.nsw.gov.au]
Sent: Thursday, 30 August 2012 3:40 PM
To: Mark Kelly
Subject: RE: Jumping Creek OEH Study Specifications

Mark

Comments I have received generally Ok with what you proposed on the need for load based objectives and need for calibration.

While it is agreed that for appropriate trigger values for water quality, the Queanbeyan River could be appropriately called significantly modified due to the dam. In terms of Anzecc guideline triggers then could also assume a 'slightly disturbed environment'.

As far as biodiversity values are concerned it is high with a large resident platypus population in the stretch of the river opposite the Jumping Creek. Lots of information on the value of the river is contained in Queanbeyan River Riparian Corridor Strategy http://www.qcc.nsw.gov.au/Growing-Our-City/Sustainability/Catchment-Management/Catchment-Management

Cheers
Miles

Miles Boak
Conservation Planning Officer, Office of Environment and Heritage
PO Box 733 (11 Farrer Place) Queanbeyan NSW 2620
Tel (02) 6229 7095 Mob 0427 919192

From: Mark Kelly [mailto:Mark.Kelly@brownconsulting.com.au]
Sent: Thursday, 30 August 2012 2:29 PM
To: Boak Miles
Cc: 'Michael Nolan (Michael.Nolan@cicaustralia.com.au)'
Subject: RE: Jumping Creek OEH Study Specifications

HI Miles,

Any News? We would like to clarify scope so we can provide a proposal to our clients, CIC.

Cheers

Mark Kelly | Manager - Water & Environment
Brown Consulting (ACT) Pty Ltd

BROWN
Smart Consulting

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Brown Consulting reaches milestone with over 400 people across 9 offices

From: Miles Boak [mailto:Miles.Boak@environment.nsw.gov.au]
Sent: Wednesday, 15 August 2012 3:38 PM

To: Mark Kelly
Subject: RE: Jumping Creek OEH Study Specifications

Hi Mark

Thanks for your email.

I have forwarded it on to Marlene Van Der Sterren who is the WSUD project officer in OEH head office.

I will get any comments back to you as soon as possible. But as discussed the EPA people here thought it makes sense to use the Googong approach and base data.

Thanks
Miles

Miles Boak
Conservation Planning Officer, Office of Environment and Heritage
PO Box 733 (11 Farrer Place) Queanbeyan NSW 2620
Tel (02) 6229 7095 Mob 0427 919192

From: Mark Kelly [mailto:Mark.Kelly@brownconsulting.com.au]
Sent: Wednesday, 15 August 2012 1:48 PM
To: Michael Nolan; Boak Miles; Malcolm Leslie; Tony Connell
Cc: Lorena Blacklock; David Leone; 'Martin Brown'
Subject: RE: Jumping Creek OEH Study Specifications

Hi Miles,

Thanks for your time this morning, it appears we're generally in agreement, though thought I should follow up with an email to provide more detail. Our proposed methodology is consistent with what was undertaken for Googong and a number of other nearby projects.

As discussed, the requirements in the attached letter generally seem reasonable, though there are several points of clarification required in order to proceed.

Based on the size and nature of the development, which is approximately 100ha compared to the size of the receiving waterway, Queanbeyan River catchment (96,000ha), and the catchment of Jumping Creek (3,500ha) we have recommended an alternative approach to conduct water quality modelling and proposed treatment measures in accordance with current water quality guidelines, which can be undertaken at reasonable time and cost.

The points are clarification are outlined below:

- **Event based modeling to calibrate MUSIC Modeling:** This is an onerous requirement which would require considerable water sampling to confirm baseline conditions, the time and cost is not warranted.

Instead, we propose to adopt best management practices stormwater management and modelling (MUSIC) according to the various recent guidelines (ACTPLA WSUD Guidelines, BMT WBM Draft NSW MUSIC Modelling Guidelines, etc.)which is considered appropriate for the proposed development.

The guidelines specify appropriate MUSIC parameters to adopt based on significant research. Calibration of the model to anticipated runoff values based on annual volumetric runoff coefficients can also be undertaken to determine if the model is under or over estimating flows. The Draft NSW Guidelines specify the use of an effective impervious area based on catchment size.

Calibration of MUSIC to event pollutant concentrations for the site is not considered necessary in order to demonstrate the effectiveness of the proposed stormwater management plan for the development as the adoption of recommended values will provide an appropriate measure of the performance of the proposed stormwater quality improvement devices.

- **Predevelopment Estimates of Pollutant Loads**: Similar to the above, this is an onerous requirement particularly if the model is to be calibrated based on water sampling. This requirement is typically only considered if there is a highly sensitive downstream receiving waterway. Queanbeyan River is a modified waterway (Googong Dam upstream and significant urban development along the main reach) with variable water quality (ActewAGL states on their website that the water quality from the Queanbeyan River catchment can be variable and requires extensive treatment).

We propose to adopt load reduction based objectives are based on % reduction from an urban catchment without WSUD measures, consistent with the guidelines reference above.

- **Adoption of concentration based objectives**: We propose that load based objectives are more appropriate for the following reasons:

o The most recent guidelines throughout Australia specify annual load based reduction objectives;
o Australian Runoff Quality (page 1-6, Sect 1.5) states that ambient water quality trigger levels "do not directly provide water quality targets for stormwater discharge or the selection, sizing and design of catchment management measures";
o The default k and C* values adopted in the MUSIC treatment nodes effectively limited the level of treatment achievable. i.e. High outflow concentrations are produced regardless of the inflow concentrations;
o Concentrations of discharges from small sites are highly variable making the selection of pollutant concentrations problematic; and
o ANZECC guidelines state "while algal growth rate (or productivity) is related to the concentration of key nutrients in the water column, the biomass is more controlled by the total mass of these nutrients available to the growing algae". Therefore concentration should not be considered as the primary criterion.

Therefore for the water quality modeling we recommend following ACT Guidelines with consideration of Draft NSW Guidelines and Australian Runoff Quality. This excludes water quality testing.

The approaches outlined above are generally considered current best management practice water quality modeling.

We would appreciate advice as to whether the above approach would be acceptable, in order the Brown Consulting to accurately scope the study requirements.

I am happy to discuss the above with relevant representatives from OEH if required.

Cheers

Mark Kelly | Manager - Water & Environment
Brown Consulting (ACT) Pty Ltd

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From: Michael Nolan [mailto:Michael.Nolan@cicaustralia.com.au]
Sent: Wednesday, 8 August 2012 11:03 AM
To: 'Miles Boak'; Malcolm Leslie; Tony Connell; Mark Kelly
Cc: Lorena Blacklock; David Leone; 'Martin Brown'
Subject: RE: Jumping Creek OEH Study Specifications

Thanks Miles,

As discussed, please kindly make arrangements for your water specialist to speak directly with Mark Kelly, Manager – Water and Environment at Brown Consulting about the study requirements. Mark has reviewed the specifications and believes they can be addressed in most cases but has some suggestions on how the modelling can be more practically completed and achieve more meaningful results.

Mark's phone number is (02) 6211 7199 and his email address is mark.kelly@brownconsulting.com.au

Subject to the discussions between Mark and your water specialist and any consequential amendments to the study specifications, we intend to engage Brown Consulting to complete the study.

Regards
Mike

Michael Nolan
Development Manager

CIC AUSTRALIA

CIC Australia Limited
PO Box 1000, Civic Square ACT 2608
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From: Miles Boak [mailto:Miles.Boak@environment.nsw.gov.au]
Sent: Thursday, 2 August 2012 10:14 AM

To: Michael Nolan
Subject: RE: Jumping Creek OEH Study Specifications

Hi Michael

Attached is the final signed letter on this issue.

EPA made some points of clarification at the last minute to clarify further the work required but essentially the same.

Again apologies for lateness.

Regards

Miles

Miles Boak
Conservation Planning Officer, Office of Environment and Heritage
PO Box 733 (11 Farrer Place) Queanbeyan NSW 2620
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ATTACHMENT 2

NSW GOVERNMENT | Office of Environment & Heritage

Our reference: FIL07/16360
Contact: Miles Boak 6229 7095

Mr Michael Nolan
Project Manager
Canberra Investment Corporation
PO Box 1000
Civic Square ACT 2608

Dear Mr Nolan,

Re: Jumping Creek Rezoning Queanbeyan – Water Quality Assessment

The Office of Environmental and Heritage (OEH) has been requested to provide advice on the additional assessment required to justify the rezoning of the deferred area of Jumping Creek residential development from Queanbeyan draft LEP 2011. This was specifically in relation to water quality assessment. It is noted that Queanbeyan City Council (QCC) resolved to defer the two development nodes in south-west section of the Jumping Creek site as the land requires further consideration in regard to urban capability.

In the past OEH has objected to rezoning of this section of the site. The area is constrained in relation to the proximity to the river, the potential for rapid export of material, in solution or suspension, during times of high flow that would make the area a high risk to input of sediment and nutrients that could result in an adverse impact on water quality of Jumping Creek and the Queanbeyan River.

It was agreed at the on-site meeting that the applicant should have opportunity to demonstrate that the above matters can be adequately addressed through best practice planning combined with engineering and/or Water Sensitive Urban Design (WSUD) solutions. The OEH therefore consider it appropriate that the proponent undertake detailed assessment including water quality modelling to estimate potential water quality impacts of the proposed development and to assess the performance of the proposed stormwater treatment systems in the specific circumstances of the Jumping Creek site. Detailed advice in this regard is contained in **Attachment 1.**

This is considered a consistent approach to meet the strategic guidelines applying to the site from the s117 Directions Sydney-Canberra Corridor Strategy Page 48 *that new urban release areas should meet storm water management targets that support the environmental values of the catchment.*

If you would like further information or clarification regarding the issues raised in this submission, please contact Miles Boak on (02) 62297095.

Yours sincerely

Sandra Jones 2/8/12

DR SANDRA JONES
A/Manager Landscape and Aboriginal Heritage Protection (South)
Conservation and Regulation Division

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11 Farrer Place Queanbeyan NSW
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ATTACHMENT 1 – WATER QUALITY ASSESSMENT JUMPING CREEK

Water Quality

The applicant should demonstrate the water quality outcomes for the proposal through provision of details for predicting and assessing potential impacts to receiving waters, including, but not limited to:

- the ambient Water Quality Objectives and environmental values of receiving waters. These refer to the community's agreed environmental values and human uses endorsed by the NSW Government as goals for ambient waters (http://www.environment.nsw.gov.au/ieo/index.htm).
- the indicators and associated trigger values or criteria for the identified environmental values. This information should be sourced from the ANZECC (2000) Guidelines for Fresh and Marine Water Quality (http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality).
- any locally specific objectives, criteria or targets which have been endorsed by the NSW Government.
- the nature and degree of impact that any discharges will have on the receiving environment.
- the significance of any identified impacts including consideration of the relevant ambient water quality outcomes. Demonstrate how the development will be designed and operated to:
    - protect the Water Quality Objectives for receiving waters where they are currently being achieved; and
    - contribute towards achievement of the Water Quality Objectives over time where they are not currently being achieved.
- the management of discharges with potential for water quality impacts
- drainage works and associated infrastructure; land-forming and excavations; working capacity of structures; and water resource requirements of the proposal
- outline site layout, demonstrating efforts to avoid proximity to water resources (especially for activities with significant potential impacts e.g. sediment ponds) and showing potential areas of modification of contours, drainage etc.
- details of any proposed sediment basins including sizing, design and management consistent with *Managing Urban Stormwater: Soils and Construction* (NSW Landcom, 2004).

Stormwater

A comparison of water quality at the boundary of the site under current conditions and under a fully realised residential development scenario that includes planned stormwater infrastructure. In addition, a detailed analysis of the post-development flows is to be conducted to meet pre-development discharges to prevent erosion of the steep slopes.

Detailed modelling should be carried out for the site that addresses development of the steep, highly erodible land by considering both the quantity and quality discharges from the proposed development. A water quality model (such as MUSIC) should be used with suitable parameters for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) and a water quantity model set up with suitable parameters for velocity and gradient analysis (erosion).

To develop the water quality detailed model (eg. MUSIC), it will be necessary to:

- Conduct (rain) event based monitoring and baseflow monitoring to gather data on flows and event mean concentrations for various intensities of runoff events
- Use the monitoring data to calibrate and validate the model rather than using model defaults for the pre-development conditions. Note that the existing published data will be too coarse for the scale of assessment required at this site.
- Provide a measure of model performance and uncertainty
- Adequately address pollutant loads as detailed below:

1. An accurate representation of the existing (i.e. natural) pollutant loads, including clear statements on the data source for pollutant concentrations adopted in the modelling

(these should be stated for both pre- and post development) and how this compares to published literature. Data could be expressed in estimates of unit loads (kg/ha/year) and in concentrations (mg/L) for TSS, TP and TN respectively. There are figures on the range of what would be expected in vegetated catchments with a mean annual rainfall of approximately 700-800 mm/yr and 'typical' values for such a scenario.

2. Accurate pre-development estimates of pollutant loads and run-off volumes calibrated to the measured data on site. The pre-development load estimates will need to be substantiated for TSS, TP and TN. The final calibrated parameters should be compared and contrasted against:

   - the typical values listed in Fletcher *et al* (2004) (http://www.catchment.crc.org.au/pdfs/technical200408.pdf)
   - default standard deviations in MUSIC (i.e. Note also Figures 2.15 to 2.20 in this reference that allow an approximate estimate of loads for different combinations of land use, % imperviousness and mean annual rainfall, which can be used to assess likely validity of the estimates);
   - Duncan (1999) *Urban Stormwater Quality Statistical Overview*.

3. Assessment of the 'ultimate condition' (i.e. developed) loads using the above references and other relevant published literature should be achievable with adequate rainfall data available to run MUSIC for the Queanbeyan area.
4. Justification of the time step utilised in the modelling of the pre and post development.
5. The water quality modelling of the proposed designs for stormwater treatment can be conducted in MUSIC or equivalent water quality modelling programs; however a detailed hydraulic assessment to prevent erosion of the hill slopes and proposed stormwater treatment measures will need to be conducted using a hydraulic modelling program.
6. The stormwater treatment measures are recommended to be designed to meet the reduction requirements in the Landcom (2004) WSUD manuals.
7. The design of the stormwater management systems should also consider the impact of the flood prone areas on their discharges and backflow effects.

Report

The resultant report should be prepared by suitably qualified expert consultants and provided with any planning proposal for the Jumping Creek site. As discussed at the site meeting indications are that it will be difficult to design a WSUD system to reduce the export of pollutants to meet the pre-development levels on site. The assessment must therefore include information on the water sensitive urban design and urban stormwater quality and quantity management (including use of the MUSIC model) and water resource management, which address the above and whose scope is specific to the lands subject to the current proposal and the Water Quality Objectives of the potential receiving waters.

Guidance Material

Ambient Water Quality Goals

DECCW considers that the goals for ambient water quality are relevant environmental goals to the project. The central reference document for managing ambient water quality is the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC Guidelines) and Water Quality Objectives framework (http://www.epa.nsw.gov.au/ieo/). The ANZECC Guidelines provide instructions for translating statements about desired environmental values and human uses into more practical management and numerical criteria.

Water quality

- National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)
- NWQMS Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000)
- Healthy Rivers Commission Report into Coastal Lakes and Statement of Joint Intent

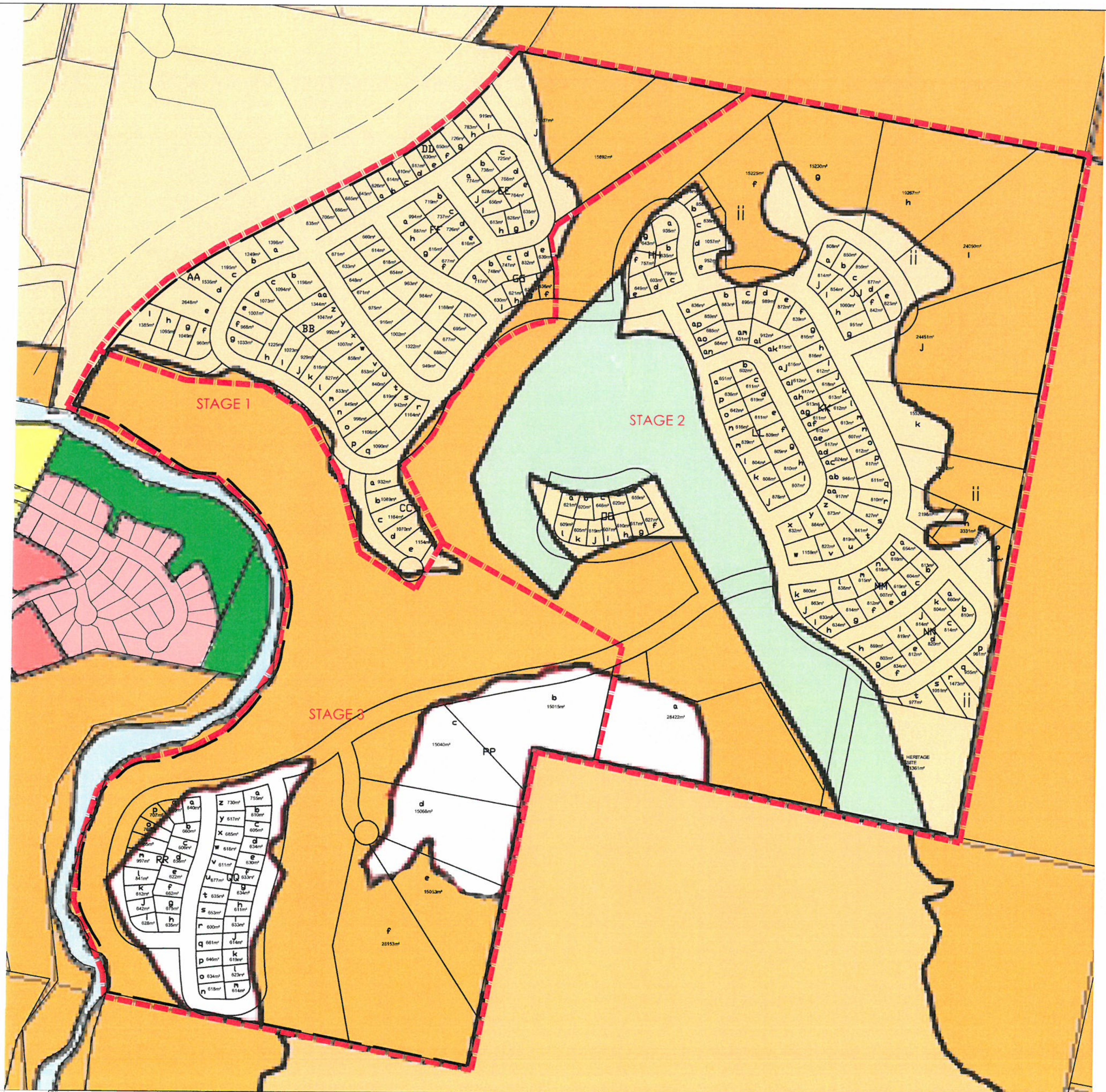
- NSW Government Water Quality and River Flow Environmental Objectives for the relevant targets within the State Water Management Outcomes Plan
- NSW Guidelines for Urban & Residential Use of Reclaimed Water (NSW Water Recycling Coordination Committee, 1993).

Wastewater

- National Water Quality Management Strategy: Guidelines for Sewerage Systems - Effluent Management (ARMCANZ/ANZECC 1997)
- National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC 2000)
- Environmental Guidelines for the Utilisation of Treated Effluent by Irrigation (NSW DEC 2004)
- Environment and Health Protection Guidelines: 'Onsite Sewage Management for Single Households', February 1998 (Silver Book).

Stormwater

- Managing Urban Stormwater: Soils and Construction (NSW Landcom, 2004)
- Landcom (2009) *Water Sensitive Urban Design*
- Melbourne Water (2004) *WSUD Engineering Procedures*
- John Argue (2007) *Basic Procedures for 'Source Control' of stormwater*
- Wong (2004) *Australian Runoff Quality*
- Pilgrim (1987) *Australian Rainfall and Runoff*



LEGEND

Zone

B1	Neighbourhood Centre
B2	Local Centre
B3	Commercial Core
B4	Mixed Use
B5	Business Development
E1	National Parks and Nature Reserves
E2	Environmental Conservation
E3	Environmental Management
E4	Environmental Living
IN1	General Industrial
IN2	Light Industrial
R1	General Residential
R2	Low Density Residential
R3	Medium Density Residential
R4	High Density Residential
R5	Large Lot Residential
RE1	Public Recreation
RE2	Private Recreation
RU2	Rural Landscape
SP1	Special Activities
SP2	Infrastructure
W1	Natural Waterways
DM	Deferred Matter

Rev	Date	Description	Drawn	Approved
A	15.10.14	For Information	PG	JE

Client: CIC AUSTRALIA

Consultant: SPACELAB CREATING TIMELESS PLACES

Orientation: N

Client CIC	Date	Designed	Date
Drawn PG	15.10.14	JE	08.03.11
Checked IM	15.10.14	Verified JE	08.03.11

Jumping Creek

LOT LAYOUT PLAN OVERLAY WITH 2012 ZONING

Date	Scale	Size
15.10.2014	1:2500	A1

Drawing Number: 14-1077 LAO

Revision: A

APPENDIX B INTENSITY – FREQUENCY – RAINFALL (IFD) DATA

Intensity-Frequency-Duration Table

Location: 35.375S 149.250E NEAR.. Jumping Creek Issued: 10/8/2015

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

Average Recurrence Interval

Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	55.6	73.2	98.2	114	136	165	189
6Mins	51.9	68.3	91.4	107	126	154	176
10Mins	42.3	55.5	73.8	85.5	101	122	139
20Mins	30.9	40.3	52.7	60.5	71.0	85.3	96.7
30Mins	25.1	32.6	42.2	48.3	56.3	67.4	76.2
1Hr	16.8	21.7	27.8	31.6	36.7	43.6	49.1
2Hrs	10.7	13.8	17.6	20.0	23.2	27.5	30.9
3Hrs	8.13	10.5	13.4	15.2	17.6	20.9	23.5
6Hrs	5.05	6.52	8.33	9.45	11.0	13.0	14.6
12Hrs	3.16	4.07	5.21	5.90	6.84	8.12	9.12
24Hrs	1.99	2.56	3.26	3.68	4.26	5.03	5.65
48Hrs	1.23	1.59	1.99	2.24	2.58	3.03	3.39
72Hrs	.900	1.16	1.45	1.62	1.86	2.19	2.44

(Raw data: 22.16, 4.13, 1.17, 41.78, 7.78, 2.1, skew=0.22, F2=4.28, F50=15.58)

APPENDIX C RATIONAL METHOD CALCULATION

Jumping Creek
C15000776

File: H:\P15\15-000776\stormwater\Rational Method\New folder\[Rational Method Calculation.xlsx]C Outlet
Date: 28.07.14
Job: C15000776
By: PM
Locality: Jumping Creek
IFD Ref: IFD_Jumping Creek
IFD Source: BOM IFD

Time of Concentration Calculations

Reference	Equation Type / Method	Area (ha)	Length (m)	Av. Slope (%)	Pipe Dia. (mm)	Velocity (m/s)	Sub-Total (mins)	t_c (min)
AR&R Vol. 1 (1987) Section 5.4.1	NSW Rational Method	3676.00	15200	2.3		2		**126**
Note: Catchment area from XP-RAFTS model from Sydney (X07008)							**Adopted tc**	**126**

C10 VALUE

			$^{1}I_{10}$ (mm/hr)		C10
			31.6	C10 from Figure 5.1 of AR&R Vol.2 = 0.3 Also consistent with Figure 5.1 of AR&R Vol.2	0.40
				Adopted C_{10}	**0.40**

Flow Calculations (QUDM 4.03.1)

tc (min) 126

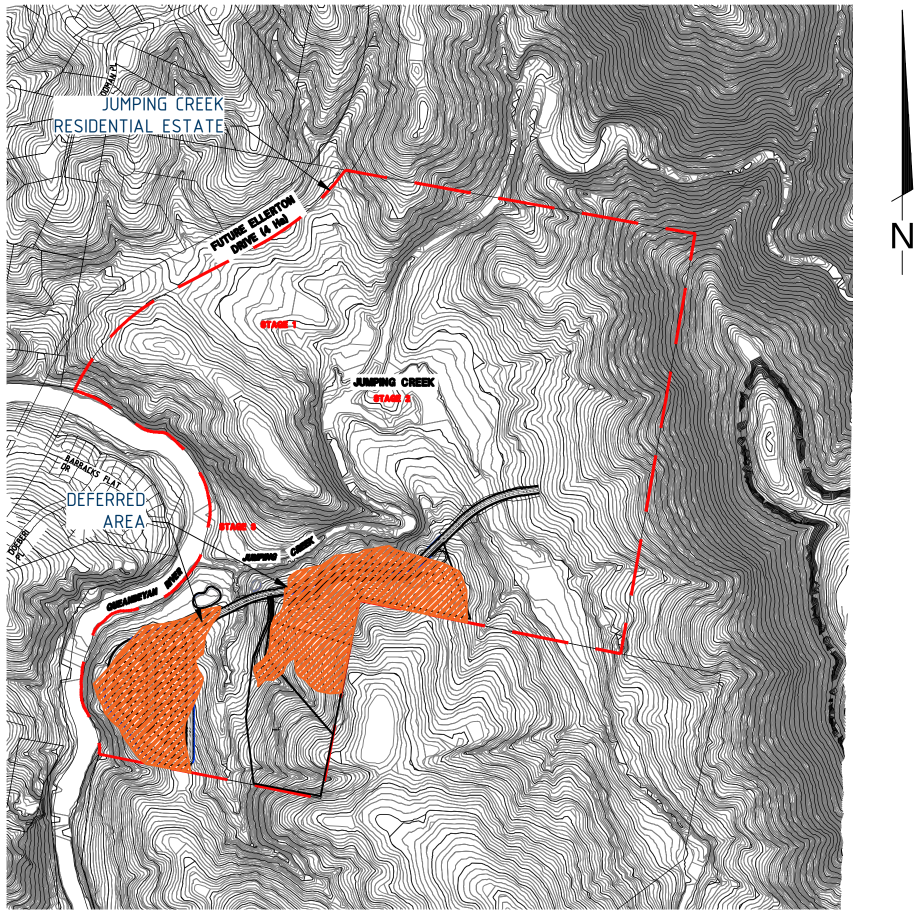
ARI	Cy	$^{tc}I_y$	A (ha)	Q (m^3/s)
1	0.276	10.42	3676.00	29.37
2	0.308	13.47	3676.00	42.36
5	0.356	17.18	3676.00	62.45
10	0.400	19.52	3676.00	79.73
20	0.440	22.64	3676.00	101.72
50	0.504	26.84	3676.00	138.13
100	0.536	30.14	3676.00	164.96

APPENDIX D DRAWINGS

JUMPING CREEK

DEFERRED AREA

CONCEPT PLANS



SEPTEMBER 2015

LOCALITY PLAN

SCALE

1:15000 100 0 100 200 300 400 1:7500

calibre CONSULTING

DRAWING SCHEDULE

JUMPING CREEK

DOCUMENT NO............ PAGE:.......OF:...............
PREPARED:.................. CHECKED:....................
DATE:............................

CONSULT AUSTRALIA

JOB No: C15776

DRAWING: C15776-000+

REVISION: -

Quality Endorsed Company ISO 9001 Lic 4084

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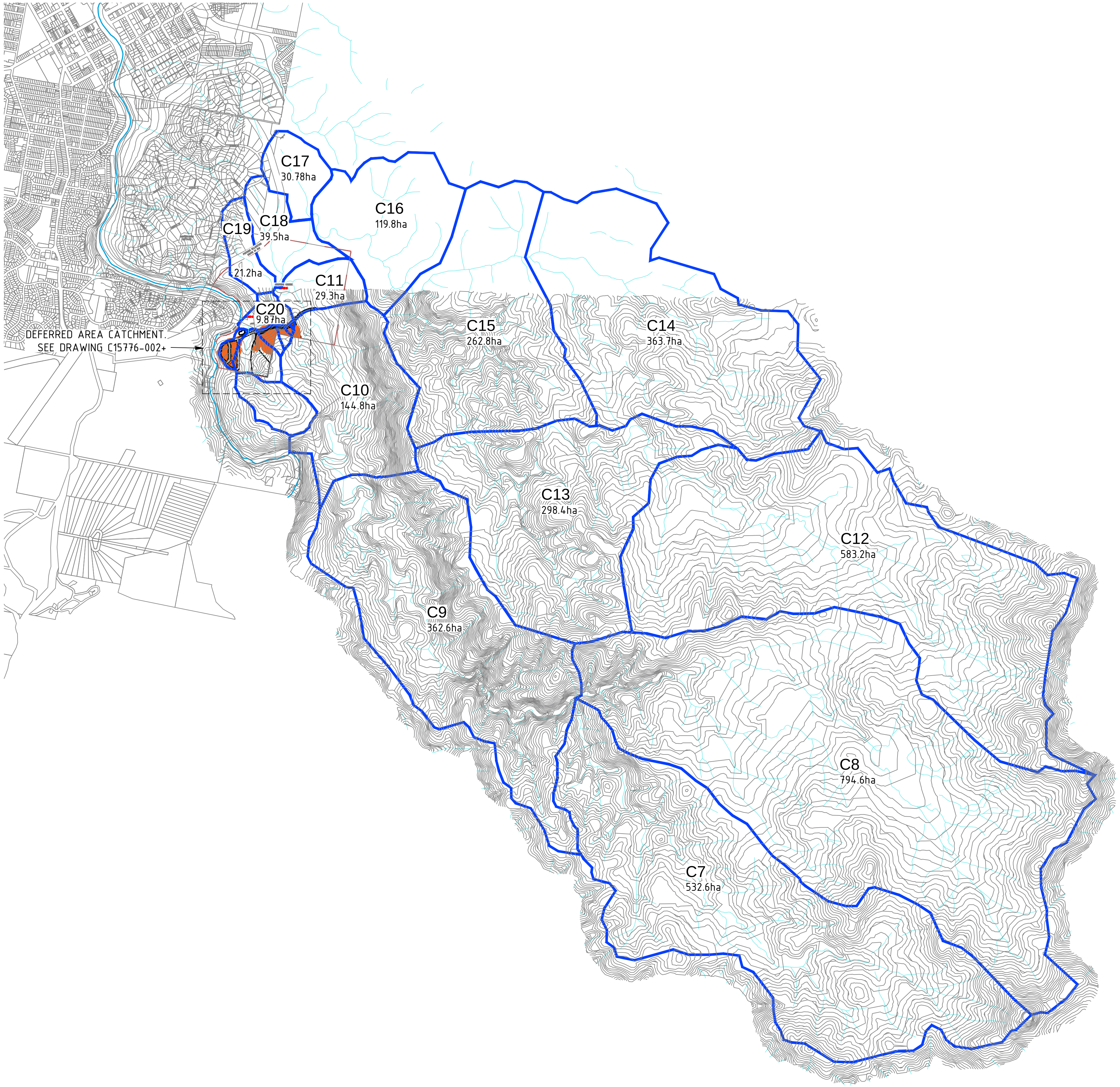
C15776#000+



LEGEND:

(blue line)	EXISTING CATCHMENT BOUNDARY
(light blue line)	QUEANBEYAN RIVER
(cyan line)	EXISTING CREEKS
C16	XP-RAFTS CATCHMENTS

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. C15776

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AMENDMENTS

WAE No.

PROJECT No.

A3 PLOT 1:40000 — SCALE (METRES) 200 100 0 200 400 600 800 1000 — A1 PLOT 1:20000

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4084

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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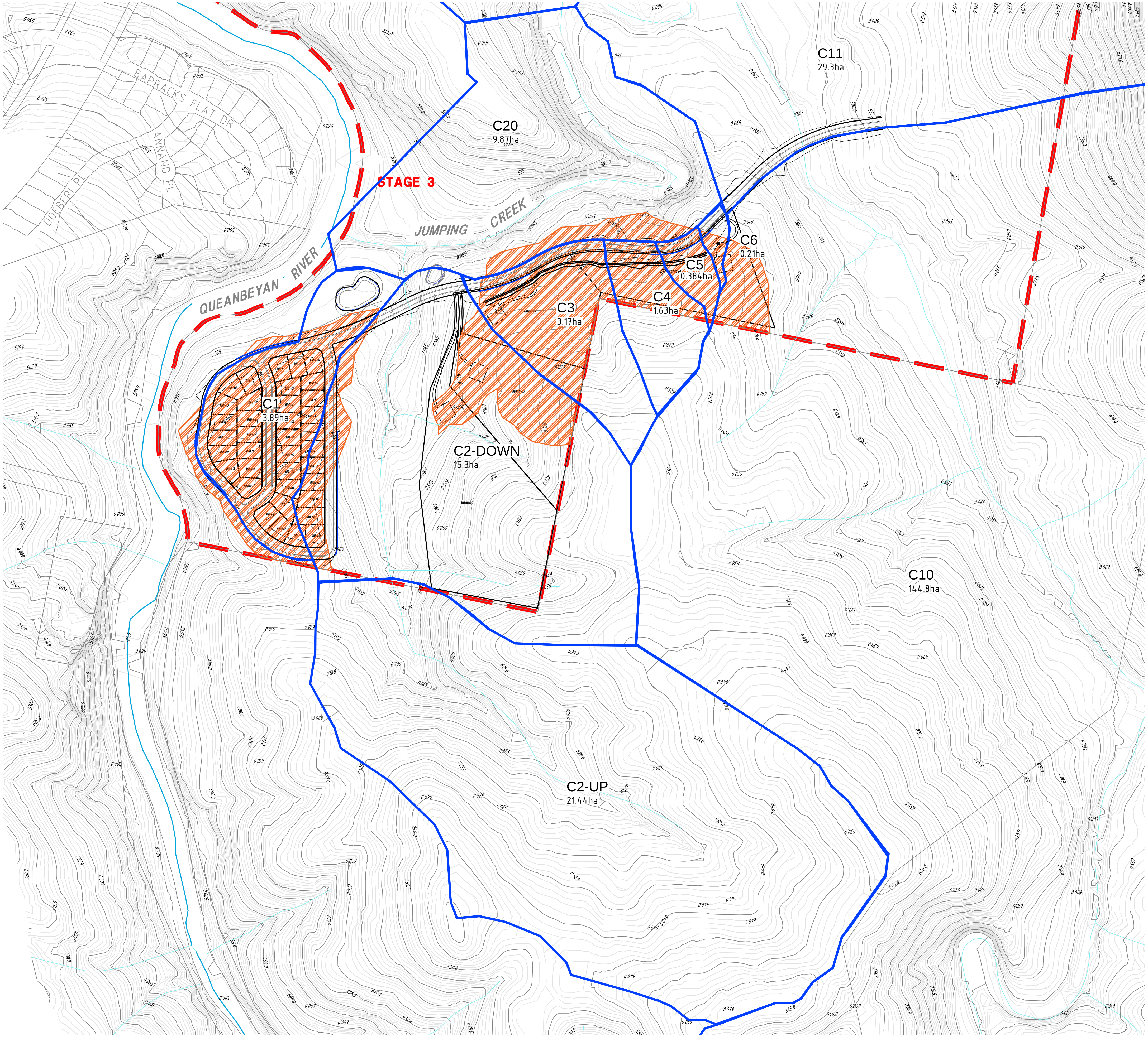
DRAWING TITLE: STORMWATER CATCHMENT PLAN EXISTING SCENARIO SHEET 1 OF 2

DRAWING NUMBER: C15776-001+

AMEND.



LEGEND:

(blue line)	EXISTING CATCHMENT BOUNDARY
(light blue line)	QUEANBEYAN RIVER
(pale line)	EXISTING CREEKS
C16	XP-RAFTS CATCHMENTS
(hatched)	DEFERRED AREA

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. C15776

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WAE No. ....

PROJECT No. ....

A3 PLOT 1:5000 — SCALE (METRES) 50 0 50 100 — A1 PLOT 1:2500

CONSULT AUSTRALIA

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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DRAWING TITLE: STORMWATER CATCHMENT PLAN EXISTING SCENARIO SHEET 2

DRAWING NUMBER: C15776-002+

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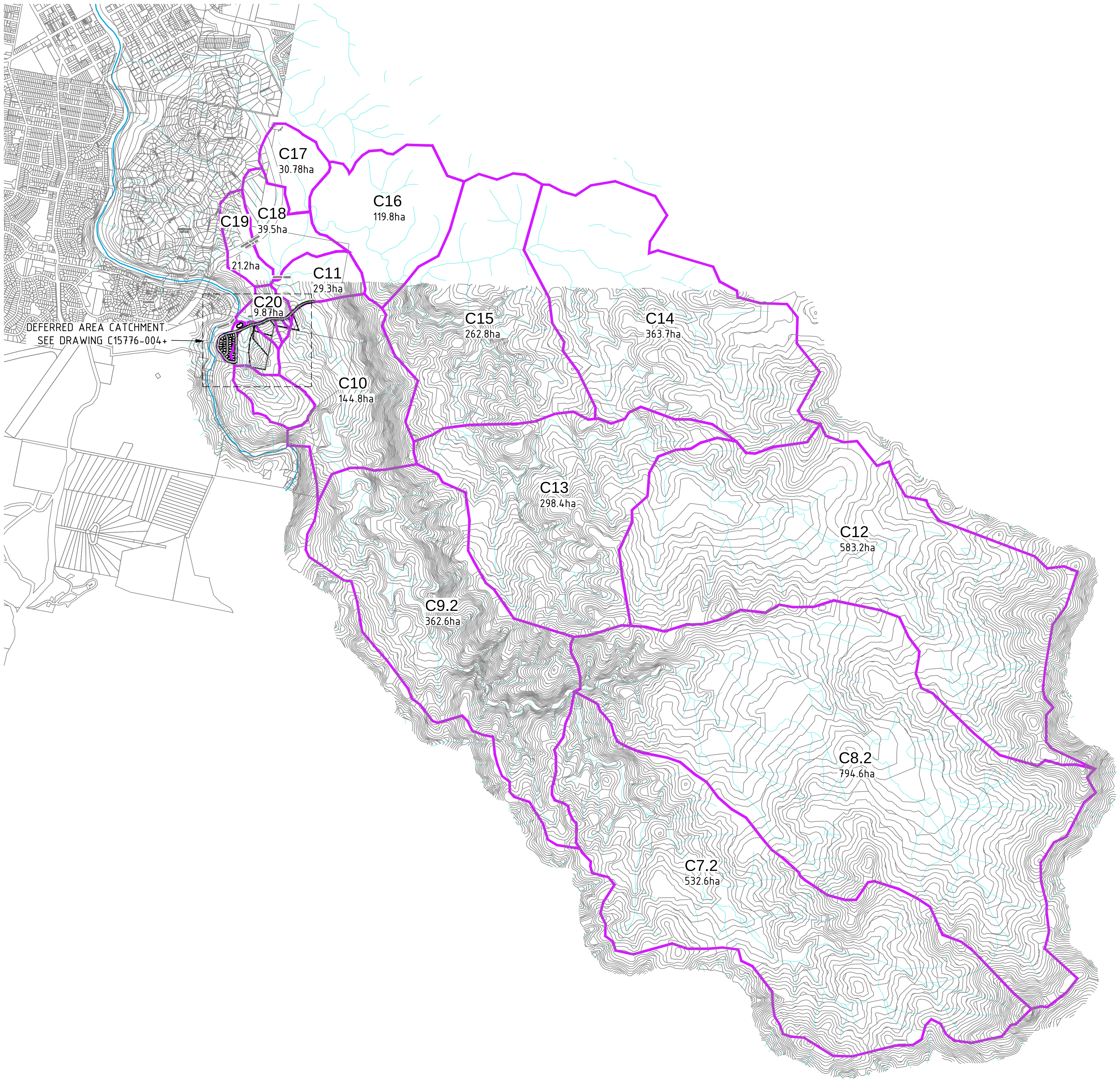

LEGEND:

(magenta line)	CATCHMENT BOUNDARY
(blue line)	QUEANBEYAN RIVER
(light blue line)	EXISTING CREEKS
C16	XP-RAFTS CATCHMENTS

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. C15776

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PROJECT No. ....

A3 PLOT 1:40000 — SCALE (METRES) 200 100 0 200 400 600 800 1000 — A1 PLOT 1:20000

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4084

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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DRAWING TITLE: STORMWATER CATCHMENT PLAN DEVELOPED SCENARIO SHEET 1 OF 2

DRAWING NUMBER: C15776-003+

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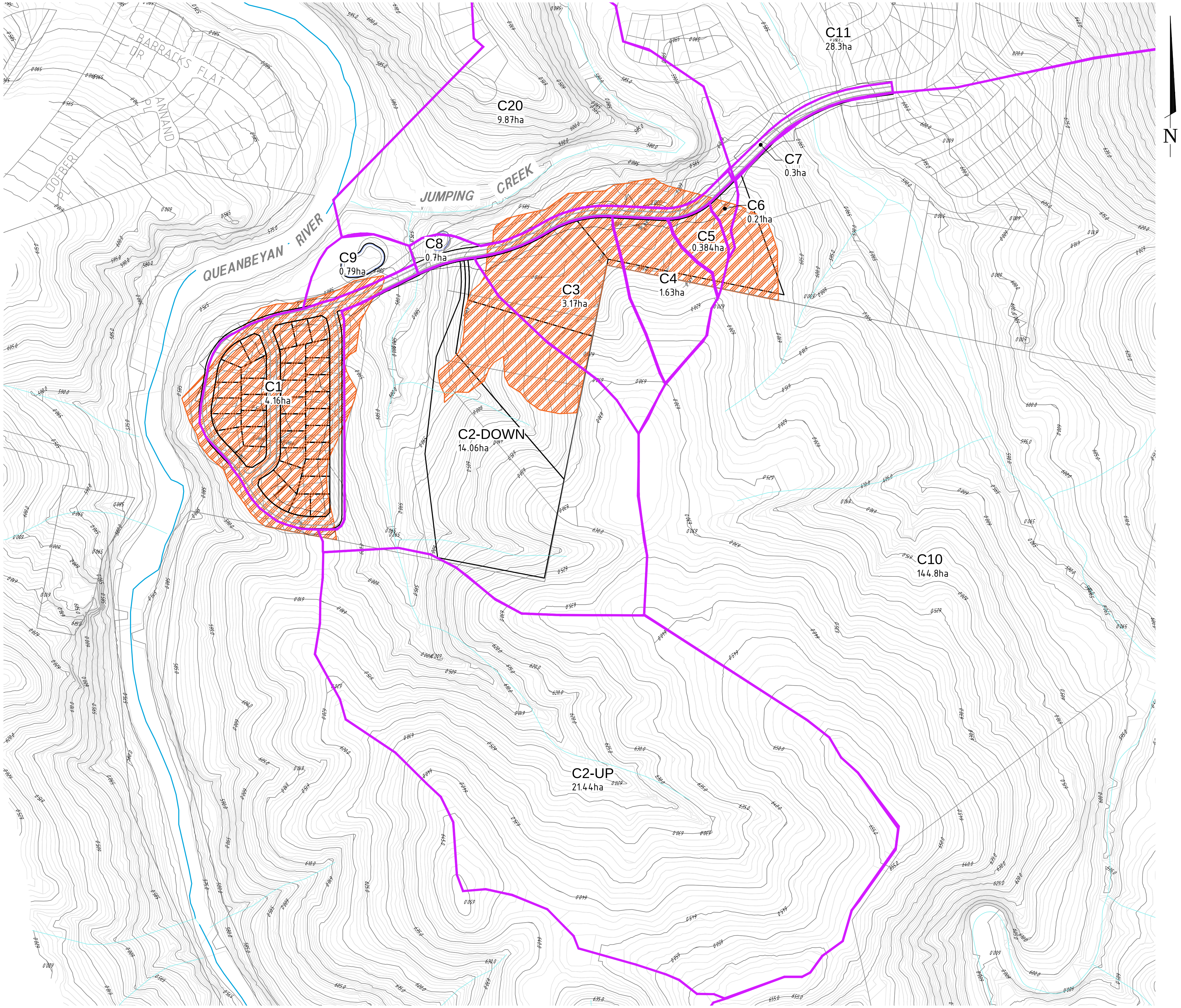

LEGEND:

(magenta line)	CATCHMENT BOUNDARY
(blue line)	QUEANBEYAN RIVER
(light blue line)	EXISTING CREEKS
C16	XP-RAFTS CATCHMENTS
(orange hatching)	DEFERRED AREA

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST VERSION OF CALIBRE CONSULTING REPORT No. C15776

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PROJECT No.

A3 PLOT 1:5000 | SCALE (METRES) 50 0 50 100 | A1 PLOT 1:2500

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PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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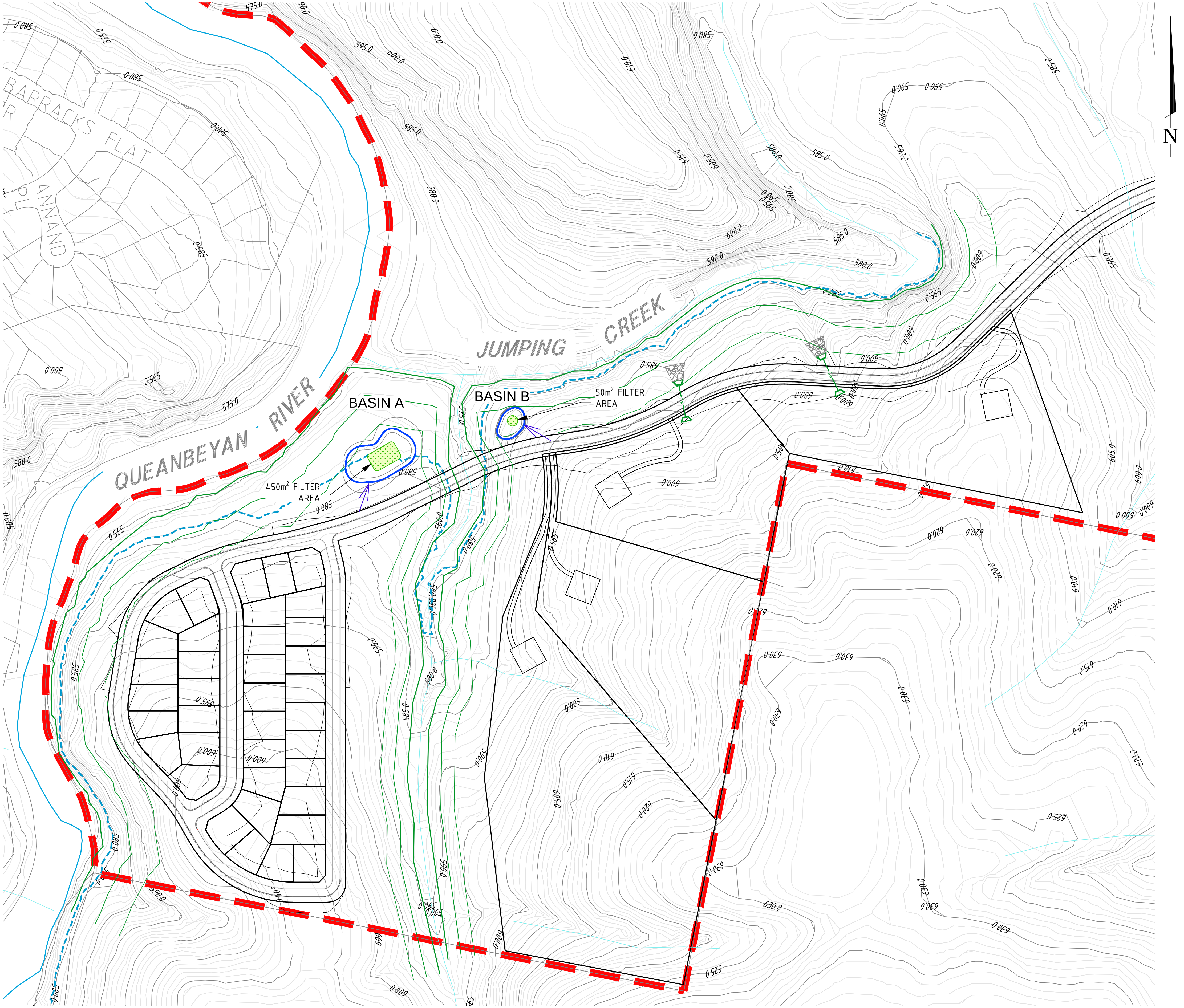

LEGEND

- BIORETENTION FILTER AREA
- INDICATIVE INFLOW POINTS
- TOP OF BANK
- RIPARIAN CORRIDOR INNER (50%)
- RIPARIAN CORRIDOR OUTER (50%)
- 100 YEAR FLOOD LEVEL
- BIORETENTION BASIN (TOP OF BANK)
- QUEANBEYAN RIVER
- EXISTING CREEKS
- FUTURE CULVERT WITH RIP-RAP PROTECTION.
- ESTATE BOUNDARY
- INDICATIVE BUILDING SITES AND DRIVEWAYS

NOTES:

1. STORMWATER QUALITY IMPROVEMENT DEVICE (SQID) CONCEPTS PREPARED ARE FOR THE CONTROL OF STORMWATER RUNOFF FROM ADJOINING FUTURE DEVELOPMENT AREAS.
2. LAYOUT AND DETAILS OF THE END OF LINE STORMWATER QUALITY IMPROVEMENT DEVICES (SQIDs) ARE CONCEPTUAL ONLY AND PROVIDED AS A GUIDE FOR THE TREATMENT TRAIN AND FUTURE DEVELOPMENT.
3. ALL RESIDENTIAL AREAS HAVE BEEN MODELLED ASSUMING MINIMUM 2kL RAINWATER TANK PER LOT/DWELLING WITH AT LEAST 175m² OF ROOF DIRECTED TO IT. EXTERNAL RE-USE ONLY.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH LATEST VERSION OF CALIBRE CONSULTING REPORT No. C15776
5. DESIGN CONTOURS NOT SHOWN ON THIS PLAN.

BASINS		
	A	B
SQID TYPE	BIORETENTION	BIORETENTION
EXTENDED DETENTION DEPTH (m)	0.5	0.3
SURFACE AREA (m^2)	1000	120
FILTER MEDIA AREA (m^2)	450	50
FILTER MEDIA DEPTH (m)	0.4	0.4
CATCHMENT AREA (HA)	4.17	0.40

	TSS	TP	TN
QCC WATER QUALITY REDUCTION TARGETS	80%	65%	65%
LOAD REDUCTION ACHIEVED	90%	82%	72%

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WAE No. ....

PROJECT No. ....

A3 PLOT 1:3000 — SCALE (METRES) 25 0 25 50 75 — A1 PLOT 1:1500

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4084

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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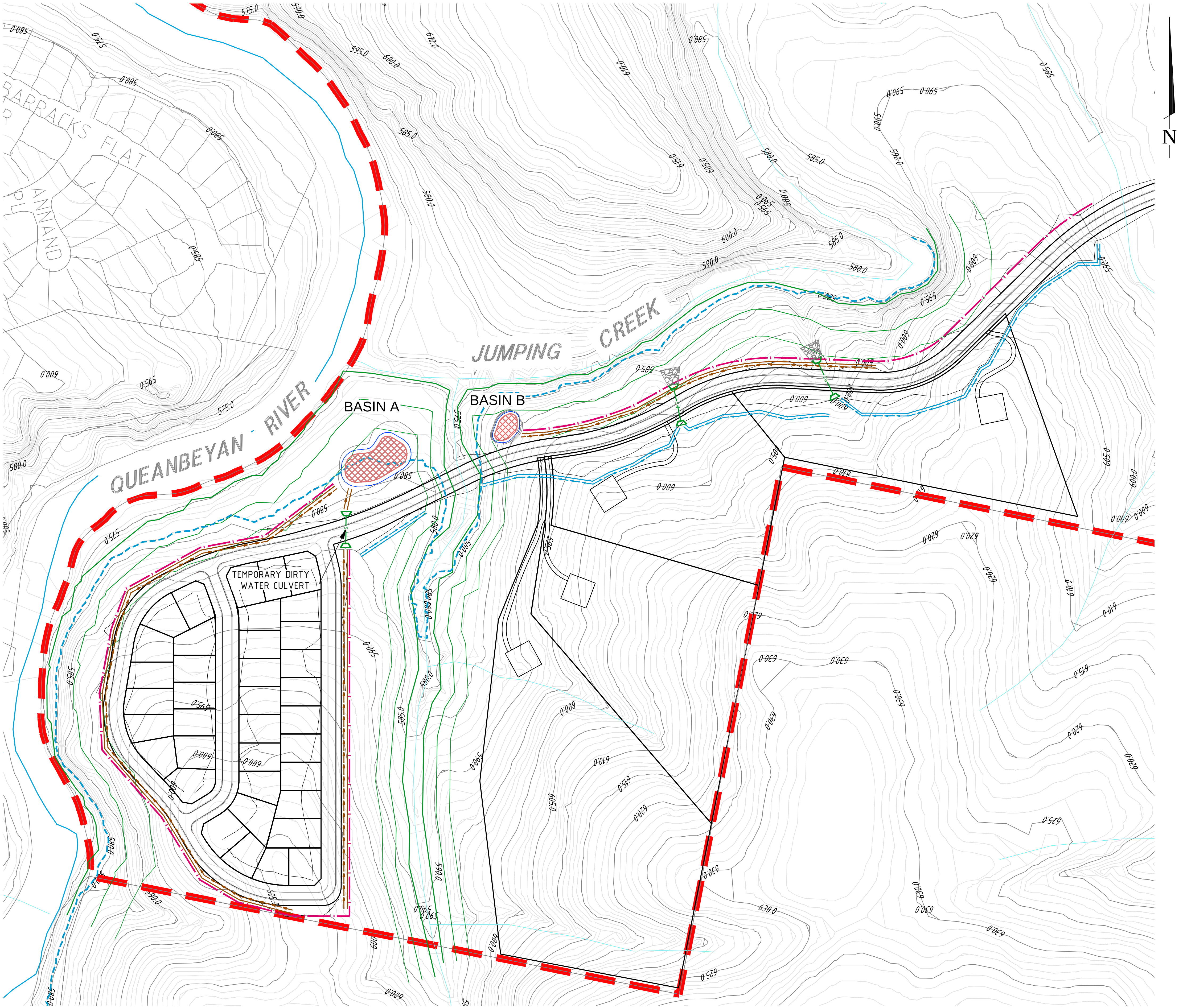
DRAWING TITLE: STORMWATER QUALITY IMPROVEMENT DEVICES

DRAWING NUMBER: C15776-005+

AMEND.



LEGEND

- TOP OF BANK
- RIPARIAN CORRIDOR INNER (50%)
- RIPARIAN CORRIDOR OUTER (50%)
- 100 YEAR FLOOD LEVEL
- SILT FENCE REMOVE WHEN STREET NOT IN USE AS CONSTRUCTION ACCESS
- CLEAR WATER DIVERSION DRAIN
- DIRTY WATER DIVERSION DRAIN
- QUEANBEYAN RIVER
- EXISTING CREEKS
- FUTURE CULVERT WITH RIP-RAP PROTECTION.
- ESTATE BOUNDARY
- TEMPORARY SEDIMENT POND
- INDICATIVE BUILDING SITES AND DRIVEWAYS

	SEDIMENT BASIN A	SEDIMENT BASIN B
MINIMUM REQUIRED SEDIMENT BASIN VOLUME (m^3)	905	213
PROVIDED SEDIMENT BASINS VOLUME	1023	240

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Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-Boundary MGA-C10084

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WAE No.

PROJECT No.

CONSULT AUSTRALIA

A3 PLOT 1:3000 — SCALE (METRES) 25 0 25 50 75 — A1 PLOT 1:1500

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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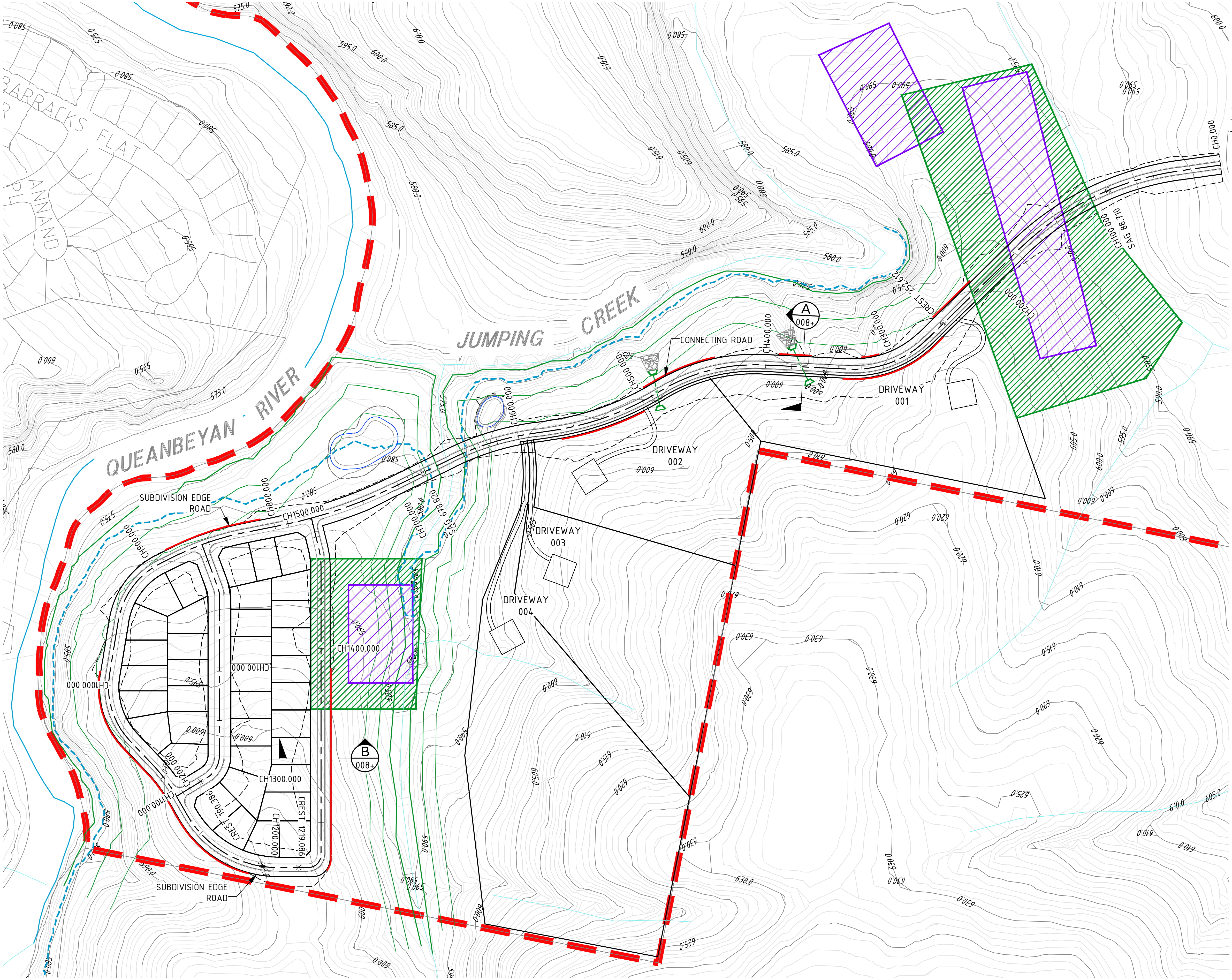
DRAWING TITLE: SOIL & WATER CONCEPT MANAGEMENT PLAN

DRAWING NUMBER: C15776-006+

AMEND.



LEGEND

- EXISTING CONTOURS (2m INTERVAL)
- GRADING LIMITS
- TOP OF BANK
- RIPARIAN CORRIDOR INNER (50%)
- RIPARIAN CORRIDOR OUTER (50%)
- 100 YEAR FLOOD LEVEL
- RETAINING WALL (typ < 1.8m)
- QUEANBEYAN RIVER
- EXISTING CREEKS
- FUTURE CULVERT WITH RIP-RAP PROTECTION.
- ESTATE BOUNDARY
- INDICATIVE BUILDING SITES AND DRIVEWAYS
- OLD MINING SITE
- ENVIRONMENTAL BUFFER AREA

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WAE No.

PROJECT No.

A3 PLOT 1:3000 — SCALE (METRES) 25 0 25 50 75 — A1 PLOT 1:1500

CONSULT AUSTRALIA

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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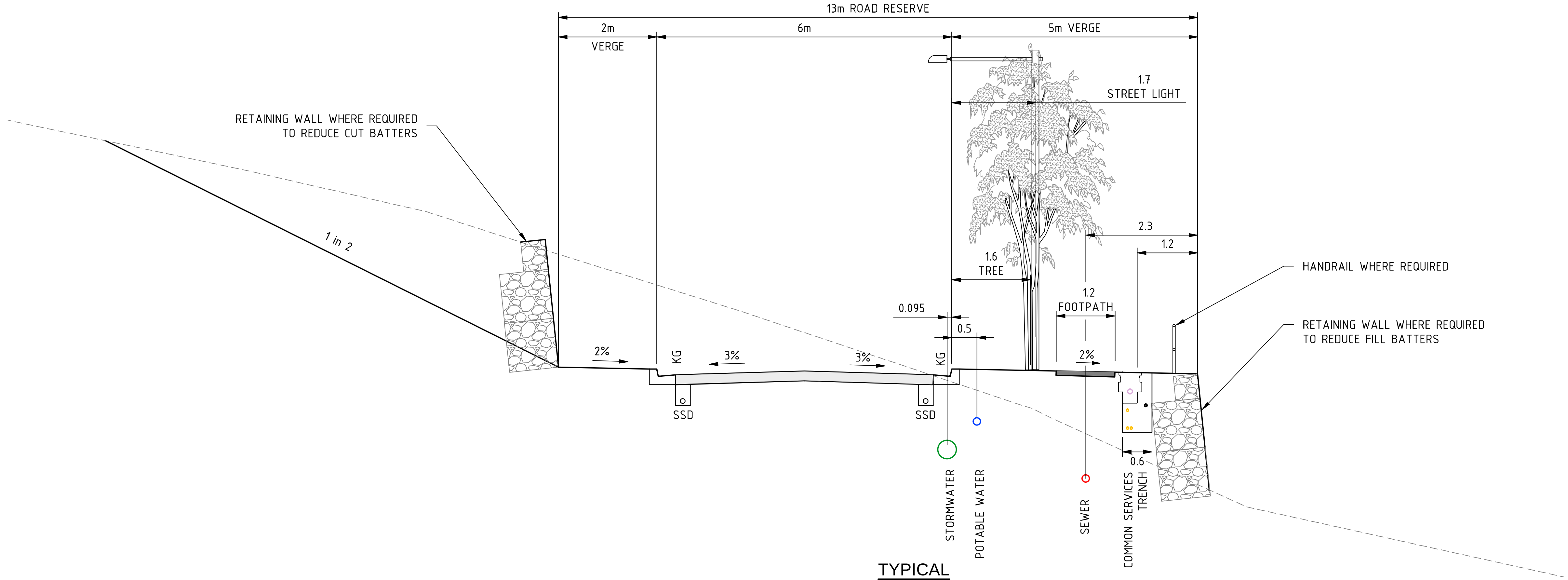
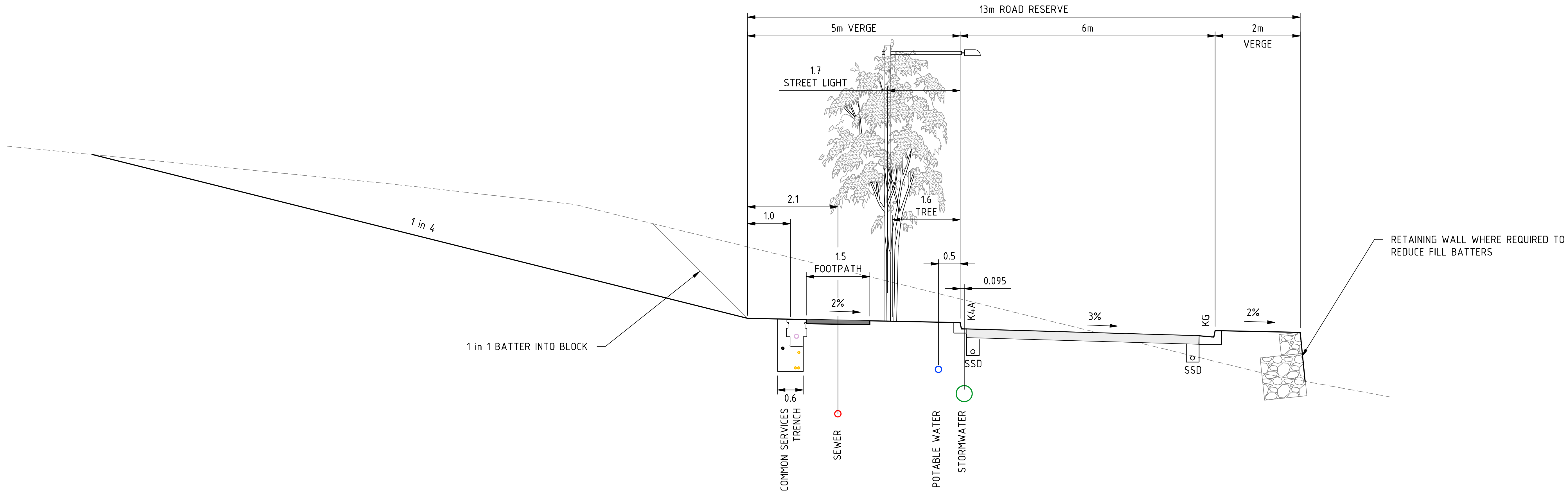
DRAWING TITLE: ROAD LAYOUT PLAN SHEET 1 OF 2

DRAWING NUMBER: C15776-007+

AMEND.



TYPICAL
SECTION A
1:50
007+



TYPICAL
SECTION B
1:50
007+

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Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-TYP SECTION-C15776 X-CONTROL-C15776 X-Boundary MGA-C10084

		DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE		PM	DC	APL	NB	23/09/2015	
AMENDMENTS	A						
	B						
	C						
	D						
	E						
	F						

WAE No. ....

PROJECT No. ....

A3 PLOT SCALE (METRES) A1 PLOT

1:100 1 0.5 0 1 2 1:50

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4084

CLIENT: AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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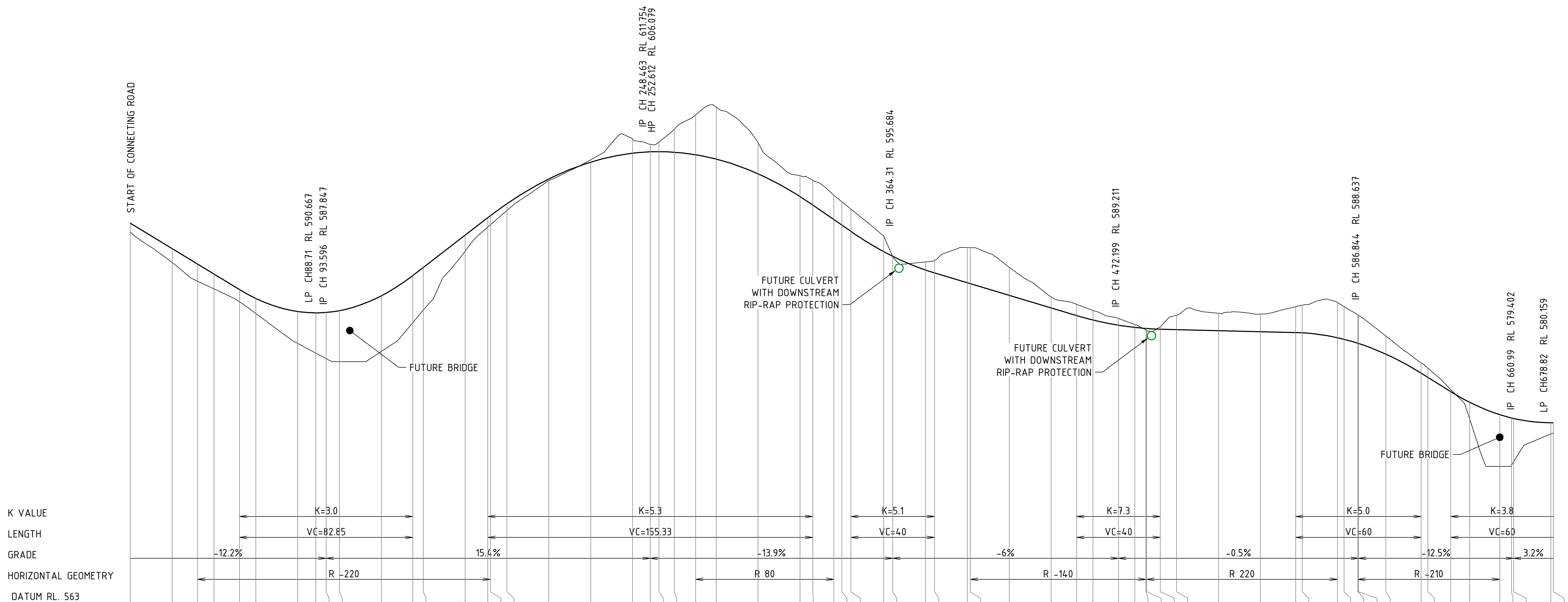
DRAWING TITLE: ROAD LAYOUT PLAN SHEET 2

DRAWING NUMBER: C15776-008+

AMEND.



CHAINAGES	DESIGN SURFACE	EXISTING SURFACE	DIFFERENCE	SUPER ELEVATION
0.000	599.247	598.391	-0.855	
20.000	596.811	595.484	-1.327	
32.184	595.327	593.696	-1.631	
40.000	594.375	592.965	-1.410	
52.172	592.892	591.734	-1.158	
60.000	592.041	590.610	-1.431	
80.000	590.794	587.742	-3.052	
88.710	590.667	586.813	-3.854	
93.596	590.707	586.295	-4.412	
100.000	590.880	586.000	-4.880	
120.000	592.299	586.978	-5.321	
135.021	594.242	589.754	-4.488	
140.000	595.010	590.934	-4.076	
160.000	598.098	596.569	-1.529	
170.796	599.764	598.864	-0.900	
172.083	599.961	599.086	-0.875	
180.000	601.105	600.455	-0.650	
200.000	603.468	603.306	-0.162	
220.000	605.076	605.300	0.224	
240.000	605.929	607.303	1.374	
248.463	606.063	606.777	0.714	
252.612	606.079	607.007	0.928	
260.000	606.028	608.218	2.191	
270.144	605.789	609.597	3.808	
280.000	605.371	610.339	4.968	
300.000	603.961	606.948	2.988	
320.000	601.795	603.778	1.983	
326.129	600.980	603.350	2.370	
336.181	599.586	601.907	2.321	
340.000	599.056	601.289	2.233	
344.310	598.458	600.591	2.132	
360.000	596.524	598.010	1.486	
364.310	596.078	596.010	-0.068	
380.000	594.761	595.544	0.783	
384.310	594.484	595.684	1.200	
400.000	593.543	596.909	3.367	
401.434	593.457	596.899	3.442	
420.000	592.343	595.009	2.666	
440.000	591.143	592.202	1.059	
452.199	590.411	591.477	1.067	
460.000	589.984	590.900	0.916	
472.199	589.486	590.122	0.636	
480.000	589.274	589.552	0.278	
485.280	589.178	589.028	-0.150	
485.661	589.173	588.989	-0.184	
492.199	589.111	589.355	0.244	
500.000	589.072	590.448	1.376	
520.000	588.972	590.633	1.661	
540.000	588.872	590.557	1.686	
556.844	588.787	591.259	2.471	
560.000	588.762	591.397	2.636	
576.810	588.290	591.658	3.368	
580.000	588.137	591.266	3.128	
586.566	587.759	590.480	2.721	
586.844	587.741	590.444	2.703	
600.000	586.716	588.452	1.736	
616.844	584.900	585.858	0.957	
620.000	584.507	585.392	0.884	
630.990	583.138	583.330	0.192	
640.000	582.122	580.515	-1.607	
654.384	580.937	576.000	-4.937	
660.000	580.621	576.117	-4.504	
660.990	580.573	576.431	-4.143	
678.820	580.159	579.094	-1.066	
680.000	580.161	579.193	-0.969	

CONNECTING ROAD

FILE: H:\P15\15-000776\drawing\C15000776-009.dwg 22nd-Sep-2015 4:03PM USER: derek clark
Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-LS-ROAD-01_1 X-LS-ROAD-01_2 X-LS-ROAD-01_3

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	PM	DC			23/09/2015	
AMENDMENTS A						
B						
C						
D						
E						
F						

WAE No.

PROJECT No.

A3 PLOT 1:2000 / 1:400 — SCALE (METRES) — A1 PLOT 1:1000 HOR / 1:200 VER

CONSULT AUSTRALIA

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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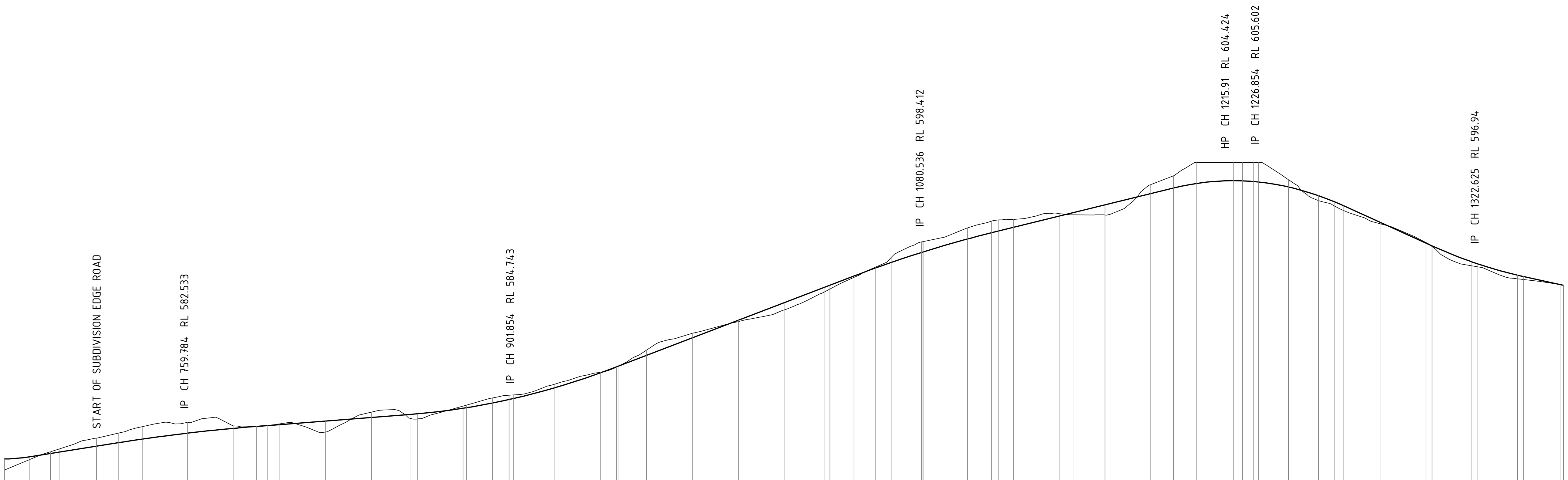
DRAWING TITLE: ROAD LONG SECTIONS SHEET 1 OF 3

DRAWING NUMBER: C15776-009+

AMEND.



K VALUE	LENGTH	GRADE	HORIZONTAL GEOMETRY
K=3.8	VC=60	3.2%	R 350
K=37.2	VC=60	1.6%	R -210
K=14.8	VC=90	7.6%	R -60
K=21.9	VC=60	4.9%	R -40
K=5.3	VC=73.97	-9%	R 40
K=8.6	VC=40	-4.4%	R -40
			R -15
			R 300

DATUM RL. 567

CHAINAGES	DESIGN SURFACE	EXISTING SURFACE	DIFFERENCE
680.000	580.161	579.193	-0.969
690.990	580.352	580.115	-0.237
700.000	580.638	580.798	0.160
703.723	580.756	581.037	0.281
720.000	581.272	581.981	0.709
729.784	581.582	582.423	0.841
740.000	581.892	582.978	1.087
759.784	582.412	583.353	0.942
760.000	582.417	583.352	0.936
780.000	582.834	583.045	0.210
789.784	582.999	583.029	0.030
794.562	583.074	583.095	0.021
800.000	583.158	583.222	0.064
820.000	583.470	582.515	-0.954
823.202	583.519	582.796	-0.724
840.000	583.781	584.244	0.463
856.854	584.043	583.699	-0.344
860.000	584.095	583.649	-0.447
880.000	584.585	584.764	0.179
881.483	584.632	584.850	0.218
892.796	585.040	585.482	0.442
900.000	585.345	585.717	0.372
901.854	585.429	585.739	0.310
920.000	586.376	586.684	0.309
940.000	587.677	587.709	0.032
946.854	588.186	588.168	-0.018
947.988	588.273	588.284	0.011
960.000	589.191	589.655	0.464
980.000	590.721	591.123	0.401
1000.000	592.251	592.136	-0.115
1000.015	592.252	592.137	-0.115
1020.000	593.781	593.146	-0.635
1037.429	595.114	594.704	-0.410
1040.000	595.311	594.976	-0.335
1050.536	596.117	596.003	-0.114
1060.000	596.821	596.903	0.082
1066.970	597.313	597.786	0.474
1080.000	598.173	599.096	0.923
1080.536	598.207	599.118	0.911
1080.630	598.213	599.122	0.909
1100.000	599.343	600.304	0.961
1110.536	599.886	600.905	1.019
1113.679	600.040	601.006	0.965
1120.000	600.351	601.036	0.685
1140.000	601.334	601.544	0.211
1146.449	601.651	601.446	-0.204
1160.000	602.317	601.429	-0.887
1180.000	603.299	604.080	0.781
1189.867	603.784	604.850	1.066
1200.000	604.185	606.000	1.815
1215.910	604.424	606.000	1.576
1220.000	604.408	606.000	1.592
1224.698	604.351	606.000	1.649
1226.854	604.311	606.000	1.689
1240.000	603.876	604.513	0.636
1253.083	603.120	602.688	-0.432
1260.000	602.590	602.232	-0.358
1263.842	602.257	601.847	-0.409
1280.000	600.795	600.675	-0.121
1300.000	598.986	599.042	0.055
1302.625	598.749	598.693	-0.056
1320.000	597.354	597.002	-0.352
1322.625	597.174	596.917	-0.257
1340.000	596.184	595.863	-0.321
1342.625	596.066	595.804	-0.262
1358.875	595.355	595.348	-0.007
1360.000	595.306	595.311	0.006

SUPER ELEVATION

SUBDIVISION EDGE ROADS

FILE: H:\P\1515-000776\drawing\C15000776-009.dwg 22nd-Sep-2015 4:03PM USER: derek.clark
Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-LS-ROAD-01_1 X-LS-ROAD-01_2 X-LS-ROAD-01_3 X-A1_15-000776

AMENDMENTS	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	PM	DC			23/09/2015	
A						
B						
C						
D						
E						
F						

WAE No.

PROJECT No.

A3 PLOT 1:2000 1:400 — SCALE (METRES) — A1 PLOT 1:1000 HOR 1:200 VER

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4084

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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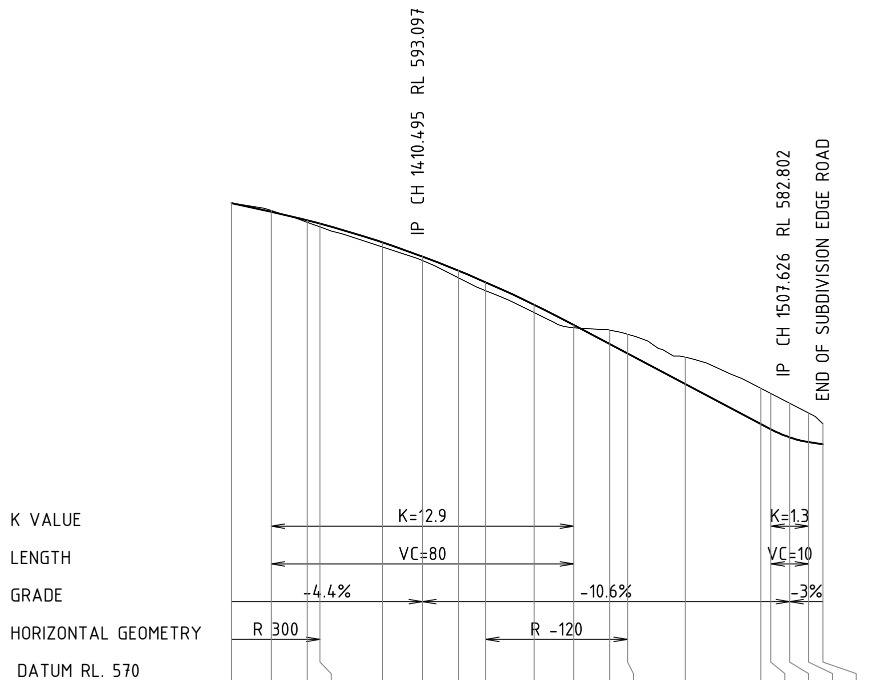
DRAWING TITLE: ROAD LONG SECTIONS SHEET 2

DRAWING NUMBER: C15776-010+

AMEND.



DESIGN SURFACE	595.306	594.847	594.396	594.218	593.217	592.474	591.728	591.116	589.927	588.857	587.850	587.348	585.730	583.610	583.332	582.897	582.652	582.539
EXISTING SURFACE	595.311	594.913	594.290	594.050	592.974	592.259	591.348	590.663	589.507	588.707	588.585	588.357	587.146	585.490	585.216	584.696	584.176	583.624
DIFFERENCE	0.006	0.066	-0.105	-0.168	-0.243	-0.215	-0.379	-0.453	-0.420	-0.150	0.735	1.010	1.415	1.879	1.884	1.799	1.524	1.085
CHAINAGES	1360.000	1370.495	1380.000	1383.382	1400.000	1410.495	1420.000	1427.197	1440.000	1450.495	1460.000	1464.737	1480.000	1500.000	1502.626	1507.626	1512.626	1516.413
SUPER ELEVATION																		

SUBDIVISION EDGE ROADS

FILE: H:\P\15\15-000776\drawing\C15000776-009-.dwg 22nd-Sep-2015 4:03PM USER: derek clark
Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-LS-ROAD-01_1 X-LS-ROAD-01_2 X-LS-ROAD-01_3

	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	PM	DC			23/09/2015	
AMENDMENTS A						
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D						
E						
F						

WAE No.

PROJECT No.

A3 PLOT 1:2000 1:400

SCALE (METRES) 10 5 0 10 20 30 40 50 / 2 1 0 2 4 6 8 10

A1 PLOT 1:1000 HOR 1:200 VER

CONSULT AUSTRALIA

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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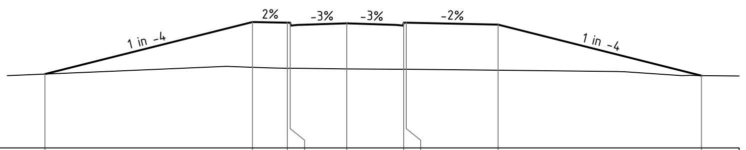
DRAWING TITLE: ROAD LONG SECTIONS SHEET 3

DRAWING NUMBER: C15776-011+

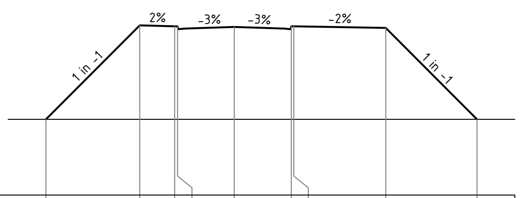
AMEND.



DATUM 590

DESIGN	593.884	596.632	596.595	596.595	596.554	596.595	596.595	596.498	593.807
EXISTING	593.884	594.240	594.195	594.193	594.164	594.134	594.132	594.084	593.807
OFFSET	-15.994	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	18.765

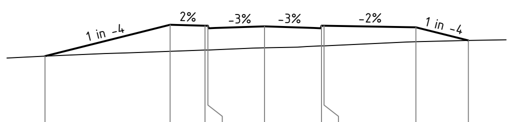
CH 150.000



DATUM 582

DESIGN	586.000	590.958	590.921	590.921	590.880	590.921	590.921	590.824	586.000
EXISTING	586.000	586.000	586.000	586.000	586.000	586.000	586.000	586.000	586.000
OFFSET	-9.958	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	12.824

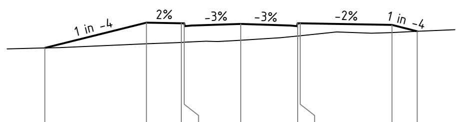
CH 100.000



DATUM 588

DESIGN	591.577	593.235	593.198	593.198	593.157	593.198	593.198	593.101	592.407
EXISTING	591.577	591.835	591.905	591.911	592.017	592.121	592.128	592.346	592.407
OFFSET	-11.632	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	10.778

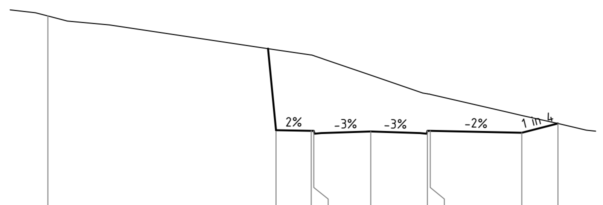
CH 50.000



DATUM 594

DESIGN	597.978	599.325	599.288	599.288	599.247	599.288	599.288	599.191	598.856
EXISTING	597.978	598.194	598.272	598.278	598.391	598.610	598.625	598.798	598.856
OFFSET	-10.387	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	9.340

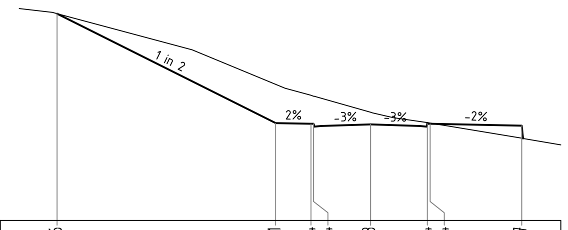
CH 0.000



DATUM 600

DESIGN	610.075	604.039	604.002	604.002	603.961	604.002	604.002	603.905	604.383
EXISTING	610.075	608.290	608.014	607.975	606.948	605.951	605.931	604.818	604.383
OFFSET	-17.072	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	9.910

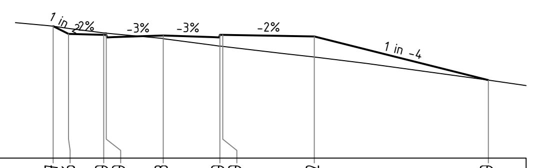
CH 300.000



DATUM 601

DESIGN	611.936	606.151	606.114	606.114	606.073	606.114	606.114	606.017
EXISTING	611.936	608.203	607.617	607.575	606.731	606.176	606.152	605.344
OFFSET	-16.570	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000

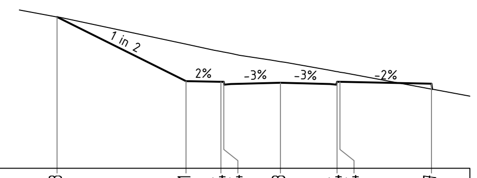
CH 250.000



DATUM 597

DESIGN	603.957	603.546	603.509	603.509	603.468	603.509	603.509	603.412	601.109
EXISTING	603.957	603.846	603.612	603.597	603.306	602.910	602.892	602.327	601.109
OFFSET	-5.821	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	17.215

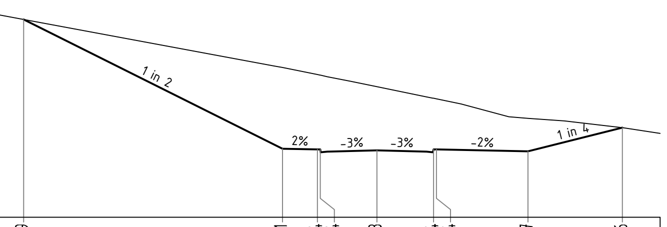
CH 200.000



DATUM 586

DESIGN	594.028	590.621	590.584	590.584	590.543	590.584	590.584	590.487
EXISTING	594.028	592.579	592.191	592.162	591.655	591.126	591.099	590.200
OFFSET	-11.815	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000

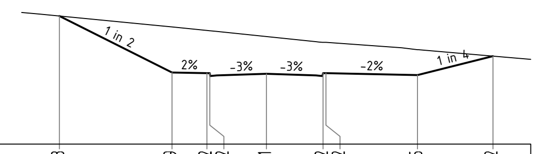
CH 450.000



DATUM 590

DESIGN	600.469	593.621	593.584	593.584	593.543	593.584	593.584	593.487	594.736
EXISTING	600.469	597.922	597.549	597.518	596.909	596.297	596.267	595.240	594.736
OFFSET	-18.695	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	12.995

CH 400.000



DATUM 594

DESIGN	600.753	597.779	597.742	597.742	597.701	597.742	597.742	597.645	598.642
EXISTING	600.753	600.177	599.989	599.974	599.669	599.373	599.362	598.986	598.642
OFFSET	-10.948	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	11.986

CH 350.000

FILE: H:\P\5\15-000776\drawing\C15000776-012-.dwg 22nd-Sep-2015 4:04PM USER: derek.clark
Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-road-1-cross_1 X-road-1-cross_3 X-road-1-cross_2 X-road-1-cross_4

	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	PM	DC			23/09/2015	
A						
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F						

WAE No.

PROJECT No.

A3 PLOT SCALE (METRES) A1 PLOT

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4004

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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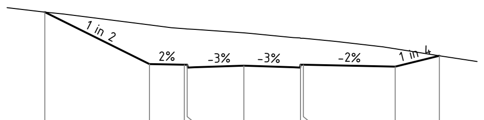
DRAWING TITLE: ROAD CROSS SECTIONS SHEET 1 OF 4

DRAWING NUMBER: C15776-012+

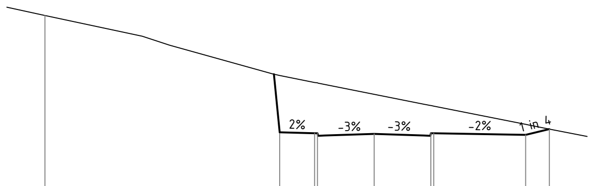
AMEND.



DATUM 583

DESIGN	589.564	586.794	586.757	586.757	586.716	586.757	586.757	586.660	587.248
EXISTING	589.564	588.878	588.681	588.670	588.452	588.177	588.163	587.617	587.248
OFFSET	-10.539	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	10.350

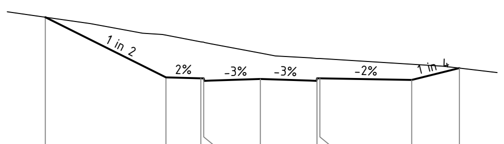
CH 600.000



DATUM 585

DESIGN	595.109	588.900	588.863	588.863	588.822	588.863	588.863	588.766	589.082
EXISTING	595.109	591.926	591.556	591.526	590.927	590.328	590.298	589.329	589.082
OFFSET	-17.418	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	9.265

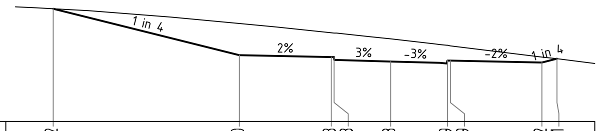
CH 550.000



DATUM 585

DESIGN	592.345	589.150	589.113	589.113	589.072	589.113	589.113	589.016	589.648
EXISTING	592.345	591.392	591.043	591.014	590.448	590.162	590.152	589.853	589.648
OFFSET	-11.390	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	10.529

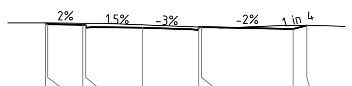
CH 500.000



DATUM 579

DESIGN	584.962	582.500	582.403	582.403	582.168	582.209	582.209	582.112	582.311
EXISTING	584.962	584.183	583.696	583.680	583.359	583.021	583.003	582.409	582.311
OFFSET	-17.849	-8.000	-3.150	-3.000	0.000	3.000	3.150	8.000	8.797

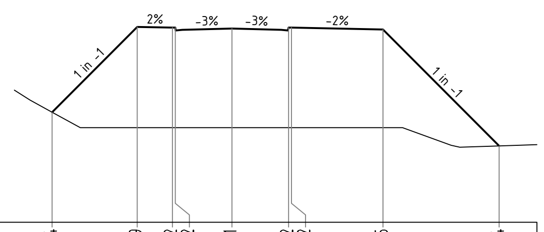
CH 750.000



DATUM 577

DESIGN	580.893	580.834	580.797	580.797	580.638	580.679	580.679	580.582	580.766
EXISTING	580.893	580.892	580.885	580.884	580.798	580.680	580.674	580.761	580.766
OFFSET	-5.118	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	8.734

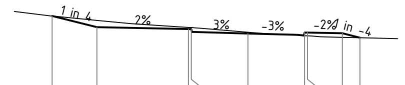
CH 700.000



DATUM 571

DESIGN	576.814	581.319	581.282	581.282	581.241	581.282	581.282	581.185	575.034
EXISTING	576.814	576.000	576.000	576.000	576.000	576.000	576.000	576.000	575.034
OFFSET	-9.506	-5.000	-3.150	-3.000	0.000	3.000	3.150	8.000	14.152

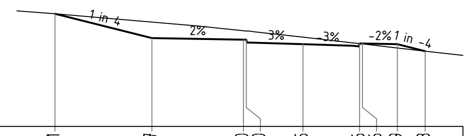
CH 650.000



DATUM 585

DESIGN	589.349	588.759	588.662	588.662	588.426	588.468	588.468	588.431	588.202
EXISTING	589.349	589.124	588.750	588.740	588.492	588.310	588.302	588.222	588.202
OFFSET	-10.360	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	5.917

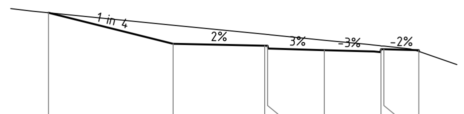
CH 950.000



DATUM 581

DESIGN	586.961	585.677	585.580	585.580	585.345	585.386	585.386	585.349	584.983
EXISTING	586.961	586.525	586.068	586.052	585.717	585.376	585.359	585.149	584.983
OFFSET	-13.134	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	6.464

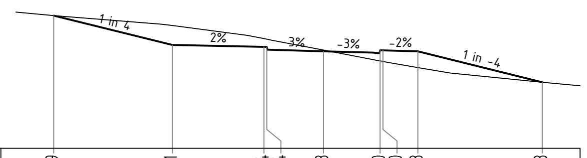
CH 900.000



DATUM 580

DESIGN	585.914	584.269	584.172	584.172	583.936	583.978	583.978	583.941
EXISTING	585.914	585.261	584.778	584.763	584.464	584.162	584.146	583.862
OFFSET	-14.579	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000

CH 850.000



DATUM 578

DESIGN	585.059	583.491	583.394	583.394	583.158	583.200	583.200	583.163	581.518
EXISTING	585.059	584.521	583.829	583.800	583.222	582.644	582.616	582.295	581.518
OFFSET	-14.274	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	11.580

CH 800.000

FILE: H:\P15\15_000776\drawing\C15000776-012-.dwg 22nd-Sep-2015 4:53PM USER: derek clark
Xrefs: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-road-1-cross_1 X-road-1-cross_3 X-road-1-cross_2 X-road-1-cross_4

	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	PM	DC			23/09/2015	
A						
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WAE No.

PROJECT No.

A3 PLOT SCALE (METRES) A1 PLOT

CONSULT AUSTRALIA

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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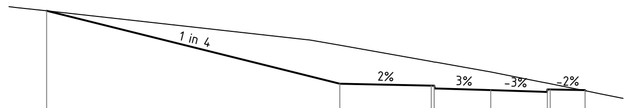
DRAWING TITLE: ROAD CROSS SECTIONS SHEET 2

DRAWING NUMBER: C15776-013+

AMEND.

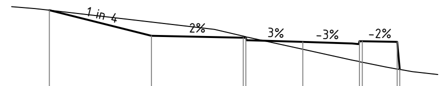
CH 1100.000



DATUM 595

DESIGN	603.557	599.676	599.579	599.579	599.343	599.384	599.384	599.347
EXISTING	603.557	601.724	600.867	600.840	600.304	599.708	599.679	599.311
OFFSET	-23.524	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000

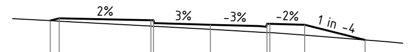
CH 1250.000



DATUM 598

DESIGN	605.011	603.660	603.563	603.563	603.328	603.369	603.369	603.332	601.878
EXISTING	605.011	604.386	603.639	603.603	602.942	602.289	602.256	601.903	601.878
OFFSET	-13.405	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	5.145

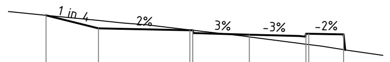
CH 1400.000



DATUM 589

DESIGN	593.431	593.550	593.453	593.453	593.217	593.259	593.259	593.222	592.422
EXISTING	593.431	593.406	593.144	593.136	592.974	592.809	592.800	592.675	592.422
OFFSET	-8.475	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	8.198

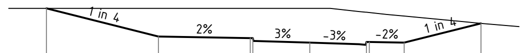
CH 1050.000



DATUM 591

DESIGN	597.103	596.409	596.312	596.312	596.076	596.117	596.117	596.080
EXISTING	597.103	596.827	596.327	596.310	595.955	595.563	595.544	595.278
OFFSET	-10.777	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000

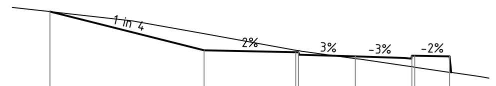
CH 1200.000



DATUM 601

DESIGN	606.000	604.518	604.421	604.421	604.185	604.227	604.227	604.190	605.208
EXISTING	606.000	606.000	606.000	606.000	606.000	605.797	605.781	605.594	605.208
OFFSET	-13.929	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	9.074

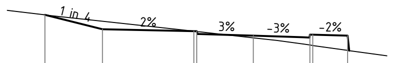
CH 1350.000



DATUM 591

DESIGN	598.116	596.075	595.978	595.978	595.743	595.784	595.784	595.747
EXISTING	598.116	596.953	596.081	596.054	595.636	595.203	595.181	594.911
OFFSET	-16.164	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000

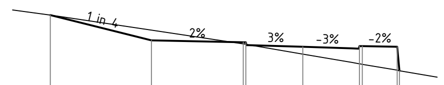
CH 1000.000



DATUM 588

DESIGN	593.345	592.584	592.487	592.487	592.251	592.293	592.293	592.256
EXISTING	593.345	593.011	592.481	592.464	592.136	591.753	591.732	591.471
OFFSET	-11.047	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000

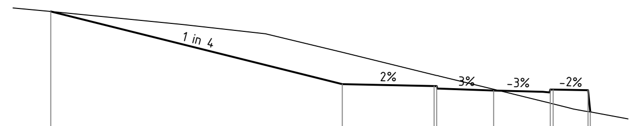
CH 1150.000



DATUM 597

DESIGN	603.498	602.158	602.061	602.061	601.825	601.867	601.867	601.830	600.562
EXISTING	603.498	602.708	601.982	601.956	601.441	600.927	600.901	600.584	600.562
OFFSET	-13.361	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	5.127

CH 1300.000



DATUM 594

DESIGN	603.175	599.319	599.222	599.222	598.986	599.028	599.028	598.991	597.837
EXISTING	603.175	601.002	599.813	599.777	599.042	598.306	598.270	597.859	597.837
OFFSET	-23.425	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	5.115

FILE: H:\P\15\15-000776\drawing\C15000776-012-.dwg 22nd-Sep-2015 4:04PM USER: derek.clark
Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-road-1-cross_1 X-road-1-cross_3 X-road-1-cross_2 X-road-1-cross_4

	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	PM	DC			23/09/2015	
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WAE No.

PROJECT No.

A3 PLOT SCALE (METRES) A1 PLOT

CONSULT AUSTRALIA

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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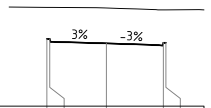
DRAWING TITLE: ROAD CROSS SECTIONS SHEET 3

DRAWING NUMBER: C15776-014+

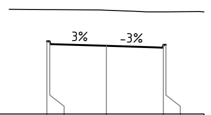
AMEND.



DATUM 580

DESIGN	583.568	583.568	583.332	583.374	583.374
EXISTING	585.256	585.255	585.216	585.118	585.118
OFFSET	-3.150	-3.000	0.000	3.000	3.150

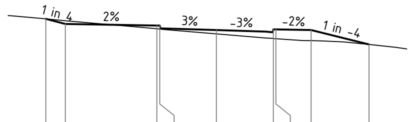
CH 1502.626



DATUM 580

DESIGN	583.846	583.846	583.610	583.652	583.652
EXISTING	585.524	585.523	585.490	585.409	585.409
OFFSET	-3.150	-3.000	0.000	3.000	3.150

CH 1500.000



DATUM 584

DESIGN	589.501	589.242	589.145	589.145	588.910	588.951	588.951	588.914	588.147
EXISTING	589.501	589.449	588.982	588.969	588.717	588.465	588.453	588.349	588.147
OFFSET	-9.036	-8.000	-3.150	-3.000	0.000	3.000	3.150	5.000	8.070

CH 1450.000

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Xref's: X-DCONT-C15776 X-EXCONT-C15776 X-BLOCK-C15776 X-DESIGN-C15776 X-A1_15-000776 X-road-1-cross_1 X-road-1-cross_3 X-road-1-cross_2 X-road-1-cross_4

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	PM	DC			23/09/2015	
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WAE No.

PROJECT No.

A3 PLOT SCALE (METRES) A1 PLOT

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4084

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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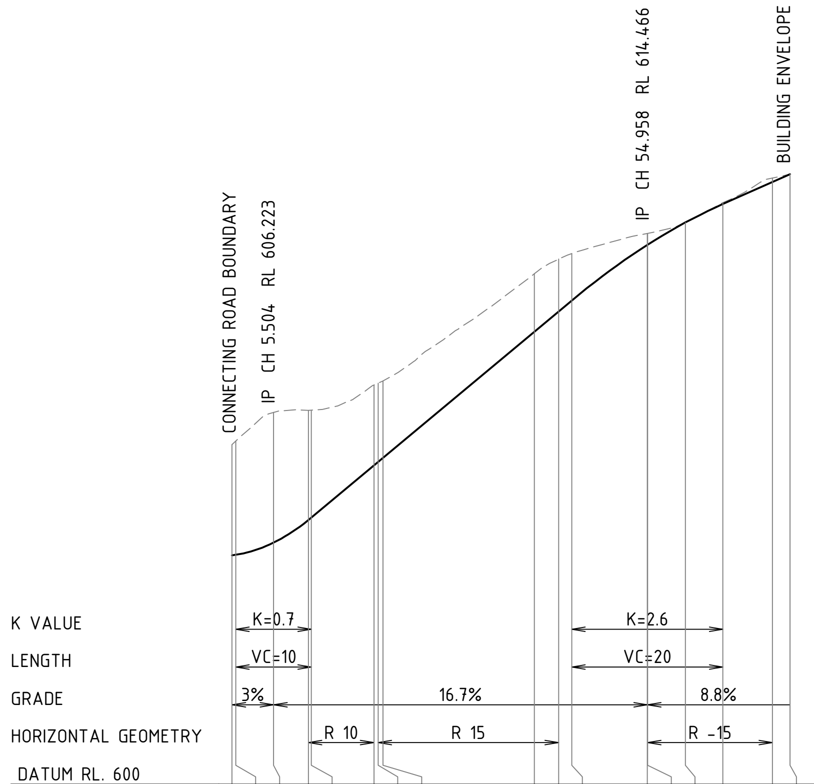
DRAWING TITLE: ROAD CROSS SECTIONS SHEET 4

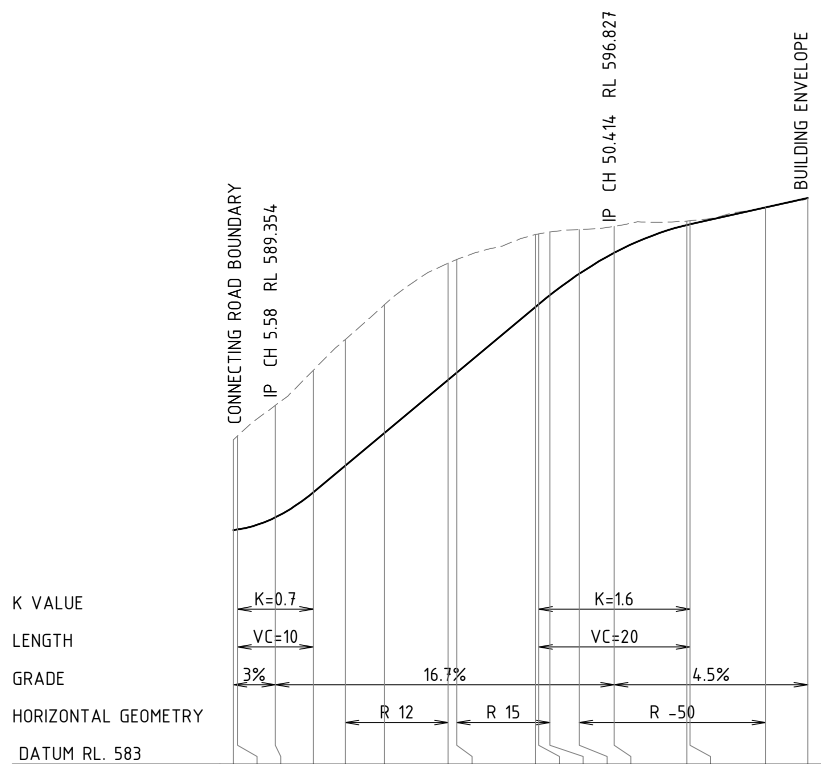
DRAWING NUMBER: C15776-015+

AMEND.



DESIGN SURFACE	606.058	606.073	606.394	606.990	607.056	608.438	608.527	608.639	611.973	612.507	612.799	614.270	614.274	614.864	615.350	615.930	616.136
EXISTING SURFACE	608.988	609.080	609.839	609.895	609.894	610.565	610.613	610.675	613.505	613.893	614.040	614.572	614.573	614.865	615.384	616.041	616.136
DIFFERENCE	2.931	3.007	3.445	2.905	2.838	2.128	2.085	2.036	1.533	1.386	1.241	0.302	0.299	0.002	0.034	0.111	0.000
CHAINAGES	0.000	0.504	5.504	10.100	10.504	18.791	19.329	20.000	40.000	43.209	44.958	54.958	54.986	60.000	64.958	71.514	73.846

DRIVEWAY 001



DESIGN SURFACE	589.187	589.204	589.525	590.187	590.894	591.757	593.162	593.350	595.091	595.160	595.400	595.965	596.521	597.253	597.272	597.718	597.966
EXISTING SURFACE	591.572	591.681	592.487	593.411	594.227	595.146	596.247	596.339	597.003	597.021	597.068	597.132	597.218	597.356	597.362	597.716	597.966
DIFFERENCE	2.386	2.477	2.962	3.224	3.333	3.388	3.084	2.990	1.912	1.861	1.668	1.167	0.697	0.103	0.090	-0.002	0.000
CHAINAGES	0.000	0.580	5.580	10.580	14.822	20.000	28.430	29.553	40.000	40.414	41.893	45.770	50.414	60.000	60.414	70.428	76.000

DRIVEWAY 002

FILE: H:\P15\15-000776\drawing\C15000776-016+.dwg 23rd-Sep-2015 11:25AM USER: derek clark
Xrefs: X-A1_15-000776 X-15-000776_Jumping-Creek-dwy-002-1 X-15-000776_Jumping-Creek-dwy-004-1 X-15-000776_Jumping-Creek-dwy-003-1 X-15-000776_Jumping-Creek-dwy-001-1

	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	PM	DC			23/09/2015	
AMENDMENTS A						
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WAE No.

PROJECT No.

A3 PLOT 1:1000 1:200 SCALE (METRES) 10 5 0 10 20 1 0 1 2 3 4 5 A1 PLOT 1:500 HOR 1:100 VER

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CLIENT CIC AUSTRALIA

PROJECT JUMPING CREEK DEFERRED AREA CONCEPT PLAN

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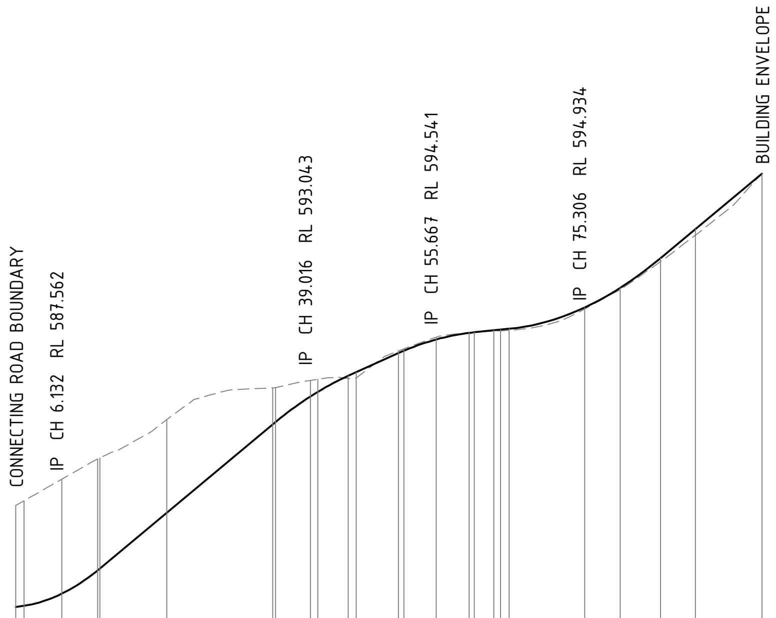
DRAWING TITLE DRIVEWAYS 001, 002, 003 & 004 LONG SECTIONS SHEET 1 OF 2

DRAWING NUMBER C15776-016+

AMEND.



K VALUE: K=0.7 | K=1.3 | K=1.4 | K=1.4

LENGTH: VC=10 | VC=10 | VC=10 | VC=20

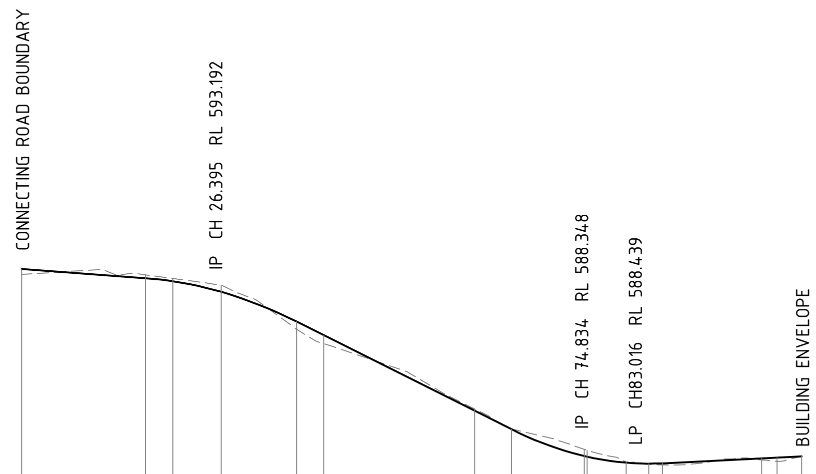
GRADE: 3% | 16.7% | 9% | 2% | 16.7%

HORIZONTAL GEOMETRY: R 100 | R 30 | R -20

DATUM RL. 581

DESIGN SURFACE	587.378	587.412	587.733	588.347	588.395	589.873	592.210	592.273	592.947	593.070	593.493	593.588	594.091	594.151	594.454	594.627	594.641	594.694	594.711	594.734	595.301	595.820	596.601	597.372	598.839
EXISTING SURFACE	590.061	590.190	590.762	591.289	591.318	592.335	593.169	593.179	593.374	593.401	593.424	593.437	594.151	594.206	594.512	594.638	594.649	594.676	594.681	594.691	595.257	595.768	596.508	597.210	598.839
DIFFERENCE	2.683	2.778	3.029	2.941	2.922	2.461	0.959	0.906	0.427	0.331	-0.069	-0.151	0.060	0.055	0.058	0.012	0.007	-0.017	-0.030	-0.043	-0.044	-0.051	-0.093	-0.162	0.000
CHAINAGES	0.000	1.132	6.132	10.840	11.132	20.000	34.016	34.402	39.016	40.000	44.016	45.075	50.667	51.350	55.667	60.000	60.667	63.286	64.144	65.306	75.306	80.000	85.306	89.932	98.734

DRIVEWAY 003



K VALUE: K=2.4 | K=1.8

LENGTH: VC=20 | VC=20

GRADE: -1.5% | -10% | 1%

HORIZONTAL GEOMETRY: R -30

DATUM RL. 582

DESIGN SURFACE	593.588	593.342	593.261	592.980	592.192	591.832	589.832	589.348	588.640	588.623	588.464	588.439	588.448	588.580	588.600	588.633
EXISTING SURFACE	593.437	593.429	593.333	593.152	591.992	591.612	589.881	589.355	588.819	588.795	588.485	588.425	588.403	588.538	588.501	588.633
DIFFERENCE	-0.151	0.087	0.072	0.172	-0.201	-0.220	0.049	0.007	0.179	0.171	0.021	-0.014	-0.046	-0.041	-0.099	0.000
CHAINAGES	0.000	16.395	20.000	26.395	36.395	40.000	60.000	64.834	74.468	74.834	80.000	83.016	84.834	97.946	100.000	103.262

DRIVEWAY 004

FILE: H:\P\15\15-000776\drawing\C15000776-016r.dwg 22nd-Sep-2015 4:04PM USER: derek clark
Xref's: X-A1_15-000776 X-15-000776_Jumping-Creek-dwy-002-1 X-15-000776_Jumping-Creek-dwy-004-1 X-15-000776_Jumping-Creek-dwy-003-1 X-15-000776_Jumping-Creek-dwy-001-1

	FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
		PM	DC			23/09/2015	
AMENDMENTS	A						
	B						
	C						
	D						
	E						
	F						

WAE No.

PROJECT No.

A3 PLOT 1:1000 / 1:200 — SCALE (METRES) 10 5 0 10 20 / 1 0 1 2 3 4 5 — A1 PLOT 1:500 HOR / 1:100 VER

CONSULT AUSTRALIA

Quality Endorsed Company ISO 9001 Lic 4084

CLIENT: CIC AUSTRALIA

PROJECT: JUMPING CREEK DEFERRED AREA CONCEPT PLAN

calibre CONSULTING

 www.calibreconsulting.co

DRAWING TITLE: DRIVEWAYS 001, 002, 003 & 004 LONG SECTIONS SHEET 2

DRAWING NUMBER: C15776-017+

AMEND.

APPENDIX E XP-RAFTS MODEL INPUT PARAMETERS – EXISTING

Catchment Name	Area	Percentage Impervious	Vectored Slope
C2Down	15.3	5%	7.05
C2Up	21.44	5%	7.05
C3	3.17	5%	15.5
C4	1.63	5%	15.88
C5	0.384	5%	14.93
C6	0.21	5%	13.4
C1	3.89	5%	9.3
C7	532.6	5%	5.65
C8	794.6	5%	5.64
C9	362.6	5%	3.5
C10	144.8	5%	1.6
C11	29.3	5%	17
C12	583.2	5%	3.6
C13	298.4	5%	5.95
C14	363.7	5%	3.39
C15	262.8	5%	5.38
C16	119.8	5%	10.8
C17	30.78	5%	8.8
C18	39.5	5%	7.03
C19	21.2	5%	8.83
C_Out	9.87	5%	1.5

APPENDIX F XP-RAFTS MODEL INPUT PARAMETERS – DEVELOPED

Catchment Name	Area	Percentage Impervious	Vectored Slope
D_C2Up	21.44	5%	7.05
D_C1	4.16	45%	9.3
D_C2Down	14.06	5%	7.05
D_C3	3.17	40%	15.5
D_C4	1.63	40%	15.88
D_C5	0.384	40%	14.93
D_C6	0.21	40%	13.4
D_C7	0.3	95%	12.62
D_C7.2	532.6	5%	5.65
D_C8	0.7	95%	6
D_C8.2	794.6	5%	5.64
D_C9	0.79	80%	1
D_C9.2	362.6	5%	3.5
D_C10	144.8	5%	1.6
D_C11	28.3	5%	17
D_C12	583.2	5%	3.6
D_C13	298.4	5%	5.95
D_C14	363.7	5%	3.39
D_C15	262.8	5%	5.38
D_C16	119.8	5%	10.8
D_C17	30.78	5%	8.8
D_C18	39.5	5%	7.03
D_C19	21.2	5%	8.83
D_Out	9.87	5%	1.5

APPENDIX G LANDDATA RIVER BANK REPORT

Surveying Development GIS

Our Reference: 15066

14 May 2015

Michael Nolan
Development Manager
CIC Australia Pty Ltd
PO Box 1000
CIVIC SQUARE
ACT 2608

Attention Mr Michael Nolan

Dear Michael,

RE: JUMPING CREEK DEVELOPMENT
DEFINITION OF THE HIGHEST BANK OF THE QUEANBEYAN RIVER

Introduction

In support of the rezoning of the deferred matter at the proposed Jumping Creek Development, LANDdata Surveys has undertaken a survey to define the highest bank on the eastern side of Queanbeyan River in the south-western area of the proposed Jumping Creek development. This report provides an outline of the research undertaken in defining the highest bank and our spatial interpretation to the location of this natural monument.

Aerial photo showing area of interest located in the southwestern corner of the proposed Jumping Creek development

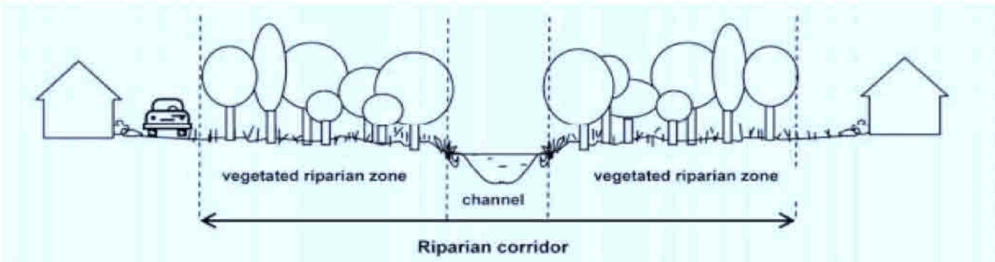
Background Information

The proposed Jumping Creek development is located on Lot 5 in DP1199045 in the Local Government Area of Queanbeyan and in close proximity to the Queanbeyan River. The close proximity of the proposed development to the Queanbeyan River means that the impact of the development is subject to assessment by the NSW Office of Water. Any controlled activities carried out on waterfront land are regulated by the *Water Management Act 2000* which defines "waterfront land" as "the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river."

The transition zone between the terrestrial environment and the watercourse is known as the riparian corridor which is described in the NSW Office of Water document "*Guidelines for riparian corridors on waterfront land*" as consisting of:

- The channel which comprises the bed and banks of the watercourse (to the highest bank) and
- The vegetated riparian zone adjoining the channel

The above description is then further clarified by the following diagram:



The location of the vegetated riparian zone is critical in considering any proposed development. To identify the extent of the vegetated riparian zone adjoining the Queanbeyan River it is first necessary to determine the location of the highest bank of the watercourse.

Queanbeyan River Bank Research and Definition

The term "highest bank of the watercourse" is difficult to establish physically on the ground due to the varied terrain which exists along the Queanbeyan River and the inherent difficulties found in defining a fixed line within the constantly changing natural environment.

Prior to any field survey, extensive research was undertaken into the flow levels of the Queanbeyan River and the history of previous surveys in the area.

- The data from the NSW Office of Water from the 01/01/2014 to the date of survey (attached in *Appendix C*) shows that the water level of Queanbeyan River at the time of survey approximately represented an average level of flow. The maximum level of the river in the past 18 months was 3 metres higher than the water level at the time of survey. Therefore, we ensured that the surveyed position of the highest bank of the watercourse was at least more than 3m above the water level at the time of survey.

- It is considered convention for old cadastral surveys to adopt the "top of bank" or "highest bank of the watercourse" as the cadastral boundary. Various publications and presentations state that "old survey measurements were often restricted to the high bank of a stream" (Kernebone, 1986) and "distances to banks stated in old surveys are seldom reliable. In many case the measurements were made to the high bank of the stream" (Hallman, 1994) and "the tendency in old surveys to measure to what was regarded as the limit of usable land, normally the top of the high bank" (B.O'Malley, 1983).Using the historical convention that old surveys would normally adopt the top of bank as the cadastral boundary we can consider that the previously defined cadastral boundary from a survey in 1984 could be a reliable indicator of the "highest bank of the watercourse" (it is important to note that this is not the correct definition of the legal boundary, but it was historical convention to adopt the highest bank for practical reasons). The cadastral survey boundary from 1984 is shown on the plan attached in *Appendix A* and good agreement is found between the highest bank as surveyed for the purposes of this report and the earlier cadastral boundary survey.

Field Survey

The field survey to physically identify the highest bank of the watercourse on the eastern side of the Queanbeyan River was performed on the 13/05/2015. *Appendix B* contains a number of photos which were taken on site and we have included an overlay with each photo which clarifies our interpretation of the highest bank. As part of the field survey the following factors, as well as the research described on the previous page, were taken into account in defining the highest bank of the watercourse:

- The extent of obvious erosion due to regular water flow.
- The limit of vegetation indicating the extent of regular water flow.
- The location of fauna habitat evidence in relation to regular water flow.

In the northern part of the subject area the terrain is fairly open with scattered vegetation and gradually sloping banks, but in the southern part of the subject area the terrain is covered with dense vegetation with very high and steep banks. The southern part of this area is also much rockier and difficult to access than the northern part of the site.

The field survey was conducted using GNSS (Global Navigation Satellite System) technology which enabled the accuracy of the survey to be within +/-20mm horizontally at a 95% confidence level.

Conclusion

The surveyed boundary from 13/05/2015 is shown in yellow on the plan attached in *Appendix A* and is an accurate representation of our interpretation of the highest bank of the Queanbeyan River. Anything beyond the line defined as the highest bank we consider to be part of the vegetated riparian zone and outside the Queanbeyan River watercourse. The survey described in this report incorporated historical survey data, information regarding the past flow levels of the Queanbeyan River and aspects of the natural environment to provide a reliable estimation of the highest bank of the Queanbeyan River.

If any additional information is required please contact the writer.

Yours Faithfully
LANDdata Surveys Pty Ltd

Matthew Stevenson
Registered Surveyor

References:

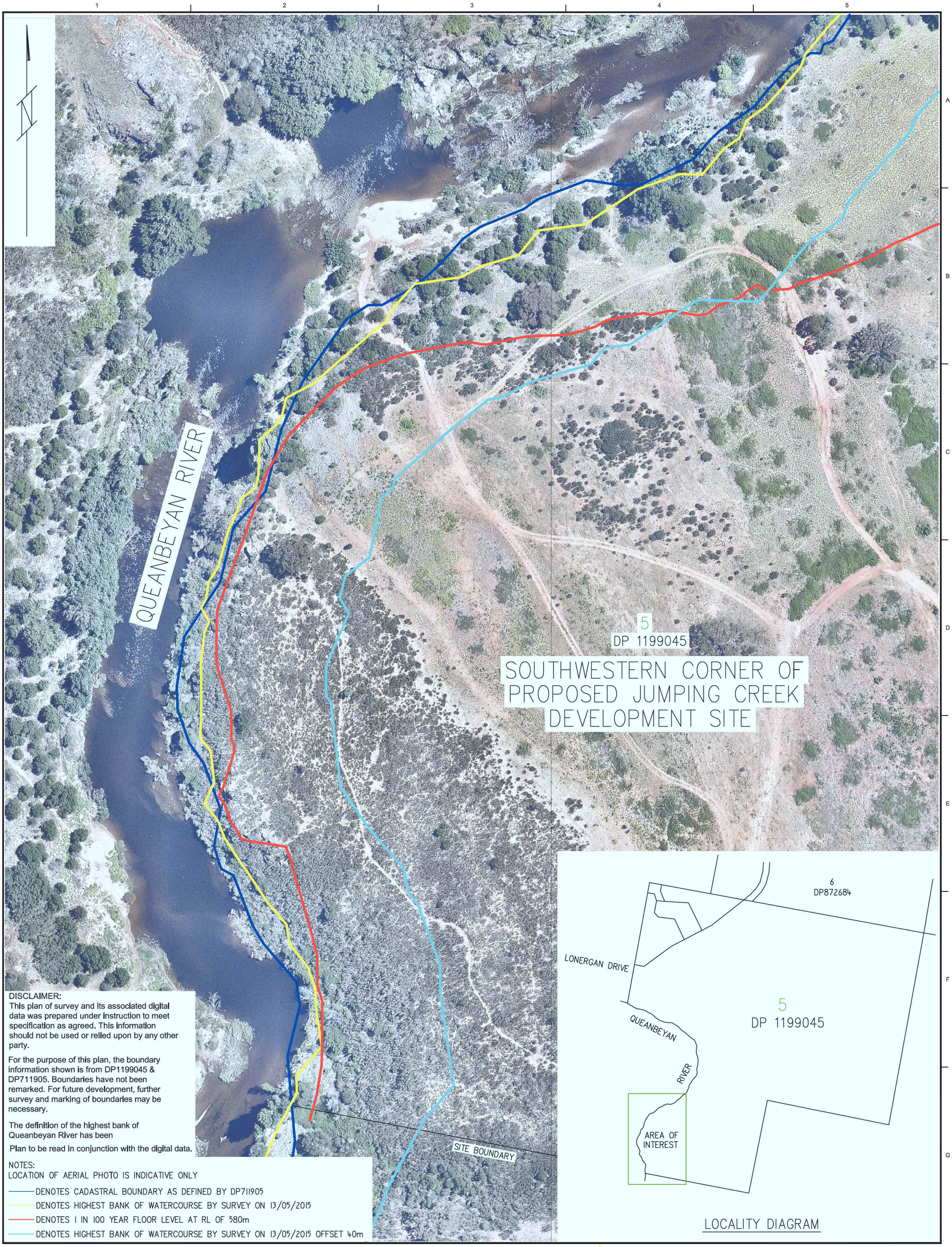
B.O'Malley, N.Ryan. (1983). *Survey Investigation Paper Presented to 59th Annual Conference of NSW Staff Surveyors.* Sydney.

Hallman. (1994). *Legal Aspects of Boundary Surveying as apply in New South Wales.* NSW: ISNSW.

Kernebone, R. (1986). *North Bank, Right Bank, Left Bank, South Bank.* Buronga: Western Lands Commission.

Water, N. O. (2012). *Guidelines for riparian corridors on waterfront land.* Department of Primary Industries.

APPENDIX A: PLAN OF SURVEY SHOWING TOP OF HIGHEST BANK AND OTHER INFORMATION



DISCLAIMER:
This plan of survey and its associated digital data was prepared under instruction to meet specification as agreed. This information should not be used or relied upon by any other party.

For the purpose of this plan, the boundary information shown is from DP1199045 & DP711905. Boundaries have not been remarked. For future development, further survey and marking of boundaries may be necessary.

The definition of the highest bank of Queanbeyan River has been

Plan to be read in conjunction with the digital data.

NOTES:
LOCATION OF AERIAL PHOTO IS INDICATIVE ONLY

- DENOTES CADASTRAL BOUNDARY AS DEFINED BY DP711905
- DENOTES HIGHEST BANK OF WATERCOURSE BY SURVEY ON 13/05/2015
- DENOTES 1 IN 100 YEAR FLOOR LEVEL AT RL OF 580m
- DENOTES HIGHEST BANK OF WATERCOURSE BY SURVEY ON 13/05/2015 OFFSET 40m

CLIENT

CIC AUSTRALIA

REVISION	DATE	ZONE

Datum A.H.D

BM SSM110159

RL 583.665

1: 750
0 5 10 15 20 30 40
METRES

LANDdata SURVEYS
11-13 Lawry Place
MACQUARIE, ACT 2614
T 02 6202 7600 F 02 6202 7699

Surveyed	M.STEVENSON	13/05/2015
Drawn	M.STEVENSON	15/05/2015
Checked		15/05/2015
Approved		

Surveyor, Registered under the Surveying and Spatial Information Act 2002 No.83.

QUEANBEYAN RIVER BANK SURVEY
JUMPING CREEK DEVELOPMENT
LOT 5 DP1199045
QUEANBEYAN

Proj No. 15066 **Rev**
Sheet No. 1 of 115066_CREEK_BOUNDARY_OFFSET.DWG

APPENDIX B: PHOTOS FROM FIELD SURVEY

Photo taken in location #1 with red line indicating definition adopted of highest bank

Photo taken in location #2 with red line indicating definition adopted of highest bank

Photo taken in location #3 with red line indicating definition adopted of highest bank

Photo taken in location #4 with red line indicating definition adopted of highest bank

Photo taken in location #5 with red line indicating definition adopted of highest bank

APPENDIX C: NSW OFFICE OF WATER STREAM WATER LEVEL GRAPH

NSW Office of Water

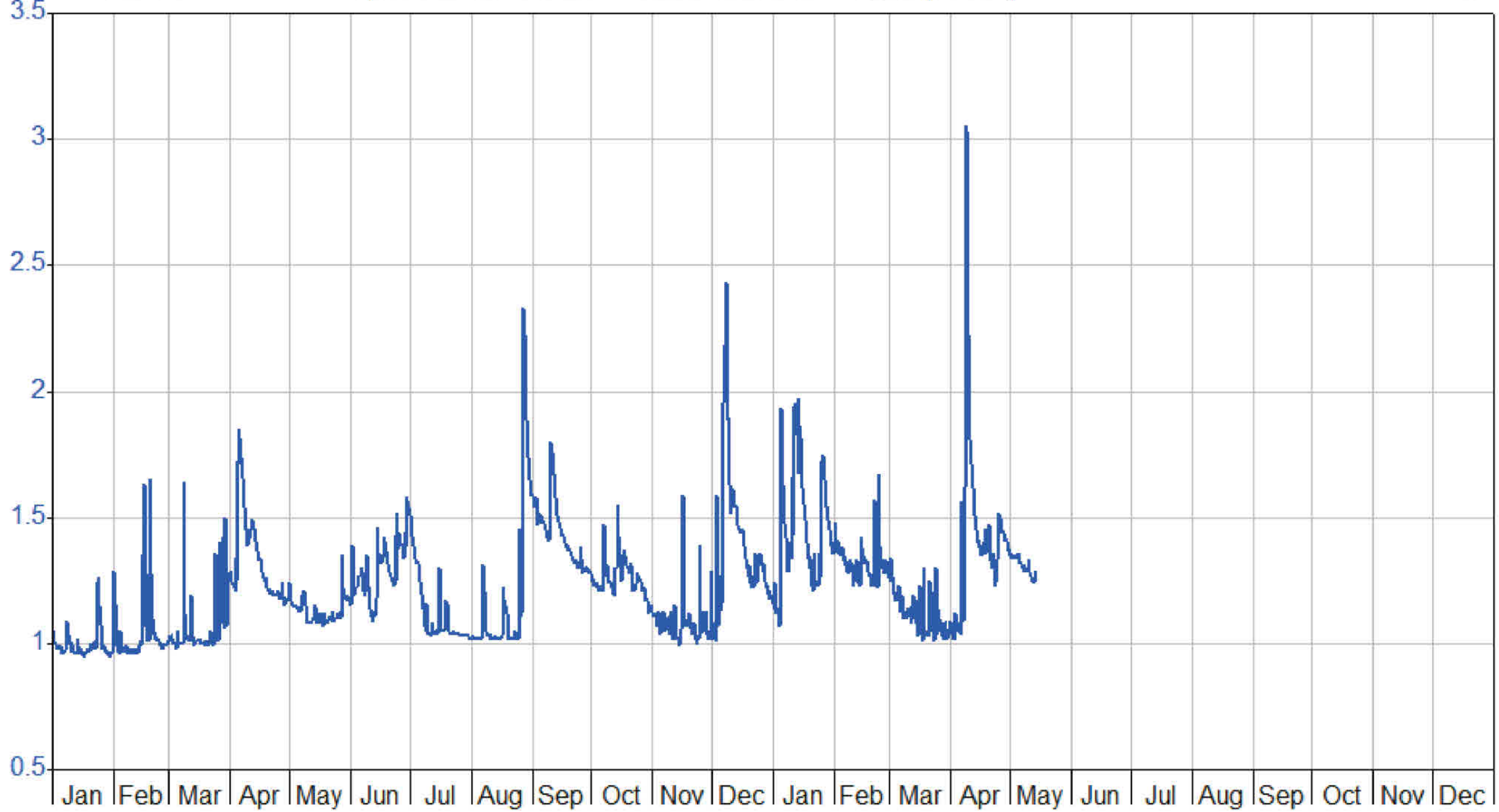
HYPLOT V133 Output 14/05/2015

Plot Start 00:00_01/01/2014

Plot End 00:00_01/01/2016

2014-16

— 410770 Qbn R. at ACT Border 100.00 Max & Min Level (Metres) CP



APPENDIX H SEDIMENT BASIN VOLUME CALCULATIONS

C15776 **PJM** **12/08/2015**

Calibre Consulting

Jumping Creek SWVMP

Sediment Basin Sizing to the NSW Blue Book 85th percentile 5 day rainfall event

						Settling Zone Volume					**Storage Zone Volume**												**Total Storage**
		A (Ha)	**Length**	**dH**	**Slope %**	**constant**	**R%ile, day (mm)**	**A (Ha)**	**Cv**	**V**	**0.5*V**	**Or**	**Constant**	**A (Ha)**	**R**	**K**	**LS**	**P**	**C**	**RUSLE**	**V**	**V use**	**Required (m^3)**
Deferred Area	RUSLE (85%ile)	4.17	300		8.66	10	25.8	4.17	0.56	602.4816	301.2408		0.17	4.17	1500	0.04	5.381	1.3	1	419.718	228.8755	301.2408	903.7224
Road (west)	RUSLE (85%ile)	0.98	300		6	10	25.8	0.98	0.56	141.5904	70.7952		0.17	0.98	1500	0.04	3.25	1.3	1	253.5	32.487	70.7952	212.3856