WALLBRIDGE GILBERT AZTEC

Copper Coast Council

Kadina Township

STORMWATER MANAGEMENT PLAN

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1 INTRODUCTION

1.1 AIM

The aim of the Kadina Stormwater Management Plan (SMP) is to:

- Review the existing status of stormwater management within the township of Kadina
- Define a relevant and achievable set of objectives for stormwater management
- Identify appropriate strategies to implement the defined objectives
- Present a series of mitigation options to address existing stormwater issues in the catchment in line with the SMP's objectives and strategies

This SMP is intended to enable the current and future management of Kadina's stormwater in line with relevant stakeholder requirements.

1.2 CONTENTS

The SMP comprises a detailed assessment of the current stormwater management within the catchment, the development of the objectives and a framework for implementation. This plan has been prepared to comply with the requirements of the Stormwater Management Authority's "Stormwater Management Planning Guidelines", (Stormwater Management Authority, 2007).

It is recognised by Council that with the nature of the catchment localised flooding can occur and although the localised flooding impacts small areas and so does not trigger action under the adopted risk matrix that works to rectify flooding that impacts small groups of residents should still be given consideration in the upgrade works proposed. Council considers it has a duty of care to the community to consider all its residents when developing a long term stormwater management strategy.

This plan contains:

- A description of the township's various catchments
- A description of all known existing stormwater assets
- An assessment of the catchment's stormwater runoff (volumes and flow rates)
- Stormwater management objectives
- Identification of stormwater management strategies and outcomes
- Implementation framework including costing, prioritisation, time frame and responsibilities
- Communication and consultation were undertaken as part of the plan development

1.3 EXISTING INVESTIGATIONS AND STUDIES

There are a number of reports that have contributed to the development of this SMP but are not included in this report, including:

- Concept Designs and Estimates for Drainage of Newtown, Russell Street and Port Moonta Catchments, Lange Dames and Campbell Australia Pty Ltd, August 1991
- Feasibility Study on Stormwater Reuse at Kadina, Tonkin, March 2000
- Moonta, Wallaroo and Kadina Stormwater Management Plan, Tonkin, July 2011

2 CATCHMENT DESCRIPTION

2.1 LOCATION

The Township of Kadina is located approximately 144 kilometres northwest of Adelaide in the Copper Coast Council. Kadina acts as the district centre for the nearby towns of Moonta, Moonta Bay, Port Hughes, Wallaroo, and more broadly the Yorke Peninsula, providing necessary shopping and regional services for this portion of the Council area.

2.2 BOUNDARY & TOPOGRAPHY

The Kadina Township catchment covers approximately 10 km^2. There is no distinct discharge point for the Kadina catchment, such as to a river or ocean. However, there are a number of internally drained local catchments within the larger catchment boundary, which drain to basins before generally discharging by evaporation and infiltration.

The topography of the catchment is very flat with few undulations and no clear fall across the catchment. The catchment includes urban, industrial and rural areas ranging in development scope.

Due to the nature of the Kadina catchment, it is difficult to determine clear catchment boundaries within the township.

A map of high flood risk infrastructure within the township is included as Appendix A.

2.3 STORMWATER INFRASTRUCTURE

There is minimal existing underground infrastructure in Kadina. Stormwater infrastructure has been installed on an ad hoc basis and there are no distinct regions that are completely serviced by an underground network. Rather, scattered underground drainage network supplements a number of formal and informal basins and swales that generally drain to one of the basins or wetlands within the catchment.

There are a number of stormwater pumps within the catchment that are used to drain their associated basin. These vary in usage; anecdotally the majority of these pumps have not been frequently used.

A summary of the existing stormwater infrastructure is provided in Table 1 and Table 2. The existing stormwater infrastructure is further described in Section 3, with a layout plan provided as Appendix E.

Since the initial development of the SMP Council have undertaken significant drainage upgrades within the CBD as part of the CBD upgrade project and worked with DPTI to undertake works associated with the South Terrace / Mines Road upgrade.

Table 1 and Table 2 have been updated to include the infrastructure installed as part of these projects.

The upgrade works associated with the CBD upgrade are included in Appendix K and the South Terrace Mines Road works are shown in Appendix L.

Table 1: Summary of Existing Infrastructure

Infrastructure	Quantity
Pipes	14,655 m
Pits	494
Pump Stations	4

Table 2: Existing Pipe Inventory

Diameter mm	Length m	Diameter mm	Length m
100	395	**675**	54
150	294	**725**	163
225	195	**750**	685
275	40	**800**	35
300	3,361	**825**	30
375	3,231	**900**	603
400	60	**1000**	36
450	2867	**1050**	434
525	517	**1100**	75
575	78	**1200**	244
600	1115	**1500**	142
Total = 14,655 m			

2.4 CURRENT DEVELOPMENT

The residential portions of the town have developed over time to contain a large range of dwelling types. These are primarily in the form of single storey detached dwellings, interspersed with more limited examples of residential flat buildings and semi-detached dwellings. Historic institutional buildings have been well preserved with the current Town Centre developing to the west of these areas.

A more detailed assessment of the demographic and development trends can be found in the Development Potential report prepared by MasterPlan, included in Appendix B.

2.5 DEVELOPMENT POTENTIAL

As detailed in the MasterPlan report, at the 2011 Census, Kadina had a population of 5,070 people, with the Copper Coast Council area having a population of 12,949 people. The 2016 census notes Kadina having a population of 5,414 and the Copper Coast Council area having a population of 14,139. The population for the Copper Coast increased at a steady growth rate of 2.5% between 1996 and 2011. The population is expected to continue to grow and therefore there is scope for development potential within Kadina as the district centre.

Key findings on the recent development trends from the MasterPlan report are as follows:

- Infill development within the Township has occurred slowly with currently available vacant allotments varying greatly in size and development potential.
- Infill development has generally been of a scale sympathetic to neighbouring properties and generally consists of single storey detached dwellings with setbacks consistent with precedents set on each streetscape.
- Typically, the new development at the Township fringe has developed with increased site coverage and decreased side and front setbacks. The fringe development has been of a consistent scale with the majority of residential development being in the form of single storey detached dwellings.

Further, there are a number of development constraints present in the township, which will limit future growth. These include heritage listed properties, the facultative ponds and the historic mine site. These are detailed further in the MasterPlan report.

The approved subdivision plan in the MasterPlan report details the extent of land divisions that have been recently occurring in Kadina inclusive of those proposals successfully deposited, those which have been consented but have now lapsed and those currently proposed.

These factors have been considered in the report to estimate the likely level of proposed future development within the Township.

2.6 CLIMATE DATA

The Bureau of Meteorology (BOM) weather station at Kadina (Number 22050) has been in operation since 2005. Prior to this, another station at Kadina (Number 22006) was in operation from 1876 to 1st August 2005. A summary of the monthly rainfall statistics for the data from both of these stations is given in Table 3. Total annual rainfall statistics are given in Table 4.

Table 3: Kadina Rainfall Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean	14.8	17.7	20.5	32.4	45.8	51.2	47.7	44.0	38.6	32.2	22.1	18.5	mm
Lowest	0.0	0.0	0.0	0.0	0.4	2.8	6.5	1.2	5.1	0.6	0.0	0.0	mm
Median	9.4	9.1	14.2	28	41.9	46.2	45.8	43.1	37.6	29.1	18.2	12.65	mm
Highest	88.7	167.2	178.3	154.8	172.5	157.1	113.8	134.8	105.6	98.6	92.3	79.3	mm

Table 4: Annual Rainfall Totals

	Total Annual Rainfall		Year Occurred
Mean	384.2	mm	
Lowest	216.6	mm	1967
Median	374.3	mm	
Highest	692.0	mm	1889

There is no evapotranspiration data for the Kadina station and therefore the Price weather station (Number 022015), which has been in operation since 1944 was used for sourcing approximate evapotranspiration data. The average evapotranspiration values for Price are summarised in Table 5.

Table 5: Price Average Daily Evapotranspiration

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
Evapotranspiration	8.6	7.8	6.2	4.1	2.6	1.8	1.9	2.6	3.8	5.4	7.1	8	5	mm

2.7 CLIMATE CHANGE

Climate change leads to changes in weather patterns over time. Impacts of climate change include changes in frequency and intensity of extreme events as well as spatial and temporal distributions. As relevant to this SMP, climate change could mean altered rainfall at Kadina and thus changes in the runoff patterns within the catchment. Further, changes in evaporation in the catchment could impact the rate at which basins dry out.

The BOM website includes a climate change and variability page, which provides trends in various climate statistics. One map demonstrates the total annual rainfall trends from 1970 to 2015 which indicate rainfall in the region has decreased between 0mm and 10 mm/10yr. This map is provided in Figure 1. This decreasing trend is supported by the rainfall data from the two Kadina weather stations from 1876 to present. A plot of the total annual rainfall trend is provided in Figure 2.

Thus the rainfall trends from available historic data indicate decreasing total annual rainfall at Kadina. However, this does not necessarily indicate that individual rainfall event intensities will decrease. The regional maximum one day precipitation trend from 1900 to present shows an increase of up to 10 mm/100yrs. The regional maximum five day precipitation trend from 1900 to present shows no change.

The total pan evaporation has shown an increasing trend between 1970 and 2015. A map showing the trend in annual total pan evaporation for this timeframe is provided in Figure 3. The regional evaporation is shown to increase between 0mm and 2.5 mm/yr.

In summary, the trends indicate that the total annual rainfall at Kadina is decreasing, but with slighter higher maximum one day precipitations. The total pan evaporation is increasing, overall resulting in a drier climate.

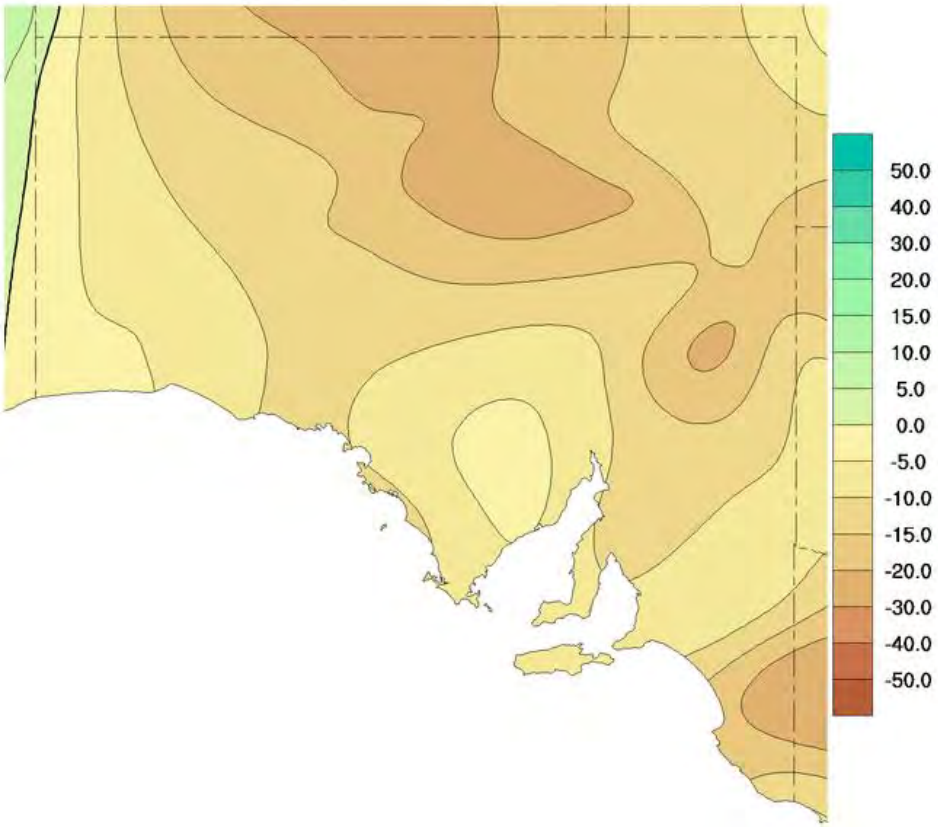

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Figure 1: Map of South Australian Total Rainfall Trends from 1970 to 2015 (mm/10yr)

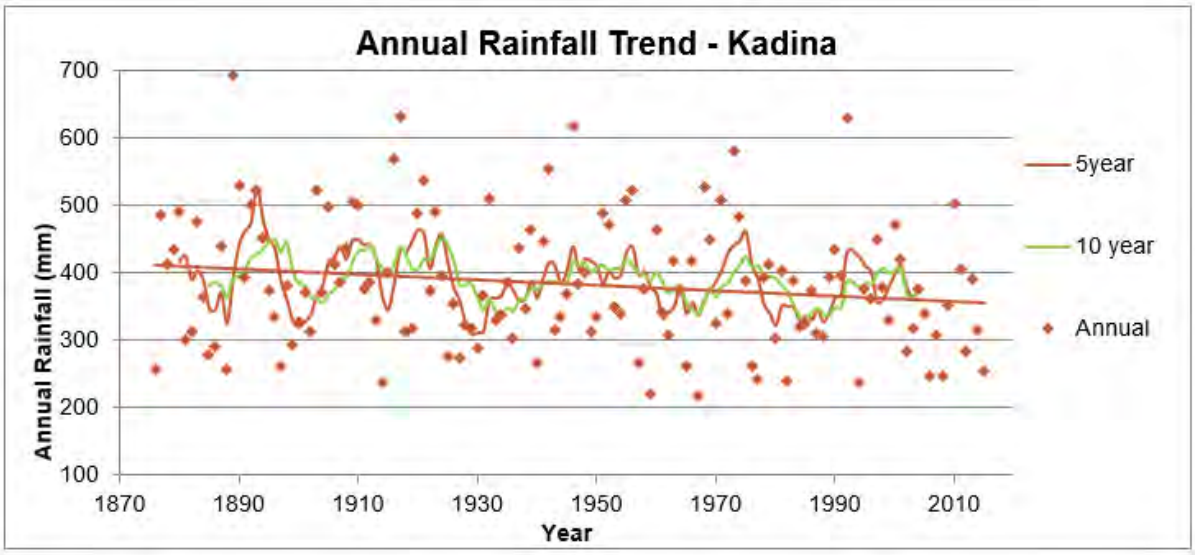

Figure 2: Plot of Kadina Annual Rainfall Trends from 1876 to 2016

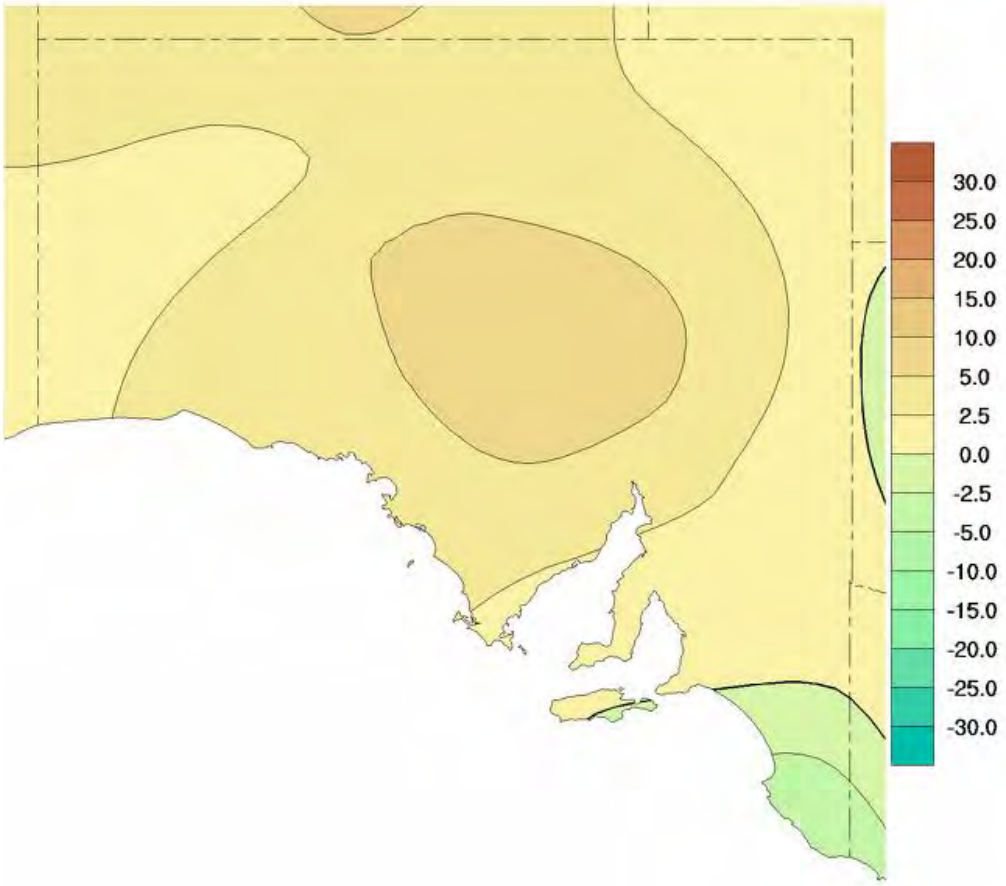

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Figure 3: Map of South Australian Annual Total Pan Evaporation Trends from 1970 to 2015 (mm/yr)

2.8 SOIL AND HYDROGEOLOGY

Kadina is situated within the Pirie-Torrens Basin, which extends from Port Broughton south to Melton, and west to Wallaroo (Martin, et al, 1998). The Geological Survey of South Australia (1:250,000 scale "Whyalla" map sheet) indicates the township is likely to be underlain by an undifferentiated quaternary profile consisting of thin, red brown sand and clay soil veneers (including Loveday Soil and Callabonna Clay) over locally exposed Bakara Soil and Ripon Calcrete characterised by hard nodular calcrete soil.

A recent geotechnical investigation carried out by WGA in the Kadina CBD comprising 14 Boreholes to depths of about 1.5 m. This investigation found the natural subsurface conditions over the depth ranges investigated were broadly consistent with the regional geology described above and was characterised by highly calcareous soils with variable calcrete inclusions.

Fill was present overlying the natural soils in each borehole and extended to depths of up to about 0.6 m. The borehole profiles were predominately A-horizon sandy clay/clayey sand over variable calcareous soils with medium plasticity clays at depth.

Groundwater was encountered in 3 of the boreholes at depths of approximately 1.45 m. In several other boreholes the soil encountered at the base of the borehole was very moist. The groundwater is interpreted to be perched groundwater within the highly calcareous soils, which likely overlay less permeable clays at depth. Seasonal variations in groundwater are likely to occur.

Generally, groundwater in the Kadina area is brackish (~2,000 to 5,000 mg/L) to saline (5,000 to 35,000 mg/L). Brackish water is only suitable for stock purposes, A total of 37 water wells have been constructed in the Kadina area to a depth typically less than 15 m below ground level. The recorded standing water level in the shallow wells ranged between 2 and 10 m below ground level. Shallow well yield has not been recorded, however, is expected to be less than 2 L/s.

Aquifers underlying the quaternary shallow watertable aquifer typically consist of the Wandearah Formation metasediments (Doora Member a biotite schist dominated unit) interbedded with Moonta Porphyry Member (felsic volcanics part of the Weetulta Formation) and Wandilta Amphibolite Member (Mafic volcanics part of the Matta Formation) (PIRSA, 2003).

Of the available information on the public WaterConnect database, a total of 247 mineral wells have been constructed at depth in the Kadina area, however, little groundwater information is recorded. Yield is reported to be 0.31 L/s (well depth 11.6 m) and 7.58 L/s (well depth 67.05 m) and salinity greater than 20,000 mg/L (saline). The groundwater is too saline for stock, domestic or irrigation uses.

3 EXISTING STORMWATER ASSETS

3.1 PIT AND PIPE NETWORK

There is limited existing stormwater infrastructure in the Kadina Township. The stormwater drainage developed somewhat organically as the Township expanded, with the naturally flat terrain relying on a man-made, overland drainage channels with almost non-existent underground stormwater infrastructure.

A layout of the Council GIS stormwater network is included in Appendix E.

The stormwater network appears to have predominately been developed on an ad hoc basis as required. Further, there are very limited connected networks, with much of the infrastructure constructed as isolated systems. As such, there is currently no defined Average Recurrence Interval (ARI) design standard for the network as a whole.

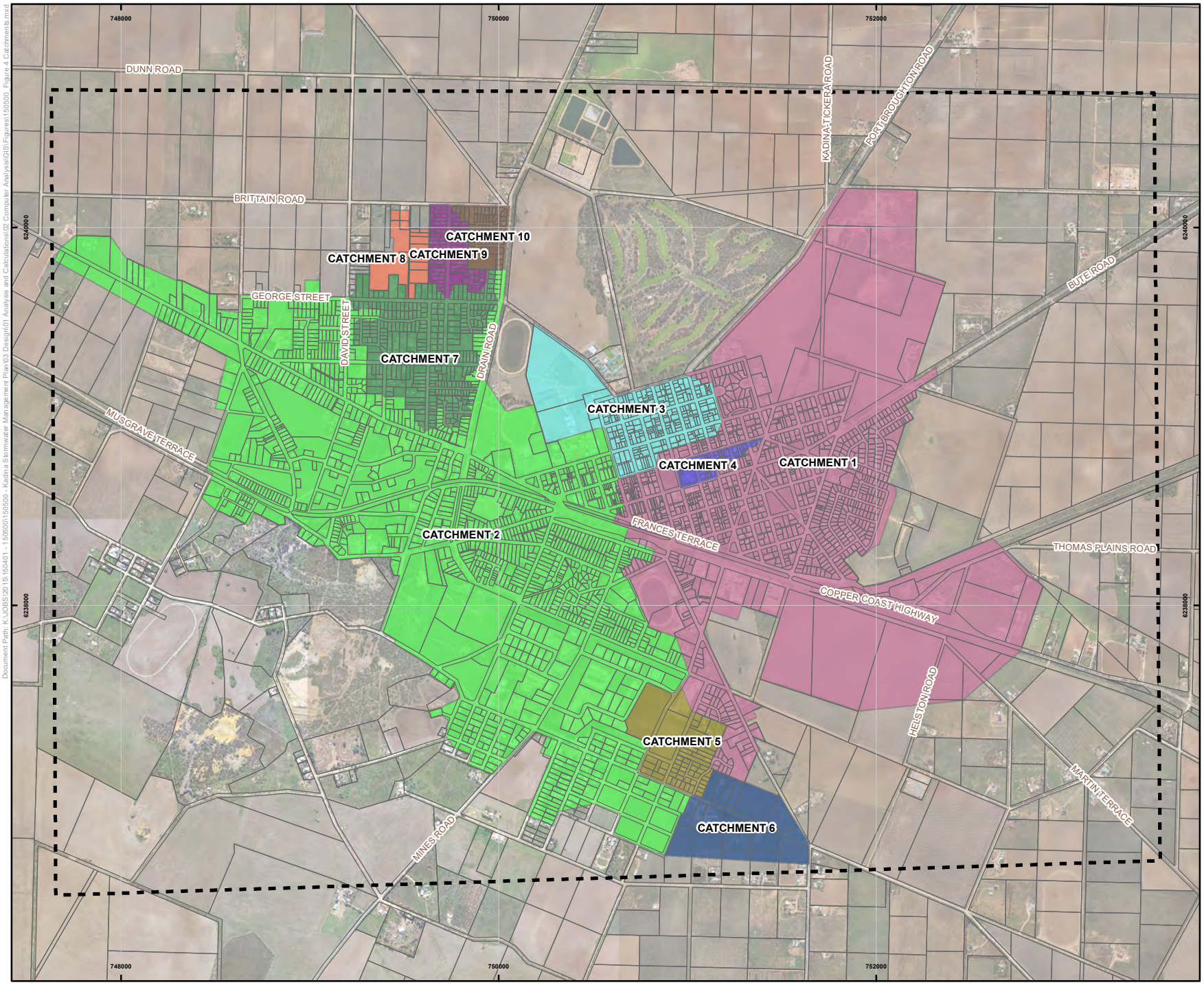
There are a number of formal and informal basins throughout the Kadina catchment as well as various wetlands. Some of these are equipped with pumps to empty the basin when required, some overflow into a nearby basin and some are dead end storages with no outlet, relying on infiltration and evaporation to drain.

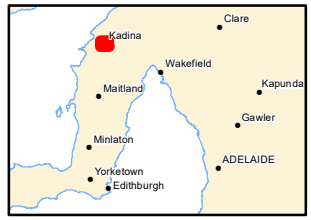
As part of the recent Kadina CBD upgrades, stormwater drainage runs have been installed within the town centre. Stormwater runoff from the town centre will be collected using inlet pits, and then conveyed underground towards the south along the roads running north-south. Once the pipes reach Frances Terrace, they are conveyed to stormwater basins to the east and west. Outlets from the basin are then connected into the existing stormwater network.

Underground drainage has been sized to convey the minor storm event, which is the 10% AEP storm event. The pipework was also sized to ensure that there are no overflows from the sag locations in major storm event (1% AEP storm event).

3.2 DESCRIPTION OF SUB-CATCHMENTS

Figure 4 and Table 6 below show a breakdown of sub-catchments in the Kadina Township. These sub-catchments were defined by Tonkin and presented in their 2011 report (Tonkin, 2011).





LEGEND

- Cadastre
- Model Bounds

Catchment Extents

- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5
- Catchment 6
- Catchment 7
- Catchment 8
- Catchment 9
- Catchment 10

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
WALLBRIDGE GILBERT AZTEC

Figure 4

Kadina Stormwater Management Plan

Catchments

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

Document Path: K:\JOBS\2215\150401 - 150500\150500 - Kadina Stormwater Management Plan\03 Design\01 Analysis and Calculations\02 Computer Analysis\GIS\Figures\150500_Figure 4 Catchments.mxd

Table 6: Sub-catchment Description Summary

Sub Catchment	Approx. Size (ha)	Description	Stormwater Infrastructure
1	331	Large catchment containing both CBD, residential, farming and vacant area. Potential for future development as per Masterplan Report.	Approximately 4.5km of stormwater pipe. Plus the recently completed CBD works as shown in Appendix K. Swale between Copper Coast Hwy and Frances Tce servicing most of the catchment. Basin located east of Schilling St, two on Port Broughton Rd with minor storage at East Tce.
2	379	Large catchment containing both residential, industrial, farming and vacant area. Extends into the old Wallaroo mining area. Potential for future development as per Masterplan Report.	Approximately 5km of stormwater pipe. Swales at Champions St and Russel St. Basin at Russell St and minor storage at Myra St. Wetlands at South Tce, Franklin Rd.
3	40	Predominately residential.	Approximately 125m of pipe discharging into wetlands on George St.
4	4.5	Predominately residential.	No existing stormwater infrastructure.
5	20	Several large blocks with houses, numerous empty fields. Potential for future development as per Masterplan Report.	Approximately 125m of stormwater pipe discharging into a swale adjacent to Ramsey St.
6	25	Several large blocks with houses, numerous empty fields. Potential for future development as per Masterplan Report.	No existing stormwater infrastructure.
7	41	Predominately residential. Potential for future development as per Masterplan Report.	Approximately 650m of stormwater pipe. Basin at Lawrence St, minor storages at Dunstone Pl and Measday Cr.
8	9	Large vacant area, minimal vegetation. Potential for future development as per Masterplan Report.	No existing stormwater infrastructure.
9	10	Predominately residential. Potential for future development as per Masterplan Report.	Approximately 80m of pipe discharging into a basin at Moyle St.
10	7.5	Predominately residential. Potential for future development as per Masterplan Report.	Approximately 750m of pipe discharging into a basin at Brittain Rd.

4 FLOODPLAIN ASSESSMENT

The Kadina township is relatively flat and has no formal watercourses running through it to discharge stormwater runoff into. Stormwater runoff generated in the town is typically captured and conveyed by the drainage network into one of numerous retention basins or wetlands scattered throughout the catchment.

As a result of the general stormwater management arrangement, there are two main types of flooding that occur in the town:

- Flooding resulting from a capacity exceedance of the major drainage system used to route stormwater into a retention basin (e.g. road reserve overtops and spills into private properties).
- Flooding resulting from a retention basin or wetland system overflowing.

The likelihood of a basin flooding event occurring during a major storm event is much higher than for a smaller storm event. However, there may not necessarily be any basin overflow in a major storm event if the basin water levels are low at the beginning of the event, while a much smaller event could cause a larger overflow if the basin levels were near capacity at the beginning of the event.

In order to examine both potential flooding types and quantify the floodplain extents in the Kadina catchment, several different hydrological and hydraulic assessments were undertaken. These included:

- 2D ‘event-based’ floodplain modelling of the catchment using the computer software TUFLOW and implementing the direct rainfall hydrological method. This allowed for assessment of flooding conditions for various single design storm events.
- Continuous simulation water balance assessments for the main retention basins, using a simplified hydrologic model. The water balance assessment covered a period of 130 years. Output from the assessment was incorporated into the flood plain maps produced from TUFLOW using GIS analysis tools.

It is noted that all modelling has been carried out with no measured flow data to calibrate against. Ideally, the modelling results would be compared to known flood levels, flows or flood extents from historical flood events. No such data exists for the Kadina Township and thus the modelling has been undertaken with careful consideration to sensitivity testing and methodology as outlined below. The results are intended for high level floodplain assessment to develop appropriate mitigation measures and not for detailed design.

4.1 TUFLOW MODELLING

4.1.1 Hydraulic Modelling

The tender brief outlined the use of an ILSAX model to create hydrographs for input into the TUFLOW model to generate the floodplain maps. As the initial phases of investigation progressed, the minimal stormwater infrastructure and the flat topography led to the development of a direct rainfall on grid model as an alternative deemed to better reflect this particular scenario.

Through cooperation with Department of Planning, Transport and Infrastructure (DPTI), the direct rainfall approach was accepted as an alternative to the use of an ILSAX model. WGA undertook modelling to compare the TUFLOW direct rainfall model and the ILSAX model. Refer to the design basis report attached in Appendix C for more details.

4.1.2 Hydrology

As outlined above, the direct rainfall method was used to generate runoff in TUFLOW, which means a rainfall event is applied over the entire model surface.

Rainfall events were based on BOM data for Kadina for the AR&R87 Intensity Frequency Duration (IFD) data. This was used to generate storm patterns in DRAINS, which were translated to hyetographs for input into TUFLOW. A range of storms from 30 mins to 12 hours were run to capture the maximum floodplain extent. The IFD curve generated for this is shown in Figure 5.

Rainfall losses were applied over the surface in two ways. The first is an Initial Loss and Continuing Loss combination (IL/CL), which was removed from the rainfall depth before it is applied to the surface. This can be considered as rainfall that is intercepted before it reaches the ground and is not converted to runoff. The second is an IL/CL which is applied as infiltration to ponded water on the ground. Impervious areas were assigned a rainfall IL/CL of 1 mm and 0 mm/hr. Pervious areas were assigned a soil infiltration IL/CL of 45 mm and 2 mm/hr (Kemp and Lipp, 1999)

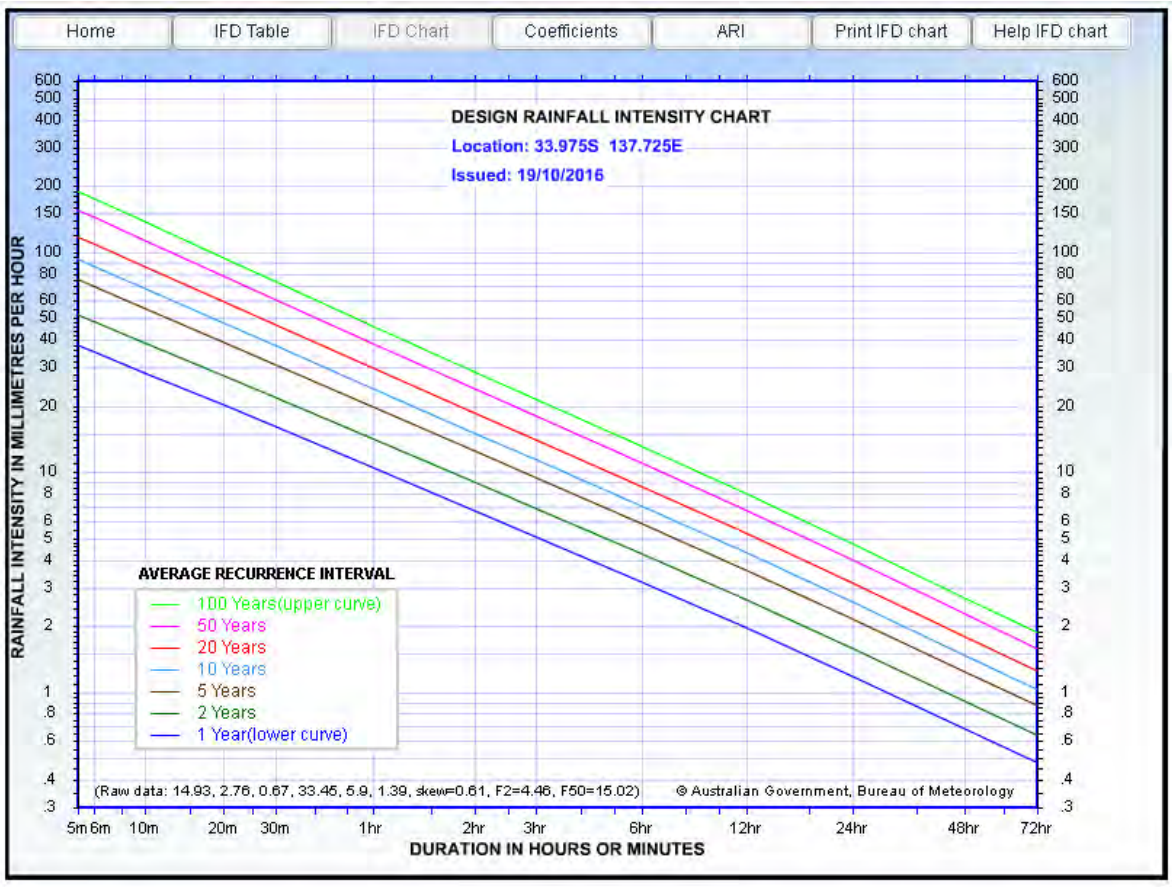


Figure 5: Kadina BOM IFD

4.1.3 Surface

The Digital Terrain Model (DTM) was supplied by AEROmetrex, digital aerial mapping specialists. This was converted into a 3D surface for input to TUFLOW. This DTM was used as a base surface for a series of break lines, also supplied by AEROmetrex, which were overlaid on the surface. These break lines provide specific elevations for elements such as kerbs, basins etc.

AEROmetrex advised the vertical accuracy of the DTM is 0.13m in 1 sigma or +/-0.13m in 1 standard deviation from the mean.

TUFLOW requires the model area to be categorised into different land use regions for the application of various parameters. The region was divided into five categories; default undeveloped land, industrial land, residential housing, rural housing and roads. This was based on aerial photography for the region and cross checked against the Land Use map supplied by Masterplan as part of their Potential Development Report.

The Manning's n values for some regions were varied with depth. This is to account for the initially low Manning's at the start of a storm event, which increases as the area becomes flooded. Table 7 summarises the Manning's n coefficients applied for each of the land use categories.

A higher roughness has been adopted for the housing surface categories to account for flow behaviour around buildings, fences etc. This is in line with recommended modelling procedures (Engineers Australia, 2012).

Table 7: Manning's n Coefficient Summary

Surface Category		Manning's n	
		Depth (m)	n
	Default Undeveloped Land		0.05
	Roads		0.015
Directly Connected	High Density	0 – 0.01 0.01 – 0.02 > 0.02	0.01 ⇕ 0.25
	Low Density	0 – 0.01 0.01 – 0.02 > 0.02	0.1 ⇕ 0.15
	Industrial	0 – 0.01 0.01 – 0.02 > 0.02	0.01 ⇕ 0.25

"⇕" indicates the Manning's n value is interpolated in this range.

4.1.4 Fraction Impervious

The fraction impervious for each surface type was estimated based on aerial photography and the Masterplan report on development guidelines. The rural housing blocks are approximately 50% developed, and the residential blocks close to the town centre have a higher development, approximately 75%. This was estimated from a sample of the residential development reviewed with aerial photography.

The initial version of the TUFLOW model assumed the impervious area of the urban blocks was evenly distributed over the allotment. The site visit found many were directly connected with runoff discharging directly to the kerb and gutter. Thus, the model was updated to reflect directly connected runoff from the urban residential blocks and industrial areas. This was modelled by including an entirely impervious buffer region around the roads.

This buffer was sized to give an average fraction impervious over the whole block in line with the results from the assessment outlined above. The directly connected fraction impervious definitions for the existing and future scenarios are attached in Appendix D.

The future development scenario was based on the development potential outlined in the Masterplan Report. Areas that were marked for development were modelled as developed areas, adopting the impervious area parameters defined above. Refer to Appendix B for a copy of the report, which includes a plan of the approved developments within the township.

4.1.5 Grid and Time Step

The model boundary was defined by the DTM extent and centred on the Kadina Township. The boundary was compared to a catchment map of the Kadina Township previously prepared by Tonkin to confirm that no external catchments were contributing to the model. The boundary extent and catchment map is shown in Section 3.

Table 8: Cell Size and Time Step Summary

Grid Category	Cell Size	Time Step
Town	2m	0.5 sec
Rural	8m	2 sec

A 2D time step between one half and one fifth of the grid size has been applied to the model as outlined in Table 8, in line with standard practice. The 1D time step has been set at 0.5 seconds. This is in line with recommended time step values for the 1D network within this 2D model setup (BMT WBM, 2016).

4.1.6 Drainage Network

The existing GIS information supplied by Council was used as a base for the 1D network input into TUFLOW. The pipe and pit delineation was assumed from Council data and the available size and invert level was applied. Where no size or invert data was available, a suitable assumption on the downstream invert and grade was applied. Generally, the grade applied was relatively flat due to the natural topography.

A site visit was undertaken to assess discrepancies or omissions in the data. Where possible, the 1D network data was refined to more accurately represent the existing infrastructure.

Pit definition has been broken into single side entry pit, double side entry pit, grated pit or open. The definition of the pit type was based on the supplied Council data and updated based on visual inspection where required. Pit inlet capacities were generated in DRAINS based on their size.

A number of stormwater pump station locations were supplied by Council. It was noted that two of the four stations were seldom used and have thus been excluded from the model. The two pump stations included are at Lawrence Street and Brittan Street detention basins, in the absence of specific pump data, the pumps were assumed to operate at a maximum flow of 20 L/s. This was based on a conservative practical flow rate achievable in the existing rising main diameter.

A plan of the drainage network is included in Appendix E.

4.1.7 Comparison with ILSAX Flows

Flows generated by TUFLOW were compared with ILSAX flows to confirm that the hydrology was consistent. As the two models are quite different in their estimation of runoff, it would not be expected that there was complete agreement.

Refer to the design basis report for more details included in Appendix C.

4.1.8 Sensitivity Testing

Through the model development phase, various sensitivity testing was undertaken to assess the impact on results and refine the adopted values. The following parameters were included in this modelling; hydraulic modelling approach, fraction impervious value and application method, infiltration rate and application method, grid size, nested grid combinations, 2D and 1D time step and results viewing methods.

As discussed above, this model cannot be calibrated to any real flood levels or flow data. Thus parameters such as the loss values and roughness coefficients have been reduced to the lower end of the recommended range to produce conservative flood conditions for review.

4.1.9 Results

The TUFLOW model was run for a variety of scenarios outlined in Table 9. For each scenario, a floodplain map and a hazard map were produced. Each of these maps was created to present the worst case envelope from the variety of storm durations modelled. Thus the maps presented show a combination of various storm events and do not represent a single storm event.

During the sensitivity testing, the range of durations that produced the maximum flood depth was determined. Further, the water balance models were used as a supplementary tool to analyse the response of the catchment in longer duration events. As the catchments in Kadina drain to basins, the critical flood response is not likely to be captured in a single storm event. The TUFLOW maps are intended to estimate flooding from individual storm events while the basin water balances are intended to estimate the long term behaviour over a larger time scale using historical rainfall data.

The maps are included in Appendix F.

The maps were compared to known flooding locations provided by Council. The maps showed good correlation to known flooding issues within the township. A summary of flooding as reported by Council is included in Appendix G.

Table 9: Summary of TUFLOW Scenarios

Development	ARI	Durations Modelled
Current	10, 20, 50 & 100	30min, 1 hour, 2 hour
Future	10, 20, 50 & 100	30min, 1 hour, 2 hour

The hazard map presents hazard categories based on the Australian Guidelines (CSIRO, 2000). It is summarised below in Table 10 and Figure 6

Table 10: Hazard Categorisation

Category	Hazard	D	V	Combination
Dry	0	0	0	N/A
Low	1	$\leq$ 0.3	$\leq$ 0.38	N/A
Medium	2	$\leq$ 0.6	$\leq$ 0.8	(D + (0.64 x V)) $\leq$ 0.82
High	3	$\leq$ 1.2	$\leq$ 1.5	(D + (0.69 x V)) $\leq$ 1.38
Extreme	4	All other cases		

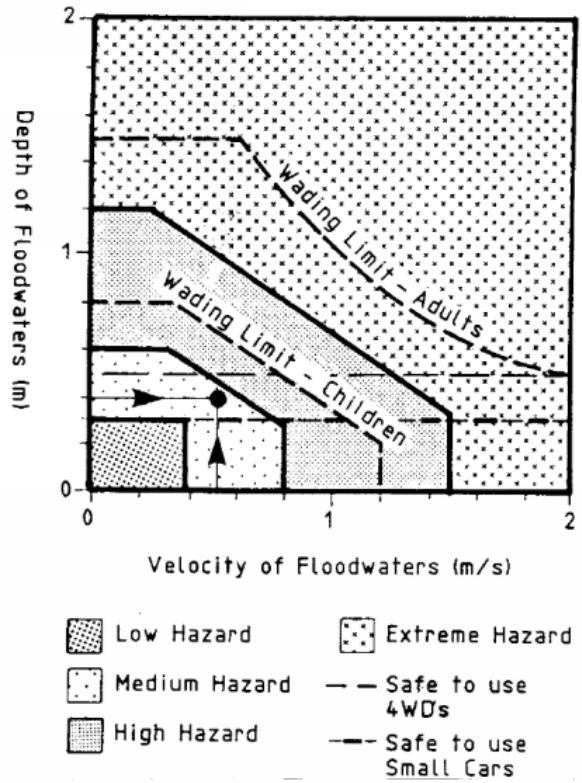


Figure 6: Hazard Category

4.2 WATER BALANCE MODELLING

As outlined above, water balance assessments were undertaken for eight basins in the catchment. These basins were identified in the TUFLOW modelling as key flooding locations. The water balance assessment enabled the levels in the basins over time to be estimated.

The water balance was set up on a daily time step using historical rainfall data records from BOM as outlined in Section 2.6, covering a period from 1876 – 2005. The daily water balance model was used to convert the daily rainfall to runoff using the basin's catchment area and runoff coefficient. Two different runoff coefficients were incorporated into the model, a small event coefficient (total daily rainfall ≤ 45mm), and a large event coefficient (total daily rainfall > 45mm). The small event runoff was taken as the equivalent catchment runoff coefficient from a 1 hour, 5 year ARI storm event in DRAINS (using the ILSAX method). The large event runoff coefficient was taken as the equivalent catchment runoff coefficient from a 1 hour, 100 year ARI storm event in DRAINS.

Table 11 provides a summary of the calculated coefficients. Note the calculated coefficients have dependence on catchment shape (area, travel times) as well as surface composition.

Table 11: Retention Basin Catchment Parameters

Basin	Surface Composition			Runoff Coefficient	
	% Paved	% Supp	% Grassed	$C_{<45mm}$	$C_{>45mm}$
Lawrence St	30	10	60	0.35	0.40
Brittain Rd	20	10	70	0.20	0.36
East Tce	25	10	65	0.20	0.35
Moyle St	25	10	65	0.20	0.35
Goldsworthy St	25	10	65	0.30	0.40
South Tce	25	10	65	0.20	0.38
Franklin Rd	30	10	60	0.20	0.38

If a basin was equipped with a pump, an allowance for a pump outflow was modelled; otherwise, basin losses were modelled as infiltration and evapotranspiration.

4.2.1 Spill Assessment

One parameter used to assess the basin's capacity was a spill event. A water surface level representing a water depth which would still be contained in the basin was defined as the spill threshold. If the water level in the basin exceeded this level, a spill event was recorded on that day and the basin volume was reset at the spill threshold. Thus the spill count represents the days when the basin is over capacity. A risk assessment for a spill event in each basin was conducted based on the consequence of a basin spill event and the likelihood, outlined below.

The consequence of a spill event is different for each basin; for example, basin overflows could enter adjacent allotments or overflow along the road to an adjacent basin or open area. A consequence table legend is shown in Table 12. The likely overflow from each basin is summarised in Table 13

Table 12: Spill Risk Assessment; Consequence Definition

Consequence	Definition
Insignificant	Negligible impact on egress routes or developed allotments.
Minor	Will have minor impacts egress routes or developed allotments.
Moderate	Potential to cause significant damage to egress routes or developed allotments.
Major	Will have a major impact on egress routes or developed allotments.
Catastrophic	Catastrophic threat to egress routes and developed allotments.

Table 13: Basin Overflow

Basin Location	Overflow	Consequence
Lawrence St	Basin is in a local low point. Lawrence St will provide some ponding storage, as will adjacent open areas. Adjacent residential allotments are within overflow area.	Moderate
Brittain Rd	Fall of land from the basin is towards the north and to an expanse of undeveloped land. Overflows likely to disperse to undeveloped area.	Minor
East Tce	Basin is in a local low point. Overflows will pond in the local depression with adjacent residential allotments, before making their way out via the road to the open area to the east.	Major
Moyle St	Overflows will travel north along Moyle St towards the low lying expanse of undeveloped land. Some low lying allotments along Moyle prone to receiving overflows.	Moderate
Goldsworthy St	Overflows will travel west towards the undeveloped land adjacent the South Tce basins.	Minor
South Tce	Located in a large open area with low lying surrounds.	Minor
Franklin Rd	Fall of land around basin towards residential allotments to the north.	Major

The likelihood of a spill was categorised based on Table 14

The likelihood of a spill event was determined by the frequency of spills returned in the water balance, summarised in Table 15

The water balance is for a time period from 1 Jan 1884 to 29 June 2016, just over 130 years. There are 23 days with a daily rainfall in excess of 45 mm and 5 days with a daily rainfall in excess of 60 mm. These are responsible for some of the larger spill events.

Table 14: Spill Risk Assessment; Likelihood Definition

Likelihood	Definition
Improbable	≤ 1 spill recorded per year on average.
Remote	≤ 5 spill recorded per year on average.
Occasional	≤ 10 spill recorded per year on average.
Probable	≤ 50 spill recorded per year on average.
Frequent	≥ 100 spill recorded per year on average.

Table 15: Water Balance Modelling Summary

Basin Location	Pump	Total Days of Spill	Average Days of Spill / Year	Maximum Spill Length	Likelihood
Lawrence St	Yes	3	0	1 day	Improbable
Brittain Rd	Yes	27	0.2	1 day	Improbable
East Tce	No	62	0.5	3 days	Improbable
Moyle St	No	750	5.7	5 days	Occasional
Goldsworthy St	No	2,248	17	7 days	Probable
South Tce	No	1	0.1	1 day	Improbable
Franklin Rd	No	0	0	0	Improbable

To complete the risk assessment, the combination of the consequence and likelihood of a basin spill event is considered as per Table 16. The results of this are summarised in Table 17

Table 16: Spill Risk Assessment; Risk Definition

Consequence ⟶ Likelihood ↓	Insignificant	Minor	Moderate	Major	Catastrophic
Improbable	Low	Low	Low	Medium	Medium
Remote	Low	Low	Medium	Serious	Serious
Occasional	Low	Medium	Serious	Serious	High
Probable	Medium	Serious	Serious	High	High
Frequent	Medium	Serious	High	High	High

Table 17: Spill Risk Assessment; Results

Basin Location	Consequence	Likelihood	Risk
Lawrence St	Moderate	Improbable	Low
Brittain Rd	Minor	Improbable	Low
East Tce	Major	Improbable	Medium
Moyle St	Moderate	Occasional	Serious
Goldsworthy St	Minor	Probable	Serious
South Tce	Minor	Improbable	Low
Franklin Rd	Moderate	Improbable	Low

The water balance modelling results indicate that the Lawrence St and Brittain Rd basins do not experience regular overflow events. This is in line with anecdotal reports from Council on the frequency of overflow events, which are summarised in Table 18.

Table 18: Anecdotal Basin Behaviour from Council

Location	Overflow Frequency	Frequency of Pump Operation
Lawrence St	Once in 15 years. Never since basin upgrades in 2004.	5 times / year
Brittain Rd	Never in memory.	5 times / year

It is recommended that more detailed analysis is undertaken for any basin for future detailed design of upgrade works, in particular, if there has been significant development within the basin's catchment area since the issue of this report.

4.3 KEY POTENTIAL FLOODING LOCATIONS

Table 19 summarises the key flooding locations identified from the TUFLOW and water balance modelling.

Table 19: Key Potential Flooding Locations Summary

Element	Location	Notes
Basins*	East Tce	Shallow depression receiving inflow from the east and west with no defined outlet.
	Gurner Crs	Open area enclosed by rear facing allotments with a poorly defined channel outlet.
	Moyle St	Small depression with no defined outlet overflowing down the street and into houses.
	Goldsworthy St	Poorly defined depression with no defined outlet.
Swales	West Tce & Paulson Rd	Undersized swales overflowing into adjacent allotments.
	Haynes St / Champion St	No formal overland flow path.
	Musgrave Tce / Franklin Rd	Undersized swale with insufficiently defined overland flow path.
	Russell St	Undersized swale.
	David St	Lack of kerbing causing minor flooding of properties in 5 year-ARI.
Underground Network	East Tce	Insufficient extent of underground drainage network.
	Digby St / Christie St	Lack of underground drainage network in low lying area with no clear overland flow path.
	Goyder St / Lindsay Tce	Insufficient pit inlet capacity causing water to pond.
	Wearn St	Lack of underground drainage network. Triggered medium hazard over a number of allotments.
	Gawler St	Lack of underground drainage network resulting in minor flooding of allotments during a 5 year-ARI.
	Day St	Lack of underground drainage network resulting in minor flooding of allotments during a 5 year-ARI.

*It is noted that although modelling does not show the Lawrence Street basin as currently having a high potential for flood impact, the basin is nearing capacity and development within that catchment in the future is likely to impact its performance. It is recommended that investigations are undertaken to determine mitigation measures should development occur and what trigger levels should be set for the proposed upgrades.

The South Terrace basin and swale are also at their current development limits and prior to development within this catchment mitigation strategies would need to be developed either by Council or any developer proposing significant development within the catchment.

4.4 WATER QUALITY

The Kadina Township catchment has no formal outlet or discharge point. There is no single receiving water body to evaluate water quality impact as a result of stormwater discharge. Runoff is collected in a series of basins and wetlands where it predominately infiltrates or evaporates.

The impact of infiltrating runoff is unlikely to cause water quality issues in the groundwater due to the treatment imparted by in the settlement infiltration process. Further, the most sizable discharge points in the catchment are wetlands where the stormwater will receive additional treatment.

As the township develops, the volume of runoff produced in the catchment will increase, however, the volume of stormwater captured in retention storages and reused will potentially also increase. Therefore, the total volume of stormwater being infiltrated into the underlying soil is not expected to increase significantly over time. Currently, the average annual infiltration volume from the basins is estimated to be of the order 130 ML/yr. Additional volume would percolate into the subsoil from pervious surfaces within the township's catchments.

As discussed in Section 2.8, the seasonally varying water table beneath Kadina is relatively shallow at times. Despite this, there have been no reported incidents of the water table level approaching the natural surface level in the vicinity of any of the retention basins/wetlands. The quality of wetland treated stormwater percolating into the underlying shallow aquifer is expected to be relatively high, and the overall risks associated with water quality in the catchment are also considered to be low. The shallow water table is relatively saline so the risk of extraction for reuse or drinking is minimal hence the exposure in relation to human health is also low.

As part of the development of this SMP, discussions held with EPA and DEWNR confirmed there were no specific water quality requirements applicable to Kadina due to the absence of a receiving water body. It is noted that the original scope for the project involved developing a water quality model for the township using the computer software package MUSIC. MUSIC is a conceptual analysis tool that analyses the performance of stormwater treatment trains in removing different stormwater contaminants such as gross pollutants, suspended solids and nutrients.

Generally, the key outputs from a MUSIC model are taken from a receiving node at the downstream end of a system, such as at a discharge point into a watercourse or other drainage element. In the case of Kadina, there is no receiving watercourse or larger water body, so there is no logical location where water quality statistics could be assessed. With this being the case, and taking into consideration the risk considerations discussed previously, it was agreed that producing a MUSIC model for the township was not necessary and this was removed from the project scope, as agreed with the Steering Committee.

On-site water quality requirements have still been incorporated into development controls to ensure that there are no adverse impacts to existing wetland systems resulting from new development.

5 STORMWATER MANAGEMENT OBJECTIVES

5.1 DEVELOPMENT

To develop the stormwater management objectives, the guidelines outlined below were considered along with specific catchment characteristics, requirements and limitations. Council's priorities were used to guide the objectives and achieve a realistic, manageable and beneficial set of objectives for stormwater management in the Township.

It is recommended that the objectives are incorporated into Council's Development Plan.

5.2 STORMWATER MANAGEMENT GUIDELINES

The SMA Guidelines outline that as a minimum, the objectives are to set goals for;

- An acceptable level of protection of the community and both private and public assets from flooding
- Management of the quality of runoff and effect on the receiving waters, both terrestrial and marine where relevant
- Extent of beneficial use of stormwater runoff
- Desirable end-state values for watercourses and riparian ecosystems
- Desirable planning outcomes associated with new development, open space, recreation and amenity
- Sustainable management of stormwater infrastructure, including maintenance

Further, in developing these objectives reference has been made to the State Government's Water Sensitive Urban Design Policy (2013) and external Stormwater Management Plan's.

5.3 OBJECTIVES

5.3.1 Flood Management

i. Minor drainage systems within the CBD require a 10-year ARI design standard. The CBD is defined as the area bordered by Taylor St, Digby St and Frances Tce.

ii. Underground drainage systems outside the CBD to be avoided unless the street surface flows flood adjacent property in a 5-year ARI event.

iii. Wherever underground drainage exists, and it is technically possible and financially viable, the minor drainage system should be capable of restricting gutter flow widths to a maximum of 2.5m during a 5-year ARI event.

iv. Where it is technically and financially viable, major flows in a 100-year ARI event should be contained within road reserves and public open spaces.

v. Where it is not technically or financially viable to contain major flows in a 100-year ARI event to road reserves and public open spaces, the flood hazard category for any flood waters entering private properties is limited to Low. Mitigation measures shall be developed for locations where this objective is violated to reduce flood risk as much as practical, taking financial and physical constraints into consideration.

5.3.2 DPTI Road Design Standards

There are specific requirements in terms of stormwater management design standard that apply to DPTI roads. The applicable requirements are summarised as follows. (noting that DPTI requirements are subject to change from time to time and the latest DPTI requirements should be referenced prior to completing final design works that may impact DPTI roads/infrastructure.

i. For sealed unkerbed roads, transverse road culverts have a design standard of 20 years ARI.

ii. For sealed kerbed roads, longitudinal and minor network has a design standard of 5 years ARI and transverse road culverts have a design standard of 50 years ARI.

5.3.3 Water Reuse

i. Where viable, stormwater runoff will be harvested for reuse purposes within the local area.

ii. Stormwater will be treated to a suitable quality in line with requirements for its intended use where a customer or reuse application is identified.

iii. Where stormwater reuse is proposed, consideration shall be given to human and environmental health risks and appropriate on-site control administered to appropriately manage these risks.

iv. Council operates a CWMS within the township of Kadina. Where stormwater reuse is considered the impacts of the reuse application on the wastewater water balance shall be assessed, with wastewater reuse taking priority over stormwater reuse.

5.3.4 New Development

i. A stormwater management plan must be developed for new developments and submitted to Council for approval.

ii. New developments should maximise opportunities for onsite stormwater reuse and provide suitable onsite stormwater storage.

iii. New developments must be built with a finished floor level at the higher of;

- 150mm above the 100-year ARI flood level
- 200mm above the street top of kerb level, or edge of road where no kerb exists.

iv. New developments of 10 allotments or more require minor infrastructure to a 5-year ARI design standard if a suitable outfall is available.

v. All new developments discharging to an existing underground network must restrict the post development peak flow from the site to pre-development peak flow in the critical 5-year and 100-year ARI event with onsite detention.

vi. All new developments will consider their impact on the downstream network, including swales and basins, and will provide adequate mitigation where the downstream network is subsequently over capacity considering both peak flow and runoff volume.

vii. All new developments must not increase the flood risk for the critical 100-year ARI event, and a major flow path for the critical 100-year ARI event to safely discharge must be provided.

viii. New developments with 5 or more car park spaces must treat runoff from driveway and carpark areas to the following targets;

Table 20: Water Quality Treatment Targets

Parameter	Treatment Target
Litter/Gross Pollutant	Retention of litter greater than 50mm for flows up to the 3-month ARI peak flow.
Oil and grease	No visible oils for flows up to the 3-month ARI peak flow.
Reduction in Average Annual Total Suspended Solids (TSS)	80%
Reduction in Average Annual Total Phosphorous (TP)	60%
Reduction in Average Annual Total Nitrogen (TN)	45%

5.3.5 Asset Management

i. Council will maintain up to date information on the location, size, age and condition of existing stormwater infrastructure.

ii. Stormwater infrastructure is to be managed sustainably and in accordance with cost-effective maintenance management plans.

It is noted that Council are currently finalising an updated Asset Management Plan. Once completed, this can be referred to for up to date asset information.

6 IDENTIFICATION OF STRATEGIES AND OUTCOMES

The following summarises the translation of the objectives into strategies and outcomes for implementation of the stormwater management methodology presented.

6.1 FLOOD MANAGEMENT

6.1.1 Minor Drainage System

To deliver the minor underground drainage system objectives defined above, the following strategies have been established.

i. The CBD development has recently been designed to a 10-year ARI design capacity.

ii. Any new development or stormwater upgrade work within the CBD will adhere to a minimum 10-year ARI design standard.

iii. Any new development or stormwater upgrade work where underground drainage network exists or is proposed will consider a design principle to restrict gutter flow width as defined in Section 5.3.1.

iv. Any new development outside of the CBD will adhere to a min 5-year ARI design standard.

6.1.2 Major Drainage System

To deliver the major drainage system objectives defined above, the following strategies have been established.

i. In designing or upgrading major drainage system components such as swales, overland flow paths and detention systems the 100-year ARI design standard will be adopted.

ii. Existing major drainage system components that are currently undersized for a 100-year ARI event have been addressed in the proposed mitigation measures.

iii. Mitigation measures have been proposed to reduce flood risk as much as practical in private properties with hazard categories above Low.

iv. Council will provide relevant and applicable emergency flood response education to the community as required.

6.1.3 DPTI Road Design Standards

To adhere to the relevant DPTI design standards for stormwater related requirements, DPTI roads within the township were assessed against the design criteria.

Refer Appendix H for the stormwater network and swales on DPTI roads and their adherence to the requirements. DPTI requirements are met for all elements except for the East Tce stormwater network and the transverse road culvert in the south.

The East Tce network is identified for upgrade as part of the mitigation works outlined in Section 7. The culvert to the south is marked for further assessment in the following catchment assessment.

6.1.4 Catchment Assessment

To deliver the flood management objectives defined above, the following catchment based observations have been made. Following this SMP, a number of more detailed assessments should be carried out on the Kadina Township. These are to evaluate the capacity and proposed sizing of certain stormwater components to a higher level of detail than what is covered in this SMP (i.e. detailed design is required) and are outlined below in Table 21.

All mitigation works including the basins identified for mitigation are subject to detailed design to confirm their appropriate upgrade size, inlet and outlet mechanism. This should be undertaken in conjunction with a detailed confirmation of catchment size and properties.

Table 21: Flood Management Strategies for Individual Catchments

Catchment	Flood Management Strategy
1	East Tce basin is currently under capacity and has been identified for mitigation. Prior to the implementation of this mitigation, any development draining to this basin should be locally managed to avoid exacerbating flooding in terms of peak flow and volume. Following mitigation works, development should be locally managed in line with the capacity of this basin in terms of peak flow and volume. The underground network around East Tce is currently under capacity and has been identified for mitigation. Until an upgrade is undertaken, development draining into this network will likely exacerbate flooding. Following mitigation works, development should be locally managed in line with the capacity of the network in terms of peak flow. The main swale in this catchment draining north is near capacity. Development draining into this swale should be locally managed to ensure flood risk is not increased downstream.
2	The Franklin Rd wetland has no outlet; development draining into the wetland should be assessed to ensure flood risk is not increased. The Paulson Rd and West Tce swales are identified for mitigation. As part of this, the downstream system should be assessed to ensure these swales are able to discharge to the South Tce basin system. Mitigation is required before development should be allowed to occur in this catchment. The South Tce basin and channel system has no outlet. Development proposed to drain into this system should be assessed to ensure flood risk is not increased. The Goldsworthy St basin is identified for mitigation. It is noted the adjacent vacant land on Russell St south of the existing basin could be used for further stormwater detention in the future if required. Development discharging to these basins should be managed such that runoff is locally controlled in terms of peak flow and volume, or the basin system is expanded to control peak flows and volume. The culvert under Mines Rd near Kennet Rd is required to have capacity for a 20 year ARI as per DPTI standards. This area shows flooding in a 20 year ARI. This may be due to the culvert capacity or it could be the associated network. The capacity of the culvert should be confirmed.

3	Digby St and Christie St are identified for upgrade with a new underground network. These works could be staged where the pits at Lindsay Tce and George St are installed before the rest of the network.
4	N/A
5	Development should be assessed to ensure increased runoff does not impact neighbouring catchments in terms of peak flow and volume.
6	Development should be assessed to ensure increased runoff does not impact neighbouring catchments in terms of peak flow and volume.
7	It is noted the Lawrence St basin is near capacity. Development discharging to this basin should be locally managed in line with the capacity of this basin in terms of peak flow and volume.
8	Development in this catchment should consider downstream discharge points in terms of peak flow and volume.
9	The Moyle St basin is identified for mitigation. Additional development discharging to this basin should be locally managed in line with the capacity of this basin in terms of peak flow and volume.
10	This catchment contains the Brittain St basin. Development discharging to this basin should be locally managed in line with the capacity of this basin in terms of peak flow and volume.

6.2 WATER REUSE

To deliver the water reuse objectives defined above, the following strategies have been developed.

i. Wastewater reuse will be prioritised over stormwater reuse to ensure adequate disposal of wastewater.

ii. Stormwater reuse schemes will be coordinated with Council to balance reuse demand with wastewater and stormwater supply over time.

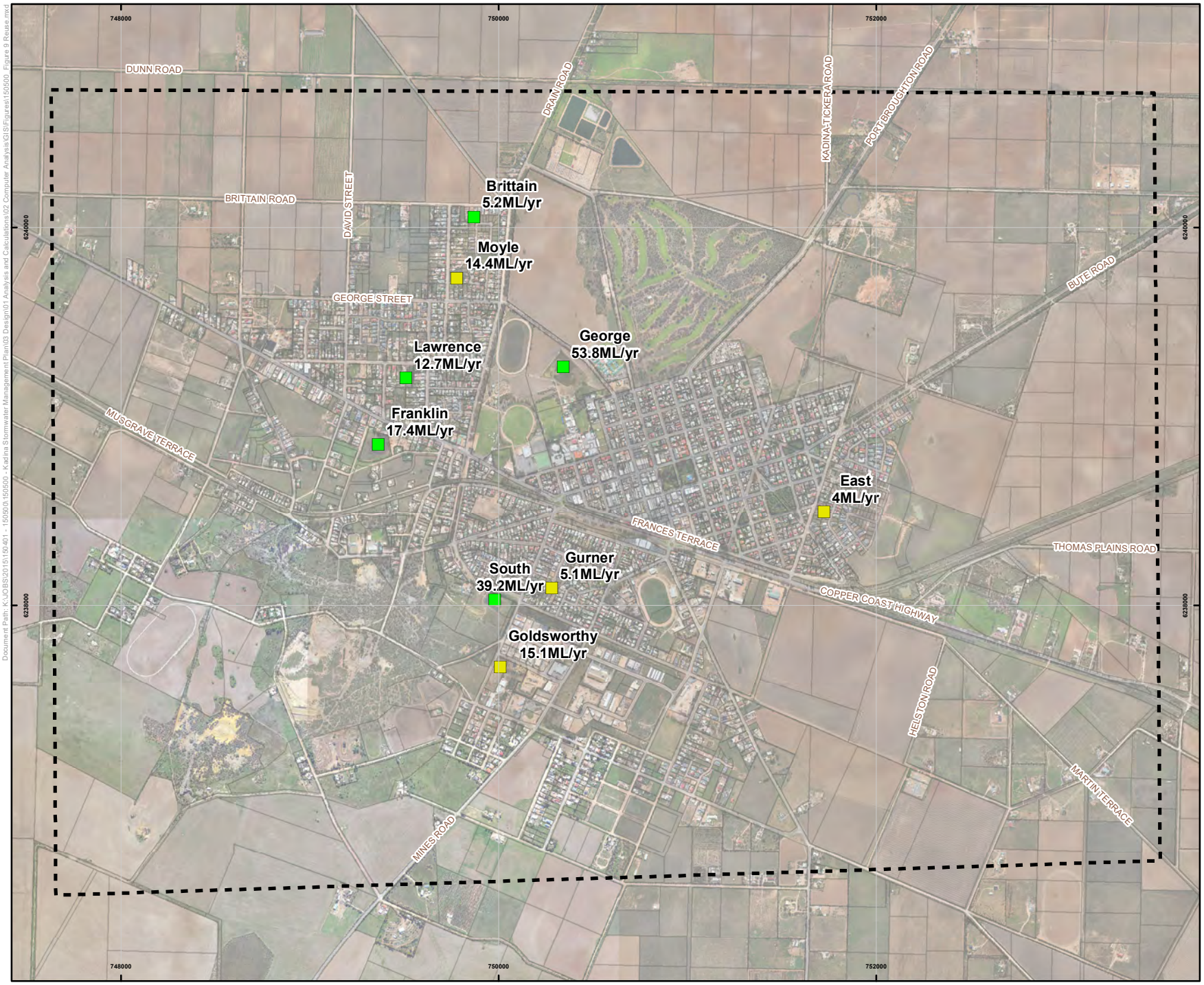
iii. Wastewater is currently treated to a Class B standard; therefore, stormwater being incorporated into the reuse scheme will need to have an equivalent treatment standard.

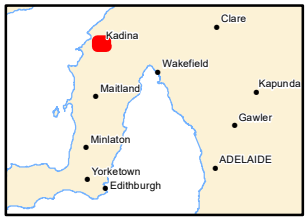
iv. The existing treatment standard of Class B is associated with restricted access irrigation. Should unrestricted access be required with a stormwater reuse opportunity, a higher treatment standard will be necessary.

There are a number of existing users of recycled wastewater around Kadina; the cemetery, golf course, football oval, hockey grounds, and an emergency irrigation area. Should new demands for water reuse be identified in the future, this could be supplied by stormwater, recycled wastewater or a combination of the two. Existing stormwater basins that could be adapted to supply future demand are highlighted in Figure 7 along with the potential yield from each basin. 'Proposed' basins (shown in yellow in the figure), indicate basins that have been upgraded in accordance with the mitigation measures shown in Appendix I.

Treatment of stormwater for reuse would need to consider the end use and associated water quality requirements.

The Swale on Drain Road transfers water to the wastewater lagoon site. The standing water from that site used to be pumped into the wastewater lagoons for treatment and reuse. However, this practice was ceased when it was determined that there were capacity issues with the wastewater treatment system. There is the opportunity in the future to consider this site for stormwater harvesting should future recycled water demand require additional sources of recycled water. While this project was not identified under the stormwater management project deliverables it is an option that could be considered in the future.





LEGEND

- Cadastre
- Model Bounds

Potential Reuse Basin

- Exisitng
- Proposed

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
WALLBRIDGE GILBERT AZTEC

Figure 7

Kadina Stormwater Management Plan

Basin Reuse Potential

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

Document Path: K:\JOBS\2015\150401 - 150500\150500 - Kadina Stormwater Management Plan\03 Design\01 Analysis and Calculations\02 Computer Analysis\GIS\Figures\150500_Figure 9 Reuse.mxd

6.3 NEW DEVELOPMENT

To deliver the general new development objectives defined above, the following strategies have been adopted.

New Development – General

i. Council will advise developers, or those preparing a stormwater management plan for a new development, regarding existing stormwater issues in the catchment as applicable to the proposed development.

ii. Council may negotiate with the developer to deliver a mutually beneficial stormwater upgrade with financial and design contributions from both parties.

iii. Council will provide developers and the wider community with information on opportunities for stormwater reuse on a development wide scale.

iv. As per Council's development plan, onsite water storage will be provided as per Table 22 and Table 23.

Table 22: Residential Onsite Stormwater Storage Size Requirements

Reticulated Water Supply at the Development	Size of Allotment	Required Size of Onsite Stormwater Storage
None available		60 kL
Available	< 450m^2	5 kL
	> 450m^2 and < 649m^2	10 kL
	> 650m^2	22 kL

Table 23: Industrial Onsite Stormwater Storage Size Requirements

Reticulated Water Supply at the Development	Size of Allotment	Required Size of Onsite Stormwater Storage
None available		60 kL
Available	< 1,000m^2	10 kL
	> 1,000m^2	22 kL

To deliver the objectives associated with the management of runoff from new developments defined above, the following strategies have been developed.

New Development – Runoff Management

i. Council will work with developers constructing minor infrastructure to ensure the interface between the new and existing stormwater system does not degrade the performance of the existing scheme.

ii. Council will provide capacity information where known to developers to ensure downstream infrastructure is not overloaded as a result of new development.

iii. Council may choose to waive the requirement for onsite detention if a mutually beneficial alternative is available e.g. the developer could contribute to the upgrade of a detention basin immediately downstream of the development rather than providing onsite detention.

6.4 ASSET MANAGEMENT

To deliver the asset management objectives defined above, the following strategies have been developed.

Asset Management

i. Council will continue to gather information on existing stormwater infrastructure where possible. This could be through either dedicated inspections or as part of other projects.

ii. Council will endeavour to update records where new information becomes available and target areas of conflicting records to rectify misinformation.

iii. Where possible, stormwater management and upgrade projects will integrate with other projects such as road upgrades and public open space works.

iv. Stormwater management and upgrade projects will consider the whole project life in terms of financial, social, environmental and community impact.

v. Council will maintain an asset register and undertake periodic condition assessments in order to develop a long term maintenance / replacement strategy.

7 IMPLEMENTATION FRAMEWORK

7.1 MITIGATION MEASURES

As part of the development of this SMP, WGA worked with Council to develop a range of mitigation measures to address stormwater related issues within the township. The mitigation measures were developed with the following aims:

- Achieving compliance with the stormwater objectives outlined in Section 5.3.
- Addressing areas in the town known to have historical stormwater issues, based on Council observations and feedback from residents of the township. Issues addressed include major flooding as well as nuisance flooding (which contribute towards accelerated degradation of Council's road assets and adversely impact the community).

The following sections provide a brief description of each of the mitigation measures developed. An overall summary of the measures in included in Table 24. A sketch plan associated with each measure is included in Appendix I. Mitigation sub-catchment area estimates have been provided and are based on the area of upstream catchment. It is noted that these measures will also provide benefit to downstream infrastructure in some circumstances.

Table 24: Summary of Mitigation Measures

Element		Location	Mitigation Measure	Sub-Catchment Area
Basins	B1	East Tce	Installation of gravity outlet	5.2 ha
	B2	Gurner Crs	Basin capacity upgrade	6.7 ha
	B3	Moyle St	Basin capacity upgrade and installation of pump outlet with rising main connecting to existing	18.8 ha
	B4	Goldsworthy St	Basin capacity upgrade	13.1 ha
	B5	Lawrence St	Investigate pump capacity increase	
	B6	South Tce	Investigation basin capacity to cater for new development	
Swales	S1	West Tce	Swale capacity upgrade and construction of protective bund	3.2 ha
	S2	Paulson Rd	Swale capacity upgrade	3.1 ha
	S3	Haynes St	Swale capacity upgrade	12.0 ha
	S4	Musgrave Tce	Swale capacity upgrade	15.1 ha
	S5	David St	Swale capacity upgrade	7.5 ha
	S6	Gurner Crs	Swale capacity upgrade	2.3 ha

Element		Location	Mitigation Measure	Sub-Catchment Area
	S7	Russell St	Swale capacity upgrade	3.2 ha
Underground Network	N1	East Tce	Installation of underground network and upgrade of existing network	9.2 ha
	N2	Digby St / Christie St	Installation of underground network and upgrade of existing pits	8.3 ha
	N3	Wearn St	Installation of underground network	8.1 ha
	N4	Gawler St	Installation of underground network	10.7 ha
	N5	Day St	Installation of underground network	2.5 ha

Note: All mitigation measures sub-catchment areas are below 40 ha

7.1.1 B1 – East Terrace Basin Upgrade

Measure B1 involves deepening the East Terrace basin to provide more storage capacity. There is no land available to increase the footprint area of this basin, however, the pipe systems are deep enough to allow for additional volume to be added vertically. A high level surcharge pit is also proposed, connecting into a new pipe run, which will allow the basin to discharge to a downstream system rather than overflowing into surrounding residences. The inclusion of this measure will greatly reduce the flood risk of the local properties around the basin.

7.1.2 B2 & S6 – Gurner Crescent Basin & Swale Upgrade

Measures B2 and S6 involved formalising a retention basin in the vacant reserve at the north eastern end of Gurner Crescent, as well as reshaping and formalising the existing flow path along Gurner Crescent into a vegetate swale. This measure will provide a continuous flow path for the local catchment to drain into the South Terrace basin and reduce nuisance ponding and local flooding.

7.1.3 B3 – Moyle Basin

Measure B3 involves increasing the retention storage capacity of the Moyle Basin and installing a pumping system and new section of rising main to allow for a slow drawdown of the basin between storm events. Both of these measures will act to reduce the risk of the basin overflowing. The new rising main will hook into the Brittain Road main, which discharges to the north. Reducing overflow risk at this site will lower flood risk for the low-lying properties along Moyle Road.

7.1.4 B4 & S7 – Goldsworthy Basin & Russell Street Swale

Measures B4 and S7 involve increasing the storage capacity of the Goldsworthy Basin, improving the outlet connectivity to Russell Street and enlarging and formalising the swale drain on Russell Street to improve its conveyance capacity. The measure will reduce the probability of the basin overflowing, which is currently high, and also ensure that when the basin does overflow the spill can be conveyed safely into the undeveloped land without causing damage to any private properties.

7.1.5 N1 – East Terrace Underground Network

Measure N1 involves installing a number of new pipe branches and stormwater inlet pits in the streets to the west of East Terrace. Currently, the inlet pits in this area are sparsely distributed, and the topography is flat. As a result, there is significant nuisance ponding and large spread widths in flows in this area. The installation of the new pipework will provide some flood risk reduction in major events, but it will provide the largest benefit during more frequent storms by eliminating ponding and impacts to road users and pedestrians.

7.1.6 N2 – Digby Street & Christie Street Underground Network

Measure N2 addresses similar issues as Measure N1, except in the catchment area around Digby and Christie Street. This measure would provide some flood risk reduction for major storms and will greatly improve the drainage efficiency in frequent storms and allow for stormwater to be routed out to the north west rather than being retained in the roadway in many locations.

7.1.7 N3 – Wearn Street Underground Network

Measure N3 involves the installation of an extensive underground system running south along Mines Road then west along South Terrace, as well as a branch from Wearn Street. Due to the flat topography, currently, the stormwater generated in this area struggles to flow out to the South Terrace basin. The new underground system will allow for much of the stormwater to be captured in inlet pits and alleviate some flood risk for the properties to the north of South Terrace in particular.

DPTI recently undertook the resurfacing of Mines Road which incorporated kerb and watertable installation. A portion of the Mines Road / South Terrace works were completed as part of this upgrade. With runoff from South Terrace being directed to the existing retention basin on the corner of South Terrace and Mines Road. This was an opportunistic project that was brought forward due to works being undertaken by DPTI on Mines Road.

7.1.8 N4 – Gawler Street Underground Network

Measure N4 involves the installation of a stretch of underground network along Gawler Street to connect the Gawler Street catchment into the existing swale on Frances Terrace. Currently Gawler Street is serviced by a swale system, however, there is no direct connectivity between this swale and the Frances Terrace system, so significant ponding occurs and some local properties are flooded in major events as a result. Like the other pipe network upgrades, the benefits of this measure will be most pronounced in frequent events, where there will be significant improvements in road trafficability conditions.

7.1.9 N5 – Day Street Underground Network

Measure N5 involves a new branch drain running southwards along Day Street, connecting into an existing underground drain to the south. The new branch will convey flow from the trapped sag at the corner of Day Street and No 3 Lane, resulting in a reduction in nuisance ponding at this location and reduction in flood risk for the properties along the western side of Day Street.

7.1.10 S1 & S2 – West Terrace & Paulson Road Swales

Measures S1 and S2 involve upgrades to the north-south swales along West Terrace and Paulson Road, construction of a bund at the northern end of the swales to block out flow from Powell Street, and construction of a new intermediate swale to route flow from Paulson Road to West Terrace at a mid-block location. The measures are aimed at improving drainage efficiency in the area to rectify flooding issues for the properties in between Paulson Road and West Terrace. Due to level constraints, there is no opportunity to install an underground system in this location. An upgrade of the culvert at the downstream end may also need to be coupled with these works.

7.1.11 S3 – Haynes Street Swale

Measure S3 involves building a swale along Haynes Street to provide a continuous flow path up to Champion Street. Currently flow is not able to drain out to the north, resulting in significant ponding in the flat verge with wide spread width.

7.1.12 S4 –Musgrave Terrace Swale

Measure S4 involves building a swale along Haynes Street to provide a continuous flow path up to the Franklin Basin. The swale will improve road trafficability and remove trapped sags and ponding areas.

7.1.13 S5 – David Street Swale

Measure S5 involves construction of a new swale along David Street, largely to provide local flood protection to the row of properties on the eastern side of David Street between George Street and Brittain Road. The new swale will drain to a culvert that routes flow over to the western side of the road, where there is currently no development.

7.1.14 B5 – Lawrence Street Basin

Should any development occur in this catchment then the impacts of upgrading the pump down system shall be investigated.

7.1.15 B6 – South Terrace Basin

Investigation mitigation measures to cater for future development.

7.2 COST ESTIMATES

Indicative cost estimates for the proposed mitigation measures are summarised in Table 25.

Table 25: Cost estimates for Mitigation Measures

	Upgrade	Location	Cost Estimate
B1	Basin upgrade and gravity outlet	East Tce	$ 365,000
B2	Basin upgrade	Gurner Crs	$ 30,000
B3	Basin upgrade and pump outlet	Moyle St	$ 185,000
B4	Basin upgrade and gravity outlet	Goldsworthy St	$ 25,000
B5	Investigate increasing pump capacity	Lawrence Street	$ 20,000
B6	Investigate future development mitigation works	South Terrace	$ 20,000
S1	Swale upgrade and bund	West Tce	$ 65,000
S2	Swale upgrade	Paulson Rd	$ 35,000
S3	Swale upgrade	Haynes St	$ 25,000
S4	Swale upgrade	Musgrave Tce	$ 105,000
S5	Swale upgrade	David St	$ 10,000
S6	Swale upgrade	Gurner Crs	$ 10,000
S7	Swale upgrade	Russell St	$ 80,000
N1	Network upgrade	East Tce	$1,635,000
N2	Network upgrade	Digby St / Christie St	$ 645,000
N3	Network upgrade	Wearn St	$ 820,000
N4	Network upgrade	Gawler St	$ 245,000
N5	Network upgrade	Day St	$ 65,000
TOTAL			**$4,385,000**

The cost estimates are presented in today's dollars and escalation costs should be applied when budgeting for future year's works.

Council should apply a design and project management allowance to the capital estimates based on their internal management policies.

In addition, Council should apply project contingency allowances in line with its policies and risk profile for the works.

Cost estimates should be updated once detailed design is complete to enable budgeting for the construction works.

7.3 RESPONSIBILITIES FOR IMPLEMENTATION

The mitigation measures proposed are within Council's authority to implement. The objectives and strategies proposed involve Council's commitment to the plan as well as developers' obligations when considering new developments within the Township.

8 FLOOD DAMAGES ASSESSMENT

8.1 FLOOD DAMAGE METHODOLOGY

To help rank the various proposed mitigation options outlined in Section 7, a flood damages assessment was undertaken to estimate potential reductions in flood damage costs associated with the works.

Flood damage costs are generally discretised into two separate categories – tangible and intangible. Tangible costs are the more readily quantifiable costs associated with damage to buildings and infrastructure, while intangible costs relate more to social factors, illnesses and other damage that can't directly be assigned a dollar value.

Tangible costs can be further broken down into direct costs and indirect costs. Indirect costs relate to things like lost business earnings and clean-up costs. Direct costs relate to repair/replacement costs to damaged items within buildings, surrounding yards and road reserves.

8.1.1 Direct Damages

Potential direct building damage costs are the maximum possible damage costs inflicted by a certain storm event. Potential direct building damage costs for this assessment were calculated using the simplified 'Model 4' outlined in the *Rapid Appraisal Method (RAM) for Floodplain Management* (NRE, 2000). This method assumes a unit damage cost for each inundated residential or small/medium sized commercial property (it was assumed that none of the commercial buildings in the town were classified as 'large'). Model 4 was considered to be appropriate for this study, as no building survey was undertaken, so building finished floor levels were not explicitly included in digital elevation model. Therefore, it was not possible to directly calculate flooding depth in each allotment in the township.

Table 3-2 in the RAM report recommends that a unit cost of $20,500.00 be adopted per inundated property. This value is based on monetary value in 2000, so for use in this study, the value was adjusted for inflation to **$31,365.00** (using Reserve Bank inflation data). A building was defined to be 'inundated' if it had a maximum ponding depth in excess of 200mm and had in excess of 25% of its lot area inundated.

In practice, actual building damage costs incurred from storms are lower than potential building damage costs, as residents can take some preventative action to minimise damage. Generally, more educated and flood aware communities are more able to reduce damage costs and actual damage costs are also proportionally lower in catchments with longer concentration times (as residents have more time to react). Table 3-5 in the RAM report provides recommended ratios of actual damage to potential damage. A value of 0.9 was adopted for this assessment, which corresponds to an inexperienced community with less than 2hrs of warning time.

Damage to infrastructure in property yards was only assumed to occur at inundated properties. A uniform value of $2,000.00 of outside damage was adopted for affected properties. This is consistent with the assumed outside building damage value adopted in the Moonta SMP.

8.1.2 Indirect Damages

Consistent with the recommendations in the RAM report and the methodology used in the Moonta SMP, indirect damages were estimated to be equal to 30% of direct damages.

8.1.3 Exclusions

The flood damage assessment did not quantify damage costs for the following:

- Damage to roads and other infrastructure or vehicles in the road reserve.
- Agricultural damage (such as loss of crops) to farmlands surrounding the township.
- Intangible damages.

8.2 RESULTS OF DAMAGE ASSESSMENT

8.2.1 Direct Building Damages

Table 26 and Table 27 provide a summary of direct building damage costs for the existing and proposed scenarios.

Table 26: Direct Building Damages – Existing Scenario

ARI	No. Properties Inundated	Damage ($)
100	44	1,380,060
50	32	1,003,680
20	16	501,840
10	8	250,920
5	3	94,095

Table 27: Direct Building Damages – Mitigated Scenario

ARI	No. Properties Inundated	Damage ($)
100	28	878,220
50	20	627,300
20	5	156,825
10	4	125,460
5	3	94,095

8.2.2 Total Damages

Table 28 and Table 29 provide a summary of total damage costs for the existing and proposed scenarios.

Table 28: Total Damages – Existing Scenario

ARI	Building Damages ($)	Outside Damages ($)	Indirect Damages ($)	Total Damages ($)
100	1,380,060	88,000	440,418	1,908,478
50	1,003,680	64,000	320,304	1,387,984
20	501,840	32,000	160,152	693,992
10	250,920	16,000	80,076	346,996
5	94,095	6,000	30,028.5	130,124

Table 29: Total Damages – Mitigated Scenario

ARI	Building Damages ($)	Outside Damages ($)	Indirect Damages ($)	Total Damages ($)
100	878,220	56,000	280,266	1,214,486
50	627,300	40,000	200,190	867,490
20	156,825	10,000	500,47.5	216,873
10	125,460	8,000	40,038	173,498
5	94,095	6,000	30,028.5	130,124

8.2.3 Average Annual Damages

As outlined in the RAM report, the average annual flood damages (AAD) can be roughly estimated by calculating the area under a graph of flood damage vs. annual exceedance probability (AEP). Two such curves were produced for the existing and proposed scenarios, as shown in Figure 8

The curves were extrapolated beyond the 5yr ARI to account for more frequent storm events. In the absence of floodplain modelling results for frequent storm events, it was assumed that the flood damage would vary linearly from the 5yr ARI to zero at an event corresponding to a 2yr ARI (0.39 AEP).

Damage costs for events larger in magnitude than the 100yr ARI (1% AEP) are typically high, however, such events have a low probability of occurring so their influence on the AAD is relatively small. Therefore the contribution of events greater in magnitude than the 100yr ARI to the AAD was omitted in the analysis.

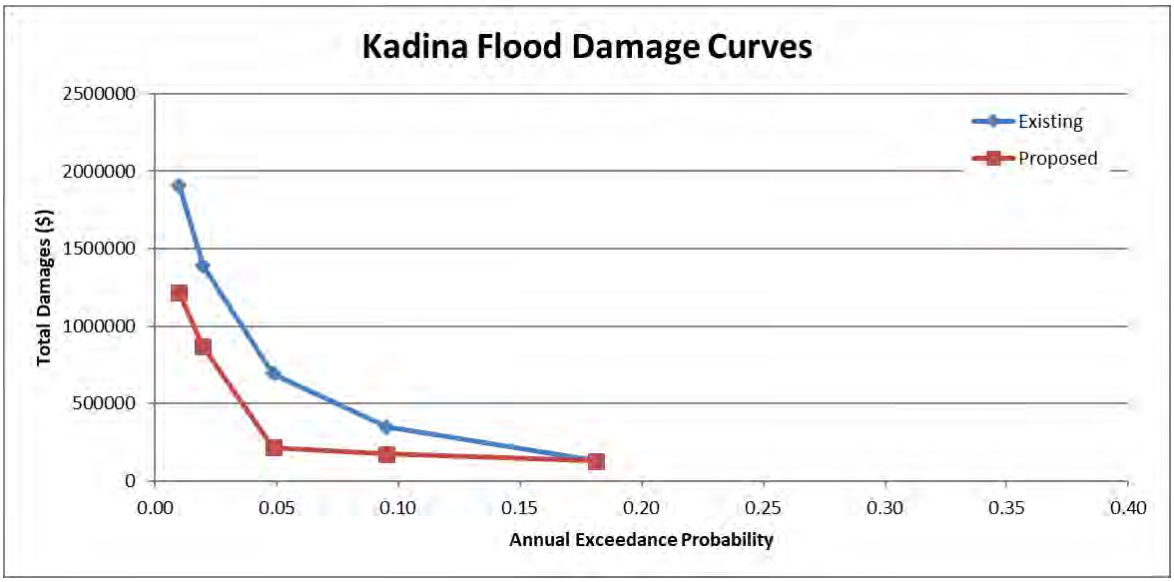


Figure 8: Flood Damage Curves

From these curves, the AADs for the two scenarios were calculated to be:

- Existing – AAD = $43,582
- Proposed – AAD = $27,587

This indicates that the implementation of the full range of mitigation measures would result in a reduction in AAD of **$15,995.**

There is some subjectivity involved with apportioning flood damage savings to individual mitigation measures, as some properties would be impacted by multiple measures and the floodplain behaviour varies in different ARI events. For the purposes of prioritisation, AAD apportioning has been based on inspecting the number of properties in each measure estimated catchment area that would be alleviated from inundation by the mitigation measure during the 100yr ARI storm. The AAD reduction was then distributed to each measure based on the percentage of total properties alleviated from inundation.

Table 30 provides a summary of the cost savings associated with each of the mitigation measures.

Table 30: Total Damages – Proposed/Future Scenario

Upgrade	Total Apportioned Percentage of Flood Damage Reduction	Reduction in Total AAD ($)
S1 & S2	13.98%	2,236
S3	2.15%	344
S4	10.75%	1,719
S5	4.30%	688
B1	18.28%	2,924
B2 & S6	16.13%	2,580
B3	6.45%	1,032
B4 & S7	5.38%	861
N1	19.35%	3,095
N2	1.08%	173
N3	2.15%	344
N4	0.00%	0*
N5	0.00%	0*

**Upgrade not directly related to property damage*

9 PRIORITISATION

The various mitigation measures were ranked using the construction cost estimates and the results from the flood damages assessment. Options were each ranked by dividing the net present value of 50 years' worth of the AAD reduction associated with the measure by the estimated construction cost of the measure. The net present value calculations utilised a discount rate of 4%.

The ranking system gives a measure of 'value for money' for a mitigation work, as increasing construction costs decreases the rank while decreasing flood damage costs reduction increases rank. A measure achieving a ranking greater than 1.0 should, in theory, be cost recoverable in a 50-year timeframe, however, this is convoluted by the fact that flood damage costs would not directly be attributed to Council while the upgrade construction costs would. The ranking system also does not account for other factors such as improvements to serviceability of roadways achieved by conveyance system upgrades (such as N4 and N5). Table 31 provides a summary of the ranking order for the different measures.

As noted in Section 6, the Digby St and Christie St (N2) upgrade could be staged such that the pits at Lindsay Tce and George St are installed before the rest of the network.

The S1 and S2 upgrades have been prioritised by Council due to issues identified by past incidents.

B5 and B6 have not been included in the prioritisation table as it is a study and the cost of the works are currently unknown. However, undertaking investigations into future mitigation at this site is considered a priority.

Table 31: Flood Impact Prioritisation

Upgrade		Rank	Prioritisation
S1 & S2	West Tce & Paulson Rd	2.06	1
S3	Haynes St	2.52	2
B2 & S6	Gurner Cres	1.04	3
S5	David St	0.91	4
B4 & S7	Goldsworthy St & Russell St	0.55	5
S4	Musgrave Tce	0.14	6
B3	Moyle St	0.10	7
B1	East Tce	0.06	8
N1	East Tce	0.04	9
N2	Digby St & Christie St	0.01	10
N3	Wearne St	0.00	11
N4	Gawler St	0.00	12

Upgrade		Rank	Prioritisation
N5	Day St	0.00	13

10 COMMUNICATION AND CONSULTATION

10.1 COMMUNICATION

Council held a community consultation forum where the community was invited to comment on the draft floodplain maps presented and raise any issues, they had regarding stormwater management. No formal submissions were received as part of this consultation.

10.2 CONSULTATION

Throughout the development phase of this document, various stakeholders have been engaged and consulted. This group includes;

- Copper Coast Council
- DPTI
- The Department of Environment, Water and Natural Resources (DEWNR)
- The Environmental Protection Agency (EPA).
- Community groups and interested parties

As outlined in Section 4.1.1, there was significant consultation with DPTI to develop a modelling methodology suitable for the unique catchment characteristics that were also within acceptable modelling guidelines.

Council also sought comment from the community based on this SMP.

The following activities were undertaken by Council:

Conducted a community information session in the Kadina Town Hall on 6 January 2016.

Undertook meetings and consultation with a number of residents on West Terrace to address their specific concerns.

Feedback was also sought through Council's website, Facebook page, through direct print displayed at Council's offices.

Consultation documentation and publications related to flooding or the SMP consultation are enclosed within Appendix J.

11 SUMMARY

Table 32 provides a summary of the recommended structural and non-structural mitigation actions for the Kadina township.

The intention is for the works to be implemented in order of priority, with the high priority works being completed first. The priority ranking does not account for external funding which may be available in the future for either State or Federal Government.

Eligibility for external funding may change the order of priority. If that work package satisfies the requirement of a particular funding grant the upgrade may be done earlier.

Funding opportunities may also be available if mitigation works are incorporated into other larger projects such as water reuse, road upgrades (as was the case with Mines Road resurfacing works completed in partnership between DPTI and Council).

Council could consider engaging the services of a grants funding specialist or just actively monitor Government Funding programs through websites such as the Australian Government's "GrantConnect" Website.

Current and past funding programmes such as those listed below may be sources of additional funding to assist Council to complete the projects outlined in this SMP.:

- Building Better Regions Fund – Infrastructure Projects Stream
- Regional Development Australia Fund
- Regional Development Initiatives
- Stronger Communities Programme
- Drought Communities Programme

At the time of preparing this SMP the mitigation works proposed did not meet the criteria for SMA funding of the capital works. This may change in the future and should be reviewed periodically.

If no external funding is available Council should work through the priority of works in line with its long term financial plan and policies.

Where works are triggered by development then the developer will be required to contribute to the augmentation costs of the stormwater network downstream of their site that are impacted by the development.

In addition to the capital works program outlined specifically in the SMP it is recommended that Council also allocate an annual budget for stormwater maintenance and repair works for such items as repair of pits, clearing and reshaping swales or minor works to address localised flooding issues.

Each financial year an allocation of funds will be set aside to contribute towards the identified mitigation measures. There may be opportunities for cost-sharing arrangements for some of the works with developers in some instances.

Table 32: Kadina Catchment Works Summary

Priority	Project/Activity Title	Capital Cost ($)	Recurrent Cost ($/a)	Flood Mitigation Benefit		Water Harvesting Benefit		Water Quality Benefit		Other Benefits	
				Measure Used? (D) – AAD Reduction (P) – Properties Affected (Q) - Qualitative	Quantification or Description of Benefit	Measure Used? (V) – Volumetric (Q) - Qualitative	Quantification or Description of Benefit	Rating (H) – High (M) – Medium (L) – Low	Quantification or Description of Benefit	Rating (H) – High (M) – Medium (L) – Low	Quantification or Description of Benefit
Structural Works											
High	S1 & S2 – West Tce & Paulson Rd swale Upgrades*	26,000	N/A	D	Reduces flood risk for a number of sensitive private properties	-	-	L	Some treatment of water in open vegetated swales	M	Improved road serviceability in minor storm events and less nuisance ponding
High	S3 – Haynes St swale upgrade	25,000	N/A	D	Reduces flood risk for some properties	-	-	L	Some treatment of water in open vegetated swales	M	Improved road serviceability in minor storm events and less nuisance ponding
High	B2 & S6 – Gurner Cres basin and swale upgrade	40,000	N/A	D	Large reduction in flooding severity for numerous properties	Q	Opportunity for future harvesting in basin if demands are created	M	Some treatment of water in open vegetated swales and basin	H	Improved amenity/biodiversity of reserve
High	S5 – David St swale upgrade	10,000	N/A	D	Reduces flood risk for some properties	-	-	L	Some treatment of water in open vegetated swales	M	Improved road serviceability in minor storm events and less nuisance ponding
High	S4 – Musgrave Tce swale upgrade	105,000	N/A	D	Reduces flood risk for a number of private properties	-	-	L	Some treatment of water in open vegetated swales	M	Improved road serviceability in minor storm events and less nuisance ponding
High**	B5 and B6 – Lawrence St and South Terrace	40,000		Q	Investigation to determine impact of basin modifications or pump upgrades to reduce future impact of development within the catchment	Q	Opportunity for future harvesting which would also reduce the mean standing water level in the basins	L	Some treatment of water through settlement within the basin	M	Improved performance of the upstream swales
Medium	B4 & S7 – Goldsworthy St & Russell St basin and swale upgrade	105,000	N/A	D	Reduces flood risk for a number of private properties	Q	Opportunity for future harvesting in basin if demands are created	M	Some treatment of water in open vegetated swales and basin	H	Potential to improve reserve amenity and biodiversity
Medium	B1 – East Tce basin upgrade	365,000	N/A	D	Reduction in flooding severity for numerous properties	Q	Opportunity for future harvesting in basin if demands are created	L	Some treatment of water in basin	H	Potential to improve reserve amenity and biodiversity
Medium	B3 – Moyle St basin upgrade	185,000	N/A	D	High – reduces flood risk for a number of private properties	Q	Opportunity for future harvesting in basin if demands are created	L	Some treatment of water in basin	H	Potential to improve reserve amenity and biodiversity
Medium	N1 – East Tce underground system upgrade	1,635,000	N/A	Q	Large flooding improvements in minor events	-	-	-	-	M	Less nuisance ponding, pavement degradation
Low	N3 – Wearne St underground system upgrade	820,000	N/A	Q	Large flooding improvements in minor events	-	-	-	-	M	Less nuisance ponding, pavement degradation
Low	N2 – Digby St & Christie St underground system upgrade	646,000	N/A	Q	Large flooding improvements in minor events	-	-	-	-	M	Less nuisance ponding, pavement degradation
Low	N4 – Gawler St underground system upgrade	245,000	N/A	Q	Large flooding improvements in minor events	-	-	-	-	M	Less nuisance ponding, pavement degradation
Low	N5 – Day St underground system upgrade	65,000	N/A	Q	Large flooding improvements in minor events	-	-	-	-	M	Less nuisance ponding, pavement degradation

** Is reliant on upgrade of the downstream basin.*

*** Council identified this project as a high priority due to observations of staff in relation to historical performance of the basin*

Non-Structural Works											
High	New development control policy relating to detention	N/A	N/A	Q	Reduction in peak flows in stormwater conveyance systems	-	-	-	-	H	Increased community awareness of flood management measures
High	Development control policy relating to retention	N/A	N/A	Q	Less volumetric discharge to retention storage basins reduces overflow risks	Q	Opportunity for on-site reuse, reduction in potable consumption	L	Retention of some minor pollutants at source	**H**	Decreased potable water usage
High	Development control policy relating to water quality	N/A	N/A	-	-	Q	Opportunity for on-site reuse, reduction in potable consumption	H	Improve quality and reduce volume of stormwater discharged to road drainage, take load off wetlands	H	Reduced maintenance demands for Council. Reduced litter/pollutant and oil discharges into retention basins, resulting in improved amenity.
High	Asset management	N/A	N/A	Q	Medium – less risk of infrastructure failure impacting on performance	-	-	-	-	H	Improved planning capacity providing benefits to Council funding/accounting.

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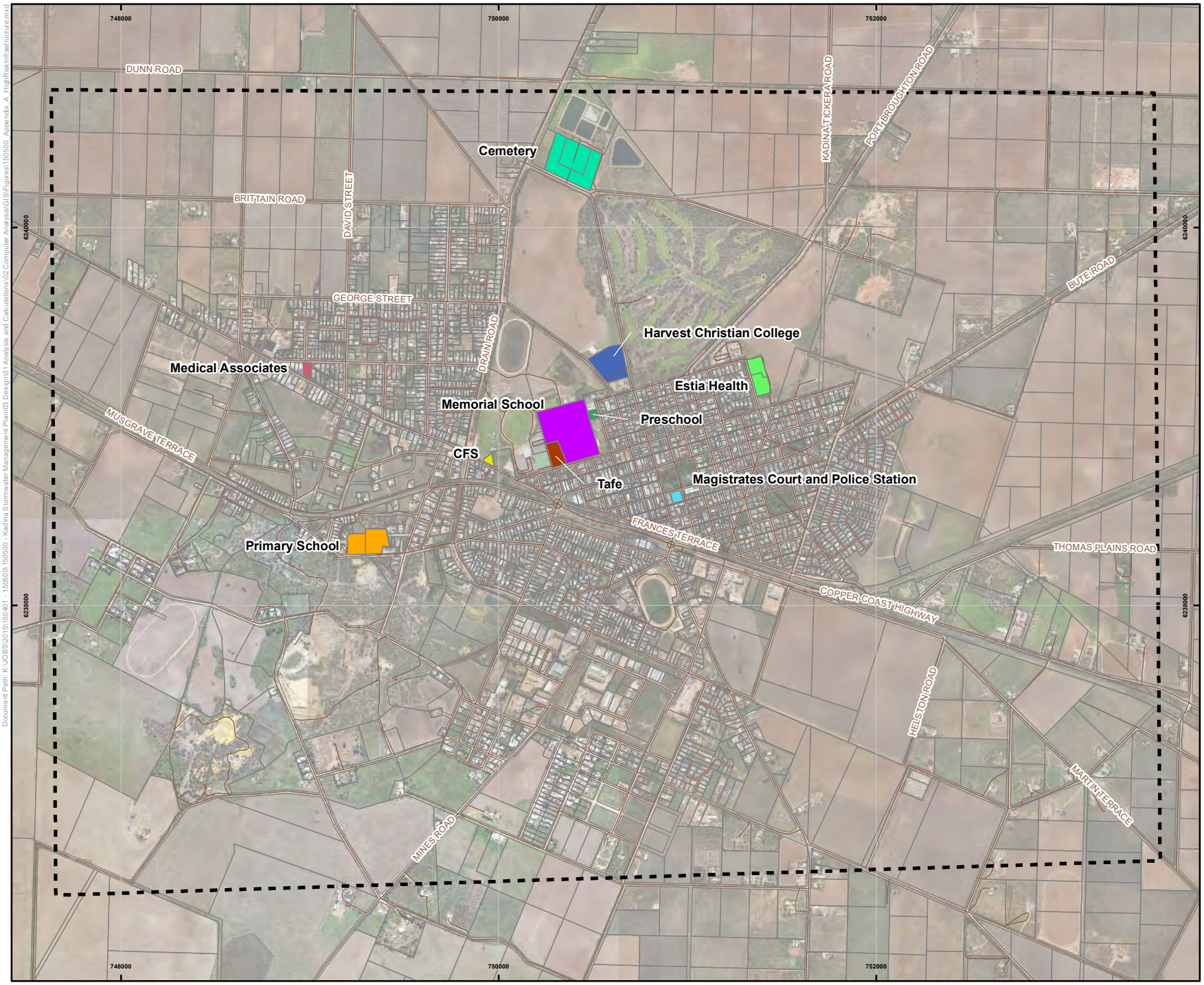
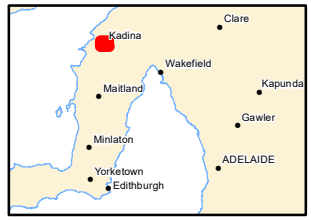
APPENDIX A

HIGH RISK INFRASTRUCTURE





LEGEND

- Roads
- Cadastre
- Model Bounds

High Risk Infrastructure

- CFS
- Cemetery
- Estia Health
- Harvest Christian College
- Magistrates Court and Police Station
- Medical Associates
- Memorial School
- Preschool
- Primary School
- Tafe

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
WALLBRIDGE GILBERT AZTEC

Appendix A

Kadina Stormwater Management Plan

High Risk Infrastructure

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

Document Path: K:\JOBS\2015\150401 - 150500\150500 - Kadina Stormwater Management Plan\03 Design\01 Analysis and Calculations\02 Computer Analysis\GIS\Figures\150500_Appendix_A_HighRiskInfrastructure.mxd

APPENDIX B

DEVELOPMENT POTENTIAL REPORT

DEVELOPMENT POTENTIAL

Kadina Stormwater Management Plan

District Council of the Copper Coast

Prepared by
MasterPlan SA Pty Ltd
ABN 30 007 755 277, ISO 9001:2008 Certified

33 Carrington Street, Adelaide SA 5000
Telephone: 8221 6000, masterplan.com.au

February 2017

1.0 INTRODUCTION

The following provides an assessment of the development potential of the Township of Kadina.

MasterPlan SA Pty Ltd has been engaged to provide development potential advice for the purposes of preparing the Kadina Stormwater Management Plan. This analysis concerns the area as defined as "*The Catchment Area*" as per the **enclosed** Catchment Area Plan.

Background

The Township of Kadina is located approximately 144 kilometres north-west of Adelaide in the District Council of the Copper Coast. At the 2011 Census, Kadina had a population of 5,070 people (ABS, 2011, "*Kadina Statistical Area Level 2*") and the Copper Coast a population of 12,949 people (ABS, 2011, "*Statistical Local Area*").

Contextually, Kadina acts as the district centre for the nearby towns of Moonta Bay, Port Hughes and Wallaroo, providing necessary shopping and regional services for this portion of the Council area. The Yorke Peninsula Regional Framework (Dec 2007) has further identified Kadina as the primary commercial and industrial hub of the Yorke Peninsula, servicing a population of over 26,000 residents.

Historically, the town has a rich mining history which led to its rapid development. The town was first surveyed in 1861 and in the thirty years that followed until 1891 the town quickly developed its historic centre and residential areas - many of which are still intact today. Whilst the mine closed in the early 1920's the growth of the town continues to be dictated by the mine's presence with the Historic Mining Zone restricting development of the town in a south-westerly direction.

Architecturally, the residential portions of the town have developed overtime to contain a large range of dwelling types. Primarily in the form of single storey detached dwellings, interspersed with more limited examples of residential flat buildings and semi-detached dwellings. Historic institutional buildings have been well preserved with the current Town Centre developing to the west of these areas. The existing areas of residential use are depicted on the **enclosed** Residential Land Use Plan.

The Mixture of Old and New Housing Styles in Kadina

At its periphery and on approach to the township from Adelaide, Cunliffe, Bute and Wallaroo the town contains rural living allotments, with the township further surrounded by broad acre primary production land.

A Rural Living Allotment in the South-east of the Township

Stormwater Management infrastructure for the Township developed somewhat organically as the Township expanded, with the naturally flat terrain relying on man-made overland drainage channels with almost non-existent subterranean stormwater infrastructure.

Recent sub-division of land for residential purposes within the Township has required the allocation of drainage reserves to be gifted to Council in order to account for the increase in stormwater run-off from newly developed allotments. The outcome of this requirement has led to numerous reserves with limited capacity to accommodate future residential growth or increases in residential density.

In order to plan for the future development of Kadina, an assessment of development potential has been undertaken to identify recent and anticipated development trends in the catchment area. The following assessment includes;

- analysis of the demographic profile of Kadina in comparison to the Copper Coast and South Australia;
- population projections for the Township;
- recent development trends – inclusive of vacant land and recent DPTI data regarding recently constructed dwellings, land divisions and land supply for future development; and
- review of the District Council of Copper Coast Development Plan and the proposed Kadina Employment Lands Development Plan Amendment to identify current and projected impacts which may potentially affect the implementation of the Stormwater Management Plan.

2.0 DEMOGRAPHIC PROFILE AND ANALYSIS

Demographic Profile

Table 1.1 Population Change (2006 - 2011)

	2006 POPULATION	2011 POPULATION	POPULATION CHANGE	POPULATION CHANGE (PERCENTAGE)
Kadina	4,026	5,070	1,044	**+25.9%**
Copper Coast	11,446	12,949	1,503	**+13.1%**
South Australia	1,514,337	1,596,572	82,235	**+5.4%**

Table 1.2 – Age Profile (2011)

	KADINA	COPPER COAST	SOUTH AUSTRALIA
0-4 years	320	729	96,143
5-14 years	722	1469	190,793
15-24 years	598	1278	208,834
Percentage 0-24 years	**32.3%**	**26.8%**	**31.1%**
25-54 years	1828	4291	643,643
55-64 years	634	2042	199,608
Percentage 25-64 years	**48.6%**	**48.9%**	**52.8%**
65 years and over	969	3139	257,551
Percentage 65 years and over	**19.1%**	**24.2%**	**16.1%**
Total Persons	5,070	12,949	1,596,572
Median age of persons	42	47	39

Table 1.3 – Individual, Family and Household Income (2011)

	MEDIAN INDIVIDUAL INCOME (WEEKLY)	MEDIAN FAMILY INCOME (WEEKLY)	MEDIAN HOUSEHOLD INCOME (WEEKLY)
Kadina	$438	$1053	$824
Copper Coast	$398	$925	$749
South Australia	$534	$1,330	$1,044

Table 1.4 – Home Ownership (2011)

	KADINA	COPPER COAST	SOUTH AUSTRALIA
Fully Owned	822	2,329	203,281
Percentage Owned	**41.4%**	**43.5%**	**32.8%**
Being Purchased	644	1,447	218,402
Percentage Being Purchased	**32.2%**	**27.0%**	**35.3%**
Rented	462	1,369	172,727
Percentage Rented	**23.1%**	**25.6%**	**27.9%**
Other Tenure Type	26	73	8,937
Not Stated	48	138	15,694

Table 1.5 – Dwelling Type and Structure (2011)

MOTOR VEHICLES PER DWELLING	KADINA	COPPER COAST	SOUTH AUSTRALIA
Occupied private dwellings	2,001	5,355	619,037
Unoccupied private dwellings	257	2,490	83,777
Total private dwellings	**2,258**	**7,845**	**702,814**
Separate house	1,898	4,962	494,471
Semi-detached, row or terrace house, townhouse	79	263	66,465
Flat, unit or apartment	4	91	54,968
Other dwelling	21	34	2,812
Average number of people per household	**2.4**	**2.2**	**2.4**

Demographic Analysis

An analysis of Australian Bureau of Statistics data from the 2006 and 2011 Census has been undertaken to provide an understanding of the demographic makeup of the Kadina Township.

Using the 2011 data, combined with some analysis and more recent demographic trends in South Australia, it is possible to build an understanding of the potential demographic trajectory of the Kadina Township over time.

The demographic data indicates that Kadina experienced a very substantial population growth of 25.9 percent or 1,044 persons between 2006 and 2011. This compares to a population growth of 13.1 percent for the Copper Coast and a growth of 5.4 percent for South Australia. Between 2012 and 2013 Kadina recorded South Australia's third fastest estimated population growth outside of greater Adelaide, behind Roxby Downs and Moonta.

Looking at age profile, Kadina has a younger population than that of the Copper Coast but an older population that that of the State with a median age of 42 in comparison to 47 and 39 years of age for the Copper Coast and State respectively. The distribution of age across the population reflects this, with 32.3 percent of the population in Kadina aged under 24 years, compared to 26.8 percent for the Copper Coast and 31.1 percent for South Australia.

Furthermore, Kadina has 19.1 percent of the population over the age of 65 years, compared to 24.2 percent for the Copper Coast which generally has quite an old population compared to both the Township and the State.

The median household income in Kadina at the 2011 Census was $824 per week compared to $749 per week for the Copper Coast and $1,044 per week for South Australia as a whole. This would be partially due to the fact that Kadina exists as a district centre for the Copper Coast and presumably there are more job opportunities in the Township compared to that of the region.

At the 2011 Census a high percentage of properties in Kadina were owned outright with 41.4 percent of houses being fully owned. This is comparative to that of the region where 43.5 percent of homes are fully owned, and much higher than that for the State in which 32.8 of homes are fully owned.

The rental market in Kadina represents 23.1 percent of the housing market, this is comparatively just below the regional and states figures for rental properties of 25.6 percent and 27.9 percent respectively. This lower rental market figure is most likely reflective of the older age demographic present in Kadina and that of the greater Copper Coast.

A further 32.2 percent of homes in Kadina are in the process of being purchased. This figure is relatively similar to that of the State in which an average of 35.3 percent of homes are in the process of being purchased but is comparatively higher than that of the region in which only 27 percent of homes are in the process of being purchased.

3.0 POPULATION PROJECTIONS

University of Adelaide (July 2012) Population Trends in the Copper Coast detail that the population for the Copper Coast has increased from 9,883 in 1996 to 12,968 in 2011 at a steady growth rate of 2.08%. The population is projected to increase to 15,871 by 2026 at an annual growth rate of 1.5%. Kadina is envisaged to account for 760 of the projected 1,934 people between 2016 and 2026. Of this projected growth, Kadina is envisaged to account for 1,140 of the projected 2,903 people. The Town must either grow or adapt in order to accommodate this projected growth.

The most recent State Government population forecasts as at February 2016 (see Table 1.6) has taken a more conservative approach within their figures, projecting an annual growth rate of 1.1% within the Copper Coast Region between 2016 and 2026. This period is expected to result in a further 1,610 residents at a rate of 161 people per annum It is however noted that the last 10 years have averaged +250 people per annum. A 1.1% growth rate within Kadina will result in a further 558 residents over this 10-year period. The average household occupancy rate (2.4 persons) against the average annual dwelling approval number confirms a projected population growth figure between those projected by the University of Adelaide and State Government.

The substantial portion of projected population growth over the Yorke Peninsula Region is made up of that growth within the Copper Coast. The adjoining Yorke Peninsula Council is projected to experience further population loss whilst Barunga West maintains a slow growth rate.

Table 1.6 – State Government Population Forecasts (2016)

	2016	2021	2026	2031
Copper Coast	14,116	14,936	15,726	16,535
Barunga West	2,482	2,555	2,684	2,803
Yorke Peninsula - North	7,216	7,148	7,078	7,026
Yorke Peninsula - South	3,874	3,858	3,747	3,597
TOTAL	**27,688**	**28,497**	**29,235**	**29,961**

Table 1.7 – Copper Coast Age Profile Forecasts (2016)

	2016	2021	2026	2031
0-24 years	3,896	4,041	4,232	4,429
Percentage 0-24 years	**27.6%**	**27%**	**26.9%**	**26.8%**
25-64 years	6,660	6,972	7,239	7,484
Percentage 25-64 years	**47.2%**	**46.7%**	**46%**	**45.2%**
65 years and over	3,560	3,923	4,255	4,622
Percentage 65 years and over	**25.2%**	**26.3%**	**27.1%**	**28%**
TOTAL	**14,116**	**14,936**	**15,726**	**16,535**

The Copper Coast is expected to experience its predominant growth in those residents over the age of 65. This age demographic is expected to rise by an additional 1,062 persons by 2031 and equate for 28% of the total population. This age demographic typically associates with a demand for single storey dwellings of a smaller roof area and within close proximity to services. This is likely to result in further infill development within the existing Kadina residential zone on allotments of a smaller size.

4.0 ECONOMIC GROWTH PROJECTIONS

Whilst no data is readily available on the economic growth projections for the Township of Kadina specifically, regionally the Northern and Yorke region contributed $2.201 million to the State economy in 2006/07 or 3.2 per cent of gross state product.

Further, the unemployment rate for the region is a full percentage point below that for the State at 4.3 per cent while the labour force participation rate is some 6 percentage points below that for the State.

The three largest employing industries for the region are;

- agriculture (20.7 per cent);
- retail trade (15.1 per cent); and
- health and community services (12.5 per cent).

Manufacturing is also significant across the region in terms of employment and gross value added (Source: Regional Development Australia Yorke and Mid North, South Australian Centre for Economic Studies, Adelaide and Flinders Universities).

In further support of the above, Council's 2014-2015 Annual Business Plan aligns the short-term progress of the Council area with the long term goals of the Strategic Plan. The Plan details that the economic goal for growth within the Council area is "*to facilitate economic prosperity, balanced growth and the enhancement of the Copper Coast.*" The key functions of this goal have regard to;

- Investment;
- Employment;
- Tourism;
- Area Promotion;
- Industry; and
- Commerce.

These key functions are the areas in which the Council area is anticipated to grow economically and those areas which are allocated funds to continue to promote economic growth for the Copper Coast Council area.

Commercial investment interest within Kadina has grown within 2016 and it is expected to continue to rise as a result of the Kadina Town Centre Upgrade currently underway. Commercial development applications within Kadina in the last 12 months have included a proposed 5.9 million dollar Aldi store in addition to a 2.7 million dollar upgrade to the existing BP Service Station.

Dwelling approval numbers within Kadina have been relatively consistent over the last six years averaging 29 approvals annually. This figure has fallen considerably when compared to the 51.7 dwelling approvals averaged annually between 2005 and 2012. This reduction coincided with the timing of the global financial crisis which brought about investment hesitation, reduced borrowing capacities and delayed retirement. It is considered that this approval number will again increase as confidence within the market grows.

Table 1.8 – Annual Residential Dwelling Approvals

FINANCIAL YEAR	KADINA	COPPER COAST
2010/2011	38	226
2011/2012	50	182
2012/2013	22	135
2013/2014	19	148
2014/2015	24	181
2015/2016	21	154
Average	**29**	**171**

It was recognised within Council's recent Development Plan Amendment that Kadina's Industrial Zone had almost reached its capacity. A short supply and strong demand for industrial land resulted in Council rezoning an additional 35 hectares of primary production land and 1.13 hectares of Historic Mining land to within the Industrial Zone. This could result in additional 80 industrial allotments.

5.0 LAND USE MAPPING

A current Land Use Map for the Catchment Area is enclosed with this analysis (Refer to the **enclosed** Land Use Map). This map provides detail on the location of each land use on an aerial base.

Kadina comprises a mixture of land uses consisting of Residential, Industrial, small pockets of Mixed Use and Tourist Accommodation, Town Centre and large expanses of Community Use land. At its periphery and on approach to the township from Adelaide, Cunliffe, Bute and Wallaroo the town contains rural living allotments with the township being surrounded by broad acre primary production.

6.0 DEVELOPMENT PLAN POLICY

Existing and Proposed Development Plan Policy

The existing Development Plan for the District Council of the Copper Coast was consolidated 9 June 2016. A Statement of Intent to commence the Kadina Employment Lands Development Plan Amendment is currently with the state government for consideration.

In terms of the existing policy context for the catchment area the area is largely residentially zoned, with some historic mining, town centre and industrial zoning. The current zoning is **enclosed** in the Zone Plan. The State Planning Policy Library has been utilised to implement appropriate stormwater management policy within Council's Development Plan. This includes amongst other detail, the incorporation of detention and retention facilities into development, stormwater re-use, aquifer recharge, clean runoff and water sensitive urban design.

In terms of the recent changes to land use zoning in the Better Development Plan (BDP) and General Development Plan Amendment (DPA) Part 2. The following changes are specific to Kadina; these changes include:

- amendment to Zone Map CoCo/18 to increase the size of the Residential Zone and reclaim 20 hectares of land currently zoned as Deferred Urban;
- amendment to Zone Map CoCo/17 – introduction of an L-shaped Commercial Zone to the south of the Town Centre, and increasing the size of the Industry Zone into the Historic Mining Zone; and
- amendment to Map CoCo/8 to reflect all of the above changes.

Note; that the land designated for residential development as per the proposed Zone Map CoCo/18 provides a significant opportunity to accommodate the towns projected population growth.

Residential Zone Policy

The Residential Zone Policy for the Council area seeks to maintain relatively low density residential living. Residential Zone Principle 12 lists (except where further specified in a Policy Area) that the "*maximum site coverage*" for dwellings is "*60 percent.*" Further, PDC 15 suggest that a dwelling should have a minimum site area and a frontage to a public road not less than that shown in the following table:

15 Except where different parameters are specified in a specific policy area or precinct, a dwelling should have a minimum site area and a frontage to a public road not less than that shown in the following table:

All Dwelling types	Minimum site area (square metres)	Minimum frontage (metres)
Where not connected to a community waste water management system	1200	15
Where connected to a community waste water management system	450	15

Likewise, PDC 18 of the Residential Zone enforces PDC 15 via the land division process suggesting; unless for the purpose of dividing an existing or approved dwelling development, land division should not create an allotment with an area less than 450 square metres, or less than 1200 square metres where not connected to a community wastewater management system.

In the context of stormwater management, these restrictions on site coverage maintain the high degree of land on which natural infiltration of stormwater occurs.

Deferred Urban Zone Policy

Those areas earmarked for future residential growth have been placed within Deferred Urban Zones as outlined within Council's Development Plan. Whilst this land is unlikely to be required over the next twenty years, it allows for forward planning and direction for future development interest.

Table 1.9 – Deferred Urban Zone Land Supply

LOCATION	VACANT GREENFIELD LAND SUPPLY	APPROX. ALLOTMENT POTENTIAL	DEMAND (DWELLINGS/YEAR) 2010 TO 2016	SUPPLY (IN YEARS)
East Kadina	28.51ha	490	29	16
West Kadina	26.9ha	470	29	16

Waste Sensitive Design Development Plan Policy

Council-wide Principles for Development Control with regard to Natural resources, more specifically "*Water Sensitive Design*" provides general qualitative guidance on the provision of broad water sensitive design techniques in the Council area. Generally, this policy is broad as intended and relates to maximising capture and reuse of stormwater, minimisation of harm to receiving waters and the inclusion of stormwater systems. The implementation and promotion of water sensitive urban design principles will assist in the reduction of flows entering Council's detention/retention basins and associated infrastructure.

Rainwater Tank Policy Council has taken a proactive approach to stormwater retention and reuse through the formulation of appropriate rainwater tank policy to be applied within development assessment. This development plan policy requires minimum rainwater tank capacities to be applied to new development that exceed minimum capacities stipulated by the state. The required capacity is dependent on water supply capabilities and the ability of the relevant allotment to cater for larger tanks. PDC's 8, 9 and 10 of the Infrastructure module within Council's Development Plan support the following on-site water storage capacities:

8 In areas where no reticulated water supply is available, development should provide for an adequate and reliable on-site water storage system having a capacity of at least 60 000 litres which is connected to the development.

9 In areas where an unrestricted reticulated water supply is available, development should provide for and be connected to an adequate and reliable on-site water storage system having a capacity of at least 22 000 litres.

10 In areas where a restricted reticulated water supply is available, development should provide for an adequate and reliable on-site water storage system having a capacity of at least 44 000 litres which should be:

Additionally, PDC 13 of the Residential Zone requires the following minimum rainwater tank capacities to be applied to new dwellings:

13 On site water storage should meet the following minimum water tank size requirements, (a) or (b):

(a) 60 000 litres where there is no reticulated water supply available

(b) in areas where there is a reticulated water supply available:

(i) 5000 litres on allotments less than 450 square metres in area

(ii) 10 000 litres on allotments with an area of 450 square metres to 649 square metres

(iii) 22 000 litres on allotments with an area of 650 square metres or greater.

As indicated within Table 1.5, Kadina's occupancy rate of 88.6% is much higher than that of the Copper Coast generally (68.3%). This additional resident population results in an increase in water reuse and as such a reduced overflow of roof catchment to Council infrastructure. The University of Adelaide (July 2012) identified that the non-resident population accounted for only 5.8% of Kadina's properties.

7.0 RECENT DEVELOPMENT TRENDS

Recent development trends in Kadina have been in the most part involving the rezoning of Primary Production land at the Township fringe together with the subdivision of large allotments within the Township for the purposes of higher density infill development.

Recent larger scaled subdivision activity about the Township fringe has generally occurred at the eastern fringe between Bute Road and Thomas Plains Road, as well as in the southern portion of the township around Agery Road and the north-west of the Township on both sides of Port Road/Copper Coast Highway and east of Drain Road. The **enclosed** Approved Subdivisions Plan details the extent at which land divisions have been recently occurring in Kadina inclusive of those proposals successfully deposited, those which have been consented but have now lapsed and those currently proposed. Of note are those depicted in blue which represent the plans deposited and provide an informative snapshot into recent development trends. This data is current to 13 April 2015.

Infill development within the Township has occurred slowly within the Township with currently available vacant allotments varying greatly in size and development potential, the images below depict some of the existing vacant allotments in Kadina.

Vacant Existing Allotments

Infill development has generally been of a scale sympathetic to neighbouring properties and generally consists of single storey detached dwellings with setbacks consistent with precedents set on each streetscape.

Extensive Historic Conservation Guidelines provided in Table CoCo/2 of the District Council of the Copper Coast provide the necessary guidance for new development within the designated conservation areas of the township.

Typically, new development at the Township fringe has developed with increased site coverage, and decreased side and front setbacks but has again developed a consistent scale of development with the majority of residential development being in the form of single storey detached dwellings.

Table 1.10 – Land Supply - Excluding Greenfield Sites with Division Potential

TOWNSHIP	ZONE	VACANT ALLOTMENTS 2016	DEMAND (DWELLINGS/YEAR) 2010 TO 2016	SUPPLY (IN YEARS)
Kadina	Within Catchment	107	29	3.7

The existing vacant allotments with frontage to a sealed road equate for a total of approximately 9 hectares. Utilising a 60% site coverage this will result in an approximate additional roof catchment of 5.4 hectares (based on the allowable capacity for site coverage). The majority of these allotments are located in clusters within new development sites such as Patricks Place, Lamshed Street, Thomas Street and Jackson Way. The stormwater networks engineered for these new developments should therefore have catered for the expected load.

Table 1.11 below outlines the extent of greenfield land supply that exists within the Kadina Catchment Area The relative Council stormwater reserves to which stormwater runoff will be directed is also outlined.

It is evident that the existing stormwater reserves located at the Kadina Dump, Kadina Wastewater Lagoons, Martin Terrace and Franklin Road are likely to receive substantial increases in runoff as a result of this infill. The requirement for on-site retention within these sites is imperative.

Table 1.11 – Greenfield Land Supply

LOCATION	LAND SUPPLY	ALLOTMENT POTENTIAL	AVG. DEMAND	SUPPLY (IN YEARS)	CATCHMENT	APPROX. ROOF AREA
East Kadina / Patricks Place	20ha	350	29	12	Onsite retention > Kadina Dump	9.87ha
George Street	10.7ha	130	29	4.5	Onsite retention > Kadina Lagoons	4.68ha
Lipson Road	6.28ha	TBA – Proposed Statement of Intent for rezoning to Commercial			Onsite retention >Franklin Road	TBA
Harris Road	2.86ha	28	29	1	Myra Street	1.26ha
Lukeman Street	6 ha	37	29	1.25	Goldsworthy Street	1.48ha
Powell Terrace	1.91ha	37 Allotment Community Division – (Balmoral Estate) Retirement Village Potential			West Terrace >Archery Club	0.82ha
Agery Rd /Champion St	6.42ha	50	29	1.7	Existing on-site swales	n/a
Doswell Tce / East Tce	9ha	90	29	3	Kadina Dump – Existing Swale	3.78ha
Lamshed Street	1.55ha	14	29	0.5	Lamshed Street	0.7ha
South Tce / Agery Rd	1.19ha	10	29	3	Martin Tce/Thomas Plains Rd	0.4
Hawke Rd	5ha - Ministerial	38	29	1.3	On-site	n/a
Thomas Street	1.258ha	14	29	0.5	Brittain Rd / Moyle Street	0.58ha
Hoare Cres	7600m^2	7	29	0.25	Lawrence St	0.33ha

Walter Road	5.64ha - Ministerial	35	29	1.2	Franklin Rd	1.4ha
Martin Terrace	35ha	Industrial Land with an approximate 75 allotment potential		20+	Onsite retention - Martin Tce/Thomas Plains Rd	TBA
TOTAL	**78.57ha Res** **35ha Ind**	**805 Res** **75 Ind.**		**30 Res** **20+ Ind**		**25.3ha**

In addition to road surface runoff, the approximate additional roof catchment as a result of this infill is at least 25.3 ha. This would result in 0.25 mega litres of catchment for every millimetre of rainfall. These infill sites allow for approximately 30 years of land supply at the current rate of demand.

8.0 DEVELOPMENT CONSTRAINTS

The future growth of the Township of Kadina is constrained by a number of physical, environmental and policy driven constraints.

Heritage Listed Properties

A number of heritage properties exist within Kadina. The desire to maintain this heritage quality of existing buildings requires special consideration when accounting for the future growth of the Township in order to account for their continued preservation and minimise the risks and impacts of potential flood incidents.

The District Council of the Copper Coast lists the heritage items that exist within the Council region and associated Townships. The heritage properties located within the Kadina Township are as follows;

Table CoCo/4 – State Heritage Places

Table CoCo/4 - State Heritage Places

Property Address	Description and/or Extent of Listed Place	Lot No. or Part Sec	Plan No.	Certificate of Title	Section 16 Criteria	SA Heritage Register ID
Drain Road KADINA	Kadina Cemetery, including the Mortuary and Wall	S2179 S2180	H211100 H211100	CT 106/6 CR 5756/452		11165
Matta Road KADINA	Matta Matta House Museum (former Mine Manager's Dwelling)	A101	D29469	CR 5750/510		10123
Newland Road KADINA	Former Harvey's Pumping Station	A60	D27952	CR 5750/494		10125
36-38 Taylor Street KADINA	Former Humphries Barber Shop (former Hancock's Barber Shop and Billiard Saloon)	A531	F197902	CT 5544/360		13618
51 Taylor Street KADINA	Kadina Town Hall (incorporating 1880 Mechanics Institute)	A565	F197936	CT 5855/806		10130

These properties, although categorised under varied degrees of listings are all earmarked for special consideration.

Further assessment of these properties will help to recognise any shortfalls that exist, for example existing floor levels etc. and will accordingly provide the basis for improvements to stormwater management infrastructure in these locations.

Flood Risk

Low lying areas inside and outside of the township will continue to be subject to degrees of flooding, affecting existing and proposed development into the future. As per the flood modelling undertaken by Walbridge and Gilbert Consulting Engineers for 5, 10, 20, 50 and 100 year intervals, the proposed changes to stormwater infrastructure within the catchment area improves the future scenario when compared to the existing.

In order to plan for a range of flood scenarios, it is important to establish efficient and effective planning procedures to achieve stormwater management objectives. These are described in Section 9.0 of this report titled 'Mitigation'.

Facultative Ponds

Currently, the majority of the wastewater from the Town is directed to the facultative ponds located to the north of Kadina on the continuation of Drain Road to the north-west of the Golf Course. The ponds, together with the existing cemetery, restrict the future development of the Town in a northerly direction past Russack Road. The Council has also flagged that these ponds may be expanded into the future to accommodate the increase in waste water as the town expands. The EPA Guidelines for Separation Distances require that facilities of this nature are separated from sensitive land uses i.e. residential development by a distance of 700 metres. The land the south of the facultative ponds bound by Russack Road, Drain Road and George Street is currently zoned Community Use but appears to be used for Primary Production. This land is in a prime location for future development for a mixture of community, residential and recreational land uses. Community Use zoning envisages only community, educational, recreational and health care facilities for the general public's benefit inclusive of the golf club and public open spaces such as ovals and playing fields. Changes to the list of non-complying forms of development within the recent Development Plan Amendment does account for this with a merit assessment of residential uses also included.

The Historic Mine Site

The Historic Mine site defined by inclusion within the Historic Mining Zone aims to conserve, enhance and maintain the historic character and the cultural significance of the land, buildings and structures in the zone. Whilst this area is not included within the "*Catchment Area*" the interface of future development with this zone must have regard to this prominent and sizeable site and as such presents itself as a significant constraint on the future development of the Township.

The Kadina Waste Landfill Facility

The former Kadina Waste Landfill Facility to the north-east of Kadina along Port Broughton Road has now been replaced by the Waste Transfer Facility in Wallaroo. Whilst the land requires further remediation works prior to future development, site remediation and ground water assessment is required prior to future development growth within this locality.

9.0 MITIGATION

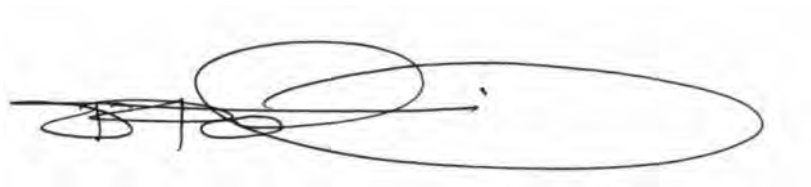
In planning context, a number of mitigation methods can be implemented in order to reduce the impacts and incidence of flooding. These actions can be both structural and non-structural, and are as follows;

- pre-application advice for new development applications;
- assessment processes (liaison with engineering staff, planning conditions and notes for applicants);

- development of an easy-to-use and effective stormwater management assessment tool to assist developers and development assessment officers;
- planning controls implemented at allotment level;
- introduction of a minimum FFL;
- tangible requirements for stormwater disposal during large scale subdivision;
- encouragement of compliance with planning conditions, and enforcement where necessary;
- establish Council processes to ensure that, where a development is proposed in an area with identified drainage deficiencies, the applicant is required to demonstrate that the stormwater discharge from the site will not compromise the ability of the drainage system to carry to 1-, 2-, and 5-year ARI flow rates;
- update Council's Development Plan to ensure that development:
  - contributes to achieving the Region's peak stormwater targets;
  - is designed with regard to the 100-year ARI floodplain and flood hazard mapping;
  - requires effective on-site (or off-site where appropriate) measures to contribute to the Region's water quality targets; and
  - incorporates stormwater harvesting, storage and reuse where appropriate;
- update Council's Development Plan to provide a standardised approach to stormwater management inclusive of maps which specifically identified flood plains under Natural Hazard Mapping overlay in the BDP mapping format;
- include water quality targets, peak flow targets, and flooding considerations (e.g. 100- year ARI flood mapping) within each Council's strategic planning processes;
- ensure works to rectify drainage deficiencies are undertaken prior to the introduction of any new Development Plan policies which encourage the intensification of land use and/or be likely to result in an increase in impervious area within a particular area of a Council; and
- train planning staff to increase their understanding of stormwater management objectives and methods and how they can be achieved through the Development Planning System.

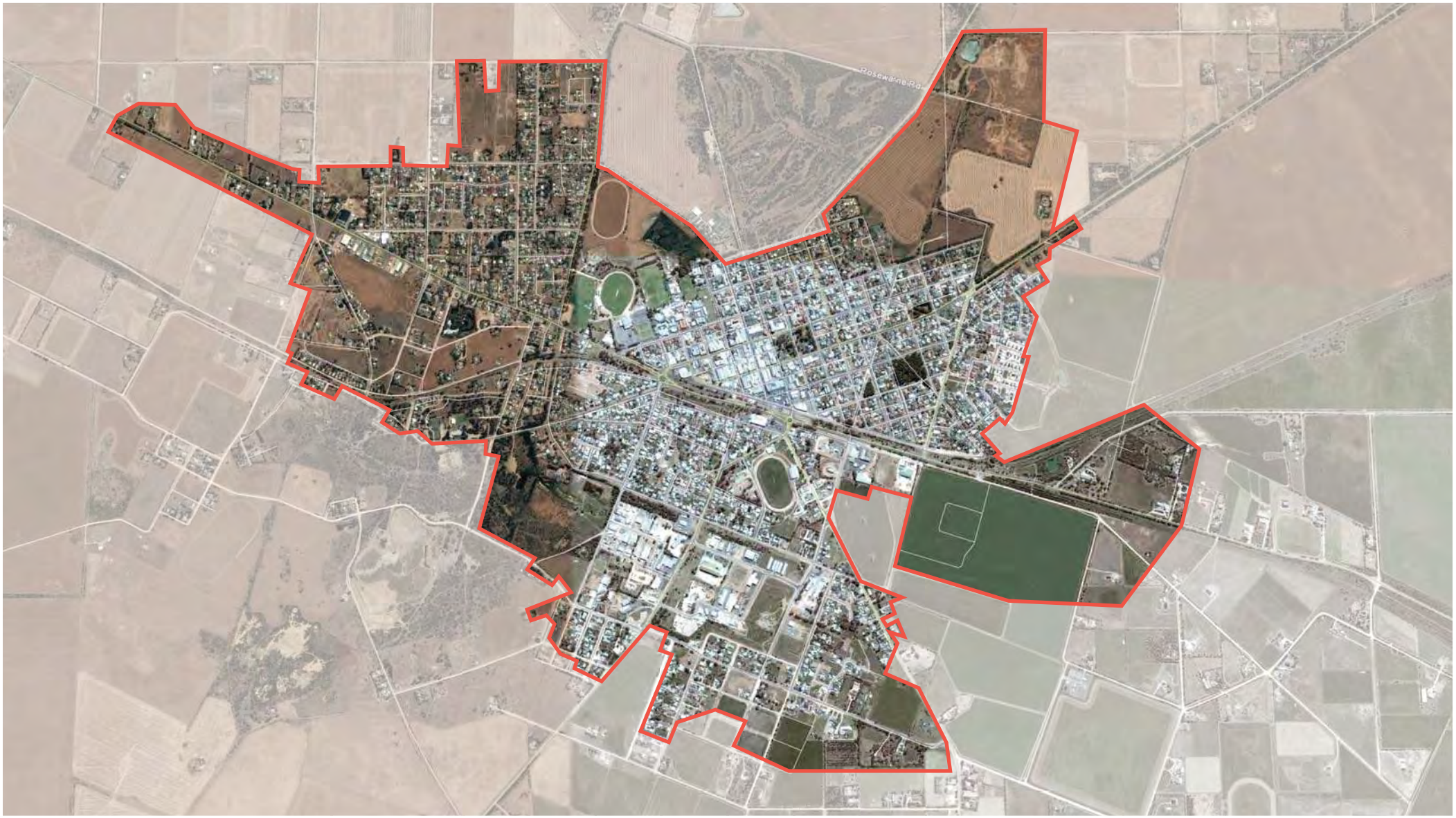
10.0 CONCLUSIONS

In order to plan for the future development of Kadina, an assessment of development potential has been undertaken to identify recent and anticipated development trends in the catchment area. The assessment provides analysis into the demographic profile of Kadina in comparison to the Copper Coast and South Australia, population projections for the Township, a review of recent development trends and a review of the Development Plan and the proposed Development Plan Amendment. This analysis identified the current and projected impacts which may potentially affect the implementation of the Stormwater Management Plan and provided a number of mitigation techniques to plan for anticipated flood scenarios effectively.



Simon Tonkin FPIA
B/A in Planning

23 February 2017



KADINA
STORMWATER MANAGEMENT

Catchment Area

NOT TO SCALE

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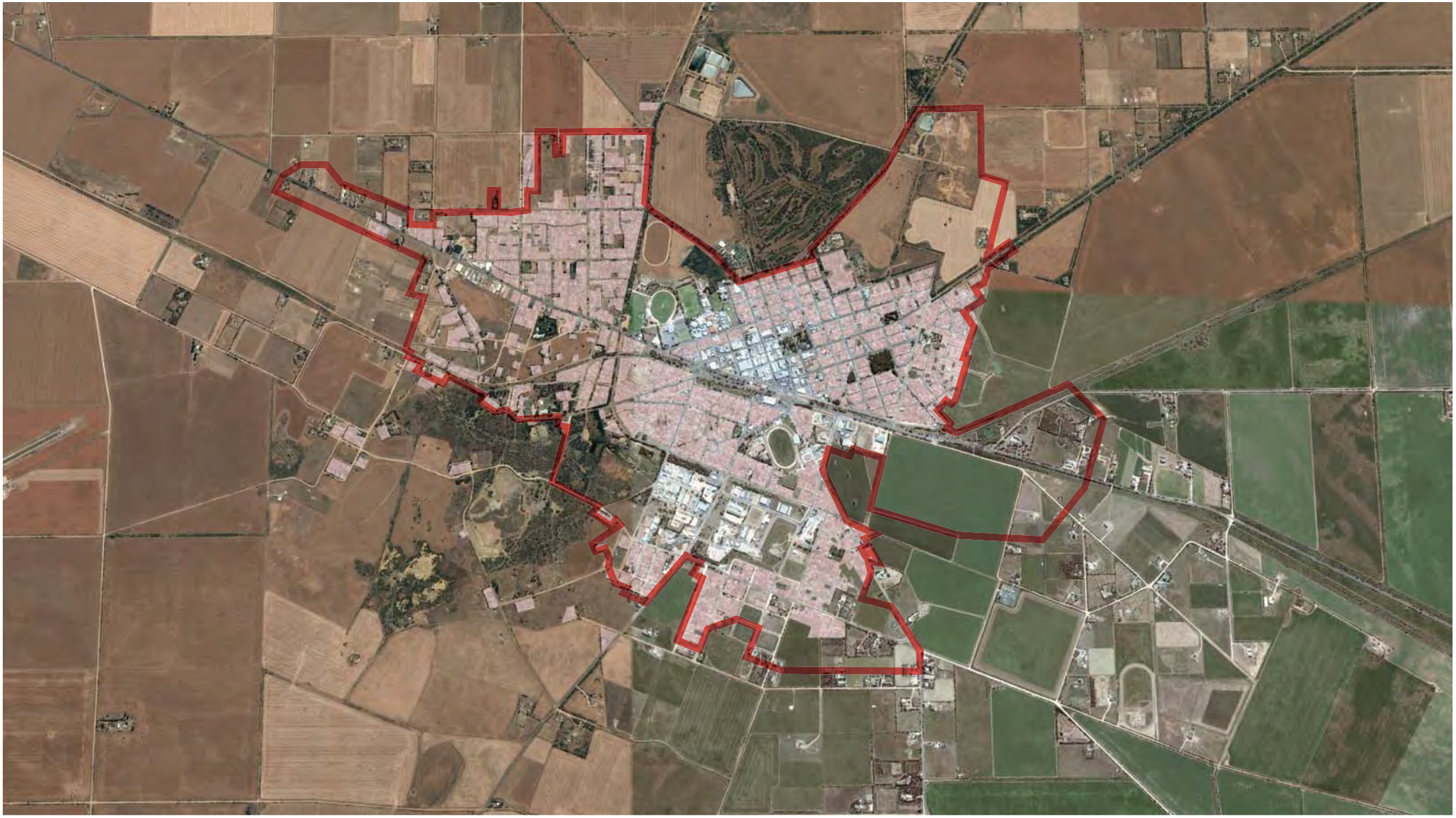

CATCHMENT AREA
RESIDENTIAL
NON PRIVATE RESIDENTIAL

KADINA
STORMWATER MANAGEMENT

Residential Land Use

NOT TO SCALE

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- CATCHMENT AREA
- RESIDENTIAL
- NON PRIVATE RESIDENTIAL
- VACANT URBAN LAND
- COMMERCIAL
- RETAIL COMMERCIAL
- UTILITIES / INDUSTRY
- FOOD INDUSTRY
- PUBLIC INSTITUTION
- EDUCATION
- RECREATION / RESERVES
- RURAL RESIDENTIAL
- VACANT
- HORTICULTURE
- FORESTRY
- AGRICULTURE
- LIVESTOCK
- MINING / QUARRYING

KADINA
STORMWATER MANAGEMENT

Land Use

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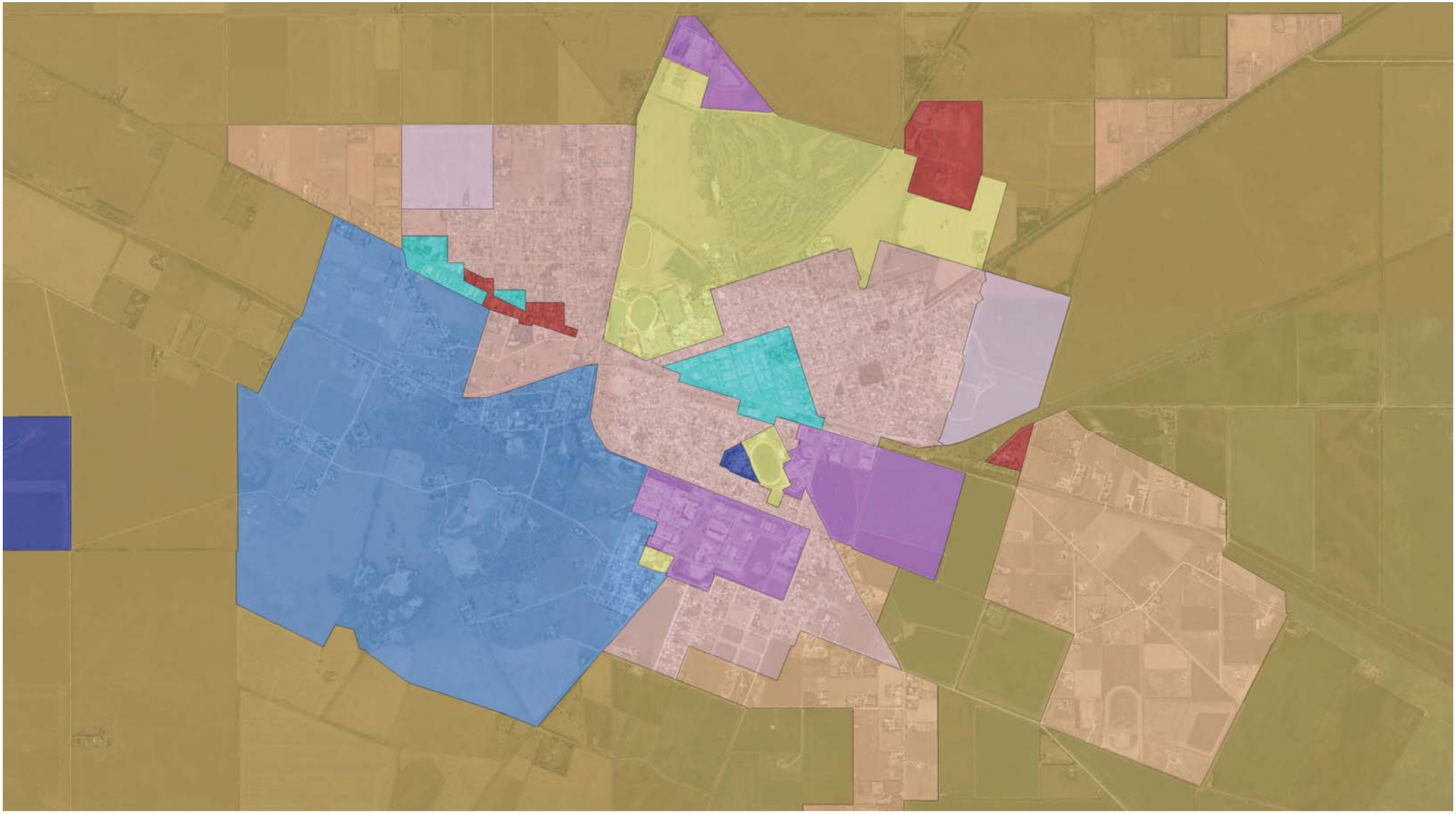

CATCHMENT AREA
COMMERCIAL
COMMUNITY FACILITIES
COUNTRY TOWNSHIP
DEFERRED URBAN
ENVIRONMENTAL CONSTRAINT
EXLUDED
HERITAGE
INDUSTRIAL
INFRASTRUCTURE
NO ZONES / DATA
OPEN SPACE
MINING
RECREATION
RESIDENTIAL
RURAL LIVING

KADINA
STORMWATER MANAGEMENT

Zones

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CATCHMENT AREA
APPROVED LAND DIVISION

KADINA
STORMWATER MANAGEMENT

Approved Land Divisions

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APPENDIX C

DESIGN BASIS REPORT

WALLBRIDGE & GILBERT
Consulting Engineers

District Council of Copper Coast

KADINA STORMWATER MANAGEMENT PLAN

PRELIMINARY DESIGN BASIS REPORT

Job No. WAD150500
Rev B
9th February 2017

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REVISION HISTORY					
Rev	Date	Issue	Originator	Checker	Approver
A	17/02/2016	For Review	LP	NS	NS
B	09/02/2017	Revised Methodology	LP	NS	NS

REPORT

BLAKES LAKE ENGINEERING, SA

WALLBRIDGE & GILBERT

1 REPORT

As part of the Kadina Stormwater Management Plan, Wallbridge & Gilbert (W&G) has prepared a TUFLOW model for the modelling of the floodplain in the Kadina township. This report further details the design basis, parameters and assumptions applied in the preparation of the floodplain maps produced by the model. This model should be read in conjunction with the main Kadina Stormwater Management Plan for which report makes up an appendix.

The basis of the design outlined in the tender was to use an ILSAX model to produce hydrographs for input into TUFLOW. Through the preliminary stages of the design, the methodology was revised to represent a direct rainfall model to generate flows within TUFLOW. This was because the preliminary phase of modelling highlighted various issues with applying the originally proposed methodology and the direct rainfall model was deemed to produce a more accurate floodplain for this project. The purpose of this report is to explain the reasons for this change in approach and to outline the design assumptions.

1.1 Grid Size and Time Step

A number of grid sizes have been used in the model development. Initially the model was run with a single cell size, which was extended to run as a nested grid model with two grids to allow for greater model resolution. The final grid configuration is outlined below in Table 1.

Table 1: Cell Size and Time Step Summary

Grid Category	Cell Size	Time Step
Town	2m	0.5 sec
Rural	8m	2.5 sec

A number of nested grid configurations were trialled. The smallest feasible cell size for the data is 1m due to the accuracy of the DTM. The areas requiring the most definition to accurately represent storage and flow behaviour are the road and to a lesser extent the Township.

Using 1m over the entire Kadina Township area results in an unmanageable number of grid cells and associated data requirements for a standard computer. Thus, a configuration of 3 nested grids was trialled; 1m cell size over the road network, 2m for the Township and 8m for the remaining area. However, this orientation produced unstable flow results and the model was returned a significantly higher mass balance error than previous configurations. Thus it was deemed that using a smaller grid size over the roads nested within the township was an unsatisfactory approach.

The model was found to perform best in terms of mass error when the township was modelled with a single cell size and the rural area was a larger cell size. Thus the final cell configuration in Table 1 was adopted.

A 2D time step between one half and one fifth of the grid size has been applied to the model as outlined in Table 1, in line with standard practice. The 1D time step has been set at 0.05 seconds. This is in line with recommended time step values for the 1D network within this 2D model setup.

1.2 Direct Rainfall on Grid Approach

The tender brief outlined the use of an ILSAX model to create hydrographs for input into the TUFLOW model to generate the floodplain maps. As the initial phases of investigation progressed, the minimal stormwater infrastructure in the town and the town's geography led to the development of a direct rainfall on grid model as an alternative. This approach was originally discussed with DPTI on a site visit during the preliminary stages of the project based on the difficulty of creating an accurate ILSAX model for the Kadina township catchment and is outlined as follows.

The 'traditional' approach to floodplain modelling involves delineating a study area into sub catchments, using either manual or automated processes based on GIS topographic data. ILSAX parameters such as impervious fraction and concentration time are then determined by aerial imagery, engineering judgement or the use of simplified formulae such as the kinematic wave equation. Following this, ILSAX hydrological calculations are undertaken in DRAINS or similar, and hydrographs for flow at the downstream ends of the catchments are input into the floodplain model as point inflows (typically snapped to a pit or a single cell). As this modelling approach usually routes the flow to underground drainage infrastructure directly, it is useful for analysing the behaviour of flooding that occurs due to the underground drainage capacity, however it is unable simulate any flood issues that would occur before runoff reaches the downstream end of a sub catchment.

As a result of the preliminary phases of the model development, it was found that the characteristics of Kadina's stormwater infrastructure and topography were not conducive to the traditional floodplain modelling approach. The limited stormwater infrastructure and flat terrain in the township raises concerns in the ILSAX model development as well as in the TUFLOW input process. If hydrograph inflow points were to be solely defined at the town's stormwater pits, then the township would have to be crudely represented by an ILSAX model with large urban catchments. The model would not account for significant depression storage within these large catchments and there would be a great deal of uncertainty associated with times of concentrations. The resultant floodplain map produced by adopting this approach would be unrealistic, containing sparse localised areas of flooding and would possibly neglect potential flood risk to properties upstream of the point inflows.

Additionally, as Kadina has relatively flat topography, it is likely that significant cross catchment flow would occur during large ARI storm events. Such flow cannot be taken into account using an ILSAX model, and would impact on the flows arriving at the downstream ends of adjacent catchments.

The direct rainfall method in TUFLOW means that rainfall is applied directly onto cells. A finite difference scheme is used to solve the shallow water equations to simulate the overland flow of this rainfall runoff, and initial and continuing losses are applied based on a 2D loss model. The direct rainfall method offers multiple advantages over the traditional method in the case of Kadina, including:

- Overland flow is modelled explicitly, so no assumptions need to be made about times of concentration or catchment boundaries
- Surface storage occurring within catchments is also modelled explicitly, which would likely be substantial within the flat catchments in Kadina.
- Flood prone areas throughout the entire study area can be more easily identified without the need for any assumptions, and the resultant floodplain maps produced would give a better overall picture of flood conditions in the area.

1.2.1 Comparison

Rational method and simplified DRAINS model comparisons were carried out in the early stages of the model development to confirm the direct rainfall TUFLOW model was producing flows in the order of magnitude predicted by the rational method.

In order to compare the results of TUFLOW with an alternate hydrological modelling program, a DRAINS model has been set up for a sample catchment of the TUFLOW model. This has allowed the comparison of the total DRAINS flow with a surface hydrograph from TUFLOW. It is noted that the lack of stormwater infrastructure in Kadina means there are no sub catchments which are captured by a single pipe for comparison, or even a combination of pipes. Thus a surface Plot Output (PO) hydrograph line has been used to read surface flows from TUFLOW discharging from the sample catchment.

It is worth noting the process by which the PO line extracts data from TUFLOW. It reads all flows that cross the PO line, and as such there is a combination of flows represented. The TUFLOW hydrograph does not represent a single channel or pipe flow as in the DRAINS hydrograph. The TUFLOW hydrograph is capturing flows along the length of the PO line whereas the DRAINS hydrograph is considering a simplified version of the sub catchment in which the flows are routed to a single pipe.

The sample catchment is labelled as 3 in Figure 1 below.

Figure 1: Sample Catchment for Comparison

A summary of the DRAINS parameters is outlined below in Table 2.

Table 2: Summary of DRAINS Parameters

DRAINS Parameter	Adopted Value
Paved and supplementary depression storage	1 mm
Grassed depression storage	50 mm
Paved %	40
Supplementary %	5
Paved and supplementary time of concentration	10 mins
Grassed time of concentration	30 mins

Surface hydrographs were obtained in two locations within the TUFLOW model. These can be compared to DRAINS as outlined below. These results were obtained for the 100 year ARI, 1 hour storm.

Table 3: Table of Location of Flow Measurements

	TUFLOW	DRAINS
Block of Allotments within Sample Catchment	Measured along the downstream borders of blocks of allotments as shown in red in Figure 2.	Read as the flow from a single DRAINS sub catchment representing a block of allotments, as shown in yellow in Figure 2.
Discharge Point of Sample Catchment	Measured at the downstream end of the sample catchment, at the main outlet channel for the catchment in Figure 1.	Read as the single end channel flow of the DRAINS model representing the sample catchment.

Figure 2: Sketch of Location of Flow Measurements

A comparison of the results between TUFLOW and DRAINS is outlined below in four categories; peak flow, volume, shape of hydrograph and a longer storm duration check.

1.2.2 Peak flow

A comparison of the peak flows at the sample catchment outflow and the runoff from one block of allotments is shown in Table 4.

The reason for the lower flow recorded in the TUFLOW model from the total catchment can be explained by the geography of the landscape in the sub catchment. The DRAINS flow is directly routed with no flow impediments to the outflow. In reality, before it reaches

the downstream channel of the catchment, there is a road verge which the water needs to build up to get high enough to breach. This action will significantly diminish the peak flow measured at the downstream end of the catchment, after this road verge.

Thus, the DRAINS flow is not an accurate representation of the actual flow behaviour due to the lack of representation of storage in the catchment, and the lower TUFLOW peak flow is considered reasonable.

In the other comparison of runoff from one block of allotments, the peak flow is being measured closer to the source without the consideration of routing through the entire catchment and the peak flows are comparable.

Table 4: Comparison of Peak Flows (1hr Storm)

Flow Location	TUFLOW	DRAINS
Block of Allotments within Sample Catchment	0.07 to 0.17 m3/s	0.14 m3/s
Discharge Point of Sample Catchment	0.5 m3/s	2.15 m3/s

1.2.3 Volume

A comparison of the peak flows at the total catchment outflow and the runoff from one block of allotments is shown in Table 5. These figures are satisfactorily comparable.

Table 5: Comparison of Volume (1hr Storm)

Flow Location	TUFLOW	DRAINS
Discharge Point of Sample Catchment	4,171m3	3,918m3

1.2.4 Shape of hydrograph

The shape of the hydrograph is a measure of the storage delay time or how the catchment produces runoff from a specified rain event.

When considering the additional actions modelled in TUFLOW compared to DRAINS, the rising and falling limbs of the hydrographs from TUFLOW generally match the shape of the DRAINS hydrograph. The rise to peak and fall to 0 represent a reasonable storage time delay from the area under consideration in the TUFLOW hydrographs.

Table 6: Comparison of Peak Flows

Flow Location	Further Explanation of the Hydrographs
Block of Allotments within Sample Catchment *Refer Figure 3*	The light purple TUFLOW 3 hydrograph with higher volume is at the lower end of the catchment and thus receives flow from upstream areas as well as the single block of allotments. The blue TUFLOW 1 hydrograph which dips slightly negative is accounted for by the relative levels in the street which could cause a temporary flow from the road to the houses.

Discharge Point of Sample Catchment *Refer Figure 4*	The dual peak follows the shape of the rainfall hyetograph which has an early low peak and a later higher peak. The time to peak is approximately 1.5 hours which is reasonable when considering the modelling methodology for the travel path within TUFLOW.

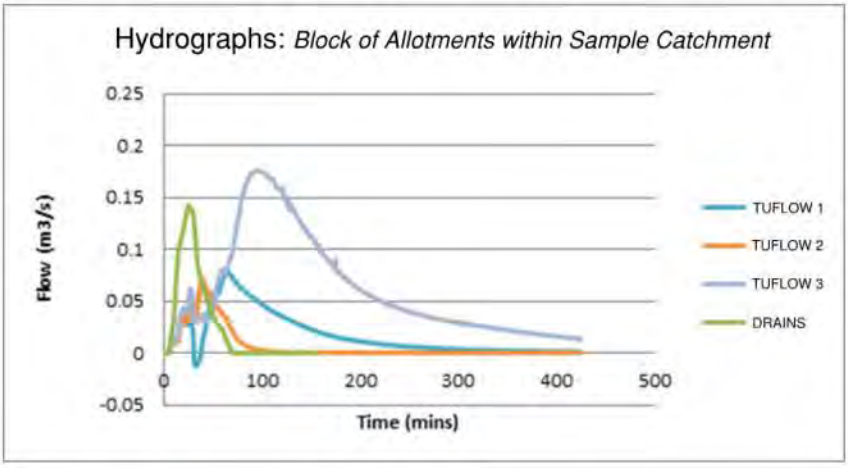


Figure 3: Hydrographs for Blocks of Allotments

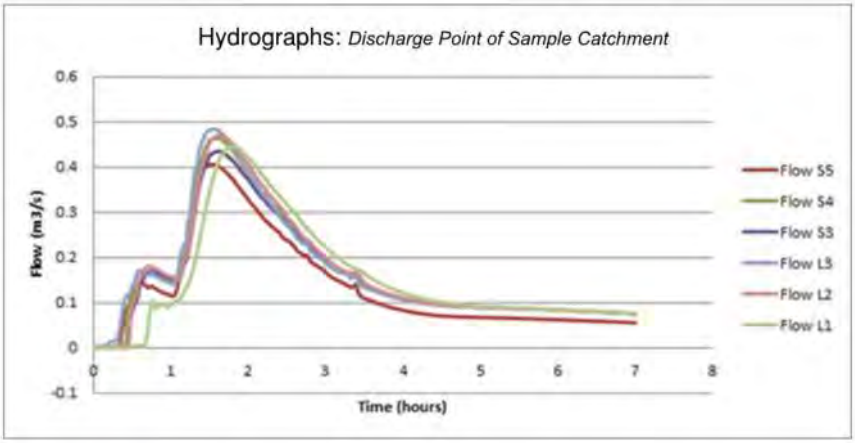


Figure 4: Hydrographs for Flows at Catchment Outlet

1.2.5 Longer Storm Duration

Further to this assessment, a longer storm duration of 12 hours, at the 100 year ARI was considered.

As shown in Table 7 the peak flow and volume compare well in the longer storm.

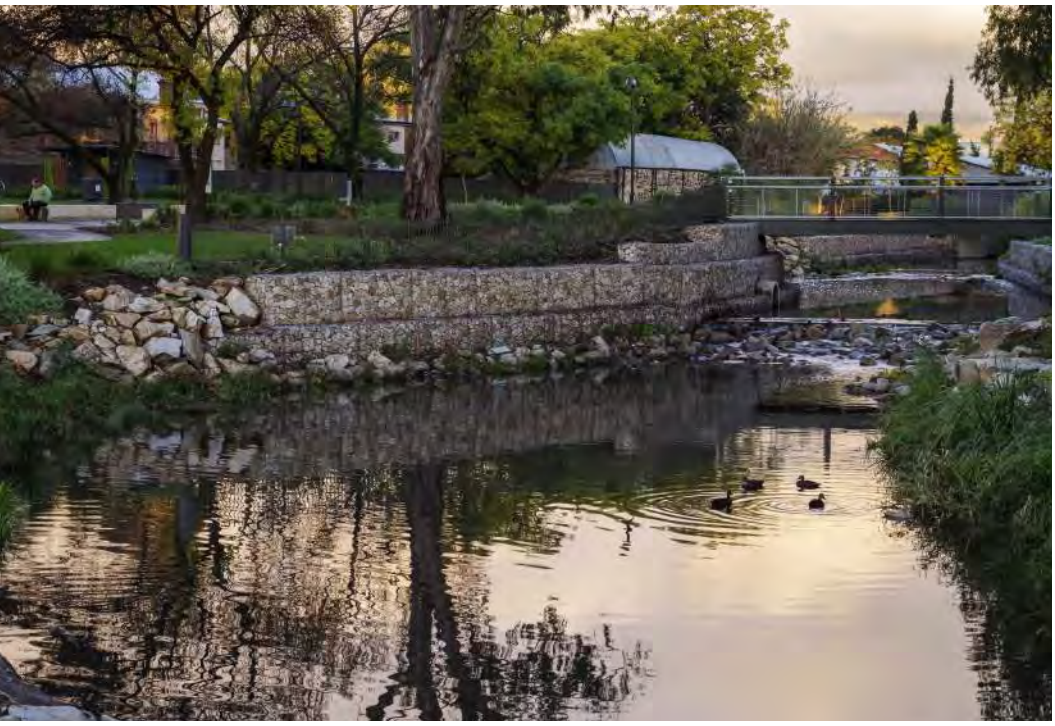
Table 7: Comparison of Peak Flow and Volume (100yr 12hr Storm)

Discharge Point of Sample Catchment	TUFLOW	DRAINS
Peak Flow	0.9 m3/s	1.18 m3/s
Volume	12,689 m3	13,321 m3

In conclusion, the comparison of the TUFLOW model results with the results of a DRAINS model produces sufficiently similar results. This methodology was confirmed and accepted by DPTI and formed the basis of the modelling for the SMP.

WALLBRIDGE & GILBERT
Consulting Engineers

AZTEC ANALYSIS
Engineers & Project Managers



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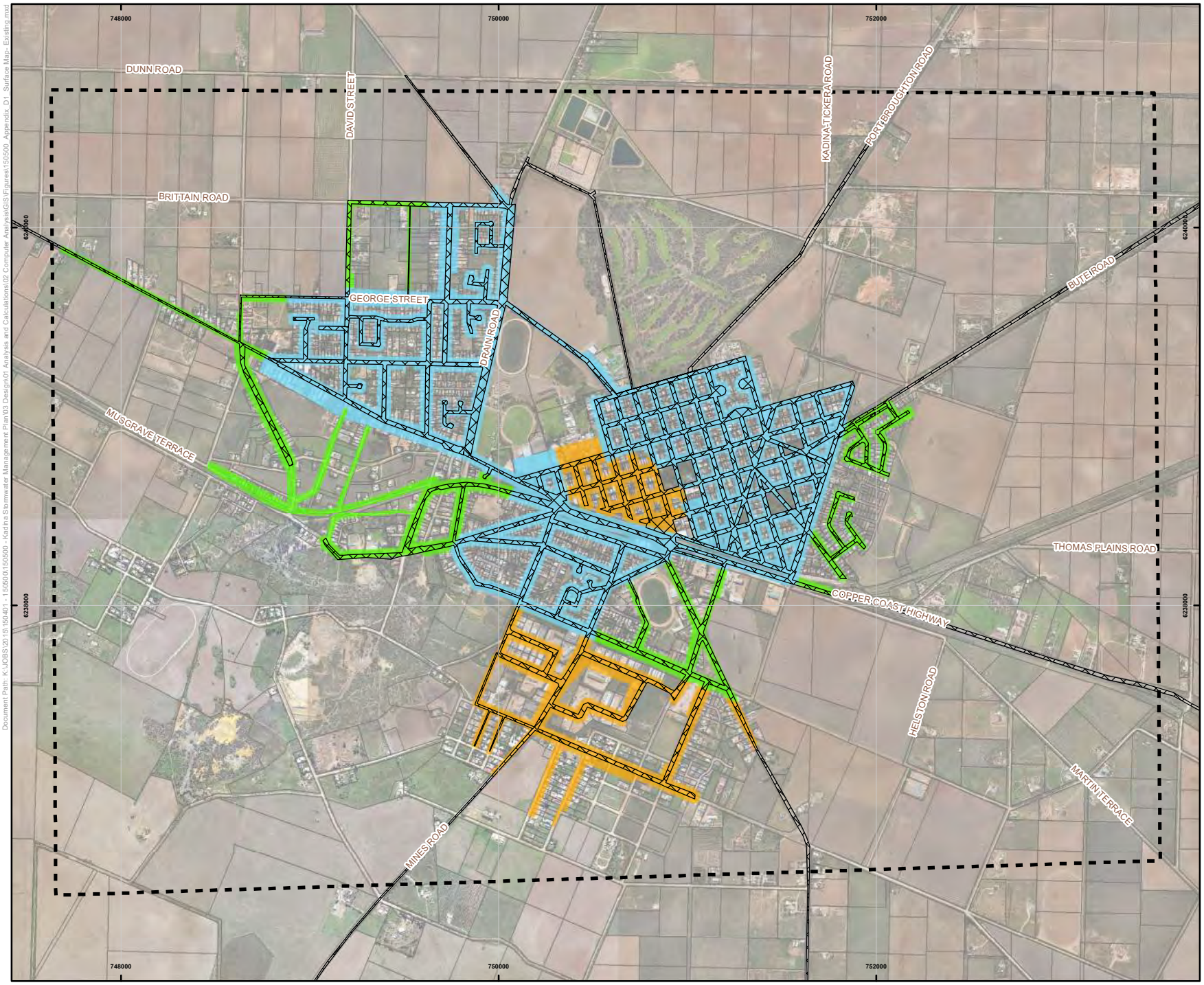
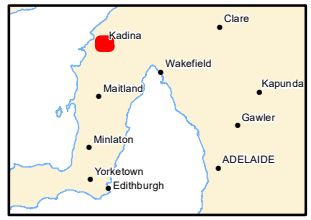
APPENDIX D

SURFACE DEFINITION MAPS





LEGEND

- Cadastre
- Roads
- Model Bounds

Surface Definition- Existing Scenario

- High Density
- Low Density
- Industrial

Material definition shown for input into TUFLOW. Areas shown are directly connected impervious area approximations as described in the Kadina SMP.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
WALLBRIDGE GILBERT AZTEC

Appendix D1

Kadina Stormwater Management Plan

Surface Definition- Existing Scenario

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

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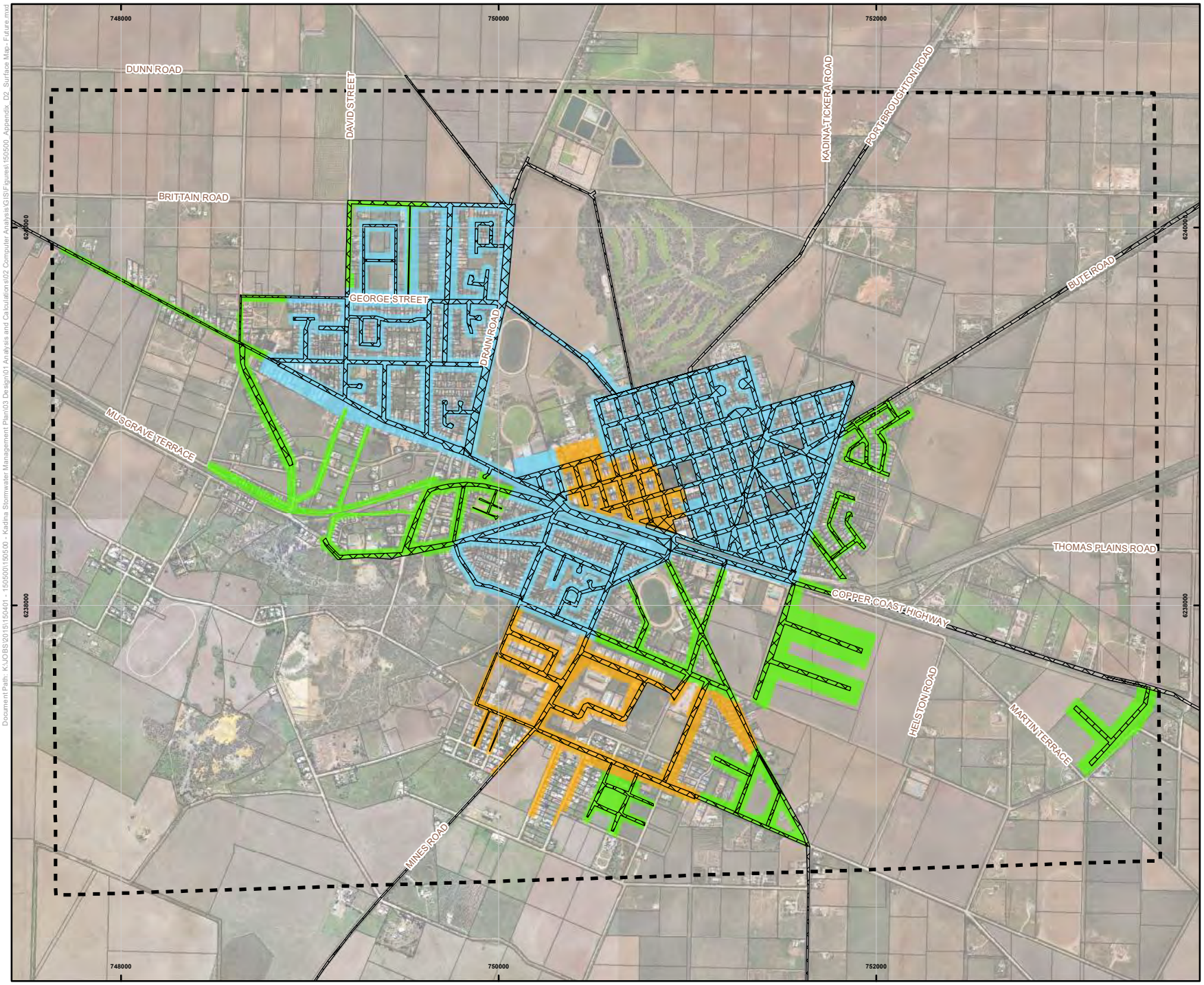

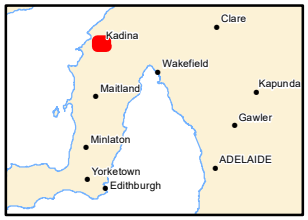

LEGEND

- Cadastre
- Roads
- Model Bounds

Surface Definition- Future Scenario

- High Density
- Low Density
- Industrial

Material definition shown for input into TUFLOW. Areas shown are directly connected impervious area approximations as described in the Kadina SMP.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

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Appendix D2

Kadina Stormwater Management Plan

Surface Definition- Future Scenario

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Note: The information shown on this map is a copyright of WGA 2017

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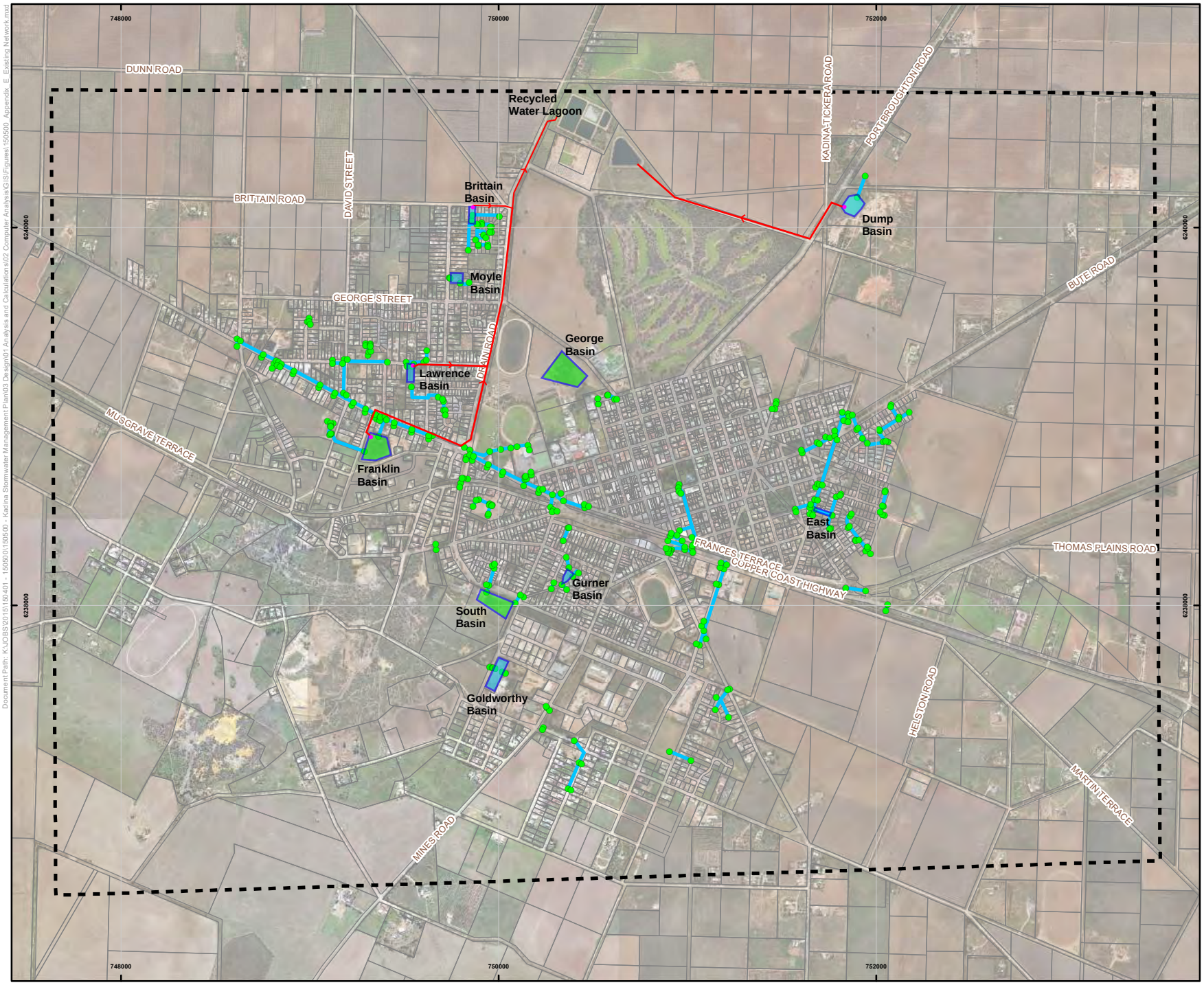
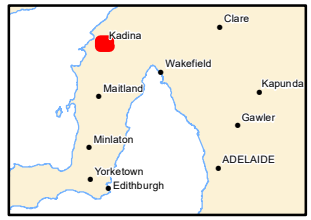
APPENDIX E

DRAINAGE NETWORK





LEGEND

- Stormwater Pit
- Stormwater Pipe
- Cadastre
- Model Bounds
- Retention Basin
- Wetland
- Stormwater Pump Station
- Pumping Main

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

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WALLBRIDGE GILBERT AZTEC

Appendix E

Kadina Stormwater Management Plan

Existing Stormwater Network

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

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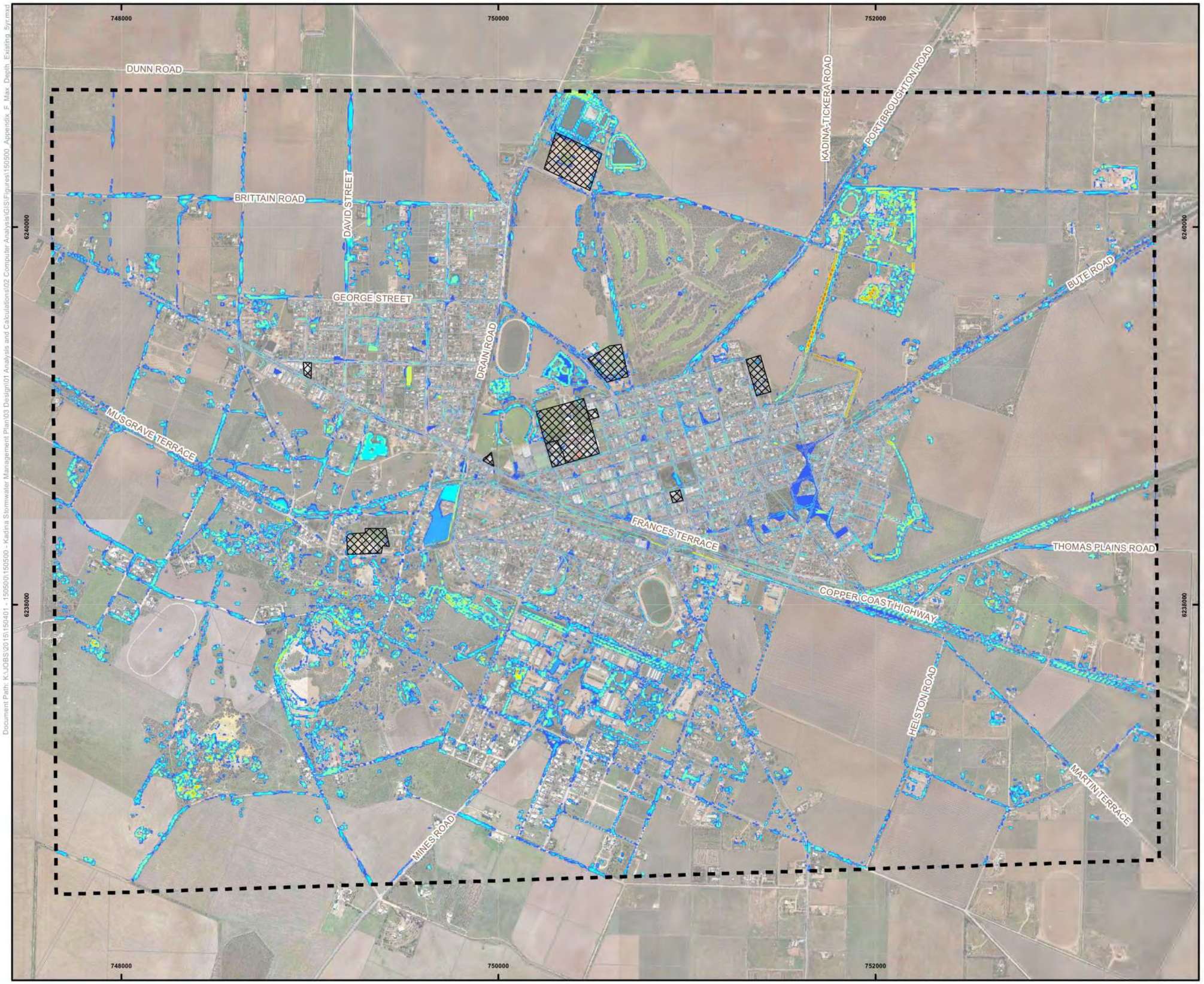
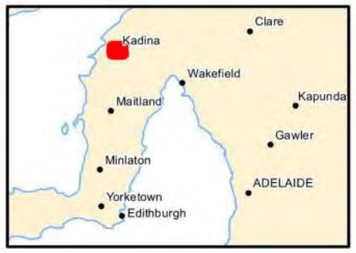
APPENDIX F

FLOODPLAIN AND HAZARD MAPS





LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

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Appendix F

Kadina Stormwater Management Plan

Max Depth- Existing Scenario (5yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

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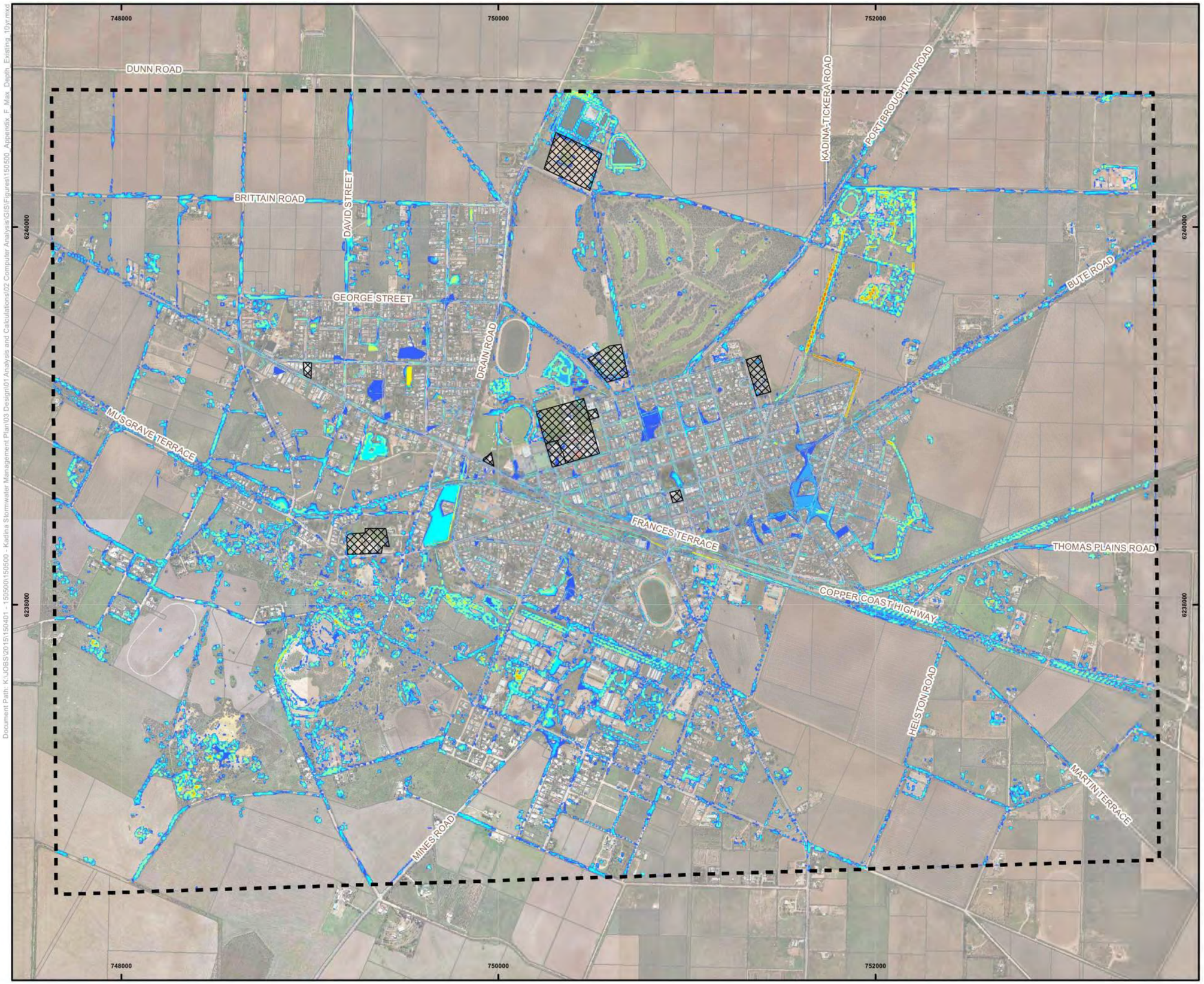

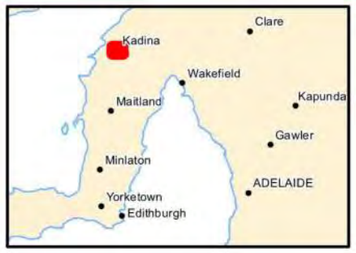

LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

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Appendix F

Kadina Stormwater Management Plan

Max Depth- Existing Scenario (10yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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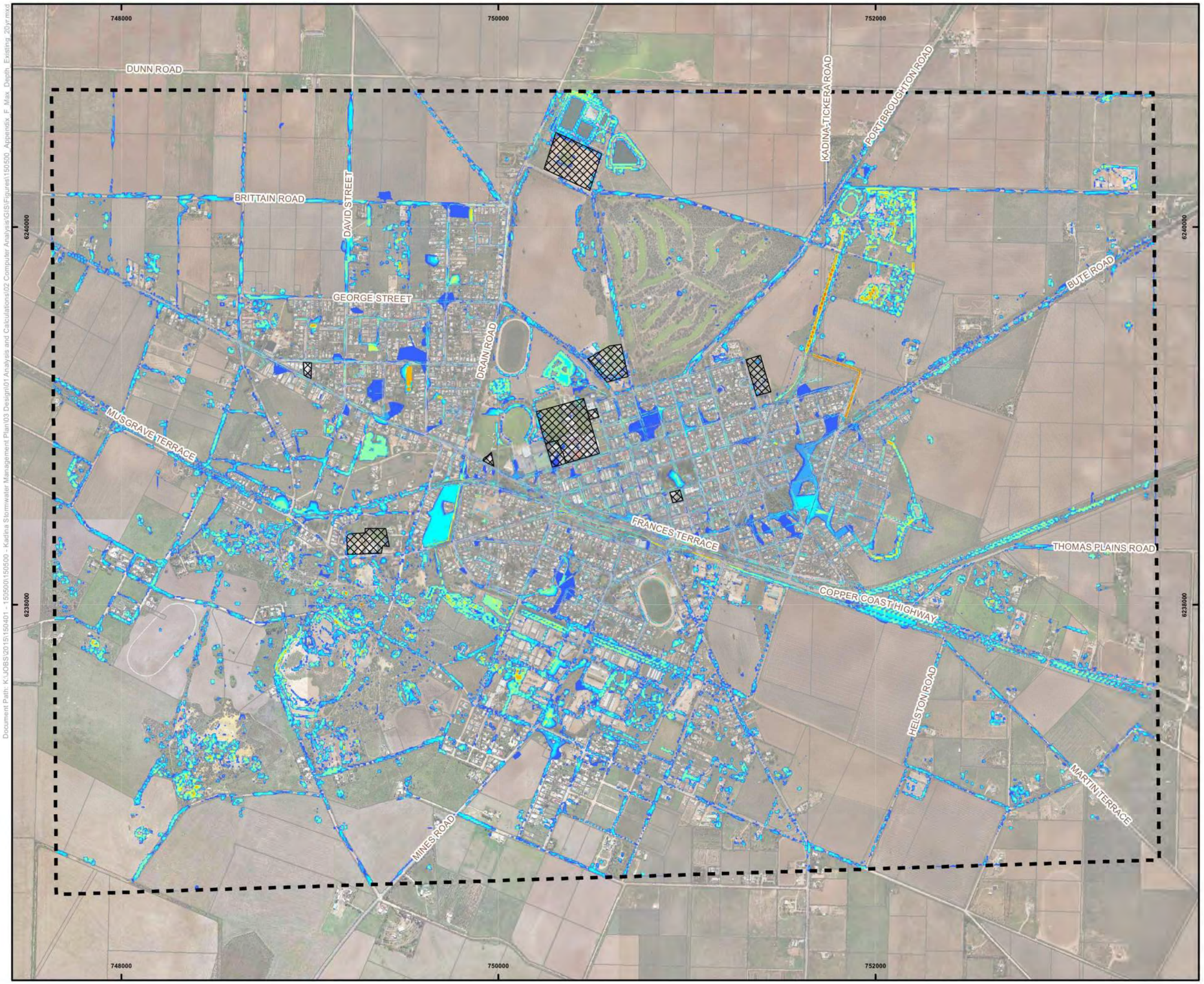

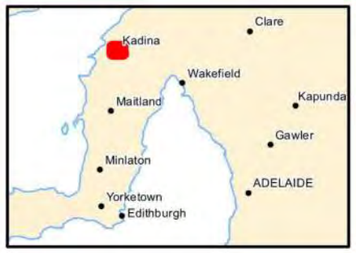

LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

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Appendix F

Kadina Stormwater Management Plan

Max Depth- Existing Scenario (20yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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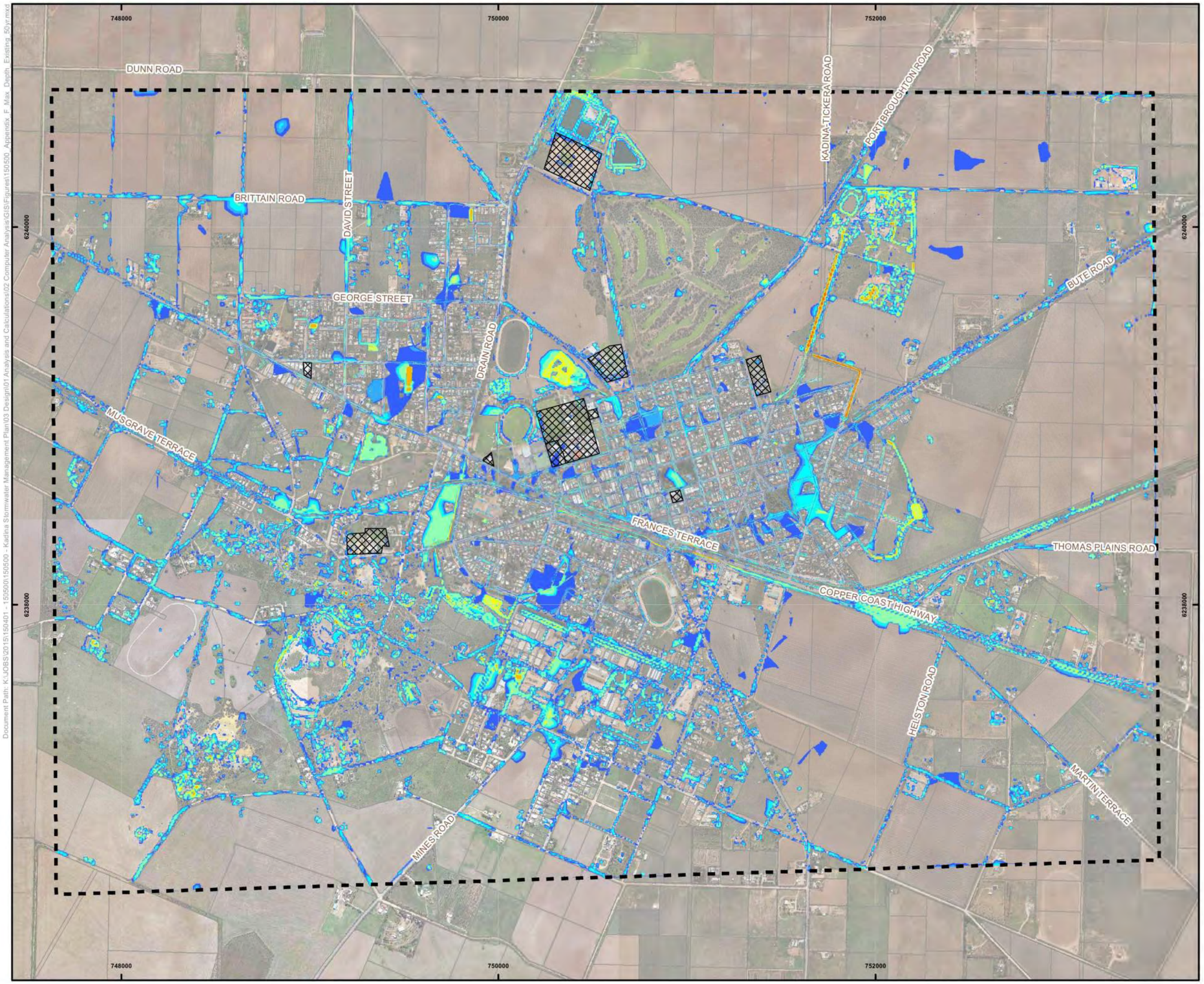

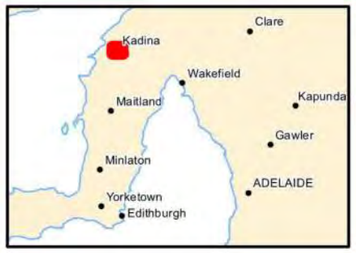

LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

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Appendix F

Kadina Stormwater Management Plan

Max Depth- Existing Scenario (50yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

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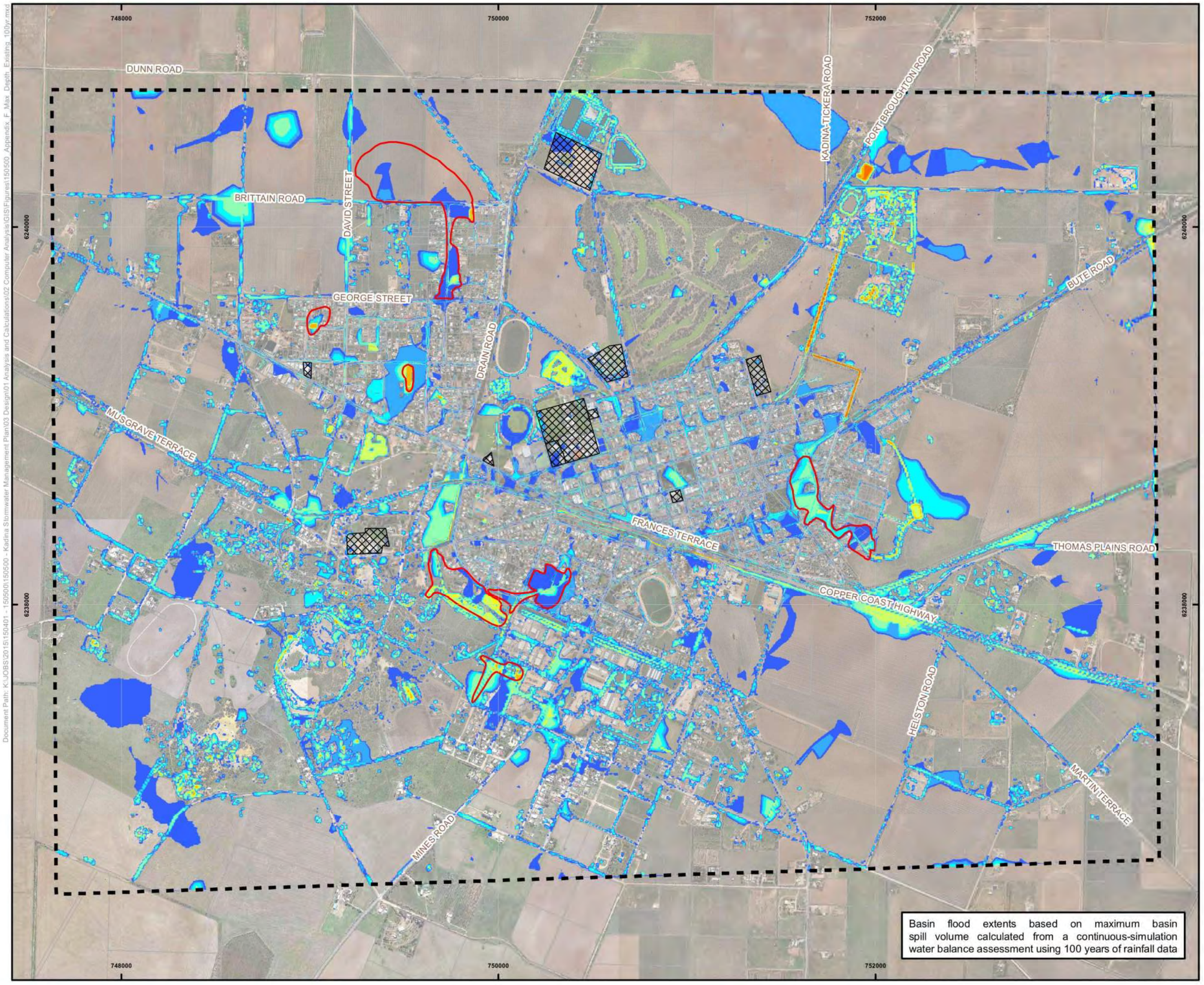
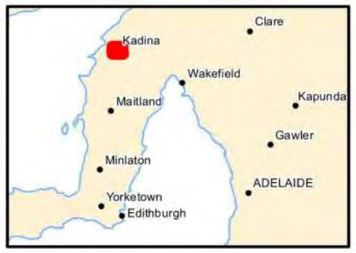


Basin flood extents based on maximum basin spill volume calculated from a continuous-simulation water balance assessment using 100 years of rainfall data



LEGEND

- Basin Overflow Extent (Existing)
- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA

WALLBRIDGE GILBERT AZTEC

Appendix F

Kadina Stormwater Management Plan

Max Depth- Existing Scenario (100yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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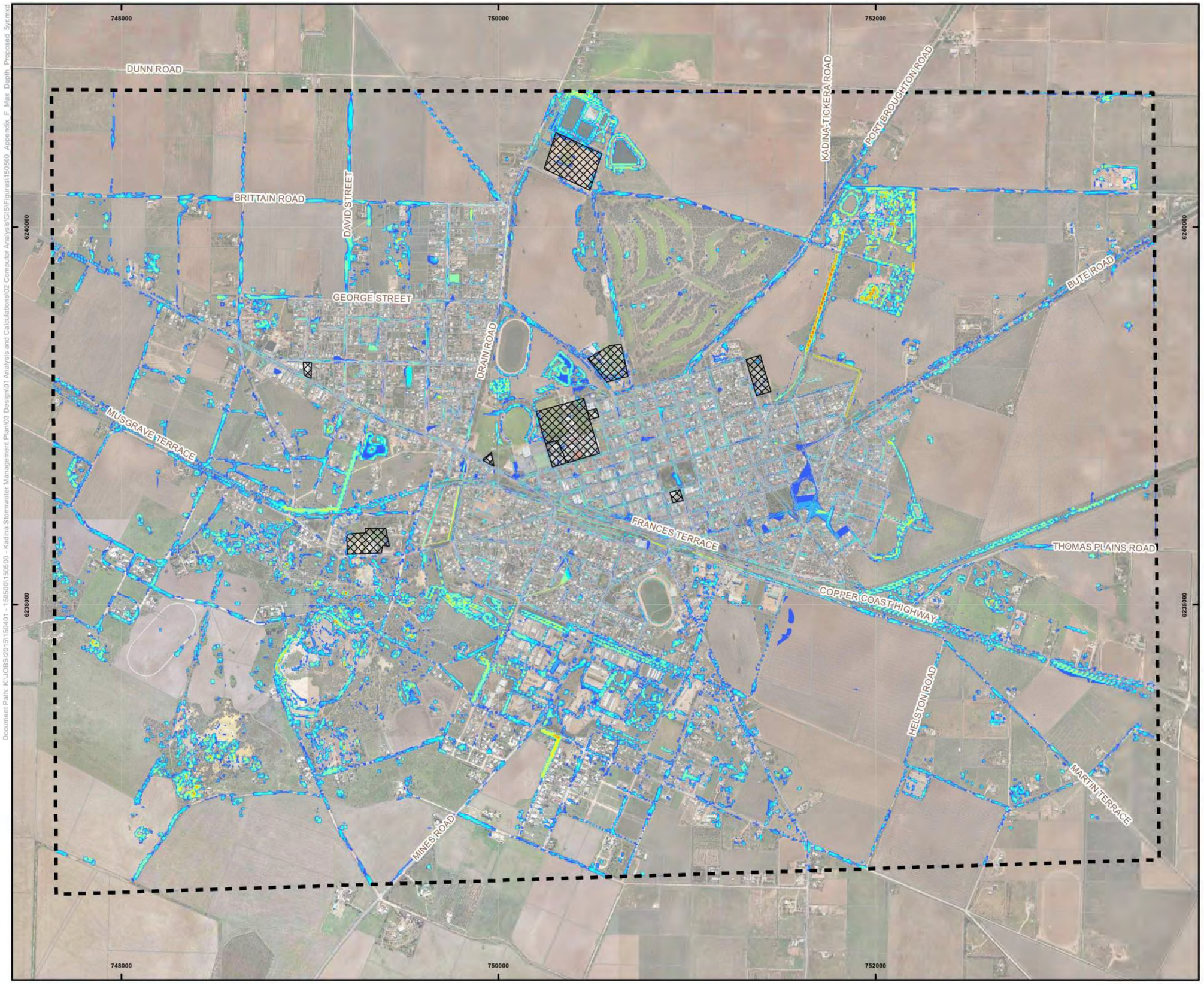

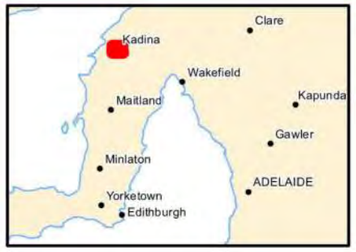

LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA

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Appendix F

Kadina Stormwater Management Plan

Max Depth- Proposed Scenario (5yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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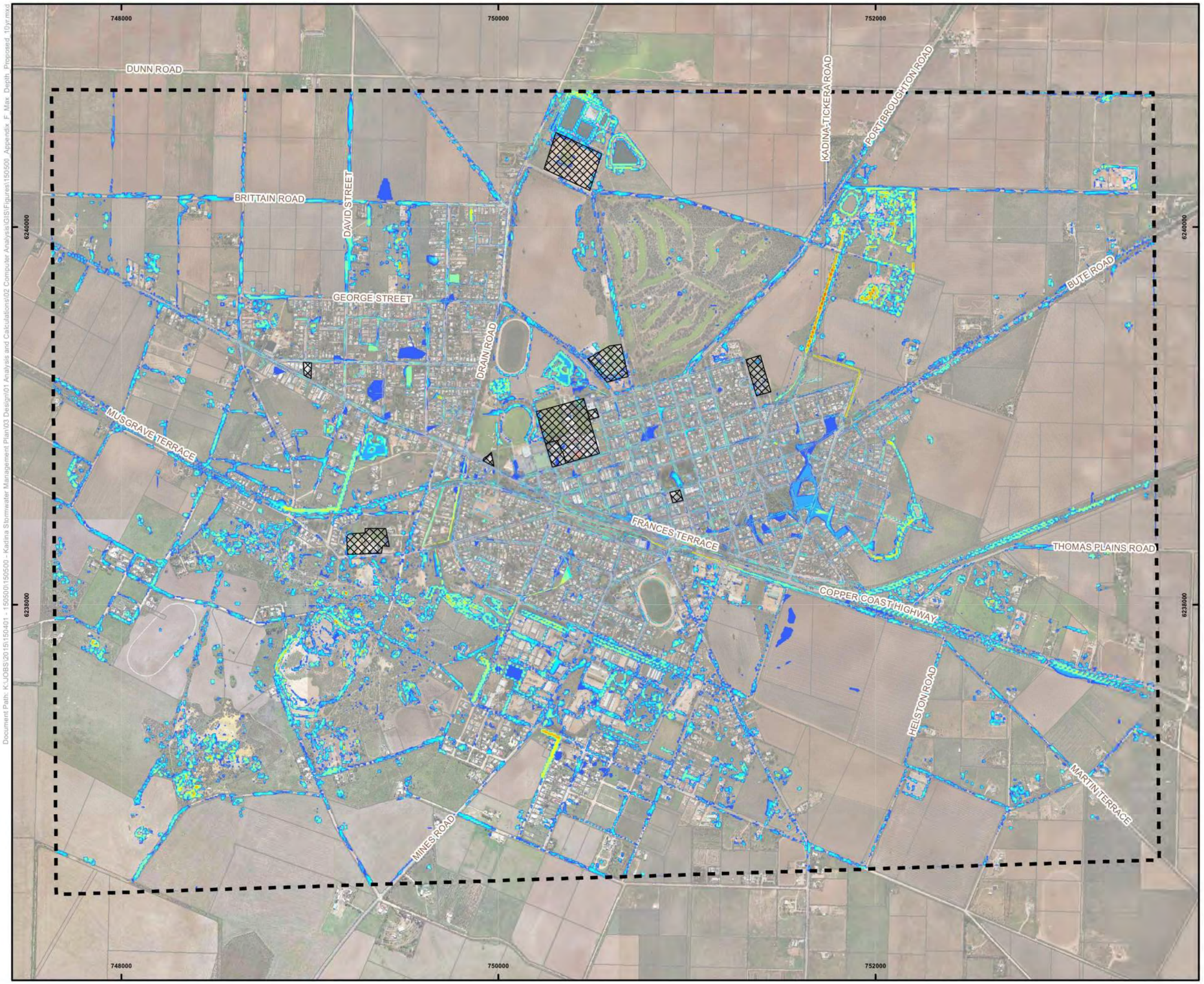

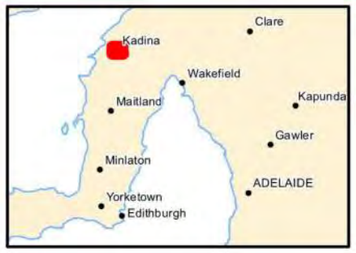

LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA

WALLBRIDGE GILBERT AZTEC

Appendix F

Kadina Stormwater Management Plan

Max Depth- Proposed Scenario (10yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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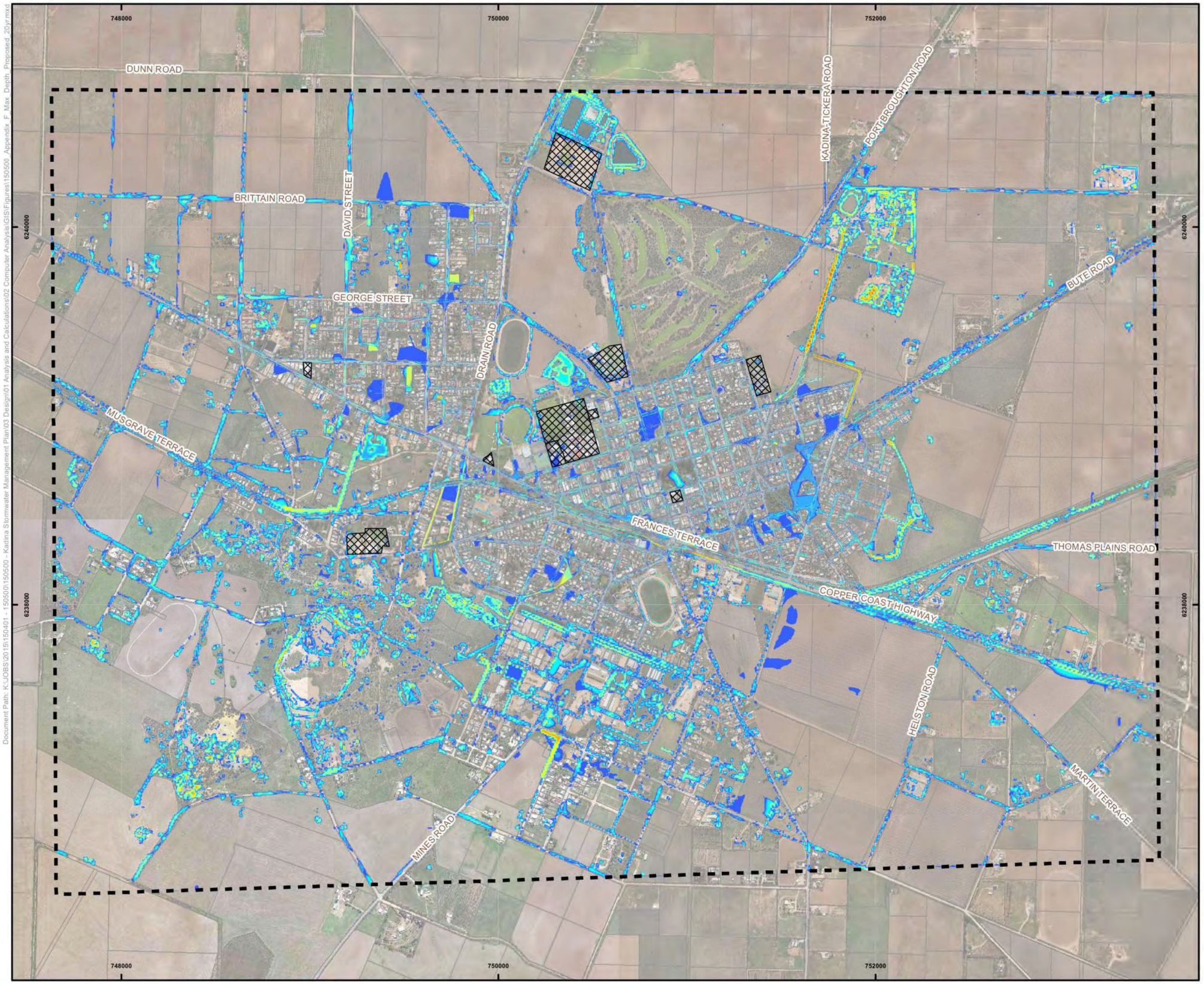

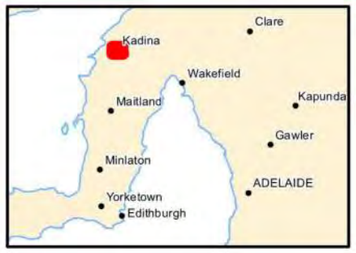

LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
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Appendix F

Kadina Stormwater Management Plan

Max Depth- Proposed Scenario (20yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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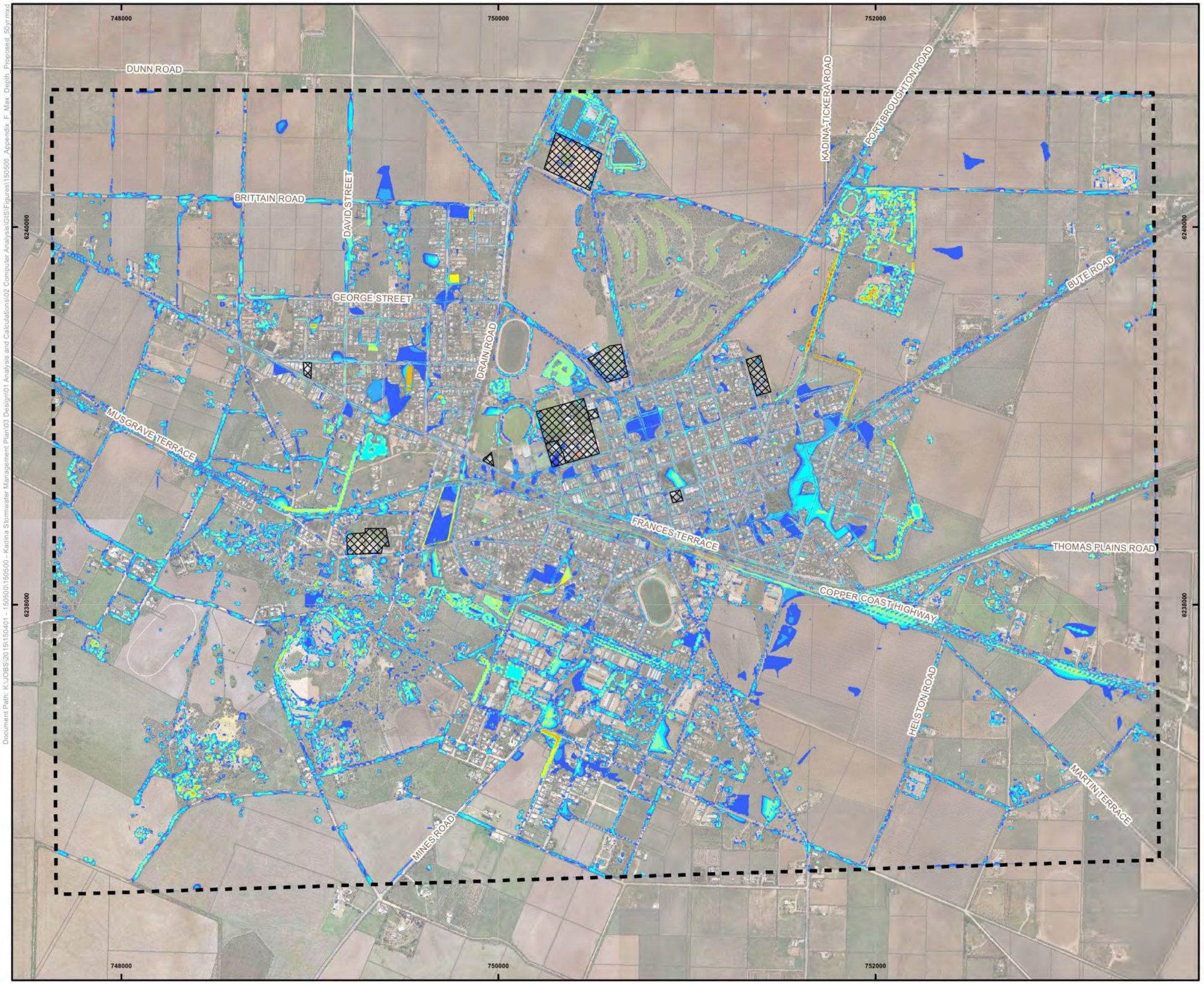

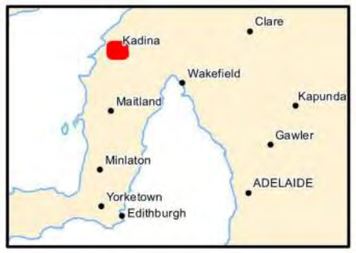

LEGEND

- Model Bounds
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
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Appendix F

Kadina Stormwater Management Plan

Max Depth- Proposed Scenario (50yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

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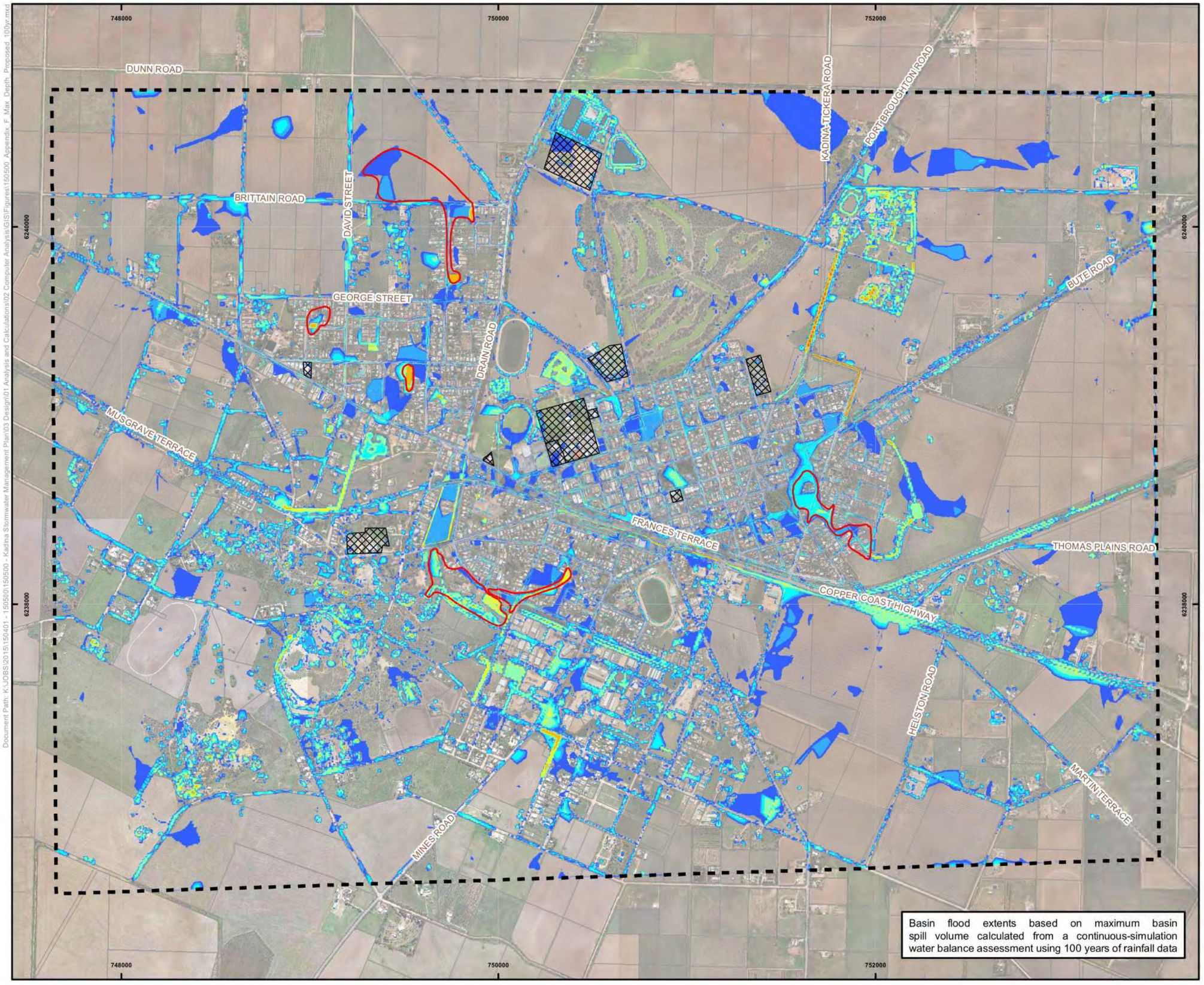
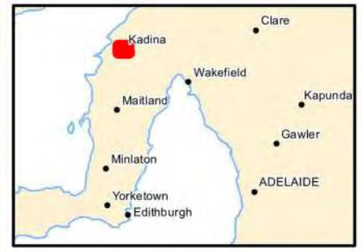




LEGEND

- Model Bounds
- Basin Overflow Extent (Proposed)
- High Risk Infrastructure
- Cadastre

Maximum Inundation Depth (m)

- 0 - 0.05 (no colour)
- 0.05 - 0.1
- 0.10 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.5 - 0.75
- 0.75 - 1.0
- 1.0 - 2.0
- 2.0- 4.0
- > 4.0 (Max 5.59)

Simulation H- Represents a maximum of the 0.5hr, 1hr and 2hr storms.

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
WALLBRIDGE GILBERT AZTEC

Appendix F

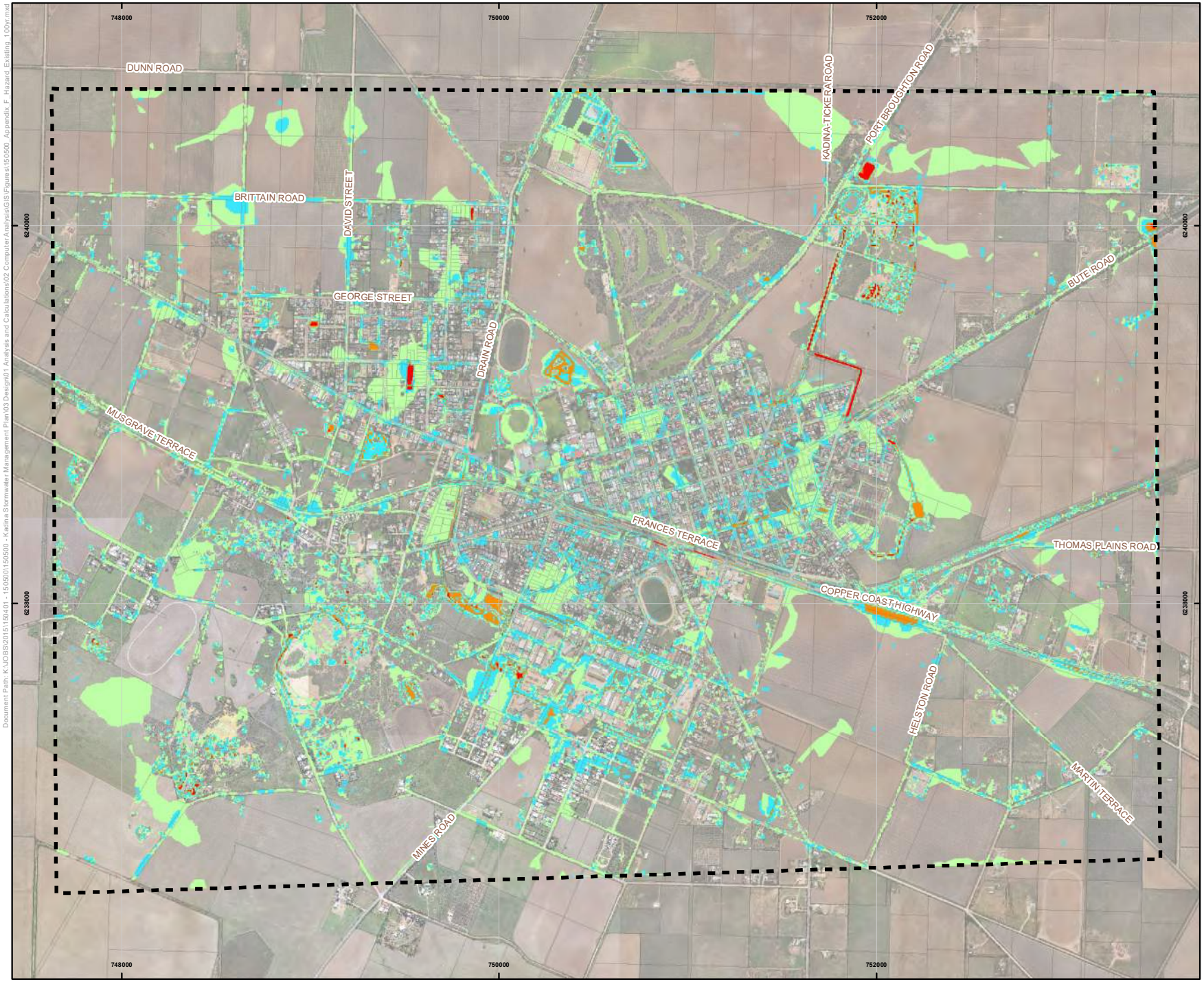
Kadina Stormwater Management Plan

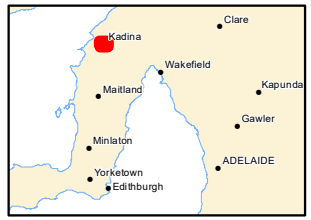
Max Depth- Proposed Scenario (100yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

Document Path: K:\JOBS\2015\150401 - 150500\150500 - Kadina Stormwater Management Plan\03 Design\01 Analysis and Calculations\02 Computer Analysis\GIS\Figures\150500 Appendix F Max Depth Proposed 100yr.mxd





LEGEND

- Cadastre
- Model Bounds

Hazard Ranking

- Low
- Moderate
- High
- Extreme

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA

WALLBRIDGE GILBERT AZTEC

Appendix F

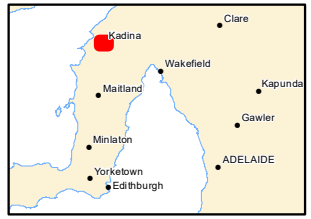
Kadina Stormwater Management Plan

Hazard Map- Existing (100yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2018

Document Path: K:\JOBS\201511504\01 - 15050\01150500 - Kadina Stormwater Management Plan\03 Design\01 Analysis and Calculations\02 Computer Analysis\GIS\Figures\150500_Appendix_F_Hazard_Existing_100yr.mxd



LEGEND

- Cadastre
- Model Bounds

Hazard Ranking

- Low
- Moderate
- High
- Extreme

N

0 200 400 600 800 m

Scale 1:28,221 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA

WALLBRIDGE GILBERT AZTEC

Appendix F

Kadina Stormwater Management Plan

Hazard Map- Future (100yr)

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2018

Document Path: K:\JOBS\2015\150401 - 150500\150500 - Kadina Stormwater Management Plan\03 Design\01 Analysis and Calculations\02 Computer Analysis\GIS\Figures\150500_Appendix F_Hazard_Future_100yr.mxd

APPENDIX G

COUNCIL REPORTED FLOODING

<u>19/20 May 2015: 14mm</u>

<u>Kadina</u>

Ewing St

No flooding occurring

Martin Tce

Basin was just over half full. Drain still had water in it. Looks to be working well.

Kadina CBD

The whole CBD seems to flow to Frances Terrace with everything East of Draper st flows east and enters drainage which goes under Ewing St. West of this enters drainage near Gunnings and seems to travel along the path to the drainage at the round-about but could not lift this heavy duty lids to find out. Large amount of water pooling at the intersection of Hallet and Frances Tce.

OTR
we never close!
Ultimate
135.7
133.9
74.9
SMOKEMART

13th Jan 2017

Kadina: 14.4mm

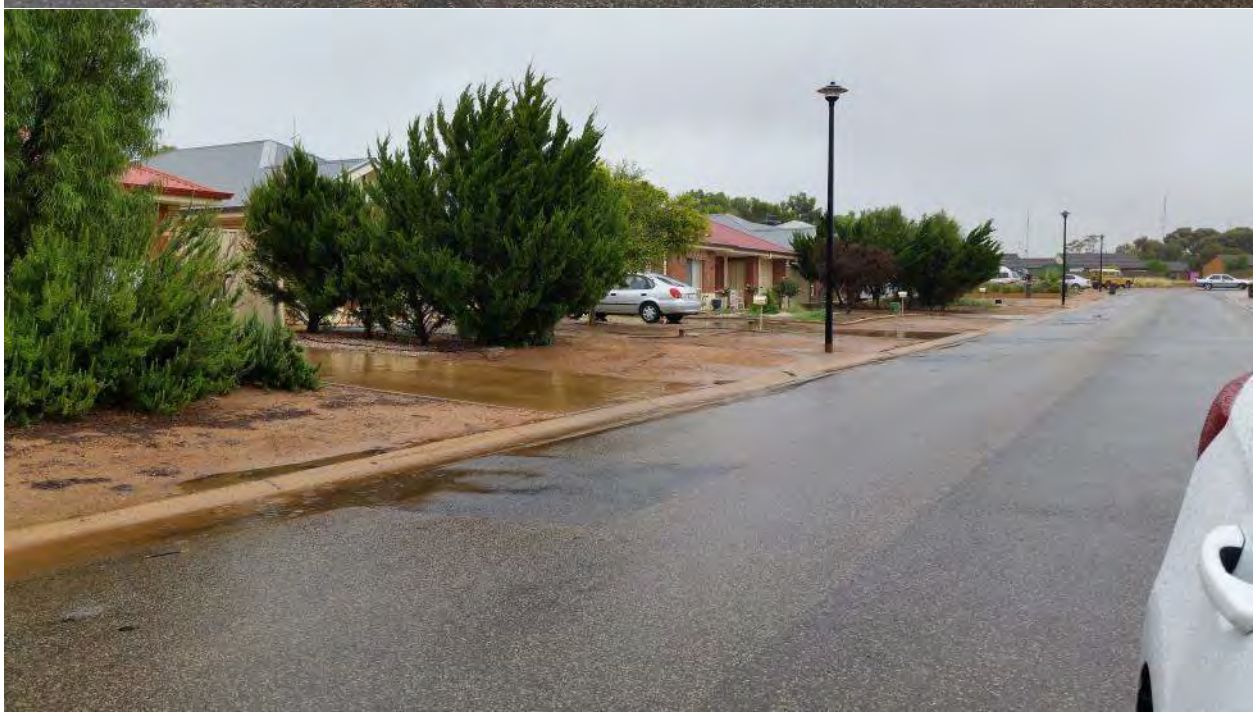
Kadina

Lipson Rd: Very flat area, with multiple areas on street pooling.

Paulson Rd: Low area, prone to flooding as water cannot escape.

Lawrence St & Olive Pde: Very flat areas, pooling in multiple locations

John Olsen Drive: Prone to flooding. Possible for capacity/maintanence issue in Kadina East system.



28 Dec 2016

Kadina: 61mm

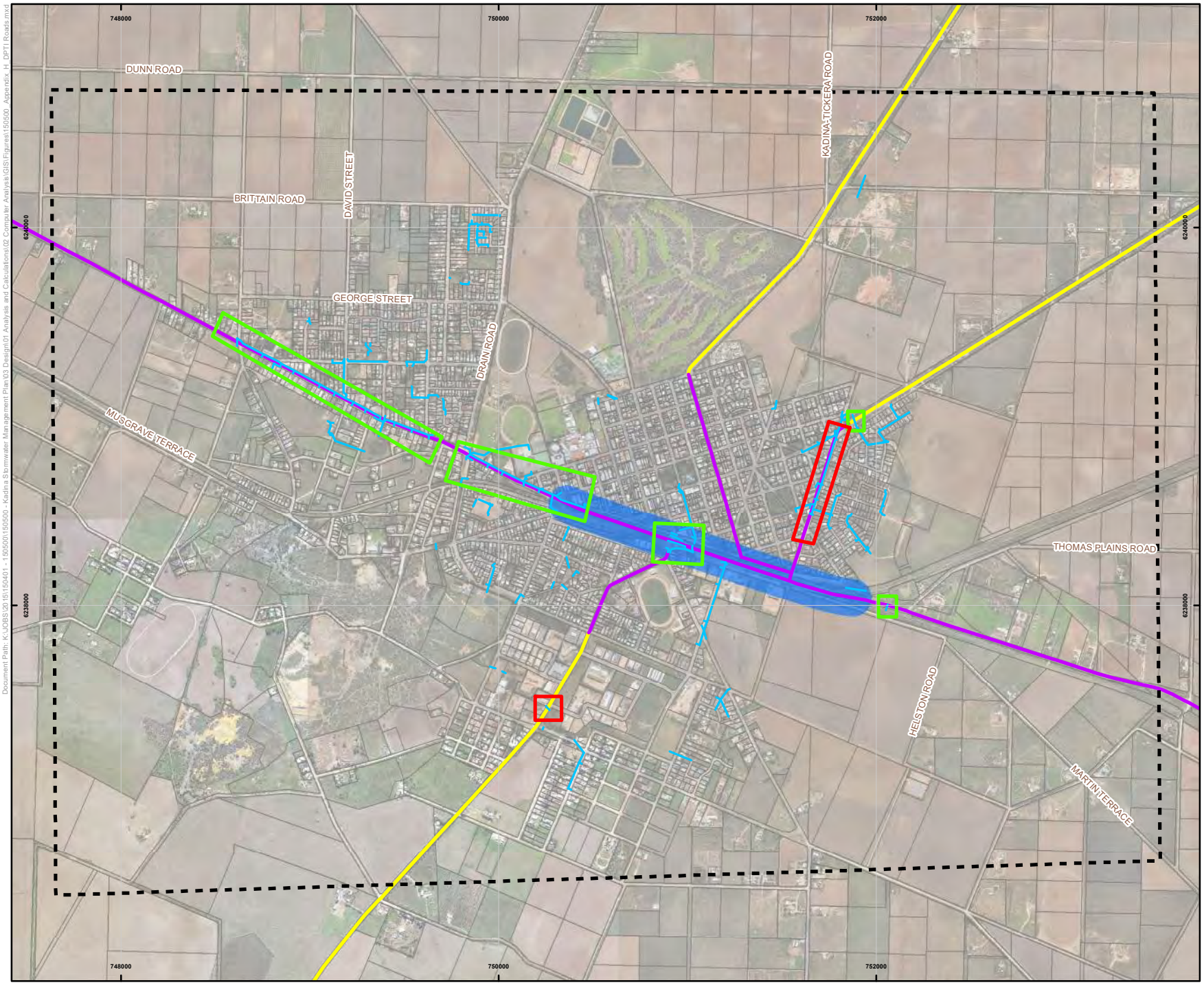
19 John Olsen Drive, Kadina **Lawrie - 0408 749 444** Believes the flooding occurred for 1 of 2 reasons. Either the system cannot cope with the new developments in the area. The outlet at the end of the open drain towards the old dump is blocked and not maintained. Sump in catchment next door to property may be getting blocked.

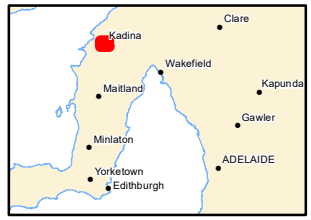
Solution: Kadina w/s study for solution

Action – Field gully cover to be installed

APPENDIX H

DPTI ROAD STORMWATER MANAGEMENT REQUIREMENTS





LEGEND

- Stormwater Pipe
- Sealed Kerbed DPTI Road
- Sealed Unkerbed DPTI Road
- Does not meet DPTI Requirements
- Meets DPTI Requirements
- Swale
- Cadastre
- Model Bounds

N

0 200 400 600 800 m

Scale 1:27,500 @ A4

Coordinate System: GDA 1994 MGA Zone 53

WGA
WALLBRIDGE GILBERT AZTEC

Appendix H

Kadina Stormwater Management Plan

Network on DPTI Roads

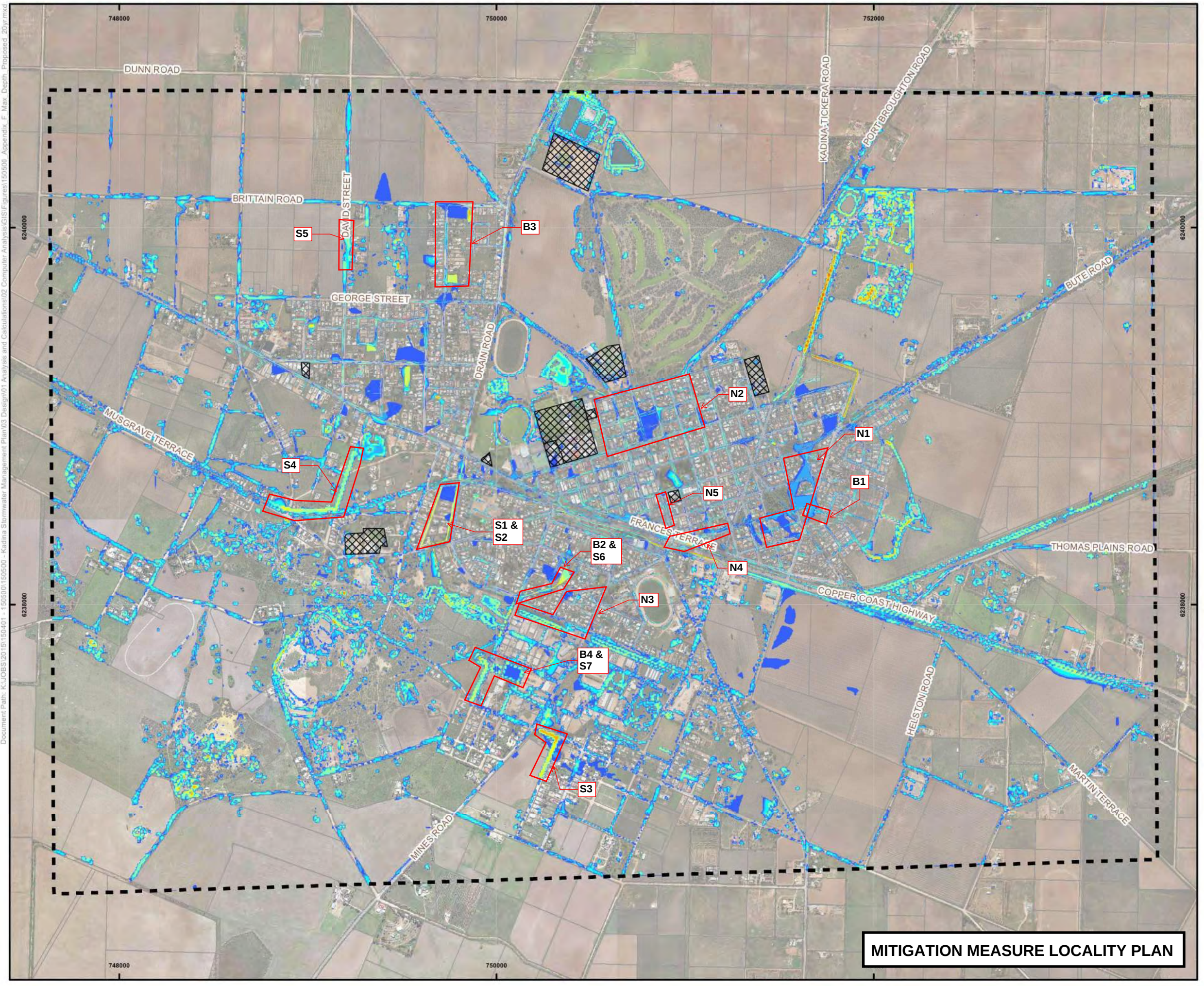
Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2017

Document Path: K:\JOBS\20151510401 - 150500\150500 - Kadina Stormwater Management Plan\03 Design\01 Analysis and Calculations\02 Computer Analysis\GIS\Figures\150500 - Appendix H - DPTI Roads.mxd

APPENDIX I

PROPOSED MITIGATION MEASURES



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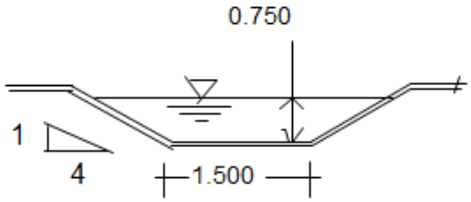
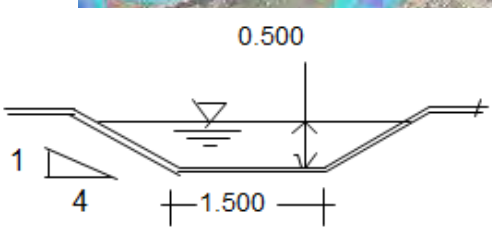
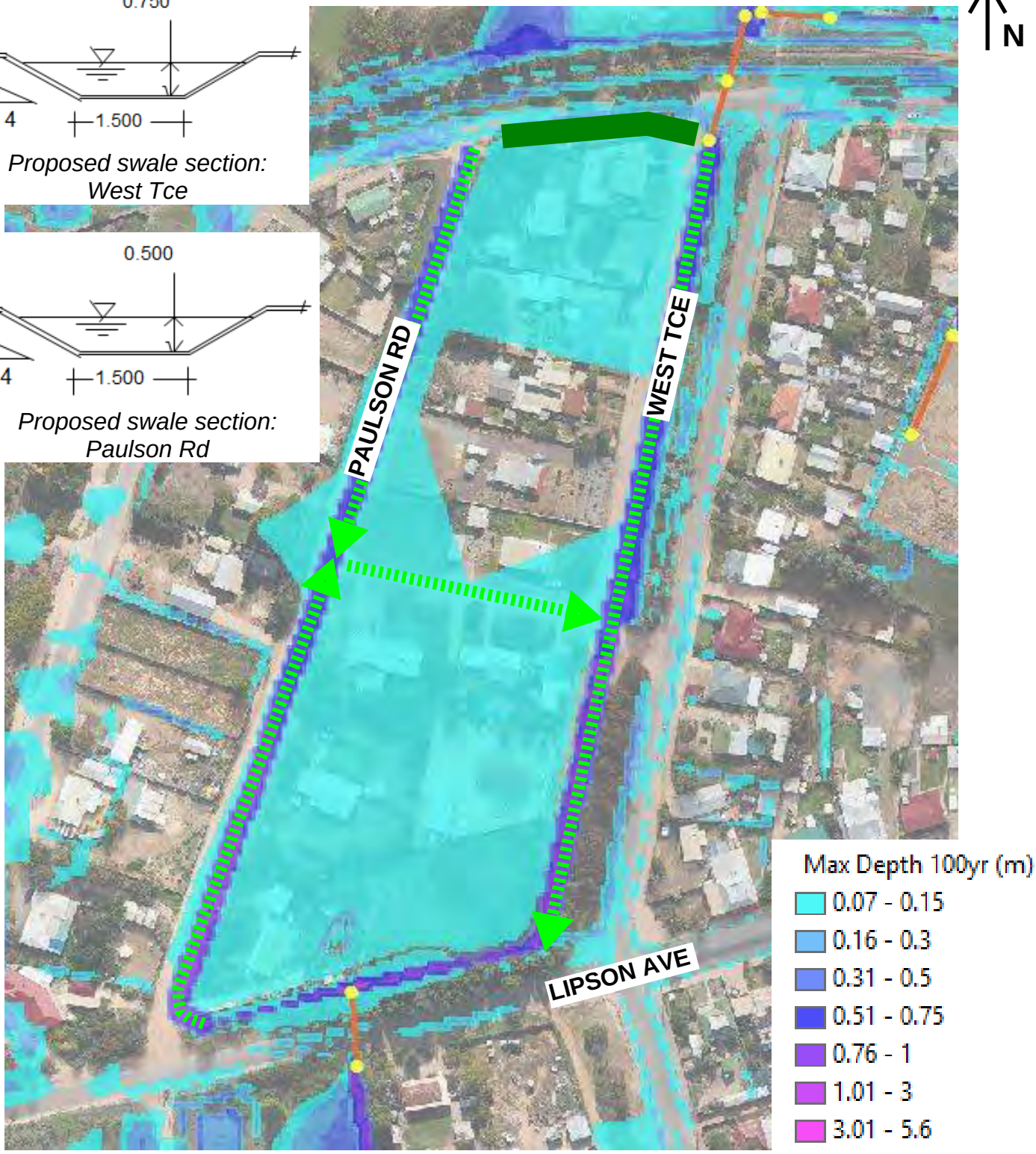


Proposed swale section: West Tce



Proposed swale section: Paulson Rd



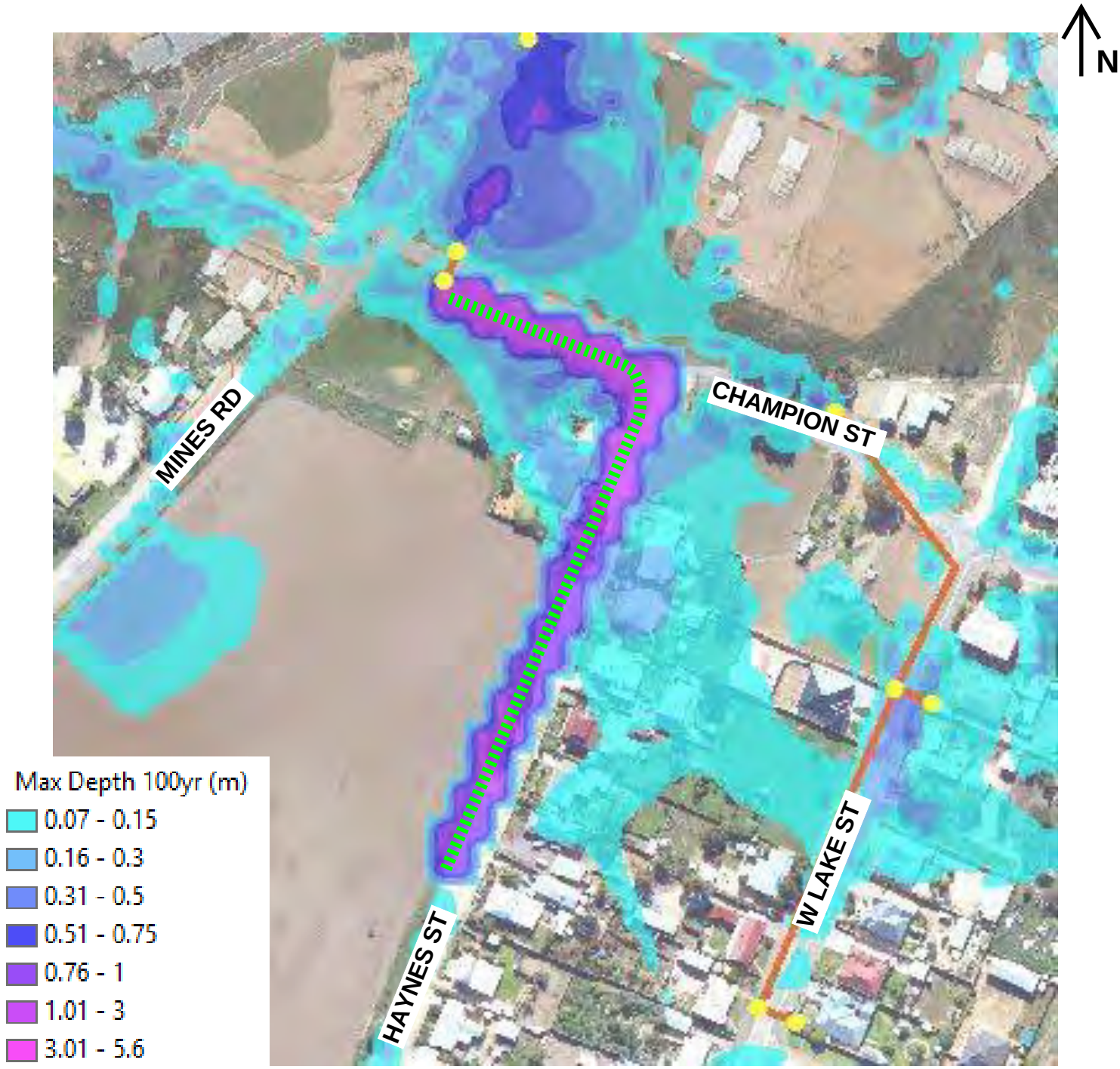
S1 & S2: West Tce & Paulson Rd

Improve capacity of existing swale down West Tce. Construct swale down Paulson Rd. Construct levee to protect flows from Powell Tce. Check culvert capacity downstream.

NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Swale
- Proposed Bund



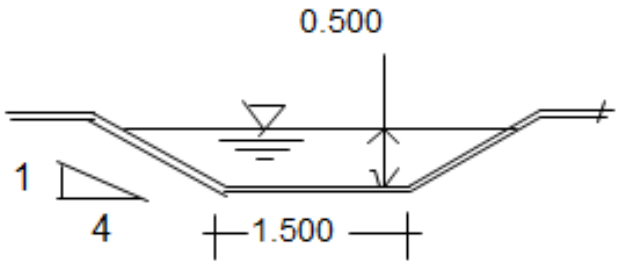
S3: Haynes St

Construct swale to provide a defined flow path.

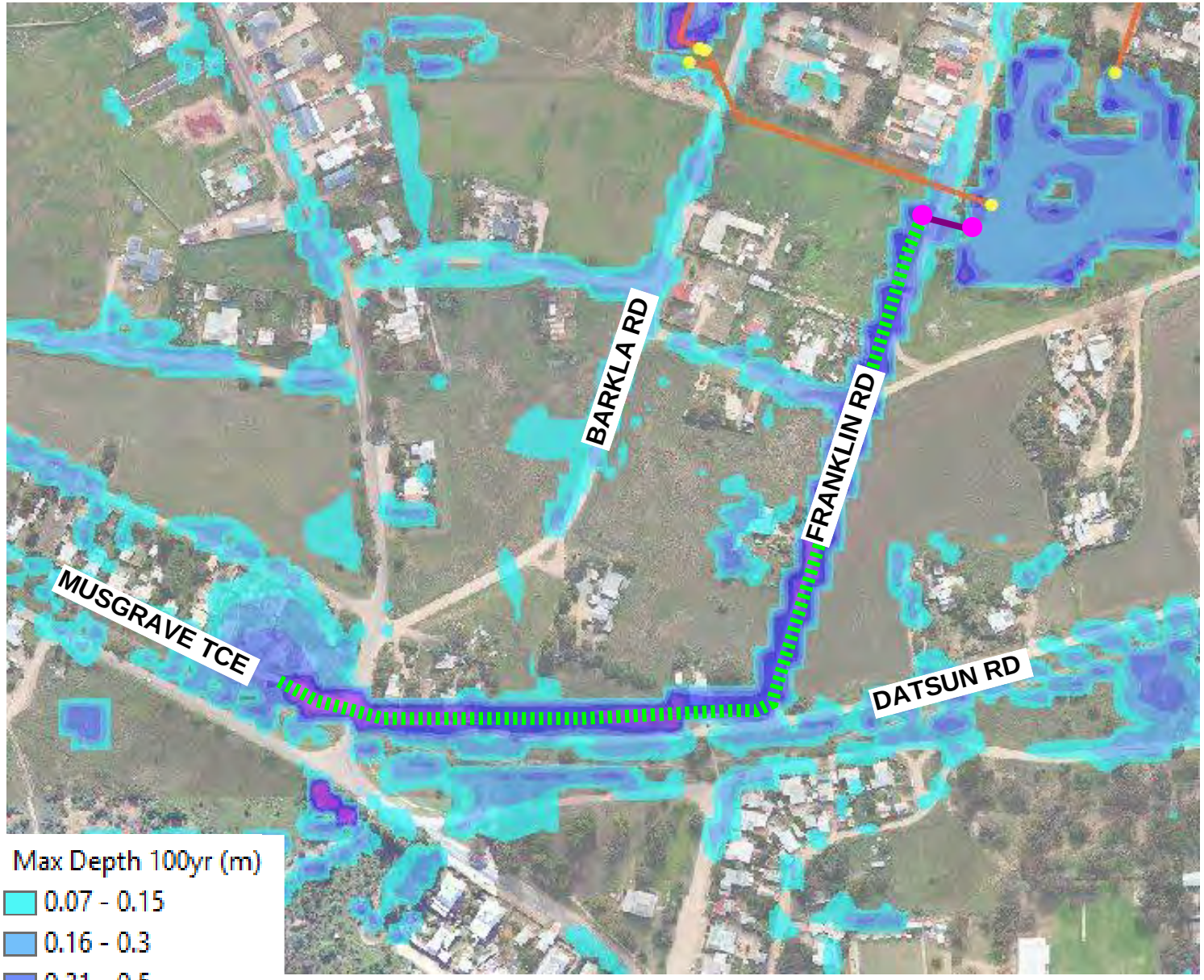
NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Swale



Proposed swale section



Max Depth 100yr (m)

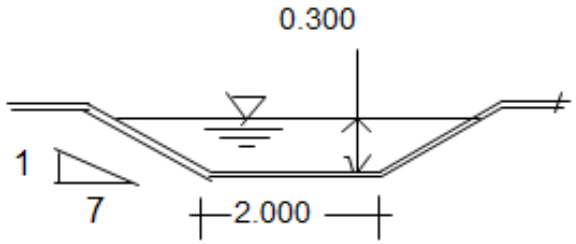
- 0.07 - 0.15
- 0.16 - 0.3
- 0.31 - 0.5
- 0.51 - 0.75
- 0.76 - 1
- 1.01 - 3
- 3.01 - 5.6

N

S4: Musgrave Tce

Construct swale to provide defined flow path. Include culverts at road crossings.

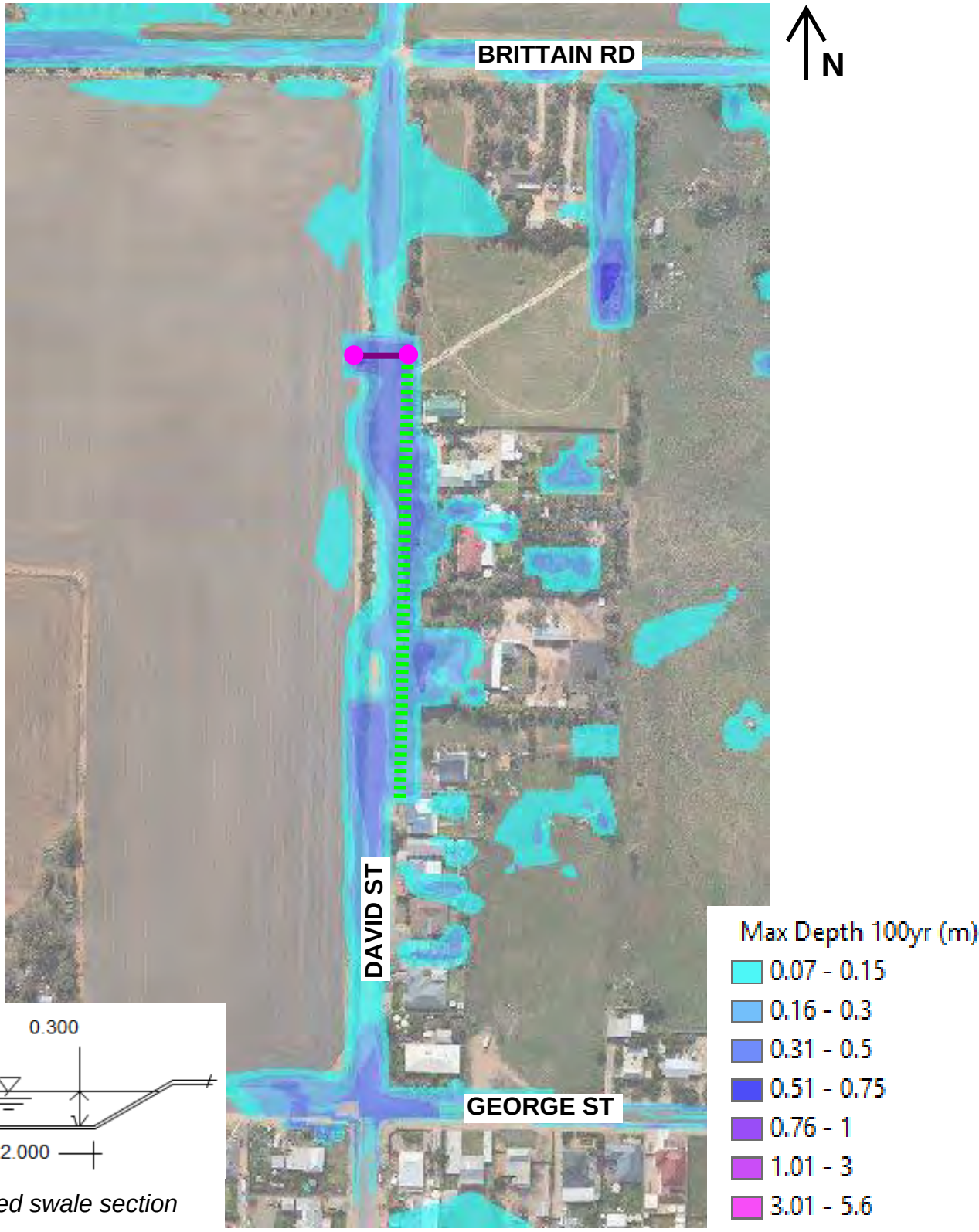
NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

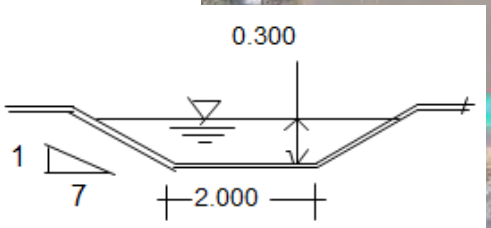


Proposed swale section

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe
- Proposed Swale





Proposed swale section

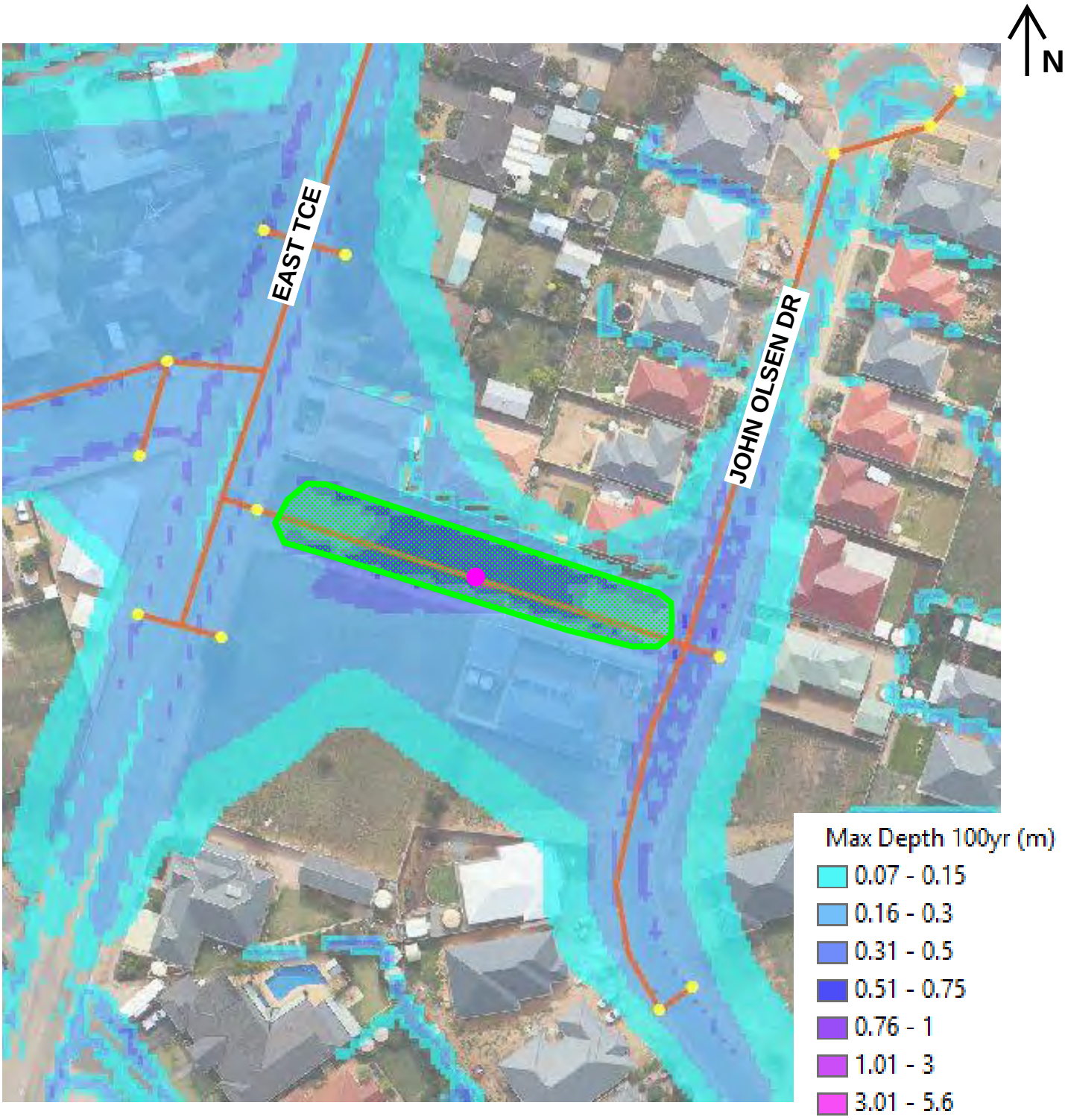
S5: David St

Construct swale to provide defined flow path.
Include culverts at road crossings.

NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe
- Proposed Swale



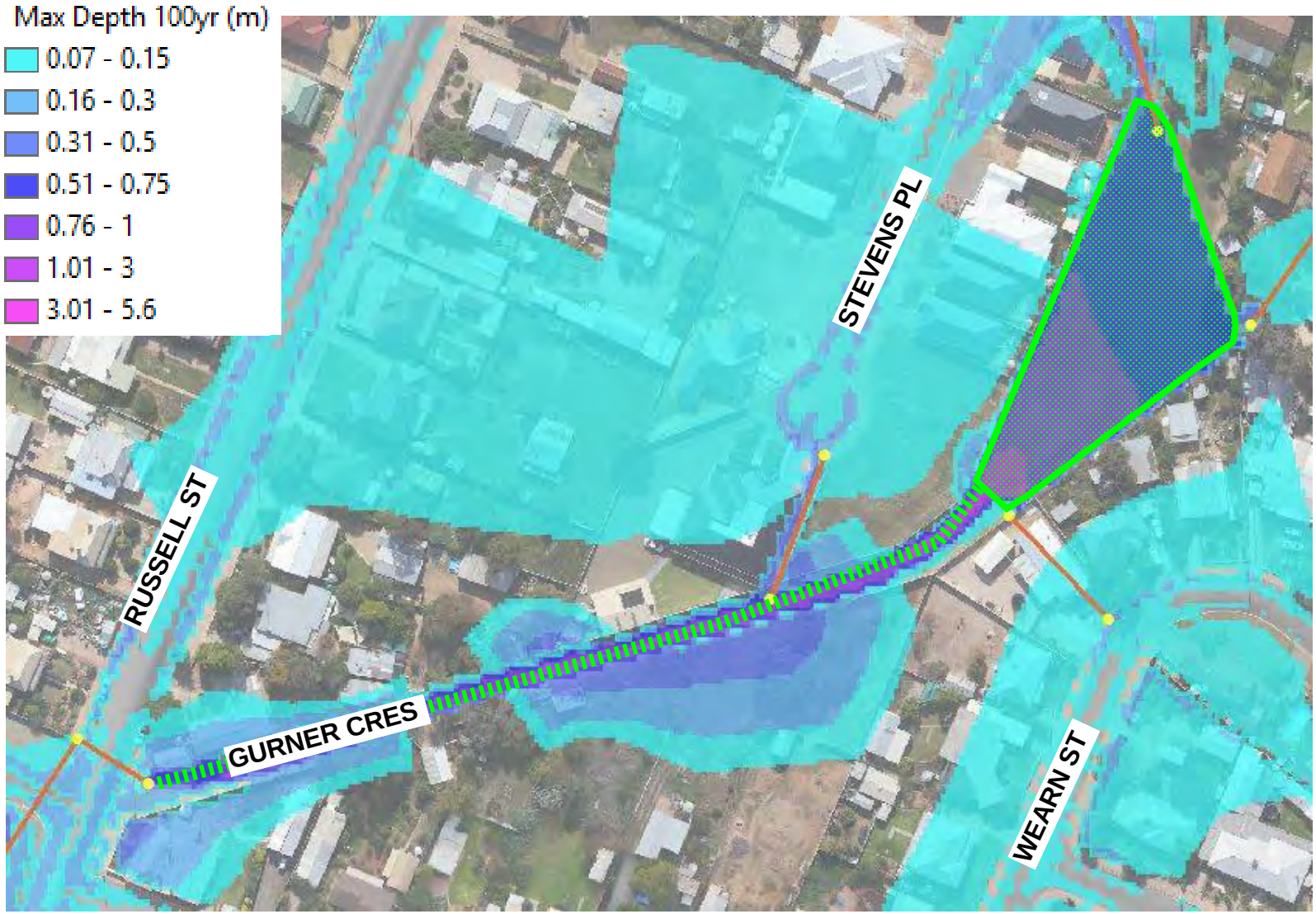
B1: East Terrace

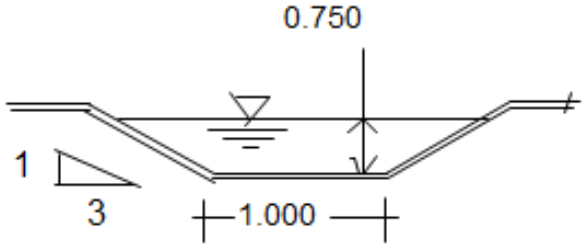
Deepen basin. Provide surcharge pit in the centre. Basin drains in East Tce network.

NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Basin





Proposed swale section

N

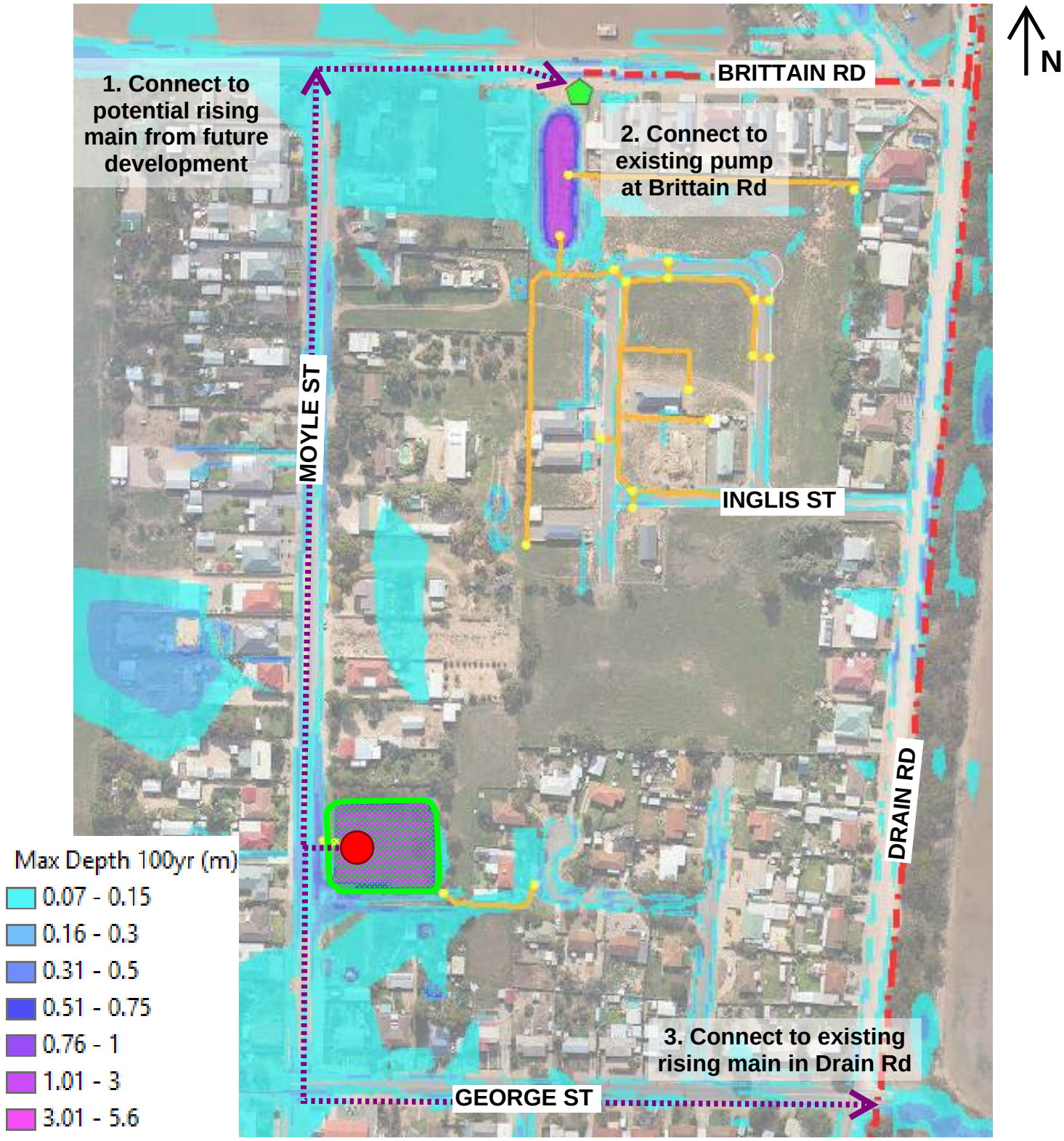
B2 & S6: Gurner Cres

1,500m3, 500mm deep basin with outlet to Gurner Cres. Formalise existing swale down Gurner Cres to South Terrace outlet.

NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Basin
- Proposed Swale



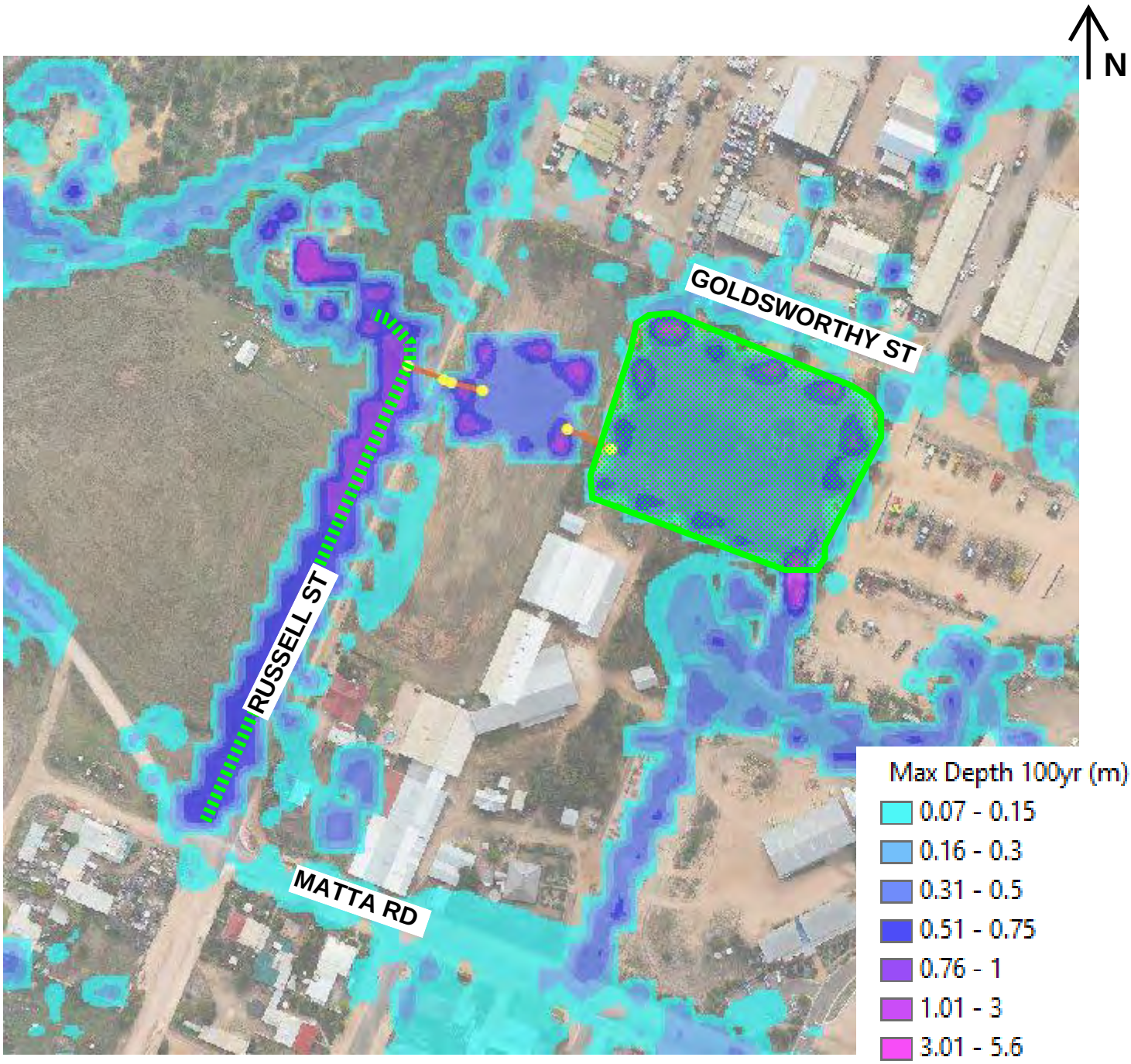
B3: Moyle St

Increase existing 1,218m3 basin to 2,500m3. Install pump to empty basin. Rising main has three potential routes as shown.

NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Existing Rising Main
- Existing Pump
- Proposed Pump
- Proposed Rising Main
- Proposed Basin



B4 & S7: Goldsworthy & Russell St

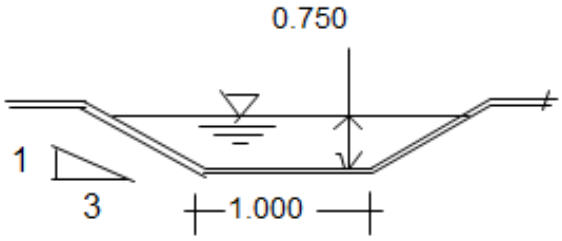
GEORGE ST

Increase existing 1,175m3 basin to 2,350m3. Utilise existing outlet to Russell St. Confirm capacity of outlet downstream basin. Improve Russell St swale capacity.

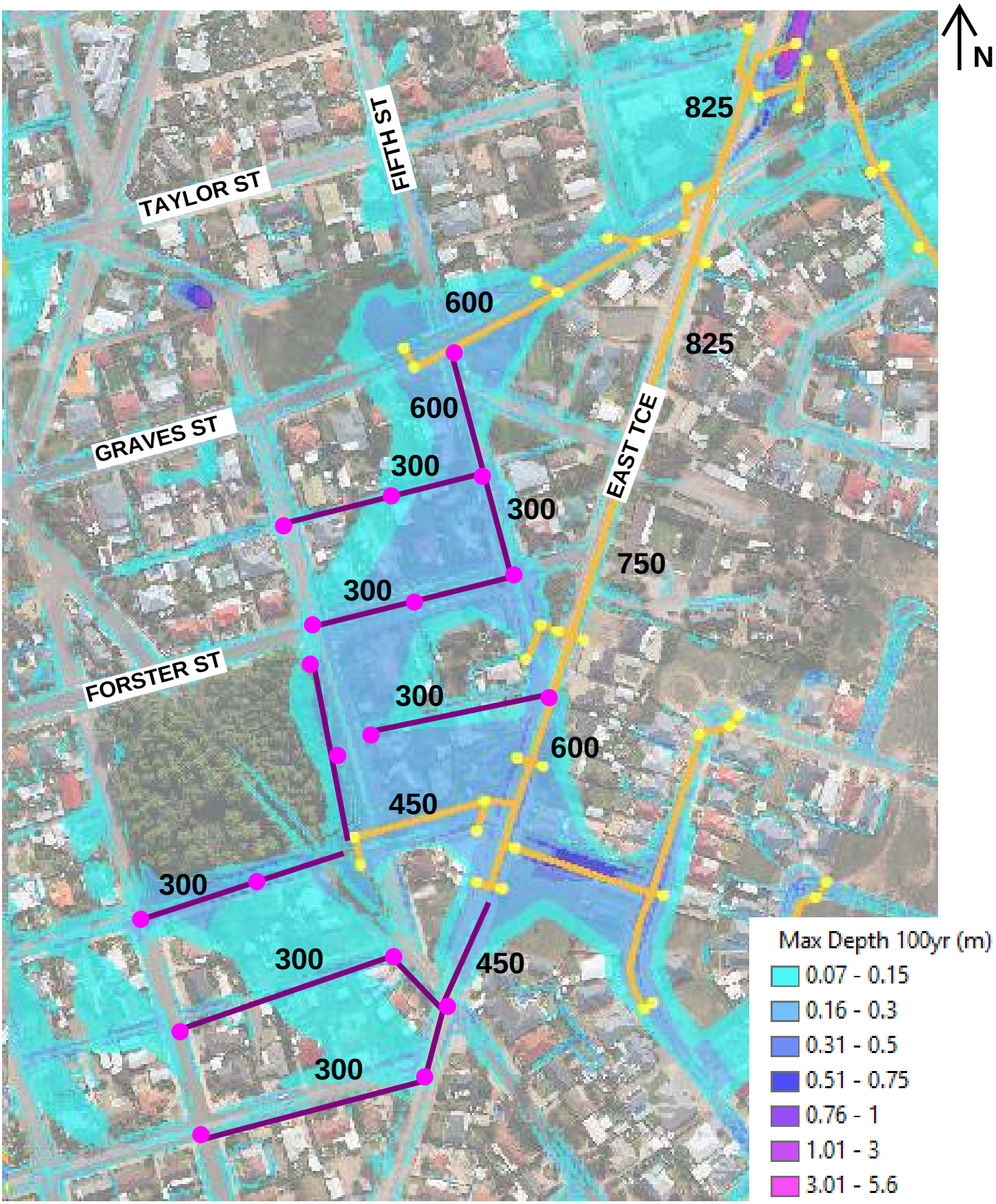
NOT FOR CONSTRUCTION
Sketch is provided for reference only.
Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Basin
- Proposed Swale



Proposed swale section



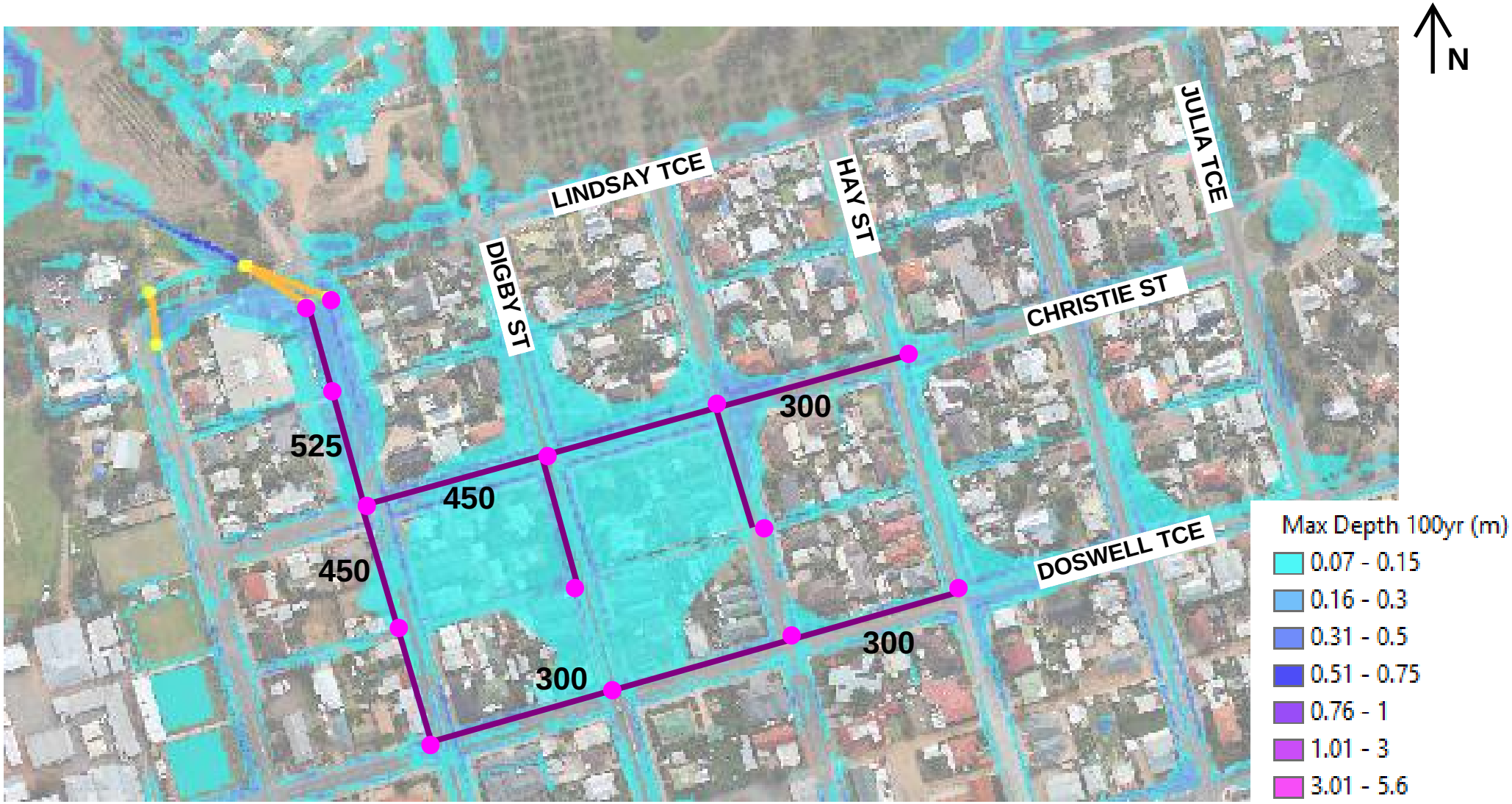
N1: East Tce

Install underground network in areas of flooding to relieve surface flows. Upgrade downstream network as required.

NOT FOR CONSTRUCTION. Sketch is provided for reference only. Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe



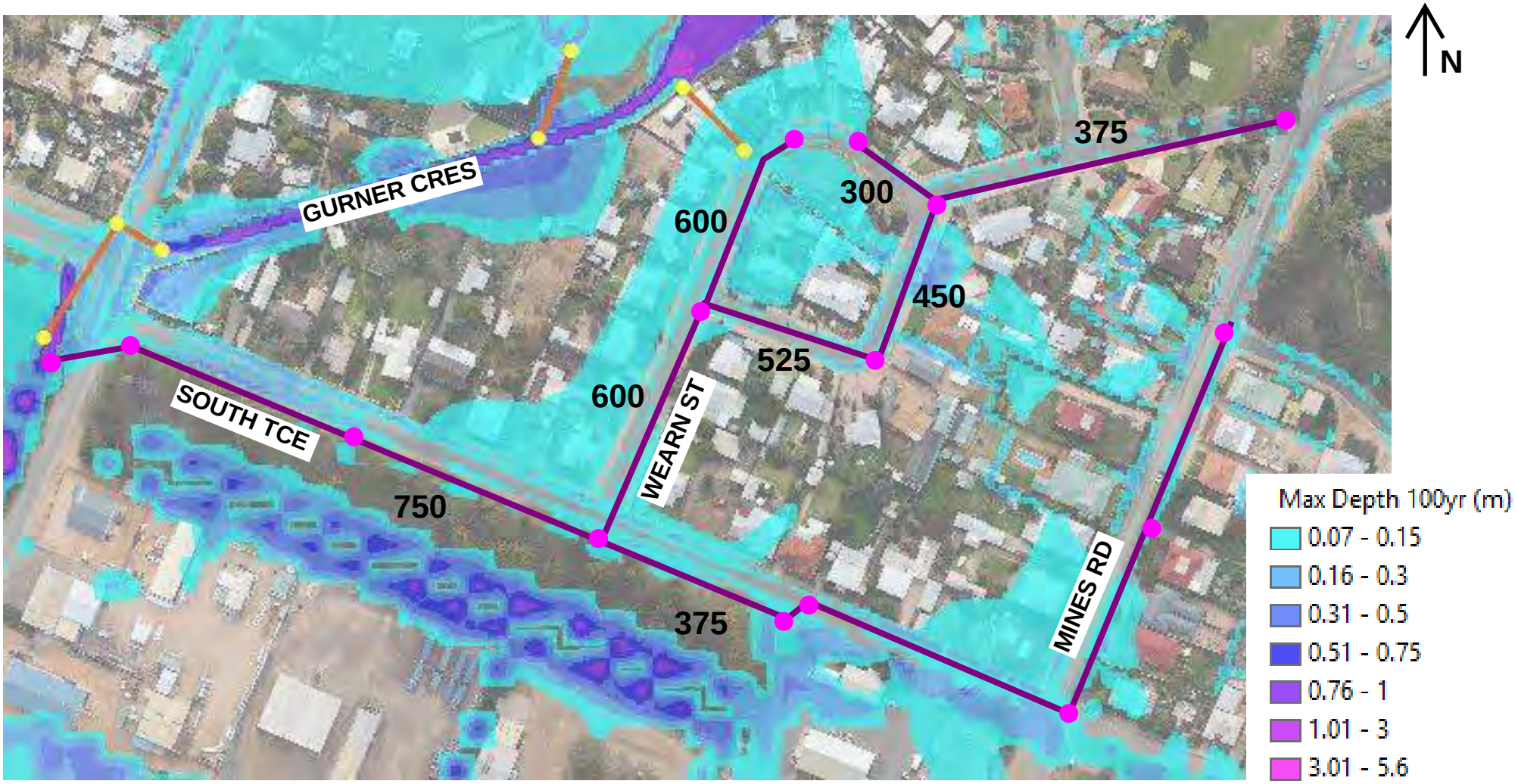
N2: Digby St & Christie St

Install underground network in areas of flooding to relieve surface flows. Replace the existing inlet pits at Lindsay Tce to increase capacity.

NOT FOR CONSTRUCTION.
Sketch is provided for reference only. Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe



N3: Wearn St

Install underground network discharging into existing swale at Russell St.

NOT FOR CONSTRUCTION.
Sketch is provided for reference only. Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe

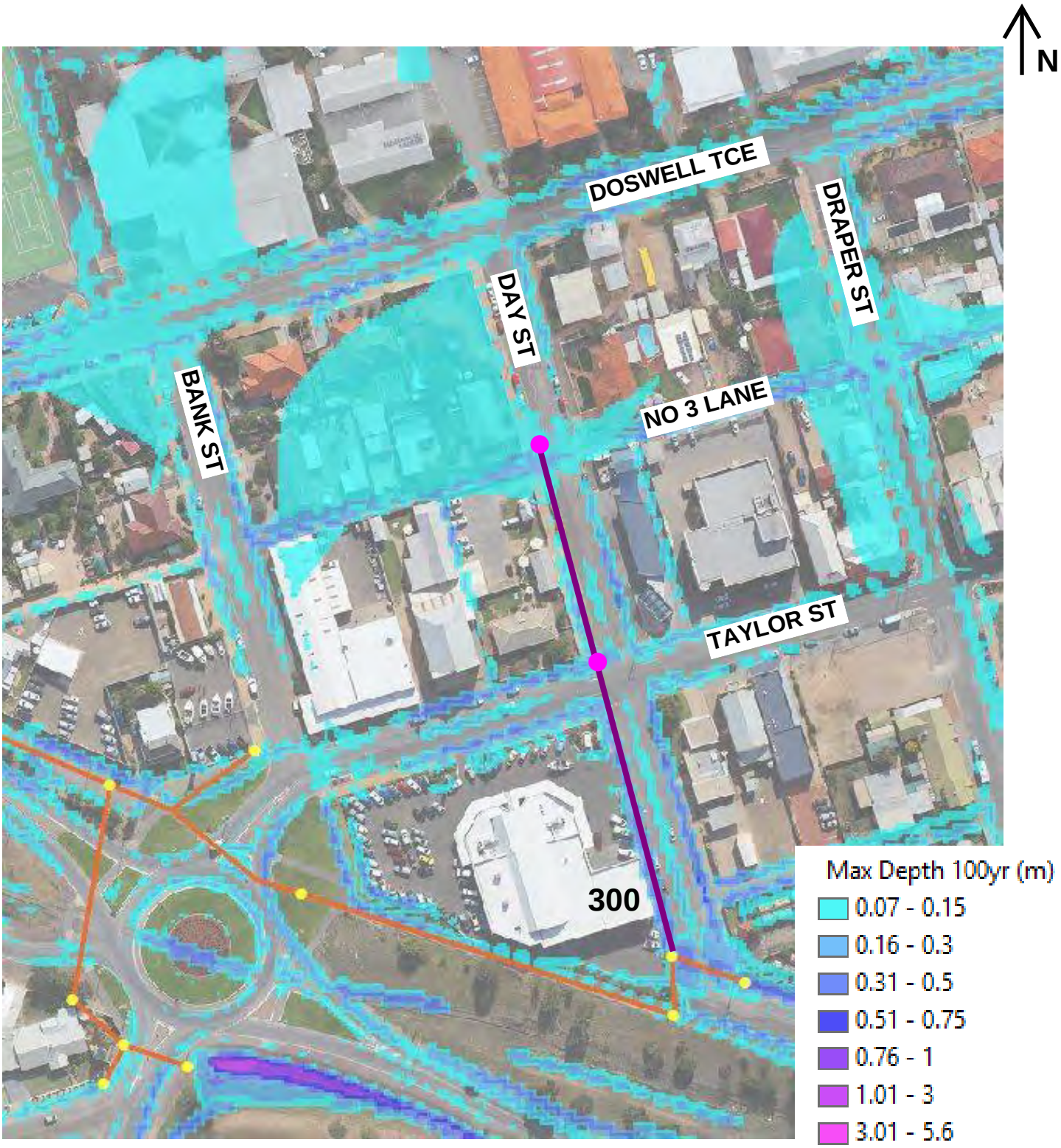
N4: Gawler St

Proposed network along Gawler St to discharge into the existing swale along Frances Tce.

NOT FOR CONSTRUCTION.
Sketch is provided for reference only. Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe



N5: Day St

Install underground network connecting into existing Frances Tce system.

NOT FOR CONSTRUCTION.
Sketch is provided for reference only. Subject to detailed design.

LEGEND

- Existing Pit
- Existing Pipe
- Proposed Pit
- Proposed Pipe

APPENDIX J

COMMUNITY CONSULTATION SUMMARY

APPENDIX K

CBD UPGRADE STORMWATER WORKS DRAWINGS

DISTRICT COUNCIL OF
THE COPPER COAST

Tel 08 8828 1200
Fax 08 8821 2736
PO Box 396, Kadina 5554
51 Taylor St, Kadina 5554
Email info@coppercoast.sa.gov.au
Web www.coppercoast.sa.gov.au
ABN 36 670 364 373

Stormwater Management Plan Information Session for Kadina

As part of Council's Stormwater Management Plan (SMP) the District Council of the Copper Coast is seeking public comment on any localised stormwater issues for Kadina as experienced by our residents.

The focus will be on local issues and will incorporate major areas of concern which can be raised and discussed individually. This input will then be considered as part of the development of the SMP.

These issues can be recorded by the use of feedback forms which will be provided at the following locations:

- On Council's website www.coppercoast.sa.gov.au
- On the Council's Facebook
- In hard copy at
    - District Council of the Copper Coast Kadina Office – 51 Taylor Street, Kadina.

Or by;

- Attending the ***Community Information Session***

  DATE: Wednesday 6 January 2016

  DROP IN ANYTIME BETWEEN: 2:30pm to 4:30pm

  LOCATION: Kadina Town Hall, 51 Taylor Street, Kadina.

For more information, please contact the District Council of the Copper Coast on 8828 1200.

YPCT: Tuesday 22nd December 2015
Public Notices

Page 45

→ Continued

TEMPORARY CLOSURE OF SWIMMING POOLS

Please note that during the period that VACSWIM Classes are being conducted at the Moonta Bay and Wallaroo swimming pools, temporary closure restrictions will apply from:

Monday, 4th to Tuesday, 12th January, 2016, (excluding weekend) between 8.30am and 1.30pm. The public not involved with SA Water VACSWIM are excluded from these swimming pool enclosures and change room areas during these times.

For any further information and enrolments please contact Surf Life Saving 8354 6996.

BEACH CLOSURE AND TEMPORARY DRY AREA NORTH BEACH WALLAROO

Notice is hereby given that North Beach, Wallaroo, will be closed to vehicles from 7am on 31st December, 2015, through to 7am on 1st January, 2016, and that a short-term Dry Area prohibiting the possession and consumption of liquor will be applied from noon 31st December, 2015, through to 7am, 1st January, 2016

SHORT-TERM DRY ZONES

Notice is hereby given that there will be short-term dry zones enforced from 12 noon on 31st December, 2015 to 7am 1st January, 2016, prohibiting the possession and consumption of liquor within the Wallaroo, North Beach, Moonta Bay and Port Hughes foreshore areas.
Copies of maps which highlight the short-term dry zone areas are available at the Council office, 51 Taylor Street, Kadina and on Council's website www.coppercoast.sa.gov.au

KADINA STORMWATER MANAGEMENT INFORMATION SESSION

6th January, 2016, at 2.30pm to 4.30pm, Kadina Town Hall, 51 Taylor Street, Kadina.

Peter Harder
CHIEF EXECUTIVE OFFICER

lifestyle location of choice

YPCT 12th January 2016

ing on Owen Terrace between Irwin and Emu Streets at an earlier meeting but rescinded the motion in December.

Her new motion suggested a 30-minute zone between Emu and Jones Streets only, but this was also defeated.

Cr Vluggen hoped a 30 minute restriction would limit people parking on the situation to settle before implementing new rules.

Cr Vluggen also moved for CEO Peter Harder to negotiate with taxi companies to create a taxi rank at the southern end of Jones Street.

This motion was amended to create a taxi rank within the shopping precinct and voted in favour.

it, Mr Thomas said.

"I believe they have some concerns about why Bank SA is leaving Wallaroo and NAB is cutting hours in Moonta.

"There might be some seeing it progress," Mr Thomas said.

"We'll look to schedule some more meetings in the next couple of weeks to develop a better idea of where we're at."

Page 10

Page 7

Making plans for Kadina stormwater

Rhiannon KOCH
JOURNALIST

DISTRICT Council of the Copper Coast held an information session about its Kadina Stormwater Management Plan last Wednesday, January 6.

The plan will be the first for the town, and the second for the region; Moonta's was recently completed.

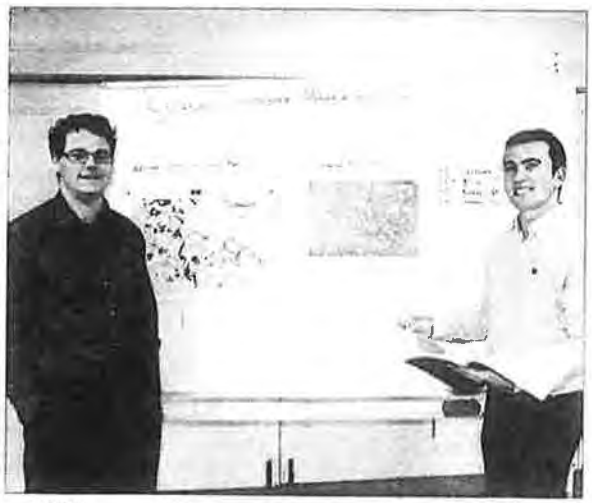
A stormwater plan for Wallaroo will be developed after Kadina's.

Residents and business owners were encouraged to attend the session and offer details of any stormwater issues but attendance was low.

Data has already been collected by council but the information session gave staff a chance to hear from the people.

"We can't see everything that's happening so if people have other information we'd like to know," infrastructure staff member Caleb Snodgrass said.

"At the session we had a feedback form for residents and there will be copies available from the Kadina council office until Friday, January 16."



PLANNING... District Council of the Copper Coast staff Caleb Snodgrass and Markus Dunatov at the Kadina Stormwater Management Plan information session last week.

Civil projects officer Markus Dunatov said the plan aims to resolve current and future stormwater issues.

"It will make our jobs easier in regards to future developments because we'll have a plan we can look at and know what measures are needed every time," Mr Dunatov said.

"It's about making sure there is enough infrastructure in the town for the future."

Australia Day awards announced for DCCC

DISTRICT Council of the Copper Coast has announced its 2016 Australia Day award winners.

Mayor Paul Thomas said this year's awards have attracted the most nominations in his time as mayor.

Council introduced a new category this year, Community Club of the Year, but most nominations were for Citizen of the Year.

Caitlin Adams, of Wallaroo, has been named the Young Achiever of the Year for her cross country running accomplishments while Dr Daniel James, also of Wallaroo, has been awarded Citizen of the Year for his role training doctors and working with the less fortunate.

Wallaroo Lions Club is the first community club award recipient for its work including free skin cancer screening.

The Gallipoli commemoration centenary march and service is Community Event of the Year.

The awards will be presented as part of Australia Day celebrations in Kadina from 11am on January 26.

Council in hot water with flooded residents

Nick PERRY
JOURNALIST

FLOODED Copper Coast residents are desperately hoping for stormwater improvements before the next heavy rain.

West Terrace, Kadina, resident Kelly Richardson and her family were moved into emergency accommodation after floodwaters filled their home last week.

The water was ankle deep inside the house, and mixed with sewage which had come up through the pipes after the property's septic also flooded.

Christmas presents were among items damaged.

Outside the house, water was deep enough to fill the gumboots Mrs Richardson was wearing as she tried to curb the property damage.

"Residents along the street have put in complaints to council about stormwater run-off in the past 12 months, but nothing has been done," she said.

Fellow West Terrace property owner Bronwyn Greenslade said the flooding would have been worse if not for some residents unblocking the stormwater drain alongside the street.

"We had no water inside, but the whole yard was ankle deep and the shed flooded," she said.

Angela Starks said she had spoken with council about West Terrace's stormwater issues in the past.

"This is not something that has just occurred because of the stupid weather patterns we're having, it's been a problem for years," she said.

There were also issues along Heritage Drive, Wallaroo.

Maria Sialas and family had a late-night surprise when a drain in their lower floor toilet began to flood the house with sewage.

"It was all through the hallway, there were bags and suitcases we had to throw out, and we had to move everything else off the floor," she said.

"We come up once a year and my parents stay here about once a month, so what would have happened if we weren't here?"

Neighbours Bill and Kaye Power were awake until 3am Wednesday trying to make sure their property didn't suffer a similar fate.

"We complained about the sewerage pump across the road about 12 to 18 months ago because of the smell and (because) it is leaking," Mrs Power said.

"They said they were going to upgrade it ('the pump) when the (Wallaroo Shores) development went ahead, but we don't know."

District Council of the Copper Coast CEO Peter Harder said individual property flooding cases were unfortunate and council would look for fixes.

However, he said the Copper Coast fared well on the whole considering the heavy deluge.

"Not everything will be able to be fixed, but we are looking at solutions and will try to mitigate the problem as best we can," Mr Harder said.

"We never like to have individuals impacted by flooding, but overall we are happy with how the area held up and with the efforts of our staff.

"We have improved a lot of areas during the past five years but will continue trying to find small fixes which can make the biggest improvements.

"You're never going to get it perfect, especially when there is a rain event like that."

SIGNIFICANT DAMAGE... Kelly Richardson and her family were moved into emergency housing after ankle deep water filled their home on West Terrace, Kadina, last week.

POOLING... Rene Pezy was unable to use her home's plumbing facilities due to flooding on West Terrace and Paulson Road.

UNHAPPY... Sam Sialas, Maria Sialas and Christine Banelis were surprised to hear the sound of water and see sewage rising from their drain on Heritage Drive, Wallaroo, on Tuesday December 27.

West Terrace solution six months away

Rhiannon KOCH
JOURNALIST

RESIDENTS of West Terrace, Kadina, will have to wait at least six months for a solution to their stormwater problems.

About 23 residents met with District Council of the Copper Coast director of infrastructure Wade Della Torre and civil projects officer Joseph Rugari to discuss their concerns yesterday (Monday, January 23).

During heavy rain, the drain along West Terrace overflows and the problem reached its peak during the December storms when several properties flooded.

Residents raised concerns about the culvert sizes on West Terrace and surrounding streets, as well as drain maintenance.

They spoke about how stormwater from Paulson Road and Lipson Avenue contributes to the problem.

Stormwater flows from West Terrace to a dam on South Terrace, which is currently at capacity, preventing stormwater from leaving the drains.

Mr Della Torre said a solution won't be found until after the town's stormwater plan is finalised, expected to be in about six months.

"As part of the plan, we're looking at the size of the dam and how big it needs to be to cater for the whole area," Mr Della Torre said.

"We know it's at capacity now but we are looking at what is needed for a big storm event, as well as making sure it caters for future development."

Mr Della Torre said information gathered from West Terrace residents will be useful.

"The maintenance of drains is also something that has been raised, and I agree that it is a problem, so we will be looking into that as soon as we can," he said.

"We're not looking for a band-aid solution, we are working on something viable for the long term."

Resident Angela Starks felt the meeting went well but will be interested to see how it progresses.

"You have to think it will become more common to have events like we had as the weather patterns change, so we need to be prepared and not be behind the eight ball," she said.

"Actions speak louder than words, so we will see."

ON-SITE MEETING... District Council of the Copper Coast director of infrastructure Wade Della Torre (left) and civil projects officer Joseph Rugari (second from right) talk to residents Angela Starks, Donna Jones, Rene Pezy, Bronwyn Greenslade and Neil Greenslade about the West Terrace stormwater situation yesterday (Monday, January 23).

DISTRICT COUNCIL OF
THE COPPER COAST

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Fax 08 8821 2736
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51 Taylor St, Kadina 5554
Email info@coppercoast.sa.gov.au
Web www.coppercoast.sa.gov.au
ABN 36 670 364 373

Stormwater Management Plan Information Session for Kadina

As part of Council's Stormwater Management Plan (SMP) the District Council of the Copper Coast held an information session. The information session was held on Wednesday 6th January 2016 in the Kadina town hall. This session was for local residence and business owners to discuss localised issues.

A notice was placed in the local newspaper on the 22nd of December 2015. In addition, a notice was given online, on the Council's Facebook page and on the Council's website. Hard copy feedback forms were provided from the Kadina Council office.

During the two hour open session, there were the following attendees; one member from the local newspaper, two residents and one councillor. All attendees received feedback forms.

There were no formal submissions received.

Stormwater Management Plan Information Session for Kadina

Community Feedback Form 2016

1. Please tick (✓) the box that best describes you:

I am a:	Kadina
Resident	
Property Owner	
Business Owner	
Community group/club	
None of the above	

2. Please place a tick (✓) on a scale from 1 to 5 below to indicate how important it is to you that flood mitigation works occur in the Kadina catchment area:

1	2	3	4	5

Not very important — Very important

3. Please place a tick (✓) on the scale of 1 to 5 below to indicate how important it is to you that Water Sensitive Urban Design (WSUD) works occur in the Kadina catchment area. This includes projects to support sustainable use of water resources, improvement of water quality and protection of watercourse and ecosystems health.

1	2	3	4	5

Not very important — Very important

4. Please place a tick (✓) on the scale of 1 to 5 below to indicate your level of support for the Stormwater Management Plan in Kadina.

1	2	3	4	5

Strongly Oppose — Strongly Support

5. Use the space below to write any notes or comments on the Stormwater Management Plan Information Session for Kadina (if necessary, please attach additional sheets).

Please return your completed forms by ***Friday 15 January 2016*** addressed to *Kadina Stormwater Plan,* District Council of the Copper Coast, PO Box 396, Kadina, SA 5554 or 51 Taylor Street, Kadina or email to info@coppercoast.sa.gov.au

For more information, please contact the District Council of the Copper Coast on 8828 1200.

APPENDIX L

MILNE ROAD UPGRADE DRAWINGS

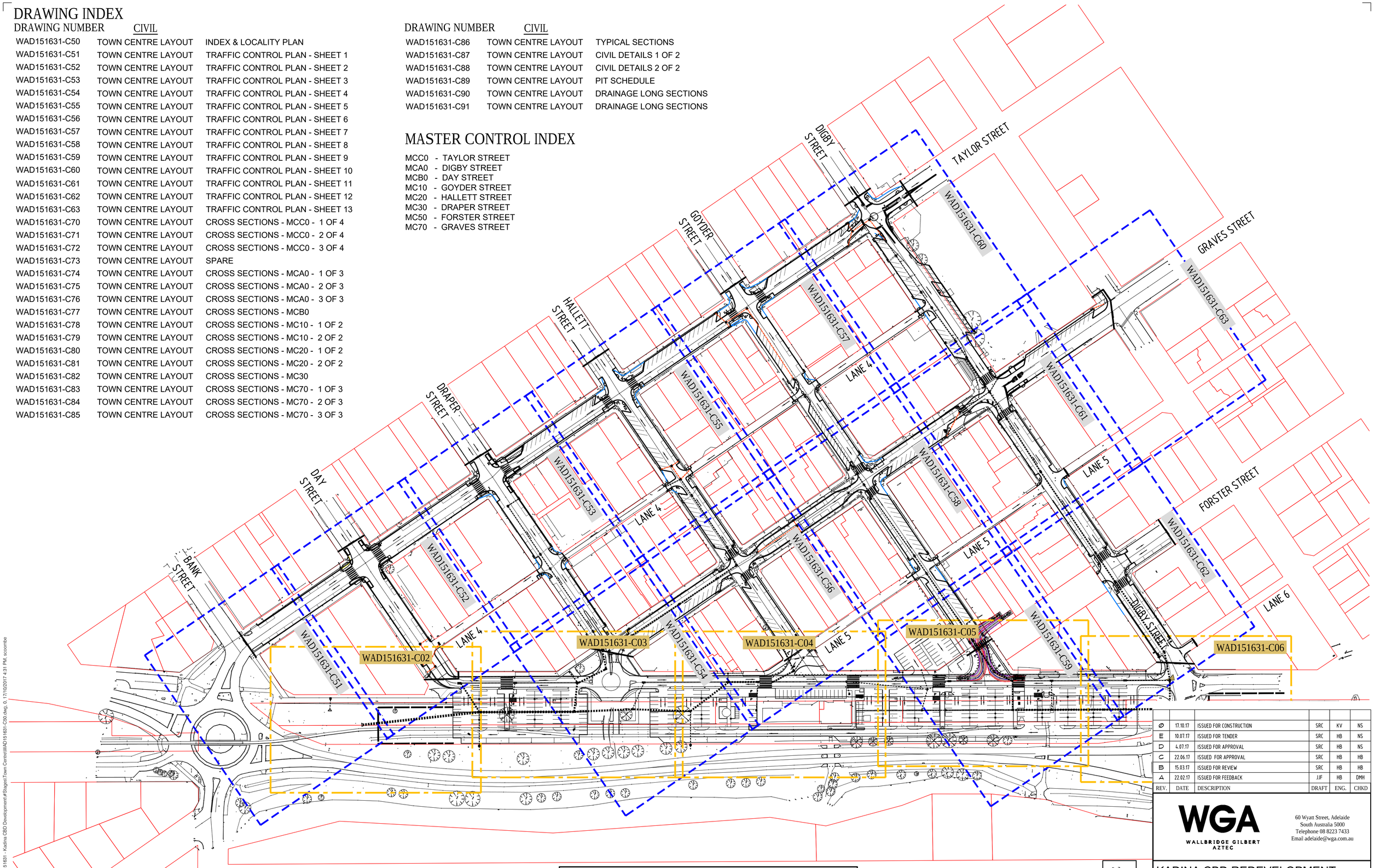
DRAWING INDEX

DRAWING NUMBER	CIVIL	
WAD151631-C50	TOWN CENTRE LAYOUT	INDEX & LOCALITY PLAN
WAD151631-C51	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 1
WAD151631-C52	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 2
WAD151631-C53	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 3
WAD151631-C54	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 4
WAD151631-C55	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 5
WAD151631-C56	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 6
WAD151631-C57	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 7
WAD151631-C58	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 8
WAD151631-C59	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 9
WAD151631-C60	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 10
WAD151631-C61	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 11
WAD151631-C62	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 12
WAD151631-C63	TOWN CENTRE LAYOUT	TRAFFIC CONTROL PLAN - SHEET 13
WAD151631-C70	TOWN CENTRE LAYOUT	CROSS SECTIONS - MCC0 - 1 OF 4
WAD151631-C71	TOWN CENTRE LAYOUT	CROSS SECTIONS - MCC0 - 2 OF 4
WAD151631-C72	TOWN CENTRE LAYOUT	CROSS SECTIONS - MCC0 - 3 OF 4
WAD151631-C73	TOWN CENTRE LAYOUT	SPARE
WAD151631-C74	TOWN CENTRE LAYOUT	CROSS SECTIONS - MCA0 - 1 OF 3
WAD151631-C75	TOWN CENTRE LAYOUT	CROSS SECTIONS - MCA0 - 2 OF 3
WAD151631-C76	TOWN CENTRE LAYOUT	CROSS SECTIONS - MCA0 - 3 OF 3
WAD151631-C77	TOWN CENTRE LAYOUT	CROSS SECTIONS - MCB0
WAD151631-C78	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC10 - 1 OF 2
WAD151631-C79	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC10 - 2 OF 2
WAD151631-C80	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC20 - 1 OF 2
WAD151631-C81	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC20 - 2 OF 2
WAD151631-C82	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC30
WAD151631-C83	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC70 - 1 OF 3
WAD151631-C84	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC70 - 2 OF 3
WAD151631-C85	TOWN CENTRE LAYOUT	CROSS SECTIONS - MC70 - 3 OF 3

DRAWING NUMBER	CIVIL	
WAD151631-C86	TOWN CENTRE LAYOUT	TYPICAL SECTIONS
WAD151631-C87	TOWN CENTRE LAYOUT	CIVIL DETAILS 1 OF 2
WAD151631-C88	TOWN CENTRE LAYOUT	CIVIL DETAILS 2 OF 2
WAD151631-C89	TOWN CENTRE LAYOUT	PIT SCHEDULE
WAD151631-C90	TOWN CENTRE LAYOUT	DRAINAGE LONG SECTIONS
WAD151631-C91	TOWN CENTRE LAYOUT	DRAINAGE LONG SECTIONS

MASTER CONTROL INDEX

MCC0 - TAYLOR STREET
MCA0 - DIGBY STREET
MCB0 - DAY STREET
MC10 - GOYDER STREET
MC20 - HALLETT STREET
MC30 - DRAPER STREET
MC50 - FORSTER STREET
MC70 - GRAVES STREET



NOTE:
DRAWINGS C02-C06 ARE FOR STAGE 1 AND FOR REFERENCE ONLY

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D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB
A	22.02.17	ISSUED FOR FEEDBACK	JJF	HB	DMH

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CONSTRUCTION ISSUE

KADINA CBD REDEVELOPMENT
COPPER COAST COUNCIL
TOWN CENTRE LAYOUT
INDEX & LOCALITY PLAN

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A1

Design	Drawn	DRAWING NUMBER Job Number	Sheet No.	Rev.
DH	DH	WAD151631	C50	Ø

When sheet printed full size, the scale bar is 100mm.
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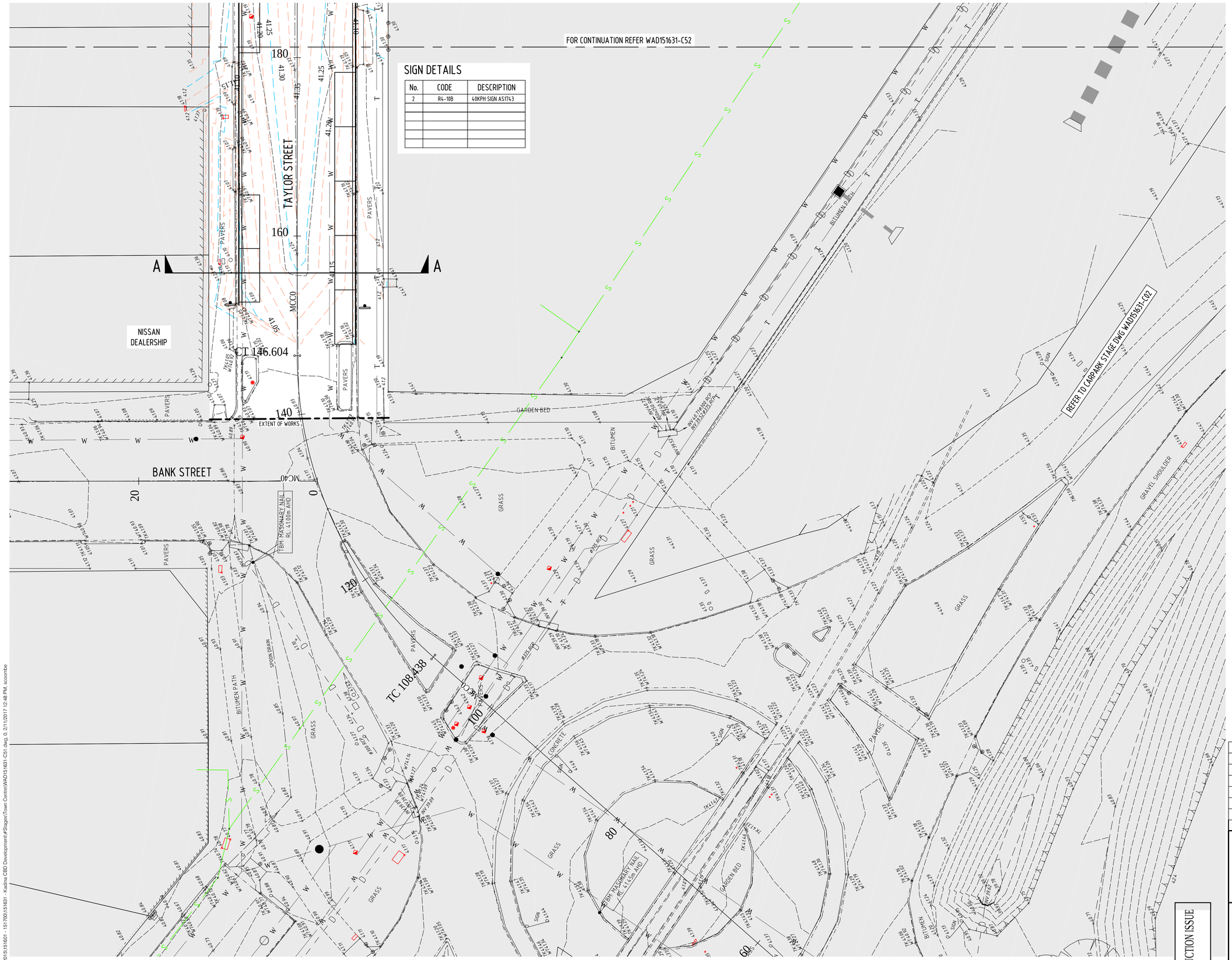

SIGN DETAILS

No.	CODE	DESCRIPTION
2	R4-10B	40KPH SIGN AS1743

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT, TK- TOP OF KERB
  - L- LANDSCAPE, PL- PLATFORM LEVEL
  - G- GRATE, BL- BENCH LEVEL
  - INV- INVERT, TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

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3. ALL R.C. STORMWATER PIPES ARE TO BE CLASS '2' WITH BEDDING TYPE 'HS2'. U.N.O.
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5. **CONTRACTOR TO CONFIRM INVERTS OF ALL EXISTING PIPES & SUMPS PRIOR TO CONNECTING & LAYING OF ALL NEW PIPEWORK.**

4 2 0 4 8
SCALE BAR (m)

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB
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KADINA CBD REDEVELOPMENT

COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 1

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A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C51	Ø

Design: DH
Drawn: DH

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TAYLOR STREET

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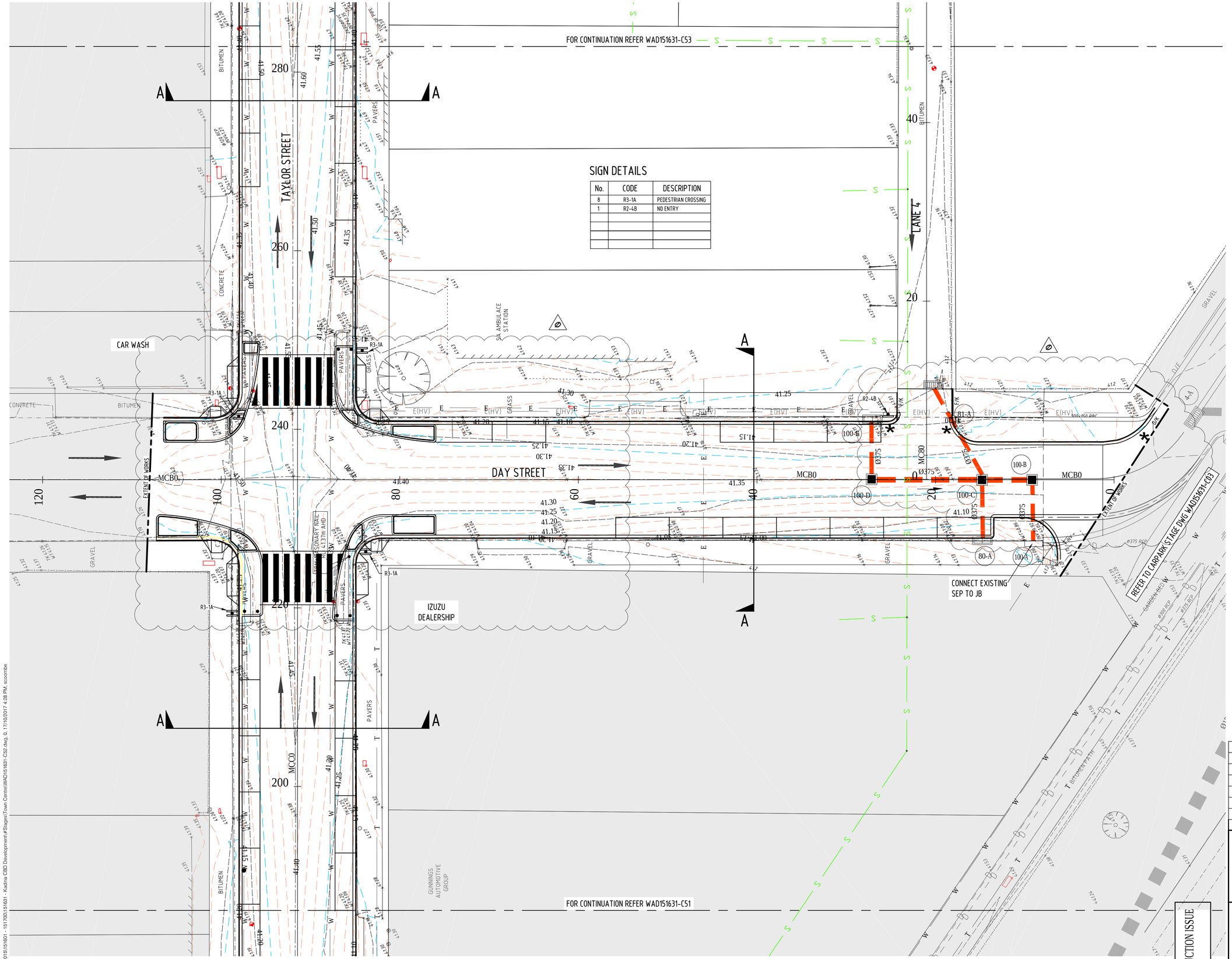

SIGN DETAILS

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1	R2-4B	NO ENTRY

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
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- EXISTING LEVELS
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TRAFFIC CONTROL PLAN - SHEET 2

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A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C52	Ø

Design DH

Drawn DH

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DAY STREET

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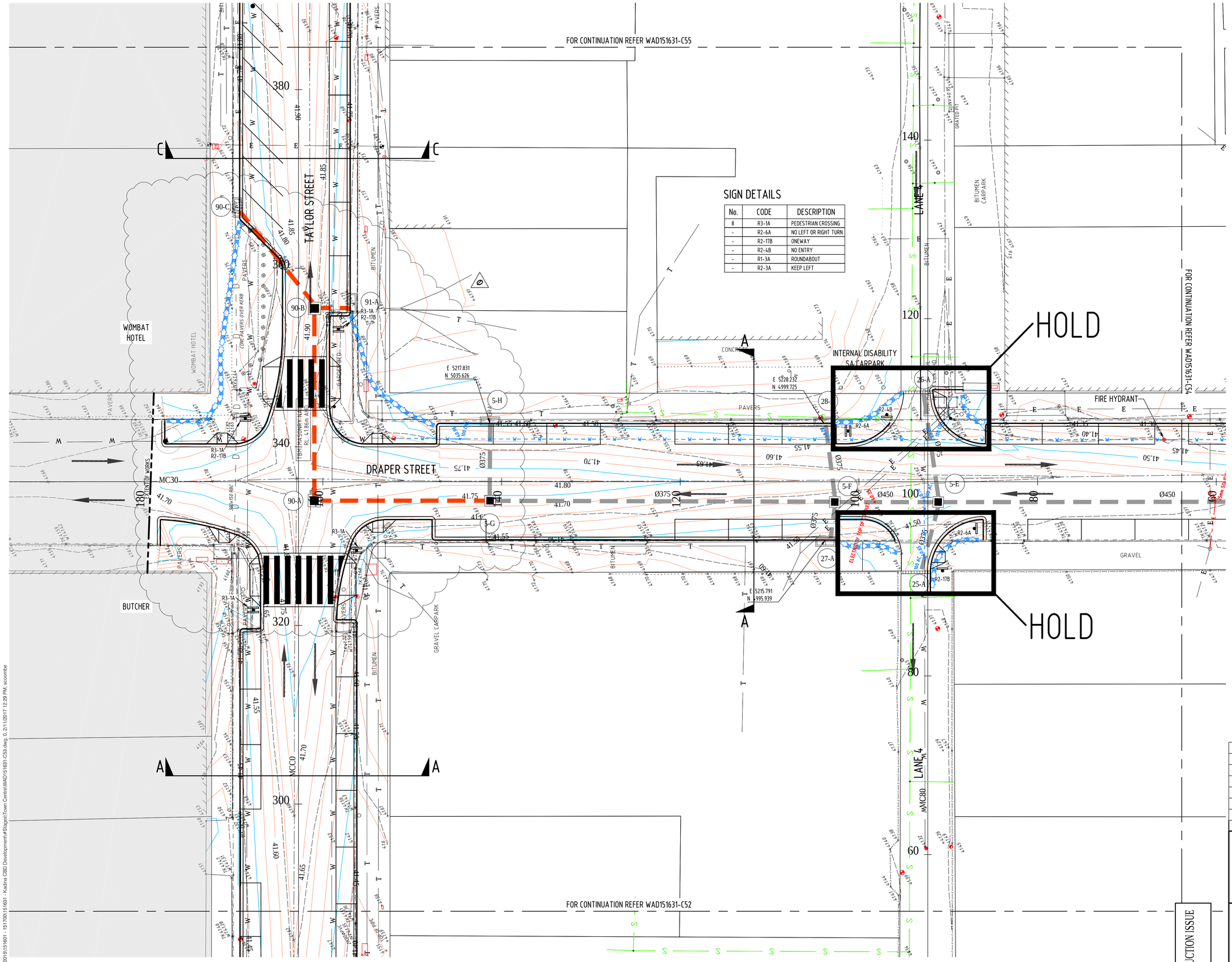

SIGN DETAILS

No.	CODE	DESCRIPTION
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-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

LEGEND:

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COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 3

©

A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C53	Ø

Design DH

Drawn DH

CONSTRUCTION ISSUE

DRAPER STREET

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

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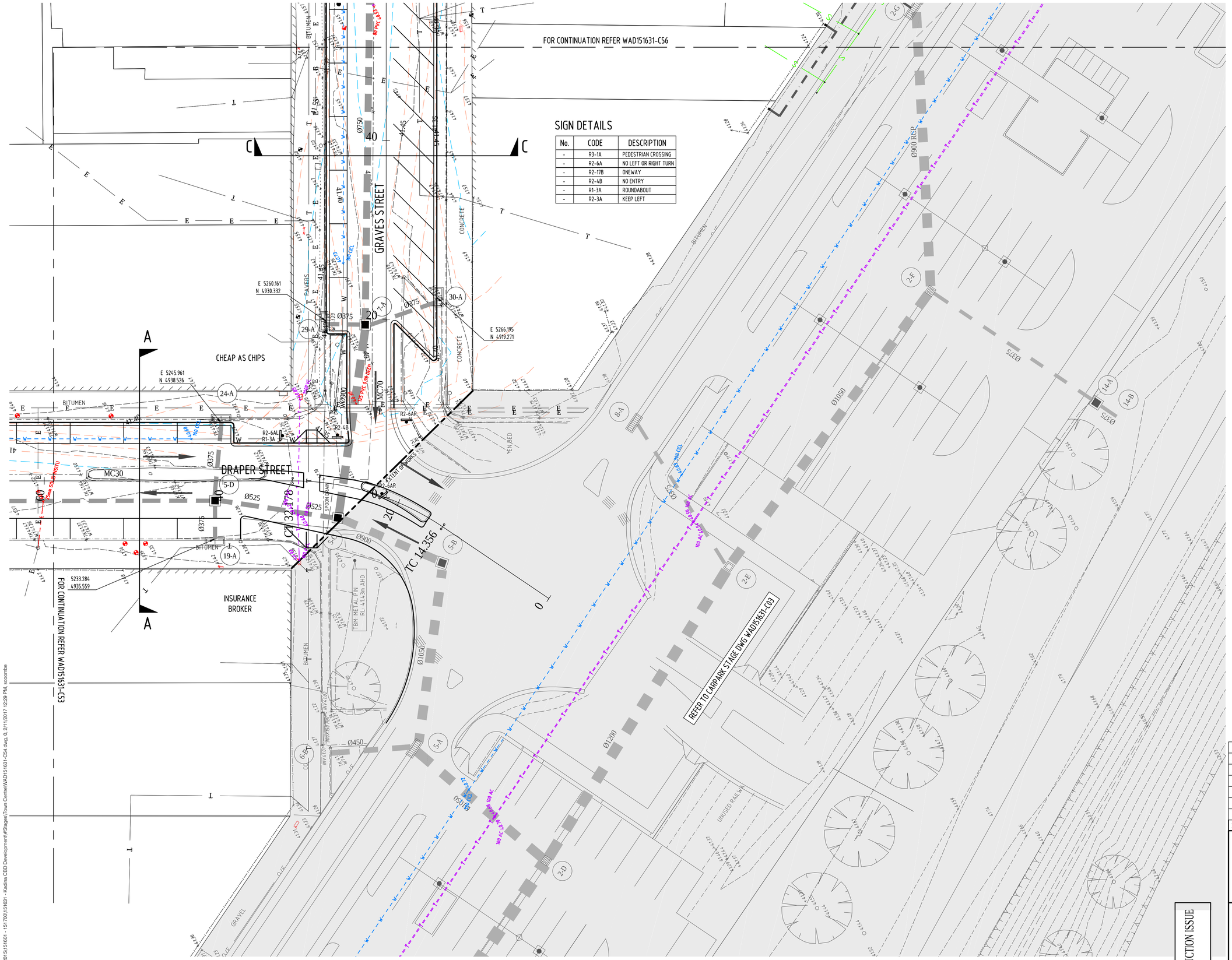

SIGN DETAILS

No.	CODE	DESCRIPTION
-	R3-1A	PEDESTRIAN CROSSING
-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT, TK- TOP OF KERB
  - L- LANDSCAPE, PL- PLATFORM LEVEL
  - G- GRATE, BL- BENCH LEVEL
  - INV- INVERT, TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

1. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS, OTHER CONSULTANTS DRAWINGS & THE SPECIFICATION.
2. ALL UPVC STORMWATER PIPES ARE TO BE SEWER CLASS 'SN4'.
3. ALL R.C. STORMWATER PIPES ARE TO BE CLASS '2' WITH BEDDING TYPE 'HS2'. U.N.O.
4. **ALL EXISTING SERVICES ARE TO BE LOCATED BY THE CONTRACTOR PRIOR TO COMMENCEMENT OF WORK.**
5. **CONTRACTOR TO CONFIRM INVERTS OF ALL EXISTING PIPES & SUMPS PRIOR TO CONNECTING & LAYING OF ALL NEW PIPEWORK.**

SCALE BAR (m): 4 2 0 4 8

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB
A	22.02.17	ISSUED FOR FEEDBACK	JJF	HB	DMH

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KADINA CBD REDEVELOPMENT

COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 4

©

A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C54	Ø

Design: DH
Drawn: DH

CONSTRUCTION ISSUE

DRAPER STREET

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

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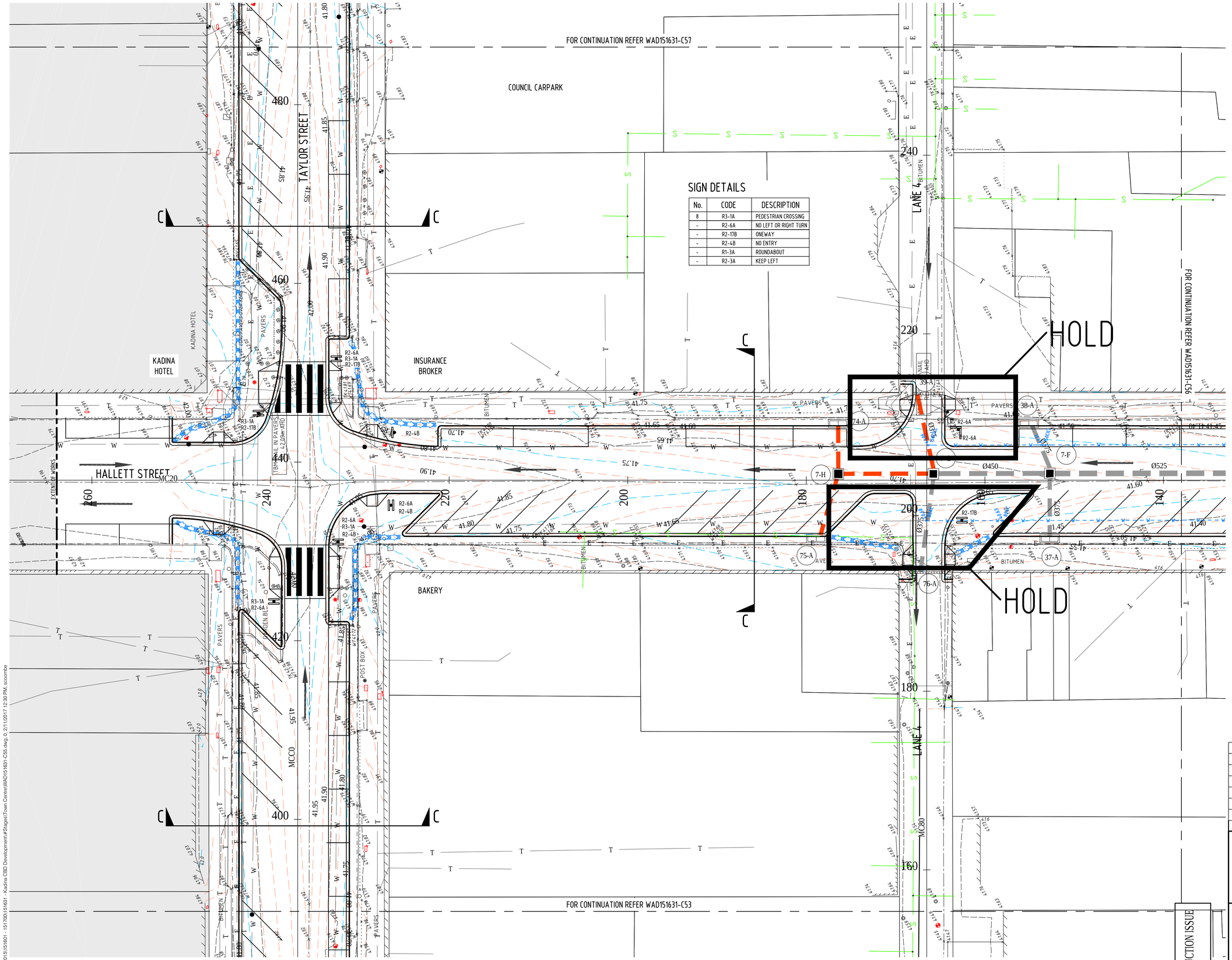

SIGN DETAILS

No.	CODE	DESCRIPTION
8	R3-1A	PEDESTRIAN CROSSING
-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT, TK- TOP OF KERB
  - L- LANDSCAPE, PL- PLATFORM LEVEL
  - G- GRATE, BL- BENCH LEVEL
  - INV- INVERT, TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

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SCALE BAR (m): 4 2 0 4 8

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB
A	22.02.17	ISSUED FOR FEEDBACK	JJF	HB	DMH

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KADINA CBD REDEVELOPMENT

COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 5

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CONSTRUCTION ISSUE

A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C55	Ø

Design: DH Drawn: DH

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

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PROVIDE 150Φ PVC CONNECTION FROM GRATE INTO GIP

GRATE. 41.60 I.L. 41.30

GRATE. 41.60 I.L. 41.30

K3-5 TO K3-10 SLOPED CHANNEL WITH K3-01030 FINAL LENGTH. PROVIDE 150Φ PVC CONNECTION FROM GRATE INTO GIP

FOR CONTINUATION REFER WAD151631-C58

GRATE. 41.147 I.L. 41.12

GRATE. 41.147 I.L. 41.16

K3-3 TO K3-30 SLOPED CHANNEL WITH K3-030 FINAL LENGTH

K3-00 CHANNEL

ACO DRAIN K300 CHANNEL WITH TYPE 876D IRON INTERCEPT HEELSAFE ANTI SLIP GRATE AND DRAIN LOK LOCKING SYSTEM, OR SIMILAR APPROVED EQUIVALENT

GRATE. 41.154 I.L. 41.24

150Φ PVC CONN. (MIN 1% GRADE)

150Φ PVC CONN. (MIN 1% GRADE)

GRATE. 41.24 I.L. 40.97

E 5344.209 N 4963.884

E 5331.015 N 4965.224

E 5327.276 N 4949.775

E 5325.342 N 4936.409

SIGN DETAILS

No.	CODE	DESCRIPTION
8	R3-1A	PEDESTRIAN CROSSING
-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

SLEEPWORLD

FURNITURE STORE

BP SERVICE STATION

RECRUITMENT AGENCY

JEWELLERS

CHIROPRACTIC CARPARK

DISABLED CARPARK

GRAVES STREET

HALLETT STREET

LANE 5

GRAVES-S STREET

FOR CONTINUATION REFER WAD151631-C55

FOR CONTINUATION REFER WAD151631-C54

REFER TO CARPARK STAGE DWG WAD151631-C04

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
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- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT, TK- TOP OF KERB
  - L- LANDSCAPE, PL- PLATFORM LEVEL
  - G- GRATE, BL- BENCH LEVEL
  - INV- INVERT, TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB TRANSITION
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
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- SIGN
- TREE PIT
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SCALE BAR (m): 4 2 0 4 8

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
2	6.09.18	GRAVES ST MALL UPDATE	SRC	KV	KV
1	16.08.18	GRAVES ST MALL UPDATE	SRC	KV	NS
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
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B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB

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KADINA CBD REDEVELOPMENT

COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 6

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A1

DRAWING NUMBER

Design	Drawn	Job Number	Sheet No.	Rev.
DH	DH	WAD151631	C56	2

CONSTRUCTION ISSUE

When sheet printed full size, the scale bar is 100mm.

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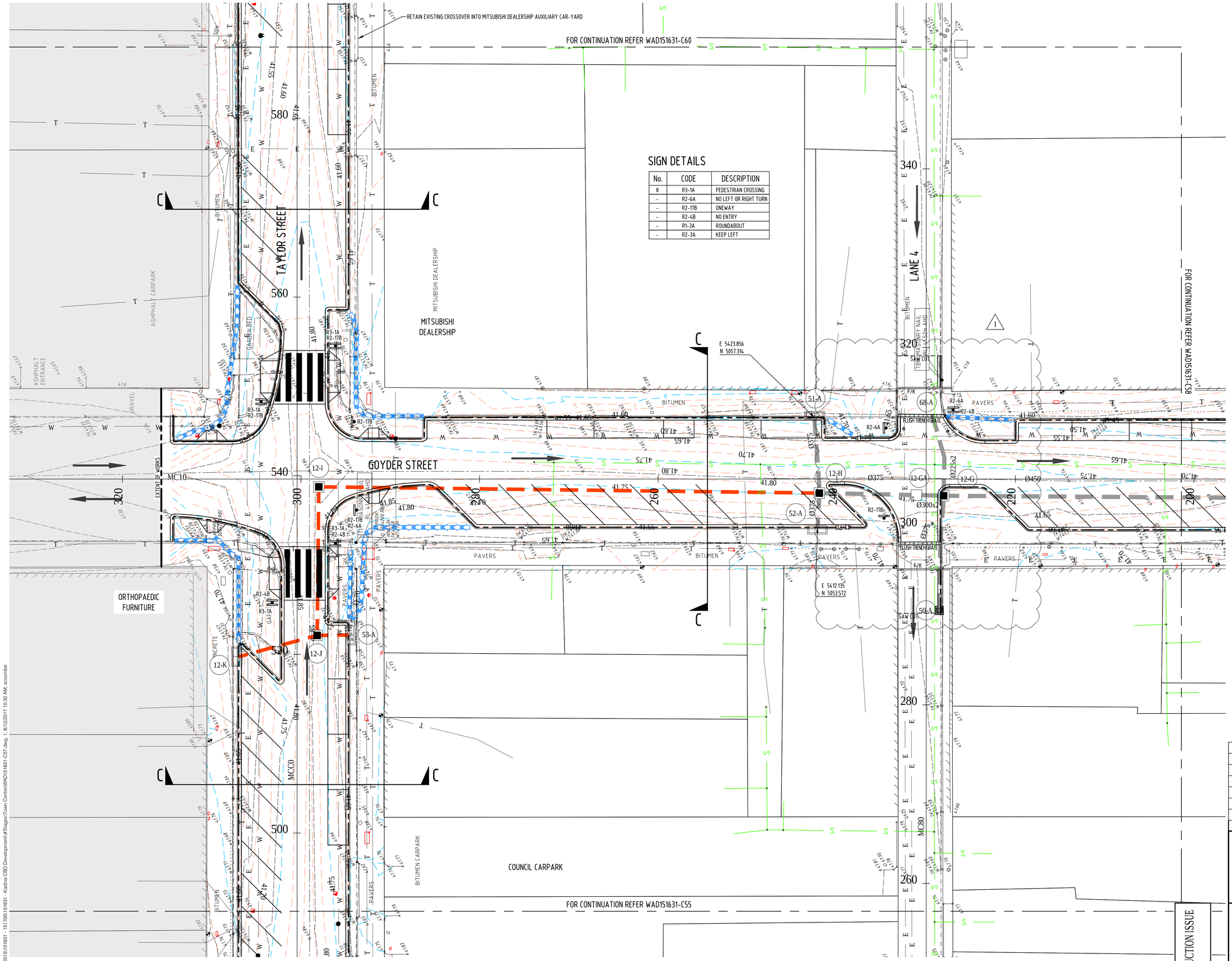

SIGN DETAILS

No.	CODE	DESCRIPTION
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-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
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- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB TRANSITION
- KERB RAMP
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- TRENCH GRATE
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- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

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SCALE BAR (m): 4 2 0 4 8

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
1	8.12.17	KERBS AT LANEWAYS AMENDED	SRC	KV	NS
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB
A	22.02.17	ISSUED FOR FEEDBACK	JJF	HB	DMH

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TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 7

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A1

DRAWING NUMBER

Design	Drawn	Job Number	Sheet No.	Rev.
DH	DH	WAD151631	C57	1

CONSTRUCTION ISSUE

GOYDER STREET

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

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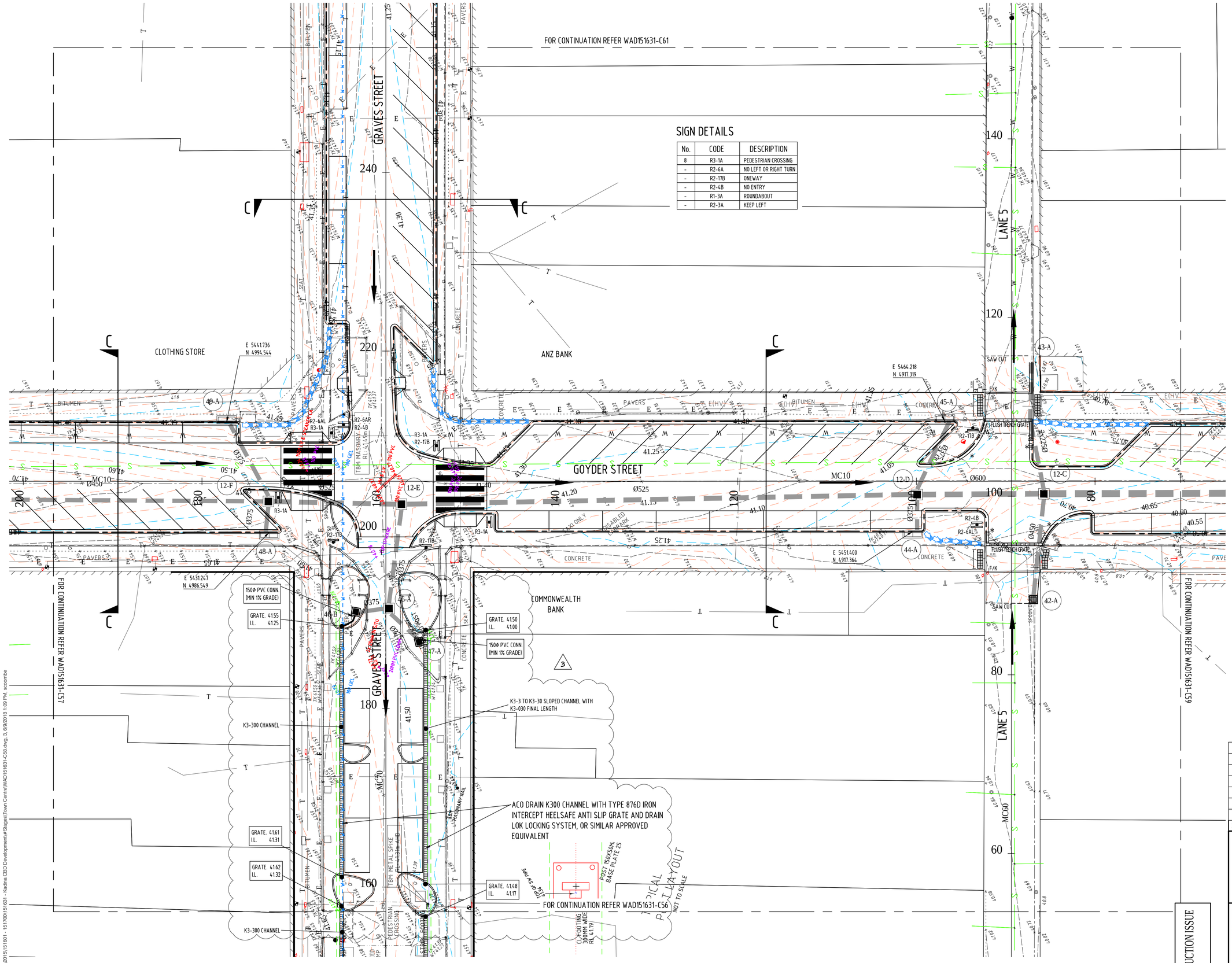

SIGN DETAILS

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- EXISTING TELSTRA (DBYD)
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- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- 19.0 EXISTING CONTOURS
- 41.3 DESIGN CONTOURS-MAJOR
- 41.3 DESIGN CONTOURS-MINOR
- P.8.150 DESIGN LEVELS
  - P- PAVEMENT
  - TK- TOP OF KERB
  - L- LANDSCAPE
  - PL- PLATFORM LEVEL
  - G- GRATE
  - BL- BENCH LEVEL
  - INV- INVERT
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- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- X REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- 125 K KERB ONLY
- 125/150 K&G KERB & GUTTER
- O/K OUTFALL KERB
- F/K FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB TRANSITION
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
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- SIGN
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4 2 0 4 8
SCALE BAR (m)

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
3	6.09.18	GRAVES ST MALL UPDATE	SRC	KV	NS
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E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB

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KADINA CBD REDEVELOPMENT

COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 8

©

A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C58	3

Design DH | Drawn DH

CONSTRUCTION ISSUE

GOYDER STREET

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

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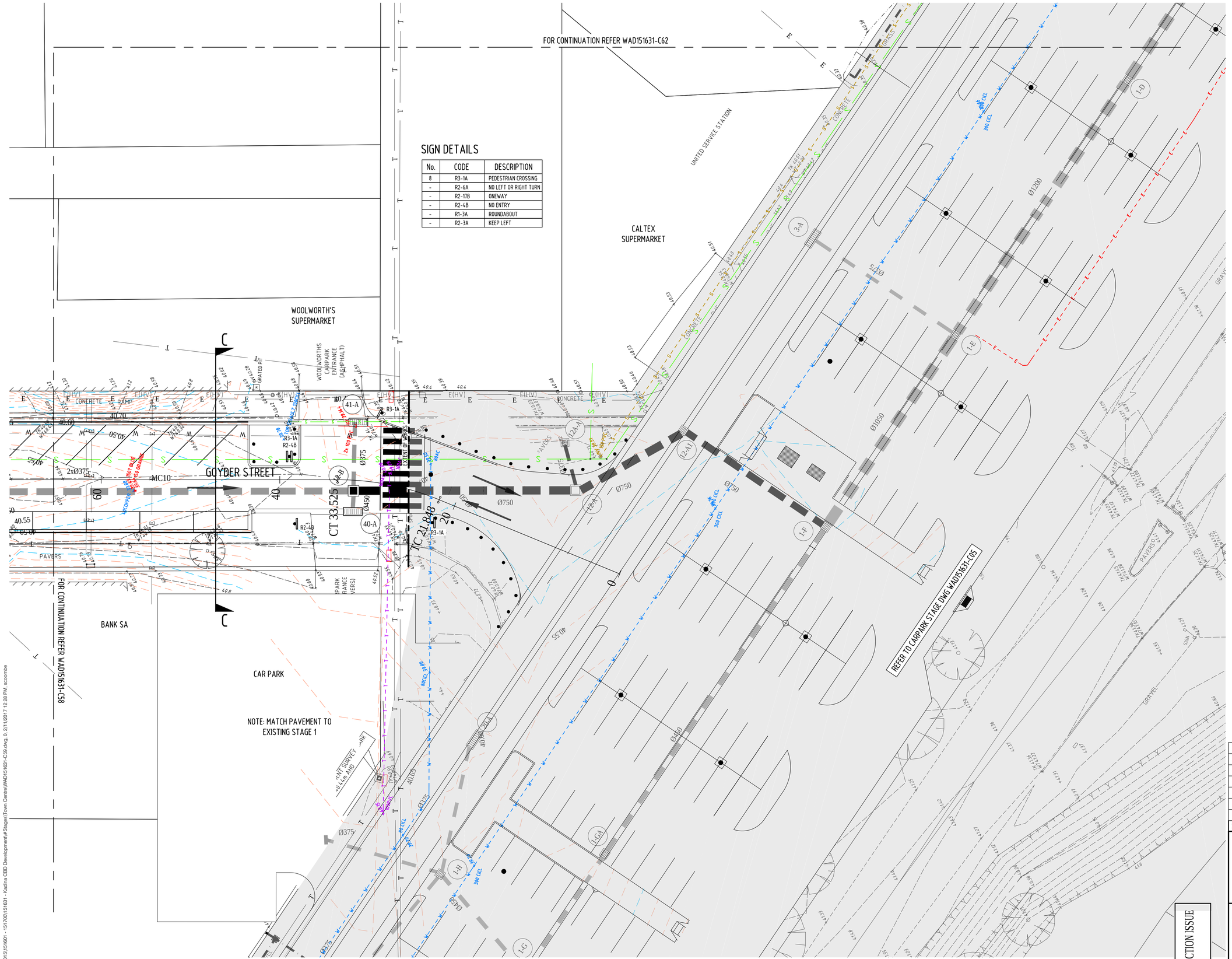

SIGN DETAILS

No.	CODE	DESCRIPTION
8	R3-1A	PEDESTRIAN CROSSING
-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT, TK- TOP OF KERB
  - L- LANDSCAPE, PL- PLATFORM LEVEL
  - G- GRATE, BL- BENCH LEVEL
  - INV- INVERT, TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

1. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS, OTHER CONSULTANTS DRAWINGS & THE SPECIFICATION.
2. ALL UPVC STORMWATER PIPES ARE TO BE SEWER CLASS 'SN4'.
3. ALL R.C. STORMWATER PIPES ARE TO BE CLASS '2' WITH BEDDING TYPE 'HS2'. U.N.O.
4. **ALL EXISTING SERVICES ARE TO BE LOCATED BY THE CONTRACTOR PRIOR TO COMMENCEMENT OF WORK.**
5. **CONTRACTOR TO CONFIRM INVERTS OF ALL EXISTING PIPES & SUMPS PRIOR TO CONNECTING & LAYING OF ALL NEW PIPEWORK.**

SCALE BAR (m): 4 2 0 4 8

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB
A	22.02.17	ISSUED FOR FEEDBACK	JJF	HB	DMH

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CONSTRUCTION ISSUE

KADINA CBD REDEVELOPMENT

COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 9

©

A1

DRAWING NUMBER

Design	Drawn	Job Number	Sheet No.	Rev.
DH	DH	WAD151631	C59	Ø

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

GOYDER STREET

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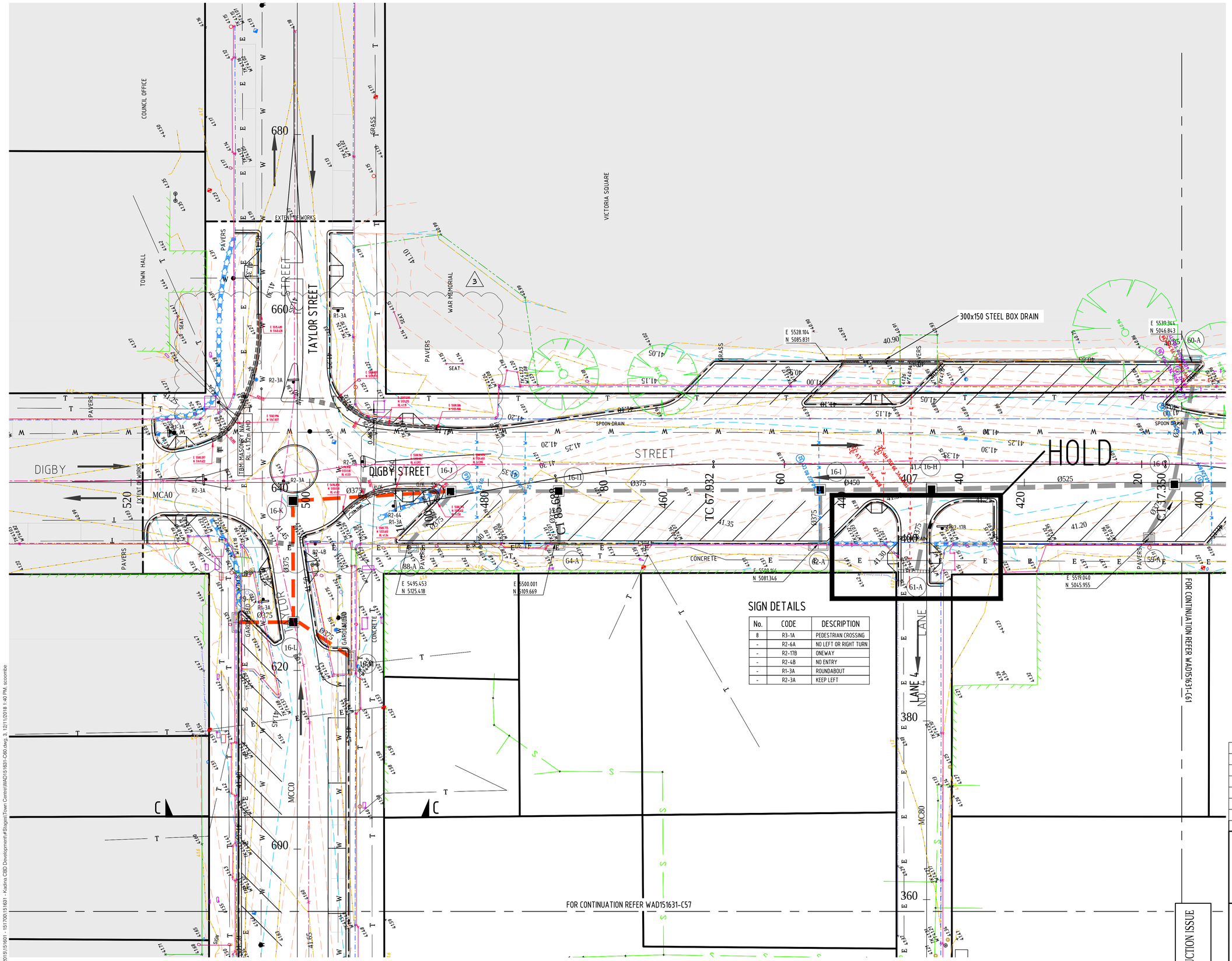

SIGN DETAILS

No.	CODE	DESCRIPTION
8	R3-1A	PEDESTRIAN CROSSING
-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT
  - TK- TOP OF KERB
  - L- LANDSCAPE
  - PL- PLATFORM LEVEL
  - G- GRATE
  - BL- BENCH LEVEL
  - INV- INVERT
  - TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB TRANSITION
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

1. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS, OTHER CONSULTANTS DRAWINGS & THE SPECIFICATION.
2. ALL UPVC STORMWATER PIPES ARE TO BE SEWER CLASS 'SN4'.
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5. **CONTRACTOR TO CONFIRM INVERTS OF ALL EXISTING PIPES & SUMPS PRIOR TO CONNECTING & LAYING OF ALL NEW PIPEWORK.**

SCALE BAR (m) 4 2 0 4 8

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
3	12.11.18	REVISIONS AS CLOUDED	SRC	KV	KV
2	7.09.18	REVISIONS AS CLOUDED	SRC	KV	KV
1	6.09.18	REVISIONS AS CLOUDED	SRC	KV	KV
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB

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KADINA CBD REDEVELOPMENT

COPPER COAST COUNCIL

TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 10

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A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C60	3

Design DH | Drawn DH

DIGBY STREET

CONSTRUCTION ISSUE

When sheet printed full size, the scale bar is 100mm.

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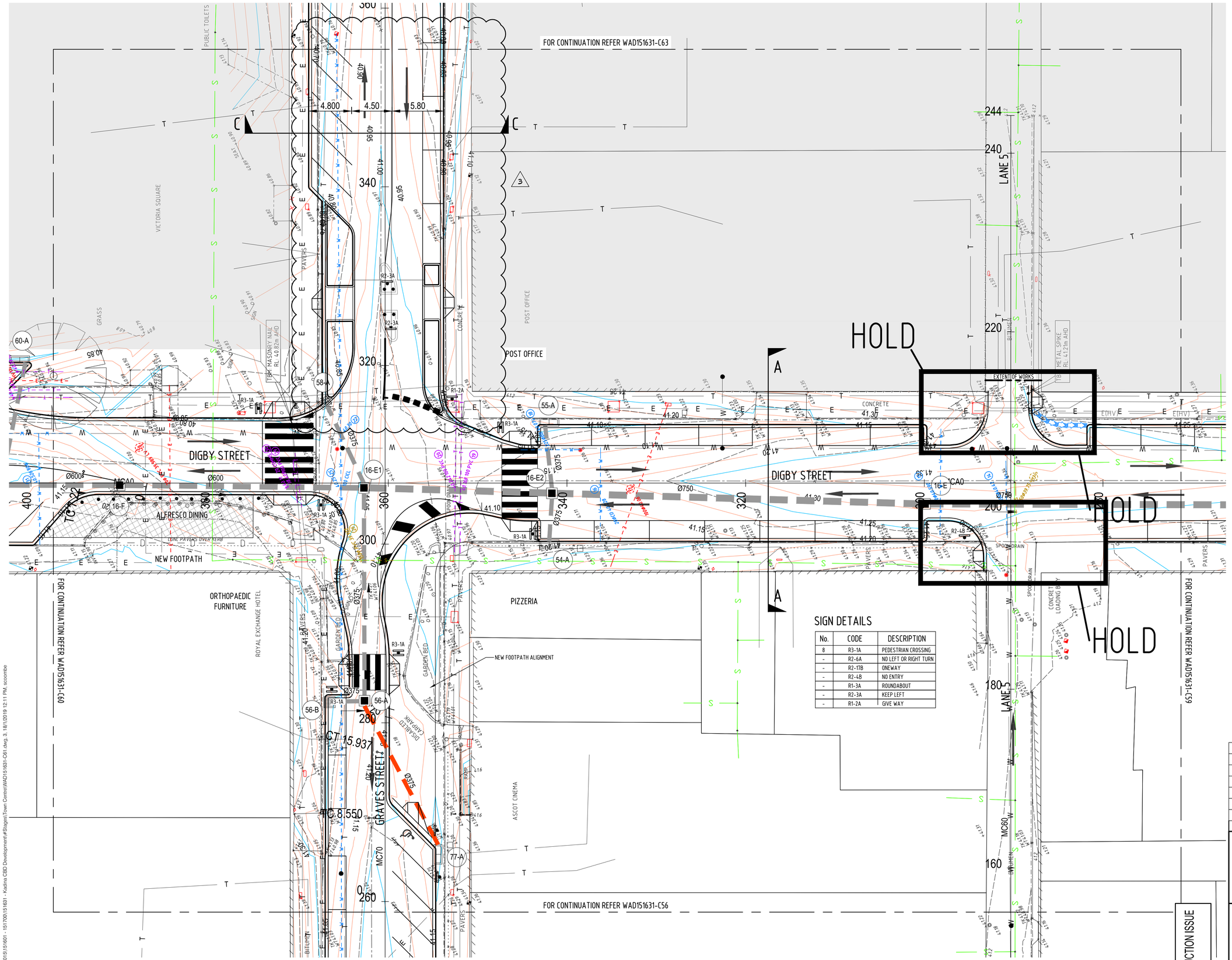

No.	CODE	DESCRIPTION
8	R3-1A	PEDESTRIAN CROSSING
-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT
-	R1-2A	GIVE WAY

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT, TK- TOP OF KERB
  - L- LANDSCAPE, PL- PLATFORM LEVEL
  - G- GRATE, BL- BENCH LEVEL
  - INV- INVERT, TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB TRANSITION
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

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4 2 0 4 8
SCALE BAR (m)

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
3	18.01.19	ROAD CHANGE	SRC	KV	HB
2	7.09.18	REVISIONS AS CLOUDED	SRC	KV	KV
1	6.09.18	REVISIONS AS CLOUDED	SRC	KV	KV
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB

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KADINA CBD REDEVELOPMENT

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TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 11

CONSTRUCTION ISSUE

A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C61	3

Design DH | Drawn DH

When sheet printed full size, the scale bar is 100mm.

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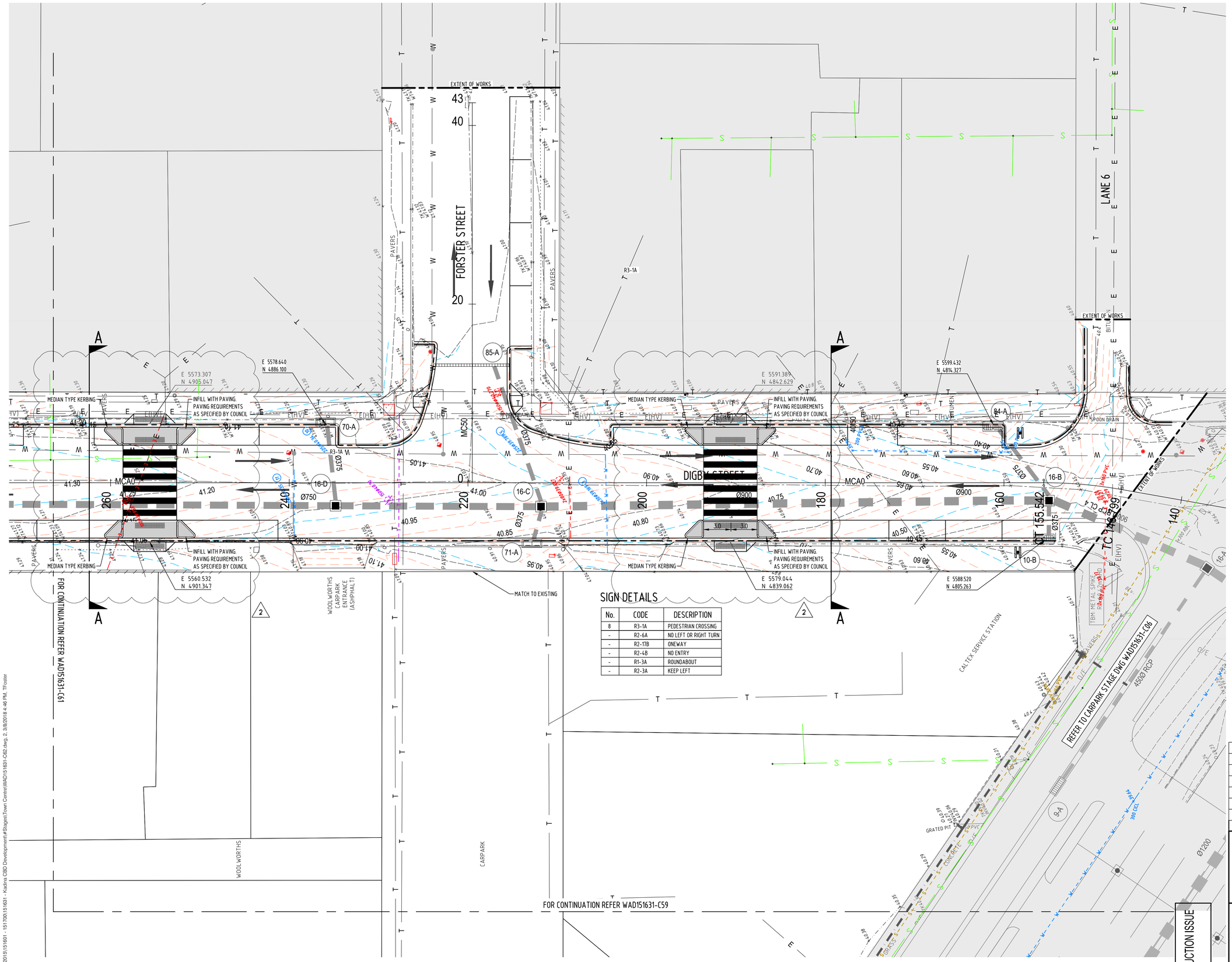

SIGN DETAILS

No.	CODE	DESCRIPTION
8	R3-1A	PEDESTRIAN CROSSING
-	R2-6A	NO LEFT OR RIGHT TURN
-	R2-17B	ONEWAY
-	R2-4B	NO ENTRY
-	R1-3A	ROUNDABOUT
-	R2-3A	KEEP LEFT

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR
- DESIGN LEVELS
  - P- PAVEMENT, TK- TOP OF KERB
  - L- LANDSCAPE, PL- PLATFORM LEVEL
  - G- GRATE, BL- BENCH LEVEL
  - INV- INVERT, TW- TOP OF WALL
- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB TRANSITION
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

1. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS, OTHER CONSULTANTS DRAWINGS & THE SPECIFICATION.
2. ALL UPVC STORMWATER PIPES ARE TO BE SEWER CLASS 'SN4'.
3. ALL R.C. STORMWATER PIPES ARE TO BE CLASS '2' WITH BEDDING TYPE 'HS2'. U.N.O.
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SCALE BAR (m): 4 2 0 4 8

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
2	03.08.18	PED. CROSSING FORSTER ST & DIGBY ST UPDATED	SRC	KV	HB
1	16.07.18	PED. CROSSING REMOVED AND DRIVEWAYS ADDED AT WOOLWORTHS	SRC	KV	HB
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB

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TOWN CENTRE LAYOUT

TRAFFIC CONTROL PLAN - SHEET 12

A1

DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C62	2

Design: DH Drawn: DH

DIGBY STREET

DRAFT

CONSTRUCTION ISSUE

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

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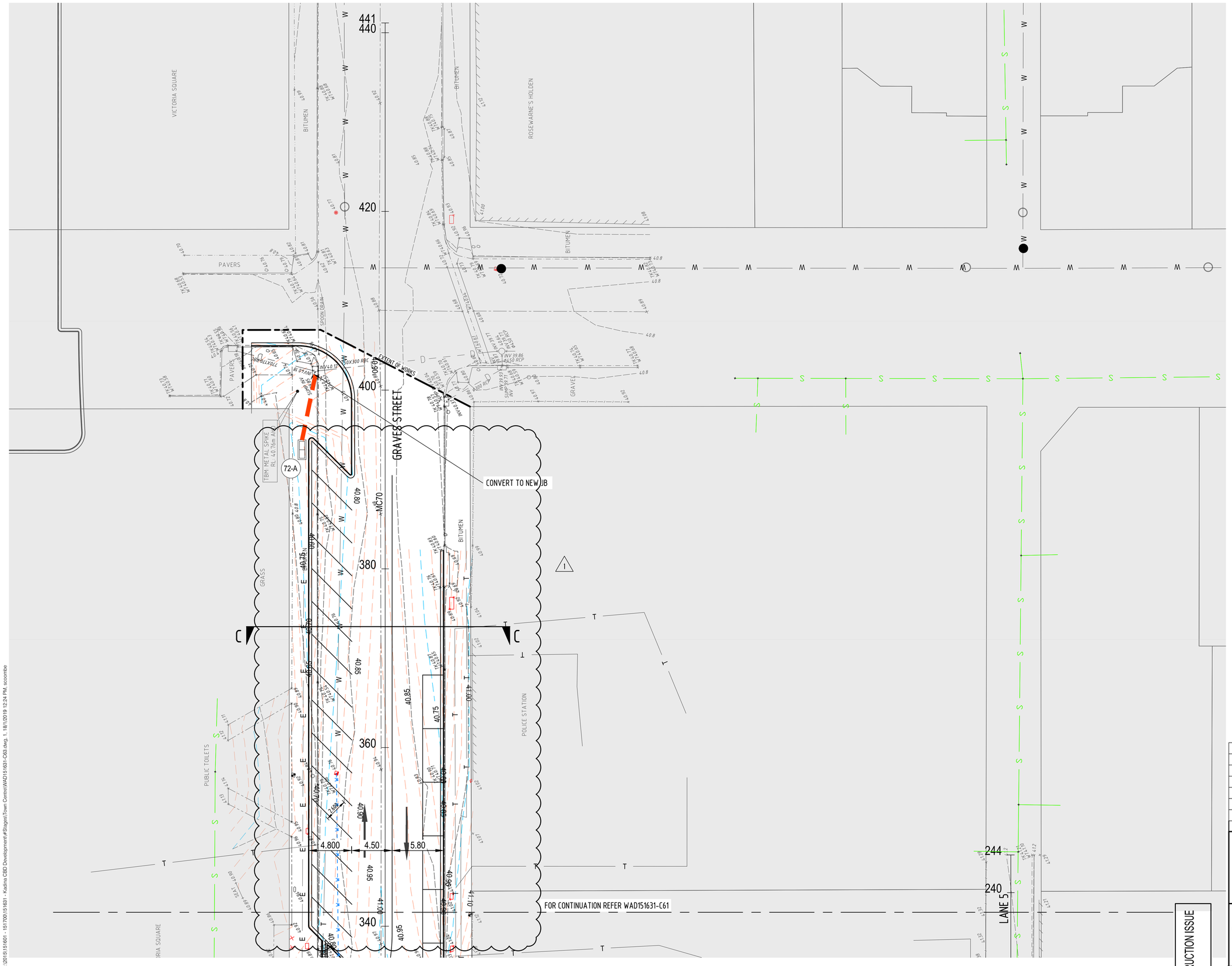

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS-MAJOR
- DESIGN CONTOURS-MINOR

DESIGN LEVELS

P- PAVEMENT	TK- TOP OF KERB
L- LANDSCAPE	PL- PLATFORM LEVEL
G- GRATE	BL- BENCH LEVEL
INV- INVERT	TW- TOP OF WALL

- STORMWATER PIPE - RCP (STAGE 2 WORKS)
- STORMWATER PIPE - RCP (STAGE 1 WORKS)
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- REFER TYPICAL SECTIONS ON DRG C86
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB TRANSITION
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- NEW BOLLARD
- DEPRESSION (IN FOOTPATH)
- DIRECTIONAL TRAFFIC ARROWS
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- TREE PIT
- TREE TO BE REMOVED (BY COUNCIL)

NOTES:

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4 2 0 4 8
SCALE BAR (m)

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
I	18.01.19	ROAD CHANGE	SRC	KV	HB
Ø	2.11.17	ISSUED FOR CONSTRUCTION	SRC	KV	NS
E	10.07.17	ISSUED FOR TENDER	SRC	HB	NS
D	4.07.17	ISSUED FOR APPROVAL	SRC	HB	NS
C	22.06.17	ISSUED FOR APPROVAL	SRC	HB	HB
B	15.03.17	ISSUED FOR REVIEW	SRC	HB	HB
A	22.02.17	ISSUED FOR FEEDBACK	JJF	HB	DMH

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TRAFFIC CONTROL PLAN - SHEET 13

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A1

DRAWING NUMBER

Design	Drawn	Job Number	Sheet No.	Rev.
DH	DH	WAD151631	C63	1

GRAVES STREET

CONSTRUCTION ISSUE

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

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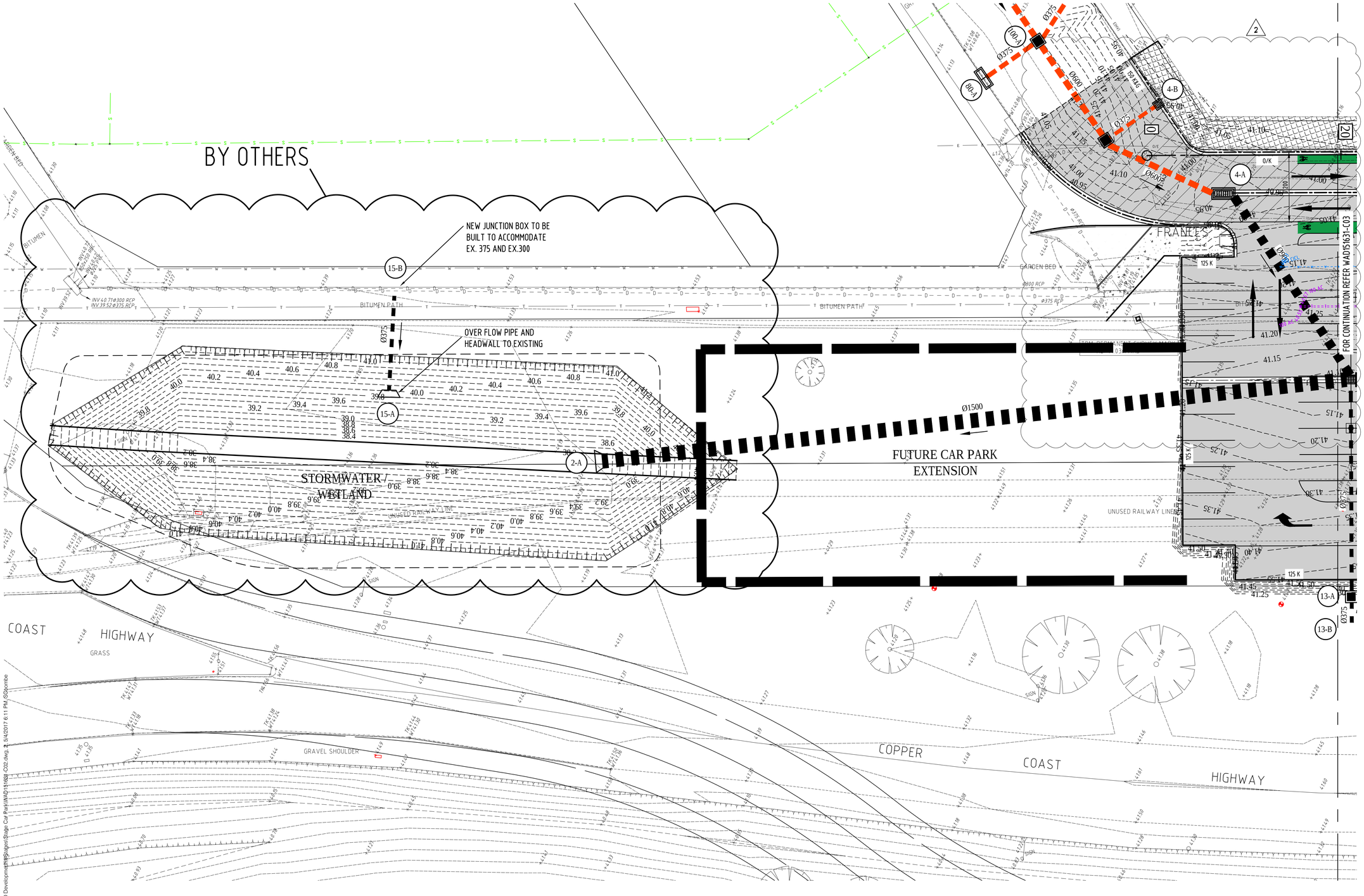

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS
- DESIGN LEVELS
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- STORMWATER PIPE - STAGE 2 WORKS
- STORMWATER PIPE - RCP
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
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- KERB ONLY
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- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- FLOW DIRECTION
- STORMWATER INSPECTION OPENING (SIO.)
- SIGN
- A.C. PAVEMENT - CARPARK
- A.C. PAVEMENT - ROAD
- A.C. PAVEMENT - ROUNDABOUT
- UNIT PAVING
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- BLOCK PAVING - TO UNDERSIDE OF SAND BEDDING LAYER ONLY
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- LANDSCAPING (BY ARCHITECT)
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5. CONTRACTOR TO CONFIRM INVERTS OF ALL EXISTING PIPES & SUMPS PRIOR TO CONNECTING & LAYING OF ALL NEW PIPEWORK.

NOTE:

FOR DRAINAGE PLANS REFER TO DRAWINGS C31 - C38.

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

4 2 0 4 8
SCALE BAR (m)

CONSTRUCTION ISSUE

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	29.07.16	CLIENT COMMENT	SRC	HB	XX
B	12.08.16	CLIENT COMMENT	SRC	HB	XX
C	18.08.16	TENDER ISSUE	SRC	HB	HB
D	13.09.16	UPDATED TENDER ISSUE	SRC	HB	HB
Ø	21.10.16	FOR CONSTRUCTION	SRC	HB	NS
2	5.04.17	LAYOUT UPDATE FOR RF10, 23, 26, 28.	SRC	KV	HB

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COPPER COAST COUNCIL
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DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C02	2

Design SRC | Drawn SRC

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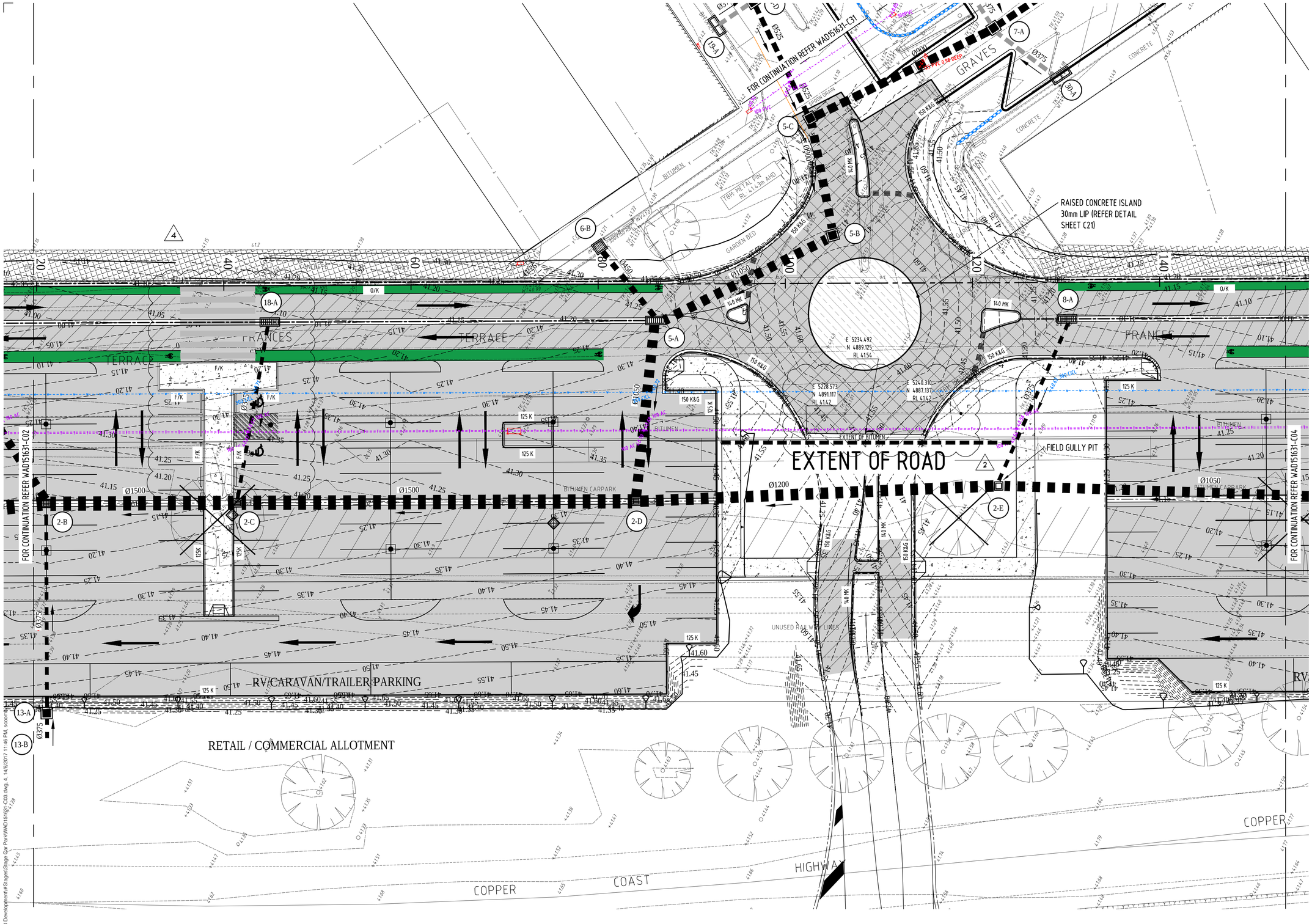

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS
- DESIGN LEVELS

P- PAVEMENT TK- TOP OF KERB
L- LANDSCAPE PL- PLATFORM LEVEL
G- GRATE BL- BENCH LEVEL
INV- INVERT TW- TOP OF WALL

- STORMWATER PIPE - STAGE 2 WORKS
- STORMWATER PIPE - RCP
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
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- STORMWATER INSPECTION OPENING (SIO.)
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NOTE:

FOR DRAINAGE PLANS REFER TO DRAWINGS C31 - C38.

SCALE BAR (m) 4 2 0 4 8

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

CONSTRUCTION ISSUE

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
C	18.08.16	TENDER ISSUE	SRC	HB	HB
D	13.09.16	UPDATED TENDER ISSUE	SRC	HB	HB
0	21.10.16	FOR CONSTRUCTION	SRC	HB	NS
1	9.03.17	FOR CONSTRUCTION	SRC	KV	NS
2	5.04.17	LAYOUT UPDATE FOR RF10, 23, 26, 28.	SRC	KV	HB
3	12.05.17	PED. CROSSING AND ROUNABOUT KERBING UPDATE	SRC	KV	HB
4	14.08.17	RFI 40,84,85,68	SRC	KV	HB

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Job Number	Sheet No.	Rev.
WAD151631	C03	4

Design SRC Drawn SRC

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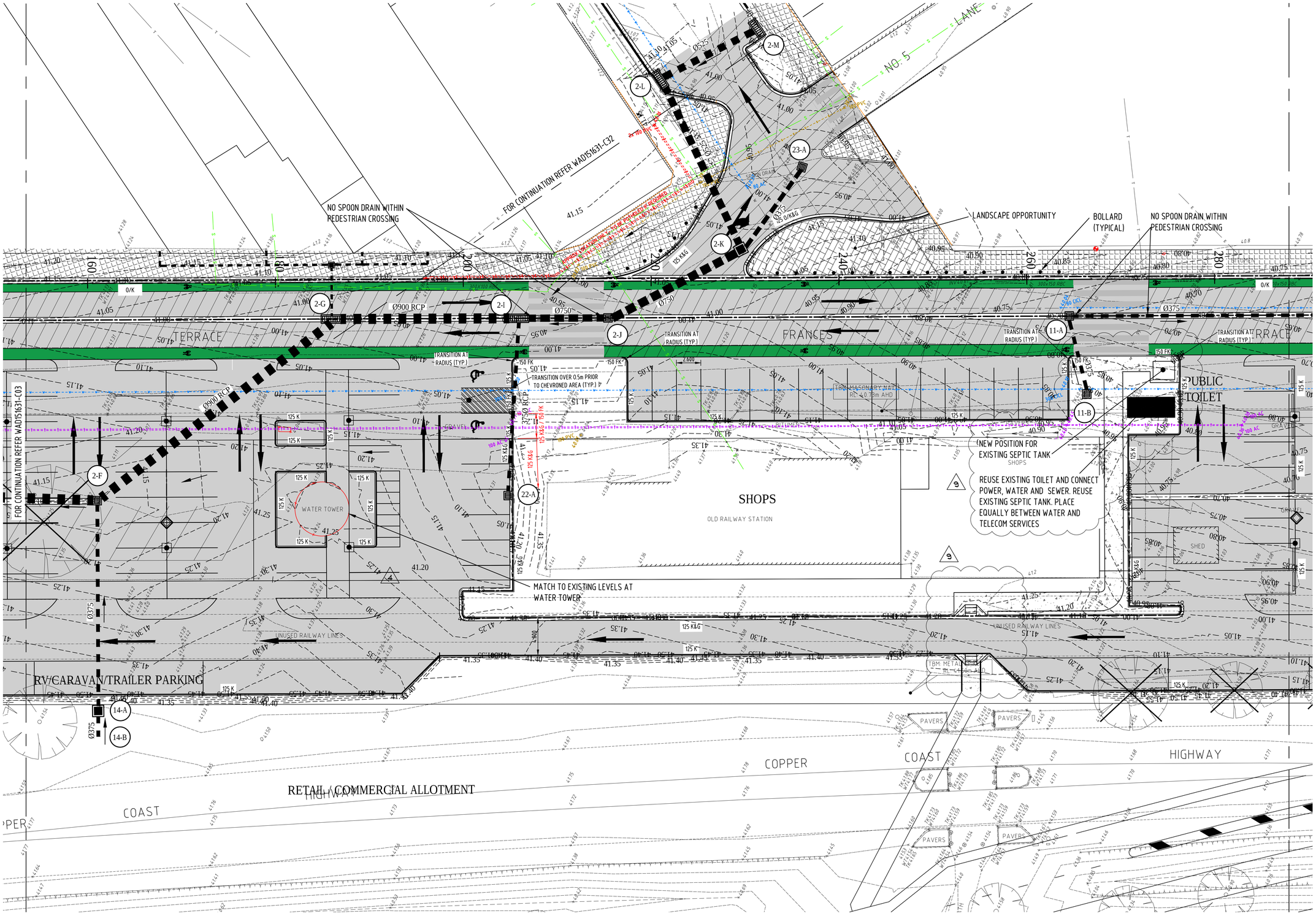

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
- EXISTING WATERMAIN (DBYD)
- EXISTING WATER HYDRANT (DBYD)
- EXISTING WATER VALVES (DBYD)
- EXISTING SEWER (GIS LOCATED)
- EXISTING TELSTRA (DEPTHED)
- EXISTING WATER (DEPTHED)
- EXISTING ELECTRICAL (DEPTHED)
- EXISTING SEWER (DEPTHED)
- EXISTING LEVELS
- EXISTING CONTOURS
- DESIGN CONTOURS
- DESIGN LEVELS

P- PAVEMENT, TK- TOP OF KERB
L- LANDSCAPE, PL- PLATFORM LEVEL
G- GRATE, BL- BENCH LEVEL
INV- INVERT, TW- TOP OF WALL

- STORMWATER PIPE - STAGE 2 WORKS
- STORMWATER PIPE - RCP
- STORMWATER PIPE : INVERT AT ANY DRAINAGE STRUCTURE OFF MAIN DRAIN TO BE A MINIMUM OF 1.0m BELOW NATURAL SURFACE AND LOCATION OF THIS STRUCTURE SUBJECT TO CHANGE
- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
- DOUBLE SIDE ENTRY PIT (SEP.)
- GRATED INLET PIT (GIP.)
- DOUBLE GRATED INLET/SEP
- V SHAPED DOUBLE GIP
- JUNCTION BOX (JB.)
- TRENCH GRATE
- FLOW DIRECTION
- STORMWATER INSPECTION OPENING (SIO.)
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NOTES:

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NOTE:

FOR DRAINAGE PLANS REFER TO DRAWINGS C31 - C38.

SCALE BAR (m): 4 2 0 4 8

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

CONSTRUCTION ISSUE

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
3	9.03.17	FOR CONSTRUCTION	SRC	KV	NS
4	5.04.17	LAYOUT UPDATE FOR RF10, 23, 26, 28.	SRC	KV	HB
5	12.05.17	KERBING AROUND WATER TOWER AND MOTORCYCLE PARKS	SRC	KV	HB
6	19.06.17	KERBING AMENDED & WHEEL STOPS REMOVED AS CLOUDED	SRC	KV	HB
7	12.07.17	KERBING AMENDED AS CLOUDED	SRC	KV	HB
8	14.08.17	RFI 40,84,85,68	SRC	KV	HB
9	24.08.17	RFI 83,89	SRC	KV	HB

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DRAWING NUMBER

Design	Drawn	Job Number	Sheet No.	Rev.
SRC	SRC	WAD151631	C04	9

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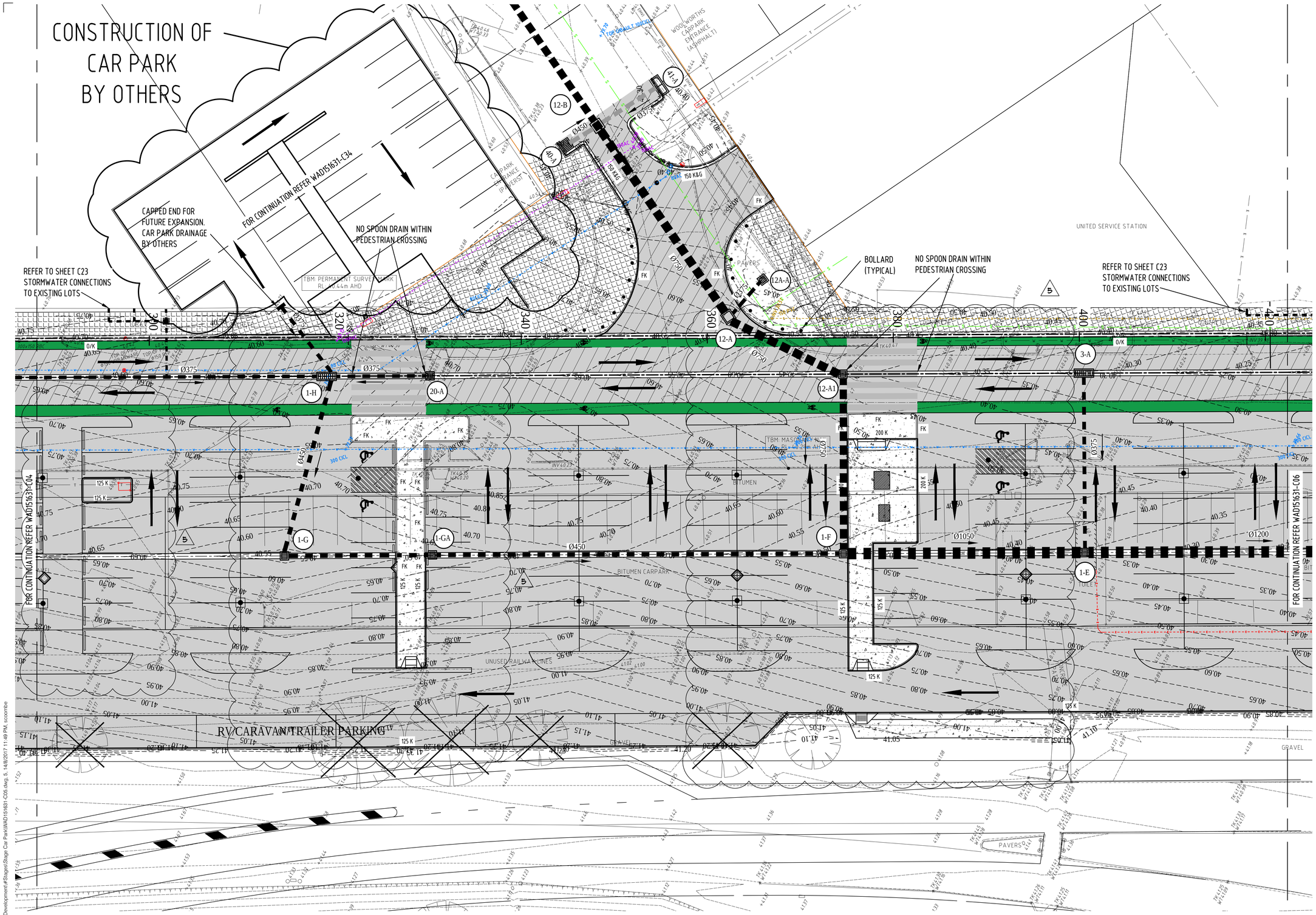

NOTE:

FOR DRAINAGE PLANS REFER TO DRAWINGS C31 - C38.

LEGEND:

- EXISTING DRAINAGE (DBYD)
- EXISTING TELSTRA (DBYD)
- EXISTING ELEC (LV) (DBYD)
- EXISTING ELEC (HV) (DBYD)
- EXISTING ELEC (OVERHEAD)
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- STORMWATER PIPE - RCP
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- STORMWATER PIPE - PVC
- KERB ONLY
- KERB & GUTTER
- OUTFALL KERB
- FLUSH KERB ONLY
- SEMI MOUNTABLE KERB
- SPOON DRAIN
- KERB RAMP
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0 50 100mm

4 2 0 4 8
SCALE BAR (m)

CONSTRUCTION ISSUE

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
D	13.09.16	UPDATED TENDER ISSUE	SRC	HB	HB
0	21.10.16	FOR CONSTRUCTION	SRC	HB	NS
1	17.11.16	FOR CONSTRUCTION	SRC	HB	HG
2	5.04.17	LAYOUT UPDATE FOR RF10, 23, 26, 28.	SRC	KV	HB
3	27.04.17	EXISTING SW PICK UP FROM PROPERTYS	SRC	KV	HB
4	16.05.17	UPDATED PIPE SIZE AS CLOUDED	SRC	KV	HB
5	14.08.17	RFI 40,84,85,68	SRC	KV	HB

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DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C05	5

Design: SRC
Drawn: SRC

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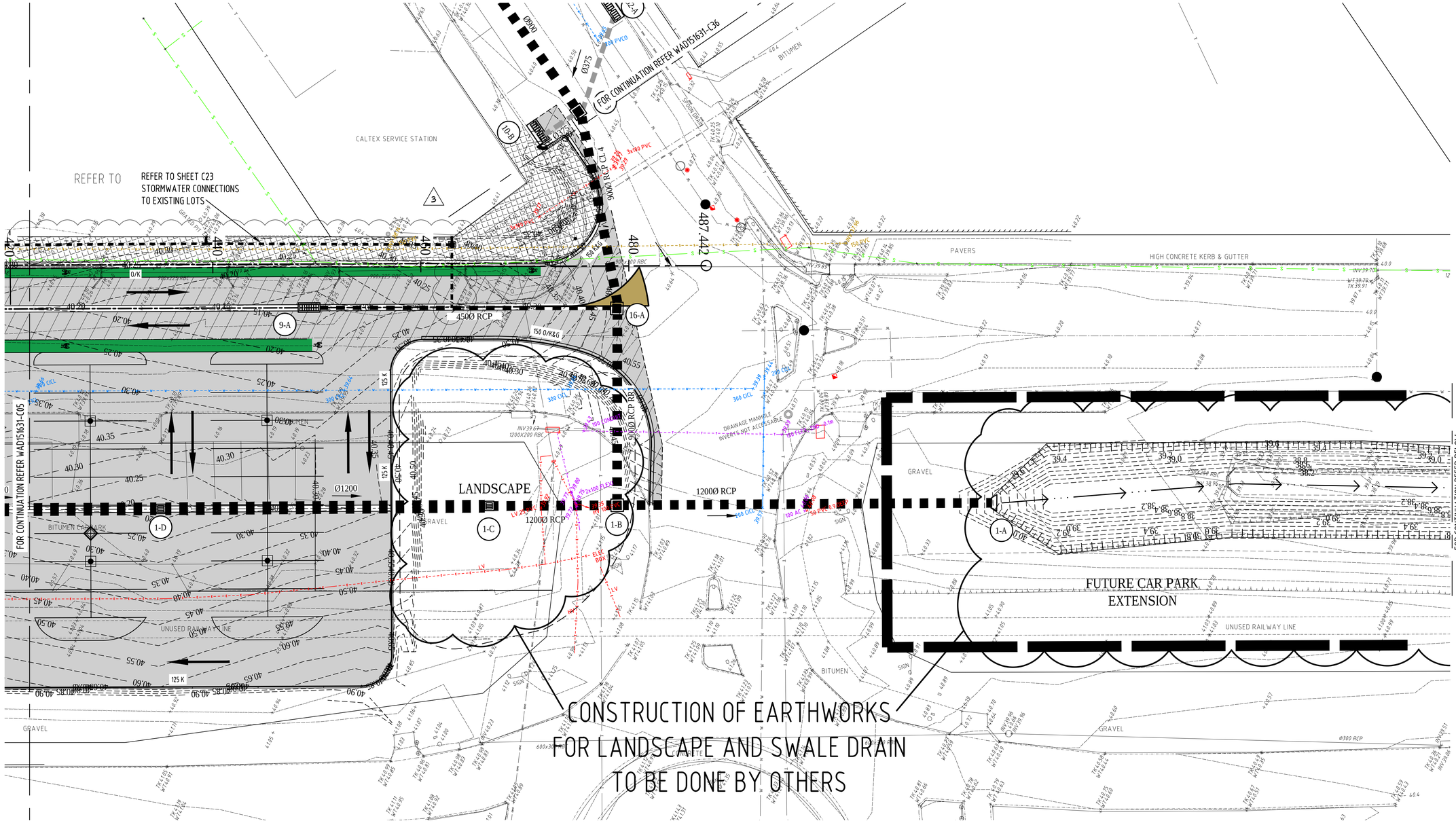
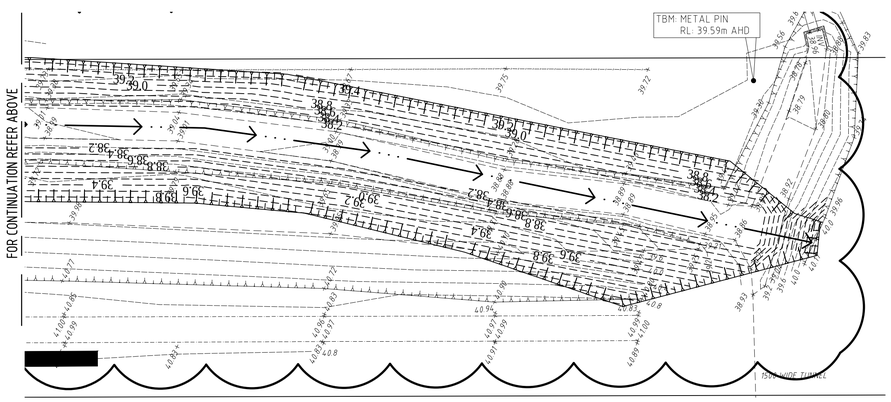


NOTE:

FOR DRAINAGE PLANS REFER TO DRAWINGS C31 - C38.



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4 2 0 4 8

SCALE BAR (m)

LEGEND:

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B	12.08.16	CLIENT COMMENT	SRC	HB	XX
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3	27.04.17	EXISTING SW PICK UP FROM PROPERTYS.	SRC	KV	HB

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DRAWING NUMBER

Job Number	Sheet No.	Rev.
WAD151631	C06	3

Design SRC Drawn SRC

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WALLBRIDGE GILBERT AZTEC

Nathan Silby
CIVIL DIRECTOR

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Email: NSilby@wga.com.au

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Facsimile: 08 8232 0967

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West Perth WA 6005
Telephone: 08 9336 6528

DARWIN
Suite 7/9 Keith Ln
Fannie Bay NT 0820
Telephone: 08 8941 1678
Facsimile: 08 8941 5060

WHYALLA
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Whyalla SA 5600
Phone: 08 8644 0432

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