TATTERSALL LANDER PTY LTD

STORMWATER MANAGEMENT REPORT

for

HARRINGTON WATERS LIFESTYLE VILLAGE

SENIORS LIVING DEVELOPMENT

MANOR ROAD, HARRINGTON

LOT 2, 4 & 6 IN DP 1219123

Prepared by

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1.0 INTRODUCTION

This report has been prepared to support a development application for a 292 lot Seniors Living subdivision proposal.

The site of the proposed development is comprised of Lots 2, 4 & 6 in DP1219123 and is located on Manor Road at Harrington.

Figure 1: Locality Diagram

2.0 BACKGROUND INFORMATION

The site is currently vacant rural style land on the outskirts of the township of Harrington. The majority of the site is zoned R5 large lot residential, with some accompanying E2 lands surrounding the creek at the south of the site.

The site is adjacent to residentially zoned land developed as part of the Harrington Waters estate to the east, with RU1 lands to the west and north. The northern part of the RU1 lands includes an existing caravan park on the opposite side of Manor Road.

3.0 SITE CONTEXT

The three existing lots are currently vacant and have been substantially cleared in the past. Vegetation is generally a mix of pasture grasses, but it does not appear to currently be actively grazed.

The topography is best described as flat, with levels generally from 2.0m to 2.7m AHD. Soils are a generally a silty sand in nature.

Photo 1: Existing Site Conditions

4.0 PROPOSED DEVELOPMENT

The proposal is for a 292-lot community title subdivision and Seniors Living development, including various community facilities and associated infrastructure including filling, private and public road and drainage construction, and services installation.

It is proposed to address stormwater impacts with a combination of a rainwater harvesting/reuse system, street scale biofilters, constructed wetlands and swales.

5.0 WATER QUALITY TARGETS

In preliminary discussions, Council have indicated the development should meet the pollution reduction targets in Table 1 below:

Table 1: Stormwater Quality Targets

Gross Pollutants (GP)	90%
Total Suspended Solids (TSS)	Neutral or Beneficial Effect
Total Phosphorus (TP)	Neutral or Beneficial Effect
Total Nitrogen (TN)	Neutral or Beneficial Effect

6.0 CONSTRAINTS AND OPPORTUNITIES / BEST PLANNING PRACTICES

Best-planning practices have been considered in the planning process for this site. The silty sand soils and undeveloped nature of the existing site present some significant challenges to meeting Water Quality targets. Additionally, the low-lying nature of the site means significant filling is required to address regional flooding and local drainage considerations. The depth to groundwater also limits some treatment/disposal options.

Early design and modelling efforts concluded that meeting the required water quality targets would not be practical considering the development site on its own. Methods that were investigated include:

- Permeable paving for the central corridor:
  Treatment benefits for paving the central corridor with permeable paving provided limited benefit whilst increasing cost and ongoing maintenance issues.
- Constructed wetlands at the outlet locations from the site:
  The high water table and low lying site makes the depths required for bathymetric zones of a constructed wetland unachievable.
- Increased biofilter area:
  Further increasing the biofilter area provided limited return on the treatment of water that was able to be directed to them.

However, the existing caravan park directly upstream of the site presents the opportunity to treat currently untreated discharge within the same catchment to ensure the overall project achieves the necessary water quality objectives.

The proposal also seeks to construct an internal drainage system that will double as both water quality and storm flow conveyance. Sections of ‘oversized’ biofiltration swales (with zero longitudinal grade) are linked via piped culverts under intersecting roads. Refer to design plans by Tattersall Lander (Appendix C) for further details. This will limit the overall gradient of the trunk drainage lines which will in turn reduce imported fill quantities to a point that makes the development viable.

A key concern will be ensuring that flow velocities do not cause scouring damage to the biofilter systems in the base of the swales. This has been addressed via the flat grades, wide cross sections and high roughness values – the flow capacity is provided via additional cross-sectional area rather than grade. Resulting velocities will be discussed in more detail in Section 9 of this report.

7.0 SOIL AND WATER MANAGEMENT

A critical time for increase pollutant loads is during construction, and with this in mind, current practice recommends guidelines from Landcom's "Blue Book". Erosion and sediment control measures should be designed and specified in accordance with the "Blue Book" guidelines, and to Council satisfaction, and be inspected and maintained during the construction phase. This will assist in ensuring adherence to pollutant prevention measures, particularly the removal of suspended solids (sediment).

As the construction footprint of each stage will be in excess of 2,500sq.m, typically it would be expected that a detailed Soil and Water Management Plan would need to be prepared for construction stage prior to release of the Construction Certificate. This would typically include calculations of likely soil loss during construction, instructions on preferred construction sequence and limiting land disturbance, and calculations for the provision and sizing of any temporary sedimentation basin to cover the period of civil works.

8.0 INTEGRATED WATER CYCLE MANAGEMENT

All created lots will be serviced with reticulated water and sewer from the MidCoast Water Services network. There is no reticulated recycled water network available in Harrington.

In line with BASIX and WSUD principles, runoff from future dwelling roof areas is to be directed into rainwater tanks for reuse within the dwelling (toilet and laundry) and external use.

9.0 STORMWATER MANAGEMENT - HYDROLOGY

The nature of urban development is that it can increase the amount of impervious surface in a catchment, which in turn can decrease runoff times and create higher peak flow rates. It is important with new developments that measures are put in place to prevent increases in runoff from the site and resulting downstream flash flooding.

This particular site is in close proximity to the Manning River, and the proposal will include appropriate trunk drainage lines to convey runoff directly to the river without any impact on adjoining properties. Given the critical duration for flooding of the river in this location is significantly longer than the proposed local drainage network, it is not intended to attempt to detain flows back to pre-developed flow rates – the purpose of the two proposed basins is to control and buffer site discharges and velocities in relation to adjoining properties and the sensitive downstream E2 lands.

A detailed 1D node and link XP Storm flood routing model has been prepared to assess the effectiveness of the proposed trunk drainage system.

The model consisted of a series of trapezoidal conduits at 0% grade with a high “Mannings n” roughness value of 0.45 representing the biofilters connected by culverts at minimum grade with trapezoidal conduits and weirs representing the roads crossing the biofilter channels.

Whilst the biofilters are intended to allow infiltration through their base, the infiltration rates over the site are not considered sufficient to provide storm attenuation. For hydrology calculations a conservative approach was taken, assuming the biofilters to already be full to the level of the extended detention depth.

The site was broken up into a series of catchments that drain to the proposed biofilters. Impervious areas were measured directly off the plans with the area of proposed roof added to the catchments.

Impervious areas were modelled with 0.3mm depression storage, 0mm initial and 0mm/hr continuing loss.

Pervious areas were modelled with 0mm depression storage, 0.5mm initial loss with 2.5mm/hr continuing loss.

Rainfall was simulated utilising the Laurenson Method with IFD data sourced from the Greater Taree City Council Handbook of Drainage Criteria.
In consultation with Council engineers, the discharge level for the site has been set to 1.3m AHD as this is the 5 year ARI flood level. A separate Flood Impact Assessment for the development by BMT WBM found that 2100 100yr flood level on the site to be 3.1m AHD at Manor Road and 3m AHD at the Manning River.
To increase the capacity of discharge from Basin 1 whilst still being able to maintain cover over the pipe, the outlet pipe has been designed as a 600mm pipe discharging at 1.15m AHD. This has been modelled with a sediment level of 150mm through the pipe to represent a discharge level of 1.3m AHD.

The model was run with three separate scenarios, a Minor Event and two separate scenarios to represent the major event.

Minor Event:

The modelling conditions for the minor event scenario included a range of durations with 5 year ARI discharging to the Manning River with a free outfall at 1.3m AHD. The culverts were then sized to ensure a drainage solution was possible that provided 150mm freeboard in the drainage system during the peak 5 year ARI event.

Major Event:

Two major event scenarios were modelled as the critical duration for the site is much lower than the critical duration for the peak flood levels of the Manning River. The probability of combining the peak 100 year ARI storm event for the site with the peak 2100 100year ARI flood level for the Manning River would have a greater recurrence interval than 100 years.
Both major event scenarios were modelled to have a 50% blockage factor in the culverts by halving the culvert width on the conduit data in XP storm from the design conduits.
The first major event scenario was a 100 year ARI storm event over the site with a 1.3m AHD free outfall. This scenario represents the peak stormflow for the site.

The second major event scenario was a 5 year ARI storm event over the site with a fixed tail water of 3m AHD representing the peak 2100 100yr flood level for the Manning River. This scenario represents a local minor event occurring at the site whilst there was also a peak 2100 100 year ARI regional flood for the Manning River.

The peak water level for the 100 year ARI was used to determine the minimum floor level for the houses in the corresponding streets.

Critical duration events varied across the network, and typically were the shorter events higher up the catchment and longer durations down in the outlet basins.

9.1 FLOW CONVEYANCE RESULTS

As the site discharges directly to a large water body (i.e the Manning River), On-Site Detention was not required and pre and post developed peak flows were not compared.

The model was used to ensure 5 year ARI events were contained in the pit, pipe and channel system as shown by Table 2.

For the 100 year ARI events the model was used to determine minimum floor levels throughout the site and to check that the detention basins prevented uncontrolled flows into neighbouring properties during a 100 year event where flooding was not already occurring. This is shown by Table 3 and Table 4.

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Table 2: Peak 5 Year ARI Water Levels

Intersection	Road Level (m AHD)	5 Year Water Level (m AHD)	Freeboard Achieved (mm)
Road 2 & 4	3.2	2.909	291
Road 2 & 5	3.13	2.902	228
Road 2 & 6	3.06	2.883	177
Road 2 & 7	2.99	2.782	208
Road 2 & 8	2.92	2.621	299
Road 2 & 9	2.8	2.519	281
Road 2 & 3	2.9	2.456	444
Road 2 Public to Private	2.92	2.341	579
Road 3 & 4	3.185	2.881	304
Road 3 & 5	3.125	2.879	246
Road 3 & 6	3.065	2.787	278
Road 3 & 7	3.005	2.71	295
Road 3 & 8	3.095	2.723	372
Road 3 & 9	2.945	2.663	282
Road 3 & 11	2.885	2.596	289
Road 2(Private) & 4	3.18	2.839	341
Road 2(Private) & 5	3.12	2.839	281
Road 2(Private) & 12(North)	3.06	2.824	236
Road 2 (Private) & 12(South)	3	2.786	214
Road 2 (Private) & 11	2.94	2.661	279
Road 2 (Private) & 10	2.88	2.449	431

Table 3: Peak 100 Year ARI Water Levels

Intersection	Peak 100 Year Water Level - 1.3m AHD Free Outfall (m AHD)	Peak 100 Year Water Level - 3m AHD Tail Water	Minimum Floor Level (m AHD)
Road 2 & 4	3.191	3.181	3.69
Road 2 & 5	3.187	3.196	3.70
Road 2 & 6	3.139	3.147	3.65
Road 2 & 7	3.071	3.089	3.59
Road 2 & 8	3.005	3.048	3.55
Road 2 & 9	2.887	3.03	3.53
Road 2 & 3	3.064	3.13	3.63
Road 2 Public to Private	3.031	3.085	3.59
Road 3 & 4	3.257	3.248	3.76
Road 3 & 5	3.252	3.243	3.75
Road 3 & 6	3.198	3.204	3.70
Road 3 & 7	3.154	3.202	3.70
Road 3 & 8	3.142	3.195	3.70
Road 3 & 9	3.105	3.161	3.66
Road 3 & 11	3.124	3.176	3.68
Road 2(Private) & 4	3.213	3.211	3.71
Road 2(Private) & 5	3.202	3.199	3.70
Road 2(Private) & 12(North)	3.167	3.166	3.67
Road 2 (Private) & 12(South)	3.141	3.146	3.65
Road 2 (Private) & 11	3.087	3.123	3.62
Road 2 (Private) & 10	3.059	3.105	3.61

Table 4: Peak 100 ARI Year Water Levels in Basins

	Discharge Level (m AHD)	Overflow Level (m AHD)	Peak 5 year Water Level (m AHD)	Peak 100 year water level - Free Outfall (m AHD)
Basin 1	1.92	2.65	2.352	2.546
Basin 2	1.3	1.5	1.367	1.398

Figure 2 through to Figure 5 below show the basin elevations. Note that Basin 1 does not completely empty due to the 150mm sediment depth conservatively applied to the whole of the discharge pipe rather than just up to 1.3m AHD.

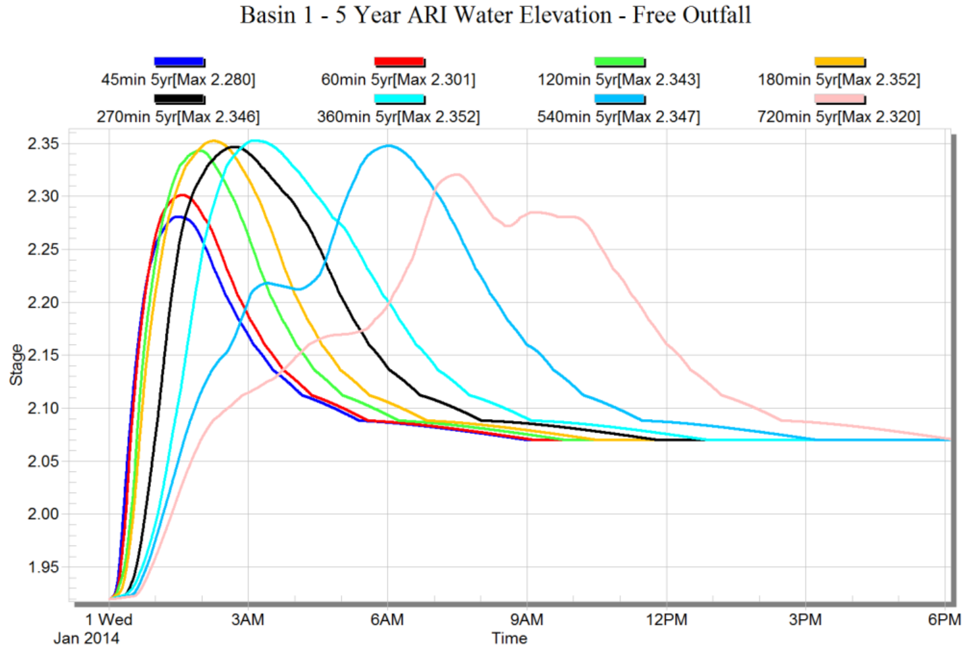


Figure 2: Basin 1 - 5 Year ARI Water Elevation

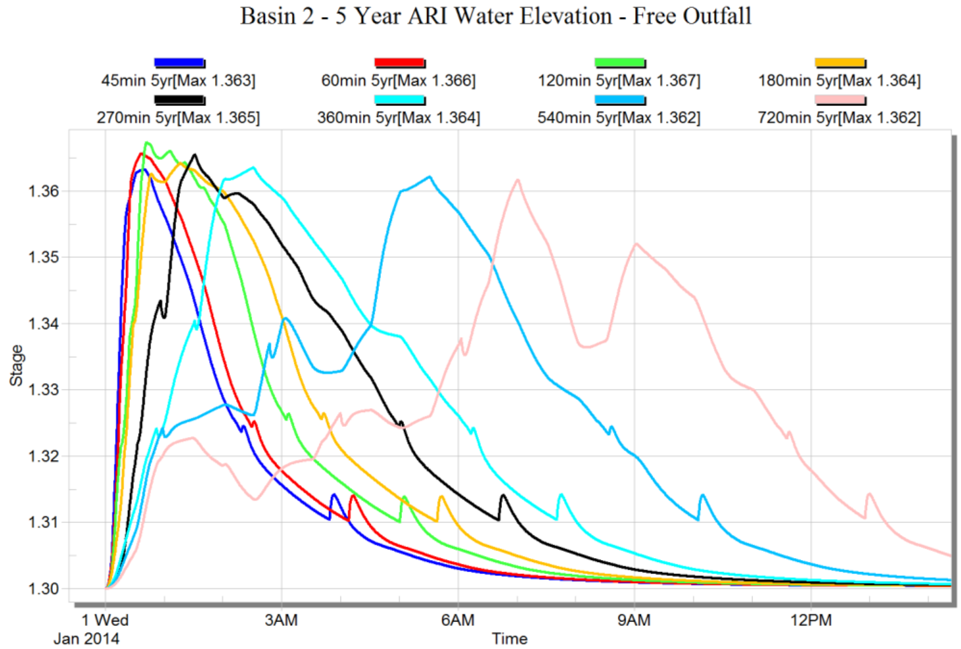


Figure 3: Basin 2 - 5 Year ARI Water Elevation

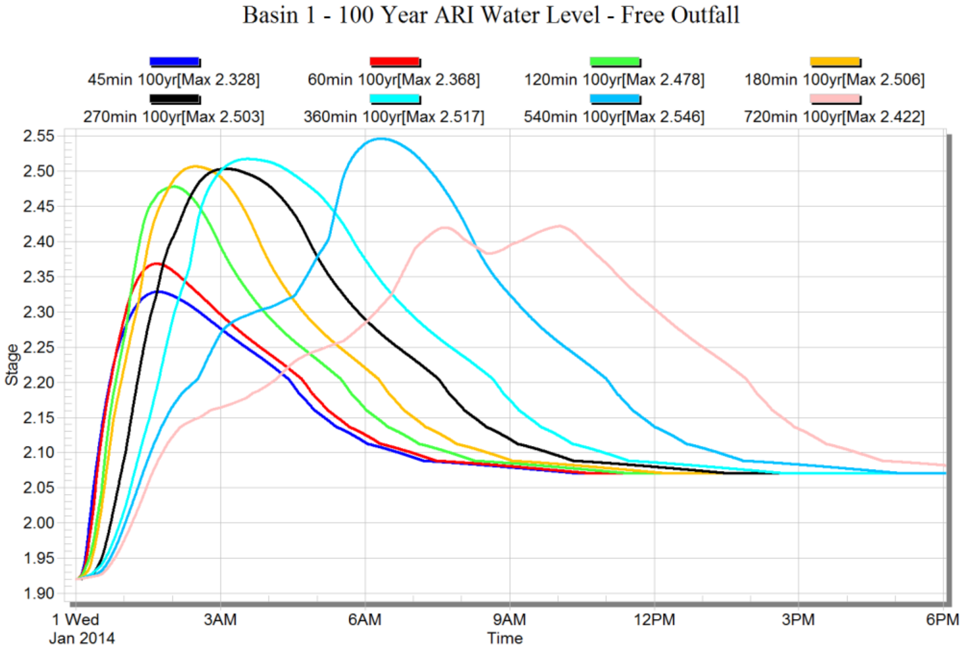


Figure 4: Basin 1 - 100 Year ARI Water Elevation

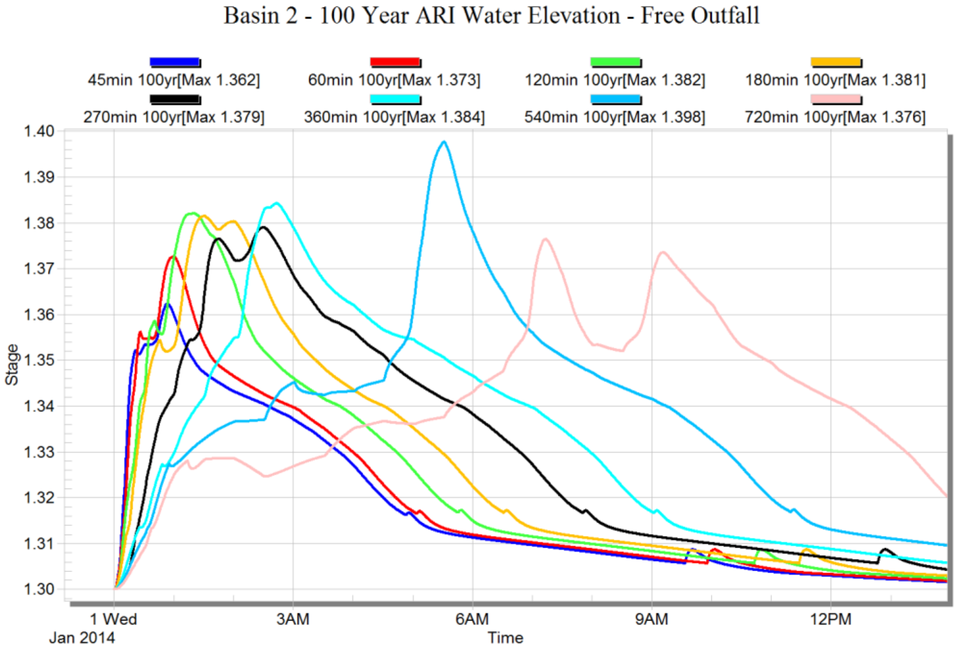


Figure 5: Basin 2 - 100 Year ARI Water Elevation

9.2 BIO-SWALE SCOUR VELOCITIES

WSUD Engineering Procedures published by Melbourne Water states that velocities in biofiltration swales should be limited to 0.5 m/s for the five-year ARI event and 1.0 m/s for flows up to the 100-year ARI.

The maximum 5yr event velocities seen in any of the biofilter swales in the are around 0.07m/s with a corresponding depth ranging between 0.85m and 0.55m (above filter base). The equivalent 1% ARI results were around 0.1m/s and 1.2m deep. Both values are well below the target values so scour / sediment washout should not be an issue.

9.3 PUBLIC SAFETY

The proposed design requires the roadside swales to transfer both the minor and major design storms' flows. Significantly flat grades and wide cross sections will ensure low velocities (as described above), but will also result in some larger depths in the major storm event. With floor levels/road levels fixed with the regional flood level and the trunk drainage falling through the site, in the major storm event the swales will actually resemble a string of basins, linked by submerged culverts.

The swales include several design features that will help to ensure public safety;

- Safe Batters - Generally, the side of each swale adjacent to the road has been graded at 1(V):6(H) to allow safe egress if anyone accidentally enters the waters during a major storm event. Steeper batters (typically 1(V):3(H) and 1(V):4(H)) exist on the far side of the swale, and will abut fencing to prevent access,

- Flat grades/wide sections – conforming to the character of the existing site, the swales will feature very flat grades. This necessitates a wide cross section in order to provide flow capacity. Combined with the high roughness values due to the level of landscaping proposed, velocities will be very low, even in major storm events,

- Well defined edges – Generally speaking the streets are straight or the swales are on the inside of the curve, reducing the likelihood of vehicles accidentally turning in to a flooded swale,

- Landscaping - Swales will also double as landscape areas, which will include tree plantings and dense macrophyte plantings, so even under major flood conditions the biofilters will provide a clear visual and tactile delineation between the roadway and the deeper drainage channel. People entering a flooded swale will be able to use the vegetation to assist with orientation and stability as they attempt to exit the water,

- Alternate Routes – Generally speaking the grid-like street pattern provides alternative access routes if a particular road crossing becomes flooded by extreme flows or culvert blockages. This should ensure there is always another safe route, and pedestrians and vehicles are not forced to cross flooded roadways.

Chapter 7, Book 6 of ARR 2016 describes several methods for determining flood hazard categories and refers to work done by Smith et al, 2014 shown below in Figure 6.

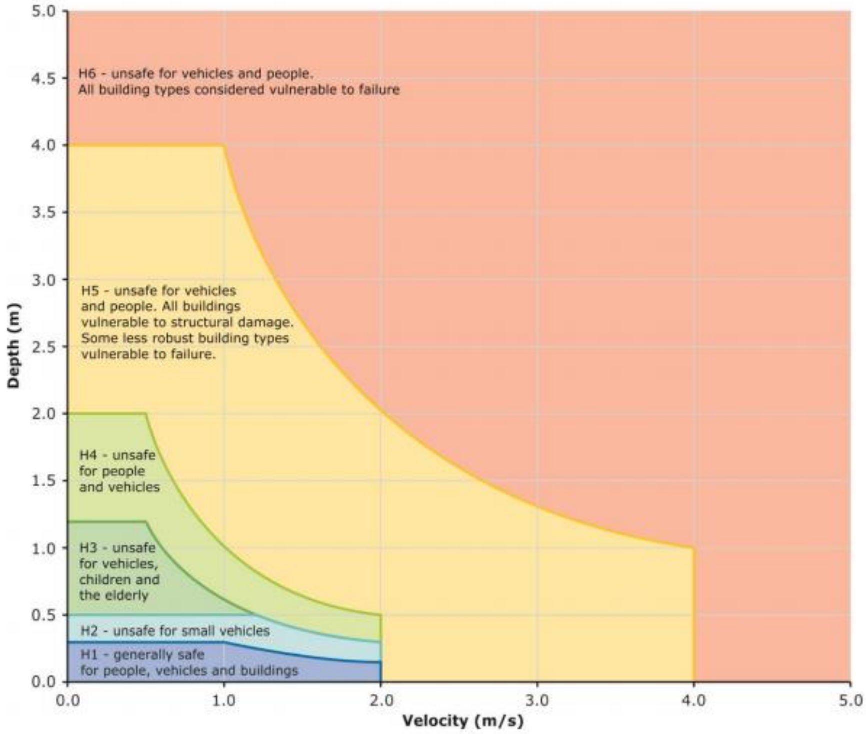


Figure 6: Hazard Categories (Smith et al, 2014)

These categories were used to assess the hazard of water flowing over the intersections in a 1 in 100 year ARI event. As shown in

Table 5 below shows that the flows over these intersections are both low velocity and low depth and as such are classed with a hazard category of *"H1 – Generally safe for people, vehicles and buildings"*

Table 5: Intersection Hazard Category

Intersection	Peak 100 Year Velocity (m/s)	Peak 100 Year Depth (m)	Velocity x Depth	Hazard Category
Road 2 & 4	0	-0.009	0.00	H1
Road 2 & 5	0.454	0.066	0.03	H1
Road 2 & 6	0.57	0.087	0.05	H1
Road 2 & 7	1.128	0.099	0.11	H1
Road 2 & 8	1.099	0.128	0.14	H1
Road 2 & 9	0.75	0.23	0.17	H1
Road 2 & 3	0	0.23	0.00	H1
Road 2 Public to Private	1	0.165	0.17	H1
Road 3 & 4	0.362	0.072	0.03	H1
Road 3 & 5	0.616	0.127	0.08	H1
Road 3 & 6	0.711	0.139	0.10	H1
Road 3 & 7	0.724	0.197	0.14	H1
Road 3 & 8	0.722	0.081	0.06	H1
Road 3 & 9	1.066	0.25	0.27	H1
Road 3 & 11	1.057	0.276	0.29	H1
Road 2(Private) & 4	0.171	0.033	0.01	H1
Road 2(Private) & 5	0.457	0.082	0.04	H1
Road 2(Private) & 12(North)	0.512	0.107	0.05	H1
Road 2 (Private) & 12(South)	1.1	0.146	0.16	H1
Road 2 (Private) & 11	1.087	0.183	0.20	H1
Road 2 (Private) & 10	1.087	0.225	0.24	H1

For the proposed flow conveyance bio swales (labelled in Appendix A), velocity is very low due to the flat gradient but the depths are much greater. This has resulted in a higher hazard category for these areas as shown in

Table 6. These higher categories are deemed acceptable as entry for people and vehicles is not intended. Additionally the design features noted at the start of the chapter allow for distinction of these areas and safe egress as water levels begin to rise.

Table 6: Bio Swale Hazard Category

Bio Swale	Peak 100 Yr Velocity (m/s)	Peak 100 Yr Depth (m)	Velocity x Depth	Hazard Category
A	0.017	1.066	0.018	H3
B	0.023	1.087	0.025	H3
C	0.053	1.099	0.058	H3
D	0.062	1.128	0.070	H3
E	0.021	1.152	0.024	H3
F	0.063	1.164	0.073	H3
G	0.088	1.222	0.108	H4
H	0.096	1.256	0.121	H4
I	0.083	1.301	0.108	H4
J	0.106	1.330	0.141	H4
K	0.095	1.206	0.115	H4
L	0.008	1.102	0.009	H3
M	0.026	1.127	0.029	H3
N	0.029	1.166	0.034	H3
O	0.032	1.203	0.038	H4
P	0.028	1.245	0.035	H4
Q	0.029	1.285	0.037	H4

9.4 REGIONAL FLOOD LEVELS

A separate Flood Impact Assessment for the development by BMT WBM found that 2100 100yr flood level on the site to be 3.1m AHD at Manor Road and 3m AHD at the Manning River. In consultation with the DCP and Council engineers, it is proposed to fill the site with the following criteria;

- Minimum future Finished Floor Levels will need to be 3.6m AHD (0.5m freeboard above the flood planning level). As such the minimum fill level on each lot has been designed to be at least 3.46m AHD, to allow direct slab-on-ground construction with no further earthworks.
- All roads (private and public) to be at least 2.7m AHD to limit the maximum 2100 100yr flood depth to 0.4m.

Additionally, the controlling downstream discharge level has been set at 1.3m AHD – the 2100 Mean High Water Mark.

10.0 STORMWATER MANAGEMENT – WATER QUALITY MODEL

10.1 BACKGROUND

The quality of runoff generated by the site is important to ensure the preservation of the downstream environments as an increased proportion of impervious area can lead to a subsequent increase in the quantities of phosphorus and nitrogen entering potential storm water runoff. The aim of this section of the study is to determine what measures need to be undertaken as part of this development to meet the water quality objectives set out in Table 1 in Section 5 of this report.

10.2 MUSIC MODELLING

MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the Cooperative Research Centre for Catchment Hydrology. MUSIC provides the ability to model both quality and quantity of runoff generated by catchments. Therefore, MUSIC can simulate annual stormwater volumes, and expected annual pollutant loadings.

MUSIC is designed to model stormwater runoff systems in urban catchments. It is used to simulate a range of temporal and spatial scales. Catchment modelling can be performed for areas up to 100 km^2, with times steps from 6 minutes to 24 hours to match the range of spatial scale. This enables long term modelling of continuous historical rainfall data from pluviograph sources and reflects the ability to account for temporal variation in data for an annual rainfall series directly.

MUSIC also has the ability to model a number of treatment devices and measure their effectiveness in terms of the quantity and quality of runoff downstream. This allows determination of the degree of reduction in annual pollutant loadings.

It is important to note that the MUSIC simulation relies heavily on input variables and it is usually recommended that MUSIC models be calibrated to local conditions wherever possible. When calibration is not possible default values can be used, or variables can be sourced from values recommended for stormwater modelling in NSW from a technical report prepared for the DECC by the Co-operative Research Centre titled "*Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures*" (Fletcher et al, 2004).

Given the scale of the proposed development site and hence the MUSIC model, it was determined to be unreasonable to perform a calibration in this instance.

10.2.1 CLIMATE / RAINFALL

To accurately model a site of this size, continuous rainfall record spanning at least five years with a six minute timestep is required. Per the recommendations of the 2010 Draft NSW MUSIC Modelling guidelines, rainfall data was obtained from the Bureau of Meteorology in the form of a historic pluviograph record from the Taree rainfall gauge. It is situated approximately 13km from the site and is of similar elevation and temporal pattern.

In accordance with the Draft MUSIC Modelling Guidelines, eight years of data between the dates of 1/1/1967 and 30/12/1975 was chosen. This data produced a mean annual rainfall of 1201mm. It was noted that the long term average rainfall (obtained from the Bureau of Meteorology) for Harrington (Oxley Anchorage Caravan Park, now closed) is 1338mm, and the Council template released recently has a mean value of 1234mm.

For the purpose of this report, all rainfall events in the nominated eight year period have been modelled.

10.2.2 EVAPORATION

To accurately model the outcome of water quality treatment measures, monthly potential evapotranspiration (PET) data is required. Monthly average areal potential evapotranspiration values were read from maps in the 'Climate Atlas of Australia, Evapotranspiration' (BoM, 2001), and are displayed below in Table 7:

Table 7: Monthly Areal Potential Evapotranspiration Figures

Month	Potential Evapotranspiration (mm)
January	180
February	135
March	135
April	90
May	65
June	50
July	50
August	70
September	100
October	135
November	150
December	165
Total	**1325**

10.2.3 NODE PARAMETERS

The MUSIC model was used to simulate the pollutant export generated during an eight year period of average rainfall. Geotechnical investigations indicate that the predominant soil types on site is silty sand. This corresponds with the rainfall-runoff parameters for Loamy Sand soils which were adopted from Section 3.6.4.3 of the Draft NSW MUSIC Modelling Guidelines (2010) and typical pollutant concentrations derived from Fletcher et al. The adopted parameters can be seen in Figure 7 and Table 8 below.

Note that a Rainfall Threshold of 1.50 mm/day was adopted for the "Sealed Road" node and 0.30 mm/day was adopted for the "Roof" node per Table 3.6 in the Draft NSW MUSIC Modelling Guidelines (2010). A Rainfall Threshold of 1.00 mm/day adopted for all other nodes.

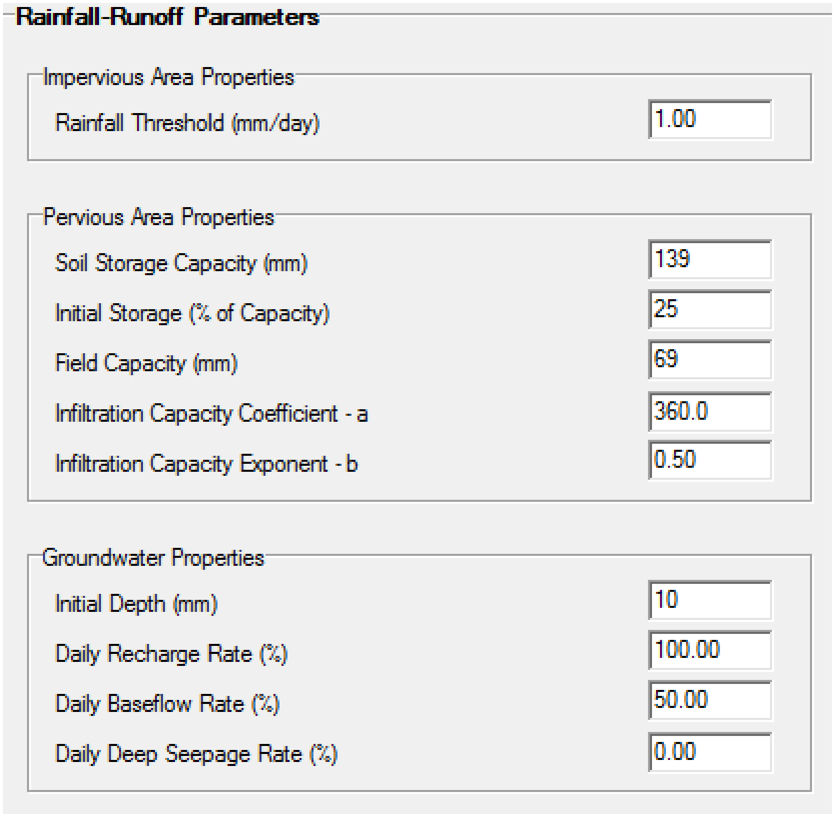


Figure 7: Adopted Rainfall-Runoff MUSIC Parameters

Table 8: Adopted MUSIC Pollutant Generation Parameters

	Rural-residential	Unsealed Road	Residential	Roof	Road
Baseflow TSS Mean (mg/L)	14	16	16	-	16
Stormflow TSS Mean (mg/L)	90	1000	140	20	270
Baseflow TP Mean (mg/L)	0.06	0.14	0.14	-	0.14
Stormflow TP Mean (mg/L)	0.22	0.5	0.25	0.13	0.5
Baseflow TN Mean (mg/L)	0.9	1.3	1.3	-	1.3
Stormflow TN Mean (mg/L)	2	2.2	2	2	2.2

10.2.4 EXISTING FLOW & POLLUTANT ANALYSIS

The existing site was modelled to simulate the current pollutant loads from the site. The majority of the site was modelled as a ‘rural-residential’ landuse, with additional nodes to represent the existing gravel access driveways on the site (‘unsealed road’ landuse, 50% impervious) and the portion of the existing caravan park draining to Manor Road (‘residential’ landuse, 60% impervious).

Generally speaking the existing silty sand soils mean there is little runoff and thus little pollution generated from the site.

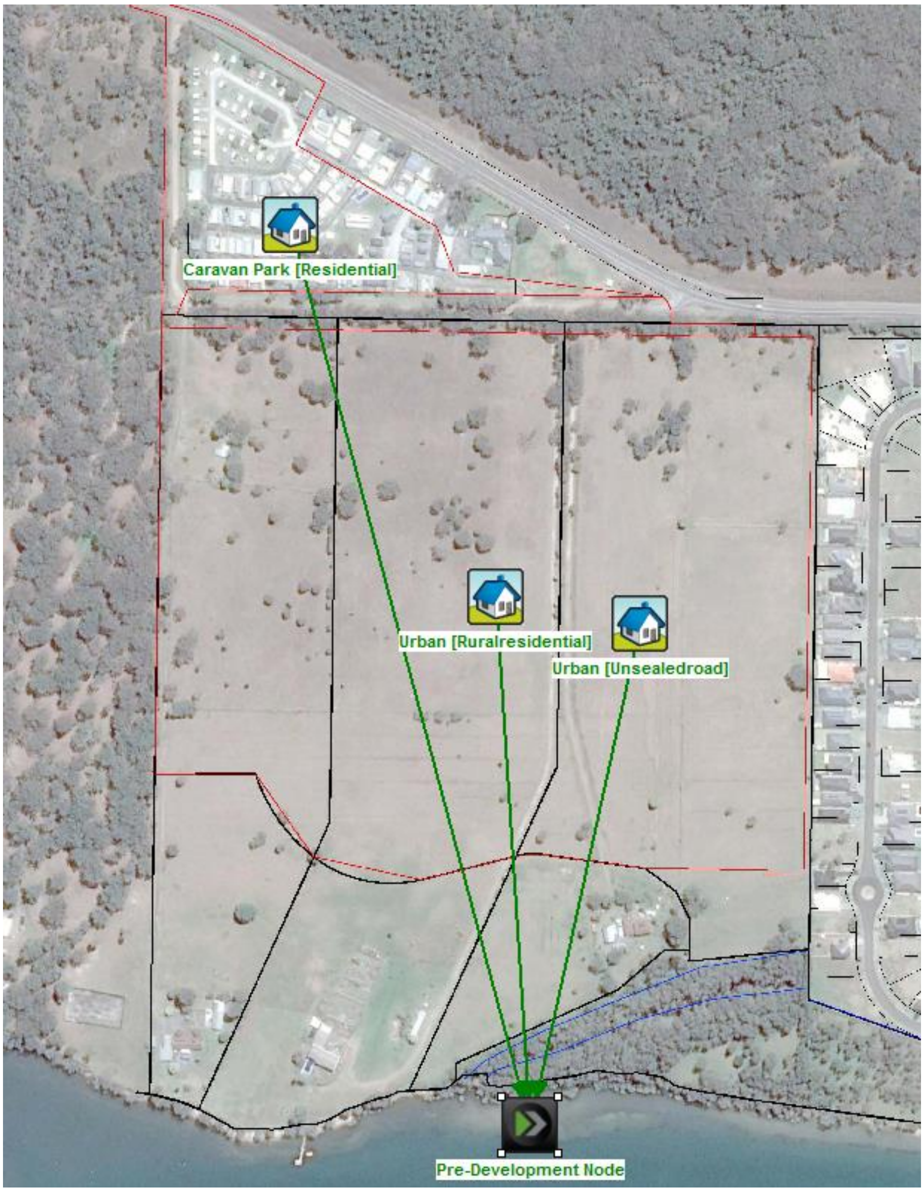


Figure 8: Existing State MUSIC Model

10.2.5 PROPOSED DEVELOPMENT FLOW & POLLUTANT ANALYSIS

Concerted efforts (including detailed MUSIC modelling) were made to try and achieve the required NorBE targets onsite, but this proved impractical given the low target levels calculated from the existing site.

In consultation with Council, it was agreed that treatment of external upstream catchment flows would be undertaken in addition to onsite treatments, to achieve an overall NorBE result.

The proposed development was modelled to determine expected pollutant loads and the effectiveness of the proposed water treatment measures. The catchment was broken up into different areas depending on the surface type, including;

- Roofs areas (measured directly off architectural design plans for the largest housing option for each lot), and modelled as “Roof” nodes with 100% impervious area;
- All road areas (measured directly off design plans) were modelled as “Sealed Road” nodes with the percentage impervious area calculated based from the measured pavement area and an estimated 14sq.m/lot driveway in the verge. The remaining pervious percentage consists of the landscaped verge area.
- The remaining urban area (open space, landscape areas and public reserve) were modelled as residential nodes with the percentage impervious estimated from the remaining driveway area (estimated 30sq.m/lot);

Modelled treatment nodes include;

- Rainwater tanks; The development proposes to build large below-ground rainwater storage and reuse tanks. Each will be a standalone system on an individual block collecting roof waters only, with overflow to an inter-allotment drainage line. They are modelled with 10kL capacity. Captured water has been modelled for reuse in toilet, laundry and external uses only. Internal reuse rates of 0.25kL/day/dwelling were adopted for a dwelling with 1-2 occupants from Table 3-12 in the 2010 Draft NSW MUSIC Modelling Guidelines. An external reuse rate of 112kL/day/dwelling was adopted (distributed by PET minus Rainfall).

  For the hotel and clubhouse areas an internal reuse rate of 0.125kL/day/ET were adopted for toilet use only in a dwelling with 1-2 occupants from Table 3-12 in the 2010 Draft NSW MUSIC Modelling Guidelines. Based off MidCoast Water’s Equivalent Tenement Policy this rate use been adjusted by a rate of 0.4/unit for the hotel and .0015/sq.m for the clubhouse.

  It has been assumed that 100% of the roof areas will be connected to the tanks;

- Biofiltration swales; The trunk drainage corridor has been modified to insert biofiltration systems in the base of each swale. This will offer treatment to runoff directed from the adjacent roads, plus piped inflow from each cross street (which will include rainwater tank overflows and pervious area runoff). Features include a 0.3m detention depth and 0.4m filter depth and an unlined base that will allow discharge via infiltration.

  The percentage of Filter Area to Impervious Area is shown in Table 9 below for each biofilter catchment. Note that the biofilters with a low percentage are typically in the top of the catchment with untreated overflow flowing to lower biofilters with a larger percentage. The drainage concept plan in Appendix A shows the labelled biofilters referred to in Table 9.
- Constructed Wetland; The buffer strip across the Manor Road frontage of the site will be utilised as a constructed wetland to treat water from Manor Road (including runoff from the caravan park opposite) as well as the 26 dwelling sites proposed adjacent.
- Buffer strips and grassed swales; The southern section of Road 2 will be constructed as one-way crossfall with a concrete edge strip, grassed verge and drainage swale on the low side to convey this water around to proposed 'Basin 2'.

Note: Basin 1 and Basin 2 have been proposed primarily for detention, flow conveyance and peak flow buffering, and are not specifically configured as constructed wetlands. They will however have permanent depths of 0.45m and 0.3m respectively and will be planted with complete macrophyte coverage. It is expected these will provide some additional water quality benefits, but neither have been included in the MUSIC modelling.

Table 9: Filter Area to Impervious Area Comparison

Bio	Filter Area (ha)	Imp A (ha)	Filter A/Imp A
A	0.0145	0.384	4%
B	0.0145	0.380	4%
C	0.013	0.387	3%
D	0.0312	0.354	9%
E	0.0093	0.913	1%
F	0.0213	0.750	3%
G	0.0132	0.536	2%
H	0.0125	0.734	2%
I	0.0276	0.509	5%
J	0.048	0.607	8%
K	0.0208	0.592	4%
L	0.0431	0.528	8%
M	0.024	0.463	5%
N	0.0233	0.418	6%
O	0.0145	0.471	3%
P	0.0223	0.394	6%
Q	0.0358	0.757	5%
R	0.0053	0.274	2%
S	0.0053	0.217	2%
T	0.0059	0.279	2%
U	0.086	0.357	24%

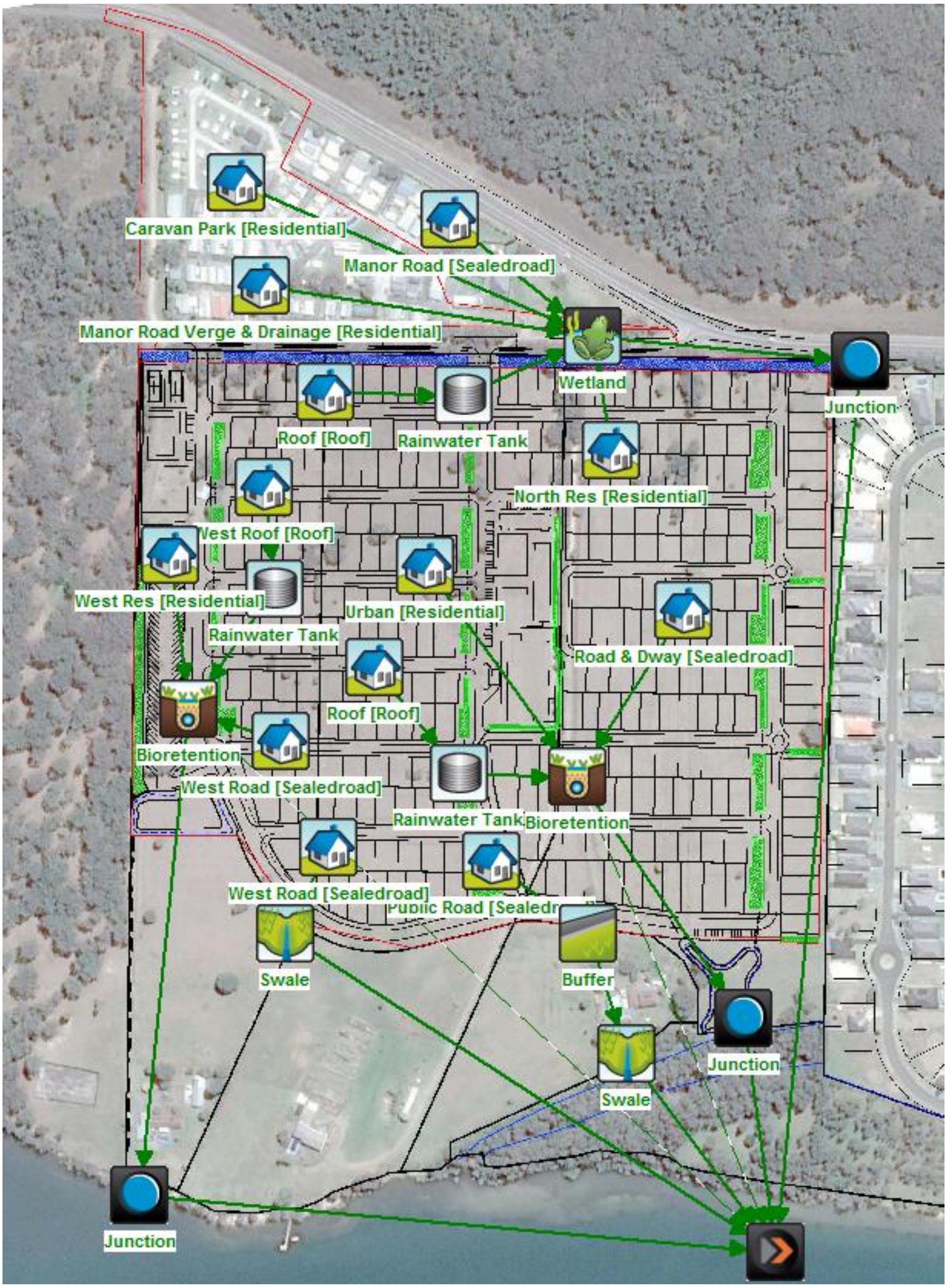


Figure 9: Proposed Development MUSIC Model

10.2.6 COMPARISON OF POLLUTANT RESULTS

Pre- and post-development pollutant loads are compared in the tables below to ensure that the Stormwater Quality Targets have been met. Table 10 shows the effectiveness of the proposed treatment measures if the external caravan park site was not included. As the caravan site to the North will flow through one of the proposed treatment measures this has been included in the model resulting in a treatment train effectiveness as shown in Table 11 demonstrating that the development will create a Neutral or Beneficial Effect on water quality.

Table 10: Comparison of Pre- and Post-Development Pollutant Loads (without Caravan Park)

	Pre-Developed	Post-Developed	NoBE Compliant	Percentage Shortfall
TSS (kg/yr)	8590	1560	Yes	N/A
TP (kg/yr)	11.8	10.8	Yes	N/A
TN (kg/yr)	115	119	No	3%
GP (kg/yr)	179	0	Yes	N/A

* NoBE = Neutral or Beneficial Effect

Table 11: Comparison of Pre- and Post-Development Pollutant Loads (with Caravan Park included)

	Pre-Developed	Post-Developed	NoBE Compliant
TSS (kg/yr)	12900	4100	Yes
TP (kg/yr)	19.3	16.2	Yes
TN (kg/yr)	173	168	Yes
GP (kg/yr)	889	0	Yes

* NoBE = Neutral or Beneficial Effect

11.0 COSTS

Installation and establishment of all WSUD devices will be undertaken at the developer's expense. Responsibility for ongoing operation and maintenance will be fall variously with the village operators (private road biofilters) and individual owners (rainwater harvesting tanks & pumps). As no costs are to be incurred by Council, a detailed cost analysis has not been provided in this report.

12.0 OPERATION AND MAINTENANCE PLAN

12.1 BIOFILTERS

The biofilter systems are private assets and will need to be maintained as part of the regular maintenance work by village ground staff. Regular maintenance is required to ensure water treatment measures continue to operate in an effective way. These tasks should be performed every three months or after heavy storm events. The maintenance schedule in Appendix B has been prepared as a typical template to direct maintenance staff undertaking routine maintenance and is based on Raingardens and Bioretention Tree Pits Maintenance Plan Example, prepared by the Facility for Advancing Water Biofiltration, Monash University. Relevant sections have been reproduced and/or modified for the specific site conditions.

Is it expected that the finalisation of the biofiltration systems will be deferred until the building construction is essentially completed, ensuring house building activities do not compromise the newly constructed WSUD devices. All biofilter maintenance activities will need to commence as soon as biofilters are planted and brought online and continue for the life of the development.

12.2 RAINWATER HARVESTING TANKS

The individual below-ground tanks will be the responsibility of each individual owner to maintain, in a similar way as other smaller housing rainwater tanks. This includes checking and cleaning gutters, any first flush devices and inlet strainers regularly (quarterly), servicing the pump system as recommended by the pump supplier (typically bi-annually) and irregular tank cleaning and desludging (as required).

13.0 CONCLUSIONS

The results derived from modelling procedures indicate that long term water quality and quantity constraints are appropriately addressed in the proposed development, through the following measures:

- Construction of unlined roadside biofiltration swales,
- Construction of a wetland across the Manor Road frontage to treat untreated upstream catchment waters,
- Installation of min. 10kL rainwater tanks with each proposed dwelling.

More so, the modelling demonstrates that the development will actually have a positive impact on stormwater pollutant levels. From a stormwater quality and quantity perspective, approval is recommended.

14.0 REFERENCES

Draft NSW MUSIC Modelling Guidelines, 2010, BMT WBM

Music Version 5.0 User Manual, 2011, eWater

Policy 11: Land Development Guidelines, Section 13 Water Sensitive Urban Design, 2007, Gold Coast Council

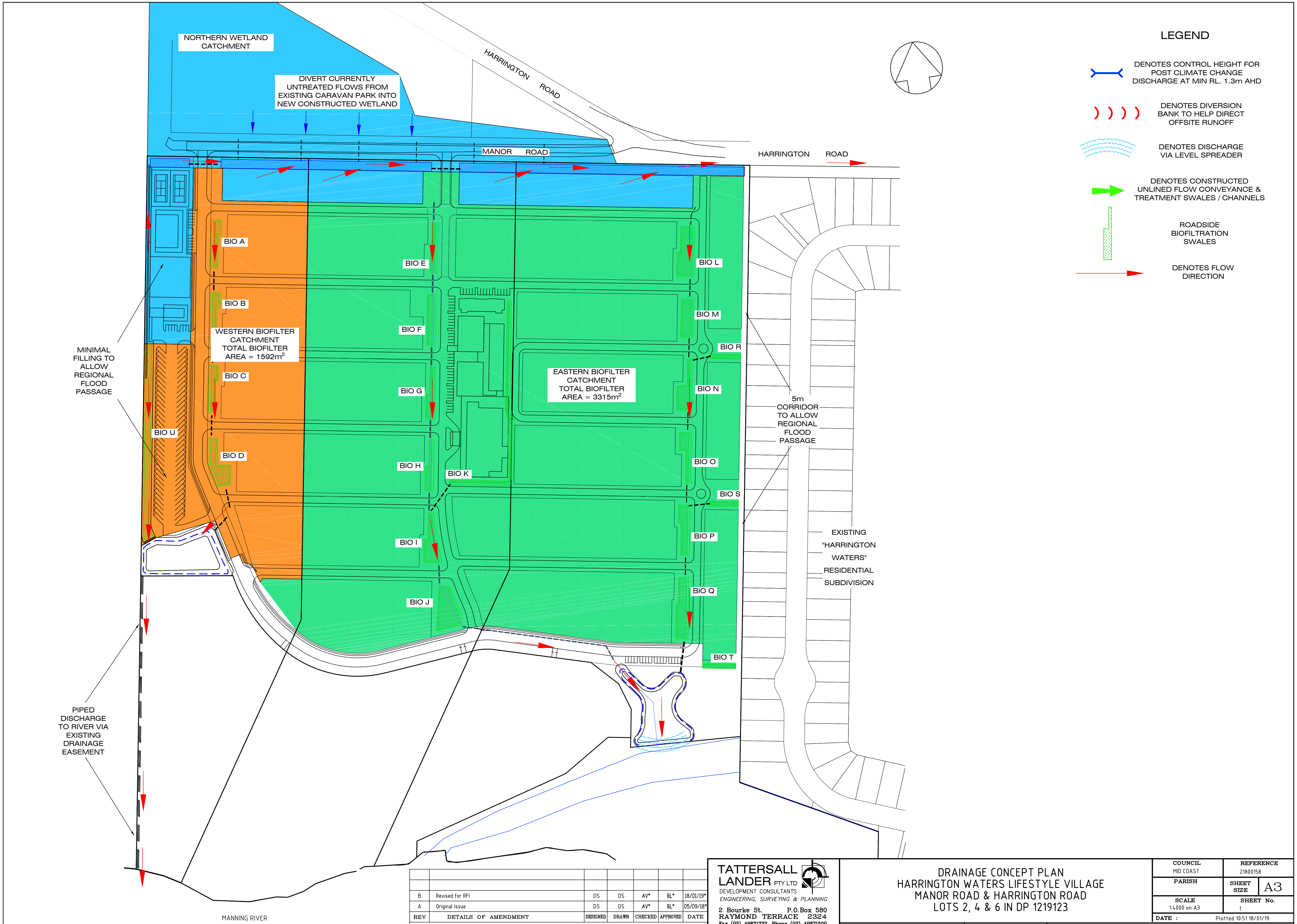
Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, 2004, Fletcher et al

WSUD Engineering Procedures: Stormwater, 2005, Melbourne Water

Grantley, S and Ron, C, 2016, Safety Design Criteria – Flood Hydraulics, Book 6 in Australian Rainfall and Runoff - A Guide to Flood Estimation, Commonwealth of Australia

Smith G P, Davey E K, and Cox R J (2014) Flood Hazard UNSW Australia Water Research Laboratory Technical Report 2014/07 30 September 2014.

APPENDIX A: DRAINAGE CONCEPT PLAN



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A	Original Issue	DS	DS	AV*	BL*	05/09/18*
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE

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DRAINAGE CONCEPT PLAN
HARRINGTON WATERS LIFESTYLE VILLAGE
MANOR ROAD & HARRINGTON ROAD
LOTS 2, 4 & 6 IN DP 1219123

COUNCIL: MID COAST
REFERENCE: 21800158
PARISH:
SHEET SIZE: A3
SCALE: 1:4000 on A3
SHEET No.: 1
DATE: Plotted 10:51 18/01/19

CLIENT:
JOB No.: 217154
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APPENDIX B: BIOFILTER MAINTENANCE TASKS

A. Filter Media Tasks

Sediment Deposition	Remove sediment build up from the surface of bioretention swales Frequency – 3 monthly after rain
Holes or scour	Infill any holes in the filter media. Check for erosion or scour and repair, provide energy dissipation (rocks & pebbles etc) if necessary Frequency – 3 monthly after rain
Filter media surface porosity	Inspect for the accumulation of an impermeable layer (such as oily or clayey sediment) that may have formed on the surface of the filter media. A symptom may be that water remains ponded in the swale for more than a few hours after a rain event. Repair minor accumulations by raking away any mulch on the surface and scarifying the surface of the filter media between plants Frequency – 3 monthly after rain
Litter Control	Check for litter (including organic litter) in and around bioretention swales. Remove both organic and anthropogenic litter to ensure flow paths and infiltration through the filter media are not hindered. Frequency – 3 monthly after rain

B. Horticultural Tasks

Pests and Diseases	Assess plants for disease, pest infection, stunted growth or senescent plants. Treat or replace as necessary. Reduced plant density reduces pollutant removal and infiltration performance Frequency – 3 monthly after rain
Maintain original plant densities	Inspect condition of all plants. Replace and dead plants immediately to maintain a minimum density of 4 plants per square metre Frequency – 3 monthly after rain
Drought / Extreme Heat	In periods of prolonged drought or extreme heat, the condition of plantings and site lawn coverage should to be monitored for signs of stress. Watering may be required to ensure plant survival Frequency – As required

Weeds	It is important to identify the presence of any rapidly spreading weeds as they occur. The presence of such weeds can reduce dominate species distributions and diminish aesthetics. Weed species can also compromise the system's long term performance. Inspect for and manually remove weed species. Application of herbicide should be limited to a wand or restrictive spot spraying due to the fact that the swales are directly connected to the stormwater system Frequency – 3 monthly after rain
Grassed buffer strip	Grassed buffer strips treat runoff as it flows off the roads, before it enters the bioretention swales. Maintaining a healthy grass cover is important, but the use of fertilisers should be kept to a minimum given their proximity to the drainage network
Lawn Fertiliser	Healthy site grass coverage is important for pollutant treatment, topsoil erosion control and aesthetics. However, if not correctly used, fertilisers can damage the downstream environment. A low Phosphorus fertiliser with restricted leaching properties such as a Fused Calcium Magnesium Phosphate or TNN Industries 'Formula 1', or equivalent is ideal. The application of fertiliser should be restricted to a maximum of twice a year

C. Drainage Tasks

Perforated Pipe	Ensure that perforated pipes are not blocked to prevent filter media and plants from becoming waterlogged. A small steady clear flow of water may be observed discharging from the perforated pipe at its connection into the downstream pit some hours after rainfall. Note that smaller rainfall events after dry weather may be completely absorbed by the filter media and not result in flow. Remote camera (eg CCTV) inspection of pipelines for blockage and structural integrity could be useful. Flushing of lines from the flushing points may be required. Frequency – 6 monthly after rain
High flow inlet pits, overflow pits and other stormwater junction pits	Ensure inflow areas and grates over pits are clear of litter and debris and in good and safe condition. A blocked grate would cause nuisance flooding of adjoining areas. Inspect for dislodged or damaged pit covers and ensure general structural integrity. Remove sediment from pits and entry sites (likely to be an irregular occurrence in mature catchment). Frequency – monthly and occasionally after rain

APPENDIX C: PROPOSED LAYOUT & DETAIL PLANS

HARRINGTON WATERS LIFESTYLE VILLAGE

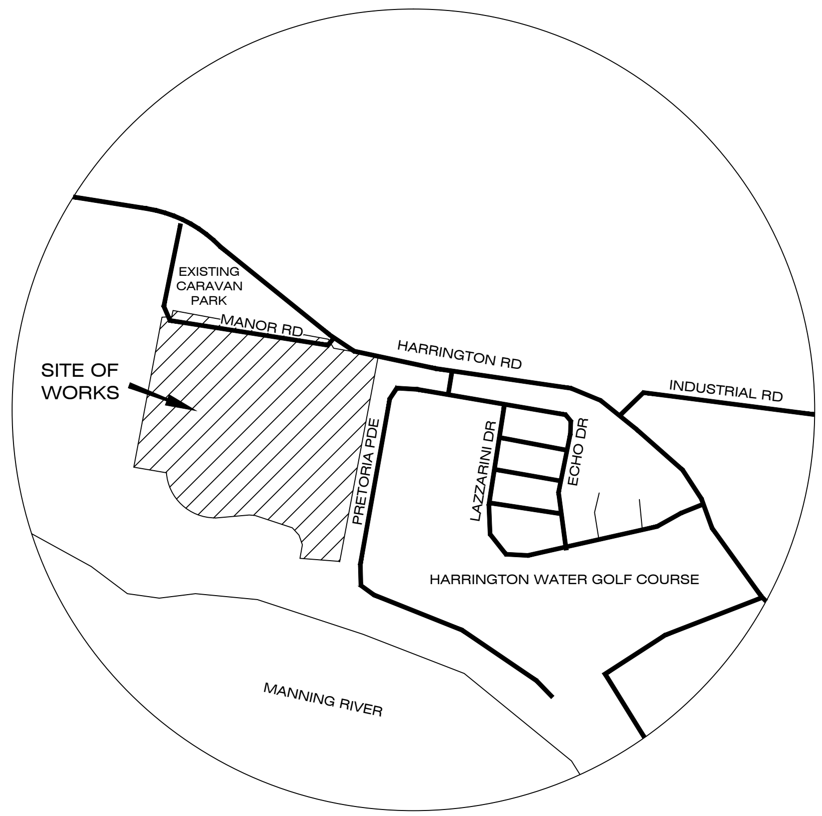
MANOR ROAD, HARRINGTON

DA DESIGN PLANS

ROAD, DRAINAGE & ASSOCIATED WORKS

Schedule of Drawings

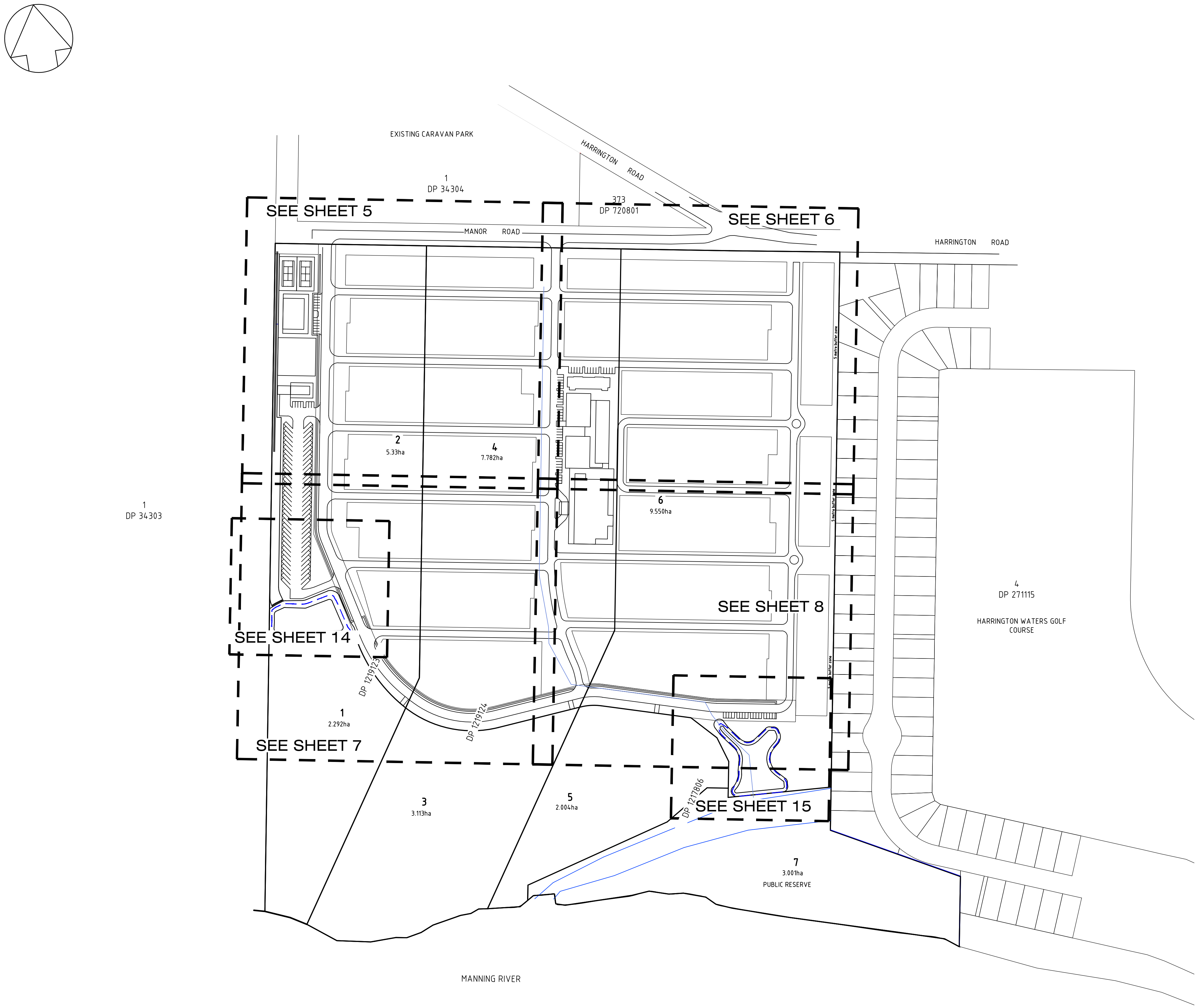
Sheet	File Number	Description	Revision
1	21800138	TITLE PAGE, DRAWING INDEX & LOCALITY SKETCH	A
2	21800139	OVERALL LAYOUT PLAN	A
3	21800140	INDICATIVE STAGING PLAN	A
4	21800141	OVERALL DETAIL PLAN	A
5	21800142	DETAIL SHEET 1	A
6	21800143	DETAIL SHEET 2	A
7	21800144	DETAIL SHEET 3	A
8	21800145	DETAIL SHEET 4	A
9	21800146	GENERAL DETAILS & ROAD TYPICAL SECTIONS	A
10	21800147	ROAD LONGITUDINAL SECTIONS	A
11	21800148	ROAD LONGITUDINAL SECTIONS - SHEET 2	A
12	21800149	ROAD LONGITUDINAL SECTIONS - SHEET 3	A
13	21800150	ROAD LONGITUDINAL SECTIONS - SHEET 4	A
14	21800151	BASIN 1 DETAIL PLAN	A
15	21800152	BASIN 2 DETAIL PLAN	A
16	21800153	BASIN SECTIONS	A
17	21800154	TYPICAL DRAINAGE LONGITUDINAL SECTION	A
18	21800155	SITE CUT-FILL PLAN	A
19	21800156	TYPICAL EROSION & SEDIMENT CONTROL PLAN	A
20	21800157	TYPICAL SOIL & WATER MANAGEMENT PLAN NOTES	A



LOCALITY SKETCH

Designed By TATTERSALL LANDER PTY LTD
DEVELOPMENT CONSULTANTS IN ENGINEERING, SURVEYING & PLANNING
PO Box 580 RAYMOND TERRACE Phone (02) 4987 1500

FILE : 21800138
JOB No. : 217154
SHEET No. : 1 of 20



REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
A	Original Issue	DS	DS	AV	BL	05/09/18*

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OVERALL LAYOUT PLAN
HARRINGTON WATERS LIFESTYLE VILLAGE
MANOR ROAD, HARRINGTON
LOTS 2, 4 & 6 IN DP 1219123

COUNCIL: MID COAST	REFERENCE: 21800139
PARISH:	SHEET SIZE: A3
SCALE: 1:4000 on A3	SHEET No.: 2
DATE :	Plotted 16:50 05/09/18

CLIENT: Bayline Developments (NSW) Pty Ltd | JOB No.: 217154 | COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

STAGE 1 - 29 LOTS
STAGE 2 - 25 LOTS
STAGE 3 - 22 LOTS
STAGE 4 - 21 LOTS
STAGE 5 - 22 LOTS
STAGE 6 - 22 LOTS
STAGE 7 - 40 LOTS
STAGE 8 - 22 LOTS
STAGE 9 - 20 LOTS
STAGE 10 - 45 LOTS
STAGE 11 - 24 LOTS

TOTAL = 292 LOTS

A	Original Issue	DS	DS	AV	BL	05/09/18*
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PROVISIONAL STAGING PLAN
HARRINGTON WATERS LIFESTYLE VILLAGE
MANOR ROAD, HARRINGTON
LOTS 2, 4 & 6 IN DP 1219123

COUNCIL	REFERENCE	
MID COAST	21800140	
PARISH	SHEET SIZE	A3
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DATE :	Plotted 16:50 05/09/18	

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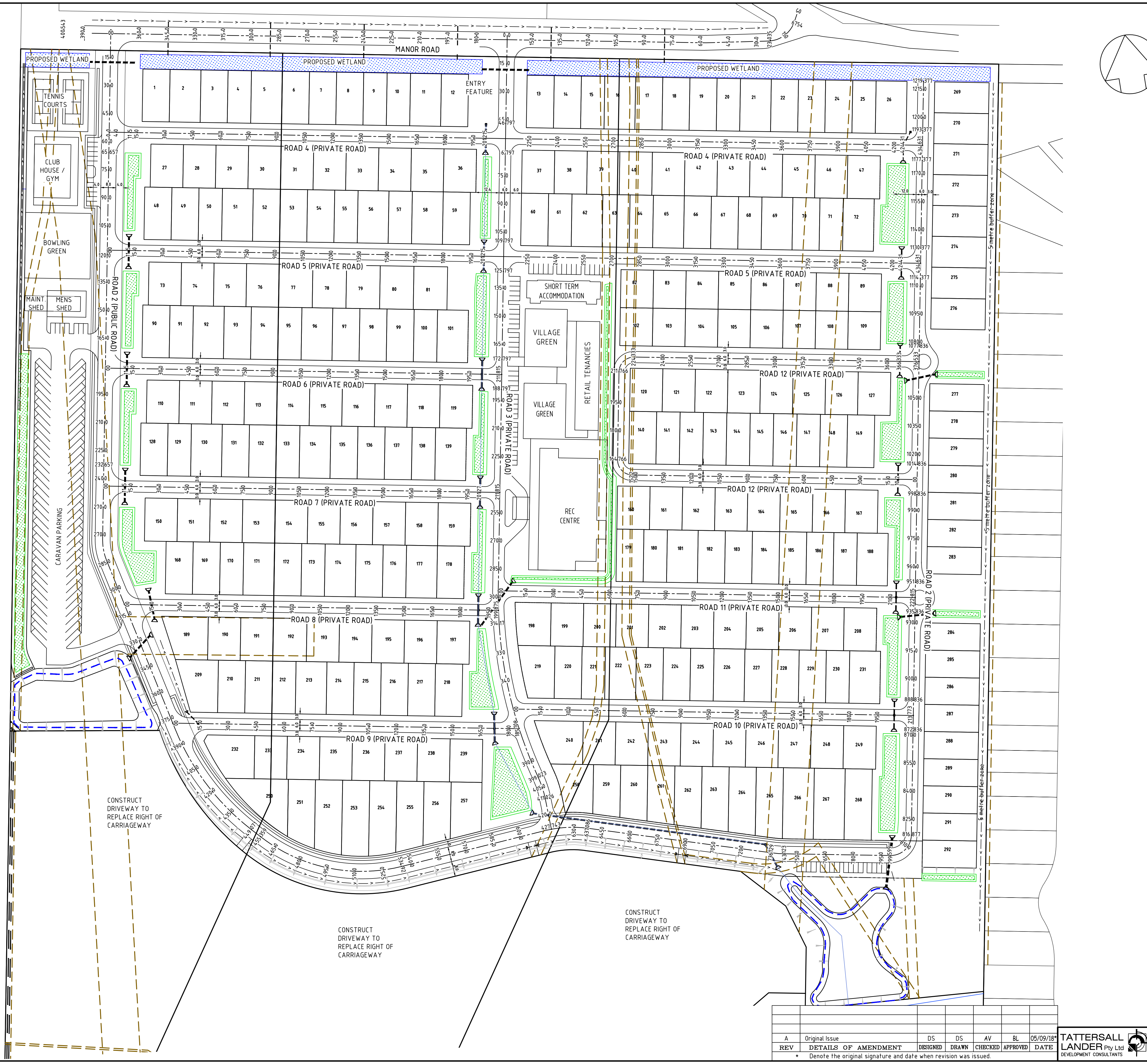

LEGEND

- PROPOSED PIPE
- PROPOSED DRAIN
- PROPOSED BIOFILTER
- PROPOSED WETLAND

OVERALL DETAIL PLAN

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
A	Original Issue	DS	DS	AV	BL	05/09/18*

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SCALE : 1:2000 for A3 sized plot

SHEET No. : 4

JOB No. : 217154

FILE : 21800141

DATE : Plotted 16:51 05/09/18

SHEET SIZE: A3

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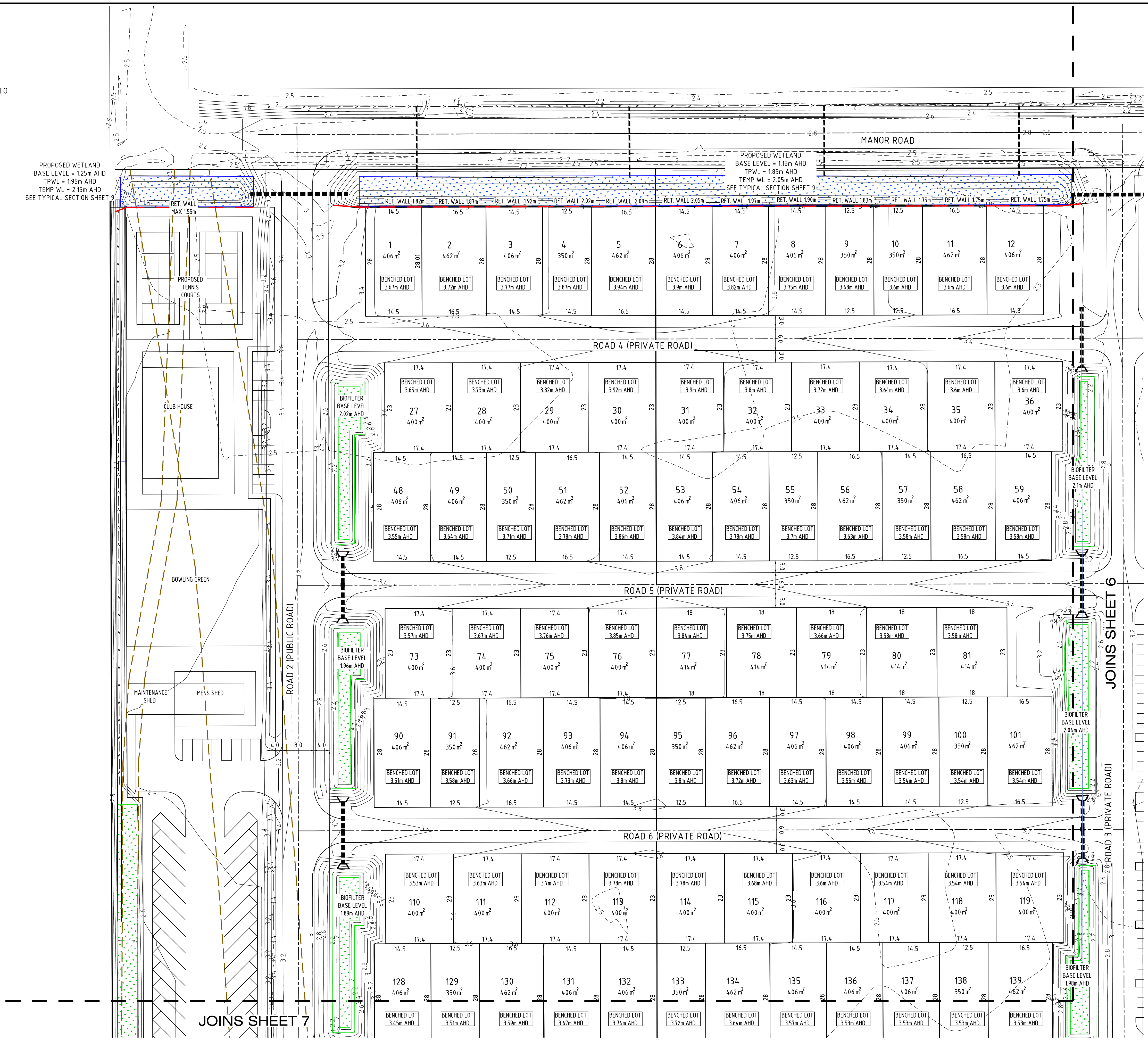

DETAIL PLAN SHEET 1

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A	Original Issue	DS	DS	AV	BL	05/09/18*

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	JOB No. : 217154	DATE : Plotted 16:51 05/09/18	

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

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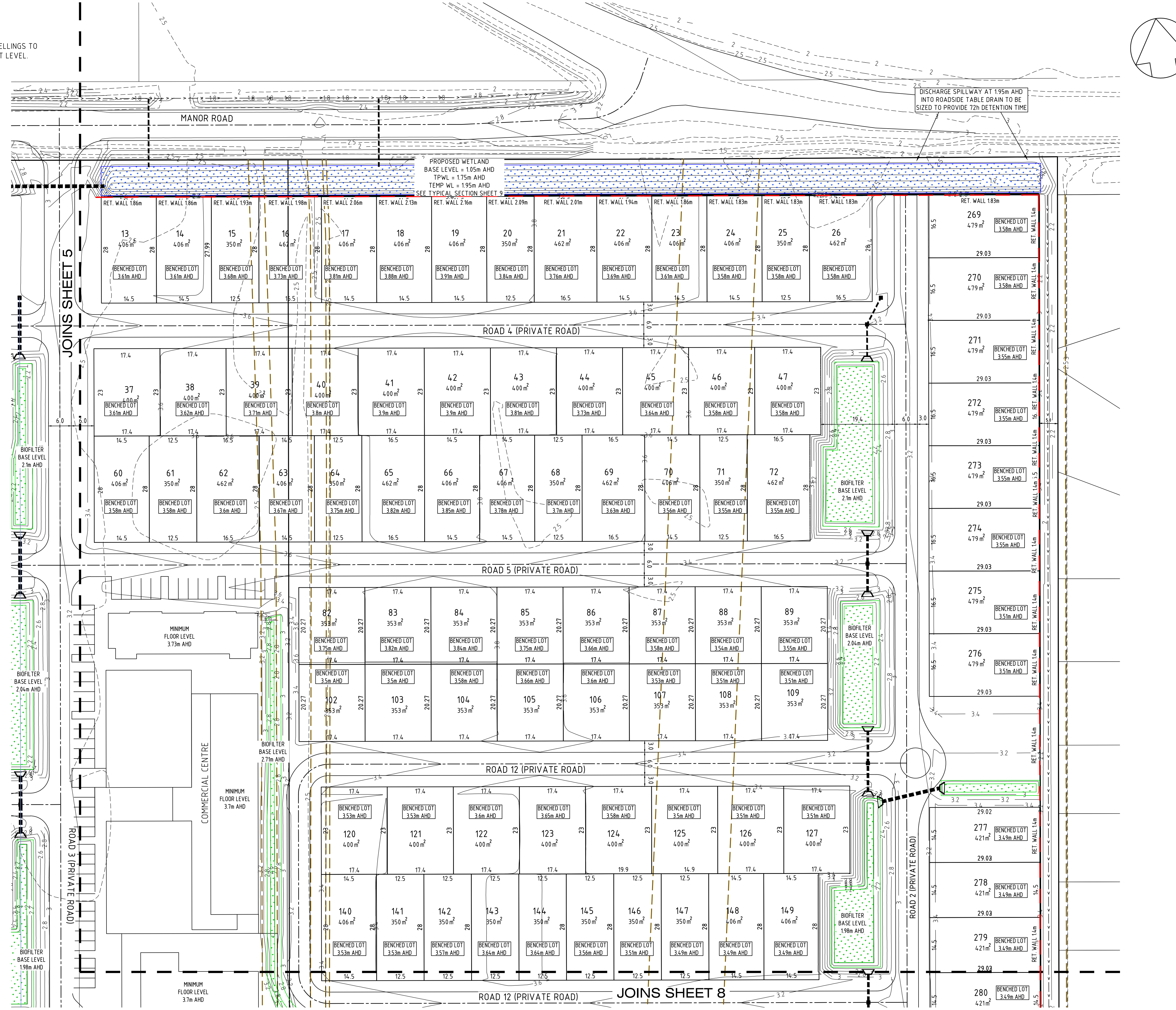

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DETAIL PLAN SHEET 2

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SCALE : 1:2000 for A3 sized plot

SHEET No. : 6

JOB No. : 217154

FILE : 21800143

DATE : Plotted 16:51 05/09/18

SHEET SIZE A3

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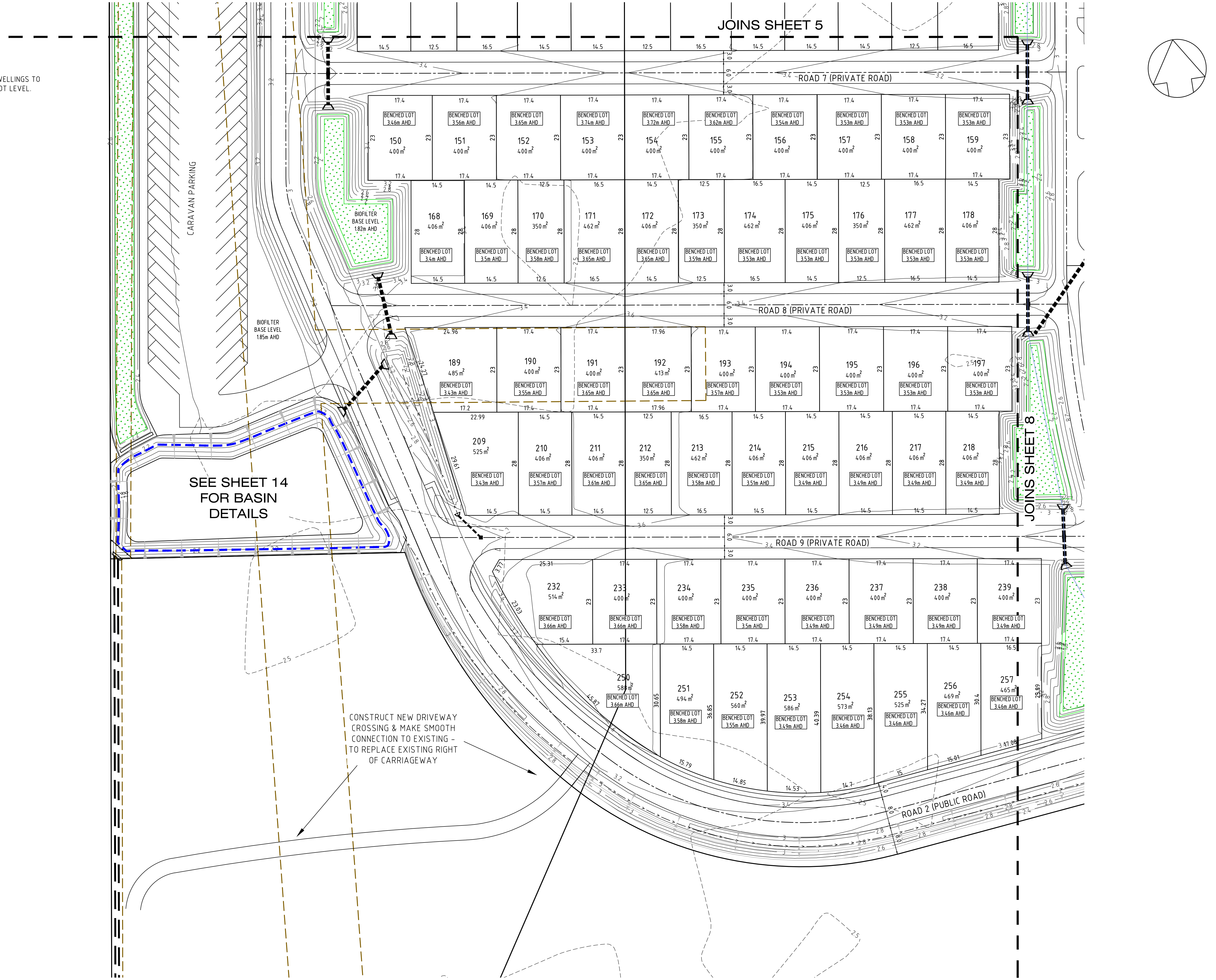

DETAIL PLAN SHEET 3

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JOB No. : 217154
FILE : 21800144
DATE : Plotted 16:51 05/09/18
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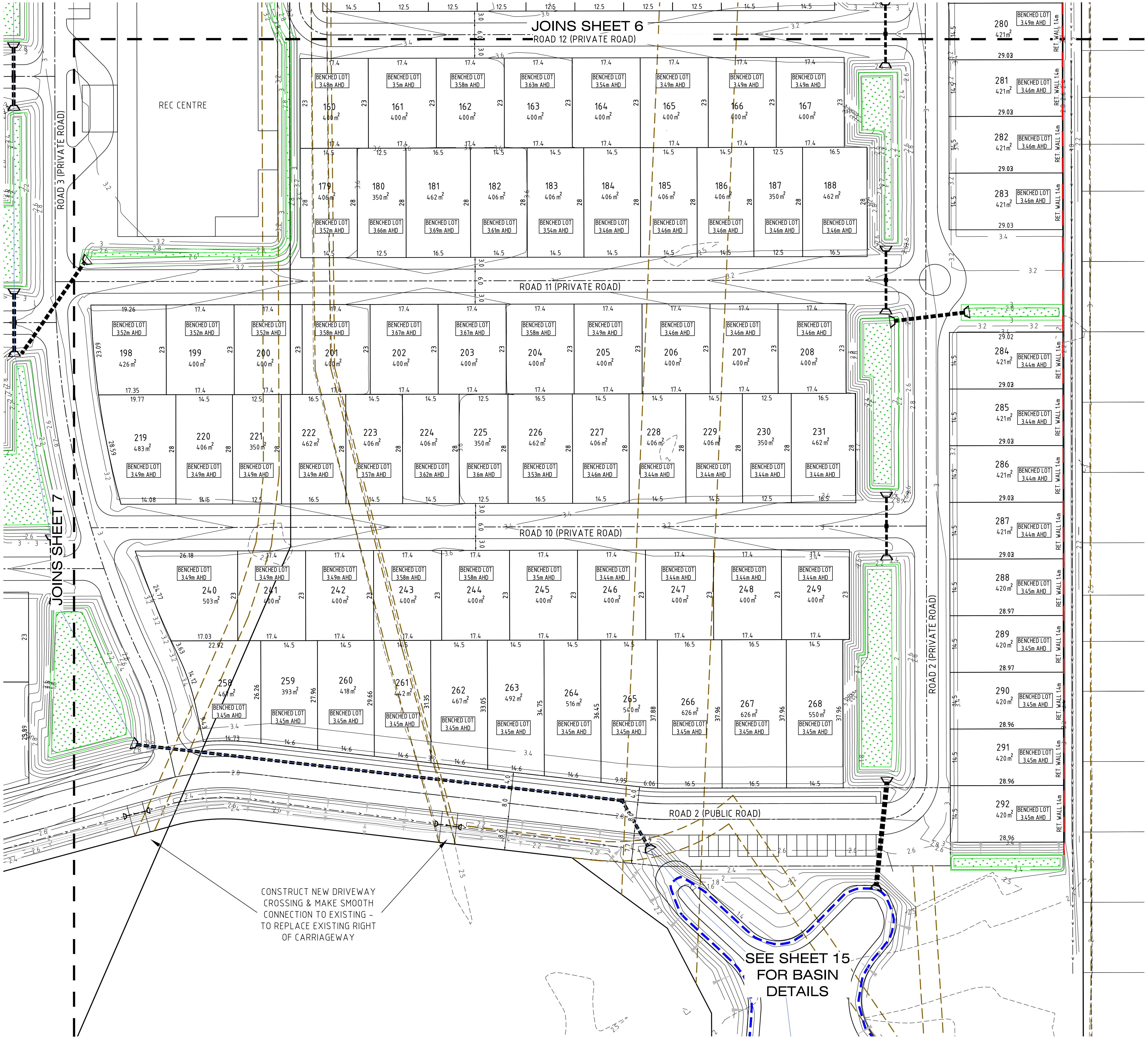

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A	Original Issue			AV	BL	05/09/18*

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DETAIL PLAN SHEET 4

TATTERSALL LANDER Pty Ltd
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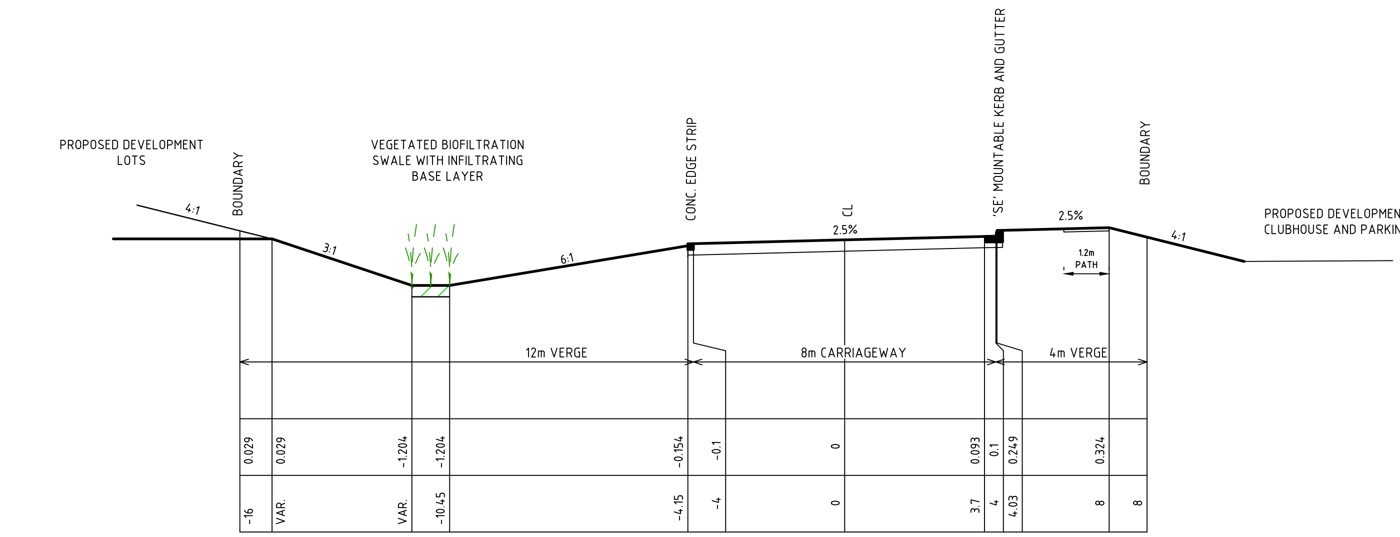

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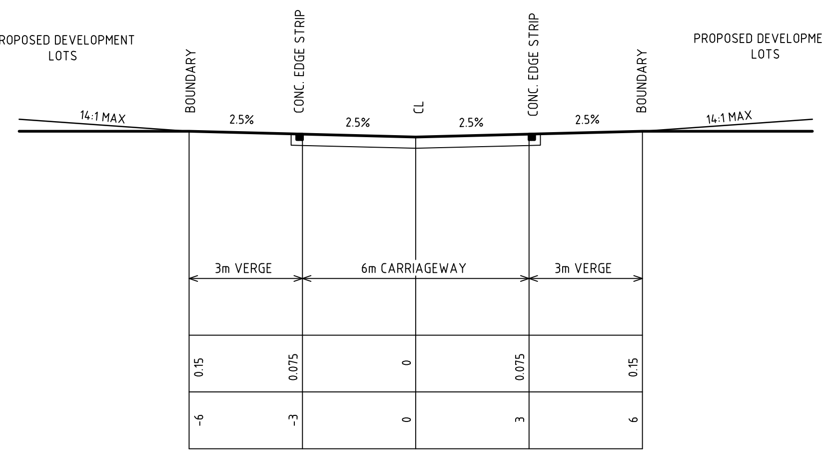

TYPICAL SECTION - ROADS 4 TO 12

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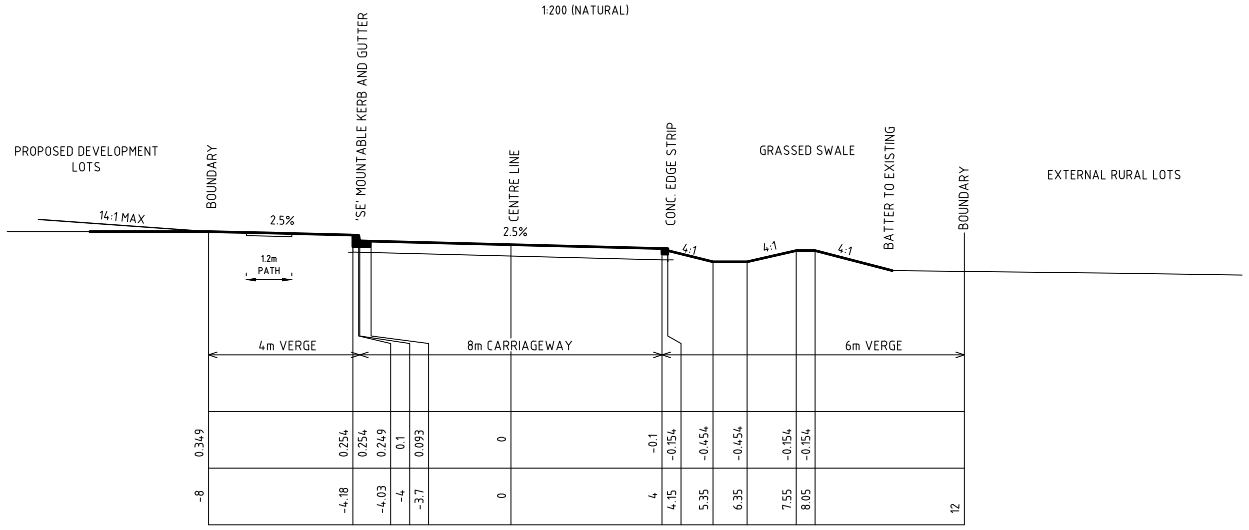

TYPICAL SECTION - ROAD 2 Ch405-Ch600

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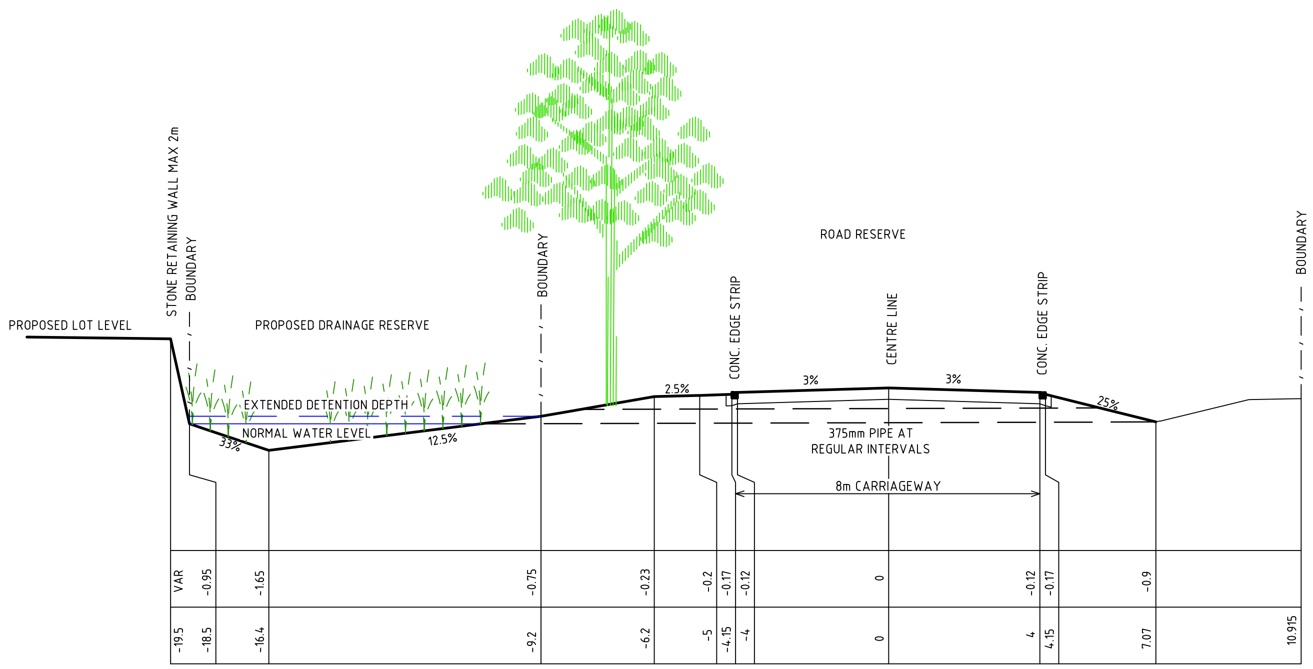

TYPICAL SECTION - MANOR ROAD

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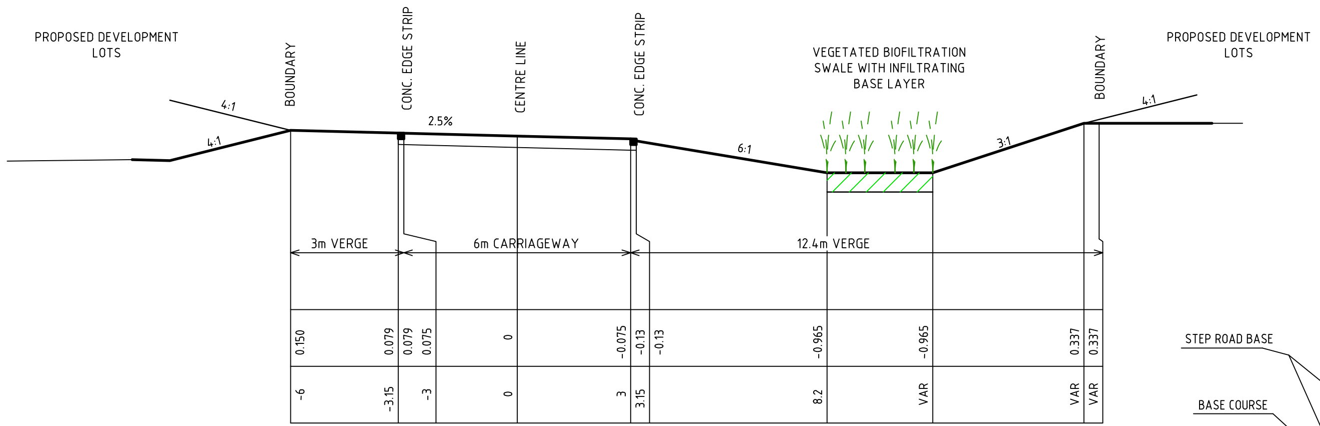

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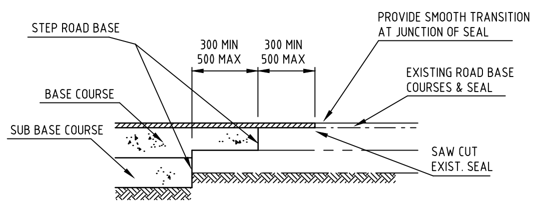
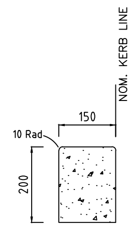


KEY JOINT DETAIL BETWEEN NEW & EXISTING PAVEMENT

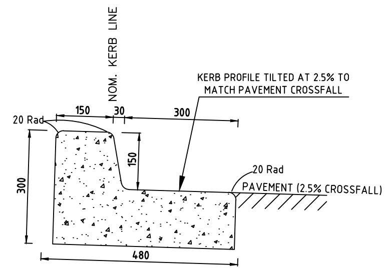
NOT TO SCALE



EDGE STRIP

NOT TO SCALE

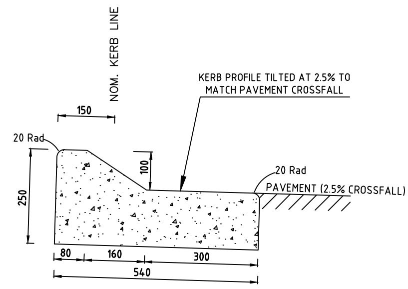
ALL DETAILS PER MCC STD. No.0107



SL - BARRIER KERB

NOT TO SCALE

ALL DETAILS PER MCC STD. NO.0107



SE - MOUNTABLE KERB AND GUTTER

NOT TO SCALE

ALL DETAILS PER MCC STD. NO.0107

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
A	Original Issue	DS	DS	AV	BL	05/09/18*

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TYPICAL SECTIONS & GENERAL DETAILS

TATTERSALL LANDER Pty Ltd DEVELOPMENT CONSULTANTS

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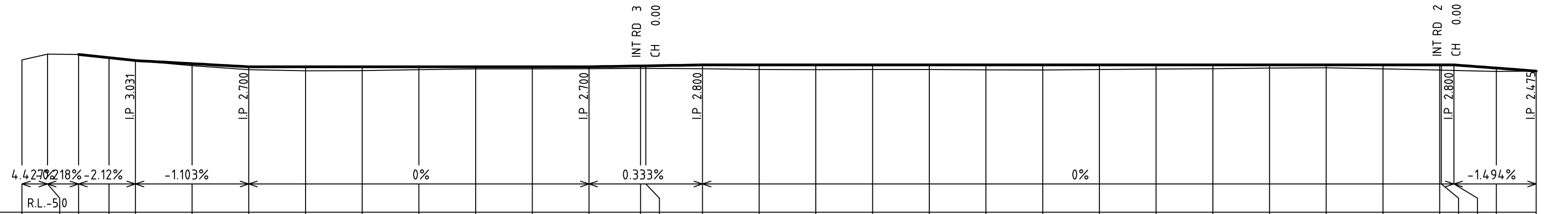

CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
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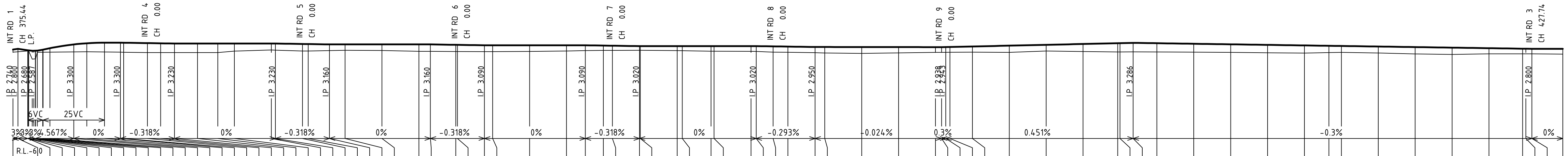
6.754	3.367	3.367
15	3.349	3.349
23.035	3.164	3.17
30	3.004	3.031
45	2.822	2.757
60	2.64	2.55
75	2.64	2.491
90	2.64	2.501
105	2.64	2.548
120	2.64	2.592
135	2.64	2.591
150	2.64	2.601
163.624	2.685	2.616
165	2.69	2.618
180	2.74	2.601
195	2.74	2.555
210	2.74	2.545
225	2.74	2.552
240	2.74	2.554
255	2.74	2.541
270	2.74	2.527
285	2.74	2.557
300	2.74	2.585
315	2.74	2.597
330	2.74	2.633
345	2.74	2.652
360	2.74	2.593
375	2.74	2.527
375.439	2.74	2.525
378.791	2.74	
390	2.573	2.458
400.543	2.415	2.475

ROAD.No.1

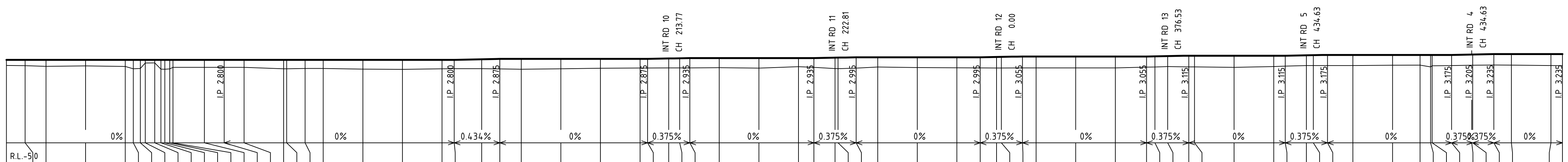
H=1:2000 V=1:400



CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
0	2.74	2.525
2	2.8	
6	2.68	
6.093	2.677	
6.398	2.669	2.63
7.815	2.644	1.958
8.471	2.642	
9.093	2.644	
9.152	2.644	1.991
9.878	2.654	2.521
12.093	2.724	
12.2	2.729	
15	2.85	2.532
24.7	3.157	
30	3.253	2.563
37.2	3.3	
43.657	3.3	2.526
45	3.296	2.519
54.657	3.265	2.493
60	3.248	2.494
65.657	3.23	2.495
75	3.23	2.496
83.264	3.23	2.498
90	3.23	2.612
105	3.23	2.706
106.657	3.23	2.689
117.657	3.195	2.621
120	3.188	2.621
128.657	3.16	2.655
135	3.16	2.681
150	3.16	2.663
165	3.16	2.594
169.657	3.16	2.594
180	3.127	2.582
180.657	3.125	2.581
191.657	3.09	2.569
195	3.09	2.568
210	3.09	2.586
225	3.09	2.625
232.657	3.09	2.653
240	3.067	2.671
243.657	3.055	2.677
254.657	3.02	2.683
255	3.02	2.683
270	3.02	2.657
272.07	3.02	2.648
283.75	3.02	2.604
285	3.02	2.604
300	3.02	2.597
302.145	3.02	2.586
308.99	3	2.528
315	2.982	2.52
326.059	2.95	2.483
330	2.949	2.464
345	2.945	2.428
360	2.942	2.471
375	2.938	2.513
377.469	2.938	2.515
379.173	2.943	
380.858	2.95	2.518
390	2.992	2.525
405	3.059	2.511
420	3.127	2.625
435	3.194	2.58
449.071	3.258	2.546
450	3.262	2.545
455.359	3.286	2.557
465	3.257	2.543
480	3.212	2.525
495	3.167	2.51
510	3.122	2.478
525	3.077	2.456
534.92	3.048	2.492
540	3.032	2.514
555	2.987	2.463
570	2.942	2.385
585	2.897	2.345
600	2.852	2.391
613.685	2.811	2.394
615	2.807	2.394
617.456	2.8	2.394
630	2.8	2.372

ROAD.No.2

H=1:2000 V=1:400



CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
630	2.8	2.372
637.086	2.8	2.359
645	2.8	2.305
660	2.8	2.339
675	2.8	2.299
678.071	2.8	2.119
680.732	2.8	2.144
682.596	2.8	2.564
686.19	2.8	2.573
688.535	2.8	2.095
690	2.8	2.083
691.845	2.8	2.113
693.089	2.8	2.227
705	2.8	2.227
712.5	2.8	
720	2.8	2.228
735	2.8	2.123
736.13	2.8	2.117
743.123	2.8	2.15
750	2.8	2.149
765	2.8	2.099
780	2.8	2.08
795	2.8	2.117
799.599	2.8	2.128
810	2.845	2.133
816.878	2.875	2.115
825	2.875	2.087
840	2.875	2.125
855	2.875	2.166
870	2.875	2.177
872.836	2.875	2.179
880.836	2.905	2.185
885	2.921	2.189
888.836	2.935	2.192
900	2.935	2.202
915	2.935	2.171
930	2.935	2.278
935.836	2.935	2.232
943.836	2.965	2.142
945	2.969	2.129
951.836	2.995	2.174
960	2.995	2.253
975	2.995	2.215
990	2.995	2.196
998.836	2.995	2.188
1005	3.018	2.183
1006.836	3.025	2.182
1014.836	3.055	2.186
1020	3.055	2.186
1035	3.055	2.188
1050	3.055	2.192
1061.836	3.055	2.246
1065	3.067	2.256
1069.836	3.085	2.29
1077.836	3.115	2.267
1080	3.115	2.261
1095	3.115	2.228
1110	3.115	2.29
1114.377	3.115	2.321
1122.378	3.145	2.369
1125	3.155	2.368
1130.378	3.175	2.367
1140	3.175	2.367
1155	3.175	2.391
1165.431	3.175	2.404
1169.412	3.175	2.265
1170	3.175	2.349
1177.378	3.175	2.366
1185	3.204	2.394
1185.378	3.205	2.396
1193.378	3.235	2.407
1200	3.235	2.397
1215	3.235	2.365
1219.378	3.235	2.357

ROAD.No.2

H=1:2000 V=1:400

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
A	Original Issue	DS	DS	AV	BL	05/09/18*

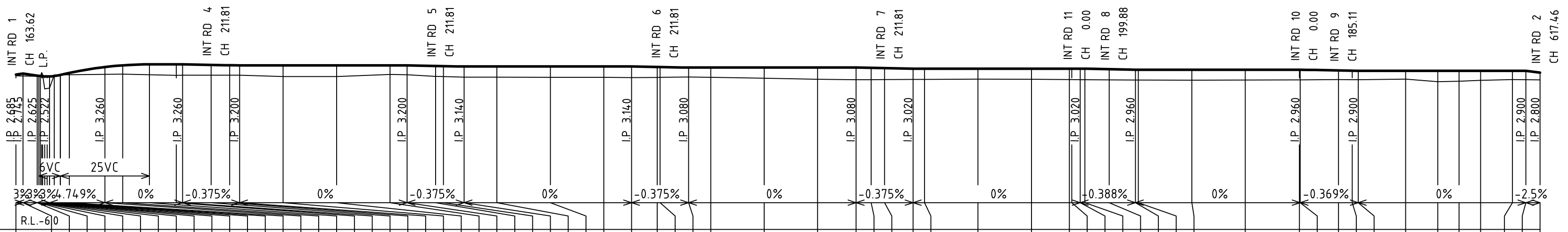
* Denote the original signature and date when revision was issued.

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

ROAD LONGITUDINAL SECTIONS

SCALE : AS SHOWN	SHEET No. : 10	FILE : 21800147	SHEET SIZE A3
	JOB No. : 217154	DATE : Plotted 16:52 05/09/18	

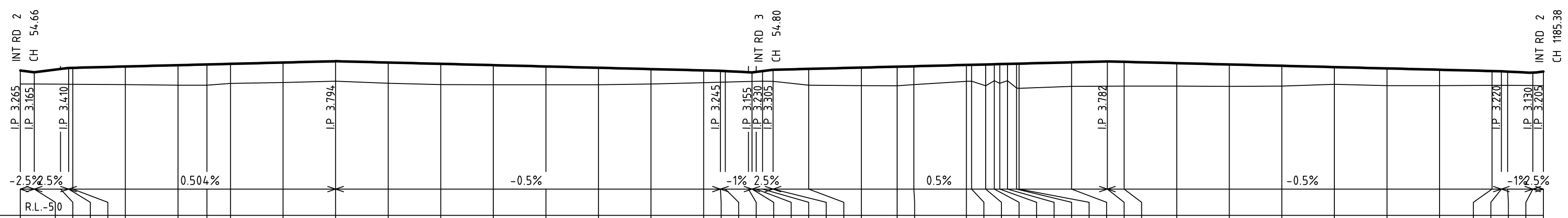
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg



CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
0	2.685	2.616
2	2.745	
6	2.625	
6.454	2.612	
6.856	2.601	2.584
7.257	2.592	2.8
7.513	2.587	2.676
8.114	2.58	1.884
8.777	2.577	
9.449	2.58	1.934
9.454	2.58	
10.771	2.603	2.668
12.454	2.664	
12.5	2.666	
15	2.779	2.679
25	3.112	
30	3.207	2.709
37.5	3.26	
45	3.26	2.643
46.798	3.26	2.652
54.798	3.23	2.655
60	3.211	2.651
62.798	3.2	2.649
75	3.2	2.573
90	3.2	2.576
105	3.2	2.694
109.798	3.2	2.677
117.798	3.17	2.588
120	3.162	2.574
125.798	3.14	2.539
135	3.14	2.538
150	3.14	2.537
165	3.14	2.534
172.798	3.14	2.513
180	3.113	2.527
180.798	3.11	2.532
188.798	3.08	2.552
195	3.08	2.537
210	3.08	2.482
225	3.08	2.423
235.798	3.08	2.399
240	3.064	2.402
243.798	3.05	2.406
251.798	3.02	2.413
255	3.02	2.416
270	3.02	2.429
285	3.02	2.424
295.622	3.02	2.404
296.339	3.02	2.403
298.69	3.02	2.401
300	3.015	2.399
306.802	2.989	2.392
314.171	2.96	2.385
315	2.96	2.384
330	2.96	2.373
345	2.96	2.378
360.191	2.96	2.392
360.425	2.96	2.392
371.16	2.92	2.405
375	2.906	2.398
376.707	2.9	2.402
390	2.9	2.43
399.023	2.9	2.288
405	2.9	2.314
411.026	2.9	2.368
420	2.9	2.404
423.743	2.9	2.401
427.743	2.8	2.394

ROAD.No.3

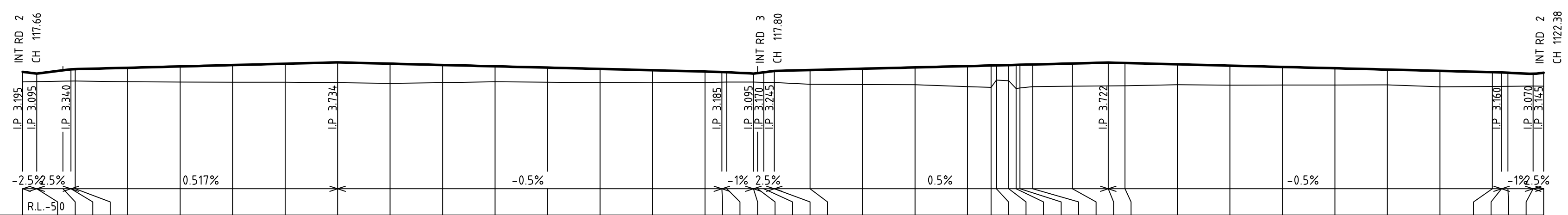
H=1:2000 V=1:400



CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
0	3.265	2.493
4	3.165	2.49
11.5	3.353	2.482
13.8	3.41	
15	3.416	2.478
30	3.492	2.458
45	3.567	2.43
53.291	3.609	2.424
60	3.643	2.526
75	3.718	2.578
90	3.794	2.655
105	3.719	2.537
120	3.644	2.46
135	3.569	2.455
150	3.494	2.451
165	3.419	2.448
180	3.344	2.492
195	3.269	2.569
199.815	3.245	
201.215	3.231	2.601
207.815	3.165	2.635
208.815	3.155	
210	3.185	2.646
211.815	3.23	2.655
214.815	3.305	2.646
225	3.356	2.422
240	3.431	2.402
250.199	3.482	2.391
255	3.506	2.46
270	3.581	2.642
271.467	3.588	2.657
275.487	3.608	2.389
277.94	3.621	2.678
279.513	3.629	2.532
281.709	3.639	2.677
284.281	3.652	2.263
285	3.656	2.251
300	3.731	2.356
310.222	3.782	
315	3.758	2.371
330	3.683	2.375
345	3.608	2.359
360	3.533	2.379
375	3.458	2.478
390	3.383	2.402
405	3.308	2.397
420	3.233	2.414
422.631	3.22	
424.431	3.202	2.419
431.631	3.13	2.406
434.631	3.205	2.396

ROAD.No.4

H=1:2000 V=1:400



CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
0	3.195	2.621
4	3.095	2.634
11.5	3.283	2.658
13.8	3.34	
15	3.346	2.664
30	3.424	2.623
45	3.501	2.605
60	3.579	2.599
75	3.657	2.602
90	3.734	2.571
105	3.659	2.529
120	3.584	2.572
135	3.509	2.626
150	3.434	2.601
165	3.359	2.573
180	3.284	2.569
195	3.209	2.585
199.815	3.185	
201.215	3.171	2.61
208.815	3.095	2.607
210	3.125	2.599
211.815	3.17	2.588
214.815	3.245	2.582
225	3.296	2.478
240	3.371	2.461
255	3.446	2.459
270	3.521	2.346
276.742	3.555	2.303
278.253	3.562	2.718
281.781	3.58	2.683
283.895	3.59	2.24
285	3.596	2.267
288.614	3.614	2.35
300	3.671	2.371
310.222	3.722	
315	3.698	2.396
330	3.623	2.458
345	3.548	2.434
360	3.473	2.436
375	3.398	2.438
390	3.323	2.451
405	3.248	2.337
420	3.173	2.355
422.631	3.16	
424.431	3.142	2.365
431.631	3.07	2.377
434.631	3.145	2.369

ROAD.No.5

H=1:2000 V=1:400

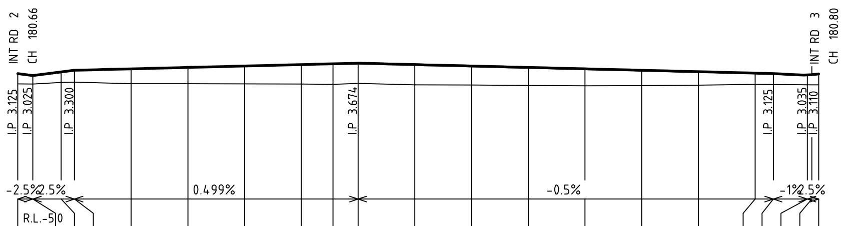
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
A	Original Issue	DS	DS	AV	BL	05/09/18*

* Denote the original signature and date when revision was issued.

ROAD LONGITUDINAL SECTIONS

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

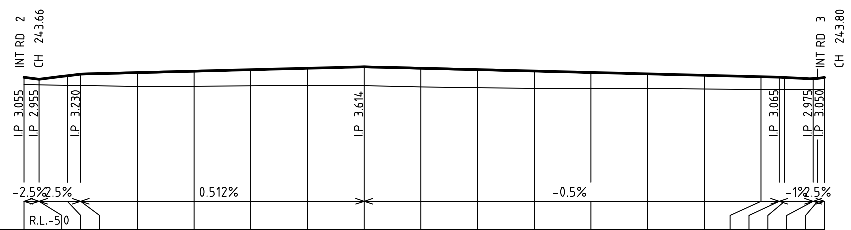
SCALE : AS SHOWN	SHEET No. : 11	FILE : 21800148	SHEET SIZE
	JOB No. : 217154	DATE : Plotted 16:52 05/09/18	A3
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg			



DESIGN LEVEL	3.125	3.025	3.213	3.3	3.375	3.45	3.524	3.599	3.641	3.674	3.599	3.524	3.449	3.374	3.299	3.224	3.149	3.125	3.035	3.065	3.11
EXISTING LEVEL	2.581	2.569	2.655	2.674	2.586	2.59	2.581	2.57	2.555	2.609	2.529	2.521	2.496	2.483	2.49	2.512	2.554			2.528	2.532
CHAINAGE	0	4	11.5	15	30	45	60	75	83.369	90	105	120	135	150	165	180	195	199.815	208.815	210	211.815

ROAD.No.6

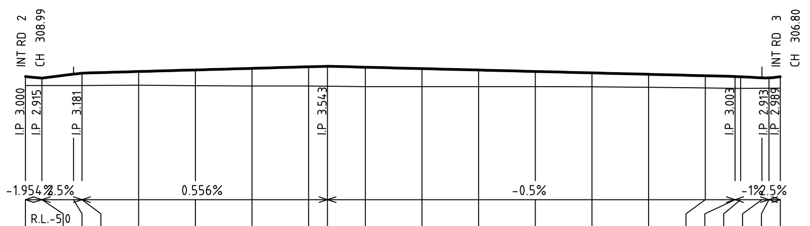
H=1:2000 V=1:400



DESIGN LEVEL	3.055	2.955	3.143	3.23	3.307	3.384	3.46	3.537	3.614	3.539	3.464	3.389	3.314	3.239	3.164	3.089	3.065	3.05	2.975	3.005	3.05
EXISTING LEVEL	2.677	2.663	2.636	2.624	2.575	2.583	2.606	2.632	2.615	2.548	2.507	2.476	2.471	2.474	2.443	2.418		2.413	2.407	2.406	2.406
CHAINAGE	0	4	11.5	15	30	45	60	75	90	105	120	135	150	165	180	195	199.815	201.27	208.815	210	211.815

ROAD.No.7

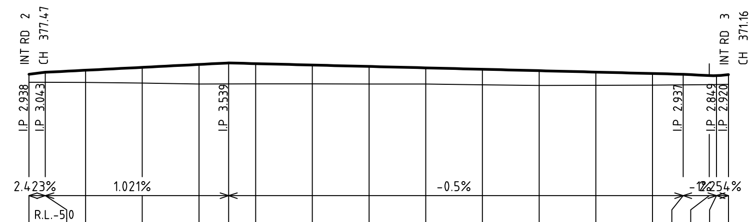
H=1:2000 V=1:400



DESIGN LEVEL	3	2.915	3.125	3.181	3.265	3.348	3.432	3.515	3.543	3.493	3.418	3.343	3.268	3.193	3.118	3.043	3.003	2.988	2.932	2.914	2.989
EXISTING LEVEL	2.528	2.526	2.522	2.523	2.539	2.515	2.504	2.498		2.469	2.468	2.465	2.466	2.459	2.434	2.398		2.375	2.379	2.384	2.392
CHAINAGE	0	4.348	12.741	15	30	45	60	75	80	90	105	120	135	150	165	180	187.875	189.39	195	196.872	199.875

ROAD.No.8

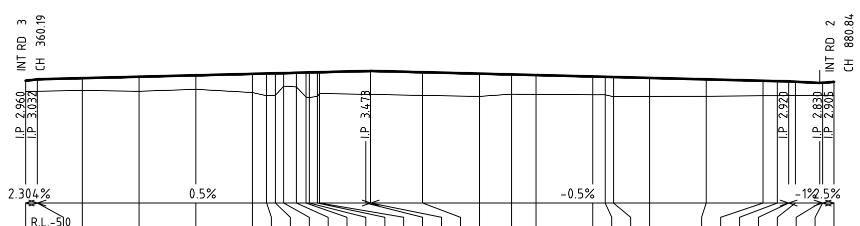
H=1:2000 V=1:400



DESIGN LEVEL	2.938	3.043	3.152	3.305	3.458	3.539	3.503	3.428	3.353	3.278	3.203	3.128	3.053	2.978	2.937	2.868	2.849	2.92
EXISTING LEVEL	2.515	2.513	2.506	2.468	2.423		2.433	2.429	2.421	2.418	2.379	2.346	2.355	2.364		2.388		2.405
CHAINAGE	0	4.348	15	30	45	52.862	60	75	90	105	120	135	150	165	173.108	180	181.938	185.108

ROAD.No.9

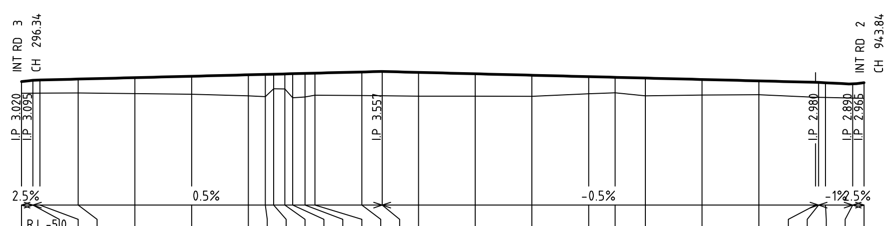
H=1:2000 V=1:400



DESIGN LEVEL	2.96	3.032	3.091	3.166	3.241	3.316	3.335	3.347	3.358	3.374	3.387	3.391	3.402	3.405	3.466	3.473	3.404	3.329	3.286	3.254	3.179	3.163	3.151	3.104	3.029	2.954	2.935	2.92	2.902	2.838	2.83	2.905
EXISTING LEVEL	2.392		2.443	2.405	2.507	2.334	2.163	2.187	2.669	2.631	2.095	2.074	2.129	2.281	2.242		2.183	2.129	2.249	2.228	2.214	2.216	2.114	2.123	2.139	2.163	2.168		2.175	2.186	2.187	2.185
CHAINAGE	0	3.125	15	30	45	60	63.723	66.056	68.275	71.597	74.14	75	77.141	77.746	90	91.249	105	120	128.523	135	150	153.269	155.483	165	180	195	198.773	201.773	203.573	210	210.773	213.773

ROAD.No.10

H=1:2000 V=1:400



DESIGN LEVEL	3.02	3.095	3.104	3.155	3.23	3.305	3.38	3.402	3.414	3.428	3.439	3.455	3.468	3.53	3.557	3.509	3.434	3.359	3.284	3.249	3.209	3.134	3.059	2.984	2.98	2.962	2.89	2.965
EXISTING LEVEL	2.403		2.417	2.42	2.387	2.354	2.268	2.229	2.644	2.632	2.172	2.211	2.308	2.287		2.256	2.251	2.241	2.381	2.434	2.27	2.312	2.333	2.196		2.183	2.15	2.142
CHAINAGE	0	3	4.871	15	30	45	60	64.487	66.712	69.668	71.725	75	77.635	90	95.407	105	120	135	150	157.005	165	180	195	210	210.815	212.615	219.815	222.815

ROAD.No.11

H=1:2000 V=1:400

A	Original Issue	DS	DS	AV	BL	05/09/18*
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE

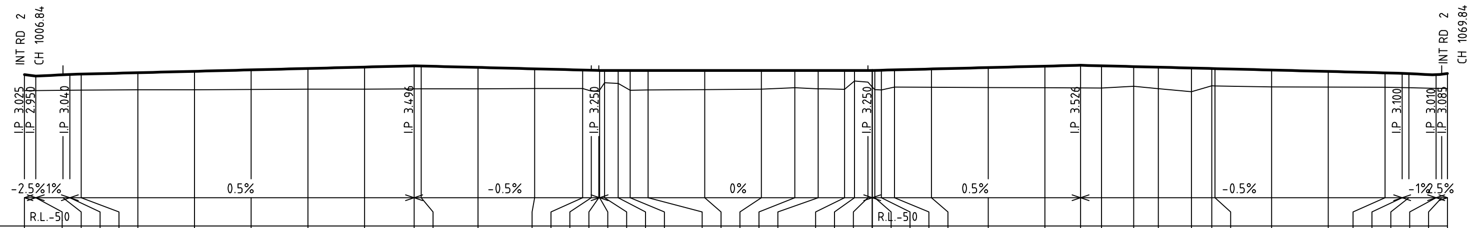
* Denote the original signature and date when revision was issued.

ROAD LONGITUDINAL SECTIONS

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

SCALE : AS SHOWN	SHEET No. :12	FILE : 21800149	SHEET SIZE
	JOB No. : 217154	DATE : Plotted 16:52 05/09/18	A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg



CHAINAGE	0	3	10.2	12	15	30	45	60	75	90	103.1	105	120	135	147.718	150	151.983
DESIGN LEVEL	3.025	2.95	3.022	3.04	3.055	3.13	3.205	3.28	3.355	3.43	3.496	3.486	3.411	3.336	3.272	3.261	3.251
EXISTING LEVEL	2.182	2.186	2.197		2.204	2.223	2.225	2.24	2.262	2.258		2.274	2.276	2.296	2.295	2.156	2.143

CHAINAGE	152.2	153.506	157.109	160.279	165	180	195	203.83	210	216.995	219.643	223.196	224.333	225	226.732	230.204	240
DESIGN LEVEL	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.253	3.262	3.279	3.328
EXISTING LEVEL	2.208	2.599	2.559	2.197	2.22	2.237	2.257	2.338	2.276	2.249	2.69	2.63	2.369	2.234	2.213	2.365	2.357

CHAINAGE	255	270	279.434	285	293.508	300	308.783	314.149	315	330	345	360	364.533	366.333	373.533	375	376.533
DESIGN LEVEL	3.403	3.478	3.526	3.498	3.455	3.423	3.379	3.352	3.348	3.273	3.198	3.123	3.1	3.082	3.01	3.047	3.085
EXISTING LEVEL	2.345	2.332		2.321	2.412	2.285	2.124	2.44	2.429	2.373	2.369	2.361		2.334	2.303	2.297	2.29

ROAD.No.12

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ROAD LONGITUDINAL SECTIONS

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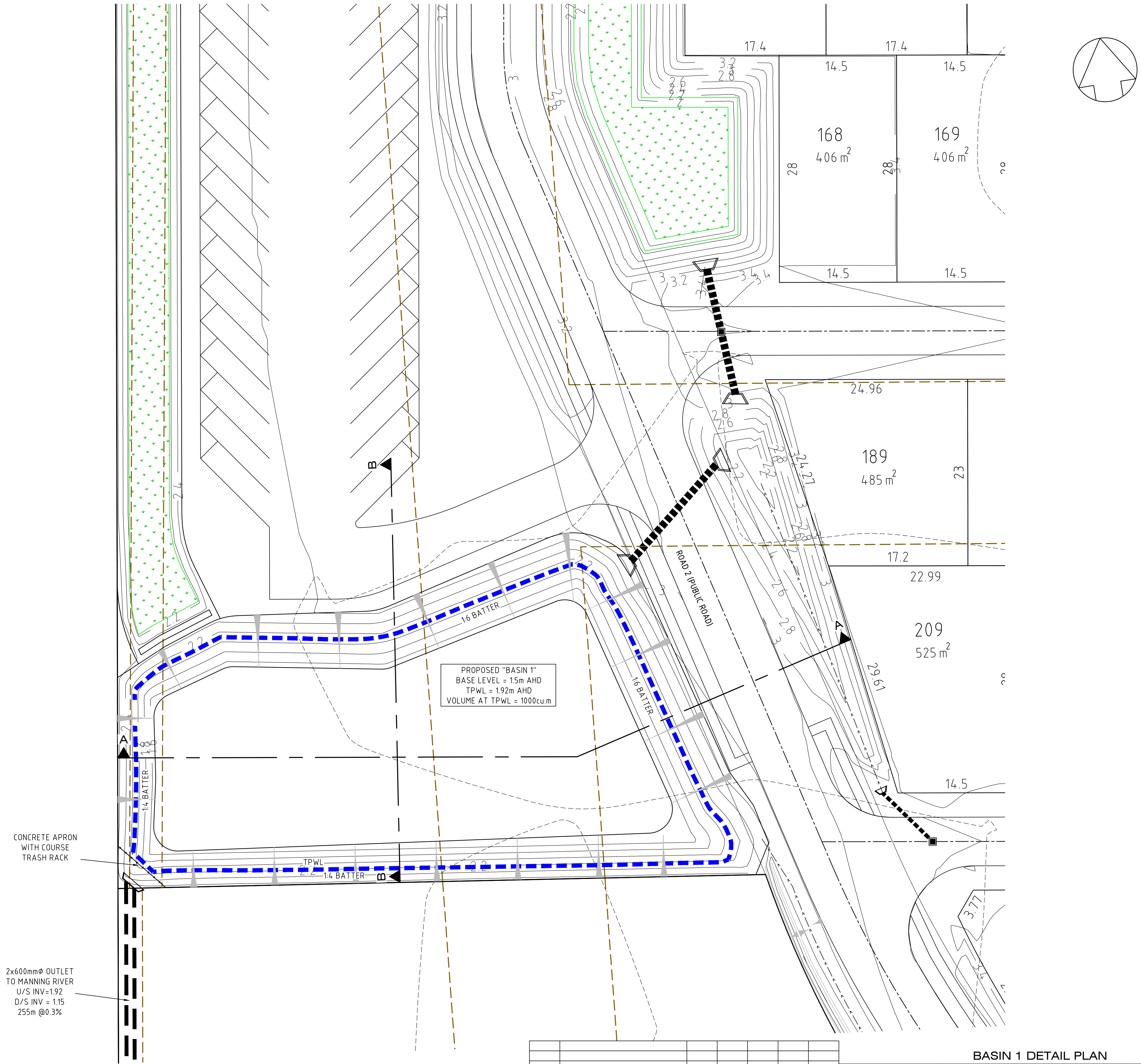

BASIN 1 DETAIL PLAN

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
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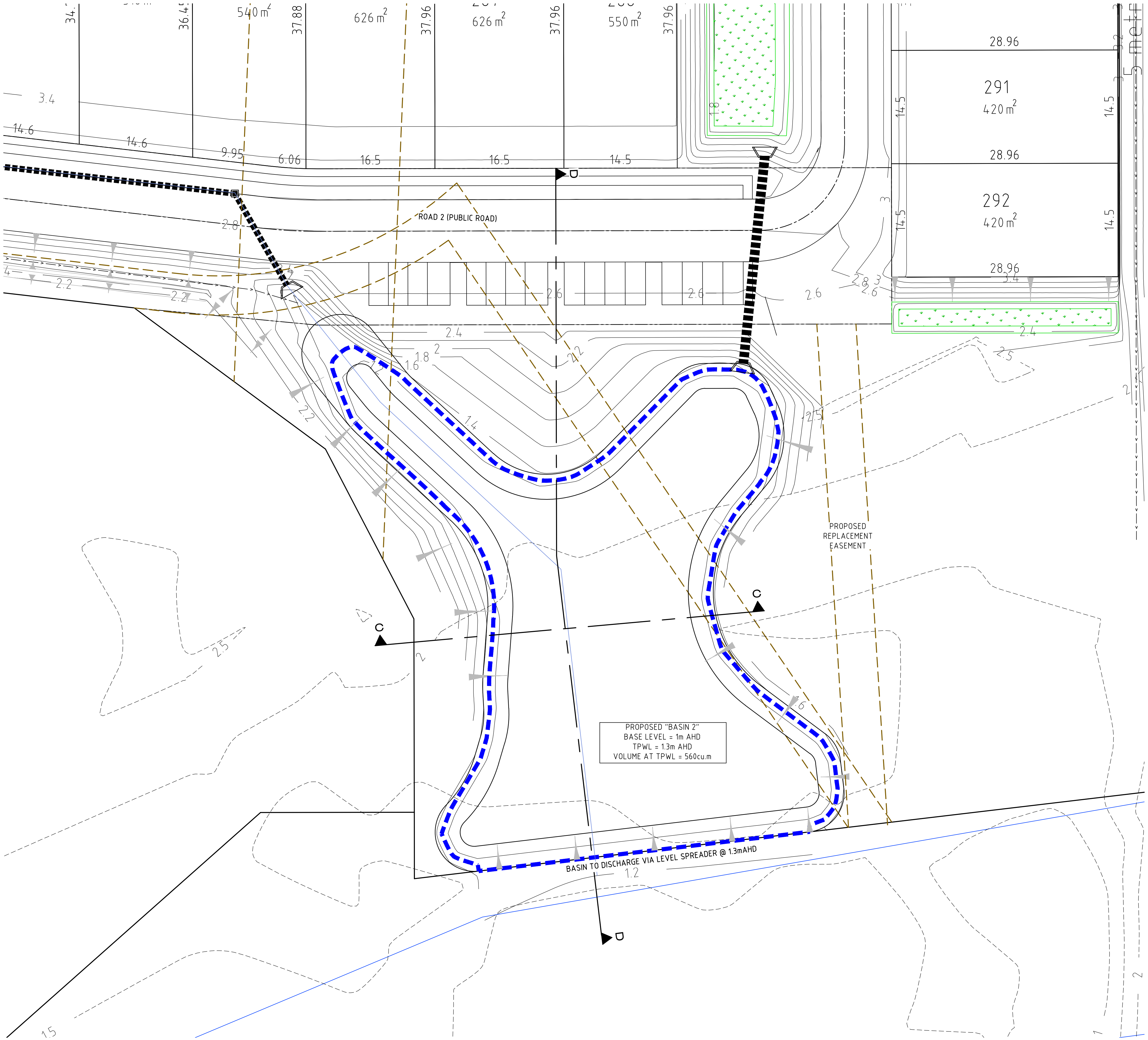

BASIN 2 DETAIL PLAN

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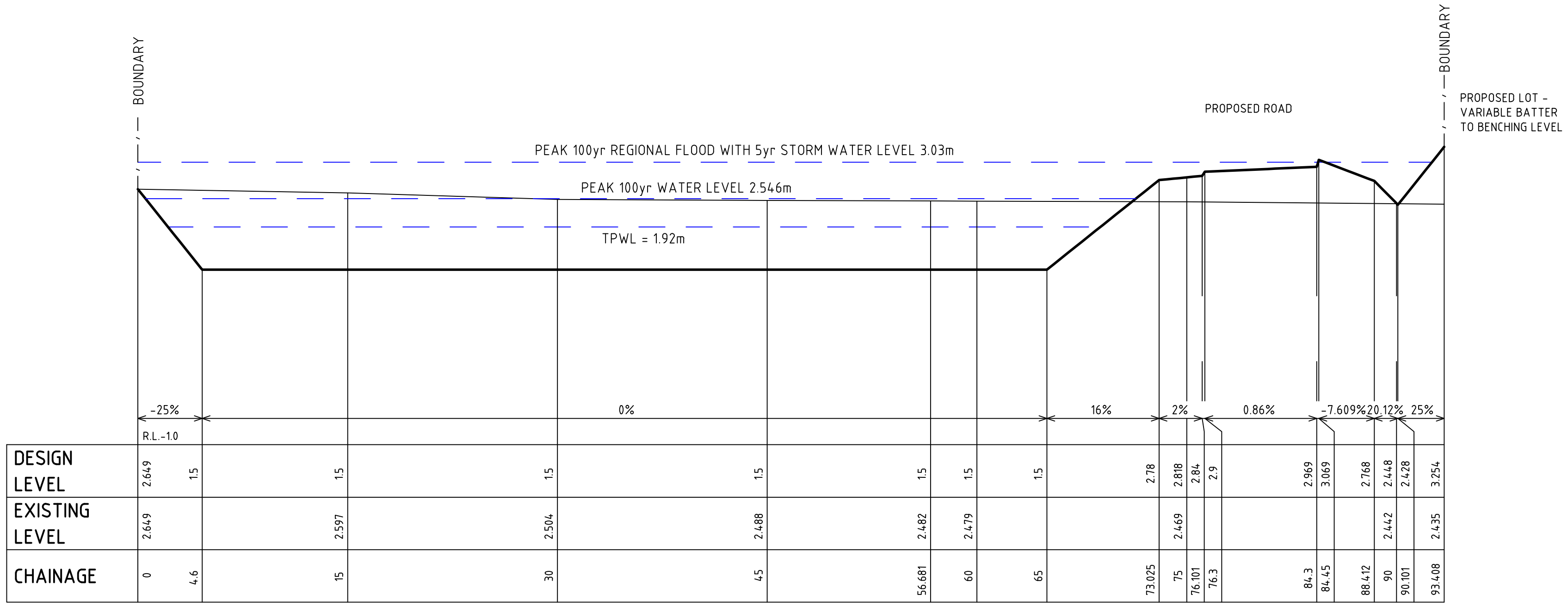

SECTION A
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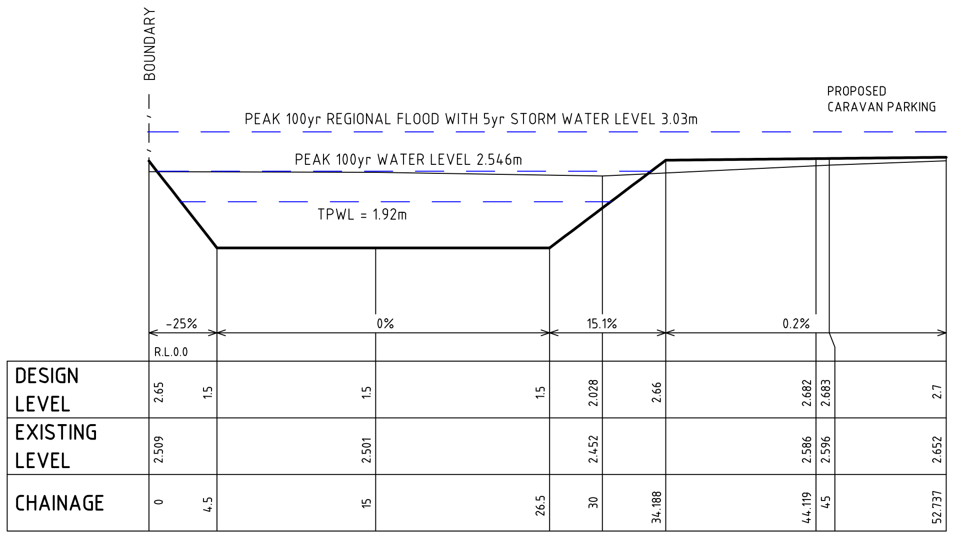

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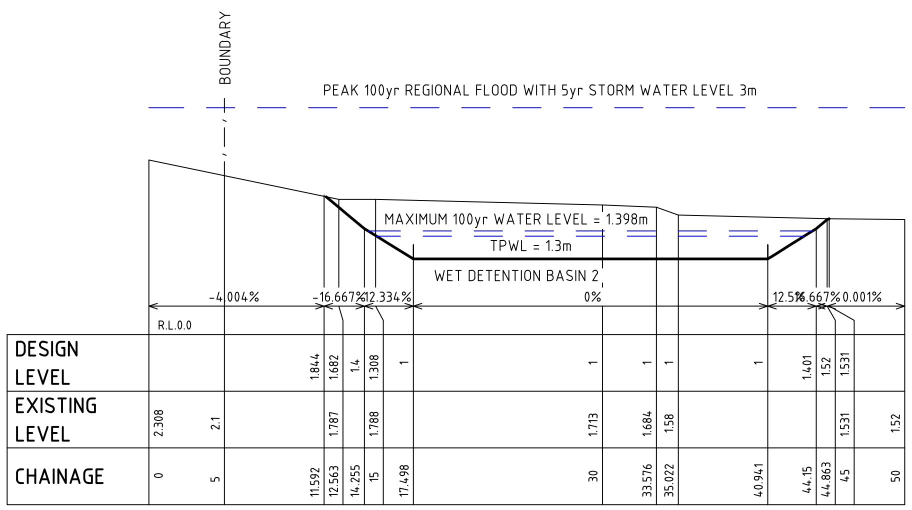

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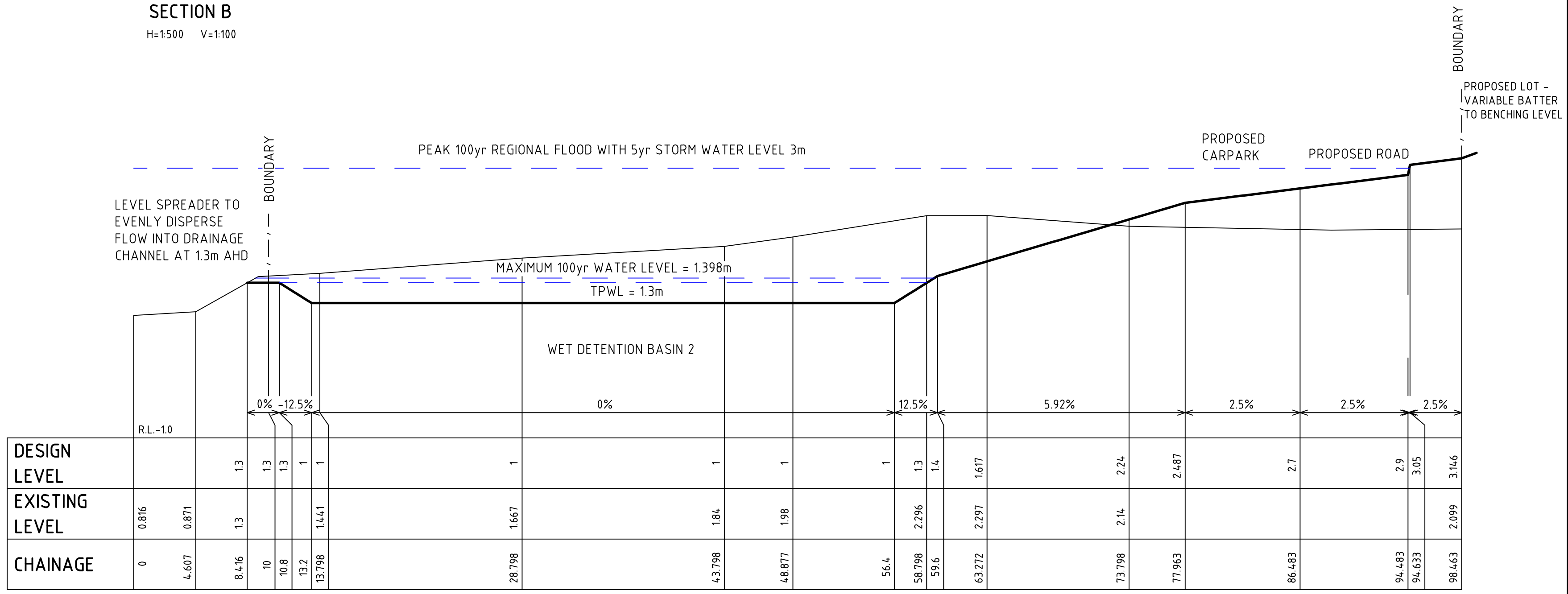

SECTION D
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BASIN SECTIONS

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
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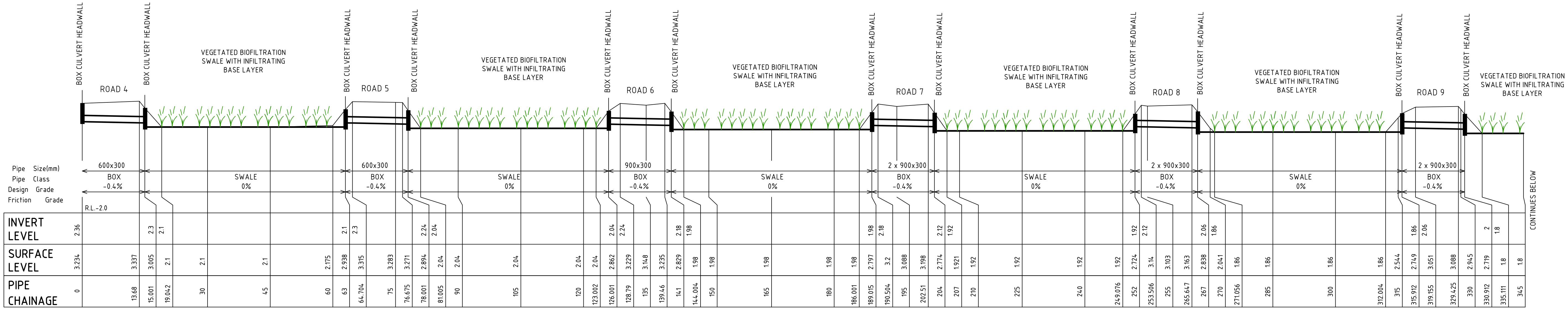

ROAD 3 DRAINAGE LINE

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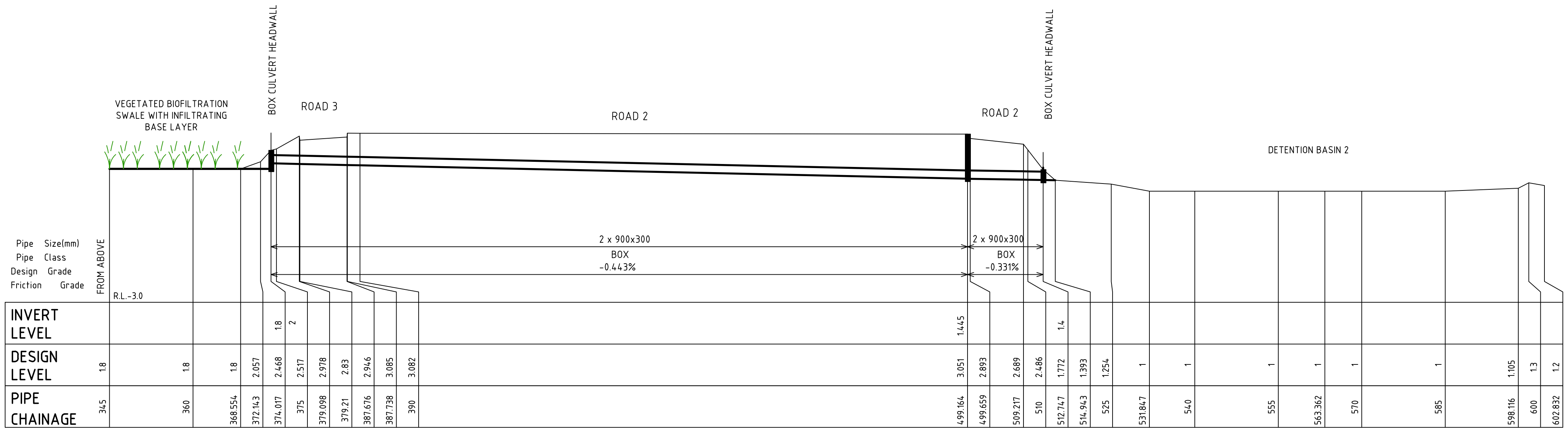

ROAD 3 DRAINAGE LINE

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TYPICAL DRAINAGE SECTION

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-1.5m to -1m	
-1m to -0.5m	
-0.5m to 0m	
0m to 0.5m	
0.5m to 1m	
1m to 1.5m	

VOLUME SUMMARY

CUT = 11,750 m³

FILL = 197,200 m³

SELECT IMPORT = 20,000 m³

NET = 165,450 m³ SHORTFALL

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CUT FILL PLAN

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JOB No. : 217154 | DATE : Plotted 16:54 05/09/18
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STANDARD SYMBOLS

EROSION AND SEDIMENT CONTROL PLANS

Construction Barrier Fencing	BF
Sediment Fence	
Straw Bale Sediment Filter	
Soil Stock Pile	S.S.P. 1
Extent Of Works	EW

NOTE
FINAL LOCATION OF TEMPORARY SOIL STOCKPILE TO BE APPROVED BY COUNCIL PRIOR TO CONSTRUCTION

TYPICAL SOIL & WATER MANAGEMENT PLAN

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
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SOIL & WATER MANAGEMENT NOTES

1. This plan is to be read in conjunction with other engineering plans and any written instructions that may be issued.

2. The contractor shall implement all soil erosion and sediment control measures prior to disturbance of the related catchment area and to the satisfaction of the Superintendent.

3. All positions shown are indicative only and are best determined on site in conjunction with the superintendent. Variations will be permitted to best suit the circumstances.

4. Cleared vegetation must be disposed of by :-
i) chipping or mulching for future landscaping and usage, or
ii) transport to an approved landfill facility.

5. Temporary crossbanks (bunds constructed with earth, straw bales or sandbags), shall be constructed during roadworks to limit slope length, where possible, to 80 metres. These shall be constructed immediately prior to forecast rain and during temporary closure of the site, including weekends.

6. Temporary rehabilitation should be undertaken on disturbed areas where works have stopped and soils are expected to remain exposed for two months.

7. Sediment barriers (e.g. sandbags or straw bales) should be located upstream of stormwater inlet pits prior to the road surface being paved and lands upslope being rehabilitated.

8. At the conclusion of each day sand bags are to be placed at the end of completed sections of road pavement to prevent scouring.

9. The contractor will inspect all erosion and pollution control works at least weekly and following every rainfall event greater than 5mm, providing particular attention to the following matters :
(a) Ensure drains operate effectively and initiate repair as required.
(b) Remove spilled sand (or other materials) from hazard areas, including lands closer than 5 metres from likely areas of concentrated or high velocity flows such as waterways and paved areas.
(c) Ensure rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
(d) Construct additional erosion and/or sediment control works as might become necessary to ensure the desired protection is given to downslope lands and waterways, i.e.,make ongoing changes to the plan.
(e) Maintain erosion and sediment control measures in a functioning condition until all earthwork activities are completed and the site is rehabilitated.
(f) Remove temporary soil conservation structures as a last activity in the rehabilitation program.

10. Utilise a single access only to the stock pile sites.

11. Drop inlets which do not outlet to silt traps shall be blocked until all works are completed.

12. Limit disturbed areas on site as much as possible at any one time, and stabilise competed areas as soon as practicable. Lands where works are not to continue for more than 20 working days must be rehabilitated. Such rehabilitation shall involve the spraying of a straw-bitumen mulch to the disturbed lands or equivalent.

13. Access areas limited to a maximum width of 10 (preferably 5) metres.

14. Conformity with this plan shall in no way reduce the responsibility of the Contractor to protect against water damage during the course of the contract.

15. Topsoil and spoil shall be stockpiled in non-hazard areas and protected from surface run-off by diversion drains or similar. Stockpiles shall be surrounded on downstream sides by silt fencing. Stockpiles shall be suitably compacted to inhibit erosion. Where the stockpiling period exceeds four (4) weeks, the stockpile shall be seeded to encourage vegetation growth.

16. Topsoil shall be respread and stabilised as soon as possible. Disturbed areas shall be left with a scarified surface to encourage water infiltration and assist keying in topsoil.

17. The contractor shall provide a turf strip behind all kerb and gutter at completion of footpath formation.

18. The contractor shall maintain grass cover until all works have been completed including the maintenance period, by frequent watering and mowing where required.

19. All drainage works shall be constructed and stabilised as quickly as possible to minimise risk of erosion.

20. Vehicular traffic shall be controlled during construction confining access where possible to proposed or existing road alignments plus 3 metres. Areas to be left undisturbed shall be marked off.

21. Site access shall be restricted to a nominated point. The construction of a shake-down area will be required at the entry to the site.

22. Facilities and/or equipment must be provided for the application of water to disturbed areas to minimise the generation of airborne dust from any area disturbed by construction activities.

23. Material removed from sediment control structures must be disposed of in a way that does not pollute waters or bushland.

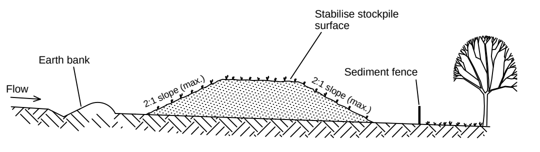
24. Waste disposal containers must be provided on site for the collection and disposal of all industrial and domestic type wastes generated on site.

25. Concrete wastes or washings from any concrete mixture or deliveries must not be deposited in any location where they can flow or be washed into waters.

26. Runoff from vehicle, construction plant or mobile plant maintenance and cleaning areas must be contained, collected and disposed of in a manner to prevent entry into any waters, including sediment retention ponds.

27. Fuelling of vehicles and construction plant must be carried out with an operator or driver present, and in a way that prevents any spillage occurring.

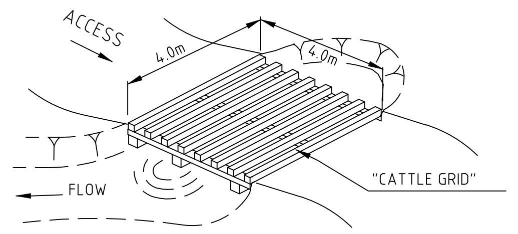
28. Prior to the controlled discharge (e.g. de-watering activities from excavations and sediment basins) of any water (groundwater or sediment laden water) from the site during construction, the following water quality objectives shall be achieved:
   * not exceed Total Suspended Solids of 50mg/L
   * not exceed Turbidity of 50 NTU
   * range within pH value of 6 to 8
   * be < 80% and > 20% saturation dissolved oxygen
   * have no odour or visible petro-chemical sheen
   * have no visible litter or waste matter
   * not contain any other contaminant, chemical or biological condition which causes any measurable adverse effect



Construction Notes

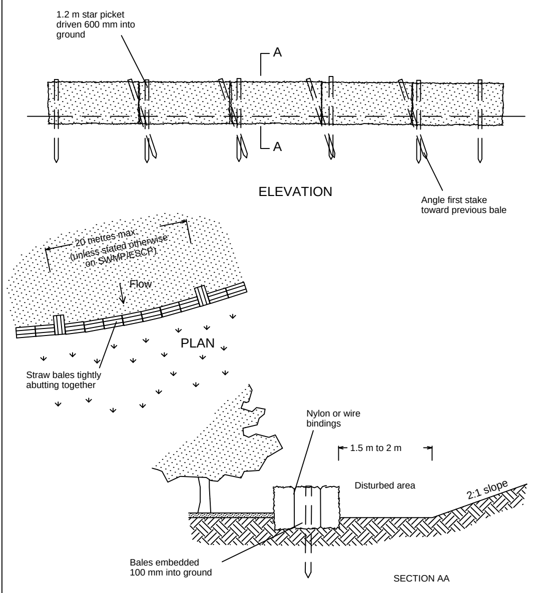
1. Place stockpiles more than 2m (preferably 5m) from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2m in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Std Drawing 5-5) on the upslope side to divert water around stockpiles & sediment fences (Std Drawing 6-8) 1-2m downslope.

STOCKPILES SD 4-1



TEMPORARY CONSTRUCTION EXIT
SHAKE-DOWN FACILITY DETAIL (CATTLE GRID)

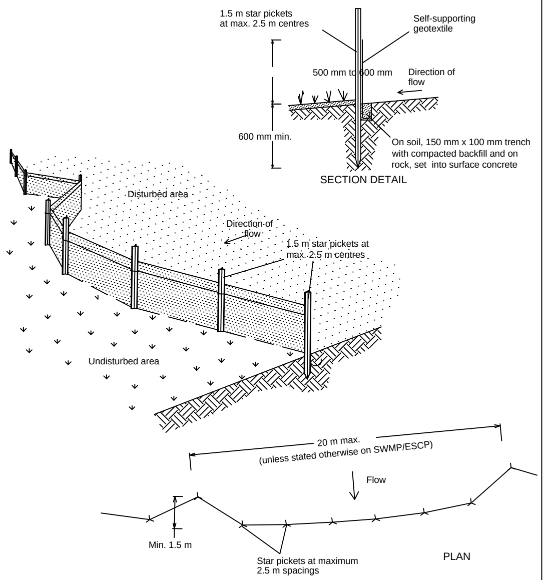
NOT TO SCALE



Construction Notes

1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

STRAW BALE FILTER SD 6-7



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit flow if concentrated at one point to 50 l/s in the design storm, usually the 10yr event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5m long star pickets into ground at 2.5m intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE SD 6-8

TYPICAL SOIL & WATER MANAGEMENT PLAN NOTES

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TATTERSALL LANDER PTY LTD

STORMWATER MANAGEMENT REPORT

for

HARRINGTON WATERS LIFESTYLE VILLAGE
SENIORS LIVING DEVELOPMENT

MANOR ROAD, HARRINGTON

LOT 2, 4 & 6 IN DP 1219123

Prepared by

TATTERSALL LANDER PTY LTD

Development Consultants

September 2018

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report has been prepared to support a development application for a 292 lot Seniors Living subdivision proposal.

The site of the proposed development is comprised of Lots 2, 4 & 6 in DP1219123 and is located on Manor Road at Harrington.

Figure 1: Locality Diagram

2.0 BACKGROUND INFORMATION

The site is currently vacant rural style land on the outskirts of the township of Harrington. The majority of the site is zoned R5 large lot residential, with some accompanying E2 lands surrounding the creek at the south of the site.

The site is adjacent to residentially zoned land developed as part of the Harrington Waters estate to the east, with RU1 lands to the west and north. The northern part of the RU1 lands includes an existing caravan park on the opposite side of Manor Road.

3.0 SITE CONTEXT

The three existing lots are currently vacant and have been substantially cleared in the past. Vegetation is generally a mix of pasture grasses, but it does not appear to currently be actively grazed.

The topography is best described as flat, with levels generally from 2.0m to 2.7m AHD. Soils are a generally a silty sand in nature.

Photo 1: Existing Site Conditions

4.0 PROPOSED DEVELOPMENT

The proposal is for a 292-lot community title subdivision and Seniors Living development, including various community facilities and associated infrastructure including filling, private and public road and drainage construction, and services installation.

It is proposed to address stormwater impacts with a combination of a rainwater harvesting/reuse system, street scale biofilters, constructed wetlands and swales.

5.0 WATER QUALITY TARGETS

In preliminary discussions, Council have indicated the development should meet the pollution reduction targets in Table 1 below:

Table 1: Stormwater Quality Targets

Gross Pollutants (GP)	90%
Total Suspended Solids (TSS)	Neutral or Beneficial Effect
Total Phosphorus (TP)	Neutral or Beneficial Effect
Total Nitrogen (TN)	Neutral or Beneficial Effect

6.0 CONSTRAINTS AND OPPORTUNITIES / BEST PLANNING PRACTICES

Best-planning practices have been considered in the planning process for this site. The silty sand soils and undeveloped nature of the existing site present some significant challenges to meeting Water Quality targets. Additionally, the low-lying nature of the site means significant filling is required to address regional flooding and local drainage considerations. The depth to groundwater also limits some treatment/disposal options.

Early design and modelling efforts concluded that meeting the required water quality targets would not be practical considering the development site on its own. Methods that were investigated include:

- Permeable paving for the central corridor:
  Treatment benefits for paving the central corridor with permeable paving provided limited benefit whilst increasing cost and ongoing maintenance issues.
- Constructed wetlands at the outlet locations from the site:
  The high water table and low lying site makes the depths required for bathymetric zones of a constructed wetland unachievable.
- Increased biofilter area:
  Further increasing the biofilter area provided limited return on the treatment of water that was able to be directed to them.

However, the existing caravan park directly upstream of the site presents the opportunity to treat currently untreated discharge within the same catchment to ensure the overall project achieves the necessary water quality objectives.

The proposal also seeks to construct an internal drainage system that will double as both water quality and storm flow conveyance. Sections of 'oversized' biofiltration swales (with zero longitudinal grade) are linked via piped culverts under intersecting roads. Refer to design plans by Tattersall Lander (Appendix C) for further details. This will limit the overall gradient of the trunk drainage lines which will in turn reduce imported fill quantities to a point that makes the development viable.

A key concern will be ensuring that flow velocities do not cause scouring damage to the biofilter systems in the base of the swales. This has been addressed via the flat grades, wide cross sections and high roughness values – the flow capacity is provided via additional cross-sectional area rather than grade. Resulting velocities will be discussed in more detail in Section 9 of this report.

7.0 SOIL AND WATER MANAGEMENT

A critical time for increase pollutant loads is during construction, and with this in mind, current practice recommends guidelines from Landcom's "Blue Book". Erosion and sediment control measures should be designed and specified in accordance with the "Blue Book" guidelines, and to Council satisfaction, and be inspected and maintained during the construction phase. This will assist in ensuring adherence to pollutant prevention measures, particularly the removal of suspended solids (sediment).

As the construction footprint of each stage will be in excess of 2,500sq.m, typically it would be expected that a detailed Soil and Water Management Plan would need to be prepared for construction stage prior to release of the Construction Certificate. This would typically include calculations of likely soil loss during construction, instructions on preferred construction sequence and limiting land disturbance, and calculations for the provision and sizing of any temporary sedimentation basin to cover the period of civil works.

8.0 INTEGRATED WATER CYCLE MANAGEMENT

All created lots will be serviced with reticulated water and sewer from the MidCoast Water Services network. There is no reticulated recycled water network available in Harrington.

In line with BASIX and WSUD principles, runoff from future dwelling roof areas is to be directed into rainwater tanks for reuse within the dwelling (toilet and laundry) and external use.

9.0 STORMWATER MANAGEMENT - HYDROLOGY

The nature of urban development is that it can increase the amount of impervious surface in a catchment, which in turn can decrease runoff times and create higher peak flow rates. It is important with new developments that measures are put in place to prevent increases in runoff from the site and resulting downstream flash flooding.

This particular site is in close proximity to the Manning River, and the proposal will include appropriate trunk drainage lines to convey runoff directly to the river without any impact on adjoining properties. Given the critical duration for flooding of the river in this location is significantly longer than the proposed local drainage network, it is not intended to attempt to detain flows back to pre-developed flow rates – the purpose of the two proposed basins is to control and buffer site discharges and velocities in relation to adjoining properties and the sensitive downstream E2 lands.

A detailed 1D node and link XP Storm flood routing model has been prepared to assess the effectiveness of the proposed trunk drainage system.

The model consisted of a series of trapezoidal conduits at 0% grade with a high "Mannings n" roughness value of 0.45 representing the biofilters connected by culverts at minimum grade with trapezoidal conduits and weirs representing the roads crossing the biofilter channels.
Whilst the biofilters are intended to allow infiltration through their base, the infiltration rates over the site are not considered sufficient to provide storm attenuation. For hydrology calculations a conservative approach was taken, assuming the biofilters to already be full to the level of the extended detention depth.

The site was broken up into a series of catchments that drain to the proposed biofilters. Impervious areas were measured directly off the plans with the area of proposed roof added to the catchments.
Impervious areas were modelled with 0.3mm depression storage, 0mm initial and 0mm/hr continuing loss.

Pervious areas were modelled with 0mm depression storage, 0.5mm initial loss with 2.5mm/hr continuing loss.

Rainfall was simulated utilising the Laurenson Method with IFD data sourced from the Greater Taree City Council Handbook of Drainage Criteria.

In consultation with Council engineers, the discharge level for the site has been set to 1.3m AHD as this is the 5 year ARI flood level. A separate Flood Impact Assessment for the development by BMT WBM found that 2100 100yr flood level on the site to be 3.1m AHD at Manor Road and 3m AHD at the Manning River.

To increase the capacity of discharge from Basin 1 whilst still being able to maintain cover over the pipe, the outlet pipe has been designed as a 600mm pipe discharging at 1.15m AHD. This has been modelled with a sediment level of 150mm through the pipe to represent a discharge level of 1.3m AHD.

The model was run with three separate scenarios, a Minor Event and two separate scenarios to represent the major event.

Minor Event:

The modelling conditions for the minor event scenario included a range of durations with 5 year ARI discharging to the Manning River with a free outfall at 1.3m AHD. The culverts were then sized to ensure a drainage solution was possible that provided 150mm freeboard in the drainage system during the peak 5 year ARI event.

Major Event:

Two major event scenarios were modelled as the critical duration for the site is much lower than the critical duration for the peak flood levels of the Manning River. The probability of combining the peak 100 year ARI storm event for the site with the peak 2100 100year ARI flood level for the Manning River would have a greater recurrence interval than 100 years.

Both major event scenarios were modelled to have a 50% blockage factor in the culverts by halving the culvert width on the conduit data in XP storm from the design conduits.

The first major event scenario was a 100 year ARI storm event over the site with a 1.3m AHD free outfall. This scenario represents the peak stormflow for the site.

The second major event scenario was a 5 year ARI storm event over the site with a fixed tail water of 3m AHD representing the peak 2100 100yr flood level for the Manning River. This scenario represents a local minor event occurring at the site whilst there was also a peak 2100 100 year ARI regional flood for the Manning River.

The peak water level for the 100 year ARI was used to determine the minimum floor level for the houses in the corresponding streets.

Critical duration events varied across the network, and typically were the shorter events higher up the catchment and longer durations down in the outlet basins.

9.1 FLOW CONVEYANCE RESULTS

As the site discharges directly to a large water body (i.e the Manning River), On-Site Detention was not required and pre and post developed peak flows were not compared.

The model was used to ensure 5 year ARI events were contained in the pit, pipe and channel system as shown by Table 2.

For the 100 year ARI events the model was used to determine minimum floor levels throughout the site and to check that the detention basins prevented uncontrolled flows into neighbouring properties during a 100 year event where flooding was not already occurring. This is shown by Table 3 and Table 4.

Table 2: Peak 5 Year ARI Water Levels

Intersection	Road Level (m AHD)	5 Year Water Level (m AHD)	Freeboard Achieved (mm)
Road 2 & 4	3.2	2.909	291
Road 2 & 5	3.13	2.902	228
Road 2 & 6	3.06	2.883	177
Road 2 & 7	2.99	2.782	208
Road 2 & 8	2.92	2.621	299
Road 2 & 9	2.8	2.519	281
Road 2 & 3	2.9	2.456	444
Road 2 Public to Private	2.92	2.341	579
Road 3 & 4	3.185	2.881	304
Road 3 & 5	3.125	2.879	246
Road 3 & 6	3.065	2.787	278
Road 3 & 7	3.005	2.71	295
Road 3 & 8	3.095	2.723	372
Road 3 & 9	2.945	2.663	282
Road 3 & 11	2.885	2.596	289
Road 2(Private) & 4	3.18	2.839	341
Road 2(Private) & 5	3.12	2.839	281
Road 2(Private) & 12(North)	3.06	2.824	236
Road 2 (Private) & 12(South)	3	2.786	214
Road 2 (Private) & 11	2.94	2.661	279
Road 2 (Private) & 10	2.88	2.449	431

Table 3: Peak 100 Year ARI Water Levels

Intersection	Peak 100 Year Water Level - 1.3m AHD Free Outfall (m AHD)	Peak 100 Year Water Level - 3m AHD Tail Water	Minimum Floor Level (m AHD)
Road 2 & 4	3.191	3.181	3.69
Road 2 & 5	3.187	3.196	3.70
Road 2 & 6	3.139	3.147	3.65
Road 2 & 7	3.071	3.089	3.59
Road 2 & 8	3.005	3.048	3.55
Road 2 & 9	2.887	3.03	3.53
Road 2 & 3	3.064	3.13	3.63
Road 2 Public to Private	3.031	3.085	3.59
Road 3 & 4	3.257	3.248	3.76
Road 3 & 5	3.252	3.243	3.75
Road 3 & 6	3.198	3.204	3.70
Road 3 & 7	3.154	3.202	3.70
Road 3 & 8	3.142	3.195	3.70
Road 3 & 9	3.105	3.161	3.66
Road 3 & 11	3.124	3.176	3.68
Road 2(Private) & 4	3.213	3.211	3.71
Road 2(Private) & 5	3.202	3.199	3.70
Road 2(Private) & 12(North)	3.167	3.166	3.67
Road 2 (Private) & 12(South)	3.141	3.146	3.65
Road 2 (Private) & 11	3.087	3.123	3.62
Road 2 (Private) & 10	3.059	3.105	3.61

Table 4: Peak 100 ARI Year Water Levels in Basins

	Discharge Level (m AHD)	Overflow Level (m AHD)	Peak 5 year Water Level (m AHD)	Peak 100 year water level - Free Outfall (m AHD)
Basin 1	1.92	2.65	2.352	2.546
Basin 2	1.3	1.5	1.367	1.398

Figure 2 through to Figure 5 below show the basin elevations. Note that Basin 1 does not completely empty due to the 150mm sediment depth conservatively applied to the whole of the discharge pipe rather than just up to 1.3m AHD.

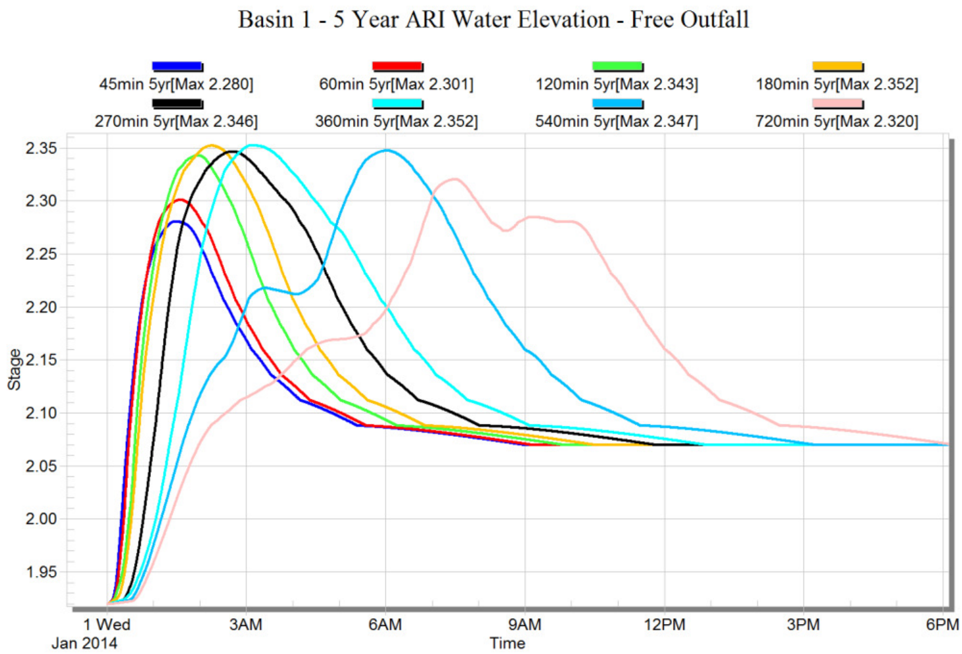


Figure 2: Basin 1 - 5 Year ARI Water Elevation

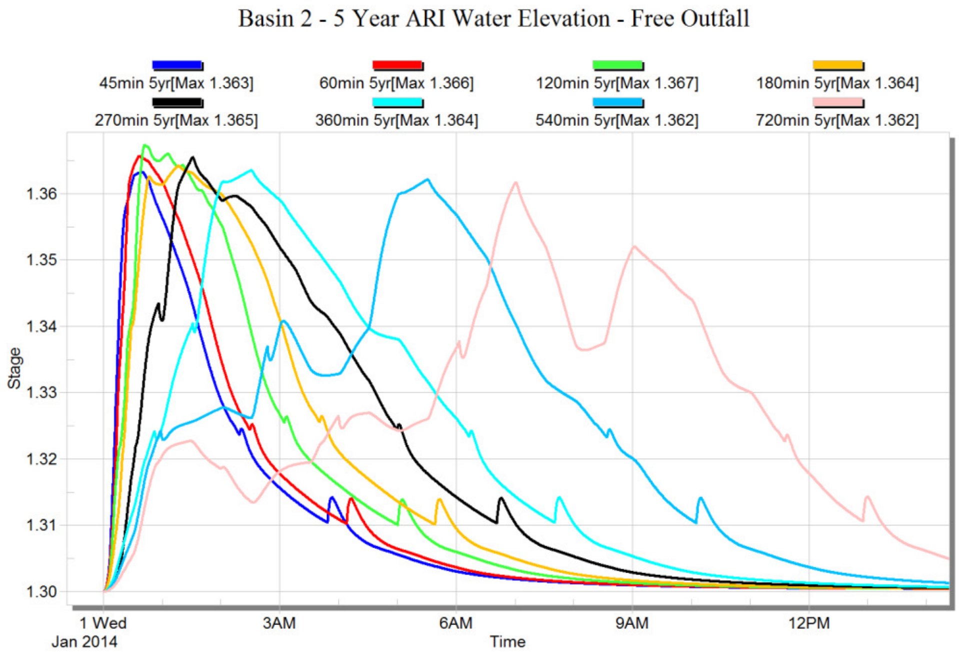


Figure 3: Basin 2 - 5 Year ARI Water Elevation

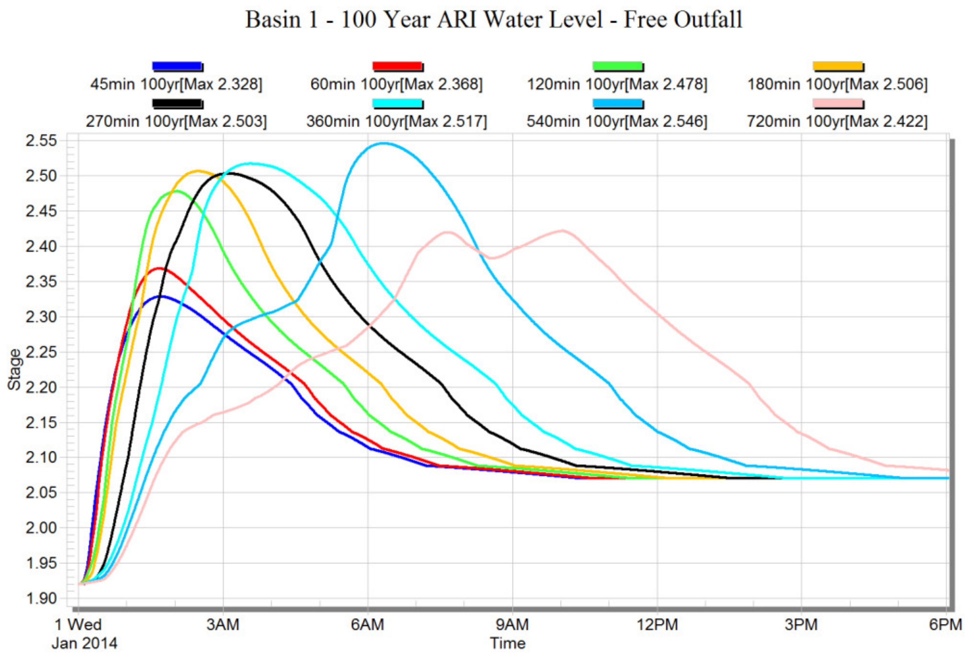


Figure 4: Basin 1 - 100 Year ARI Water Elevation

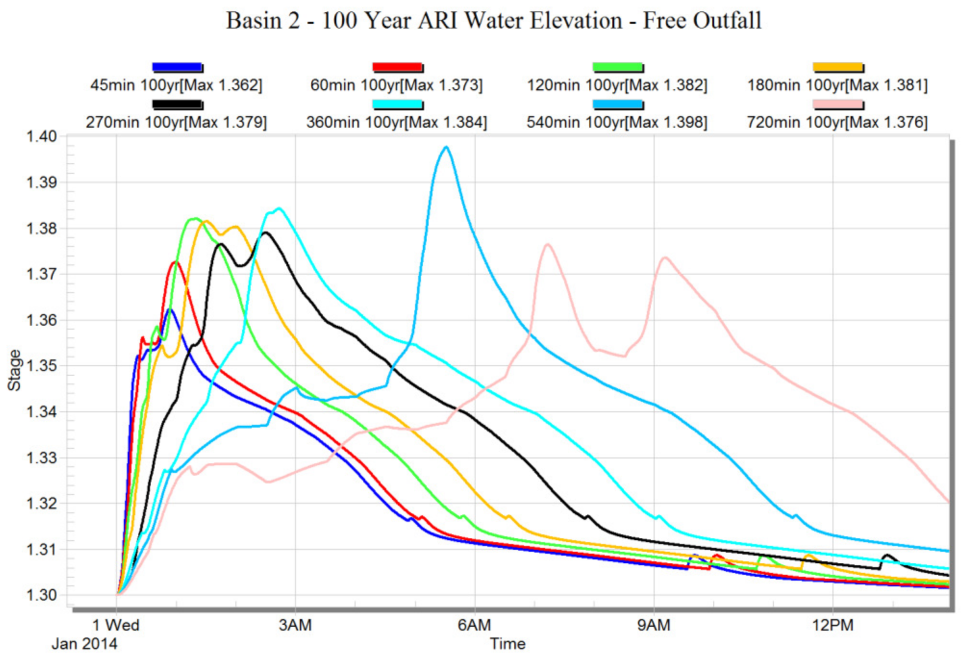


Figure 5: Basin 2 - 100 Year ARI Water Elevation

9.2 BIO-SWALE SCOUR VELOCITIES

WSUD Engineering Procedures published by Melbourne Water states that velocities in biofiltration swales should be limited to 0.5 m/s for the five-year ARI event and 1.0 m/s for flows up to the 100-year ARI.

The maximum 5yr event velocities seen in any of the biofilter swales in the are around 0.07m/s with a corresponding depth ranging between 0.85m and 0.55m (above filter base). The equivalent 1% ARI results were around 0.1m/s and 1.2m deep. Both values are well below the target values so scour / sediment washout should not be an issue.

9.3 PUBLIC SAFETY

The proposed design requires the roadside swales to transfer both the minor and major design storms' flows. Significantly flat grades and wide cross sections will ensure low velocities (as described above), but will also result in some larger depths in the major storm event. With floor levels/road levels fixed with the regional flood level and the trunk drainage falling through the site, in the major storm event the swales will actually resemble a string of basins, linked by submerged culverts.

The swales include several design features that will help to ensure public safety;

- Safe Batters - Generally, the side of each swale adjacent to the road has been graded at 1(V):6(H) to allow safe egress if anyone accidentally enters the waters during a major storm event. Steeper batters (typically 1(V):3(H) and 1(V):4(H)) exist on the far side of the swale, and will abut fencing to prevent access,

- Flat grades/wide sections – conforming to the character of the existing site, the swales will feature very flat grades. This necessitates a wide cross section in order to provide flow capacity. Combined with the high roughness values due to the level of landscaping proposed, velocities will be very low, even in major storm events,

- Well defined edges – Generally speaking the streets are straight or the swales are on the inside of the curve, reducing the likelihood of vehicles accidentally turning in to a flooded swale,

- Landscaping - Swales will also double as landscape areas, which will include tree plantings and dense macrophyte plantings, so even under major flood conditions the biofilters will provide a clear visual and tactile delineation between the roadway and the deeper drainage channel. People entering a flooded swale will be able to use the vegetation to assist with orientation and stability as they attempt to exit the water,

- Alternate Routes – Generally speaking the grid-like street pattern provides alternative access routes if a particular road crossing becomes flooded by extreme flows or culvert blockages. This should ensure there is always another safe route, and pedestrians and vehicles are not forced to cross flooded roadways.

Chapter 7, Book 6 of ARR 2016 describes several methods for determining flood hazard categories and refers to work done by Smith et al, 2014 shown below in Figure 6.

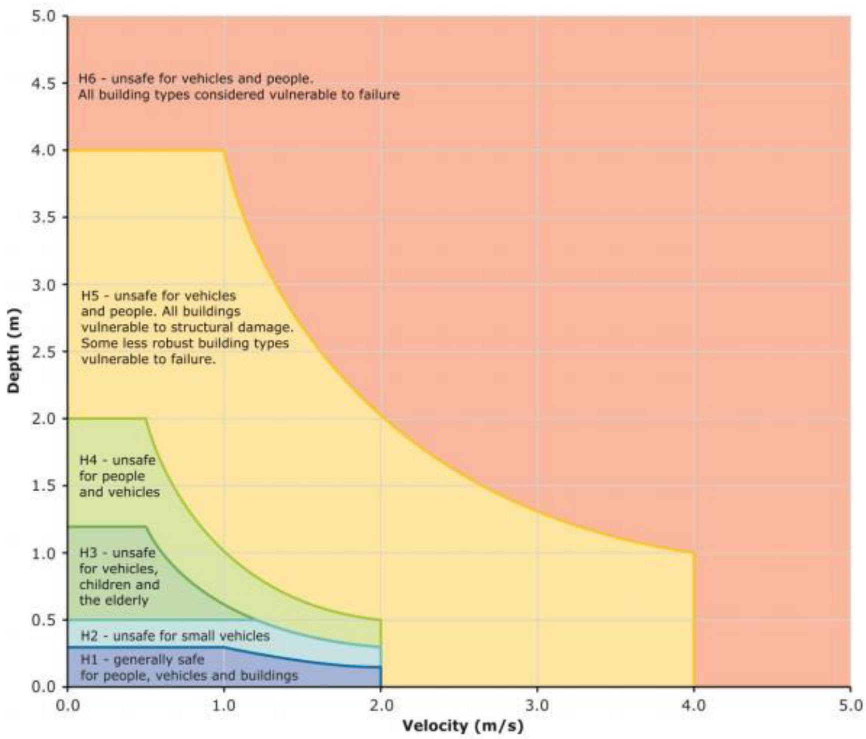


Figure 6: Hazard Categories (Smith et al, 2014)

These categories were used to assess the hazard of water flowing over the intersections in a 1 in 100 year ARI event. As shown in

Table 5 below shows that the flows over these intersections are both low velocity and low depth and as such are classed with a hazard category of *"H1 – Generally safe for people, vehicles and buildings"*

Table 5: Intersection Hazard Category

Intersection	Peak 100 Year Velocity (m/s)	Peak 100 Year Depth (m)	Velocity x Depth	Hazard Category
Road 2 & 4	0	-0.009	0.00	H1
Road 2 & 5	0.454	0.066	0.03	H1
Road 2 & 6	0.57	0.087	0.05	H1
Road 2 & 7	1.128	0.099	0.11	H1
Road 2 & 8	1.099	0.128	0.14	H1
Road 2 & 9	0.75	0.23	0.17	H1
Road 2 & 3	0	0.23	0.00	H1
Road 2 Public to Private	1	0.165	0.17	H1
Road 3 & 4	0.362	0.072	0.03	H1
Road 3 & 5	0.616	0.127	0.08	H1
Road 3 & 6	0.711	0.139	0.10	H1
Road 3 & 7	0.724	0.197	0.14	H1
Road 3 & 8	0.722	0.081	0.06	H1
Road 3 & 9	1.066	0.25	0.27	H1
Road 3 & 11	1.057	0.276	0.29	H1
Road 2(Private) & 4	0.171	0.033	0.01	H1
Road 2(Private) & 5	0.457	0.082	0.04	H1
Road 2(Private) & 12(North)	0.512	0.107	0.05	H1
Road 2 (Private) & 12(South)	1.1	0.146	0.16	H1
Road 2 (Private) & 11	1.087	0.183	0.20	H1
Road 2 (Private) & 10	1.087	0.225	0.24	H1

For the proposed flow conveyance bio swales (labelled in Appendix A), velocity is very low due to the flat gradient but the depths are much greater. This has resulted in a higher hazard category for these areas as shown in

Table 6. These higher categories are deemed acceptable as entry for people and vehicles is not intended. Additionally the design features noted at the start of the chapter allow for distinction of these areas and safe egress as water levels begin to rise.

Table 6: Bio Swale Hazard Category

Bio Swale	Peak 100 Yr Velocity (m/s)	Peak 100 Yr Depth (m)	Velocity x Depth	Hazard Category
A	0.017	1.066	0.018	H3
B	0.023	1.087	0.025	H3
C	0.053	1.099	0.058	H3
D	0.062	1.128	0.070	H3
E	0.021	1.152	0.024	H3
F	0.063	1.164	0.073	H3
G	0.088	1.222	0.108	H4
H	0.096	1.256	0.121	H4
I	0.083	1.301	0.108	H4
J	0.106	1.330	0.141	H4
K	0.095	1.206	0.115	H4
L	0.008	1.102	0.009	H3
M	0.026	1.127	0.029	H3
N	0.029	1.166	0.034	H3
O	0.032	1.203	0.038	H4
P	0.028	1.245	0.035	H4
Q	0.029	1.285	0.037	H4

9.4 REGIONAL FLOOD LEVELS

A separate Flood Impact Assessment for the development by BMT WBM found that 2100 100yr flood level on the site to be 3.1m AHD at Manor Road and 3m AHD at the Manning River. In consultation with the DCP and Council engineers, it is proposed to fill the site with the following criteria;

- Minimum future Finished Floor Levels will need to be 3.6m AHD (0.5m freeboard above the flood planning level). As such the minimum fill level on each lot has been designed to be at least 3.46m AHD, to allow direct slab-on-ground construction with no further earthworks.
- All roads (private and public) to be at least 2.7m AHD to limit the maximum 2100 100yr flood depth to 0.4m.

Additionally, the controlling downstream discharge level has been set at 1.3m AHD – the 2100 Mean High Water Mark.

10.0 STORMWATER MANAGEMENT – WATER QUALITY MODEL

10.1 BACKGROUND

The quality of runoff generated by the site is important to ensure the preservation of the downstream environments as an increased proportion of impervious area can lead to a subsequent increase in the quantities of phosphorus and nitrogen entering potential storm water runoff. The aim of this section of the study is to determine what measures need to be undertaken as part of this development to meet the water quality objectives set out in Table 1 in Section 5 of this report.

10.2 MUSIC MODELLING

MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the Cooperative Research Centre for Catchment Hydrology. MUSIC provides the ability to model both quality and quantity of runoff generated by catchments. Therefore, MUSIC can simulate annual stormwater volumes, and expected annual pollutant loadings.

MUSIC is designed to model stormwater runoff systems in urban catchments. It is used to simulate a range of temporal and spatial scales. Catchment modelling can be performed for areas up to 100 km^2, with times steps from 6 minutes to 24 hours to match the range of spatial scale. This enables long term modelling of continuous historical rainfall data from pluviograph sources and reflects the ability to account for temporal variation in data for an annual rainfall series directly.

MUSIC also has the ability to model a number of treatment devices and measure their effectiveness in terms of the quantity and quality of runoff downstream. This allows determination of the degree of reduction in annual pollutant loadings.

It is important to note that the MUSIC simulation relies heavily on input variables and it is usually recommended that MUSIC models be calibrated to local conditions wherever possible. When calibration is not possible default values can be used, or variables can be sourced from values recommended for stormwater modelling in NSW from a technical report prepared for the DECC by the Co-operative Research Centre titled "*Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures*" (Fletcher et al, 2004).

Given the scale of the proposed development site and hence the MUSIC model, it was determined to be unreasonable to perform a calibration in this instance.

10.2.1 CLIMATE / RAINFALL

To accurately model a site of this size, continuous rainfall record spanning at least five years with a six minute timestep is required. Per the recommendations of the 2010 Draft NSW MUSIC Modelling guidelines, rainfall data was obtained from the Bureau of Meteorology in the form of a historic pluviograph record from the Taree rainfall gauge. It is situated approximately 13km from the site and is of similar elevation and temporal pattern.

In accordance with the Draft MUSIC Modelling Guidelines, eight years of data between the dates of 1/1/1967 and 30/12/1975 was chosen. This data produced a mean annual rainfall of 1201mm. It was noted that the long term average rainfall (obtained from the Bureau of Meteorology) for Harrington (Oxley Anchorage Caravan Park, now closed) is 1338mm, and the Council template released recently has a mean value of 1234mm.

For the purpose of this report, all rainfall events in the nominated eight year period have been modelled.

10.2.2 EVAPORATION

To accurately model the outcome of water quality treatment measures, monthly potential evapotranspiration (PET) data is required. Monthly average areal potential evapotranspiration values were read from maps in the 'Climate Atlas of Australia, Evapotranspiration' (BoM, 2001), and are displayed below in Table 7:

Table 7: Monthly Areal Potential Evapotranspiration Figures

Month	Potential Evapotranspiration (mm)
January	180
February	135
March	135
April	90
May	65
June	50
July	50
August	70
September	100
October	135
November	150
December	165
Total	**1325**

10.2.3 NODE PARAMETERS

The MUSIC model was used to simulate the pollutant export generated during an eight year period of average rainfall. Geotechnical investigations indicate that the predominant soil types on site is silty sand. Rainfall-runoff parameters for Silty Sand soils were adopted from Section 3.6.4.3 of the Draft NSW MUSIC Modelling Guidelines (2010) and typical pollutant concentrations derived from Fletcher et al. The adopted parameters can be seen in Figure 7 and Table 8 below.

Note that a Rainfall Threshold of 1.50 mm/day was adopted for the “Sealed Road” node and 0.30 mm/day was adopted for the “Roof” node per Table 3.6 in the Draft NSW MUSIC Modelling Guidelines (2010). A Rainfall Threshold of 1.00 mm/day adopted for all other nodes.

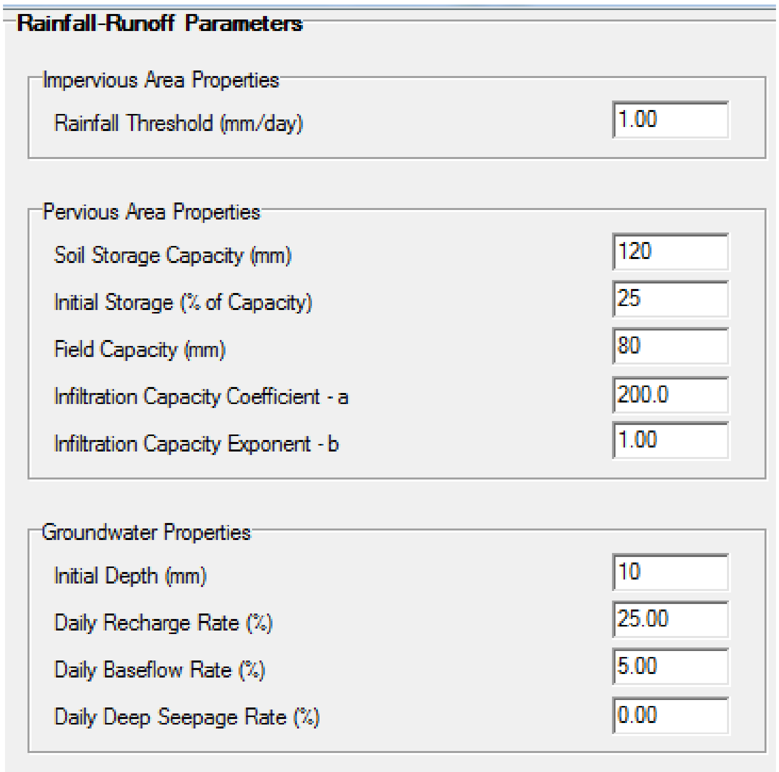


Figure 7: Adopted Rainfall-Runoff MUSIC Parameters

Table 8: Adopted MUSIC Pollutant Generation Parameters

	Rural-residential	Unsealed Road	Residential	Roof	Road
Baseflow TSS Mean (mg/L)	14	16	16	-	16
Stormflow TSS Mean (mg/L)	90	1000	140	20	270
Baseflow TP Mean (mg/L)	0.06	0.14	0.14	-	0.14
Stormflow TP Mean (mg/L)	0.22	0.5	0.25	0.13	0.5
Baseflow TN Mean (mg/L)	0.9	1.3	1.3	-	1.3
Stormflow TN Mean (mg/L)	2	2.2	2	2	2.2

10.2.4 EXISTING FLOW & POLLUTANT ANALYSIS

The existing site was modelled to simulate the current pollutant loads from the site. The majority of the site was modelled as a 'rural-residential' landuse, with additional nodes to represent the existing gravel access driveways on the site ('unsealed road' landuse, 50% impervious) and the portion of the existing caravan park draining to Manor Road ('residential' landuse, 60% impervious).

Generally speaking the existing silty sand soils mean there is little runoff and thus little pollution generated from the site.

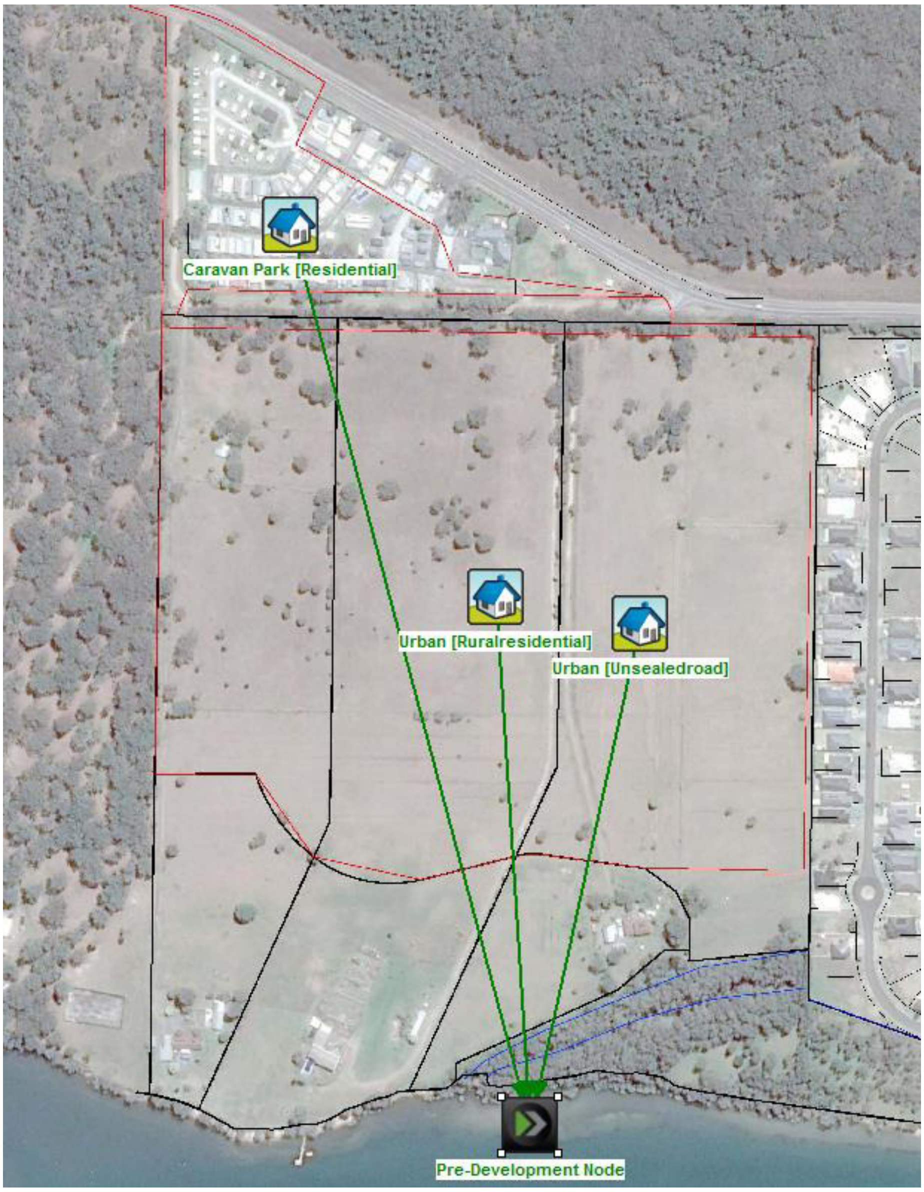


Figure 8: Existing State MUSIC Model

10.2.5 PROPOSED DEVELOPMENT FLOW & POLLUTANT ANALYSIS

Concerted efforts (including detailed MUSIC modelling) were made to try and achieve the required NorBE targets onsite, but this proved impractical given the low target levels calculated from the existing site.

In consultation with Council, it was agreed that treatment of external upstream catchment flows would be undertaken in addition to onsite treatments, to achieve an overall NorBE result.

The proposed development was modelled to determine expected pollutant loads and the effectiveness of the proposed water treatment measures. The catchment was broken up into different areas depending on the surface type, including;

- Roofs areas (measured directly off architectural design plans for the largest housing option for each lot), and modelled as “Roof” nodes with 100% impervious area;
- All road areas (measured directly off design plans) were modelled as “Sealed Road” nodes with the percentage impervious area calculated based from the measured pavement area and an estimated 14sq.m/lot driveway in the verge. The remaining pervious percentage consists of the landscaped verge area.
- The remaining urban area (open space, landscape areas and public reserve) were modelled as residential nodes with the percentage impervious estimated from the remaining driveway area (estimated 30sq.m/lot);

Modelled treatment nodes include;

- Rainwater tanks; The development proposes to build large below-ground rainwater storage and reuse tanks. Each will be a standalone system on an individual block collecting roof waters only, with overflow to an inter-allotment drainage line. They are modelled with 10kL capacity. Captured water has been modelled for reuse in toilet, laundry and external uses only. Internal reuse rates of 0.25kL/day/dwelling were adopted for a dwelling with 1-2 occupants from Table 3-12 in the 2010 Draft NSW MUSIC Modelling Guidelines. An external reuse rate of 112kL/day/dwelling was adopted (distributed by PET minus Rainfall).

  For the hotel and clubhouse areas an internal reuse rate of 0.125kL/day/ET were adopted for toilet use only in a dwelling with 1-2 occupants from Table 3-12 in the 2010 Draft NSW MUSIC Modelling Guidelines. Based off MidCoast Water’s Equivalent Tenement Policy this rate use been adjusted by a rate of 0.4/unit for the hotel and .0015/sq.m for the clubhouse.

  It has been assumed that 100% of the roof areas will be connected to the tanks;

- Biofiltration swales; The trunk drainage corridor has been modified to insert biofiltration systems in the base of each swale. This will offer treatment to runoff directed from the adjacent roads, plus piped inflow from each cross street (which will include rainwater tank overflows and pervious area runoff). Features include a 0.3m detention depth and 0.4m filter depth and an unlined base that will allow discharge via infiltration;
- Constructed Wetland; The buffer strip across the Manor Road frontage of the site will be utilised as a constructed wetland to treat water from Manor Road (including runoff from the caravan park opposite) as well as the 26 dwelling sites proposed adjacent.
- Buffer strips and grassed swales; The southern section of Road 2 will be constructed as one-way crossfall with a concrete edge strip, grassed verge and drainage swale on the low side to convey this water around to proposed ‘Basin 2’.

Note: Basin 1 and Basin 2 have been proposed primarily for detention, flow conveyance and peak flow buffering, and are not specifically configured as constructed wetlands. They will however have permanent depths of 0.45m and 0.3m respectively and will be planted with complete macrophyte coverage. It is expected these will provide some additional water quality benefits, but neither have been included in the MUSIC modelling.

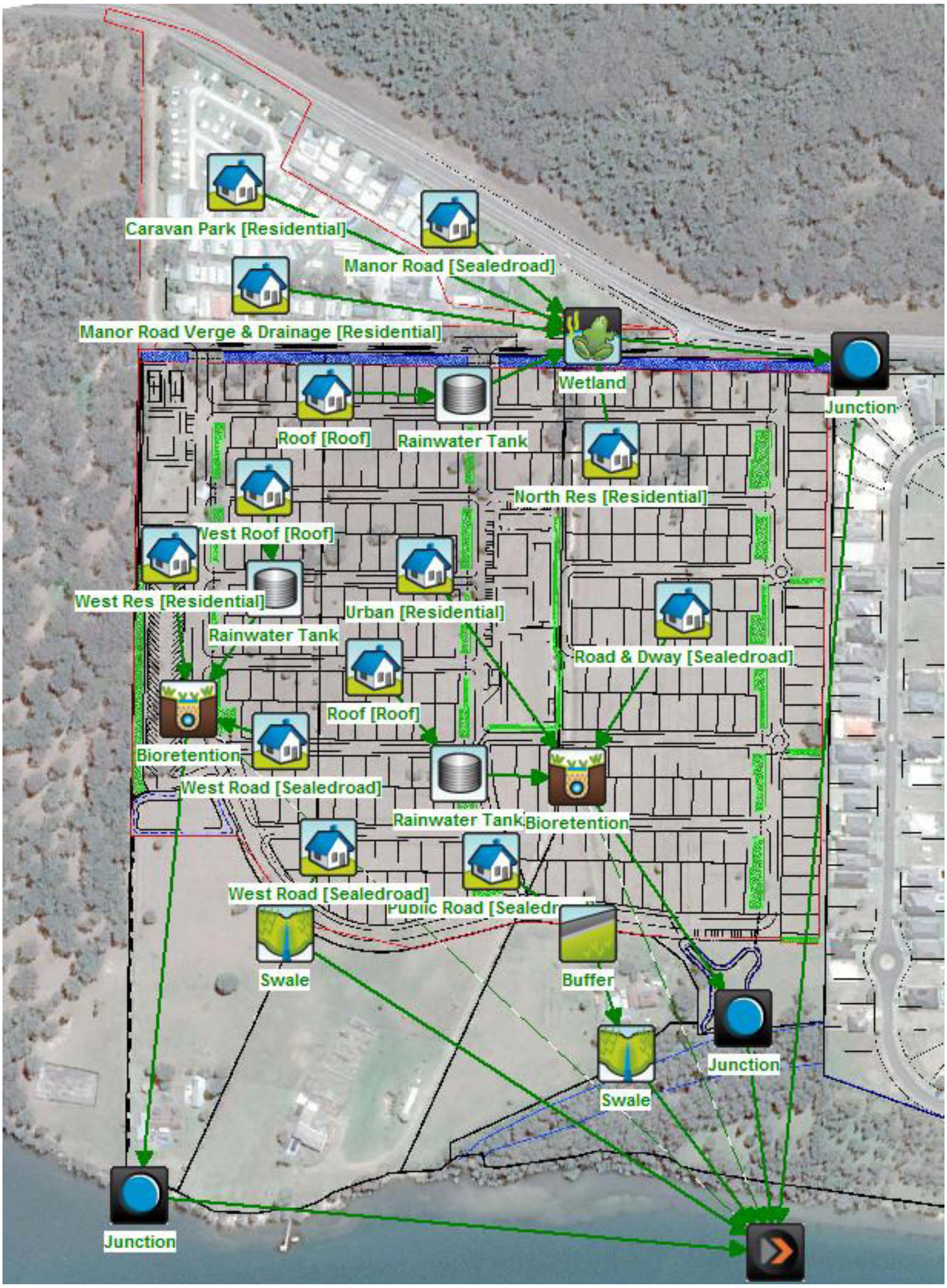


Figure 9: Proposed Development MUSIC Model

10.2.6 COMPARISON OF POLLUTANT RESULTS

Pre- and post-development pollutant loads are compared in the tables below to ensure that the Stormwater Quality Targets have been met. Table 9 shows the effectiveness of the proposed treatment measures if the external caravan park site was not included. As the caravan site to the North will flow through one of the proposed treatment measures this has been included in the model resulting in a treatment train effectiveness as shown in Table 10 demonstrating that the development will create a Neutral or Beneficial Effect on water quality.

Table 9: Comparison of Pre- and Post-Development Pollutant Loads (without Caravan Park)

	Pre-Developed	Post-Developed	NoBE Compliant	Percentage Shortfall
TSS (kg/yr)	10700	2080	Yes	N/A
TP (kg/yr)	14.9	16.4	No	10%
TN (kg/yr)	129	137	No	6%
GP (kg/yr)	246	0	Yes	N/A

* NoBE = Neutral or Beneficial Effect

Table 10: Comparison of Pre- and Post-Development Pollutant Loads (with Caravan Park included)

	Pre-Developed	Post-Developed	NoBE Compliant
TSS (kg/yr)	15400	4770	Yes
TP (kg/yr)	22.6	21.6	Yes
TN (kg/yr)	186	184	Yes
GP (kg/yr)	977	0	Yes

* NoBE = Neutral or Beneficial Effect

11.0 COSTS

Installation and establishment of all WSUD devices will be undertaken at the developer's expense. Responsibility for ongoing operation and maintenance will be fall variously with the village operators (private road biofilters) and individual owners (rainwater harvesting tanks & pumps). As no costs are to be incurred by Council, a detailed cost analysis has not been provided in this report.

12.0 OPERATION AND MAINTENANCE PLAN

12.1 BIOFILTERS

The biofilter systems are private assets and will need to be maintained as part of the regular maintenance work by village ground staff. Regular maintenance is required to ensure water treatment measures continue to operate in an effective way. These tasks should be performed every three months or after heavy storm events. The maintenance schedule in Appendix B has been prepared as a typical template to direct maintenance staff undertaking routine maintenance and is based on Raingardens and Bioretention Tree Pits Maintenance Plan Example, prepared by the Facility for Advancing Water Biofiltration, Monash University. Relevant sections have been reproduced and/or modified for the specific site conditions.

Is it expected that the finalisation of the biofiltration systems will be deferred until the building construction is essentially completed, ensuring house building activities do not compromise the newly constructed WSUD devices. All biofilter maintenance activities will need to commence as soon as biofilters are planted and brought online and continue for the life of the development.

12.2 RAINWATER HARVESTING TANKS

The individual below-ground tanks will be the responsibility of each individual owner to maintain, in a similar way as other smaller housing rainwater tanks. This includes checking and cleaning gutters, any first flush devices and inlet strainers regularly (quarterly), servicing the pump system as recommended by the pump supplier (typically bi-annually) and irregular tank cleaning and desludging (as required).

13.0 CONCLUSIONS

The results derived from modelling procedures indicate that long term water quality and quantity constraints are appropriately addressed in the proposed development, through the following measures:

- Construction of unlined roadside biofiltration swales,
- Construction of a wetland across the Manor Road frontage to treat untreated upstream catchment waters,
- Installation of min. 10kL rainwater tanks with each proposed dwelling.

More so, the modelling demonstrates that the development will actually have a positive impact on stormwater pollutant levels. From a stormwater quality and quantity perspective, approval is recommended.

14.0 REFERENCES

Draft NSW MUSIC Modelling Guidelines, 2010, BMT WBM

Music Version 5.0 User Manual, 2011, eWater

Policy 11: Land Development Guidelines, Section 13 Water Sensitive Urban Design, 2007, Gold Coast Council

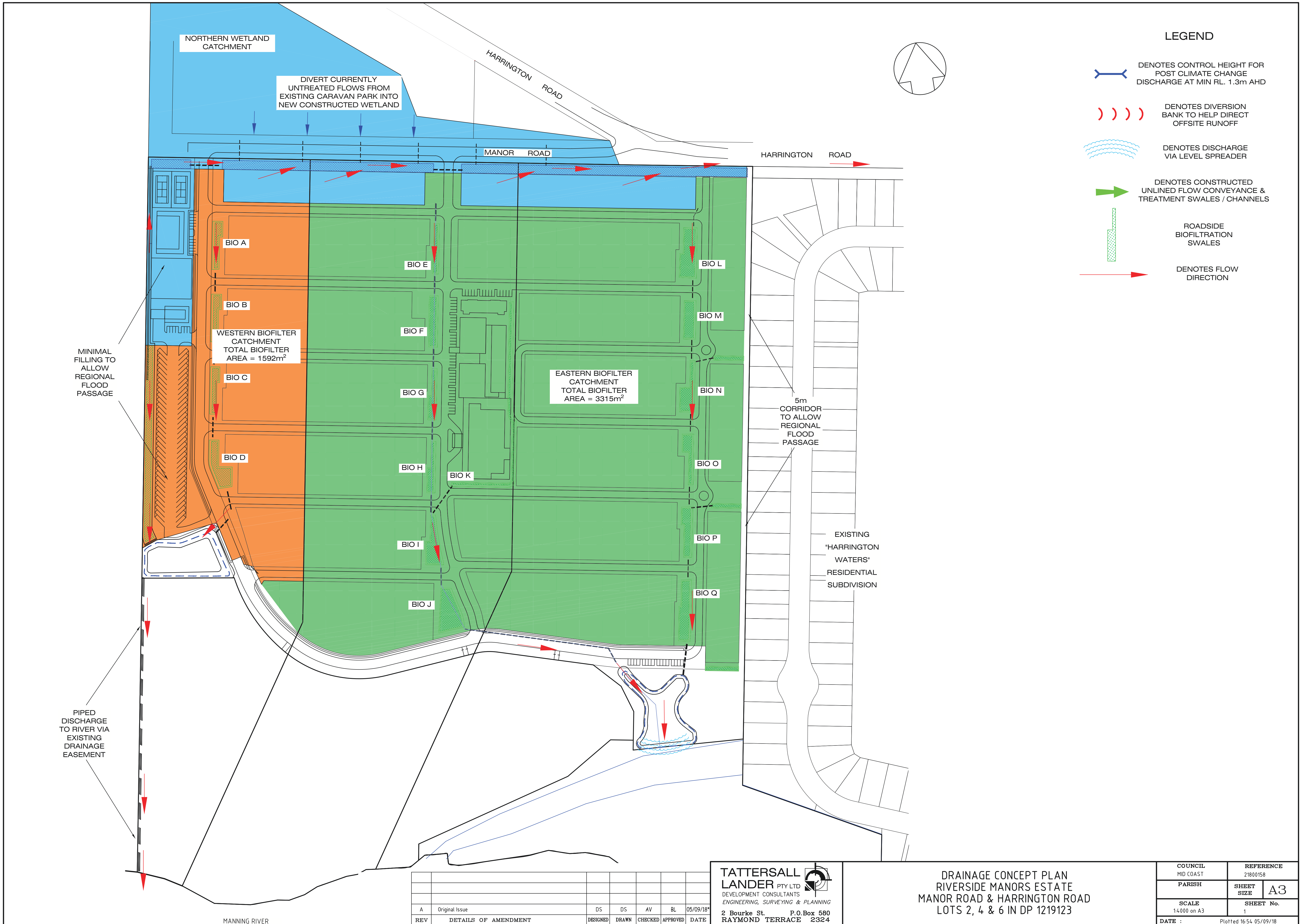
Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, 2004, Fletcher et al

WSUD Engineering Procedures: Stormwater, 2005, Melbourne Water

Grantley, S and Ron, C, 2016, Safety Design Criteria – Flood Hydraulics, Book 6 in Australian Rainfall and Runoff - A Guide to Flood Estimation, Commonwealth of Australia

Smith G P, Davey E K, and Cox R J (2014) Flood Hazard UNSW Australia Water Research Laboratory Technical Report 2014/07 30 September 2014.

APPENDIX A: DRAINAGE CONCEPT PLAN



A	Original Issue	DS	DS	AV	BL	05/09/18*
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE

* Denote the original signature and date when revision was issued.

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DRAINAGE CONCEPT PLAN
RIVERSIDE MANORS ESTATE
MANOR ROAD & HARRINGTON ROAD
LOTS 2, 4 & 6 IN DP 1219123

COUNCIL: MID COAST	REFERENCE: 21800158
PARISH	SHEET SIZE: A3
SCALE: 1:4000 on A3	SHEET No.: 1
DATE :	Plotted 16:54 05/09/18

CLIENT:
JOB No.: 217154
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

APPENDIX B: BIOFILTER MAINTENANCE TASKS

A. Filter Media Tasks

Sediment Deposition	Remove sediment build up from the surface of bioretention swales Frequency – 3 monthly after rain
Holes or scour	Infill any holes in the filter media. Check for erosion or scour and repair, provide energy dissipation (rocks & pebbles etc) if necessary Frequency – 3 monthly after rain
Filter media surface porosity	Inspect for the accumulation of an impermeable layer (such as oily or clayey sediment) that may have formed on the surface of the filter media. A symptom may be that water remains ponded in the swale for more than a few hours after a rain event. Repair minor accumulations by raking away any mulch on the surface and scarifying the surface of the filter media between plants Frequency – 3 monthly after rain
Litter Control	Check for litter (including organic litter) in and around bioretention swales. Remove both organic and anthropogenic litter to ensure flow paths and infiltration through the filter media are not hindered. Frequency – 3 monthly after rain

B. Horticultural Tasks

Pests and Diseases	Assess plants for disease, pest infection, stunted growth or senescent plants. Treat or replace as necessary. Reduced plant density reduces pollutant removal and infiltration performance Frequency – 3 monthly after rain
Maintain original plant densities	Inspect condition of all plants. Replace and dead plants immediately to maintain a minimum density of 4 plants per square metre Frequency – 3 monthly after rain
Drought / Extreme Heat	In periods of prolonged drought or extreme heat, the condition of plantings and site lawn coverage should to be monitored for signs of stress. Watering may be required to ensure plant survival Frequency – As required

Weeds	It is important to identify the presence of any rapidly spreading weeds as they occur. The presence of such weeds can reduce dominate species distributions and diminish aesthetics. Weed species can also compromise the system's long term performance. Inspect for and manually remove weed species. Application of herbicide should be limited to a wand or restrictive spot spraying due to the fact that the swales are directly connected to the stormwater system Frequency – 3 monthly after rain
Grassed buffer strip	Grassed buffer strips treat runoff as it flows off the roads, before it enters the bioretention swales. Maintaining a healthy grass cover is important, but the use of fertilisers should be kept to a minimum given their proximity to the drainage network
Lawn Fertiliser	Healthy site grass coverage is important for pollutant treatment, topsoil erosion control and aesthetics. However, if not correctly used, fertilisers can damage the downstream environment. A low Phosphorus fertiliser with restricted leaching properties such as a Fused Calcium Magnesium Phosphate or TNN Industries 'Formula 1', or equivalent is ideal. The application of fertiliser should be restricted to a maximum of twice a year

C. Drainage Tasks

Perforated Pipe	Ensure that perforated pipes are not blocked to prevent filter media and plants from becoming waterlogged. A small steady clear flow of water may be observed discharging from the perforated pipe at its connection into the downstream pit some hours after rainfall. Note that smaller rainfall events after dry weather may be completely absorbed by the filter media and not result in flow. Remote camera (eg CCTV) inspection of pipelines for blockage and structural integrity could be useful. Flushing of lines from the flushing points may be required. Frequency – 6 monthly after rain
High flow inlet pits, overflow pits and other stormwater junction pits	Ensure inflow areas and grates over pits are clear of litter and debris and in good and safe condition. A blocked grate would cause nuisance flooding of adjoining areas. Inspect for dislodged or damaged pit covers and ensure general structural integrity. Remove sediment from pits and entry sites (likely to be an irregular occurrence in mature catchment). Frequency – monthly and occasionally after rain

APPENDIX C: PROPOSED LAYOUT & DETAIL PLANS

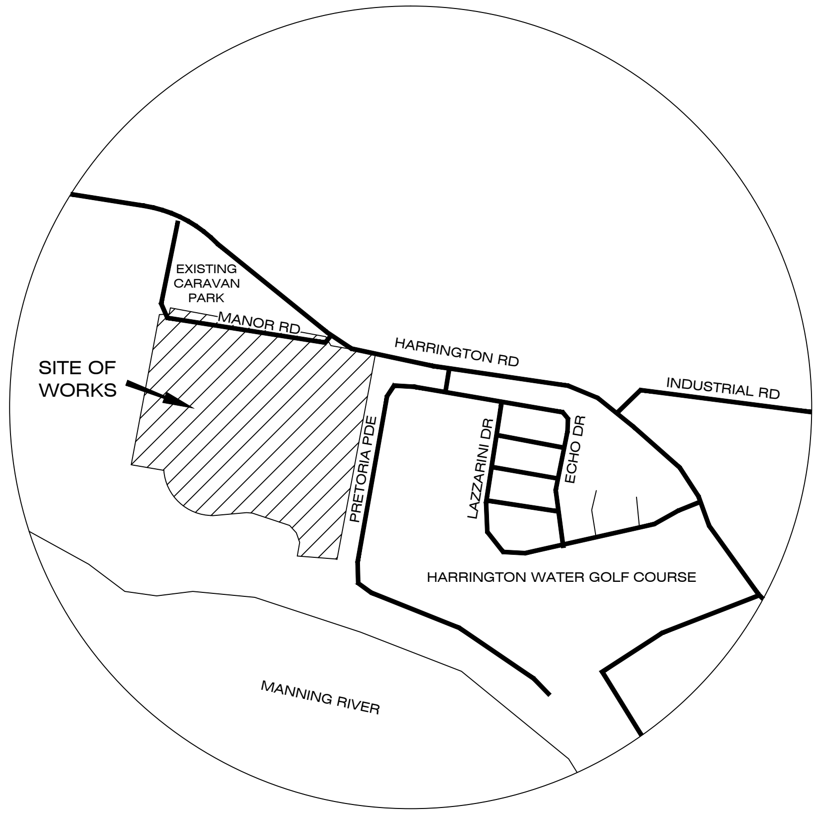
HARRINGTON WATERS LIFESTYLE VILLAGE

MANOR ROAD, HARRINGTON

DA DESIGN PLANS

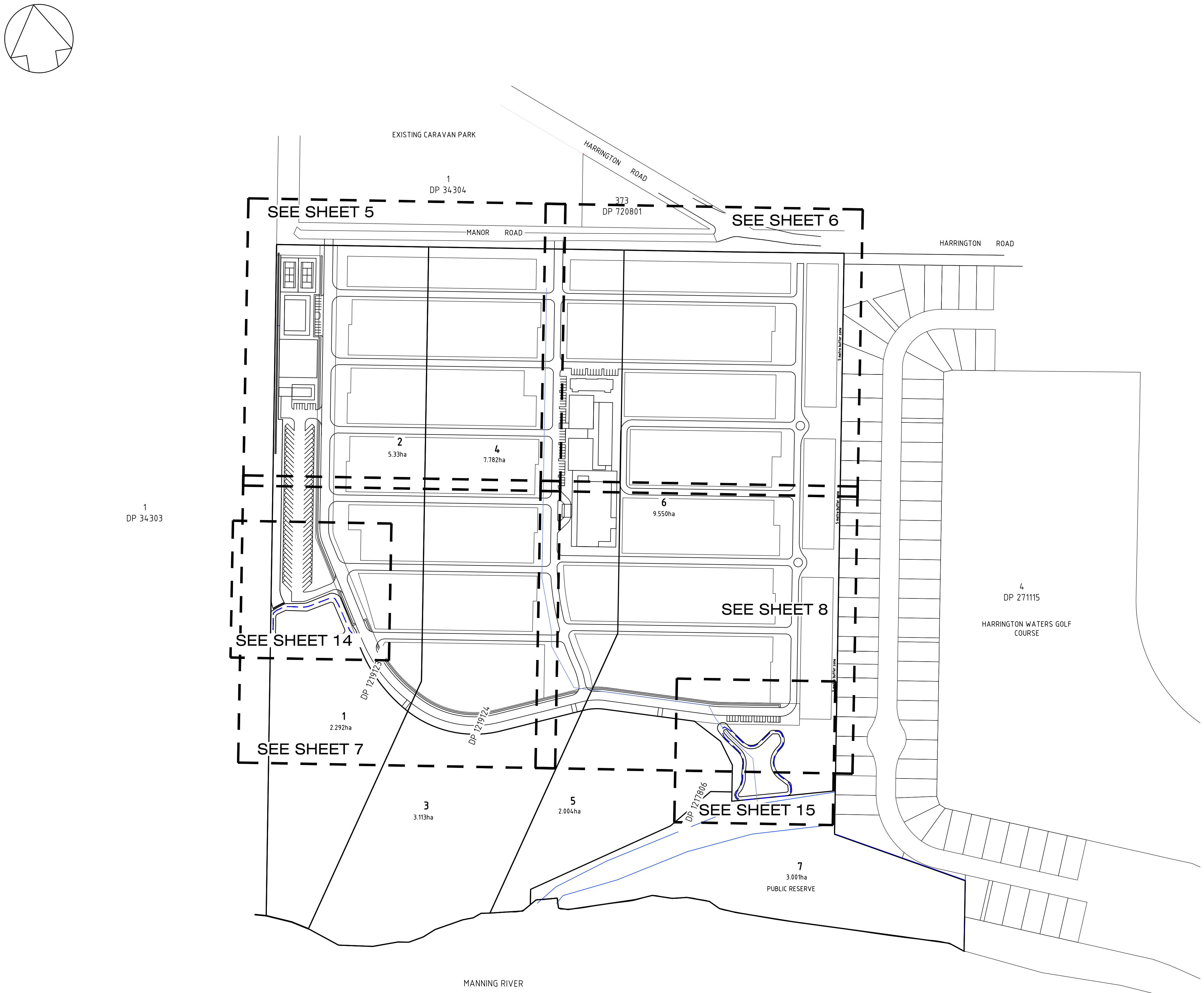
ROAD, DRAINAGE & ASSOCIATED WORKS

Schedule of Drawings



LOCALITY SKETCH

Designed By TATTERSALL LANDER PTY LTD
DEVELOPMENT CONSULTANTS IN ENGINEERING, SURVEYING & PLANNING
PO Box 580 RAYMOND TERRACE Phone (02) 4987 1500



B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE

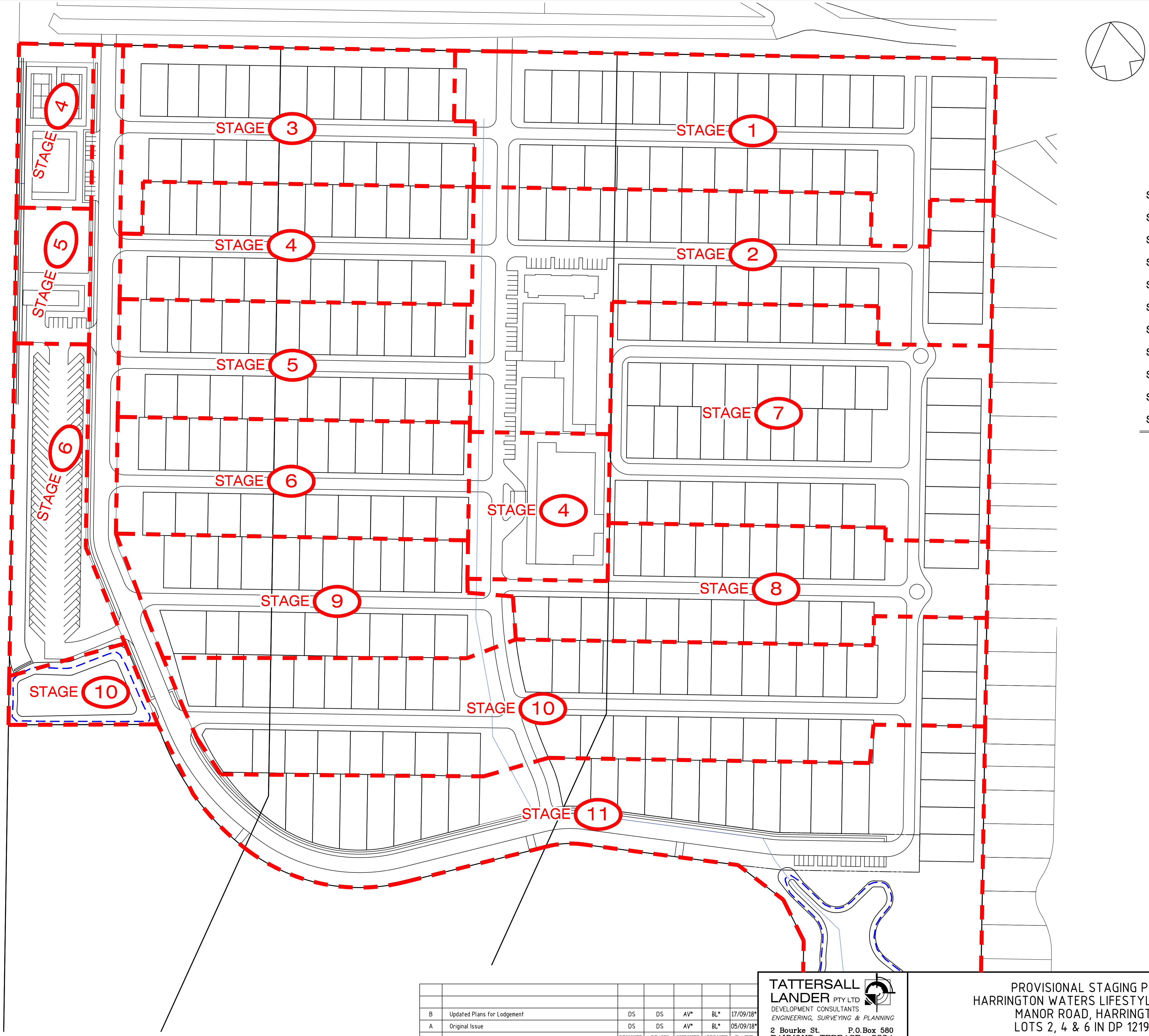
* Denote the original signature and date when revision was issued.

TATTERSALL LANDER PTY LTD
DEVELOPMENT CONSULTANTS
ENGINEERING, SURVEYING & PLANNING
2 Bourke St. P.O.Box 580
RAYMOND TERRACE 2324
Fax (02) 49871733 Phone (02) 49871500

OVERALL LAYOUT PLAN
HARRINGTON WATERS LIFESTYLE VILLAGE
MANOR ROAD, HARRINGTON
LOTS 2, 4 & 6 IN DP 1219123

COUNCIL	REFERENCE
MID COAST	21800139
PARISH	SHEET SIZE A3
SCALE 1:4000 on A3	SHEET No. 2
DATE :	Plotted 11:02 17/09/18

CLIENT: Bayline Developments (NSW) Pty Ltd **JOB No.:** 217154 COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg



STAGE 1 - 29 LOTS
STAGE 2 - 25 LOTS
STAGE 3 - 22 LOTS
STAGE 4 - 21 LOTS
STAGE 5 - 22 LOTS
STAGE 6 - 22 LOTS
STAGE 7 - 40 LOTS
STAGE 8 - 22 LOTS
STAGE 9 - 20 LOTS
STAGE 10 - 45 LOTS
STAGE 11 - 24 LOTS
TOTAL = 292 LOTS

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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TATTERSALL LANDER PTY LTD
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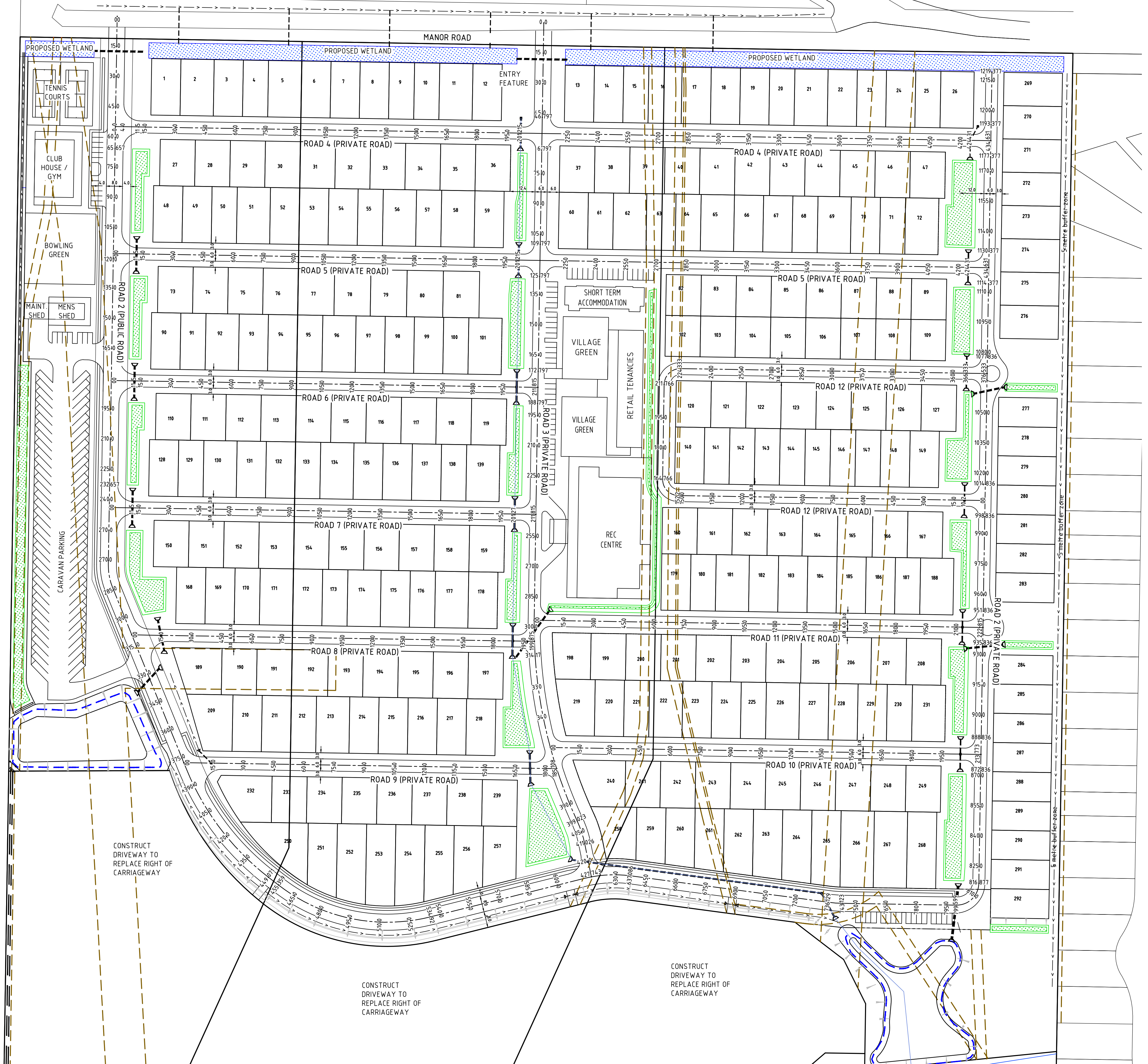
2 Bourke St. P.O.Box 580
RAYMOND TERRACE 2324
Fax (02) 49871733 Phone (02) 49871500

PROVISIONAL STAGING PLAN
HARRINGTON WATERS LIFESTYLE VILLAGE
MANOR ROAD, HARRINGTON
LOTS 2, 4 & 6 IN DP 1219123

COUNCIL: MID COAST	REFERENCE: 21800140
PARISH	SHEET SIZE: A3
SCALE: 1:2000 on A3	SHEET No.: 3
DATE : Plotted 11:03 17/09/18	

CLIENT: Bayline Developments (NSW) Pty Ltd | JOB No.: 217154 | COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg



LEGEND

- PROPOSED PIPE
- PROPOSED DRAIN
- PROPOSED BIOFILTER
- PROPOSED WETLAND

OVERALL DETAIL PLAN

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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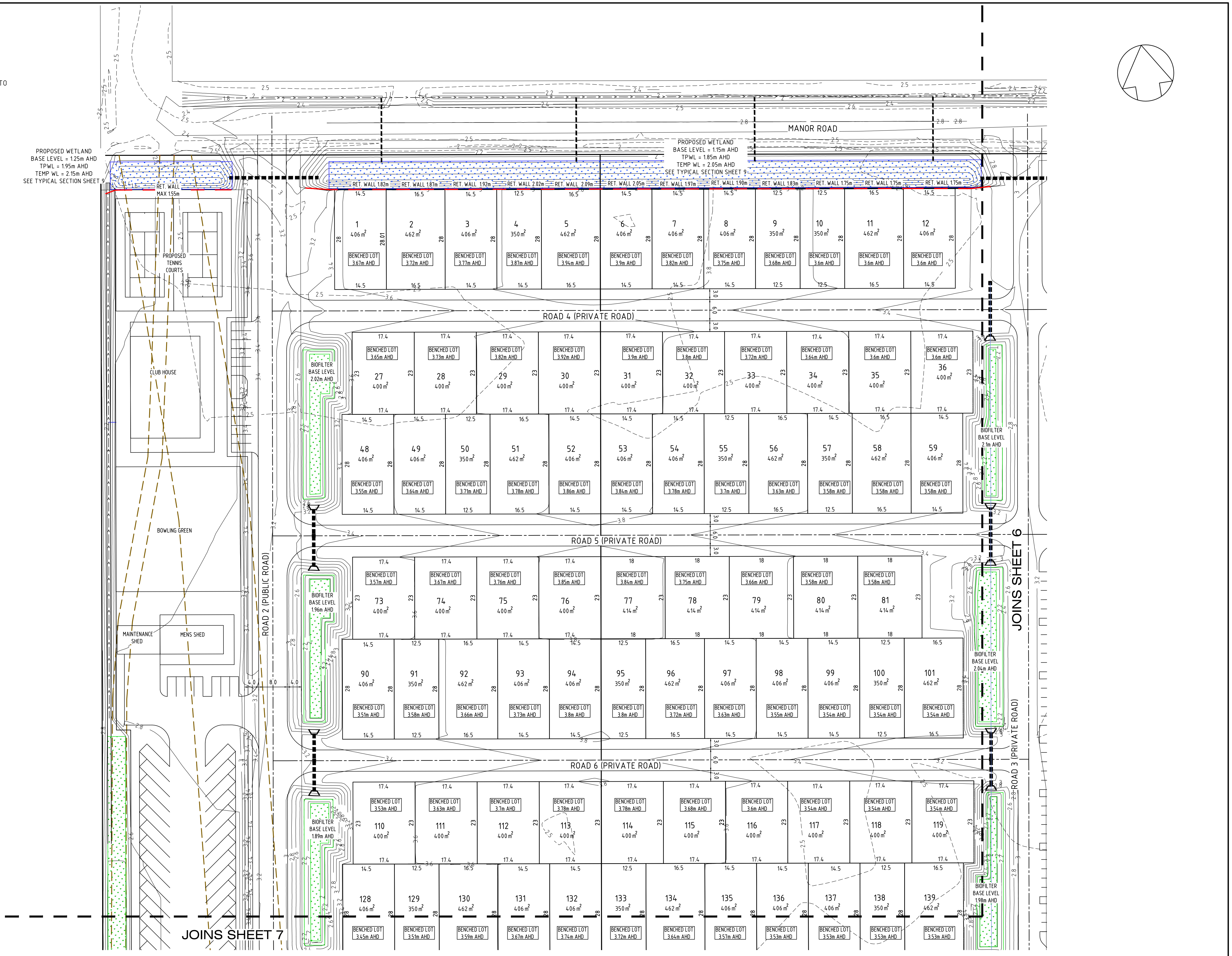
TATTERSALL LANDER Pty Ltd DEVELOPMENT CONSULTANTS

SCALE : 0 10 20m	SHEET No. : 4	FILE : 21800141	SHEET SIZE
1:2000 for A3 sized plot	JOB No. : 217154	DATE : Plotted 11:03 17/09/18	A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

BENCHING NOTES:

1. FINISHED FLOOR LEVEL OF DWELLINGS TO BE 170mm ABOVE BENCHED LOT LEVEL.



B	Updated Plans	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE

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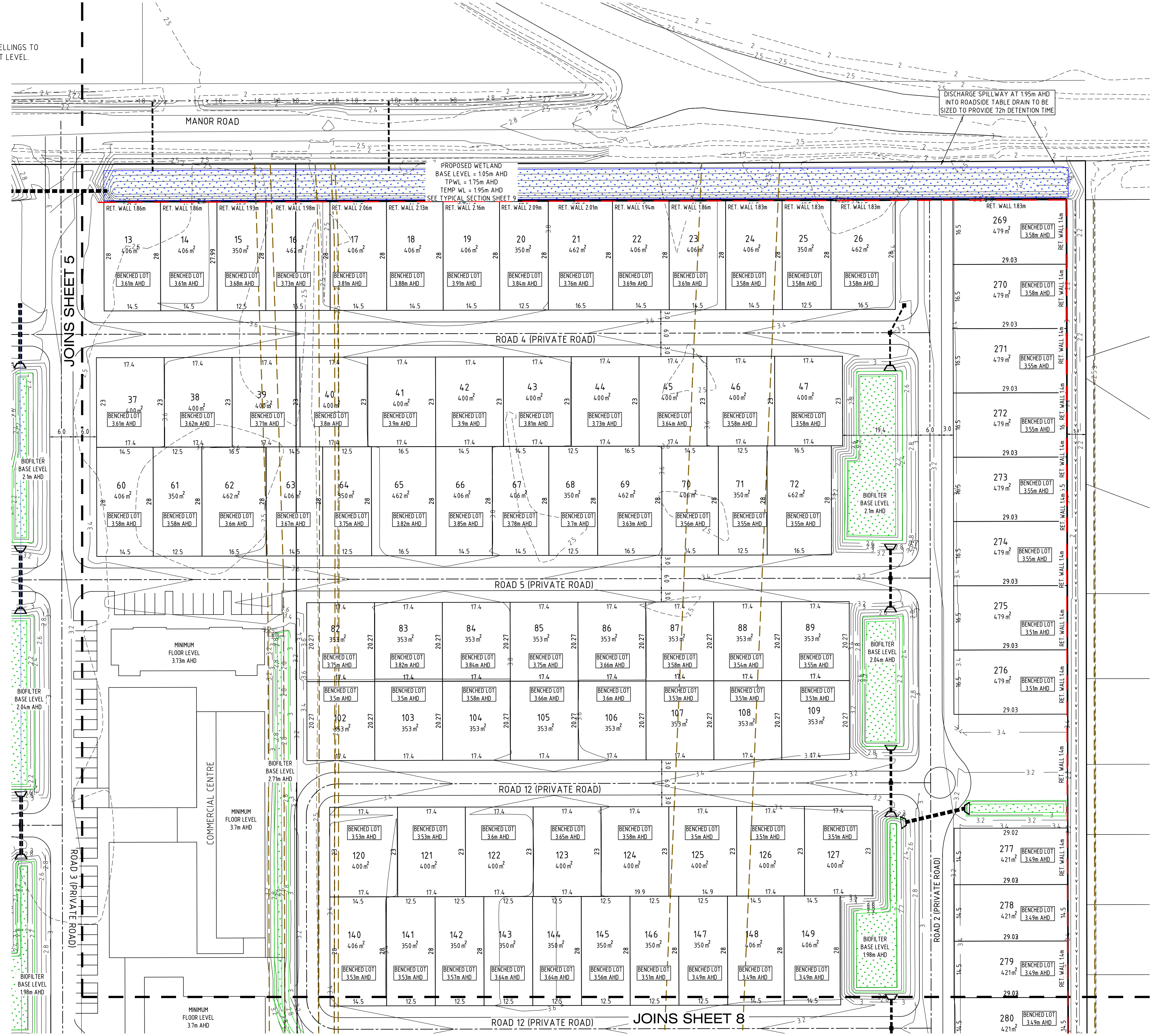
TATTERSALL LANDER Pty Ltd DEVELOPMENT CONSULTANTS

DETAIL PLAN SHEET 1

SCALE: 1:1000 for A3 sized plot | SHEET No. :5 | JOB No. : 217154 | FILE : 21800142 | DATE : Plotted 11:03 17/09/18 | SHEET SIZE A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

BENCHING NOTES:
1. FINISHED FLOOR LEVEL OF DWELLINGS TO BE 170mm ABOVE BENCHED LOT LEVEL.



DETAIL PLAN SHEET 2

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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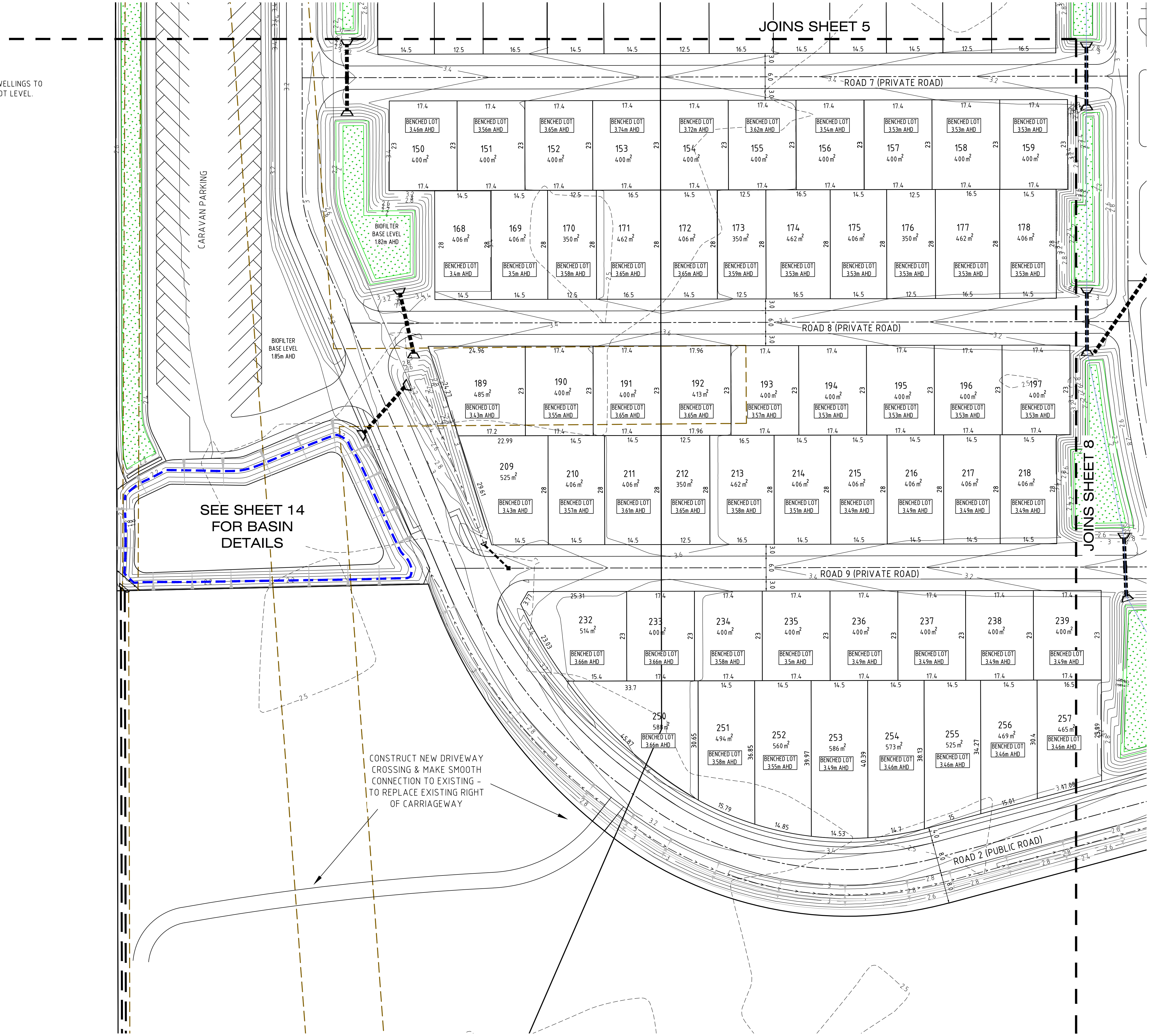
DEVELOPMENT CONSULTANTS

SCALE : 1:2000 for A3 sized plot	SHEET No. : 6	FILE : 21800143	SHEET SIZE
	JOB No. : 217154	DATE : Plotted 11:04 17/09/18	A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

BENCHING NOTES:
1. FINISHED FLOOR LEVEL OF DWELLINGS TO BE 170mm ABOVE BENCHED LOT LEVEL.



REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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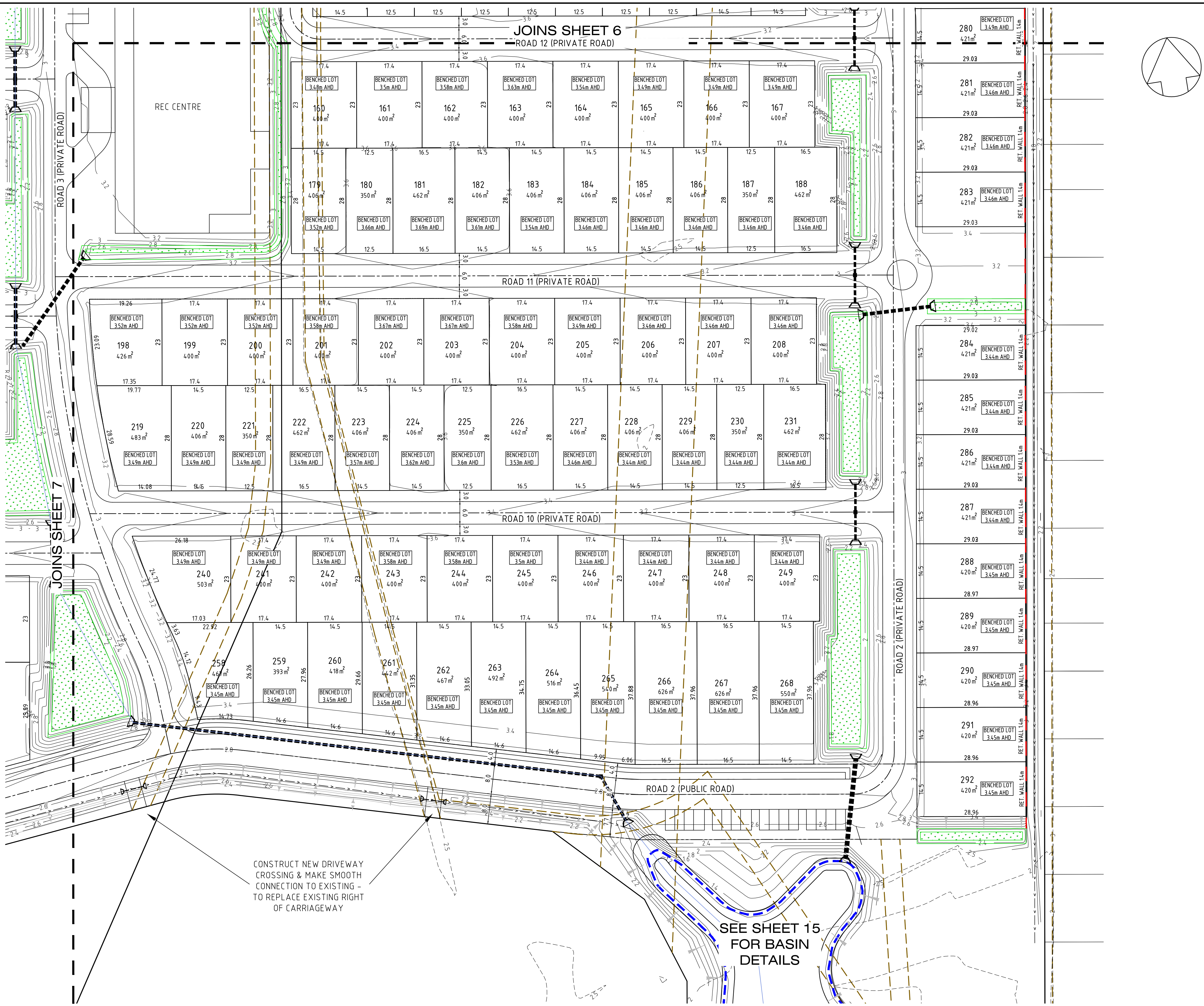
DETAIL PLAN SHEET 3

SCALE : 1:2000 for A3 sized plot
SHEET No. : 7
JOB No. : 217154
FILE : 21800144
DATE : Plotted 11:04 17/09/18
SHEET SIZE A3
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

BENCHING NOTES:
1. FINISHED FLOOR LEVEL OF DWELLINGS TO BE 170mm ABOVE BENCHED LOT LEVEL.



REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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DETAIL PLAN SHEET 4

TATTERSALL LANDER Pty Ltd DEVELOPMENT CONSULTANTS

SCALE : 1:2000 for A3 sized plot	SHEET No. : 8	FILE : 21800145	SHEET SIZE A3
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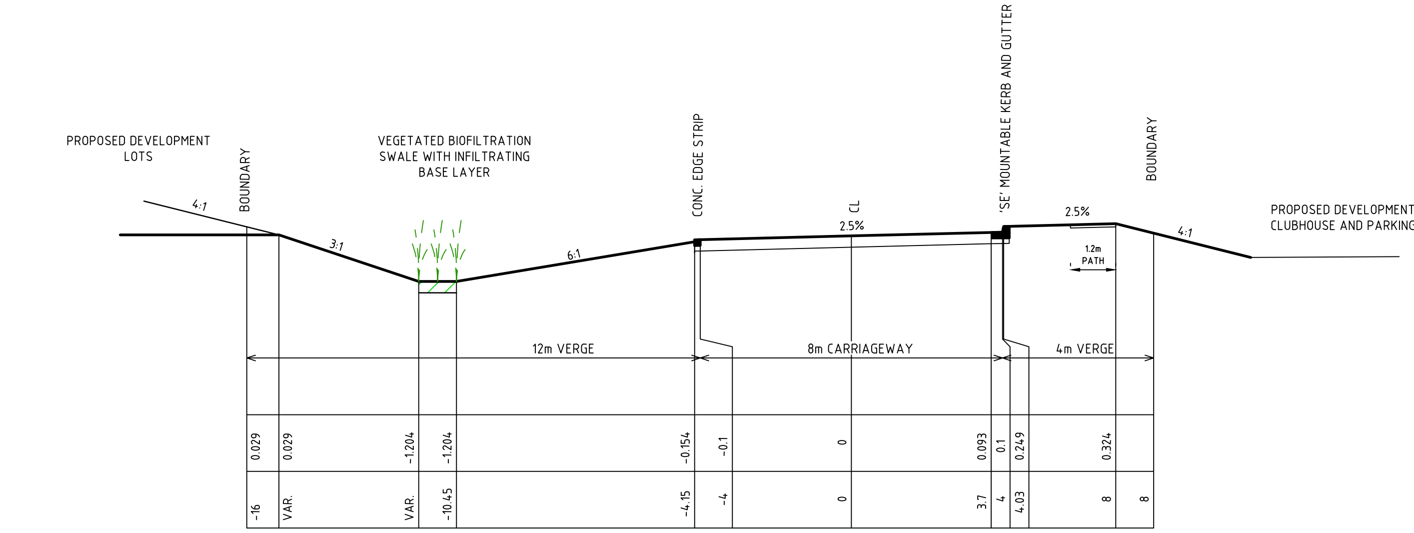
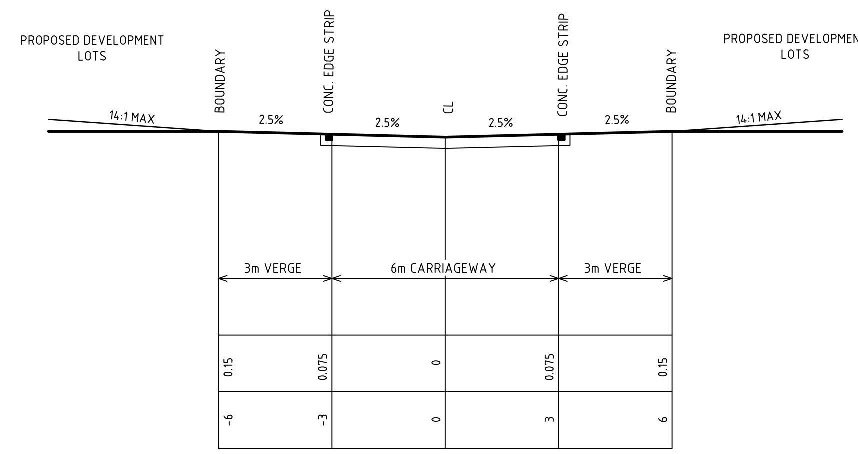


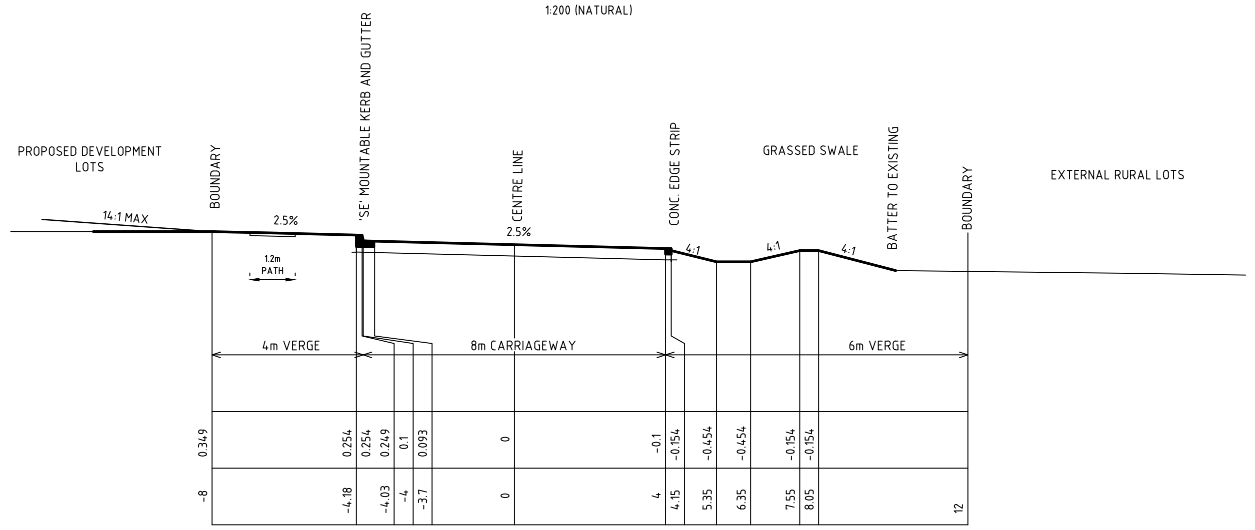
TYPICAL SECTION - ROAD 2 Ch60.0-Ch300

1:200 (NATURAL)



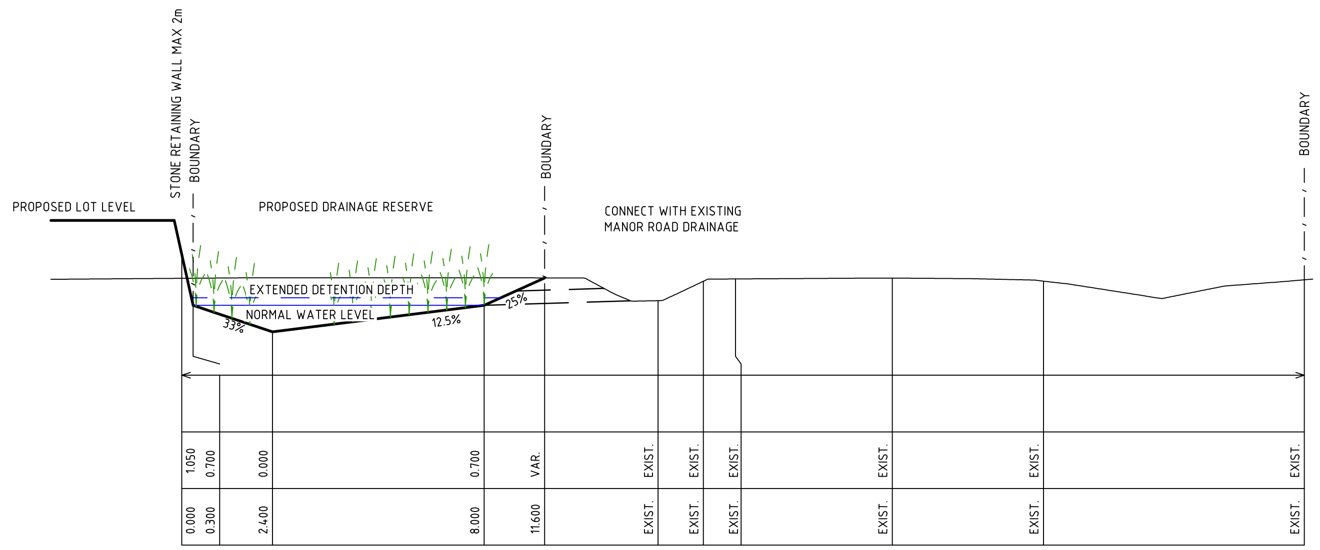
TYPICAL SECTION - ROADS 4 TO 12

1:200 (NATURAL)



TYPICAL SECTION - ROAD 2 Ch405-Ch600

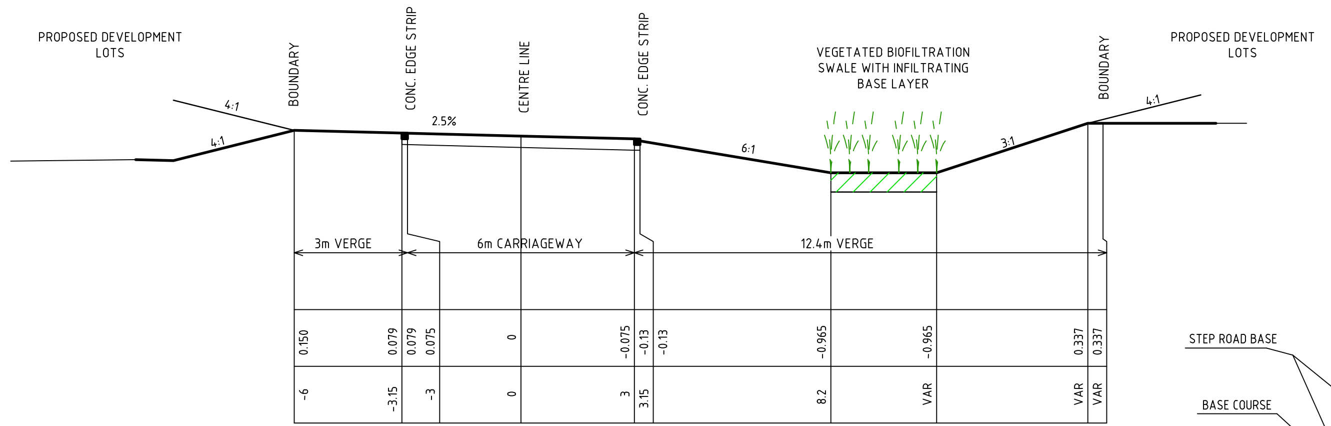
1:200 (NATURAL)



TYPICAL SECTION - MANOR ROAD

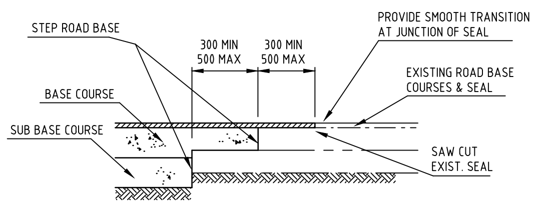
1:200 (NATURAL)

1:200 (NATURAL)



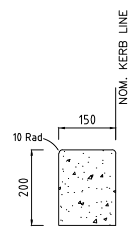
TYPICAL SECTION - ROAD 3 & ROAD 2 Ch799.6-Ch1220 (Mirrored)

1:200 (NATURAL)



KEY JOINT DETAIL BETWEEN NEW & EXISTING PAVEMENT

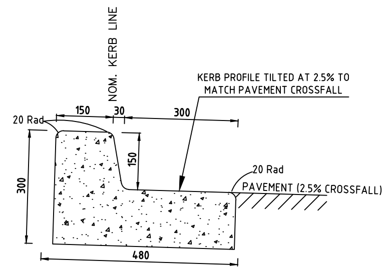
NOT TO SCALE



EDGE STRIP

NOT TO SCALE

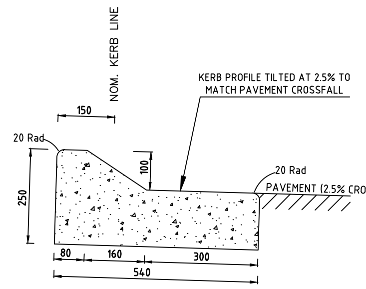
ALL DETAILS PER MCC STD. No.0107



SL - BARRIER KERB

NOT TO SCALE

ALL DETAILS PER MCC STD. N0.0107



SE - MOUNTABLE KERB AND GUTTER

NOT TO SCALE

ALL DETAILS PER MCC STD. N0.0107

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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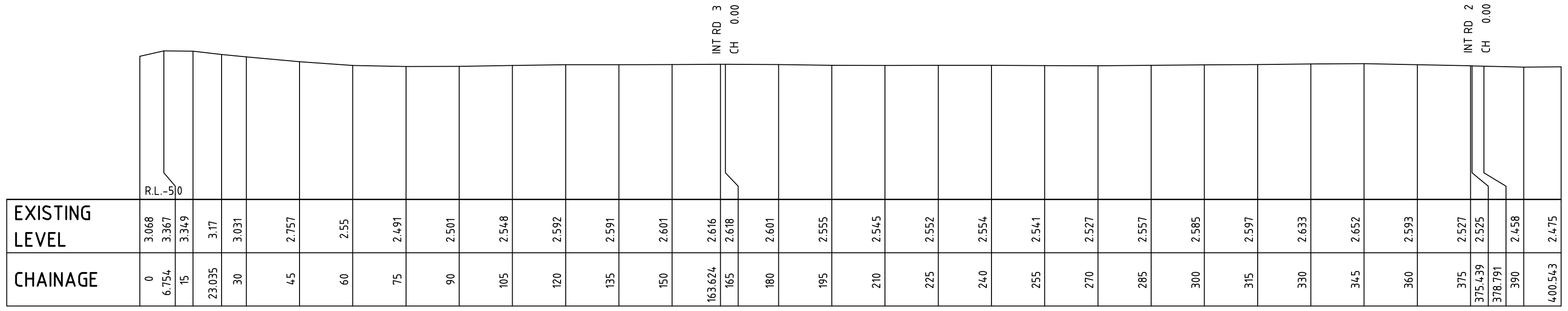
TYPICAL SECTIONS & GENERAL DETAILS

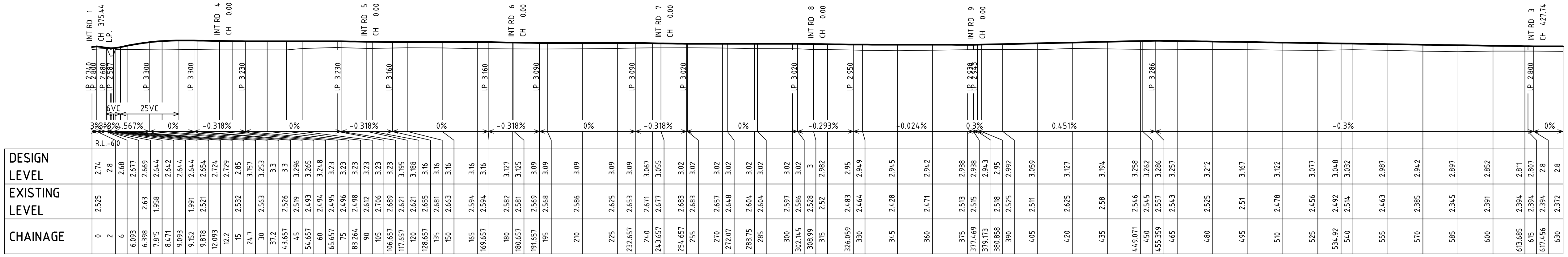
SCALE : AS SHOWN	SHEET No. : 9	FILE : 21800146	SHEET SIZE A3
	JOB No. : 217154	DATE : Plotted 11:04 17/09/18	

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg



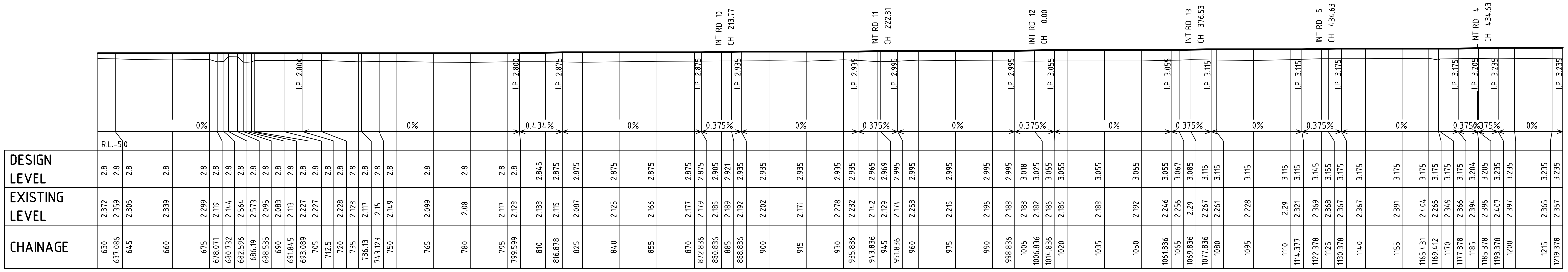
MANOR ROAD - EXISTING

H=1:2000 V=1:400



ROAD.No.2

H=1:2000 V=1:400



ROAD.No.2

H=1:2000 V=1:400

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*
*	Denote the original signature and date when revision was issued.					

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ROAD LONGITUDINAL SECTIONS

SCALE : AS SHOWN	SHEET No. :10	FILE : 21800147	SHEET SIZE A3
	JOB No. : 217154	DATE : Plotted 11:04 17/09/18	
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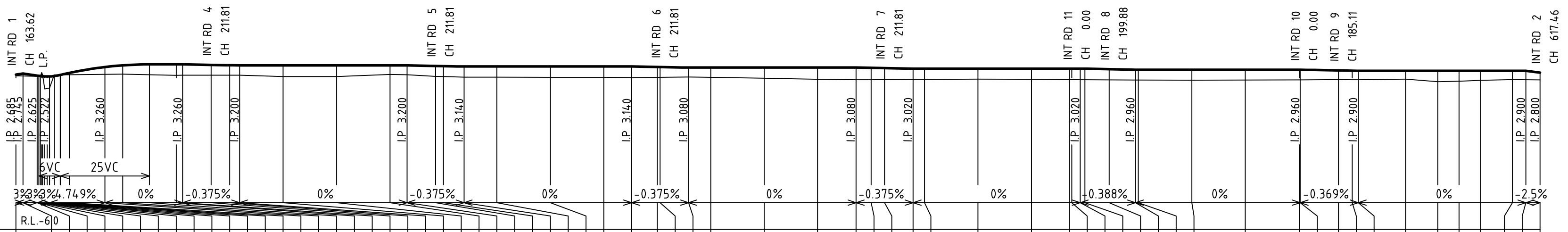
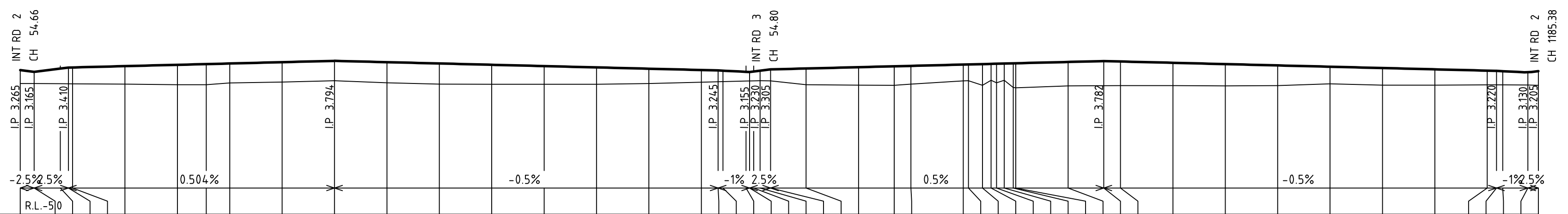


CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
0	2.685	2.616
2	2.745	
6	2.625	
6.454	2.612	
6.856	2.601	2.584
7.257	2.592	2.8
7.513	2.587	2.676
8.114	2.58	1.884
8.777	2.577	
9.449	2.58	1.934
9.454	2.58	
10.771	2.603	2.668
12.454	2.664	
12.5	2.666	
15	2.779	2.679
25	3.112	
30	3.207	2.709
37.5	3.26	
45	3.26	2.643
46.798	3.26	2.652
54.798	3.23	2.655
60	3.211	2.651
62.798	3.2	2.649
75	3.2	2.573
90	3.2	2.576
105	3.2	2.694
109.798	3.2	2.677
117.798	3.17	2.588
120	3.162	2.574
125.798	3.14	2.539
135	3.14	2.538
150	3.14	2.537
165	3.14	2.534
172.798	3.14	2.513
180	3.113	2.527
180.798	3.11	2.532
188.798	3.08	2.552
195	3.08	2.537
210	3.08	2.482
225	3.08	2.423
235.798	3.08	2.399
240	3.064	2.402
243.798	3.05	2.406
251.798	3.02	2.413
255	3.02	2.416
270	3.02	2.429
285	3.02	2.424
295.622	3.02	2.404
296.339	3.02	2.403
298.69	3.02	2.401
300	3.015	2.399
306.802	2.989	2.392
314.171	2.96	2.385
315	2.96	2.384
330	2.96	2.373
345	2.96	2.378
360.191	2.96	2.392
360.425	2.96	2.392
371.16	2.92	2.405
375	2.906	2.398
376.707	2.9	2.402
390	2.9	2.43
399.023	2.9	2.288
405	2.9	2.314
411.026	2.9	2.368
420	2.9	2.404
423.743	2.9	2.401
427.743	2.8	2.394

ROAD.No.3

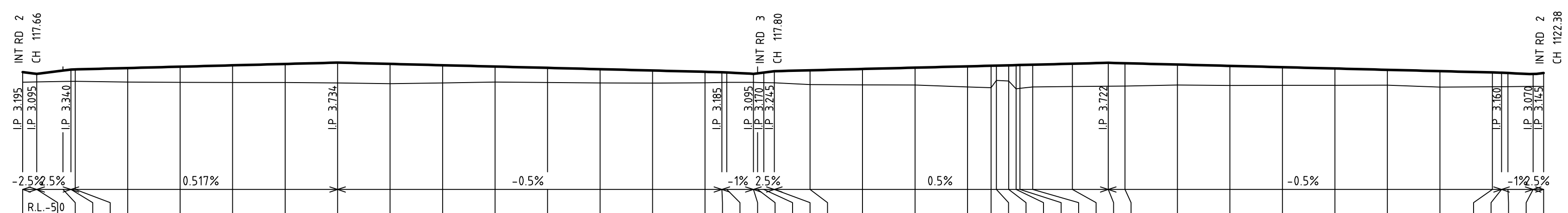
H=1:2000 V=1:400



CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
0	3.265	2.493
4	3.165	2.49
11.5	3.353	2.482
13.8	3.41	
15	3.416	2.478
30	3.492	2.458
45	3.567	2.43
53.291	3.609	2.424
60	3.643	2.526
75	3.718	2.578
90	3.794	2.655
105	3.719	2.537
120	3.644	2.46
135	3.569	2.455
150	3.494	2.451
165	3.419	2.448
180	3.344	2.492
195	3.269	2.569
199.815	3.245	
201.215	3.231	2.601
207.815	3.165	2.635
208.815	3.155	
210	3.185	2.646
211.815	3.23	2.655
214.815	3.305	2.646
225	3.356	2.422
240	3.431	2.402
250.199	3.482	2.391
255	3.506	2.46
270	3.581	2.642
271.467	3.588	2.657
275.487	3.608	2.389
277.94	3.621	2.678
279.513	3.629	2.532
281.709	3.639	2.677
284.281	3.652	2.263
285	3.656	2.251
300	3.731	2.356
310.222	3.782	
315	3.758	2.371
330	3.683	2.375
345	3.608	2.359
360	3.533	2.379
375	3.458	2.478
390	3.383	2.402
405	3.308	2.397
420	3.233	2.414
422.631	3.22	
424.431	3.202	2.419
431.631	3.13	2.406
434.631	3.205	2.396

ROAD.No.4

H=1:2000 V=1:400



CHAINAGE	DESIGN LEVEL	EXISTING LEVEL
0	3.195	2.621
4	3.095	2.634
11.5	3.283	2.658
13.8	3.34	
15	3.346	2.664
30	3.424	2.623
45	3.501	2.605
60	3.579	2.599
75	3.657	2.602
90	3.734	2.571
105	3.659	2.529
120	3.584	2.572
135	3.509	2.626
150	3.434	2.601
165	3.359	2.573
180	3.284	2.569
195	3.209	2.585
199.815	3.185	
201.215	3.171	2.61
208.815	3.095	2.607
210	3.125	2.599
211.815	3.17	2.588
214.815	3.245	2.582
225	3.296	2.478
240	3.371	2.461
255	3.446	2.459
270	3.521	2.346
276.742	3.555	2.303
278.253	3.562	2.718
281.781	3.58	2.683
283.895	3.59	2.24
285	3.596	2.267
288.614	3.614	2.35
300	3.671	2.371
310.222	3.722	
315	3.698	2.396
330	3.623	2.458
345	3.548	2.434
360	3.473	2.436
375	3.398	2.438
390	3.323	2.451
405	3.248	2.337
420	3.173	2.355
422.631	3.16	
424.431	3.142	2.365
431.631	3.07	2.377
434.631	3.145	2.369

ROAD.No.5

H=1:2000 V=1:400

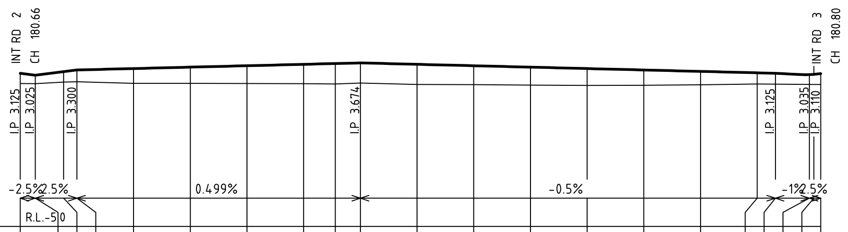
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

* Denote the original signature and date when revision was issued.

ROAD LONGITUDINAL SECTIONS

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

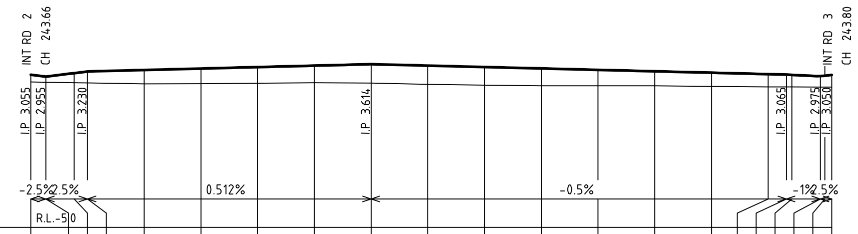
SCALE : AS SHOWN	SHEET No. :11	FILE : 21800148	SHEET SIZE A3
	JOB No. : 217154	DATE : Plotted 11:05 17/09/18	
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg			



DESIGN LEVEL	3.125	3.025	3.213	3.3	3.375	3.45	3.524	3.599	3.641	3.674	3.599	3.524	3.449	3.374	3.299	3.224	3.149	3.125	3.035	3.065	3.11
EXISTING LEVEL	2.581	2.569	2.655	2.674	2.586	2.59	2.581	2.57	2.555	2.609	2.529	2.521	2.496	2.483	2.49	2.512	2.554			2.528	2.532
CHAINAGE	0	4	11.5	15	30	45	60	75	83.369	90	105	120	135	150	165	180	195	199.815	208.815	210	211.815

ROAD.No.6

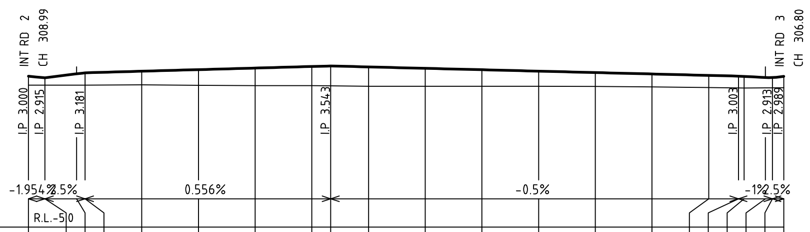
H=1:2000 V=1:400



DESIGN LEVEL	3.055	2.955	3.143	3.23	3.307	3.384	3.46	3.537	3.614	3.539	3.464	3.389	3.314	3.239	3.164	3.089	3.065	3.05	2.975	3.005	3.05
EXISTING LEVEL	2.677	2.663	2.636	2.624	2.575	2.583	2.606	2.632	2.615	2.548	2.507	2.476	2.471	2.474	2.443	2.418		2.413	2.407	2.406	2.406
CHAINAGE	0	4	11.5	15	30	45	60	75	90	105	120	135	150	165	180	195	199.815	201.27	208.815	210	211.815

ROAD.No.7

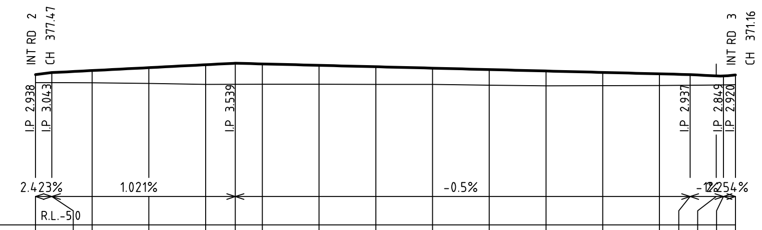
H=1:2000 V=1:400



DESIGN LEVEL	3	2.915	3.125	3.181	3.265	3.348	3.432	3.515	3.543	3.493	3.418	3.343	3.268	3.193	3.118	3.043	3.003	2.988	2.932	2.914	2.989
EXISTING LEVEL	2.528	2.526	2.522	2.523	2.539	2.515	2.504	2.498		2.469	2.468	2.465	2.466	2.459	2.434	2.398		2.375	2.379	2.384	2.392
CHAINAGE	0	4.348	12.741	15	30	45	60	75	80	90	105	120	135	150	165	180	187.875	189.39	195	196.872	199.875

ROAD.No.8

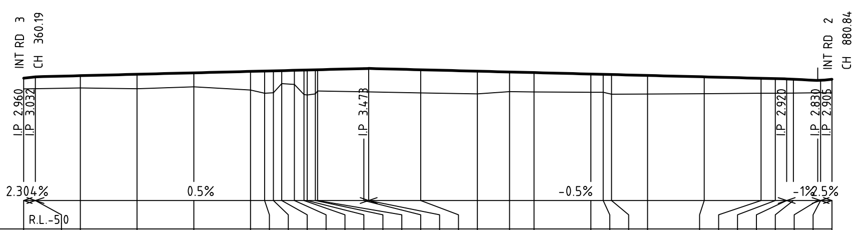
H=1:2000 V=1:400



DESIGN LEVEL	2.938	3.043	3.152	3.305	3.458	3.539	3.503	3.428	3.353	3.278	3.203	3.128	3.053	2.978	2.937	2.868	2.849	2.92
EXISTING LEVEL	2.515	2.513	2.506	2.468	2.423		2.433	2.429	2.421	2.418	2.379	2.346	2.355	2.364		2.388		2.405
CHAINAGE	0	4.348	15	30	45	52.862	60	75	90	105	120	135	150	165	173.108	180	181.938	185.108

ROAD.No.9

H=1:2000 V=1:400

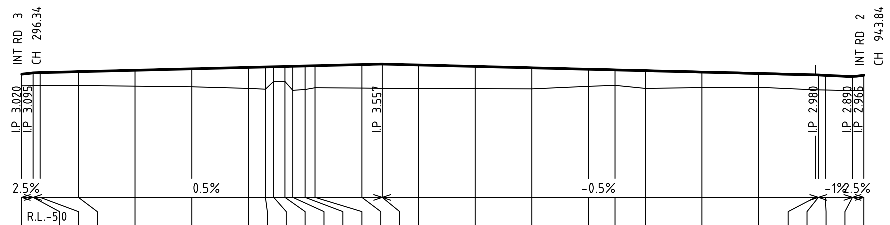


DESIGN LEVEL	2.96	3.032	3.091	3.166	3.241	3.316	3.335	3.347	3.358	3.374	3.387	3.391	3.402	3.405	3.466	3.473
EXISTING LEVEL	2.392		2.443	2.405	2.507	2.334	2.163	2.187	2.669	2.631	2.095	2.074	2.129	2.281	2.242	
CHAINAGE	0	3.125	15	30	45	60	63.723	66.056	68.275	71.597	74.14	75	77.141	77.746	90	91.249

DESIGN LEVEL	3.404	3.329	3.286	3.254	3.179	3.163	3.151	3.104	3.029	2.954	2.935	2.92	2.902	2.838	2.83	2.905
EXISTING LEVEL	2.183	2.129	2.249	2.228	2.214	2.216	2.114	2.123	2.139	2.163	2.168		2.175	2.186	2.187	2.185
CHAINAGE	105	120	128.523	135	150	153.269	155.483	165	180	195	198.773	201.773	203.573	210	210.773	213.773

ROAD.No.10

H=1:2000 V=1:400



DESIGN LEVEL	3.02	3.095	3.104	3.155	3.23	3.305	3.38	3.402	3.414	3.428	3.439	3.455	3.468	3.53	3.557
EXISTING LEVEL	2.403		2.417	2.42	2.387	2.354	2.268	2.229	2.644	2.632	2.172	2.211	2.308	2.287	
CHAINAGE	0	3	4.871	15	30	45	60	64.487	66.712	69.668	71.725	75	77.635	90	95.407

DESIGN LEVEL	3.509	3.434	3.359	3.284	3.249	3.209	3.134	3.059	2.984	2.98	2.962	2.89	2.965
EXISTING LEVEL	2.256	2.251	2.241	2.381	2.434	2.27	2.312	2.333	2.196		2.183	2.15	2.142
CHAINAGE	105	120	135	150	157.005	165	180	195	210	210.815	212.615	219.815	222.815

ROAD.No.11

H=1:2000 V=1:400

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

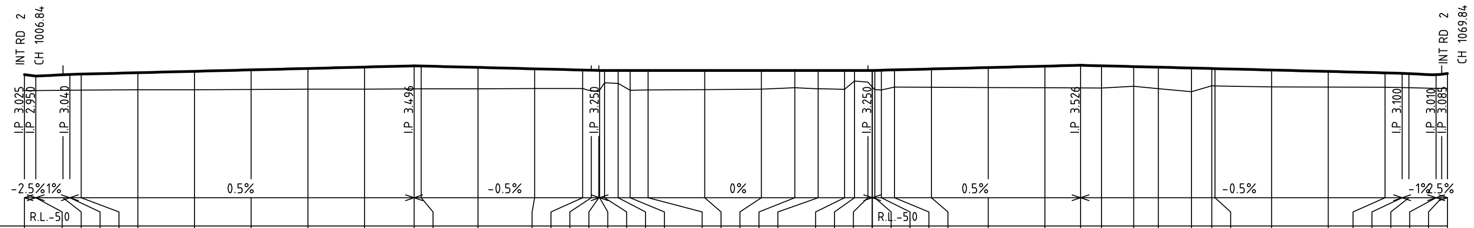
* Denote the original signature and date when revision was issued.

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

ROAD LONGITUDINAL SECTIONS

SCALE : AS SHOWN	SHEET No. :12	FILE : 21800149	SHEET SIZE
	JOB No. : 217154	DATE : Plotted 11:05 17/09/18	A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg



DESIGN LEVEL	3.025	2.95	3.022	3.04	3.055	3.13	3.205	3.28	3.355	3.43	3.496	3.486	3.411	3.336	3.272	3.261	3.251
EXISTING LEVEL	2.182	2.186	2.197		2.204	2.223	2.225	2.24	2.262	2.258		2.274	2.276	2.296	2.295	2.156	2.143
CHAINAGE	0	3	10.2	12	15	30	45	60	75	90	103.1	105	120	135	147.718	150	151.983

DESIGN LEVEL	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.253	3.262	3.279	3.328
EXISTING LEVEL	2.208	2.599	2.559	2.197	2.22	2.237	2.257	2.338	2.276	2.249	2.69	2.63	2.369	2.234	2.213	2.365	2.357
CHAINAGE	152.2	153.506	157.109	160.279	165	180	195	203.83	210	216.995	219.643	223.196	224.333	225	226.732	230.204	240

DESIGN LEVEL	3.403	3.478	3.526	3.498	3.455	3.423	3.379	3.352	3.348	3.273	3.198	3.123	3.1	3.082	3.01	3.047	3.085
EXISTING LEVEL	2.345	2.332		2.321	2.412	2.285	2.124	2.44	2.429	2.373	2.369	2.361		2.334	2.303	2.297	2.29
CHAINAGE	255	270	279.434	285	293.508	300	308.783	314.149	315	330	345	360	364.533	366.333	373.533	375	376.533

ROAD.No.12

H=1:2000 V=1:400

B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE

* Denote the original signature and date when revision was issued.

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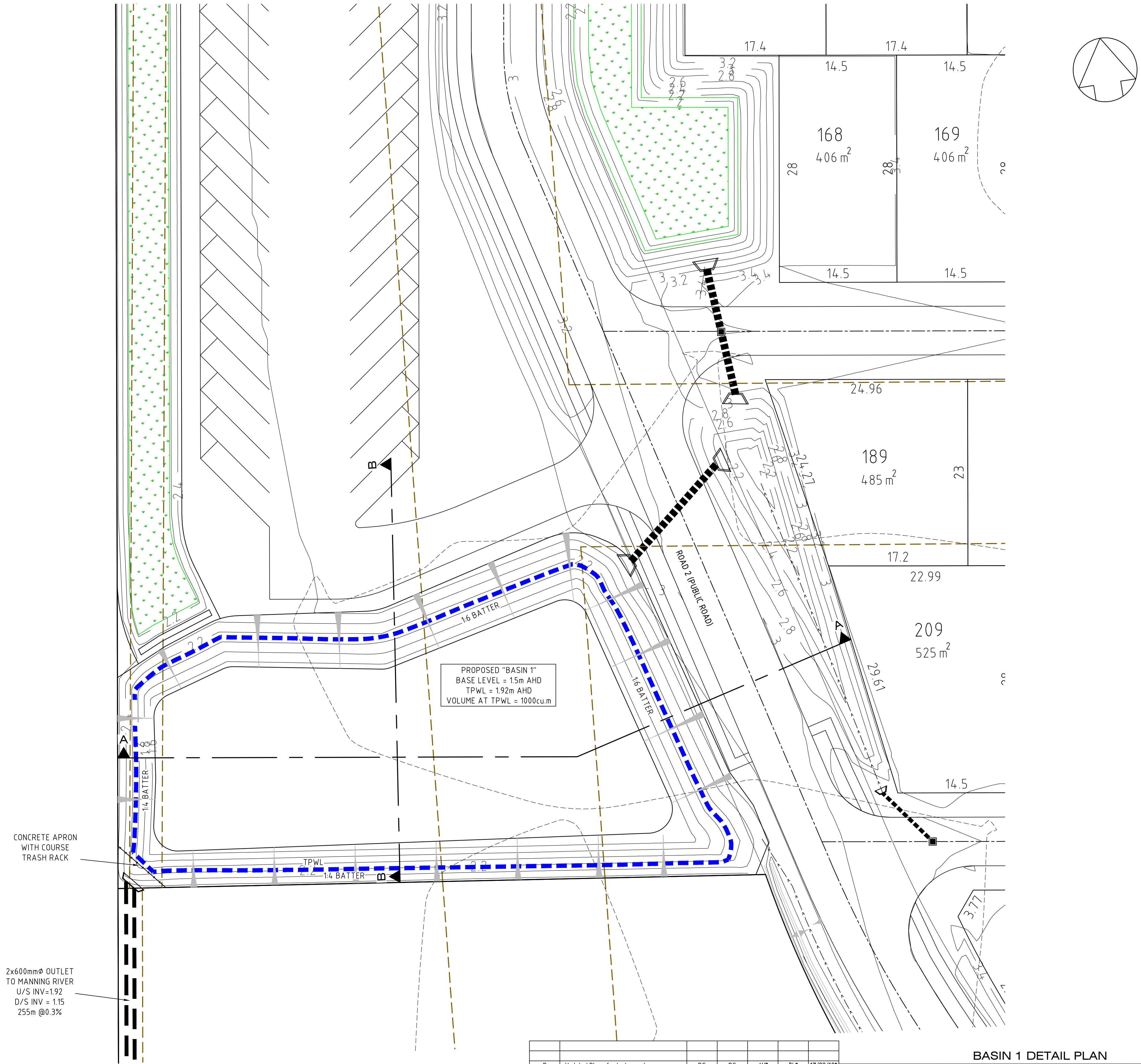
ROAD LONGITUDINAL SECTIONS

SCALE : AS SHOWN	SHEET No. :13	FILE : 21800150	SHEET SIZE
	JOB No. : 217154	DATE : Plotted 11:05 17/09/18	A3
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg			



REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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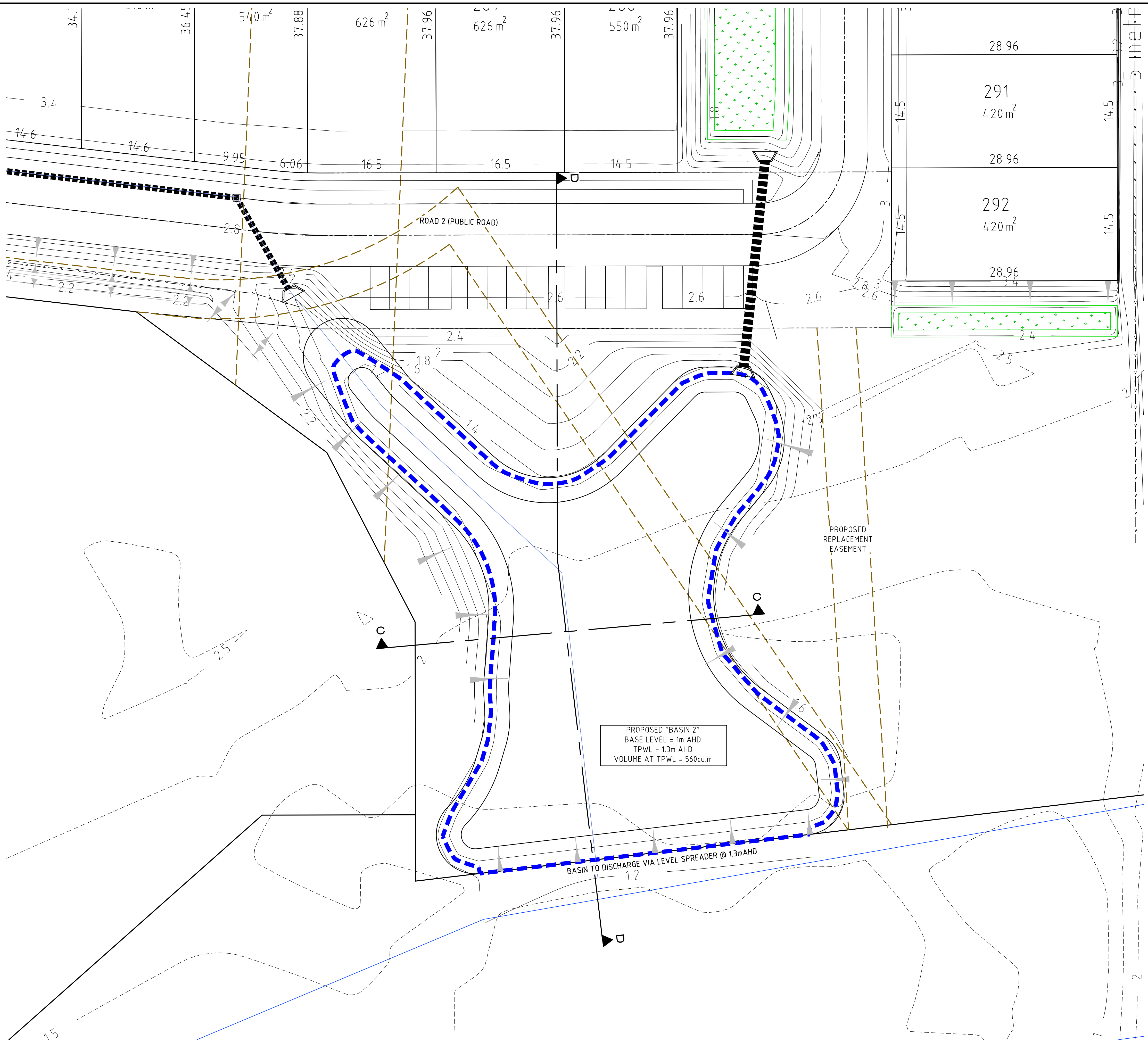
BASIN 1 DETAIL PLAN

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

SCALE : 0 10 20m 1:2000 for A3 sized plot	SHEET No. :14 JOB No. : 217154	FILE : 21800151 DATE : Plotted 11:05 17/09/18	SHEET SIZE A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg



BASIN 2 DETAIL PLAN

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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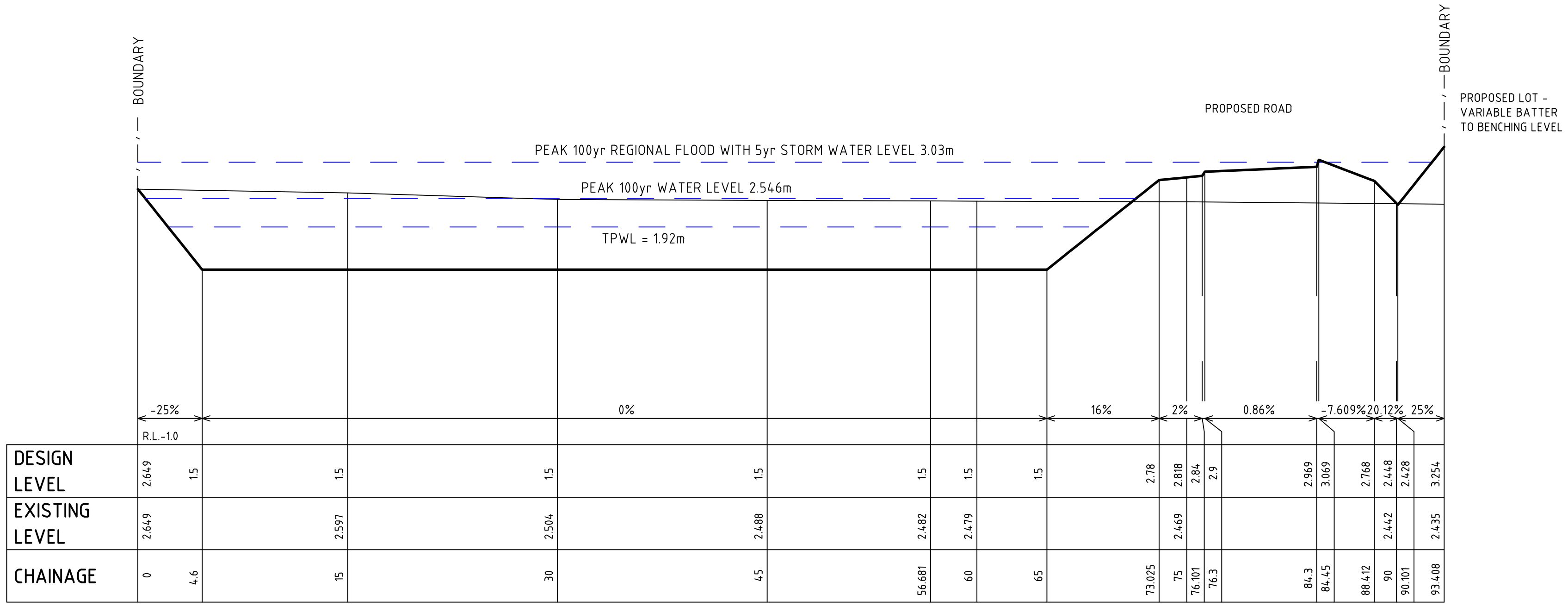
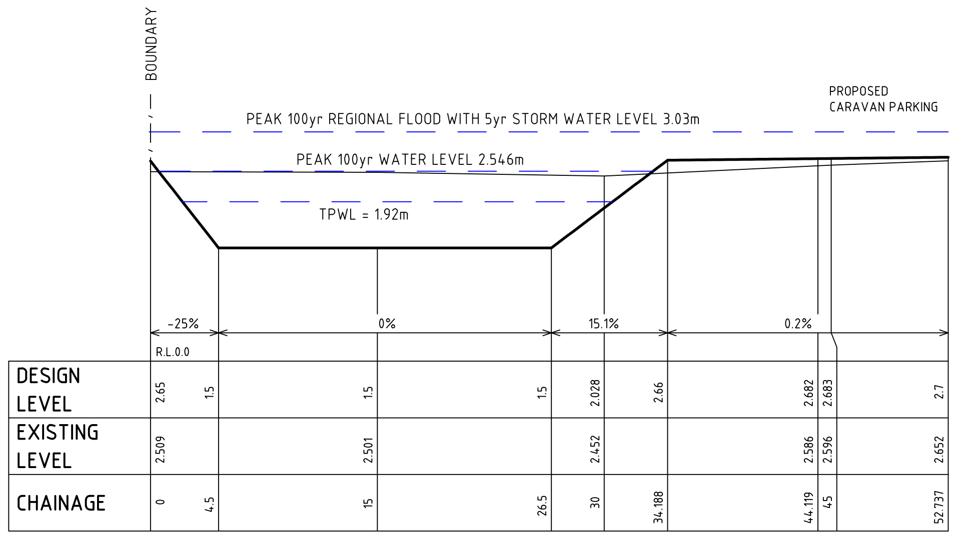
DEVELOPMENT CONSULTANTS

SCALE : 0 10 20m 1:2000 for A3 sized plot	SHEET No. :15	FILE : 21800152	SHEET SIZE
	JOB No. : 217154	DATE : Plotted 11:06 17/09/18	A3
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg			



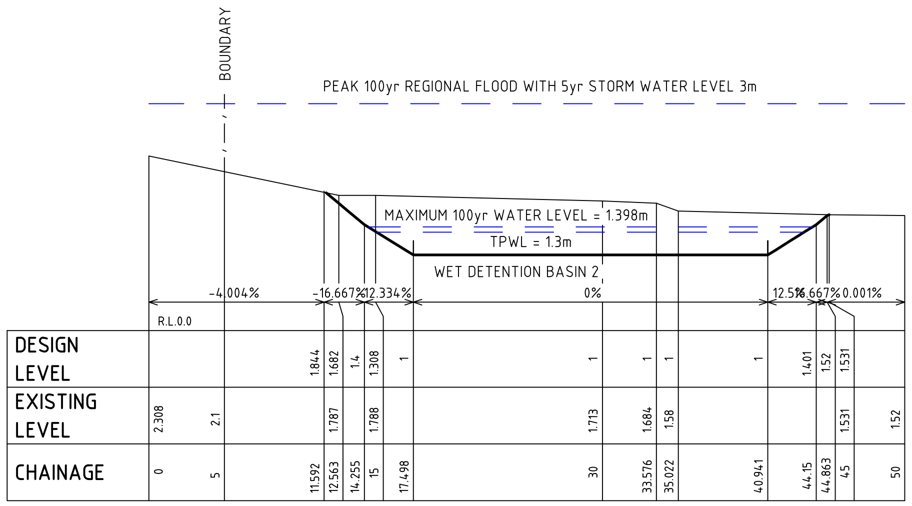
SECTION A

H=1:500 V=1:100



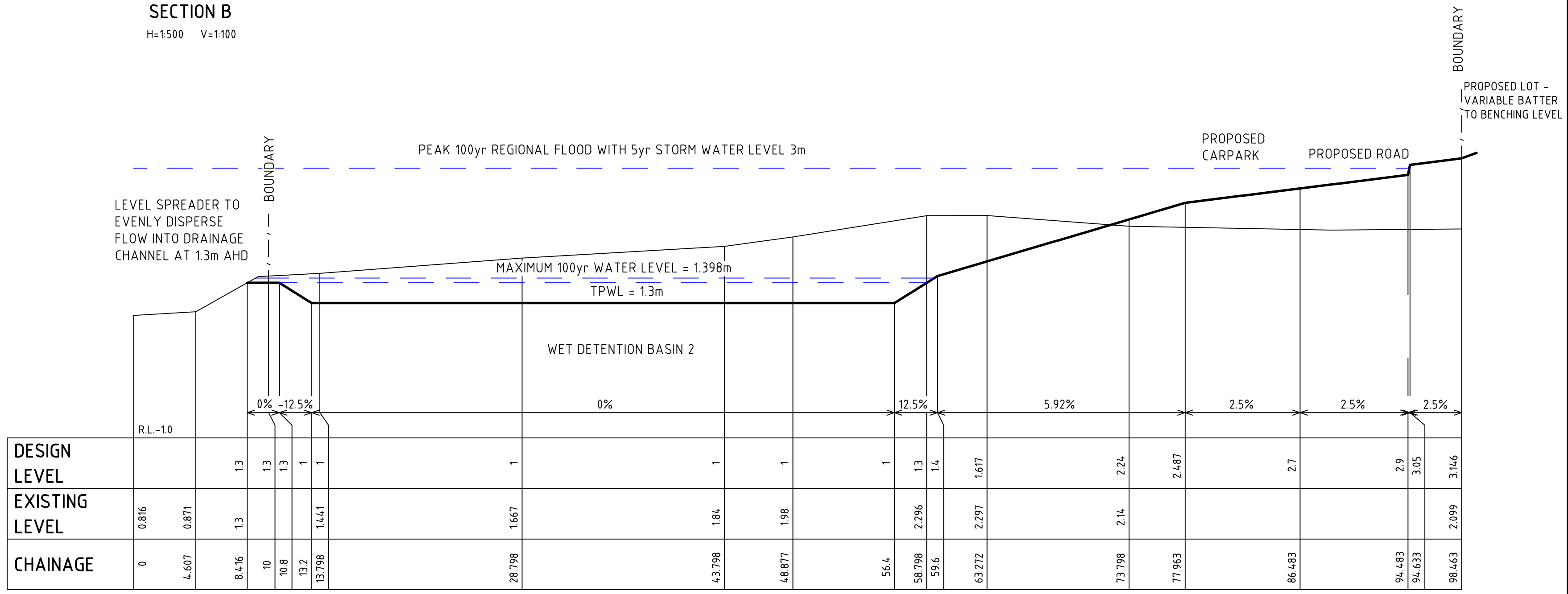
SECTION B

H=1:500 V=1:100



SECTION C

H=1:500 V=1:100



SECTION D

H=1:500 V=1:100

B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*
REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE

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TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

BASIN SECTIONS

SCALE : 0 10 20m
1:2000 for A3 sized plot

SHEET No. :16

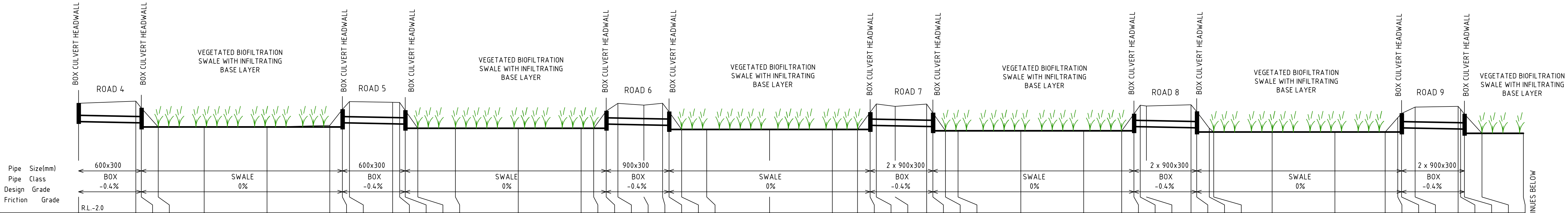
JOB No. : 217154

FILE : 21800153

DATE : Plotted 11:06 17/09/18

SHEET SIZE A3

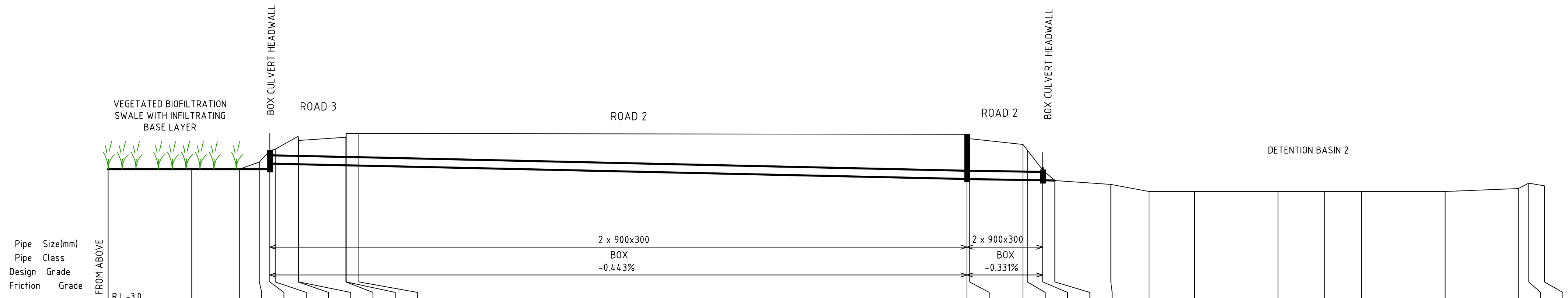
COMPUTER FILE : S:\projects\Harrington\dwg\217154_ Harrington DA Plans.dwg



PIPE CHAINAGE	INVERT LEVEL	SURFACE LEVEL
0	2.36	3.234
13.68		3.337
15.001	2.3	3.005
19.042	2.1	2.1
30		2.1
45		2.1
60		2.175
63	2.1	2.938
64.704	2.3	3.315
75		3.283
76.675		3.271
78.001	2.24	2.894
81.005	2.04	2.04
90		2.04
105		2.04
120		2.04
123.002		2.04
126.001	2.04	2.862
128.79	2.24	3.229
135		3.148
139.46		3.235
141	2.18	2.829
144.004	1.98	1.98
150		1.98
165		1.98
180		1.98
186.001		1.98
189.015	1.98	2.797
190.504	2.18	3.2
195		3.088
202.51		3.198
204	2.12	2.774
207	1.92	1.921
210		1.92
225		1.92
240		1.92
249.076		1.92
252	1.92	2.724
253.506	2.12	3.14
255		3.103
265.647		3.163
267	2.06	2.838
270	1.86	2.041
271.056		1.86
285		1.86
300		1.86
312.004		1.86
315		2.544
315.912	1.86	2.749
319.155	2.06	3.051
329.425		3.088
330		2.945
330.912	2	2.719
335.111	1.8	1.8
345		1.8

ROAD 3 DRAINAGE LINE

H=1:500 V=1:100



PIPE CHAINAGE	INVERT LEVEL	DESIGN LEVEL
345		1.8
360		1.8
368.554		1.8
372.143		2.057
374.017	1.8	2.468
375	2	2.517
379.098		2.978
379.21		2.83
387.676		2.946
387.738		3.085
390		3.082
499.164	1.445	3.051
499.659		2.893
509.217		2.689
510		2.486
512.747	1.4	1.772
514.943		1.393
525		1.254
531.847		1
540		1
555		1
563.362		1
570		1
585		1
598.116		1.105
600		1.3
602.832		1.2

ROAD 3 DRAINAGE LINE

H=1:500 V=1:100

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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TYPICAL DRAINAGE SECTION

SCALE : AS SHOWN
SHEET No. :17
JOB No. : 217154
FILE : 21800154
DATE : Plotted 11:06 17/09/18
SHEET SIZE A3
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

	-1.5m to -1m
	-1m to -0.5m
	-0.5m to 0m
	0m to 0.5m
	0.5m to 1m
	1m to 1.5m

VOLUME SUMMARY

CUT	=	11,750 m³
FILL	=	197,200 m³
SELECT IMPORT	=	20,000 m³
NET	=	165,450 m³ SHORTFALL

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

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CUT FILL PLAN

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

SCALE : 0 10 20m
1:2000 for A3 sized plot

SHEET No. :18

JOB No. : 217154

FILE : 21800155

DATE : Plotted 11:06 17/09/18

SHEET SIZE A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

STANDARD SYMBOLS
EROSION AND SEDIMENT CONTROL PLANS

Construction Barrier Fencing	BF
Sediment Fence	
Straw Bale Sediment Filter	
Soil Stock Pile	S.S.P. 1
Extent Of Works	EW

NOTE

FINAL LOCATION OF TEMPORARY SOIL STOCKPILE TO BE APPROVED BY COUNCIL PRIOR TO CONSTRUCTION

TYPICAL SOIL & WATER MANAGEMENT PLAN

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

* Denote the original signature and date when revision was issued.

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

SCALE : 0 10 20m
1:2000 for A3 sized plot

SHEET No. :19
JOB No. : 217154
FILE : 21800156
DATE : Plotted 11:07 17/09/18
SHEET SIZE A3

COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg

SOIL & WATER MANAGEMENT NOTES

1. This plan is to be read in conjunction with other engineering plans and any written instructions that may be issued.

2. The contractor shall implement all soil erosion and sediment control measures prior to disturbance of the related catchment area and to the satisfaction of the Superintendent.

3. All positions shown are indicative only and are best determined on site in conjunction with the superintendent. Variations will be permitted to best suit the circumstances.

4. Cleared vegetation must be disposed of by :-
i) chipping or mulching for future landscaping and usage, or
ii) transport to an approved landfill facility.

5. Temporary crossbanks (bunds constructed with earth, straw bales or sandbags), shall be constructed during roadworks to limit slope length, where possible, to 80 metres. These shall be constructed immediately prior to forecast rain and during temporary closure of the site, including weekends.

6. Temporary rehabilitation should be undertaken on disturbed areas where works have stopped and soils are expected to remain exposed for two months.

7. Sediment barriers (e.g. sandbags or straw bales) should be located upstream of stormwater inlet pits prior to the road surface being paved and lands upslope being rehabilitated.

8. At the conclusion of each day sand bags are to be placed at the end of completed sections of road pavement to prevent scouring.

9. The contractor will inspect all erosion and pollution control works at least weekly and following every rainfall event greater than 5mm, providing particular attention to the following matters :
(a) Ensure drains operate effectively and initiate repair as required.
(b) Remove spilled sand (or other materials) from hazard areas, including lands closer than 5 metres from likely areas of concentrated or high velocity flows such as waterways and paved areas.
(c) Ensure rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate.
(d) Construct additional erosion and/or sediment control works as might become necessary to ensure the desired protection is given to downslope lands and waterways, i.e.,make ongoing changes to the plan.
(e) Maintain erosion and sediment control measures in a functioning condition until all earthwork activities are completed and the site is rehabilitated.
(f) Remove temporary soil conservation structures as a last activity in the rehabilitation program.

10. Utilise a single access only to the stock pile sites.

11. Drop inlets which do not outlet to silt traps shall be blocked until all works are completed.

12. Limit disturbed areas on site as much as possible at any one time, and stabilise competed areas as soon as practicable. Lands where works are not to continue for more than 20 working days must be rehabilitated. Such rehabilitation shall involve the spraying of a straw-bitumen mulch to the disturbed lands or equivalent.

13. Access areas limited to a maximum width of 10 (preferably 5) metres.

14. Conformity with this plan shall in no way reduce the responsibility of the Contractor to protect against water damage during the course of the contract.

15. Topsoil and spoil shall be stockpiled in non-hazard areas and protected from surface run-off by diversion drains or similar. Stockpiles shall be surrounded on downstream sides by silt fencing. Stockpiles shall be suitably compacted to inhibit erosion. Where the stockpiling period exceeds four (4) weeks, the stockpile shall be seeded to encourage vegetation growth.

16. Topsoil shall be respread and stabilised as soon as possible. Disturbed areas shall be left with a scarified surface to encourage water infiltration and assist keying in topsoil.

17. The contractor shall provide a turf strip behind all kerb and gutter at completion of footpath formation.

18. The contractor shall maintain grass cover until all works have been completed including the maintenance period, by frequent watering and mowing where required.

19. All drainage works shall be constructed and stabilised as quickly as possible to minimise risk of erosion.

20. Vehicular traffic shall be controlled during construction confining access where possible to proposed or existing road alignments plus 3 metres. Areas to be left undisturbed shall be marked off.

21. Site access shall be restricted to a nominated point. The construction of a shake-down area will be required at the entry to the site.

22. Facilities and/or equipment must be provided for the application of water to disturbed areas to minimise the generation of airborne dust from any area disturbed by construction activities.

23. Material removed from sediment control structures must be disposed of in a way that does not pollute waters or bushland.

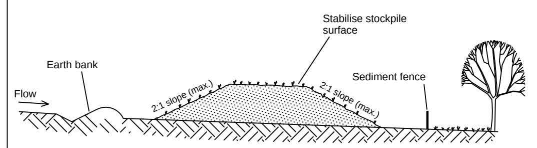
24. Waste disposal containers must be provided on site for the collection and disposal of all industrial and domestic type wastes generated on site.

25. Concrete wastes or washings from any concrete mixture or deliveries must not be deposited in any location where they can flow or be washed into waters.

26. Runoff from vehicle, construction plant or mobile plant maintenance and cleaning areas must be contained, collected and disposed of in a manner to prevent entry into any waters, including sediment retention ponds.

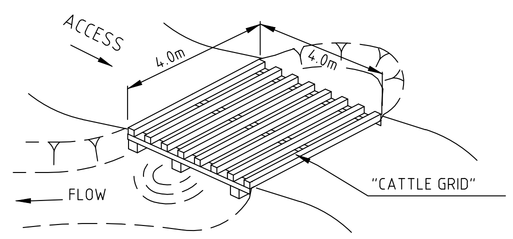
27. Fuelling of vehicles and construction plant must be carried out with an operator or driver present, and in a way that prevents any spillage occurring.

28. Prior to the controlled discharge (e.g. de-watering activities from excavations and sediment basins) of any water (groundwater or sediment laden water) from the site during construction, the following water quality objectives shall be achieved:
   * not exceed Total Suspended Solids of 50mg/L
   * not exceed Turbidity of 50 NTU
   * range within pH value of 6 to 8
   * be < 80% and > 20% saturation dissolved oxygen
   * have no odour or visible petro-chemical sheen
   * have no visible litter or waste matter
   * not contain any other contaminant, chemical or biological condition which causes any measurable adverse effect



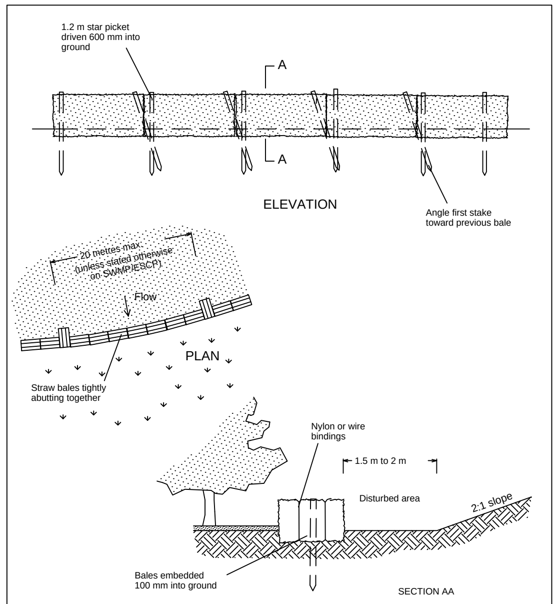
Construction Notes
1. Place stockpiles more than 2m (preferably 5m) from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2m in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Std Drawing 5-5) on the upslope side to divert water around stockpiles & sediment fences (Std Drawing 6-8) 1-2m downslope.

STOCKPILES SD 4-1



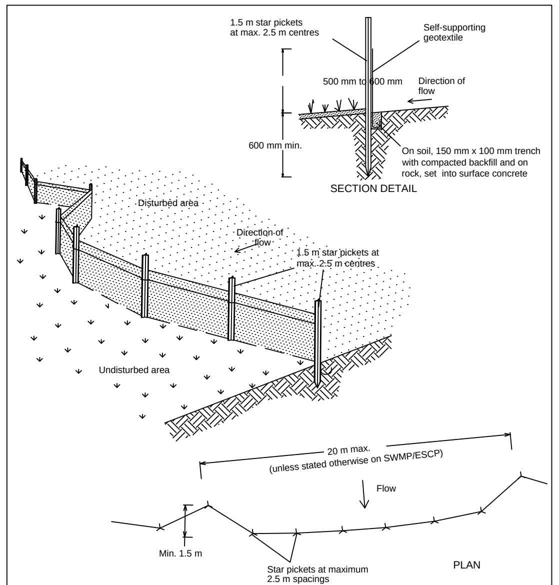
TEMPORARY CONSTRUCTION EXIT
SHAKE-DOWN FACILITY DETAIL (CATTLE GRID)

NOT TO SCALE



Construction Notes
1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

STRAW BALE FILTER SD 6-7



Construction Notes
1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit flow if concentrated at one point to 50 l/s in the design storm, usually the 10yr event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5m long star pickets into ground at 2.5m intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE SD 6-8

TYPICAL SOIL & WATER MANAGEMENT PLAN NOTES

REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
B	Updated Plans for Lodgement	DS	DS	AV*	BL*	17/09/18*
A	Original Issue	DS	DS	AV*	BL*	05/09/18*

* Denote the original signature and date when revision was issued.

TATTERSALL LANDER Pty Ltd
DEVELOPMENT CONSULTANTS

SCALE :	SHEET No. :20	FILE : 21800157	SHEET SIZE
	JOB No. : 217154	DATE : Plotted 11:07 17/09/18	A3
COMPUTER FILE : S:\projects\Harrington\dwg\217154_Harrington DA Plans.dwg			