Proposed Stables Complex at the Newcastle Jockey Club, Darling Street Broadmeadow NSW

Stormwater Management and Soil & Water Management Report

for

Newcastle Jockey Club

MPC Ref: 160548.1
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p: 02 4927 5566
e: admin@mpceng.com.au
w: www.mpceng.com.au

Level 1, 16 Telford Street
Newcastle East NSW 2300
PO Box 553, The Junction NSW 2291

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mpc consulting engineers civil+structural

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MPC Consulting Engineers

ABN 14 904 295 412
Suite 3, Level 1, 16 Telford Street NEWCASTLE NSW 2300
PO Box 553, THE JUNCTION NSW 2291
Tel: (02) 4927 5566 Fax: (02) 4927 5577 Email: admin@mpceng.com.au
Web : www.mpcconsultingengineers.com.au

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1. Background Information

1.1 Basis of Report

This report has been prepared by MPC Consulting Engineers ('MPC') to assist with the Development Approval of the Stormwater Management and Soil & Water Management works for the proposed Stables Complex and associated car park at the Newcastle Jockey Club ('NJC'). It is not intended to represent a final engineering design for the proposed stormwater infrastructure.

Further detailed design and documentation of the stormwater management infrastructure would be conducted for the Construction Certificate application once approval of the concept has been advised and any specific Development Conditions issued by Newcastle City Council ('NCC').

MPC will be happy to provide any additional information, regarding the proposed stormwater management or sediment and erosion control measures, which would assist with the Development Approval process, if requested by NCC.

1.2 Preamble

The general arrangement of the proposed Stables Complex and associated car park is depicted on the architectural drawings by EJE that are included in **Appendix B** of this report.

The Stables Complex will be situated on the south-west corner of the existing NJC site, near the corner of Chatham Street and Darling Street Broadmeadow NSW. The car park will be located to the south and east of the stables area, fronting onto Darling Street to the South.

Pavements will generally comprise a combination of permeable paving and flexible asphalt for the car park, and concrete slabs on ground for pathways.

Management of stormwater runoff for the proposed development has be designed in accordance with the Council's Development Control Plan and relevant Technical Manuals, relevant Australian Standards (in particular AS3500.3) and Australian Rainfall and Runoff.

1.3 Stormwater Management Plan

In devising this Stormwater Management Plan for the proposed development, the following issues have been addressed:

- Water Quality Management;
- Stormwater Management;
- Soil & Water Management;
- Stormwater Harvesting.

The stormwater and environmental management philosophy employed in the Stormwater Management Plan is discussed in Section 3 of this report.

As well as permanent water management controls, construction phase controls are also addressed, in Section 5 of this report.

1.4 Background Information

The following background information has been considered in the design of the proposed stormwater management system.

- A copy of the flood certificate supplied by the City of Newcastle ('CN') for the NJC property is included in **Appendix H** of this report.
- The recently completed Race Day Tie-Up Stalls development on the NJC site serves as a precedent for the overall design approach to management of stormwater on the NJC site. The approach to stormwater harvesting, quality, detention and general management of flows for the proposed Stables Complex will be similar to the approach accepted by CN for the Tie-Up Stalls development.
- MPC has consulted with the CN's asset department and obtained information relating to the existing CN stormwater drainage assets in Darling Street and Chatham Street.
- MPC has obtained confirmation from CN's Mr. Alastair Peddie (Senior Development Officer – Engineering) in an email dated 30 September 2020 that the flood certificate issued by CN in May 2019 (Flood Information Certificate No. FL2019/00101) can be used for this proposed development in the south-west corner of the NJC site.

2. Site and Catchment Details

2.1 The Existing Site

The existing site comprises five lots with a total area of 48.9 Ha and is utilised as an equine racing and training facility.

The proposed development area is to be located in the south-west corner of the site, in the position shown in Figure 1.

Figure 1: Site Location

The northern portion of the development site comprises existing asphalt pavements, existing (decommissioned) race day tie-up stalls, and grassed surfaces. This northern area slopes to the north-east towards the race track where surface stormwater is collected in a network of grassed swales and in-ground pipes.

The existing southern portion of the development site comprises grassed surfaces, and slopes southward towards Darling Street. Existing surface flows in the southern portion of the site drain to the street drainage in Darling Street and Chatham.

Photographs of the existing site are included in **Appendix A** of this report.

2.2 The Proposed Site

Architectural drawings by EJE Architects have been provided to MPC and show the site layout for the proposed development. These have been used as the basis of the stormwater management and sediment and erosion control concept design. A copy of the architectural site plan is included in **Appendix B** of this report.

The proposed site generally comprises the following:

- An equine arrivals and goods storage area, comprising:
  - Asphalt pavements for equine and goods drop-offs
  - Goods storage shed, equipment shed and site office
  - Stormwater basins
- A two-storey equine stables complex, comprising:
  - Two-storey stables buildings (7x “blocks”)
  - Elevated concourses including access ramps and stairs
  - Horse walkers, wash bays and sand rolls
- The car park to the south and east, comprising:
  - Asphalt pavements
  - Portions of permeable pavement
  - Concrete dish drains, kerbs and gutters
  - Raingardens for water quality
- A maintenance area to the north, comprising:
  - Two-storey maintenance and amenities building
  - Asphalt hardstand

The proposed site entry points will be from Darling Street and Chatham Street which are consistent with the pre-existing site entry points.

The general arrangement of the proposed car park and the driveway crossings is illustrated on the Stormwater Management Plans in **Appendix C** of this report.

3. Stormwater Management Philosophy

The proposed stormwater management system has been designed in accordance with the requirements of the current Newcastle City Council Development Control Plan, relevant NCC Technical Manuals, *AS3500.3 Stormwater Drainage*, and Australian Rainfall and Runoff.

The key design considerations were as follows.

- Safety and Efficiency

  Ensure that rainwater runoff from the developed site for all design storms up to a 1:100-year ARI event is directed through the drainage network to the proposed stormwater discharge points safely and efficiently and in accordance with NCC Development Control Plan ('DCP') and AS/NZS 3500.3-2003.

  Ensure that overland flow in the event of a choked or blocked piped system does not adversely impact on adjacent properties and does not exceed accepted safe velocity-depth criteria.

- Flood

  Compliance with the requirements specified in the Flood Certificate supplied by NCC.

- Stormwater Quantity

  Provide detention of the post-developed flows for all storms up to the 100-year ARI event, such that they do not exceed the pre-developed condition.

- Stormwater Quality

  Ensure contaminated water from developed areas is passed through an appropriate pollution and sediment control system and meets the WSUD requirements of the NCC DCP.

- Stormwater Re-Use / Harvesting

  New rainwater collection tanks with a water re-use facility to service horse wash bays and irrigation of surrounding landscaped areas.

4. Proposed Stormwater Management Facilities

4.1 Description of Proposed Stormwater Management Facilities

The stormwater management concept plans are shown in **Appendix C** to this report. The principal stormwater management components are listed below:

4.1.1 Arrivals Area

- Stormwater runoff from roof areas (goods storage shed, equipment shed and site office) will be directed via an in-ground (charged) pipe network to above-ground rainwater storage tanks located adjacent to each respective building. The rainwater tanks will be fitted with a first-flush system to address water quality and will be plumbed back into the facility to re-use collected water for amenities, hose-down and landscaping.
- Overflow from the rainwater collection tank behind the goods storage shed will be directed to Chatham Street.
- Overflow from the rainwater collection tank behind the equipment shed and site office will be directed into an infiltration trench with high-level overflows directed to Chatham Street.
- Where possible, rainwater runoff from new paved surfaces will be directed to landscaped areas or permeable paving for infiltration.
- Stormwater from paved areas will be directed vie an in-ground pipe system to a bio-retention basin (via a Gross Pollutant Trap) for water quality treatment and also with capacity to provide detention for all storms up to and including the 1% AEP storm event.
- The site office building has been specified with a floor level of RL 7.00m AHD which is higher than the minimum habitable floor level of RL 6.85m AHD specified in the flood certificate from CN.
- The goods storage shed and equipment shed (non-habitable buildings) have been specified with a floor level of RL 6.500m AHD which is higher than the 1% AEP flood level of RL 6.35m AHD specified in the flood certificate from CN.

4.1.2 Stables Complex

- Stormwater runoff from roof areas will be directed via an in-ground (charged) pipe network to above-ground rainwater storage tanks located adjacent to each respective building. The rainwater tanks will be fitted with a first-flush system to address water quality and will be plumbed back into the stables buildings to re-use collected water for amenities, hose-down and landscaping.
- Overflow from the rainwater collection tanks adjacent to Blocks B, C and D will be directed into an infiltration trench. High-level overflows from each trench will be directed through an in-ground stormwater pit and pipe network to the existing drainage system in Darling Street.

- Overflow from the rainwater collection tanks adjacent to Block A will be directed into an infiltration trench. High-level overflows from this trench will be directed through an in-ground stormwater pit and pipe network to the existing drainage system on the NJC site, directing the stormwater towards the dam in the middle of the track.
- Overflow from the rainwater collection tanks adjacent to Blocks E, F and G will be directed into an infiltration trench. High-level overflows from each trench will be directed through an in-ground stormwater pit and pipe network to the existing drainage system in Chatham Street.
- Stormwater from the southern side of the roof of Block D, and from adjacent pavement areas, will be directed to a bio-retention basin between the building and the arrivals area.
- Stormwater runoff from the elevated concourse areas will generally be directed towards landscaped areas on site for infiltration. Stormwater from the portion of the elevated concourse adjacent to the arrivals area will be directed to the bio-retention basin west of Block D.

4.1.3 Car Parks

- Stormwater runoff from the car parks will be directed towards portions of permeable paving and raingardens at various locations throughout the car parks.
- The design intent for the car parks is to encourage infiltration of stormwater on the site, with water quality provided by the raingardens for treatable flows.
- On-site detention will be provided on the surface of the car parks, keeping storage depths below the required 200mm.

4.1.4 Maintenance Precinct

- Stormwater runoff from paved areas will be directed vie an in-ground pipe system to Gross Pollutant Trap and sand filter pit for water quality, with outflows directed to the existing drainage system in Chatham Street.
- On site detention of stormwater in the maintenance hardstand will be provided on the pavement surface, keeping storage depths below the required 200mm.

Stormwater quality requirements have been addressed further in Section 4.5 of this report.

4.2 Design Storm Events

The stormwater management system will collect runoff for all design events up to the 100-year ARI for subsequent storage, re-use and disposal (as appropriate).

In-ground pits and pipes on the proposed development have been designed for a Minor Storm event of 1:10 years ARI (10% AEP).

The site has been designed for a 1:100-year ARI (1% AEP) Major Storm event using a pit blockage factor of 0.5 for all pits.

4.3 Site Catchment Parameters

4.3.1 Pre-Developed Site

MPC conducted a site analysis using the following information:

- Site survey (copy included in Appendix I of this report)
- Visual inspection of the existing site
- Visual inspection of the existing road stormwater drainage infrastructure
- Desktop review of drainage asset data obtained from City of Newcastle asset management department.

The existing site was split into sub-catchments as depicted on Figure 2, based on the existing surface fall directions.

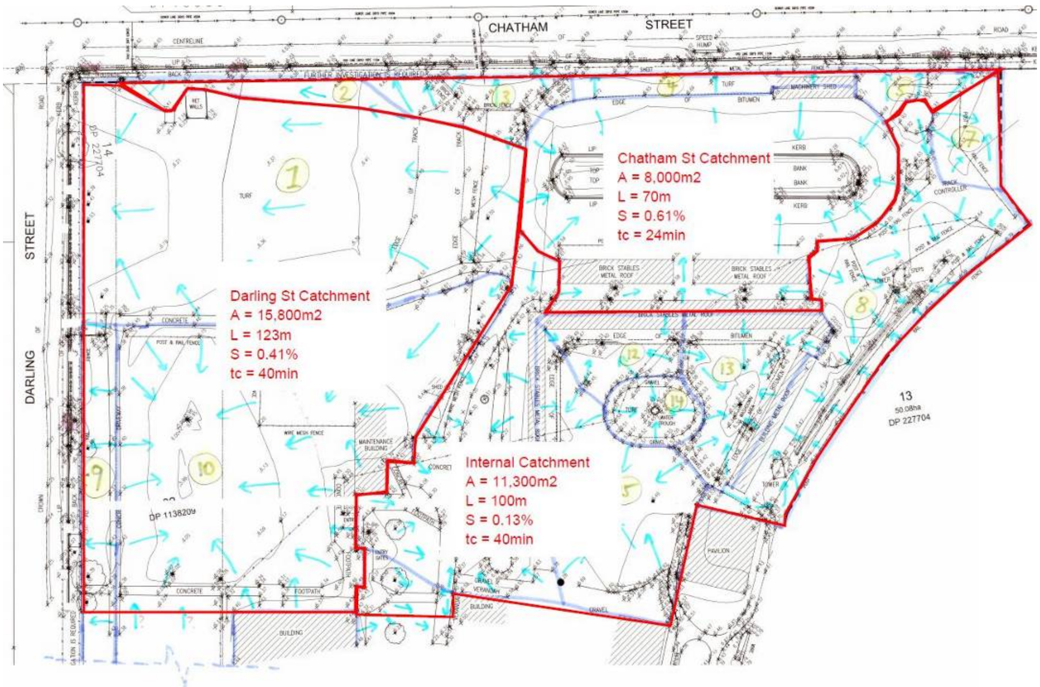

Figure 2: Pre-Developed Sub-Catchment Plan (Site Analysis)

The results of the site analysis were relied on for estimating pre-developed storm flows for all storms up to and including the major storm event. A summary of the minor and major storm pre-developed flows is provided in Table 1.

Table 1: Pre-Developed Catchment Parameters and Flows

Sub-catchment ID	Sub-catchment Description	Area (Ha)	Minor Storm (ARI= 10yrs)		Major Storm (ARI= 100yrs)	
			tc (min)	Q_{10} (L/s)	tc (min)	Q_{100} (L/s)
Darling	Southern portion of the site, draining to Darling Street	1.58	47	104	35	345
Chatham	Western portion of the site, draining to Chatham Street	0.80	25	105	20	242
Internal	North-east portion of the site, draining to the dam in the middle of the track	1.13	63	84	48	201

Calculations used for estimating the pre-developed flow rates are included in Appendix D of this report.

4.3.2 Post-Developed Site

The arrangement of sub-catchments adopted in the stormwater management design for this development are depicted in Figure 3.

The break-up of the post-developed site is approximately as described in Table 2 (areas shown are approximate):

Table 2: Post-Developed Catchment Parameters

No.	Sub-catchment Description	Area (Ha)	% Impervious	tc (min)
1	Western sub-catchment (Arrivals Area, Stables Blocks E, F and G, and Maintenance Area)	1.570	66%	5
2	North-eastern sub-catchment (Stables Block A and the 3x north-eastern horse-walkers)	0.560	83%	5
3	South-eastern sub-catchment (Stables Blocks B, C and D, and the car parks)	0.870	72%	5

The post-developed stables complex and car park site will therefore incorporate a total of 1.57 + 0.56 + 0.87 = 3.00 ha catchment area (being 71% impervious) and which is only 6.3% of the existing 47.8 ha Newcastle Jockey Club lot area.

Pit Blockage Factors

All stormwater pits were checked for inlet capacity using a 50% pit blockage factor for the major storm analysis.

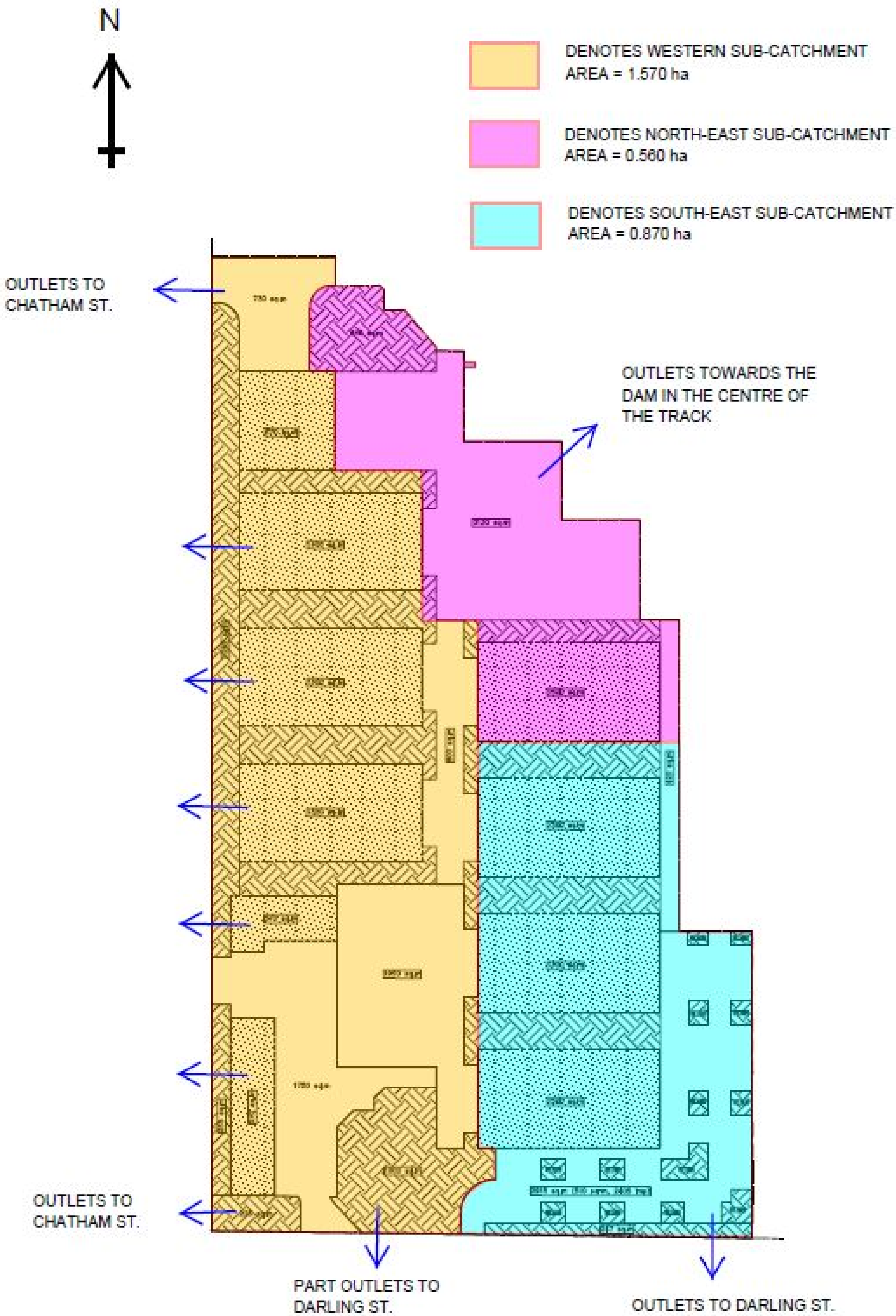

Figure 3: Post-Developed Sub-Catchment Plan

4.4 Safety and Efficiency

4.4.1 Site Discharge Index

Calculations relating to the site discharge index are included in **Appendix D** of this report.

The sub-catchments direct-connected to the street drainage are as follows:

- Frontage to Chatham Street = 1,262 + 255 = 1,517 m^2
- Frontage to Darling Street = 247 m^2

The total direct-connected area is therefore 1,517 + 247 = 1,764 m^2 noting that 100% of this direct-connected area is pervious landscaped / turfed area.

All other areas are managed using the controls described in this report.

The total developed area is 30,000 m^2. Subsequently, the site discharge index is:

SDI = 1,764 / 30,000 = 0.059 < 0.10 therefore complies with SDI requirement.

4.4.2 Pits and Pipes

In-ground stormwater pits and pipes were sized using the following:

- Rainfall intensities as specified in the IFD table within the stormwater management Technical Manual issued by NCC
- Sub-catchments as illustrated in Figure 2 of this report
- Minor and major storm flow rates calculated for each sub-catchment using the rational method, as summarised in Appendix D
- Pit inlet capacities using methods prescribed in Australian Rainfall and Runoff
- Pipe flow capacities using methods prescribed in Australian Rainfall and Runoff and AS3500.3

4.5 Flooding and Coastal Erosion

4.5.1 General

MPC has identified and considered the flood risk of the site through consultation with the City of Newcastle ('CN'), in particular Alastair Peddie, CN's Senior Development Officer in Engineering. The flooding and coastal erosion requirements of the SEARs have been addressed as follows.

1. A flood certificate for the site was issued by CN (Certificate No FL2019/00101), a copy of which is included in Appendix H of this report.
2. The constraints specified in the flood certificate issued by CN are informed by the most recent flood modelling that has been undertaken for the local catchment. A copy of the relevant flood study is included in Appendix J of this report ("Throsby, Cottage and CDB Flood Study", BMT WBM, Report No. R.B15058.002.01.doc, revision 0).

3. Potential changes to flood risk on-site or off-site due to the proposed development have been considered through the constraint imposed on the quantity of site filling as specified in the flood certificate. The flood certificate prescribes a limit to the amount of filling that can be added to the site by the development to address flood risk associated with redistribution of flood water from flood storage areas.
4. Constraints on the finished floor levels for the development were imposed by the flood certificate. These constraints are set at 500mm above the 1% AEP flood surface level so as to take into account potential effects of coastal processes and hazards, climate change, sea level rise and increases in rainfall intensity.
5. The flood certificate stipulates that onsite flood refuge is required for the proposed development. This constraint mitigates the on-site flood risk by ensuring there is adequate safe refuge space on site in the event of a flood.

4.5.2 Filling

In accordance with the flood certificate, filling of a flood storage area by more than 20% is not generally allowed due to redistribution of flood water.

The existing NJC site comprises a total of 47.8Ha of land. Of that area virtually 100% of the property is affected by the PMF event at RL 7.3m AHD (Map 3-A, Newcastle Flood plain Risk Management Study, Rev A, and the Flood certificate). MPC conducted an overlay of the site survey data with PMF flood map and determined that the Storage depths for the PMF are likely to be in the vicinity of 1.0m – 1.3m around the majority of the site

The proposed development will overlap with only the south-western portion of the flood storage extent, as illustrated by the hatched area in Figure 4, which has been obtained by overlaying the site survey flood map included with the Flood certificate received from CN.

The maximum possible displaced flood storage extent from the proposed development is approximately 0.75ha, which is 1.6% of the overall property area, which is significantly less than the required 20% as per the flood certificate.

So, considering that the City of Newcastle flood modelling and planning has allowed for fill to be placed on up to 20% of the site to mitigate the risk of adverse impacts to flood risk, and the proposed development only proposes to place fill on 1.6% of the site, the filling associated with the proposed development will not have a detrimental impact on flood risk and so complies with the SEARs.

4.5.3 Floor Levels

According to the flood certificate, the minimum level for occupiable rooms has been set as RL 6.85m AHD, being 500mm above the 1% AEP flood level. All “occupiable rooms” within the proposed stables complex have been set with a floor level of RL 7.000m AHD so comply with the flood certificate and the SEARs.

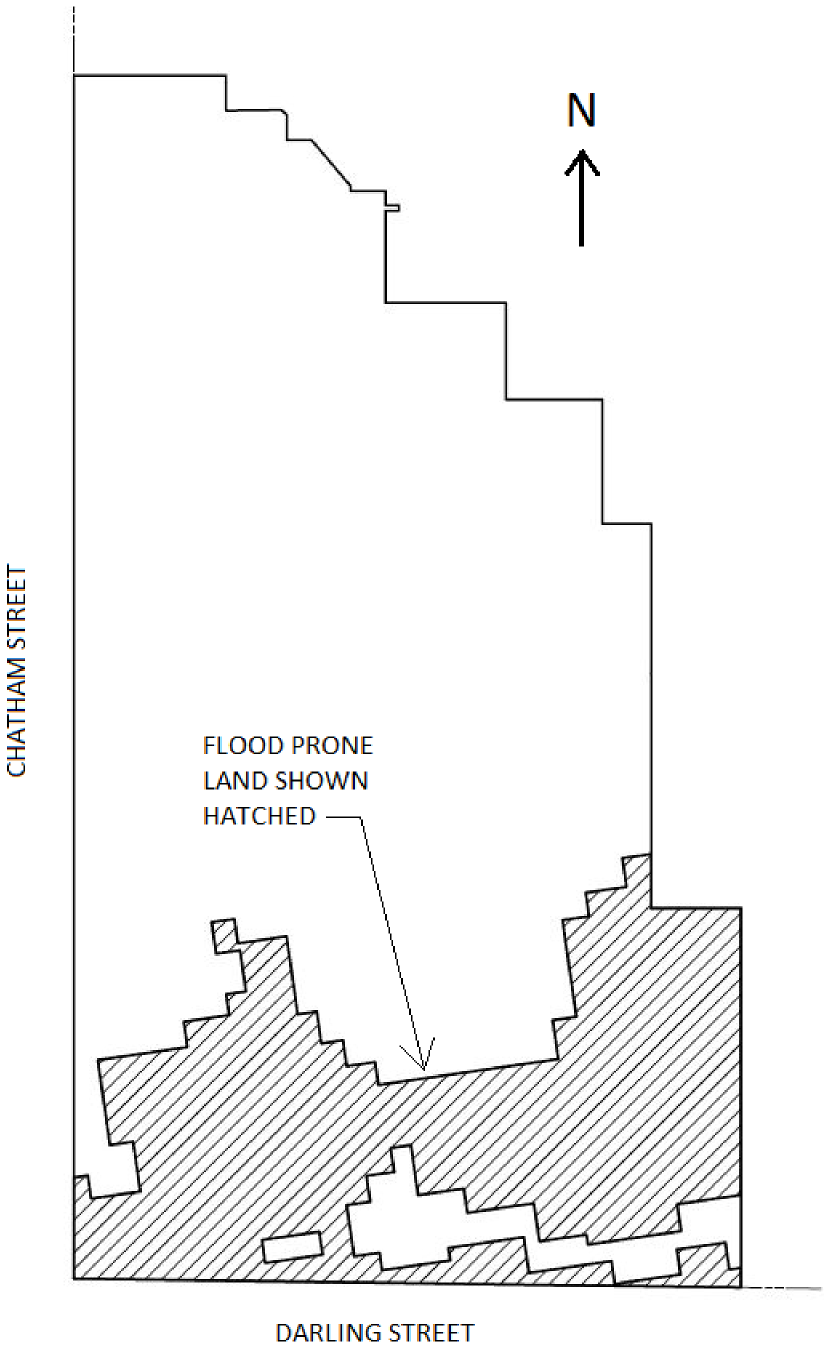

Figure 4: 1% AEP Flood Storage Extent on the Proposed Development

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4.5.4 Onsite Flood Refuge

Onsite flood refuge in a PMF event is already available on the site at the grandstands and buildings located directly east of the proposed development area. In addition, the proposed Stables Complex comprises two-storey construction with an extensive elevated concourse and elevated stables. Access to the elevated concourse is via stairs and ramps that are shown on the architectural drawings. Subsequently, the existing NJC facilities, and the proposed elevated stables and concourse, provide sufficient flood refuge for the development, and so comply with the flood certificate and the SEARs.

4.5.5 Responses to the Relevant SEARs Requirements

SEARs Item No.	Requirement	Response
9	Flooding & Coastal Erosion – mapping of relevant features as described in the Floodplain Development Manual 2005 (NSW Government 2005)	
9a	Flood prone land.	Flood prone land on the proposed development site has been mapped in the flood study Throsby, Cottage and CDB Flood Study (BMT WBM, Report No. R.B15058.002.01.doc, revision 0), a copy of which is included in Appendix J of this report. A flood certificate for the proposed development site was issued by the City of Newcastle (Certificate No FL2019/00101), a copy of which is included in Appendix H of this report. The flood certificate has been prepared by the City of Newcastle on the basis of the flood mapping undertaken by BMT WBM described above. MPC has overlayed the flood mapping with the site survey and produced the flood prone land illustration in Figure 4 of this report.
9b	Flood planning area.	The flood planning level for habitable floors of the proposed development site is RL 6.85m AHD which is 500mm above the 1% AEP flood level of the flood prone land on the site. Within the plan extent of the proposed redevelopment, the highest pre-existing ground surface level is at approximately RL 6.75m AHD, therefore the full extent of the proposed redevelopment area lies within the Flood Planning Area being the site area below the flood planning area. All “occupiable rooms” within the proposed stables complex have been set with a floor level of not less than RL 7.000m AHD so will not be below the flood planning level.
9c	Hydraulic categorisation.	Flood storage and flood fringe areas of the flood prone land have been defined by the “Flood Classification” map included with the flood certificate. An annotated copy of the map is included in Appendix H of this report.

SEARs Item No.	Requirement	Response
10	Describe the flood assessment and flood modelling.	The flood modelling relied on for the flood assessment of the development was undertaken by BMT WBM and is described in their Report No. R.B15058.002.01.doc, revision 0, a copy of which is included in Appendix J of this report. Flood levels for the assessment were determined from the flood report, the flood maps (which were generated as part of the flood report), and from the flood certificate. The relevant flood maps are included in Appendix J of this report and show the extent of the development area affected by each of the flood events with a 10-year ARI, 20-year ARI, 50-year ARI, 100-year ARI, 200-year ARI, and PMF events.
11	Effects of the proposed development on the flood behaviour under a range of flood design events.	The effect of the proposed development on the flood behaviour has been addressed using the prior assessment and modelling undertaken by the City of Newcastle. Potential changes to flood risk on-site or off-site due to the proposed development have been considered through the constraint imposed on the quantity of site filling for the development as specified in the flood certificate. The flood certificate prescribes a limit to the amount of filling that can be added to the site by the development to address flood risk associated with redistribution of flood water from flood storage areas. In accordance with the flood certificate, filling of a flood storage area by more than 20% is not generally allowed due to redistribution of flood water. The existing NJC site comprises a total of 47.8Ha of land. Of that area virtually 100% of the property is affected by the PMF event at RL 7.3m AHD (Map 3-A, Newcastle Flood plain Risk Management Study, Rev A, and the Flood certificate). MPC conducted an overlay of the site survey data with PMF flood map and determined that the Storage depths for the PMF are likely to be in the vicinity of 1.0m – 1.3m around the majority of the site The proposed development will overlap with only the south-western portion of the flood storage extent, as illustrated by the hatched area in Figure 4, which has been obtained by overlaying the site survey flood map included with the Flood certificate. The maximum possible displaced flood storage extent from the proposed development is approximately 0.75ha, which is 1.6% of the overall property area, which is significantly less than the required 20% as per the flood certificate. So, considering that the City of Newcastle flood modelling and planning has allowed for fill to be placed on up to 20% of the site to mitigate the risk of adverse impacts to flood risk, and the proposed development only proposes to place fill on 1.6% of the site, the filling associated with the proposed development will not have a detrimental impact on flood risk and so complies with the SEARs

SEARs Item No.	Requirement	Response
12a	Impact of the development on flood behaviour for flood events up to and including the PMF.	MPC considered the proposed development footprint in conjunction with the flood maps of the flood events with a 10-year ARI, 20-year ARI, 50-year ARI, 100-year ARI, 200-year ARI, and PMF events. The results indicated that: • The 10, 20 and 50-year ARI flood events are not affected by the proposed development. • The 100-year and 200-year ARI flood events partly overlap the proposed development. • The PMF flood event fully overlaps the proposed development. The extent of fill proposed for the development is generally limited to the building footprints which only partly overlap with the 100-year and 200-year ARI flood events. MPC considers the small extent of the site area proposed to be filled for the development (0.75Ha = 1.6% of the Property area) being such a small portion of the 20% permissible under the prescribed conditions of the Flood Certificate, indicates that the impact on the flood behaviour by the proposed development will be negligible.
12b	Impact of the development on flood behaviour affecting other properties.	In addition to the process described in the response to Item 12a, MPC considered the “Risk to Property”, “Risk to Life”, “PMF Stability” and “Flow velocities” maps included with the flood certificate. MPC considers the small extent of the site area proposed to be filled for the development (0.75Ha = 1.6% of the Property area) being such a small portion of the 20% permissible under the prescribed conditions of the Flood Certificate, indicates that the impact on the flood risk to property and life on adjacent properties by the proposed development will be negligible.
12c	Relevant provisions of the NSW Flood plain Development Manual 2005 have been considered	The Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM Pty Ltd, No. R.N2246.001.03.docx, revision 3, 2012) was prepared using the principles for floodplain management as outlined in the NSW Floodplain Development Manual (2005), as described in the executive summary of the report. The flood modelling relied on for the flood assessment of the proposed development was also undertaken by BMT WBM (Report No. R.B15058.002.01.doc, revision 0). MPC therefore considers that the relevant provisions of the NSW Flood plain Development Manual 2005 have been considered in the flood modelling and flood assessment for the proposed development.
13a	Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure	As described in the response to Item 12b, the impact on the flood risk to property, assets and infrastructure on adjacent properties by the proposed development will be negligible.

SEARs Item No.	Requirement	Response
13b	Consistency with Council floodplain risk management plans	As described in the response to Item 12c, the relevant provisions of the NSW Flood plain Development Manual 2005 have been considered in the flood modelling and flood assessment for the proposed development.
13c	Compatibility with the flood hazard of the land	The proposed development is predominantly within a “flood fringe” classification with a smaller portion being “flood storage”. The portions are illustrated on the Flood Classification Map in Appendix H of this report. The proposed development is predominantly within a “H2” PMF stability hazard (unsafe for small vehicles) with a smaller portion being ““H3” PMF stability hazard (unsafe for all vehicles, children and the elderly). The portions are illustrated on the PMF Stability Map in Appendix H of this report. Considering the nature of the proposed development, being an equine racing and training facility no general public access, the proposed use of the land within the development area is compatible with the flood hazard of the land.
13d	Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land	The proposed development is not within a floodway, confirmed by the flood certificate and the “Flood Classification Map” included in Appendix H of this report. As described in the response to item 12a the impact on the flood behaviour (which includes flood storage) by the proposed development will be negligible. The development is therefore considered to be compatible with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.
13e	Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	MPC considers the small extent of the site area proposed to be filled for the development (0.75Ha = 1.6% of the Property area) being such a small portion of the 20% permissible under the prescribed conditions of the Flood Certificate, indicates that the impact on the flood behaviour by the proposed development will be negligible.
13f	Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses	As described in the response to item 12a the impact on the flood behaviour by the proposed development will be negligible. In addition, the stormwater management infrastructure of the proposed development, and the construction phase soil and water management systems, has been designed with on-site detention to limit discharge flow rates leaving the development site to manage the risk of direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

SEARs Item No.	Requirement	Response
13g	Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council	The proposed development will have a beneficial impact on existing community emergency management arrangements for flooding due to the extensive area of flood refuge being provided by the development. The requirement for flood refuge space in the development was specified in Council's flood certificate.
13h	Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council	The ground floor equine stables have been designed with a floor level at RL 7.000m AHD which is higher than the flood planning level of RL 6.85m AHD specified by Council, even though the equine stables themselves are not necessarily "occupiable rooms". These floor levels will manage the risk to life for the horses and the people accessing the facility.
13i	Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES.	The flood certificate specifies a PMF flood level of RL7.30m AHD with a maximum flow velocity of 1.10m/s. The floor level in the ground floor stables of the proposed development is designed as RL 7.00m AHD. Subsequently, under a PMF flood event, the depth of water (0.30m) x flow velocity (1.10m/s) = 0.33m/s2 which is below the accepted safe threshold of 0.40m/s2. Subsequently, even during a PMF event the flow depths and velocities will be within levels that are safe for emergency management, evacuation and access. In addition, there are numerous egress paths, ramps and stairs providing access to the flood refuge areas on the upper level of the proposed development, which will provide adequate contingency for the protection of life during a PMF event.
13j	Any impacts the development may have on the social and economic costs to the community as consequence of flooding	Considering the responses listed above, MPC is not cognisant of any changes to the social or economic costs to the community as consequence of flooding on the proposed development site.
14	Potential effects of coastal processes and hazards (within the meaning of the Coastal Management Act 2016), including sea level rise and climate change:	
14a	On the proposed development	Existing ground surface levels within the proposed development site are generally higher than RL 6.0m AHD, and the majority of the proposed development will be constructed higher than RL 7.0m AHD. Subsequently, the risk to the proposed development of sea level rise from climate change is considered very low.
14b	Arising from the proposed development	Considering the responses to the previous items listed above, MPC is not cognisant of any potential effects on coastal processes or hazards arising from the proposed development site.

4.6 Stormwater Quantity (Detention)

On-site detention has been provided in the following:

- Arrivals Area – OSD storage provided in the bioretention basins “BRB3”
- Southern elevated concourse – OSD storage provided in the bioretention basins “BRB1” and “BRB2”
- Stables buildings – Rainwater re-use storage provided in above-ground rainwater tanks, plus OSD storage within infiltration trenches.
- Maintenance Area hardstand – OSD provided as surface detention on the hardstand (up to 200mm storage depth)
- Northern elevated concourse – OSD storage not required since rainwater will be directed to the dam in the centre of the race track
- Car Park – OSD provided as surface detention on the hardstand (up to 200mm storage depth) and infiltration through permeable paving and rain gardens.

Basin numbers referred to in this report are as denoted on MPC’s stormwater management plans included in **Appendix C** of this report.

The basin geometry has been set using landscaped slopes not exceeding 1V:3H so as to maximise the plan extent of the basin and still enable access for maintenance.

The software package “DRAINS” was used to model the post-developed stormwater system, using an ILSAX hydrological model. Relevant calculations and sketches are included in **Appendix D** of this report.

Pre-developed and post-developed Flows are summarised in **Table 3** below.

Table 3: OSD Results

Sub-catchment ID	Sub-catchment Description	Minor Storm (ARI= 10yrs)		Major Storm (ARI= 100yrs)	
		Pre-dev Flow (L/s)	Controlled Post-dev Flow (L/s)	Pre-dev Flow (L/s)	Controlled Post-dev Flow (L/s)
Darling	Southern portion of the site, draining to Darling Street	104	108	345	212
Chatham	Western portion of the site, draining to Chatham Street	105	13 (north) 50 (south) 63 (total)	242	23 (north) 208 (south) 231 (total)
Total flows to the public drainage system	Darling St + Chatham St flows	209	171 (<209 therefore acceptable)	587	443 (<587 therefore acceptable)

Table 3 demonstrates that the controlled post-developed flows from the proposed Stables Complex site do not exceed the pre-developed flow rates for the minor or the major storm events.

Emergency Overflow Weir from the Basin

Consideration was given to the possibility of full blockage of the outlet pipe system draining the basins. In this event, it was assumed that the OSD basins filled completely and the post-developed (uncontrolled) major storm flows over the weir of the basin.

Overflow of the basins over their respective spillways, resulting from potential system blockages during major storm flows, are summarised in **Table 4** below.

Table 4: OSD Basin Spillway Flows

Basin ID	Peak Major Storm Flow Rate (L/s)	Weir Length (m)	Flow Depth (m)	Flow Velocity (m/s)	Velocity x Depth (m^2/s)
BRB1 (to BRB2)	870	4	0.291	0.8	0.23 (<0.4 therefore okay)
BRB2 (to Darling Street)	121	20	0.076	0.8	0.01 (<0.40 there okay)
BRB3 (to Chatham Street)	175	4	0.054	1.0	0.05 (<0.40 there okay)

Table 4 demonstrates that the emergency spillway flows are all within recommended safe levels.

4.7 Stormwater Quality (WSUD)

Stormwater quality requirements from the NCC DCP have been incorporated into the overall stormwater management design for the site.

Water quality measures for the site have been modelled using MUSIC software and include the following:

- Rainwater from the roof of the proposed new buildings will be directed through a first-flush device before being stored in water re-use tanks. Stored water will be re-used on site, and overflows from this system will be directed to infiltration trench with OSD storage capacity. High-level overflows from the infiltration trenches will be directed to the existing site drainage network.
- Stormwater from impermeable car park pavement areas will be directed to areas of permeable paving for infiltration, and to “rain gardens” (similar to WSUD Bioretention System – Roadway – City of Newcastle Standard Drawing A2404) for treatment before being released to the Chatham Street stormwater drainage system.
- Stormwater from pavements in the Arrivals Area will be directed via an in-ground pipe system to a Gross Pollutant Trap for primary treatment, then to the bio-retention basin “BRB3” for tertiary treatment.
- Stormwater from pavements in the Maintenance Area will be directed via an in-ground pipe system to a Gross Pollutant Trap for primary treatment, then to a sand filter for tertiary treatment, before being released to the Chatham Street drainage network.
- Stormwater from the southern portion of the elevated concourse will be directed via suspended pipe system with a first-flush system for primary

treatment, then to the bio-retention basin “BRB1” and “BRB2” for tertiary treatment.

- Typical details of the bio-retention basins have been included on the stormwater management drawings.

The stormwater quality devices and systems have been specified on the stormwater management plans included in **Appendix C**. A schematic of the MUSIC model for the car park catchment is included in Figure 5.

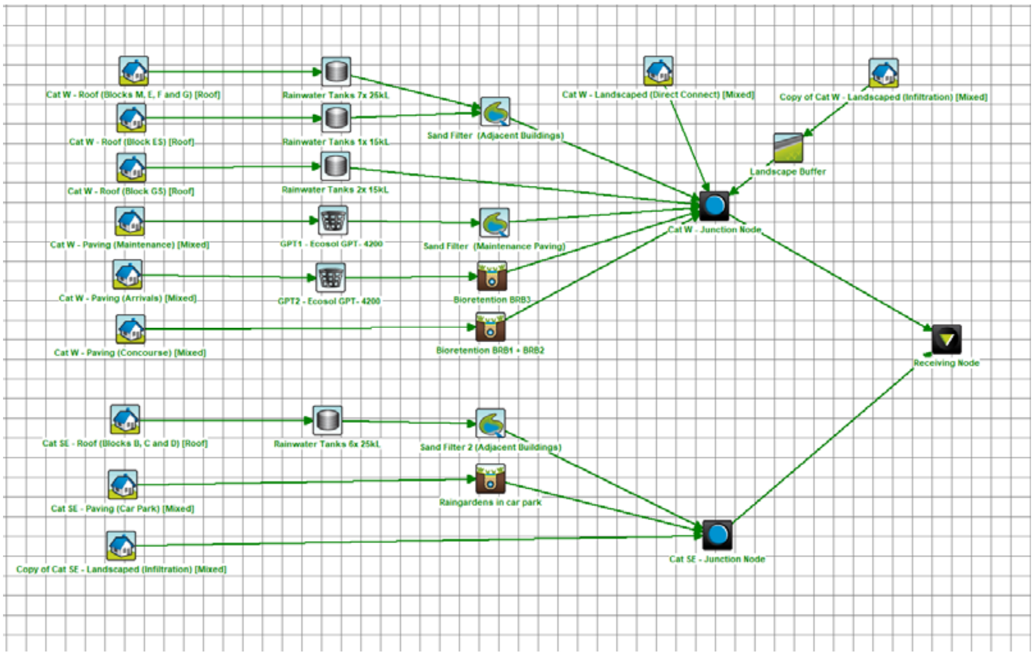


Figure 5: MUSIC Model Schematic

The proposed treatment train achieves the water quality targets listed Table 4.

Table 4: Stormwater Quality Outcome Summary

Pollutant	Target Reduction in annual load	Reduction in annual load Achieved
Total Suspended Solids	85%	91.8%
Total Phosphorus	65%	83.1%
Total Nitrogen	45%	80.5%
Gross Pollutants	90%	100%

A copy of the MUSICLink report is included in **Appendix G**.

The OSD basins have also been sized as a temporary sediment control basin for initial bulk earthworks construction phase, in accordance with the procedures in the “*Soils* *and Construction – Managing Urban Stormwater"* guidelines. Additional details in this regard are included in **Appendix E** and **Appendix F.**

4.8 Stormwater Re-Use / Harvesting

Rainwater from the roof of the new buildings will be directed through a first-flush device before being stored in water re-use tanks. Stored water will be re-used on site as follows:

- In horse wash bays within the new Stables buildings
- In horse wash bays within the new concourse
- For toilets in the Stables Complex
- For irrigation within the Stables Complex precinct

Thirteen (13) rainwater tanks, each holding up to 25,000L, will be adjacent to the Stables buildings.

Three (3) rainwater tanks, each holding up to 15,000L, will be adjacent to the Goods and Equipment Store buildings.

Therefore, there will be a total of 370,000L of additional re-use storage capacity provided in above-ground rainwater tanks within the Stables Complex which will be supplied by the roof areas of the new Stables buildings.

4.9 Maintenance of Stormwater Management Facilities

Maintenance of concrete pits, pipes and paved flow paths will be minimal however will still involve occasional cleaning.

- Ideally, pits and pipes should be inspected (and cleaned if necessary) at 3 month intervals and following large rainfall events.
- Trash screens and silt ponds should be inspected and cleaned at 3 month intervals and following large rainfall events;
- Removal of sediment from the sediment ponds to be undertaken annually, or after heavy rainfall events;
- Bio-retention basins should be inspected and maintained in accordance with the recommendations in "Bioretention Technical Design Guidelines" by Water By Design (October 2014).

5. Construction Phase Soil and Water Management

The construction phase approach adopted for this site will incorporate principles recommended by the NSW Department of Housing, namely:

- Plan for erosion and sediment control concurrently with engineering design and in advance of earthworks proper assessment of site constraints and integration of the various needs;
- Minimise the area of soil exposure;
- Conserve the topsoil where possible:
- Control water flow from top of the development area, through the works and out the bottom of the site, for example,
    - divert clean runoff above denuded areas
    - minimize slope gradient and length. Excavated batter slopes of 3H:1V are considered acceptable provided they are turfed and landscaped as soon as possible;
    - keep runoff at non-erodible velocities
    - trap soil and water pollutants
- Rehabilitate disturbed lands quickly.

A sediment and erosion control plan is shown on MPC Drawings included in **Appendix E** of this report. Calculations used in the sizing of the sediment basins have been included in **Appendix F**. The required volumes for each temporary basin are specified on the sediment and erosion control plan in **Appendix F**.

The volume of the settling and storage zones of the temporary basins have been sized using methods outlined in the “Soils and Construction” (Blue Book) by NSW Department of Housing. The volumes for each temporary basin are specified on the

In addition, general controls will be provided on the site prior to and during all earthworks in accordance with EPA Site Work Practices. Features of the construction phase erosion and sediment controls adopted for this site include:

- Prevention of sediment and polluted runoff water from being directed off the construction site;
- Control of actual and potential soil erosion – grassing and stabilization of embankments and drainage outlets where required.
- Stabilised stockpile areas adjacent to existing access roads on the site, to minimise site disturbance required for access to the stockpile areas during initial stages of construction;
- Scour protection at discharge locations, comprising combinations of geofabrics (jute mesh) and rock-filled mattresses.
- Stabilised site access to provide a firm base for vehicle entry/exit and to prevent the main access from becoming a source of sediment;

- Sediment control measures are to be constructed prior to any other site disturbance works.

6. Summary

This report has been prepared by MPC Consulting Engineers to assist with the Development Approval of the Stormwater Management and Soil & Water Management works for the proposed Chatham Street Stables Complex and associated car park at the Newcastle Jockey Club.

This report has been prepared to assist with the Development Approval of the proposed stormwater management works. Further detailed design and documentation would be conducted once approval of the Development Approval has been advised and any specific Development Conditions issued by Newcastle City Council.

For further information in relation to this stormwater management plan please contact the undersigned.

Signed:

MPC Consulting Engineers

BENJAMIN CURRAN

BE (Civil)(Hons), MIEAust (#1465387)

CPEng, NPER (Civil/Structural) RPEQ

Director, Senior Engineer

Appendix A

Photographs of the Existing Site

Photograph 1: Existing Pit "ExP1" in Darling Street

Photograph 2: Existing Pits "ExP2" and "ExP3" in Darling Street

Photograph 3: Existing Pit “ExP4” in Chatham Street

Photograph 4: Existing Pit “ExP5” in Chatham Street

Photograph 5: Existing Pit "ExP6" in Chatham Street

Photograph 6: Existing Pit "ExP7" Adjacent to the Track

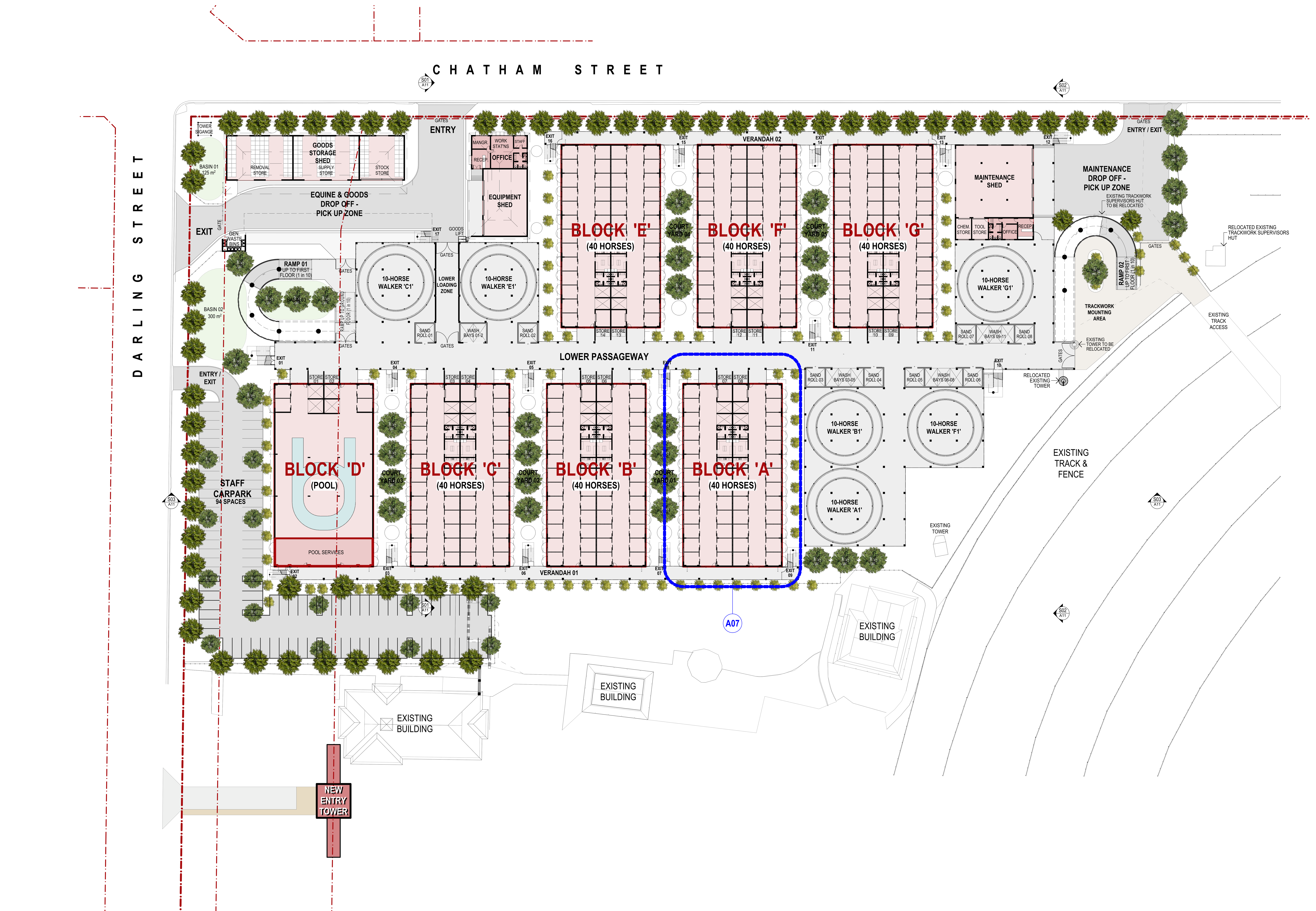
Photograph 7: View of Darling Street – Looking East

Photograph 8: View of the Chatham Street Entry – Looking South

Appendix B

Architectural Site Plan

NEWCASTLE JOCKEY CLUB



OVERALL GROUND FLOOR PLAN

1:500 @ A1

DEVELOPMENT APPLICATION

11553-DA-NJC Stable Complex.pln

NEWCASTLE RACECOURSE • EST 1907 •

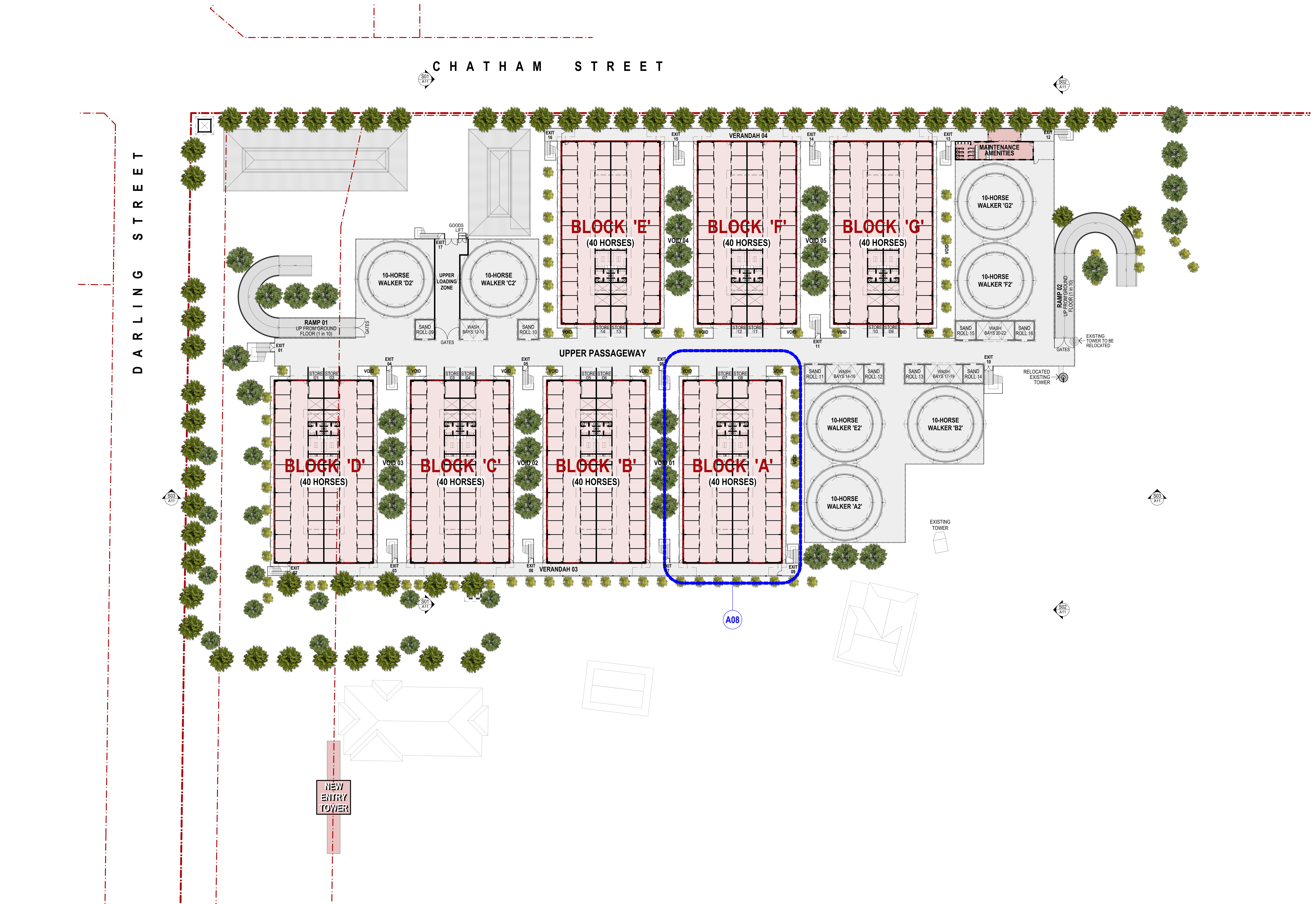
NEW STABLES COMPLEX

CNR. CHATHAM & DARLING ST's, BROADMEADOW

11553 - DA - A06 - 13/07/2021 - rev. A

EJE architecture

NJC
NEWCASTLE JOCKEY CLUB



OVERALL FIRST FLOOR PLAN
1:500 @ A1

DEVELOPMENT APPLICATION

11553-DA-NJC Stable Complex.pln

NEWCASTLE
RACECOURSE
• EST 1907 •

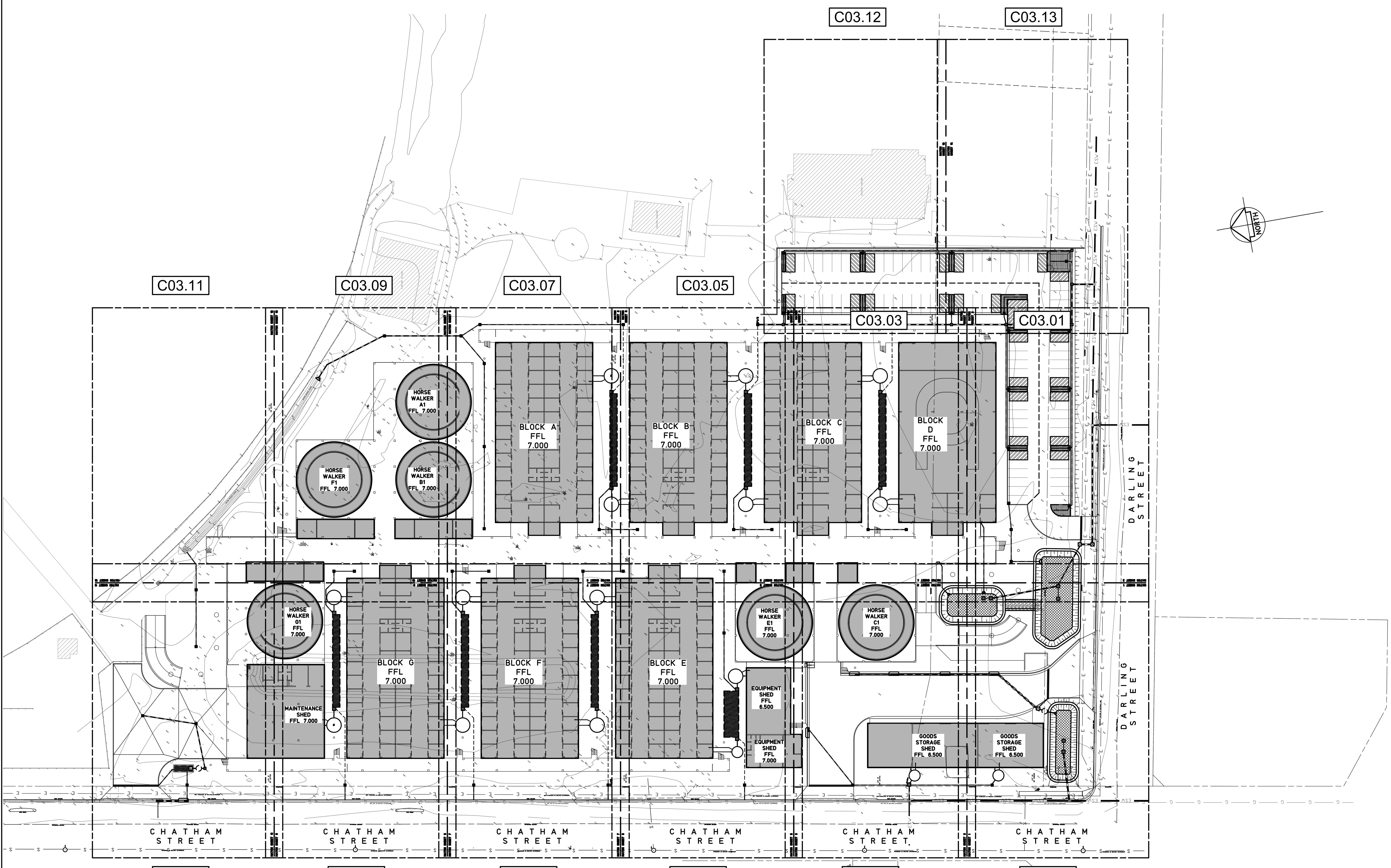
NEW STABLES COMPLEX
CNR. CHATHAM & DARLING ST's, BROADMEADOW

11553 - DA - A07 - 13/07/2021 - rev. A

EJE architecture

Appendix C

Stormwater Management Plans



SITE PLAN
STORMWATER DRAWING LAYOUTS

SCALE 1:500

NOT FOR CONSTRUCTION

ISSUE	REASON FOR ISSUE	DATE
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PO BOX 553
THE JUNCTION, NSW 2291
Tel: (02) 4927 5566
Fax: (02) 4927 5577
Email: admin@mpceng.com.au
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A.C.N. 098 542 575

CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SITE PLAN
STORMWATER DRAWING LAYOUTS

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.W.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:500	16-548-1	C03	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

STORMWATER PLAN
SHEET 1

SCALE 1:100

STORMWATER NOTES
1. REFER TO DRAWING C03.11 FOR STORMWATER NOTES AND PIT SCHEDULE
2. REFER TO DRAWING C03.12 FOR LEGEND

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STORMWATER PLAN

SHEET 3

SCALE 1:100

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STORMWATER PLAN SHEET 4

SCALE 1:100

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STORMWATER PLAN
SHEET 5

SCALE 1:100

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FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

STORMWATER PLAN
SHEET 6

SCALE 1:100

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DO NOT SCALE DRAWING

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SHEET 7

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PROPOSED STABLES COMPLEX AT;
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No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

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FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

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TITLE
STORMWATER PLAN
SHEET 8

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
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SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C03.07	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

STORMWATER PLAN
SHEET 9

SCALE 1:100

STORMWATER NOTES

1. REFER TO DRAWING C03.11 FOR STORMWATER NOTES AND PIT SCHEDULE
2. REFER TO DRAWING C03.12 FOR LEGEND

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Fax: (02) 4927 5577
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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
STORMWATER PLAN
SHEET 9

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
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SCALES	JOB No	DRAWING No	ISSUE
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STORMWATER PLAN
SHEET 10

SCALE 1:100

STORMWATER NOTES
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2. REFER TO DRAWING C03.12 FOR LEGEND

ISSUE	REASON FOR ISSUE	DATE
2	DEVELOPMENT APPLICATION	12.08.21
1	ISSUED FOR APPROVAL	09.07.21
0	PRELIMINARY	02.07.21

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mpc consulting engineers civil+structural
Level 1,
16 Telford Street,
NEWCASTLE EAST, NSW 2300
PO BOX 553
THE JUNCTION, NSW 2291
Tel: (02) 4927 5566
Fax: (02) 4927 5577
Email: admin@mpceng.com.au
Web: www.mpceng.com.au
A.C.N. 098 542 575

CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
STORMWATER PLAN
SHEET 10

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.W.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C03.09	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

STORMWATER PLAN
SHEET 11

SCALE 1:100

STORMWATER NOTES
1. REFER TO DRAWING C03.11 FOR STORMWATER NOTES AND PIT SCHEDULE
2. REFER TO DRAWING C03.12 FOR LEGEND

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TITLE
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SHEET 11

PROJECT
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No.100 DARLING STREET,
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C.W.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C03.10	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

STORMWATER PLAN
SHEET 12

SCALE 1:100

STORMWATER NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITH AS3500.3.
2. ALL PIPES TO HAVE A 1% MINIMUM FALL U.N.O.
3. ALL DOWNPIPES (DP) TO BE SPECIFIED BY ARCHITECT. FOR EXACT LOCATION OF DOWNPIPES, REFER TO ARCHITECTURAL DRAWINGS.
4. ALL PIPES TO BE UPVC U.N.O
5. ALL UPVC PIPES TO BE SEWER GRADE AND TO AS1260.
6. ALL REINFORCED CONCRETE PIPES (RCP) TO BE SPIGOT AND SOCKET TYPE WITH RUBBER RINGS CLASS 2 TO AS4058.
7. PITS TO BE CI&D REINFORCED PRE-CAST CONCRETE PITS OR EQUIVALENT PROPRIETARY PITS.
8. ALL LIDS AND GRATES TO BE PROPRIETARY HEAVY DUTY IN AREAS OF VEHICULAR TRAFFIC, LIGHT DUTY ELSEWHERE, IN ACCORDANCE WITH AS3996.
9. MINIMUM COVER TO STORMWATER PIPES TO BE AS FOLLOW U.N.O:
   TRAFFICABLE AREAS - 450mm, LANDSCAPED AREAS - 300mm.
   PIPES TO BE CONCRETE ENCASED IF MINIMUM COVERS CANNOT BE OBTAINED IN TRAFFICABLE AREAS, REFER TO CLAUSE 3.8 AS3500.3. ALTERNATIVELY USE UPVC SEWER GRADE PIPES UNDER ROAD AND BUILDINGS.
10. PROVIDE 100Φ AG DRAINS IN FILTER SOCKS TO ALL LANDSCAPED AREAS, PLANTER BEDS AND STORMWATER PIPE TRENCHES. ALL AG DRAINS TO BE BEDDED IN COARSE AGGREGATE AND TO BE CONNECTED TO STORMWATER SYSTEM.
11. ALL PITS, DETENTION TANKS AND PROPRIETARY POLLUTION CONTROL DEVICES TO BE CLEANED OF SEDIMENT AT 3 MONTH MAXIMUM INTERVALS.
12. ALL EXISTING SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF WORK.
13. ANY FOOTPATHS, KERB AND GUTTER OR ROADWAY DISTURBED BY WORKS TO BE REINSTATED TO CURRENT COUNCIL REQUIREMENTS.
14. PROVIDE ACCESS LADDER TO TANK AS REQUIRED, REFER TO AS1657.

NOTE
ALL DOWNPIPES FROM EACH UNIT TO CONNECT TO EACH UNITS SLIMLINE ABOVE GROUND WATER STORAGE TANK TYPICAL

NOTE
DRIVEWAY GRADES TO CURRENT COUNCIL REQUIREMENTS. BUILDER TO CONFIRM GRADES PRIOR TO CONSTRUCTION OF DRIVEWAY

NOTE
MPC CONSULTING ENGINEERS CAN CONFIRM THAT THE LOCATION AND DEPTH OF THE PROPOSED UNDERGROUND DETENTION TANK WILL NOT ADVERSELY AFFECT ANY NEW OR EXISTING BUILDING FOUNDATIONS WHEN THE TANK IS EMPTY TYPICAL

NOTE
BUILDER TO PROVIDE ADEQUATE SHORING IN ORDER TO MAINTAIN STABILITY OF EXISTING NEIGHBOURING STRUCTURES AND FENCES DURING EXCAVATION WORKS TYPICAL

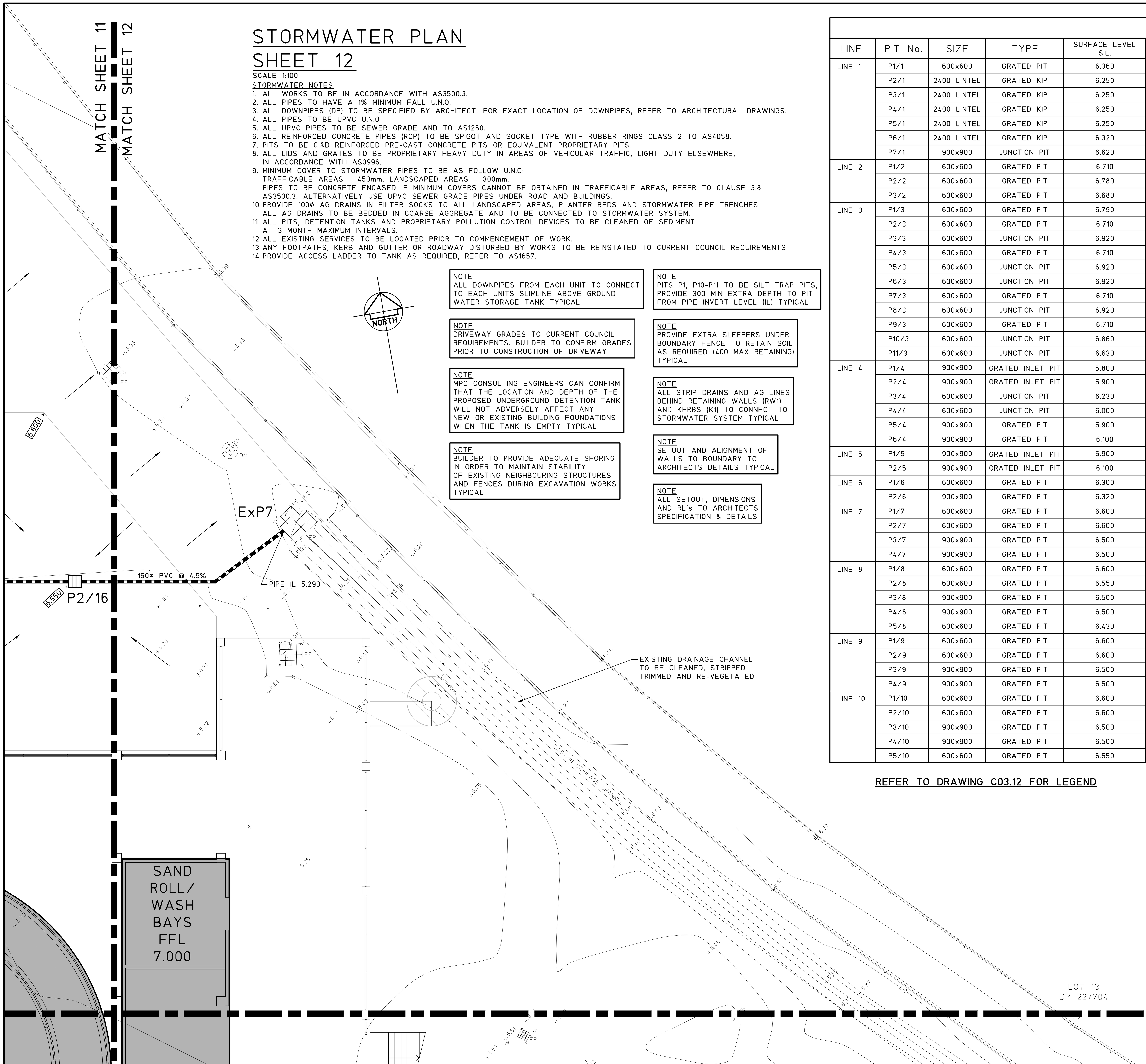
NOTE
PITS P1, P10-P11 TO BE SILT TRAP PITS, PROVIDE 300 MIN EXTRA DEPTH TO PIT FROM PIPE INVERT LEVEL (IL) TYPICAL

NOTE
PROVIDE EXTRA SLEEPERS UNDER BOUNDARY FENCE TO RETAIN SOIL AS REQUIRED (400 MAX RETAINING) TYPICAL

NOTE
ALL STRIP DRAINS AND AG LINES BEHIND RETAINING WALLS (RW1) AND KERBS (K1) TO CONNECT TO STORMWATER SYSTEM TYPICAL

NOTE
SETOUT AND ALIGNMENT OF WALLS TO BOUNDARY TO ARCHITECTS DETAILS TYPICAL

NOTE
ALL SETOUT, DIMENSIONS AND RL's TO ARCHITECTS SPECIFICATION & DETAILS



PIT SCHEDULE

LINE	PIT No.	SIZE	TYPE	SURFACE LEVEL S.L.	INVERT LEVEL I.L.
LINE 1	P1/1	600x600	GRATED PIT	6.360	5.708
	P2/1	2400 LINTEL	GRATED KIP	6.250	5.800
	P3/1	2400 LINTEL	GRATED KIP	6.250	5.857
	P4/1	2400 LINTEL	GRATED KIP	6.250	5.808
	P5/1	2400 LINTEL	GRATED KIP	6.250	5.744
	P6/1	2400 LINTEL	GRATED KIP	6.320	5.682
	P7/1	900x900	JUNCTION PIT	6.620	5.616
LINE 2	P1/2	600x600	GRATED PIT	6.710	6.068
	P2/2	600x600	GRATED PIT	6.780	6.003
	P3/2	600x600	GRATED PIT	6.680	5.873
LINE 3	P1/3	600x600	GRATED PIT	6.790	6.218
	P2/3	600x600	GRATED PIT	6.710	6.207
	P3/3	600x600	JUNCTION PIT	6.920	6.187
	P4/3	600x600	GRATED PIT	6.710	5.999
	P5/3	600x600	JUNCTION PIT	6.920	5.979
	P6/3	600x600	JUNCTION PIT	6.920	5.905
	P7/3	600x600	GRATED PIT	6.710	5.771
	P8/3	600x600	JUNCTION PIT	6.920	5.751
	P9/3	600x600	GRATED PIT	6.710	5.630
	P10/3	600x600	JUNCTION PIT	6.860	5.610
	P11/3	600x600	JUNCTION PIT	6.630	5.438
LINE 4	P1/4	900x900	GRATED INLET PIT	5.800	5.120
	P2/4	900x900	GRATED INLET PIT	5.900	5.100
	P3/4	600x600	JUNCTION PIT	6.230	5.066
	P4/4	600x600	JUNCTION PIT	6.000	5.053
	P5/4	900x900	GRATED PIT	5.900	5.220
	P6/4	900x900	GRATED PIT	6.100	5.200
LINE 5	P1/5	900x900	GRATED INLET PIT	5.900	5.120
	P2/5	900x900	GRATED INLET PIT	6.100	5.100
LINE 6	P1/6	600x600	GRATED PIT	6.300	5.868
	P2/6	900x900	GRATED PIT	6.320	5.635
LINE 7	P1/7	600x600	GRATED PIT	6.600	6.150
	P2/7	600x600	GRATED PIT	6.600	6.003
	P3/7	900x900	GRATED PIT	6.500	5.170
	P4/7	900x900	GRATED PIT	6.500	5.170
LINE 8	P1/8	600x600	GRATED PIT	6.600	6.300
	P2/8	600x600	GRATED PIT	6.550	6.140
	P3/8	900x900	GRATED PIT	6.500	5.170
	P4/8	900x900	GRATED PIT	6.500	5.170
	P5/8	600x600	GRATED PIT	6.430	6.240
LINE 9	P1/9	600x600	GRATED PIT	6.600	6.150
	P2/9	600x600	GRATED PIT	6.600	6.003
	P3/9	900x900	GRATED PIT	6.500	5.170
	P4/9	900x900	GRATED PIT	6.500	5.170
LINE 10	P1/10	600x600	GRATED PIT	6.600	6.150
	P2/10	600x600	GRATED PIT	6.600	6.003
	P3/10	900x900	GRATED PIT	6.500	5.170
	P4/10	900x900	GRATED PIT	6.500	5.170
	P5/10	600x600	GRATED PIT	6.550	6.340

LINE	PIT No.	SIZE	TYPE	SURFACE LEVEL S.L.	INVERT LEVEL I.L.
LINE 11	P1/11	600x600	GRATED PIT	6.600	6.150
	P2/11	600x600	GRATED PIT	6.600	6.003
	P3/11	900x900	GRATED PIT	6.500	5.170
	P4/11	900x900	GRATED PIT	6.500	5.170
LINE 12	P1/12	600x600	GRATED PIT	6.600	6.150
	P2/12	600x600	GRATED PIT	6.600	6.003
	P3/12	900x900	GRATED PIT	6.500	5.170
	P4/12	900x900	GRATED PIT	6.500	5.170
	P5/12	600x600	GRATED PIT	6.660	6.440
LINE 13	P1/13	600x600	GRATED PIT	6.600	6.280
	P2/13	600x600	GRATED PIT	6.600	6.170
	P3/13	600x600	GRATED PIT	6.600	6.060
	P4/13	600x600	GRATED PIT	6.710	6.250
	P5/13	600x600	GRATED PIT	6.770	6.060
	P6/13	600x600	GRATED PIT	6.790	5.960
	P7/13	600x600	GRATED PIT	6.500	5.860
LINE 14	P1/14	600x600	GRATED PIT	6.600	6.150
	P2/14	900x900	GRATED PIT	6.600	6.003
	P3/14	900x900	GRATED PIT	6.500	5.170
	P4/14	600x600	GRATED PIT	6.500	5.170
	P5/14	600x600	GRATED PIT	6.660	6.470
LINE 15	P1/15	600x600	GRATED PIT	6.480	5.801
	P2/15	600x600	GRATED PIT	6.480	5.698
	P3/15	600x600	GRATED PIT	6.480	5.581
	P4/15	600x600	JUNCTION PIT	6.630	5.421
	P5/15	600x600	JUNCTION PIT	6.630	5.235
	P6/15	600x600	GRATED PIT	6.280	5.441
LINE 16	P1/16	600x600	GRATED PIT	6.630	6.030
	P2/16	600x600	GRATED PIT	6.550	5.830
LINE 17	P1/17	600x600	GRATED PIT	6.500	5.900
	P2/17	600x600	GRATED PIT	6.740	5.800
	P3/17	600x600	GRATED PIT	6.800	5.700
	P4/17	600x600	GRATED PIT	6.500	5.200
	P5/17	2700 LINTEL	GRATED KIP	6.260	5.140
LINE 18	P1/18	600x600	GRATED PIT	6.710	5.770
	P2/18	600x600	GRATED PIT	6.710	5.694
	P3/18	600x600	GRATED PIT	6.710	5.620
LINE 19	P1/19	600x600	GRATED PIT	6.480	5.674
	P2/19	600x600	GRATED PIT	6.480	5.599
	P3/19	600x600	GRATED PIT	6.480	5.523
	P4/19	600x600	GRATED PIT	6.480	5.458
	GD1	300 WIDE	GRATED DRAIN	REFER TO PLAN	200 MIN DEEP
	GD2	300 WIDE	GRATED DRAIN	REFER TO PLAN	200 MIN DEEP
	GD3	300 WIDE	GRATED DRAIN	REFER TO PLAN	200 MIN DEEP
	GD4	300 WIDE	GRATED DRAIN	REFER TO PLAN	200 MIN DEEP
	ExP1	Ex PIT	JUNCTION PIT	6.120	4.820 (TBC)
	ExP2	Ex PIT	JUNCTION PIT	6.020	4.947 (TBC)
	ExP3	Ex LINTEL	EXISTING KIP	5.780	4.961 (TBC)
	ExP4	Ex LINTEL	EXISTING KIP	6.050	5.000 (TBC)
	ExP5	Ex LINTEL	EXISTING KIP	6.150	5.102 (TBC)
	ExP6	Ex LINTEL	NEW JUNCTION PIT	6.260	5.070 (TBC)
	ExP7	Ex PIT	GRATED PIT	6.210 (GRATE)	4.760 (TBC)

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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
STORMWATER PLAN
SHEET 12

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
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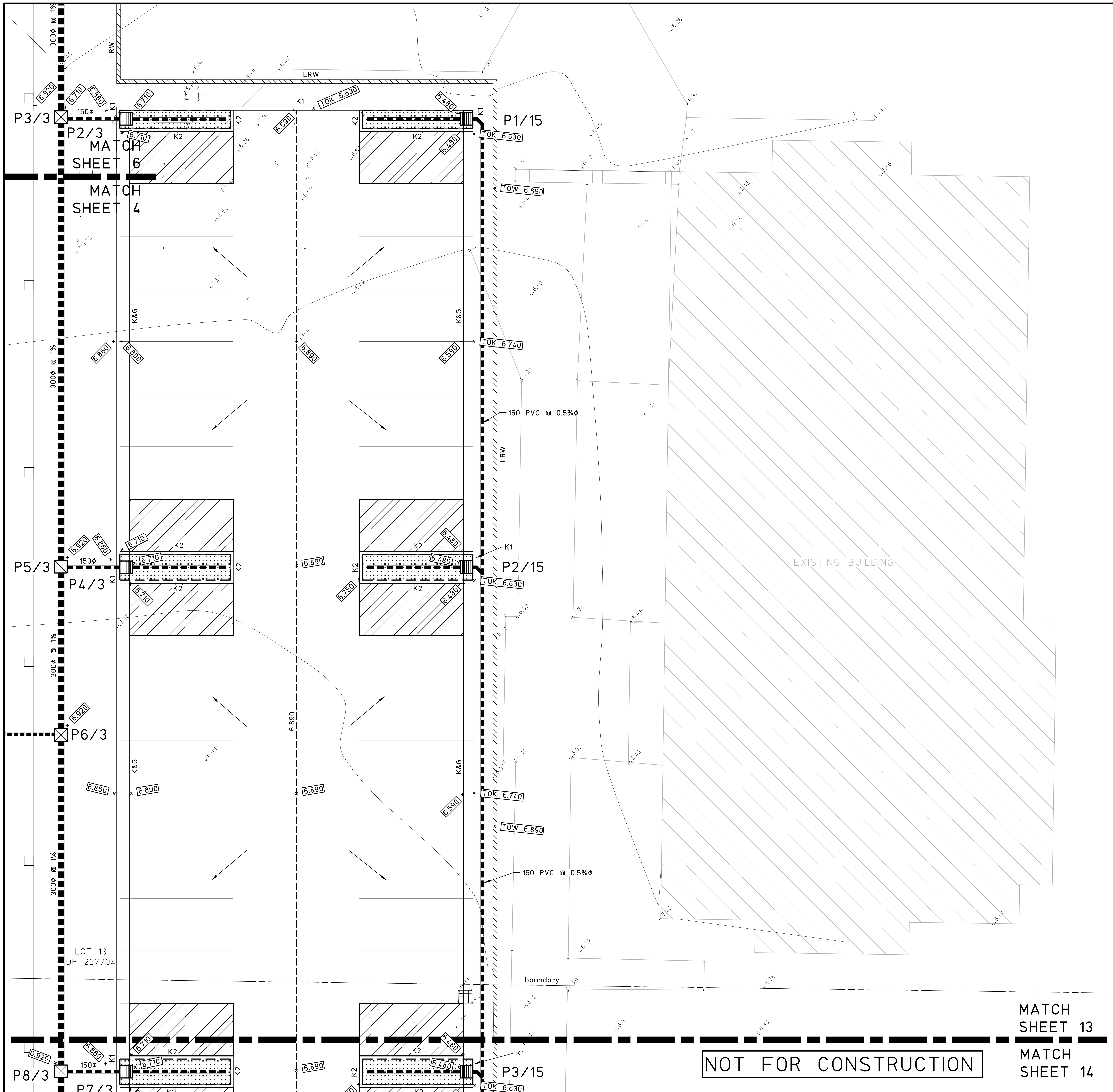
1:100	16-548-1	C03.11	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm



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LEGEND

Symbol	Description
	DENOTES STORMWATER PIPE
	DENOTES CHARGED STORMWATER PIPE
6.0	DENOTES EXISTING CONTOUR
6.890	DENOTES DESIGN CONTOUR
×6.400	DENOTES EXISTING LEVELS
× 6.710	DENOTES DESIGN SPOT LEVELS
K1	DENOTES 150 HIGH KERB U.N.O.
K2	DENOTES 150 WIDE EDGE STRIP FLUSH WITH THE ADJACENT PAVEMENT
K&G	DENOTES 120 HIGH KERB AND GUTTER
RW1/RW2	DENOTES RETAINING WALL
LRW	DENOTES LANDSCAPE RETAINING WALL
REB	DENOTES RETAINING EDGE BEAM TO BUILDING SLAB
GS1	DENOTES 2000 WIDE x 200 MIN DEEP GRASS LINED SWALE, 1% MIN FALL UNO
	DENOTES DIRECTION OF SURFACE FLOWS
	DENOTES PERMEABLE PAVING TO LANDSCAPE ARCHITECTS DETAILS
"T1" = 25,000 L "T2" = 15,000 L	DENOTES PROPRIETARY ABOVE-GROUND STORAGE TANK STORING ROOF RAINWATER TO MANUFACTURERS SPECIFICATION. TANK SHALL BE FITTED WITH A FIRST FLUSH SYSTEM, PUMP TO SUPPLY TOILETS AND LAUNDRY AND A DIVERSION SWITCH TO MAINS SUPPLY ON TANK BEING EMPTY. BACK FLOW PREVENTION TO MAINS WATER SHALL BE PROVIDED. TANK TO OVERFLOW TO STORMWATER SYSTEM.
AG	DENOTES 100ϕ AG DRAIN IN FILTER SOCK
TYPE 1	DENOTES INFILTRATION TRENCH 25m LONG x 2m WIDE x 0.88m DEEP REFER TO DETAILS
TYPE 2	DENOTES INFILTRATION TRENCH 12.5m LONG x 4m WIDE x 0.88m DEEP REFER TO DETAILS
	DENOTES 900x900 MANHOLE PIT LID
	DENOTES OVERLAND FLOW DIRECTION IN MAJOR STORM EVENT
GPT	DENOTES ECOSOL GPT-4200 GROSS POLLUTANT TRAP OR APPROVED EQUIVALENT TO MANUFACTURERS SPECIFICATION
RS1	DENOTES ROCK LINED TRAPAZOIDAL SPILLWAY CHANNEL, REFER TO DETAILS
	DENOTES RAIN GARDEN, WSUD BIORETENTION SYSTEM TO N.C.C. STANDARD DRAWING A2404

STORMWATER PLAN SHEET 13

SCALE 1:100

STORMWATER NOTES
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STORMWATER PLAN
SHEET 14

SCALE 1:100

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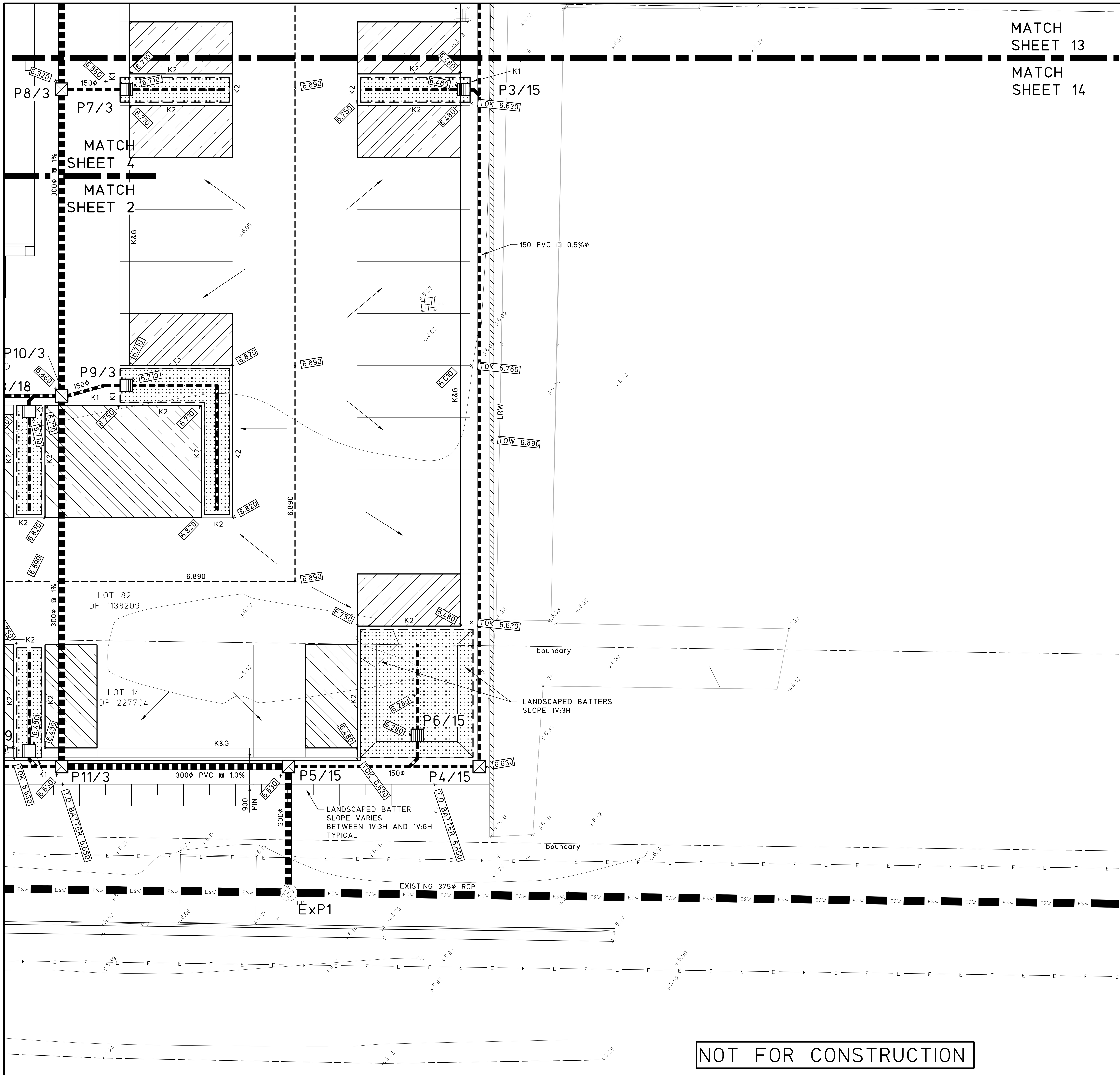

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STORMWATER PLAN
SHEET 14

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PROPOSED STABLES COMPLEX AT;
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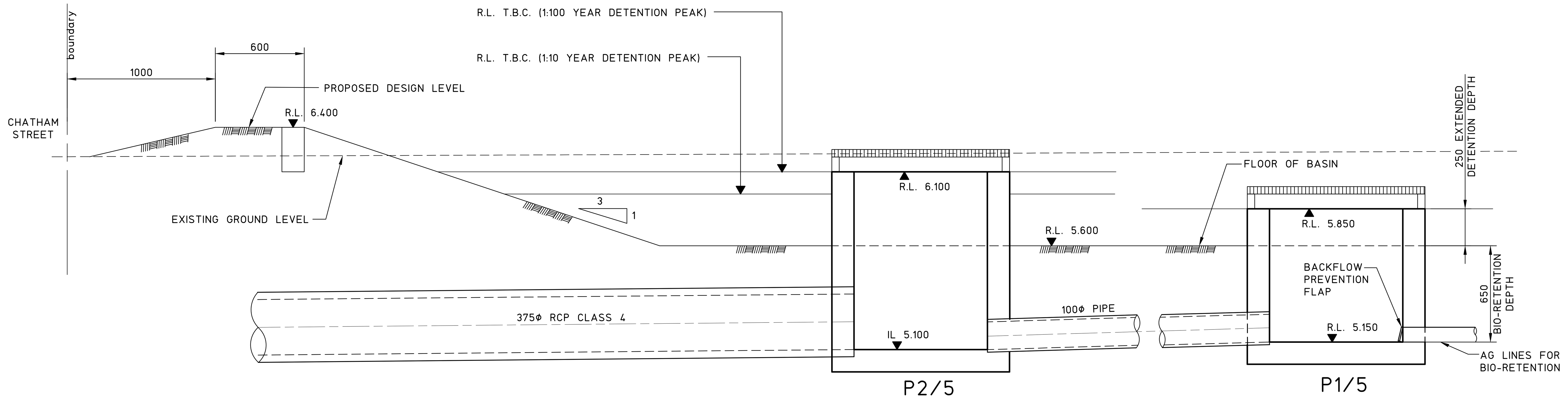
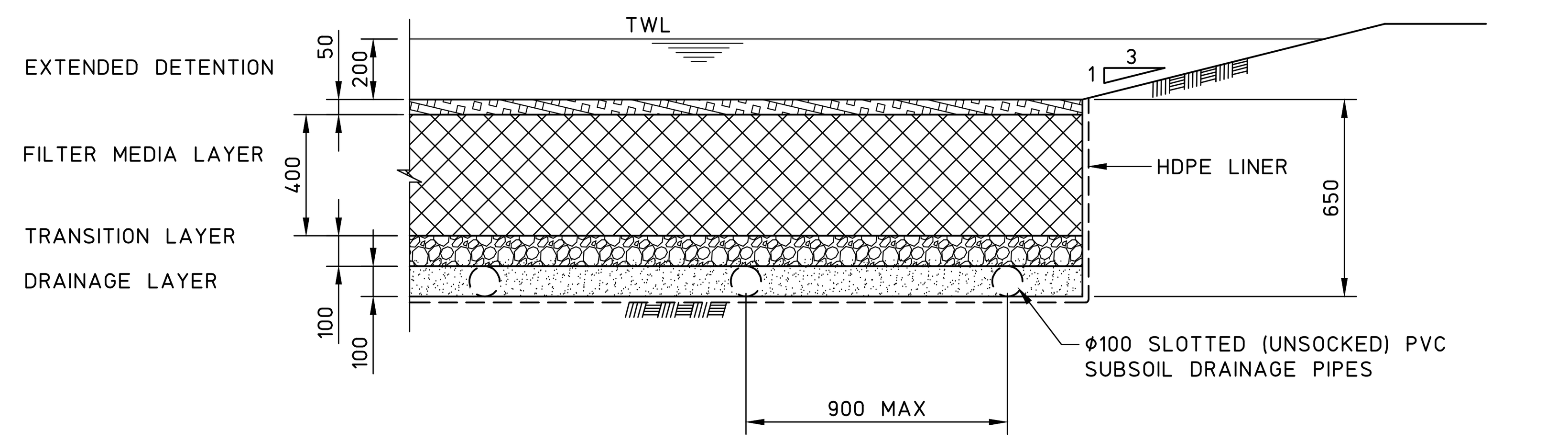


SECTION 1 (C03.00)
SCALE 1:20

NOTE
PROVIDE COMPACTED FILL WHERE REQUIRED TO UNDERSIDE OF BIO-RETENTION BASIN



TYPICAL BIO-RETENTION CROSS-SECTION

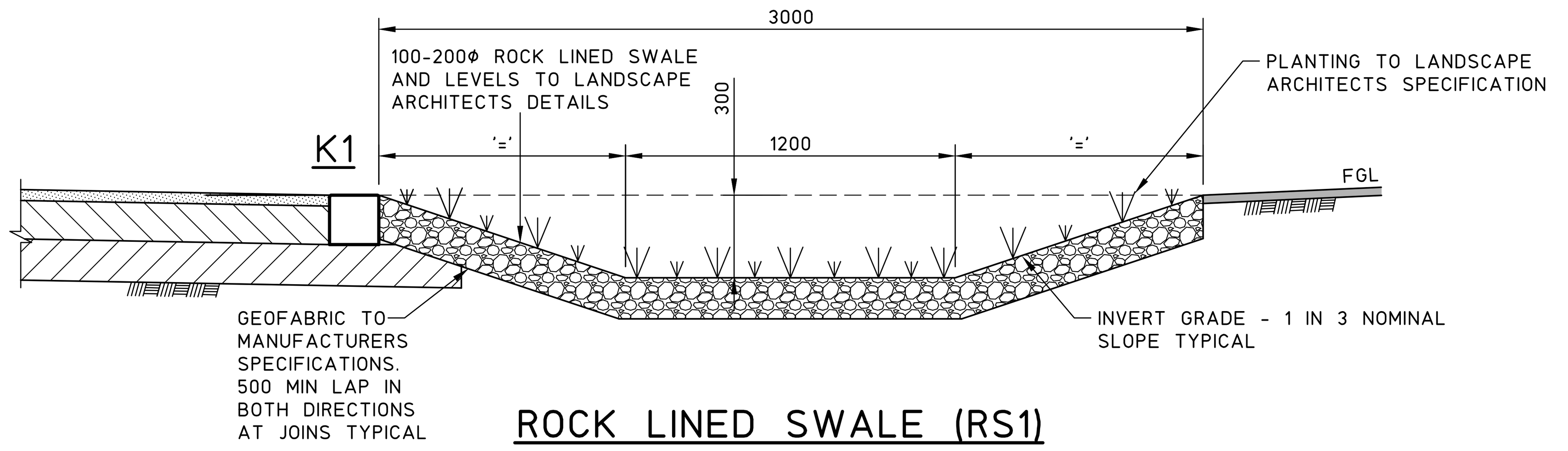
NOT TO SCALE

MULCH LAYER:
- WASHED AGGREGATE 10-20 mm
- MIN 50mm THICK.

FILTER MEDIA LAYER:
- MIN 450mm THICK
- BENEDICTS 'BIO-RETENTION FILTER MEDIA (M165)' OR APPROVED EQUIVALENT WITH MINUMUM REQUIREMENTS
  - -- SANDY LOAM MIX
  - -- SATURATED HYDRAULIC CONDUCTIVITY 100mm/HR - 300mm/HR
  - -- TOTAL CLAYAND SILT CONTENT <3%
  - -- ORGANIC CONTENT <5%

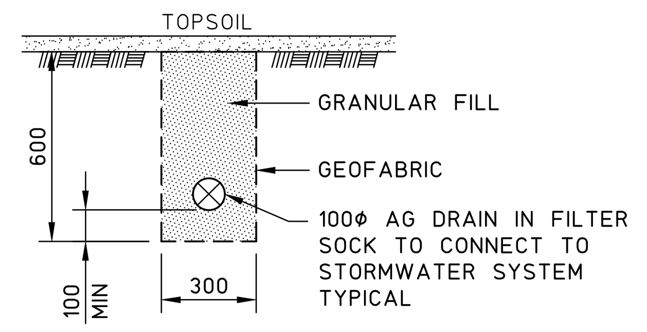
TRANSITION LAYER SPECIFICATIONS:
- MIN 100mm THICK.
- BENEDICTS 'WASHED GLASS-SAND (GSMEDIUM)' OR APPROVED EQUIVALENT WITH MINIMUM REQUIREMENTS AS FOLLOWS:
  - -- COARSE WASHED RIVER SAND CONTAINING LITTLE OR NO FINES OR RECYCLED CRUSHED GLASS EQUIVALENT

DRAINAGE LAYER SPECIFICATIONS:
- MIN 150mm THICK
- BENEDICTS 'NO FINES DRAINAGE GRAVEL (5mm GRADE)' OR APPROVED EQUIVALENT WITH MINIMUM PRODUCT REQUIREMENTS AS FOLLOWS:
  - -- CLEAN GRAVEL 5mm



ROCK LINED SWALE (RS1)

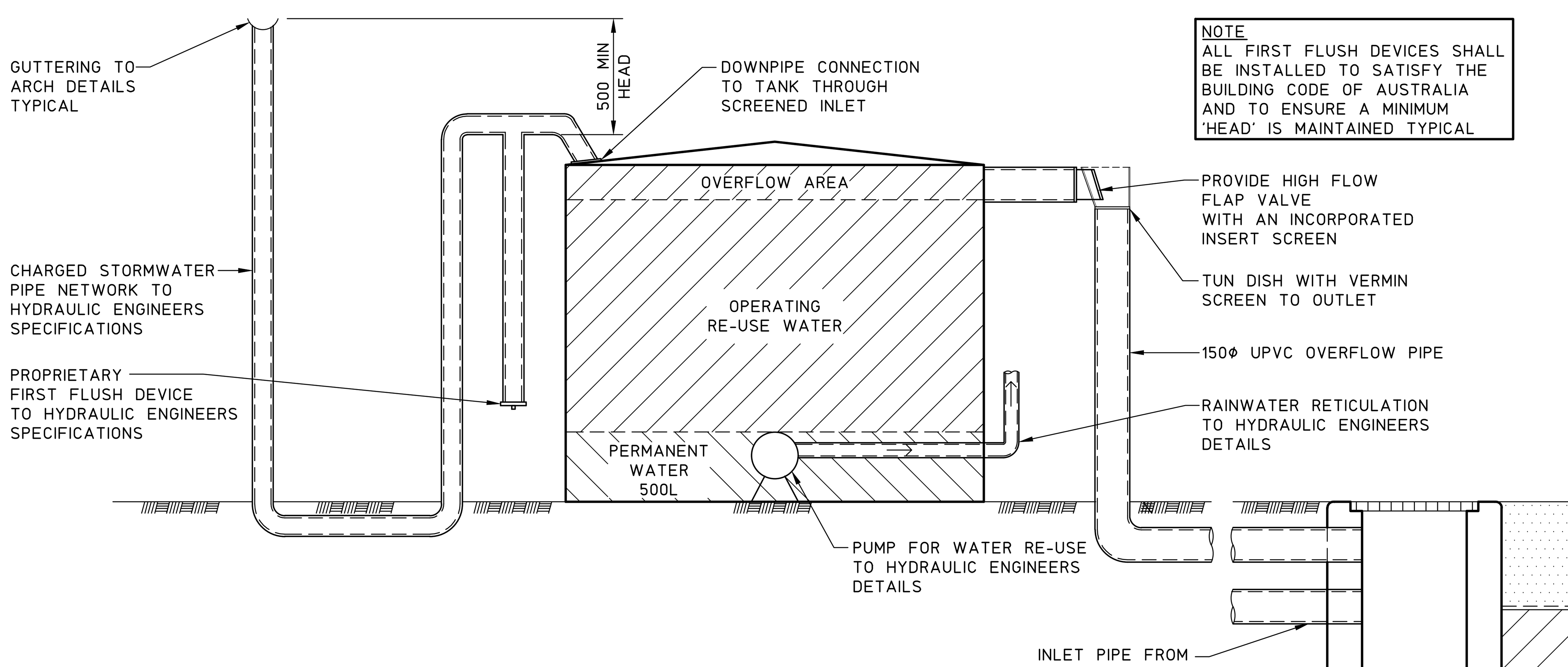
SCALE 1:20



AG DRAIN TRENCH

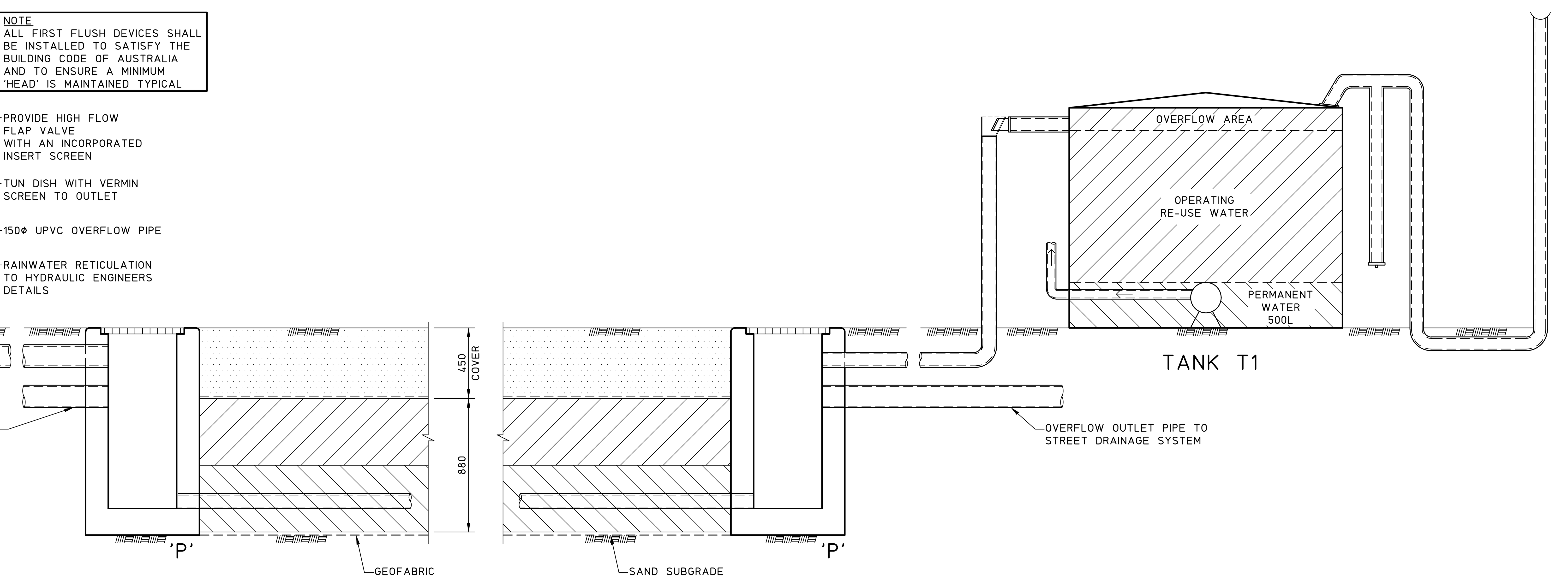
SCALE 1:20

NOTE
ALL FIRST FLUSH DEVICES SHALL BE INSTALLED TO SATISFY THE BUILDING CODE OF AUSTRALIA AND TO ENSURE A MINIMUM 'HEAD' IS MAINTAINED TYPICAL



TYPICAL TANK (T1) DETAIL

SCALE 1:20



TYPICAL INFILTRATION TRENCH DETAIL

SCALE 1:20

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THE JUNCTION, NSW 2291
Tel: (02) 4927 5566
Fax: (02) 4927 5577
Email: admin@mpceng.com.au
Web: www.mpceng.com.au
A.C.N. 098 542 575

CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
STORMWATER DETAILS

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.W.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:20	16-548-1	C03.14	0

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

Appendix D

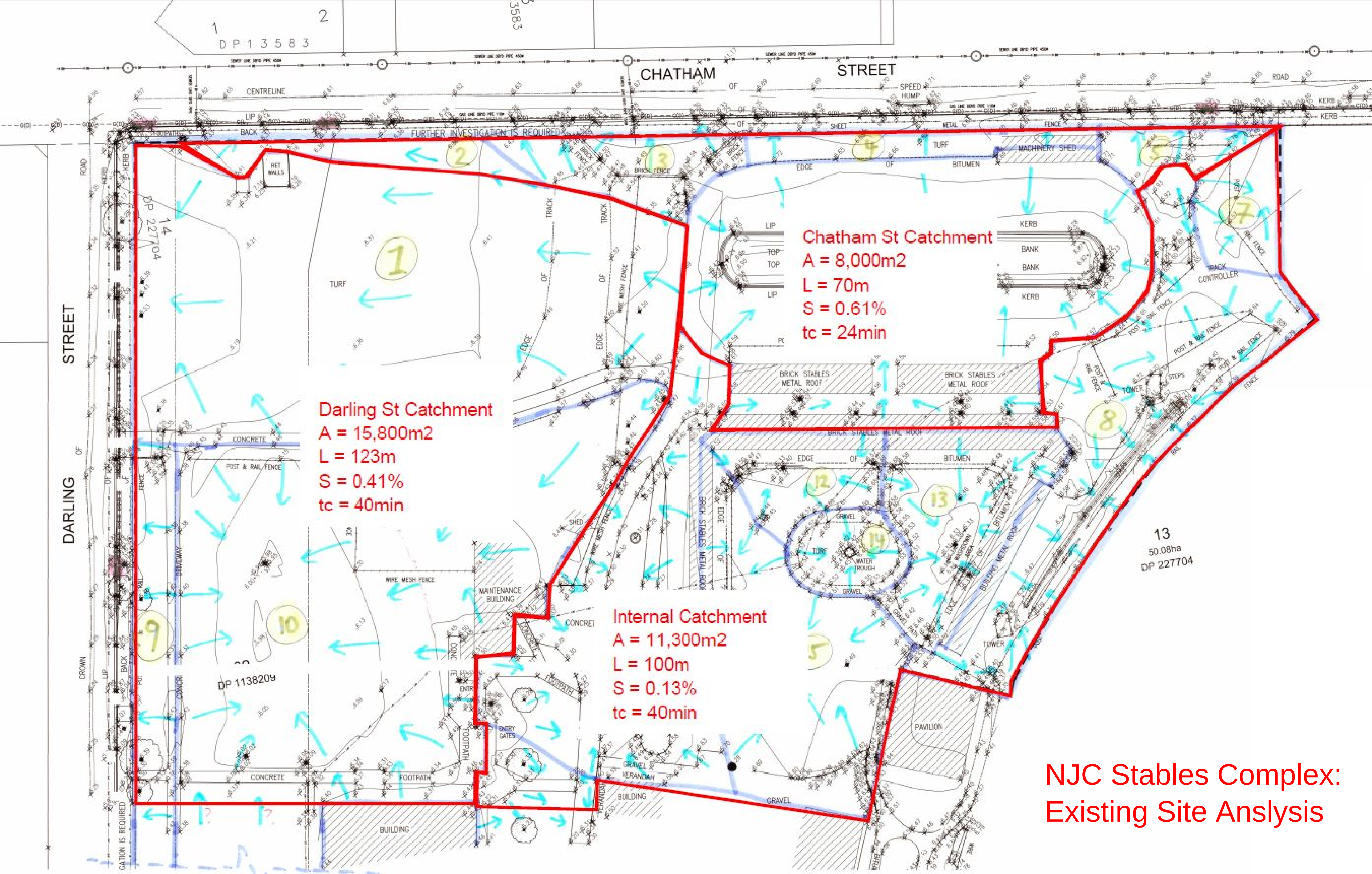
Stormwater Management Calculations

Pre-Developed site analysis

Pre-Developed flow calculations

DRAINS schematic

DRAINS calculation summary


CHATHAM STREET
DARLING STREET
Chatham St Catchment
A = 8,000m2
L = 70m
S = 0.61%
tc = 24min
Darling St Catchment
A = 15,800m2
L = 123m
S = 0.41%
tc = 40min
Internal Catchment
A = 11,300m2
L = 100m
S = 0.13%
tc = 40min
FURTHER INVESTIGATION IS REQUIRED
MACHINERY SHED
BRICK STABLES METAL ROOF
MAINTENANCE BUILDING
PAVILION
TRACK CONTROLLER
TOWER
WATER TROUGH
ENTRY GATES
BUILDING
13
50.08ha
DP 227704
DP 1138209
DP 13583
NJC Stables Complex:
Existing Site Anslysis

Project: NJC Chatham St
Job No: 16-548
Subject: Chatham St Sub-Catchment - Pre-developed flow estimates

Date: 27.7.2021

PRE-DEVELOPED SITE FLOWS - Chatham Street Sub-Catchment

Sub-catchment No.		**Chatham**	
Sub-catchment area	A_{sub} =	8000	m2
Sub-catchment length	L_{sub} =	70	m
Average slope	s =	0.0061	
Roughness	n =	0.2	
Runoff coefficients:	C_5	0.48	
	C_{10}	0.50	
	C_{20}	0.53	
	C_{50}	0.58	
	C_{100}	0.61	
<u>20% AEP Storm: (ARI=4.48)</u>			
Initial trial time of concentration	t_{c_i} =	28	min
5 Yr Storm Rainfall Intensity	I_{tc_5} =	71.9	mm/hr
Calculated time of concentration	t_{c_5} =	28.2	min
Actual rainfall intensity (Minor storm)	I_{tc_5} =	71.9	mm/hr
Minor Flow	Q_5 =	77	L/s
<u>MINOR Storm: (ARI=10)</u>			
Initial trial time of concentration	t_{c_i} =	25	min
10 Yr Storm Rainfall Intensity	I_{tc_10} =	93.9	mm/hr
Calculated time of concentration	t_{c_10} =	25.4	min
Actual rainfall intensity (Minor storm)	I_{tc_10} =	93.9	mm/hr
Minor Flow	Q_{10} =	105	L/s
<u>MAJOR Storm: (ARI=20)</u>			
Initial trial time of concentration	t_{c_i} =	25	min
20 Yr Storm Rainfall Intensity	I_{tc_20} =	93.9	mm/hr
Calculated time of concentration	t_{c_20} =	25.4	min
Actual rainfall intensity (Minor storm)	I_{tc_20} =	93.9	mm/hr
Minor Flow	Q_{20} =	110	L/s
<u>MAJOR Storm: (ARI=50)</u>			
Initial trial time of concentration	t_{c_i} =	21	min
50 Yr Storm Rainfall Intensity	I_{tc_50} =	152	mm/hr
Calculated time of concentration	t_{c_50} =	20.9	min
Actual rainfall intensity (Minor storm)	I_{tc_50} =	152	mm/hr
Minor Flow	Q_{50} =	196	L/s
<u>MAJOR Storm: (ARI=100)</u>			
Initial trial time of concentration	t_{c_i} =	20	min
100 Yr Storm Rainfall Intensity	I_{tc_100} =	180	mm/hr
Calculated time of concentration	t_{c_100} =	19.6	min
Actual rainfall intensity (Minor storm)	I_{tc_100} =	180	mm/hr
Minor Flow	Q_{100} =	242	L/s

Project: NJC Chatham St
Job No: 16-548
Subject: Darling St Sub-Catchment - Pre-developed flow estimates

Date: 27.7.2021

PRE-DEVELOPED SITE FLOWS - Darling Street Sub-Catchment

Sub-catchment No.		**Darling**	
Sub-catchment area	A_{sub} =	15800	m2
Sub-catchment length	L_{sub} =	123	m
Average slope	s =	0.0041	
Roughness	n =	0.2	
Runoff coefficients:	C_5	0.48	
	C_{10}	0.50	
	C_{20}	0.53	
	C_{50}	0.58	
	C_{100}	0.61	

<u>20% AEP Storm: (ARI=4.48)</u>

Initial trial time of concentration	t_{c_i} =	52	min
5 Yr Storm Rainfall Intensity	I_{tc_5} =	49.3	mm/hr
Calculated time of concentration	t_{c_5} =	51.9	min
Actual rainfall intensity (Minor storm)	I_{tc_5} =	49.3	mm/hr
Minor Flow	Q_5 =	104	L/s

<u>MINOR Storm: (ARI=10)</u>

Initial trial time of concentration	t_{c_i} =	47	min
10 Yr Storm Rainfall Intensity	I_{tc_10} =	64.3	mm/hr
Calculated time of concentration	t_{c_10} =	46.6	min
Actual rainfall intensity (Minor storm)	I_{tc_10} =	64.3	mm/hr
Minor Flow	Q_{10} =	142	L/s

<u>MAJOR Storm: (ARI=20)</u>

Initial trial time of concentration	t_{c_i} =	43	min
20 Yr Storm Rainfall Intensity	I_{tc_20} =	80.9	mm/hr
Calculated time of concentration	t_{c_20} =	42.6	min
Actual rainfall intensity (Minor storm)	I_{tc_20} =	80.9	mm/hr
Minor Flow	Q_{20} =	188	L/s

<u>MAJOR Storm: (ARI=50)</u>

Initial trial time of concentration	t_{c_i} =	38	min
50 Yr Storm Rainfall Intensity	I_{tc_50} =	107	mm/hr
Calculated time of concentration	t_{c_50} =	38.0	min
Actual rainfall intensity (Minor storm)	I_{tc_50} =	107	mm/hr
Minor Flow	Q_{50} =	272	L/s

<u>MAJOR Storm: (ARI=100)</u>

Initial trial time of concentration	t_{c_i} =	35	min
100 Yr Storm Rainfall Intensity	I_{tc_100} =	130	mm/hr
Calculated time of concentration	t_{c_100} =	35.2	min
Actual rainfall intensity (Minor storm)	I_{tc_100} =	130	mm/hr
Minor Flow	Q_{100} =	345	L/s

Project: NJC Chatham St
Job No: 16-548
Subject: Internal Sub-Catchment - Pre-developed flow estimates

Date: 27.7.2021

PRE-DEVELOPED SITE FLOWS - Internal Sub-Catchment

Sub-catchment No.		**Internal**	
Sub-catchment area	A_{sub} =	11300	m2
Sub-catchment length	L_{sub} =	100	m
Average slope	s =	0.0013	
Roughness	n =	0.2	
Runoff coefficients:	C_5	0.48	
	C_{10}	0.50	
	C_{20}	0.53	
	C_{50}	0.58	
	C_{100}	0.61	
<u>20% AEP Storm: (ARI=4.48)</u>			
Initial trial time of concentration	t_{c_i} =	70	min
5 Yr Storm Rainfall Intensity	I_{tc_5} =	40.7	mm/hr
Calculated time of concentration	t_{c_5} =	69.8	min
Actual rainfall intensity (Minor storm)	I_{tc_5} =	40.7	mm/hr
Minor Flow	Q_5 =	61	L/s
<u>MINOR Storm: (ARI=10)</u>			
Initial trial time of concentration	t_{c_i} =	63	min
10 Yr Storm Rainfall Intensity	I_{tc_10} =	53.3	mm/hr
Calculated time of concentration	t_{c_10} =	62.7	min
Actual rainfall intensity (Minor storm)	I_{tc_10} =	53.3	mm/hr
Minor Flow	Q_{10} =	84	L/s
<u>MAJOR Storm: (ARI=20)</u>			
Initial trial time of concentration	t_{c_i} =	57	min
20 Yr Storm Rainfall Intensity	I_{tc_20} =	67.7	mm/hr
Calculated time of concentration	t_{c_20} =	57.0	min
Actual rainfall intensity (Minor storm)	I_{tc_20} =	67.7	mm/hr
Minor Flow	Q_{20} =	113	L/s
<u>MAJOR Storm: (ARI=50)</u>			
Initial trial time of concentration	t_{c_i} =	51	min
50 Yr Storm Rainfall Intensity	I_{tc_50} =	88.9	mm/hr
Calculated time of concentration	t_{c_50} =	51.1	min
Actual rainfall intensity (Minor storm)	I_{tc_50} =	88.9	mm/hr
Minor Flow	Q_{50} =	162	L/s
<u>MAJOR Storm: (ARI=100)</u>			
Initial trial time of concentration	t_{c_i} =	48	min
100 Yr Storm Rainfall Intensity	I_{tc_100} =	106	mm/hr
Calculated time of concentration	t_{c_100} =	47.6	min
Actual rainfall intensity (Minor storm)	I_{tc_100} =	106	mm/hr
Minor Flow	Q_{100} =	201	L/s

"DRAINS" STORMWATER MODEL SCHEMATIC

PIT / NODE DETAILS			Version 15																	
Name	Type	Family	Size	Ponding	Pressure	Surface	Max Pond	Base	Blocking	x	y	Bolt-down	id	Part Full	Inflow	Pit is	Internal	Inflow is	Minor Safe	Major Safe
				Volume	Change	Elev (m)	Depth (m)	Inflow	Factor			lid		Shock Los	Hydrograph		Width	Misaligned	Pond Dept	Pond Depth
				(cu.m)	Coeff. Ku			(cu.m/s)									(mm)		(m)	(m)
P4_13	OnGrade	Grated inle	900x900		1.5	6.71		0	0	-769743.24	-254767.77	No	38	1 x Ku	No	New	900	Yes		
P5_13	OnGrade	Grated inle	900x900		1.5	6.79		0	0	-769743.24	-216062.77	No	91	1 x Ku	No	New				
P6_13	OnGrade	Grated inle	900x900		2.1	6.78		0	0	-772793.24	-210966.78	No	90	1 x Ku	No	New	900	No		
P7_13	OnGrade	Grated inle	900x900		1.5	6.50		0	0	-772793.24	-190312.77	No	95	1 x Ku	No	New	900	No		
HW1_V-DRAIN	Node					5.73		0		-784037.10	-172554.099		844		No					
P1-11	Sag	Grated inle	600x600	3.7	2.8	6.6	0.1	0	0.5	-825058.24	-258577.77	No	42	1 x Ku	No	New	600	No	0.10	0.15
P2-11	Sag	Grated inle	600x600	3.7	2.6	6.6	0.1	0	0.5	-825058.24	-248267.77	No	41	1 x Ku	No	New	600	Yes	0.10	0.15
P3-11	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-813841.11	-251577.77	No	40	1 x Ku	No	New	900	No	0.15	0.30
P3_1	Sag	NEWCAST	3.0m Lintel	1.2	2.0	6.25	0.05	0	0.5	-864258.23	-317871.98	No	55	1 x Ku	No	New	900	No	0.15	0.30
P4_1	Sag	NEWCAST	2.4m Lintel	1.2	4.7	6.25	0.05	0	0.5	-864229.07	-328326.84	No	74278	1 x Ku	No	New		No	0.15	0.30
P5_1	Sag	NEWCAST	2.4m Lintel	1.2	5.1	6.25	0.05	0	0.5	-864279.52	-342200.70	No	74480	1 x Ku	No	New	900	No	0.15	0.30
P6_1	Sag	NEWCAST	2.4m Lintel	2.4	1.6	6.25	0.2	0	0.5	-864178.62	-355519.60	No	74671	1 x Ku	No	New	900	No	0.15	0.30
P7_1	OnGrade	Grated inle	900x900		1.3	6.62		0	0	-873422.73	-366716.74	Yes	51	1 x Ku	No	New	900	No		
GPT-BRB3	OnGrade	Grated inle	900x900		1.3	6.625		0	0	-874066.27	-368501.77	Yes	50	1 x Ku	No	New	900	No		
HW1-BRB3	Node					5.60		0		-875022.52	-371252.454		76266		No					
P2_1	Sag	NEWCAST	2.4m Lintel	4.5	4.9	6.25	0.1	0	0.5	-879123.23	-304676.38	No	56	1 x Ku	No	New	900	No	0.15	0.25
P1_1 + GD4	OnGrade	Grated inle	900x900		1.9	6.36		0	0	-894028.53	-316651.77	No	57	1 x Ku	No	New	900	Yes		
P2_6	OnGrade	Grated inle	900x900		2.7	6.32		0	0	-893873.23	-331911.59	Yes	58	1 x Ku	No	New	900	Yes		
ExP5	OnGrade	NEWCAST	2.4m Lintel		5.9	6.15		0	0	-898098.64	-331763.52	No	117748	1 x Ku	No	Existing	900	No		
ExP4	Sag	NEWCAST	2.4m Lintel	11.4	0.9	6.05	0.12	0	0.5	-898011.46	-375073.69	No	118365	1 x Ku	No	Existing	900	No	0.15	0.30
CHATHAM-RN-0	Node					6.19		0		-898490.94	-401070.259		121172		No					
P2_2	Sag	Grated inle	600x600	2.6	5.2	6.78	0.08	0	0.5	-825058.23	-359454.36	No	67	1 x Ku	No	New	600	No	0.08	0.20
P3_2	Sag	Grated inle	600x600	1.3	4.7	6.68	0.08	0	0.5	-833683.23	-359454.36	No	66	1 x Ku	No	New	600	Yes	0.08	0.20
HW2 (BRB2)	Node					5.8		0		-833712.78	-367050.329		52843		No					
GD2_NORTH	OnGrade	Grated inle	900x900		5.9	6.45		0	0	-894023.17	-129650.08	No	100	1 x Ku	No	New	900	No		
SAND_FILTER_NORTH	OnGrade	Grated inle	900x900		0.0	6.80		0	0	-889933.24	-133882.84	No	110	1 x Ku	No	New	900	No		
P4_27	OnGrade	Grated inle	900x900		0.2	6.50		0	0	-894142.50	-138449.95	No	99	1 x Ku	No	New	900	No		
P5_17	OnGrade	NEWCAST	2.4m Lintel		1.5	6.27		0	0	-898290.50	-138435.98	No	98	1 x Ku	No	New	600	Yes		
ExP6	Sag	Grated inle	900x900	130	0.3	6.26	0.39	0	0.5	-898308.44	-129160.17	No	97	1 x Ku	No	New	900	Yes	0.15	0.50
Chatham St - North	Node					6.27		0		-902695.48	-129186.367		805		No					
P1_17	Sag	Grated inle	900x900	30	2.9	6.50	0.15	0	0.5	-877983.25	-124671.73	No	103	1 x Ku	No	New	900	No	0.20	0.30
P2_17	Sag	Grated inle	900x900	12	1.5	6.74	0.1	0	0.5	-877519.88	-141729.51	No	497	1 x Ku	No	New	900	Yes	0.08	0.15
P1_16	Sag	Grated inle	900x900	6	5.2	6.63	0.12	0	0.5	-856633.14	-139457.59	No	104	1 x Ku	No	New	900	No	0.10	0.30
P2_16	Sag	Grated inle	900x900	10	1.8	6.55	0.15	0	0.5	-841333.21	-139457.59	No	105	1 x Ku	No	New	900	No	0.15	0.30
ExPit_Track	Sag	Grated inle	1200x1200	120	7.9	5.59	0.78	0	0.5	-827584.19	-139526.30	No	108	1 x Ku	No	Existing	1200	Yes	0.61	0.93
JP at Track Crossing	Node					6.37		0		-830096.26	-137200.942		842		No					
Tank_T1-B-N	Node					6.5		0		-818166.77	-253777.218		285		No					
Tank_T1-A-S	Node					6.5		0		-783571.05	-249188.998		328		No					
P4-11	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-787914.58	-251537.67	No	317	1 x Ku	No	New		No	0.15	0.30
P1-9	Sag	Grated inle	600x600	3.7	2.8	6.6	0.1	0	0.5	-825125.14	-295337.78	No	378	1 x Ku	No	New		No	0.10	0.15
P2-9	Sag	Grated inle	600x600	3.7	2.3	6.6	0.1	0	0.5	-824981.01	-284456.24	No	380	1 x Ku	No	New		No	0.10	0.15
P3-9	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-813633.06	-287785.16	No	403	1 x Ku	No	New		No	0.15	0.30
T1-C-N	Node					6.5		0		-818344.42	-290169.008		390		No					
TANK-T1-B-S	Node					6.5		0		-783595.07	-285392.523		417		No					
P4-9	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-788060.63	-287851.88	No	412	1 x Ku	No	New		No	0.15	0.30
TRACK1	Node					6.04		0		-822899.48	-136342.968		1045		No					
P1_13	Sag	Grated inle	900x900	5	5.9	6.60	0.25	0	0.5	-824826.89	-217311.43	No	1148	1 x Ku	No	New	900	No	0.15	0.30
P2_13	Sag	Grated inle	900x900	18	5.9	6.60	0.25	0	0.5	-802600.75	-217232.90	No	1144	1 x Ku	No	New	900	No	0.15	0.30
P3_13	Sag	Grated inle	900x900	11	2.0	6.60	0.25	0	0.5	-780252.97	-217237.77	No	89	1 x Ku	No	New	900	No	0.15	0.30
TRACK2	Node					6.37		0		-767337.35	-173487.446		1214		No					
BYPASS2	Node					6.65		0		-764650.11	-254927.819		1392		No					
BYPASS1	Node					6.60		0		-766222.12	-216164.790		1394		No					
P3-3	OnGrade	Grated inle	900x900		1.5	6.92		0	0	-769743.24	-297932.80	Yes	30	1 x Ku	No	New		Yes		
P5_3	OnGrade	Grated inle	900x900		1.8	6.92		0	0	-769811.29	-319331.81	Yes	1689	1 x Ku	No	New	900	No		
P6_3	OnGrade	Grated inle	900x900		0.2	6.92		0	0	-769728.04	-327308.09	Yes	1735	1 x Ku	No	New	900	No		
P7_3	OnGrade	Grated inle	900x900		1.2	6.92		0	0	-769728.04	-343254.37	Yes	1743	1 x Ku	No	New	900	No		
Pit21	OnGrade	Grated inle	900x900		2.1	6.860		0	0	-769740.70	-358057.77	Yes	20	1 x Ku	No	New	900	No		
P11_3	OnGrade	Grated inle	900x900		1.3	6.63		0	0	-769740.70	-375857.77	Yes	15	1 x Ku	No	New		No		
Pit15	OnGrade	Grated inle	900x900		2.3	6.630		0	0	-758862.78	-375857.77	Yes	14	1 x Ku	No	New	900	Yes		
ExP1	OnGrade	Grated inle	900x900		1.9	6.12		0	0	-758873.63	-381882.56	Yes	32910	1 x Ku	No	Existing	900	Yes		
DARLING_ST_RN	Node					6.09		0		-743387.62	-382077.638		33012		No					
P1_15	OnGrade	Grated inle	900x900		1.5	6.480		0	0	-749693.32	-297955.55	Yes	28	1 x Ku	No	New	900	No		
P2_15	OnGrade	Grated inle	900x900		2.1	6.48		0	0	-749693.32	-319355.55	Yes	27	1 x Ku	No	New	900	No		
P3_15	OnGrade	Grated inle	900x900		1.5	6.48		0	0	-749693.32	-343355.55	Yes	21	1 x Ku	No	New	900	No		

P4_15	OnGrade	Grated inle	900x900		2.5	6.48		0	0	-749693.23	-375857.77	Yes	13	1 x Ku	No	New	900	Yes				
BLOCK_D_ROOF	Node					7		0		-822499.52	-348744.928		16868		No							
P3_4	OnGrade	Grated inle	900x900		0.0	6.23		0	0	-829071.99	-377968.81	Yes	6	1 x Ku	No	New	900	Yes				
P4_4	OnGrade	Grated inle	900x900		0.2	6.0		0	0	-829099.87	-380874.88	Yes	7	1 x Ku	No	New	900	Yes				
ExP2	OnGrade	Grated inle	900x900		2.0	6.02		0	0	-796943.98	-381299.38	Yes	33247	1 x Ku	No	Existing	900	Yes				
P3_19	OnGrade	Grated inle	900x900		1.3	6.630		0	0	-787193.23	-375857.77	Yes	16	1 x Ku	No	New	900	No				
P2_19	OnGrade	Grated inle	900x900		1.8	6.63		0	0	-803093.23	-375857.77	Yes	17	1 x Ku	No	New	900	No				
P1_19	OnGrade	Grated inle	900x900		0.9	6.63		0	0	-818676.98	-375710.13	Yes	25794	1 x Ku	No	New	900	No				
N402	Node					5.94		0		-749376.37	-384017.368		30043		No							
N403	Node					5.87		0		-769569.61	-383722.576		30160		No							
N404	Node					5.81		0		-787404.52	-383398.305		30235		No							
N405	Node					5.803		0		-802999.00	-383250.909		30385		No							
N406	Node					5.866		0		-818593.49	-382956.117		30481		No							
ExP3	Sag	NEWCAST1	2.4m Lintel	240	7.9	5.78	0.49	0	0.5	-796866.16	-383181.33	No	32056	1 x Ku	No	Existing	900	Yes	0.15	0.22		
P2_18	OnGrade	Grated inle	900x900		1.5	6.86		0	0	-787193.23	-358057.77	Yes	19	1 x Ku	No	New	900	No				
P1_18	OnGrade	Grated inle	900x900		1.8	6.86		0	0	-803093.23	-358057.77	Yes	18	1 x Ku	No	New	900	No				
GD1	Node					6.16		0		-821918.74	-378257.136		46775		No							
N458	Node					5.944		0		-834731.58	-382459.688		50539		No							
N469	Node					6.4		0		-832439.28	-365522.128		53656		No							
L1 CONCOURSE (SOUTH)	Node					7		0		-838167.85	-330964.006		56961		No							
N480	Node					6.0		0		-845349.18	-366775.253		58595		No							
P1_7	Sag	Grated inle	600x600	3.7	2.8	6.6	0.1	0	0.5	-824876.18	-330787.95	No	63010	1 x Ku	No	New		No	0.10	0.15		
P2_7	Sag	Grated inle	600x600	3.7	2.3	6.6	0.1	0	0.5	-824788.15	-320665.15	No	63119	1 x Ku	No	New		No	0.10	0.15		
P3_7	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-814049.18	-324802.30	No	63237	1 x Ku	No	New		No	0.15	0.30		
T1-D-NTH	Node					6.5		0		-818208.33	-326125.110		63683		No							
T1-C-STH	Node					6.5		0		-783402.03	-322102.886		64590		No							
P4_7	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-787641.87	-324538.22	No	63354	1 x Ku	No	New		No	0.15	0.30		
T1-GOODS_SHED_STH	Node					6.35		0		-891441.88	-356051.925		85816		No							
P1_6	OnGrade	Grated inle	600x600		1.2	6.30		0	0	-894023.23	-354321.05	Yes	63	1 x Ku	No	New	600	Yes				
T1-GOOD-STORAGE-NTH	Node					6.35		0		-891377.59	-333253.948		86315		No							
P1_8	OnGrade	Grated inle	600x600		4.5	6.6		0	0	-836725.13	-282071.90	No	90566	1 x Ku	No	New	600	No				
P2_8	OnGrade	Grated inle	600x600		3.3	6.55		0	0	-852755.97	-282299.11	No	90813	1 x Ku	No	New	600	No				
P3_8	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-869419.93	-285474.75	No	70	1 x Ku	No	New	900	No	0.15	0.30		
T2-EQSHD	Node					6.5		0		-864582.22	-287149.517		91746		No							
T1-E-STH	Node					6.5		0		-882693.91	-281862.036		94069		No							
P4_8	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-880319.93	-285474.75	No	69	1 x Ku	No	New	900	No	0.15	0.30		
CHATHAM-RN-1	Node					6.20		0		-898017.61	-287449.612		97152		No							
P1_10	Sag	Grated inle	600x600	3.7	2.8	6.6	0.1	0	0.5	-836219.01	-254174.86	No	103436	1 x Ku	No	New		No	0.10	0.15		
P2_10	Sag	Grated inle	600x600	3.7	2.3	6.6	0.1	0	0.5	-836582.26	-244851.62	No	103530	1 x Ku	No	New		No	0.10	0.15		
P3_10	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-847540.08	-246970.54	No	103840	1 x Ku	No	New	900	No	0.50	0.40		
T1-E-NTH	Node					6.5		0		-843603.27	-250650.059		104045		No							
T1-F-STH	Node					6.5		0		-877790.42	-245422.838		107970		No							
P4_10	Sag	Grated inle	900x900	14	1.8	6.5	0.2	0	0.5	-873281.89	-247055.30	No	106798	1 x Ku	No	New		No	0.20	0.40		
CHATHAM-RN-2	Node					6.300		0		-898011.46	-250077.481		109193		No							
N646	Node					5.78		0		-796782.95	-398236.965		126392		No							
GD3	OnGrade	Grated inle	900x900		5.0	6.440		0	0	-863367.84	-368856.63	No	131576	1 x Ku	No	New	600	No				
N197	Node					6.78		0		-879868.91	-142962.757		522		No							
P3_17	OnGrade	Grated inle	900x900		3.0	6.80		0	0	-889892.08	-146012.33	Yes	102	1 x Ku	No	New	900	Yes				
GPT-4200	OnGrade	Grated inle	900x900		1.3	6.80		0	0	-889824.18	-144926.06	Yes	101	1 x Ku	No	New	900	No				
SAND_FILTER_STH PIT	OnGrade	Grated inle	900x900		0.2	6.80		0	0	-889864.33	-143566.10	No	109	1 x Ku	No	New	900	No				
DETENTION BASIN DETAILS																						
Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id							
TRENCH_11	5.07	31.6		None						-800798.46	-252083.82	No			347							
	5.95	31.6																				
	5.951	1.62																				
	6.5	1.62																				
	6.501	31.6																				
	6.55	140																				
	6.6	248																				
	6.7	600																				
	6.8	620																				
SAND FILTER	5.23	0.81		Culvert	2					-889985.00	-138377.33	No			487							
	5.63	0.81																				
	5.631	8																				
	6.45	8																				
	6.451	0.81																				
	6.8	0.81																				

TRENCH9	5.07	31.6		None						-800600.49	-288516.79	No			1537							
	5.95	31.6																				
	5.951	1.62																				
	6.5	1.62																				
	6.501	31.6																				
	6.55	140																				
	6.6	248																				
	6.7	600																				
	6.8	620																				
P2_3 BASIN	6.61	6		Pit/Sump				Grated inle	600x600	-764445.68	-297976.02	No			3317							
	6.709	6																				
	6.71	20																				
	6.8	46																				
	6.86	50																				
P1_15 BASIN	6.38	6		Pit/Sump				Grated inle	600x600	-752853.52	-297949.07	No			4453							
	6.479	6																				
	6.48	20																				
	6.59	46																				
	6.74	50																				
P2_15 BASIN	6.38	6		Pit/Sump				Grated inle	600x600	-753002.31	-319457.95	No			7100							
	6.479	6																				
	6.48	33																				
	6.59	90																				
	6.74	100																				
P4_3 BASIN	6.61	6		Pit/Sump				Grated inle	600x600	-764499.19	-319369.51	No			8150							
	6.709	6																				
	6.71	33																				
	6.8	90																				
	6.86	100																				
P3_15 BASIN	6.38	6		Pit/Sump				Grated inle	600x600	-753193.92	-343390.14	No			9202							
	6.479	6																				
	6.48	33																				
	6.59	90																				
	6.74	100																				
P7_3 BASIN	6.61	6		Pit/Sump				Grated inle	600x600	-764731.49	-343312.27	No			9285							
	6.709	6																				
	6.71	33																				
	6.8	90																				
	6.86	100																				
P9_3 BASIN	6.61	12		Pit/Sump				Grated inle	600x600	-766061.59	-359720.62	No			10270							
	6.709	12																				
	6.71	68																				
	6.82	68																				
	6.89	286																				
P4_15 BASIN	6.28	18		Pit/Sump				Grated inle	600x600	-752434.56	-372521.28	No			11005							
	6.479	32																				
	6.48	60																				
	6.63	120																				
	6.89	195																				
BRB1	5.2	0.81		Pit/Sump				Grated inle	900x900	-844945.73	-349097.02	No			57810							
	5.699	0.81																				
	5.7	80																				
	6.4	146																				
BRB2	5.1	0.81		Pit/Sump				Grated inle	900x900	-834347.66	-374912.39	No			49280							
	5.599	0.81																				
	5.6	180																				
	6.2	280																				
	6.3	350																				
P11_3 BASIN	6.38	6		Pit/Sump				Grated inle	600x600	-771353.69	-373621.59	No			24980							
	6.479	6																				
	6.48	20																				
	6.59	90																				
	6.74	100																				
P3_19 BASIN	6.38	6		Pit/Sump				Grated inle	600x600	-787348.86	-373468.77	No			25238							
	6.479	6																				
	6.48	20																				
	6.59	90																				
	6.74	100																				

P2_19 BASIN	6.38	6		Pit/Sump				Grated inle	600x600	-803089.33	-373825.35	No			25271							
	6.479	6																				
	6.48	20																				
	6.59	90																				
	6.74	100																				
P1_19 BASIN	6.38	6		Pit/Sump				Grated inle	600x600	-819746.72	-373774.41	No			25525							
	6.479	6																				
	6.48	20																				
	6.59	90																				
	6.74	100																				
Basin73	6.61	6		Pit/Sump				Grated inle	600x600	-787230.00	-361277.12	No			42163							
	6.709	6																				
	6.71	33																				
	6.8	90																				
	6.86	100																				
Basin76	6.61	6		Pit/Sump				Grated inle	600x600	-803140.27	-361701.62	No			42724							
	6.709	6																				
	6.71	33																				
	6.8	90																				
	6.86	100																				
TRENCH7	5.07	31.6		None						-801211.77	-324643.45	No			64276							
	5.95	31.6																				
	5.951	1.62																				
	6.5	1.62																				
	6.501	31.6																				
	6.55	140																				
	6.6	248																				
	6.7	600																				
	6.8	620																				
BRB3	5.1	0.81		Pit/Sump				Grated inle	900x900	-887985.60	-373335.60	No			82268							
	5.599	0.81																				
	5.6	69																				
	6.4	143																				
	6.5	180																				
TRENCH8	5.07	50		None						-874672.30	-285494.46	No			96056							
	5.95	50																				
	5.951	1.62																				
	6.5	1.62																				
	6.501	50																				
	6.55	140																				
	6.6	248																				
	6.7	600																				
	6.8	620																				
TRENCH10	5.07	31.6		None						-858897.47	-247127.94	No			106594							
	5.95	31.6																				
	5.951	1.62																				
	6.5	1.62																				
	6.501	31.6																				
	6.55	140																				
	6.6	248																				
	6.7	600																				
	6.8	620																				
SUB-CATCHMENT DETAILS																						
Name	Pit or	Total	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Lag Time	Gutter	Gutter	Gutter	Rainfall
	Node	Area	Area	Area	Area	Time	Time	Time	Length	Length	Length	Slope(%)	Slope	Slope	Rough	Rough	Rough	or Factor	Length	Slope	FlowFactor	Multiplier
		(ha)	%	%	%	(min)	(min)	(min)	(m)	(m)	(m)	%	%	%					(m)	%		
CAT P6_13	P6_13	0.0170	0.0	100.0	0.0	5	5	2										0				1
CAT P7_13	P7_13	0.0110	0.0	100.0	0.0	5	5	2										0				1
CAT_P1-11	P1-11	0.0134	75.0	25.0	0.0	5	5	0										0				1
CAT_P2-11	P2-11	0.0134	75.0	25.0	0.0	5	5	0										0				1
CAT_P3-11	P3-11	0.0243	0.0	100.0	0.0	5	5	0										0				1
CAT P3_1	P3_1	0.0330	100.0	0.0	0.0	5	5	2										0				1
CAT P4_1	P4_1	0.0210	100.0	0.0	0.0	5	5	2										0				1
CAT P5_1	P5_1	0.0440	100.0	0.0	0.0	5	5	2										0				1
CAT P6_1	P6_1	0.0340	100.0	0.0	0.0	5	5	2										0				1
CAT P2_1	P2_1	0.0270	100.0	0.0	0.0	5	5	2										0				1
CAT P1_1 + GD4	P1_1 + GD	0.0050	100.0	0.0	0.0	5	5	2										0				1

CAT P2_2	P2_2	0.0060	100.0	0.0	0.0	5	5	2										0				1
CAT P3_2	P3_2	0.0060	100.0	0.0	0.0	5	5	2										0				1
CAT_GD2_NORTH	GD2_NOR	0.0180	100.0	0.0	0.0	5	5	2										0				1
Cat-P1_17	P1_17	0.0400	100.0	0.0	0.0	5	5	2										0				1
Cat_P2_17	P2_17	0.0250	100.0	0.0	0.0	5	5	2										0				1
CAT P1_16	P1_16	0.0380	0.0	100.0	0.0	5	5	2										0				1
CAT P2_16	P2_16	0.0180	0.0	100.0	0.0	5	5	2										0				1
CAT ExPit_Track	ExPit_Trac	0.1200	0.0	100.0	0.0	5	5	2										0				1
CAT-T1-B-N	Tank_T1-E	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT-Tank_T1-A-S	Tank_T1-A	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT_P4-11	P4-11	0.0243	0.0	100.0	0.0	5	5	0										0				1
CAT_P1-9	P1-9	0.0134	75.0	25.0	0.0	5	5	0										0				1
CAT_P2-9	P2-9	0.0134	75.0	25.0	0.0	5	5	0										0				1
CAT_P3-9	P3-9	0.0243	0.0	100.0	0.0	5	5	0										0				1
CAT-T1-C-N	T1-C-N	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT_TANK-T1-B-S	TANK-T1-E	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT_P4-9	P4-9	0.0243	0.0	100.0	0.0	5	5	0										0				1
CAT P1_13	P1_13	0.0100	0.0	100.0	0.0	5	5	2										0				1
CAT P2_13	P2_13	0.0140	0.0	100.0	0.0	5	5	2										0				1
CAT P3_13	P3_13	0.0100	0.0	100.0	0.0	5	5	2										0				1
CAT P2_3 BASIN	P2_3 BASI	0.0153	87.0	13.0	0.0	5	5	2										0				1
CAT P1_15 BASIN	P1_15 BAS	0.0115	83.0	17.0	0.0	5	5	2										0				1
CAT P2_15 BASIN	P2_15 BAS	0.0200	83.0	17.0	0.0	5	5	2										0				1
CAT P4_3 BASIN	P4_3 BASI	0.0269	87.0	13.0	0.0	5	5	2										0				1
CAT P3_15 BASIN	P3_15 BAS	0.0189	81.0	19.0	0.0	5	5	2										0				1
CAT P7_3 BASIN	P7_3 BASI	0.0253	86.0	14.0	0.0	5	5	2										0				1
CAT P9_3 BASIN	P9_3 BASI	0.0317	71.0	29.0	0.0	5	5	2										0				1
CAT P4_15 BASIN	P4_15 BAS	0.0272	80.0	20.0	0.0	5	5	2										0				1
CAT BLOCK_D ROOF	BLOCK_D_	0.0780	100.0	0.0	0.0	5	5	2										0				1
CAT BRB1	BRB1	0.0730	50.0	50.0	0.0	5	5	2										0				1
CAT BRB2	BRB2	0.0500	0.0	100.0	0.0	5	5	2										0				1
CAT P1_3 BASIN	P11_3 BAS	0.0137	74.0	26.0	0.0	5	5	2										0				1
CAT P3_19 BASIN	P3_19 BAS	0.0134	74.0	26.0	0.0	5	5	2										0				1
CAT P2_19 BASIN	P2_19 BAS	0.0134	74.0	26.0	0.0	5	5	2										0				1
CAT P1_19 BASIN	P1_19 BAS	0.0139	90.0	10.0	0.0	5	5	2										0				1
CAT P2_18 BASIN	Basin73	0.0184	81.0	19.0	0.0	5	5	2										0				1
CAT P1_18 BASIN	Basin76	0.0263	87.0	13.0	0.0	5	5	2										0				1
CAT L1 CONCOURSE	L1 CONCC	0.2100	100.0	0.0	0.0	5	5	2										0				1
CAT P1_7	P1_7	0.0134	75.0	25.0	0.0	5	5	0										0				1
CAT P2_7	P2_7	0.0134	75.0	25.0	0.0	5	5	0										0				1
CAT P3_7	P3_7	0.0243	100.0	0.0	0.0	5	5	0										0				1
CAT T1-D-NTH	T1-D-NTH	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT T1-C-STH	T1-C-STH	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT P4_7	P4_7	0.0243	0.0	100.0	0.0	5	5	0										0				1
CAT GOOD SHED STH	T1-GOODS	0.0300	100.0	0.0	0.0	5	5	2										0				1
CAT GOODS SHED NTH	T1-GOOD-	0.0300	100.0	0.0	0.0	5	5	2										0				1
CAT P1_8	P1_8	0.0110	75.0	25.0	0.0	5	5	0										0				1
CAT P2_8	P2_8	0.0100	75.0	25.0	0.0	5	5	0										0				1
CAT P3_8	P3_8	0.0135	0.0	100.0	0.0	5	5	0										0				1
CAT EQPTSHD	T2-EQSHD	0.0370	100.0	0.0	0.0	5	5	2										0				1
CAT T1-E-STH	T1-E-STH	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT P4_8	P4_8	0.0135	0.0	100.0	0.0	5	5	0										0				1
CAT P1_10	P1_10	0.0134	75.0	25.0	0.0	5	5	0										0				1
CAT P2_10	P2_10	0.0134	75.0	25.0	0.0	5	5	0										0				1
Cat619	P3_10	0.0243	0.0	100.0	0.0	5	5	0										0				1
CAT T1-E-NTH	T1-E-NTH	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT T1-F-STH	T1-F-STH	0.0243	100.0	0.0	0.0	5	0	0										0				1
CAT P4_10	P4_10	0.0243	0.0	100.0	0.0	5	5	0										0				1
CAT GD3	GD3	0.0040	100.0	0.0	0.0	5	5	2										0				1
PIPE DETAILS																						
Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg	Rl	Chg	RL	etc			
			(m)	(m)	(m)	(%)		(mm)	(mm)						(m)	(m)	(m)	(m)	(m)			
P4_13 - P5_13	P4_13	P5_13	38.1	6.250	6.060	0.50	uPVC, not	225	242	0.01	NewFixed	1	P4_13	0								
P5_13 - P6_13	P5_13	P6_13	5.2	6.060	5.960	1.92	uPVC, not	225	242	0.01	NewFixed	1	P5_13	0								
P6_13 - P7_13	P6_13	P7_13	20.1	5.960	5.860	0.50	uPVC, not	225	242	0.01	NewFixed	1	P6_13	0								
P7_13 - HW1	P7_13	HW1_V-DI	20.6	5.860	5.730	0.63	uPVC, not	225	242	0.01	NewFixed	1	P7_13	0								
P1_11 - P2_11	P1-11	P2-11	9.7	6.150	6.053	1.00	uPVC, not	150	154	0.01	NewFixed	1	P1-11	0								

P2-11_P3-11	P2-11	P3-11	11.6	6.003	5.887	1.00	uPVC, not	150	154	0.01	NewFixed	1	P2-11	0
TRENCH-11_1	P3-11	TRENCH_	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P3-11	0
P3_1 - P4_1	P3_1	P4_1	9.7	5.857	5.808	0.51	uPVC, und	100	105	0.01	NewFixed	1	P3_1	0
P4_1 - P5_1	P4_1	P5_1	12.8	5.808	5.744	0.50	uPVC, und	225	239	0.01	NewFixed	1	P4_1	0
P5_1 - P6_1	P5_1	P6_1	12.3	5.744	5.682	0.50	uPVC, und	225	239	0.01	NewFixed	1	P5_1	0
P6_1 - P7_1	P6_1	P7_1	13.2	5.682	5.616	0.50	uPVC, und	300	303	0.01	NewFixed	1	P6_1	0
P7_1 - GPT_BRB3	P7_1	GPT-BRB3	1.2	5.616	5.610	0.50	uPVC, not	225	242	0.01	NewFixed	1	P7_1	0
GPT_BRB3 - BRB3	GPT-BRB3	HW1-BRB3	2	5.610	5.600	0.50	uPVC, not	225	242	0.01	NewFixed	1	GPT-BRB3	0
P2_1 - P1_1 + GD4	P2_1	P1_1 + GD	18.4	5.800	5.708	0.50	uPVC, und	150	154	0.01	NewFixed	1	P2_1	0
P1_1 - P2_6	P1_1 + GD	P2_6	14.5	5.708	5.635	0.50	uPVC, und	150	154	0.01	NewFixed	1	P1_1 + GD	0
P2_6 - ExP5	P2_6	ExP5	3.8	5.635	5.597	1.00	uPVC, und	225	239	0.01	NewFixed	1	P2_6	0
ExP5 - ExP4	ExP5	ExP4	42.3	5.102	5.000	0.24	Concrete, u	375	375	0.013	Existing	1	ExP5	0
Pipe1059	ExP4	CHATHAM	21	5.000	4.958	0.20	Concrete, u	375	375	0.013	Existing	1	ExP4	0
Pipe17	P2_2	P3_2	8	6.003	5.923	1.00	uPVC, not	150	154	0.01	NewFixed	1	P2_2	0
P3_2 - HW2	P3_2	HW2 (BRB	7.3	5.873	5.800	1.00	uPVC, not	150	154	0.01	NewFixed	1	P3_2	0
GD2 - SAND FILTER	GD2_NOR	SAND_FIL	6	5.930	5.860	1.17	uPVC, not	150	154	0.01	NewFixed	1	GD2_NOR	0
SAND_FILTER_INLET2	SAND_FIL	SAND FILT	2.5	5.660	5.630	1.20	uPVC, not	225	242	0.01	NewFixed	1	SAND_FIL	0
SAND FILTER - P4_17	SAND FILT	P4_27	3.5	5.230	5.200	0.86	uPVC, not	150	154	0.01	NewFixed	1	SAND FILT	0
P4_17 - P5_27	P4_27	P5_17	3.8	5.200	5.160	1.05	uPVC, not	150	154	0.01	NewFixed	1	P4_27	0
P5_17 - ExP6	P5_17	ExP6	6	5.140	5.070	1.17	Concrete, u	375	375	0.013	NewFixed	1	P5_17	0
ExP6 - Chatham North	ExP6	Chatham S	12	5.070	4.950	1.00	Concrete, u	375	375	0.013	Existing	1	ExP6	0
P1_17 - P2_17	P1_17	P2_17	15	5.900	5.820	0.53	uPVC, und	225	239	0.01	NewFixed	1	P1_17	0
P1_16 - P2_16	P1_16	P2_16	14.7	6.030	5.880	1.02	uPVC, not	150	154	0.01	NewFixed	1	P1_16	0
Pipe69	P2_16	ExPit_Trac	11	5.830	5.290	4.91	uPVC, not	150	154	0.01	NewFixed	1	P2_16	0
Pipe at Track Crossing	ExPit_Trac	JP at Track	3.8	4.760	4.722	1.00	Concrete, r	375	375	0.013	Existing	1	ExPit_Trac	0
T1-B-N_P3-11	Tank_T1-B	P3-11	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	Tank_T1-B	0
T1-A-S_P4-9	Tank_T1-A	P4-11	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	Tank_T1-A	0
TRENCH-11_2	P4-11	TRENCH_	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P4-11	0
P1-9_P2-9	P1-9	P2-9	9.7	6.150	6.053	1.00	uPVC, not	150	154	0.01	NewFixed	1	P1-9	0
P2-9_P3-9	P2-9	P3-9	11.6	6.003	5.887	1.00	uPVC, not	150	154	0.01	NewFixed	1	P2-9	0
P196	P3-9	TRENCH9	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P3-9	0
T1-C-N_P3-9	T1-C-N	P3-9	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	T1-C-N	0
TANK-T1-B-S_P4-9	TANK-T1-B	P4-9	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	TANK-T1-B	0
P198	P4-9	TRENCH9	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P4-9	0
P1_13 - P2_13	P1_13	P2_13	21.5	6.280	6.170	0.51	uPVC, not	150	154	0.01	NewFixed	1	P1_13	0
P2_13 - P3_13	P2_13	P3_13	21	6.170	6.060	0.52	uPVC, not	150	154	0.01	NewFixed	1	P2_13	0
P3_13 - P6_13	P3_13	P6_13	9	6.060	5.960	1.11	uPVC, not	150	154	0.01	NewFixed	1	P3_13	0
P2_3 BASIN OUTLET	P2_3 BASI	P3-3	2.4	6.211	6.187	1.00	uPVC, not	100	105	0.01	NewFixed	1	P2_3 BASI	0
P3_3 - P5_3	P3-3	P5_3	20.8	6.187	5.979	1.00	uPVC, not	300	303	0.01	NewFixed	1	P3-3	0
P5_3 - P6_3	P5_3	P6_3	7.4	5.979	5.905	1.00	uPVC, not	300	303	0.01	NewFixed	1	P5_3	0
P6_3 - P8_3	P6_3	P7_3	15.4	5.905	5.751	1.00	uPVC, not	300	303	0.01	NewFixed	1	P6_3	0
P8_3 - P10_3	P7_3	Pit21	14.1	5.751	5.610	1.00	uPVC, not	300	303	0.01	NewFixed	1	P7_3	0
P10_3 - P11_3	Pit21	P11_3	17.2	5.610	5.438	1.00	uPVC, not	300	303	0.01	NewFixed	1	Pit21	0
P11_3 - P5_15	P11_3	Pit15	10.3	5.438	5.335	1.00	uPVC, not	300	303	0.01	NewFixed	1	P11_3	0
P5_15 - ExP1	Pit15	ExP1	5.4	5.235	5.127	2.00	uPVC, not	300	303	0.01	NewFixed	1	Pit15	0
ExP1 - DARLING_ST_RN	ExP1	DARLING_	10	4.820	4.786	0.34	Concrete, u	375	375	0.013	Existing	1	ExP1	0
P1_15 BASIN OUTLET	P1_15 BAS	P1_15	2.4	5.825	5.801	1.00	uPVC, not	100	105	0.01	NewFixed	1	P1_15 BAS	0
P1_15 - P2_15	P1_15	P2_15	20.7	5.801	5.698	0.50	uPVC, not	150	154	0.01	New	1	P1_15	0
P2_15 - P3_15	P2_15	P3_15	23.4	5.698	5.581	0.50	uPVC, not	150	154	0.01	NewFixed	1	P2_15	0
P3_15 - P4_15	P3_15	P4_15	31.9	5.581	5.421	0.50	uPVC, not	150	154	0.01	NewFixed	1	P3_15	0
P4_15 - P5_15	P4_15	Pit15	8.6	5.421	5.335	1.00	uPVC, not	150	154	0.01	NewFixed	1	P4_15	0
P2_15 BASIN OUTLET	P2_15 BAS	P2_15	2.4	5.722	5.698	1.00	uPVC, not	100	105	0.01	NewFixed	1	P2_15 BAS	0
P4_3 BASIN OUTLET	P4_3 BASI	P5_3	2.4	6.003	5.979	1.00	uPVC, not	100	105	0.01	NewFixed	1	P4_3 BASI	0
P3_15 BASIN OUTLET	P3_15 BAS	P3_15	2.4	5.605	5.581	1.00	uPVC, not	100	105	0.01	NewFixed	1	P3_15 BAS	0
P7_3 BASIN OUTLET	P7_3 BASI	P7_3	2.4	5.775	5.751	1.00	uPVC, not	100	105	0.01	NewFixed	1	P7_3 BASI	0
P9_3 BASIN OUTLET	P9_3 BASI	Pit21	2.4	5.634	5.610	1.00	uPVC, not	100	105	0.01	NewFixed	1	P9_3 BASI	0
P4_15 BASIN OUTLET	P4_15 BAS	P4_15	2.4	5.445	5.421	1.00	uPVC, not	100	105	0.01	NewFixed	1	P4_15 BAS	0
block d roof - brb1	BLOCK_D	BRB1	19	6.550	5.900	3.42	uPVC, not	150	154	0.01	NewFixed	1	BLOCK_D	0
BRB1 - BRB2	BRB1	BRB2	22	5.200	5.100	0.45	uPVC, not	100	105	0.01	NewFixed	1	BRB1	0
P2_4 - P3_4	BRB2	P3_4	6	5.100	5.066	0.57	uPVC, not	100	105	0.01	NewFixed	1	BRB2	0
P3_4 - P4_4	P3_4	P4_4	2.6	5.066	5.053	0.50	Concrete, r	375	375	0.013	NewFixed	1	P3_4	0
P4_4 - ExP2	P4_4	ExP2	31.3	5.053	4.947	0.34	Concrete, u	375	375	0.013	NewFixed	1	P4_4	0
ExP2 - ExP1	ExP2	ExP1	37.4	4.947	4.820	0.34	Concrete, u	375	375	0.013	Existing	1	ExP2	0
P11_3 BASIN OUTLET	P11_3 BAS	P11_3	2.4	5.462	5.438	1.00	uPVC, not	100	105	0.01	NewFixed	1	P11_3 BAS	0
P3_19 BASIN OUTLET	P3_19 BAS	P3_19	2.4	5.547	5.523	1.00	uPVC, not	100	105	0.01	NewFixed	1	P3_19 BAS	0
P3_19 - P11_3	P3_19	P11_3	16.9	5.523	5.438	0.50	uPVC, not	150	154	0.01	NewFixed	1	P3_19	0
P2_19 BASIN OUTLET	P2_19 BAS	P2_19	2.4	5.623	5.599	1.00	uPVC, not	100	105	0.01	NewFixed	1	P2_19 BAS	0
P2_19 - P3_19	P2_19	P3_19	15.2	5.599	5.523	0.50	uPVC, not	150	154	0.01	NewFixed	1	P2_19	0

P1_19 BASIN OUTLET	P1_19 BAS	P1_19	2.4	5.698	5.674	1.00	uPVC, not	100	105	0.01	NewFixed	1	P1_19 BAS	0			
P1_19 - P2_19	P1_19	P2_19	15	5.674	5.599	0.50	uPVC, not	150	154	0.01	NewFixed	1	P1_19	0			
ExP3 - ExP2	ExP3	ExP2	1.4	4.961	4.947	1.00	Concrete,	375	375	0.013	Existing	1	ExP3	0			
P2_18 BASIN OUTLET	Basin73	P2_18	2.4	5.718	5.694	1.00	uPVC, und	100	105	0.01	NewFixed	1	Basin73	0			
P2_18 - P10_3	P2_18	Pit21	16.9	5.694	5.610	0.50	uPVC, und	150	154	0.01	NewFixed	1	P2_18	0			
P1_18 BASIN OUTLET	Basin76	P1_18	2.4	5.794	5.770	1.00	uPVC, und	100	105	0.01	NewFixed	1	Basin76	0			
P1_19 - P2_18	P1_18	P2_18	15.2	5.770	5.694	0.50	uPVC, und	150	154	0.01	NewFixed	1	P1_18	0			
GD1 - P3_4	GD1	P3_4	7	5.136	5.066	1.00	Concrete,	150	150	0.013	NewFixed	1	GD1	0			
CONCOURSE - BRB1	L1 CONCO	BRB1	13	6.550	5.900	5.00	uPVC, not	225	242	0.01	NewFixed	1	L1 CONCO	0			
P1_7 - P2_7	P1_7	P2_7	9.7	6.150	6.053	1.00	uPVC, not	150	154	0.01	NewFixed	1	P1_7	0			
P2_7 - P3_7	P2_7	P3_7	11.6	6.003	5.887	1.00	uPVC, not	150	154	0.01	NewFixed	1	P2_7	0			
P3_7 - TRENCH7	P3_7	TRENCH7	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P3_7	0			
T1-D-NTH OVERFLOW	T1-D-NTH	P3_7	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	T1-D-NTH	0			
T1-C-STH - P4_7	T1-C-STH	P4_7	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	T1-C-STH	0			
P4_7 = TRENCH7	P4_7	TRENCH7	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P4_7	0			
BRB3 - ExP4	BRB3	ExP4	10	5.100	5.000	1.00	uPVC, not	100	105	0.01	NewFixed	1	BRB3	0			
T1 - P1_6	T1-GOOD	P1_6	1.2	5.900	5.888	1.00	uPVC, und	150	154	0.01	NewFixed	1	T1-GOOD	0			
P1_6 - P2_6	P1_6	P2_6	21.6	5.868	5.652	1.00	uPVC, und	150	154	0.01	NewFixed	1	P1_6	0			
T1 - P2_6	T1-GOOD-	P2_6	1.2	5.900	5.888	1.00	uPVC, und	150	154	0.01	NewFixed	1	T1-GOOD-	0			
P1_8 - P2_8	P1_8	P2_8	16	6.300	6.140	1.00	uPVC, not	150	154	0.01	NewFixed	1	P1_8	0			
P2_8 - TRENCH8	P2_8	P3_8	17.3	6.140	5.967	1.00	uPVC, not	150	154	0.01	NewFixed	1	P2_8	0			
P3_8 - TRENCH8	P3_8	TRENCH8	5	5.320	5.070	5.00	uPVC, not	150	154	0.01	NewFixed	1	P3_8	0			
T2-EQPSHD - P3_8	T2-EQSHD	P3_8	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	T2-EQSHD	0			
T1-E-STH - P4_8	T1-E-STH	P4_8	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	T1-E-STH	0			
P4_8 - TRENCH8	P4_8	TRENCH8	5	5.320	5.070	5.00	uPVC, not	150	154	0.01	NewFixed	1	P4_8	0			
P1_10 - P2_10	P1_10	P2_10	9.7	6.150	6.053	1.00	uPVC, not	150	154	0.01	NewFixed	1	P1_10	0			
P2_10 - P3_10	P2_10	P3_10	11.6	6.003	5.887	1.00	uPVC, not	150	154	0.01	NewFixed	1	P2_10	0			
P3_10 - TRENCH10	P3_10	TRENCH1	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P3_10	0			
P1008	T1-E-NTH	P3_10	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	T1-E-NTH	0			
T1-F-STH - P4_10	T1-F-STH	P4_10	2	6.090	6.050	2.00	uPVC, not	150	154	0.01	NewFixed	1	T1-F-STH	0			
P4_10 - TRENCH10	P4_10	TRENCH1	12.5	5.320	5.070	2.00	uPVC, not	150	154	0.01	NewFixed	1	P4_10	0			
GD3 - P7_1	GD3	P7_1	10	5.791	5.691	1.00	uPVC, und	150	154	0.01	NewFixed	1	GD3	0			
P2_17 - P3_17	N197	P3_17	13	5.800	5.700	0.77	uPVC, und	225	239	0.01	NewFixed	1	N197	0			
P3_17 - GPT	P3_17	GPT-4200	2.4	5.700	5.680	0.83	uPVC, not	225	242	0.01	NewFixed	1	P3_17	0			
GPT - SAND FILTER	GPT-4200	SAND_FIL	2.4	5.680	5.660	0.83	uPVC, not	225	242	0.01	NewFixed	1	GPT-4200	0			
SAND_TANK_INLET1	SAND_FIL	SAND_FIL1	2.5	5.660	5.630	1.20	uPVC, not	225	242	0.01	NewFixed	1	SAND_FIL	0			
DETAILS of SERVICES CROSSING PIPES																	
Pipe	Chg	Bottom	Height of S	Chg	Bottom	Height of S	Chg	Bottom	Height of S	etc							
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc							
CHANNEL DETAILS																	
Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Widtl	L.B. Slope	R.B. Slope	Manning	Depth	Roofed				
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)					
OVERFLOW ROUTE DETAILS																	
Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Deptl	SafeDepth	Safe	Bed	D/S Area		id	U/S IL	D/S IL	Length (m)
			Time	Level	Length	Coeff. C	Section	Major Storr	Minor Storr	DxV	Slope	Contributing					
			(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%					
OF P4_13 - BYPASS2	P4_13	BYPASS2	0.1				4m wide gr	1.2	0.3	0.4	0.79	0		1413	6.71	6.65	7
OF P5_13 - BYPASS1	P5_13	BYPASS1	0.1				4m wide gr	1.2	0.3	0.4	16.67	0		1395	6.79	6.6	1.14
OF P6_13 - P7_13	P6_13	P7_13	0.2				4m wide gr	1.2	0.3	0.4	1.39	0		1213	6.78	6.5	20.1
OF P7_13 - TRACK2	P7_13	TRACK2	0.2				4m wide gr	1.2	0.3	0.4	0.81	0		1215	6.5	6.37	16
V-DRAIN	HW1_V-DI	ExPit_Trac	1.4				NJC V-DR.	1.2	0.6	0.6	0.24	100		845	5.73	5.59	58
OF P1_11 - P3_11	P1-11	P3-11	0.1				4m wide gr	1.2	0.3	0.4	1.00	0		1386	6.7	6.6	10
OF P2_11 - P3_11	P2-11	P3-11	0.1				4m wide gr	1.2	0.3	0.4	1.33	0		1387	6.7	6.6	7.5
OF P3_11 - TRENCH11	P3-11	TRENCH_	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		1388	6.5	6.4	12.5
OF TRENCH11 - BYPASS2	TRENCH_	P4_13	0.1	6.800	4	1.62	4m wide gr	1.2	0.3	0.4	1.00	0		1499	6.8	6.71	9
OF P3_1 - P4_1	P3_1	P4_1	0.1				Gutter Flov	0.3	0.3	0.36	1.03	0		79375	6.3	6.25	4.85
OF P4_1 - P5_1	P4_1	P5_1	0.1				Gutter Flov	0.3	0.3	0.36	0.78	0		79565	6.3	6.25	6.4
OF P5_1 - P6_1	P5_1	P6_1	0.1				Gutter Flov	0.3	0.3	0.36	0.81	0		79657	6.3	6.25	6.15
OF P6_1 - GD3	P6_1	GD3	0.1				Gutter Flov	0.3	0.3	0.36	0.33	0		79768	6.45	6.44	3
OF HW1 - BRB3	HW1-BRB	BRB3	0.1				4m wide gr	1.2	0.3	0.4	1.00	0		83853	5.6	5.5	10
OF386	P2_1	P3_1	0.1				Dummy OF	0.15	0.05	0.36	1.49	0		125429	6.35	6.25	6.7
OF372	ExP5	ExP4	0.7				Gutter Flov	0.3	0.3	0.36	0.24	0		119287	6.15	6.05	41.3
OF374	ExP4	CHATHAM	0.1				PAVEMEN	0.3	0.3	0.4	1.30	0		121667	6.17	6.05	9.2
OF P2_2 - BRB2	P2_2	N469	0.1				Pathway 4	0.3	0.15	0.6	9.58	0		53808	6.86	6.4	4.8
OF P3_2	P3_2	N469	0.1				Pathway 4	0.3	0.15	0.6	9.58	0		53880	6.68	6.4	4.8

OF234	HW2 (BRB	BRB2	0.1				4m wide gr	1.2	0.3	0.4	2.86	0		54467	5.8	5.6	7
OF GD2 - ExP6	GD2_NOR	ExP6	0.1				Gutter Flov	0.3	0.3	0.36	4.75	0		43863681	6.45	6.26	4
OF SandFilterNth - P5_17	SAND_FIL	P5_17	0.1				Spillway	0.3	0.3	0.36	6.63	0		850	6.8	6.27	8
OF SandFilter - P5_17	SAND FIL1	P5_17	0.1	6.800	5	1.62	7.5m wide	0.3	0.3	0.36	6.63	0		855	6.8	6.27	8
OF P4_17 - P5_17	P4_27	P5_17	0.1				7.5m wide	0.3	0.3	0.36	5.75	0		849	6.5	6.27	4
OF P5_17 - eXp6	P5_17	ExP6	0.2				Gutter Flov	0.3	0.3	0.36	0.12	0		856	6.27	6.26	8
OF ExP6 - ChathamSt Node	ExP6	Chatham S	0.1				20 m wide	0.2	0.2	0.4	6.67	0		857	6.61	6.27	6
OF P1_17 - GD2	P1_17	GD2_NOR	0.1				7.5m wide	0.3	0.3	0.36	1.67	100		846	6.65	6.45	12
OF P2_17 - GD2	P2_17	GD2_NOR	0.1				Gutter Flov	0.3	0.3	0.36	3.90	0		847	6.84	6.45	10
OF P1_16 - P2_16	P1_16	P2_16	0.1				7.5m wide	0.3	0.3	0.36	2.74	0		1028	6.75	6.55	7.3
OF P2_16 - ExPt_Track	P2_16	ExPit_Trac	0.1				7.5m wide	0.3	0.3	0.36	13.47	0		1029	6.6	5.59	7.5
OF_TO_TRACK1	ExPit_Trac	TRACK1	0.1				20 m wide	0.2	0.2	0.4	3.30	0		1044	6.37	6.04	10
OF P4_11 - TRENCH11	P4-11	TRENCH_	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		1389	6.5	6.4	12.5
OF P1_9 - P3_9	P1-9	P3-9	0.1				4m wide gr	1.2	0.3	0.4	1.00	0		1567	6.7	6.6	10
OF P2_9 - P3_9	P2-9	P3-9	0.1				4m wide gr	1.2	0.3	0.4	1.33	0		1553	6.7	6.6	7.5
OF P3_9 - TRENCH9	P3-9	TRENCH9	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		1576	6.5	6.4	12.5
OF TRENCH9 - BYPASS3	TRENCH9	P2_3 BASI	0.1	6.800	4	1.62	4m wide gr	1.2	0.3	0.4	1.00	0		1590	6.8	6.71	9
OF P4-9 - TRENCH9	P4-9	TRENCH9	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		1582	6.5	6.4	12.5
OF P1_13 - P2_13	P1_13	P2_13	0.1				4m wide gr	1.2	0.3	0.4	2.38	0		1210	6.85	6.6	10.5
OF P2_13 - P3_13	P2_13	P3_13	0.1				4m wide gr	1.2	0.3	0.4	2.38	0		1211	6.85	6.6	10.5
OF P3_13 - P6_13	P3_13	P6_13	0.1				4m wide gr	1.2	0.3	0.4	1.56	0		1212	6.85	6.78	4.5
OF BYP2 - BYP1	BYPASS2	BYPASS1	1.3				4m wide gr	1.2	0.3	0.4	0.15	0		19606	6.65	6.6	36
OF BYP1 - P7_13	BYPASS1	P7_13	0.6				4m wide gr	1.2	0.3	0.4	0.38	0		20040	6.6	6.5	26
OF1 P2_3 - P1_15	P2_3 BASI	P1_15 BAS	0.1	6.890	10	1.62	Spillway	0.3	0.3	0.36	4.88	0		17105	6.89	6.48	8.4
OF P1_15 - P2_15	P1_15 BAS	P2_15 BAS	0.1	6.590	2.7	1.62	Gutter Flov	0.3	0.3	0.36	1.03	50		21071	6.59	6.48	10.7
OF P2_15 - P3_15	P2_15 BAS	P3_15 BAS	0.1	6.590	2.7	1.62	Gutter Flov	0.3	0.3	0.36	0.87	50		23665	6.59	6.48	12.7
OF P4_3 - P2_15	P4_3 BASI	P2_15 BAS	0.1	6.890	20	1.62	20 m wide	0.2	0.2	0.4	4.88	0		17172	6.89	6.48	8.4
OF P3_15 - P4_15 BASIN	P3_15 BAS	P4_15 BAS	0.1	6.590	2.7	1.62	Gutter Flov	0.3	0.3	0.36	0.87	40		24193	6.59	6.48	12.7
OF P7_3 - P3_15	P7_3 BASI	P3_15 BAS	0.1	6.890	20	1.62	20 m wide	0.2	0.2	0.4	4.88	0		17519	6.89	6.48	8.4
OF P9_3 BASIN - P11_3 BAS	P9_3 BASI	P11_3 BAS	0.1	6.890	10	1.62	Spillway	0.3	0.3	0.36	4.88	0		29140	6.89	6.48	8.4
OF P4_15 BASIN	P4_15 BAS	N402	0.1	6.630	10	1.62	Spillway	0.3	0.3	0.36	10.62	0		31478	6.63	5.94	6.5
OF BRB1 - BRB2	BRB1	N480	0.1	6.100	3	1.62	4m wide gr	1.2	0.3	0.4	1.00	0		58680	6.1	6	10
OF BRB2 - N458	BRB2	N458	0.1	6.200	18	1.62	20 m wide	0.2	0.2	0.4	5.45	0		51134	6.2	5.944	4.7
OF P11_3 BASIN	P11_3 BAS	N403	0.1	6.630	10	1.62	Spillway	0.3	0.3	0.36	11.69	0		31421	6.63	5.87	6.5
OF P3_19 BASIN	P3_19 BAS	N404	0.1	6.630	10	1.62	Spillway	0.3	0.3	0.36	12.62	0		31317	6.63	5.81	6.5
OF P2_19 BASIN	P2_19 BAS	N405	0.1	6.630	10	1.62	Spillway	0.3	0.3	0.36	12.72	0		31252	6.63	5.803	6.5
OF P1_19 BASIN	P1_19 BAS	N406	0.1	6.630	4	1.62	4m wide gr	1.2	0.3	0.4	11.75	0		31192	6.63	5.866	6.5
OF179	N402	N403	0.3				Gutter Flov	0.3	0.3	0.36	0.35	0		33718	5.94	5.87	20
OF181	N403	N404	0.3				Gutter Flov	0.3	0.3	0.36	0.34	0		33856	5.87	5.81	17.6
OF184	N404	ExP3	0.1				Gutter Flov	0.3	0.3	0.36	0.32	0		34151	5.81	5.78	9.5
OF178	N405	ExP3	0.1				Gutter Flov	0.3	0.3	0.36	0.37	0		33625	5.803	5.78	6.2
OF172	N406	N405	0.2				Gutter Flov	0.3	0.3	0.36	0.40	0		31112	5.866	5.803	15.8
OF395	ExP3	N646	0.1				30m wide s	0.3	0.3	0.6	8.17	0		126690	6.27	5.78	6
OF P2_18 BASIN - P3_19 BA	Basin73	P3_19 BAS	0.1	6.890	10	1.62	Spillway	0.3	0.3	0.36	4.88	0		42324	6.89	6.48	8.4
OF P1_18 BASIN - P2_19 BA	Basin76	P2_19 BAS	0.1	6.890	10	1.62	Spillway	0.3	0.3	0.36	4.88	0		42639	6.89	6.48	8.4
OF219	N458	N406	0.3				Gutter Flov	0.3	0.3	0.36	0.34	0		50632	5.944	5.866	23
OF230	N469	HW2 (BRB	0.1				4m wide gr	1.2	0.3	0.4	37.50	0		53962	6.4	5.8	1.6
OF N480 - BRB2	N480	BRB2	0.1				4m wide gr	1.2	0.3	0.4	2.86	0		58757	6	5.6	14
OF262	P1_7	P3_7	0.1				4m wide gr	1.2	0.3	0.4	1.00	0		67973	6.7	6.6	10
OF P2_7 - P3_7	P2_7	P3_7	0.1				4m wide gr	1.2	0.3	0.4	1.33	0		68318	6.7	6.6	7.5
OF P3_7 - TRENCH7	P3_7	TRENCH7	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		67677	6.5	6.4	12.5
OF243	TRENCH7	P4_3 BASI	0.1	6.800	4	1.62	4m wide gr	1.2	0.3	0.4	1.00	0		66584	6.8	6.71	9
OF254	P4_7	TRENCH7	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		67340	6.5	6.4	12.5
OF BRB3 - ExP4	BRB3	ExP4	0.1	6.400	4	1.62	4m wide gr	1.2	0.3	0.4	7.00	0		84179	6.4	6.05	5
OF P1_8 - P2_8	P1_8	P2_8	0.2				4m wide gr	1.2	0.3	0.4	0.59	0		91577	6.6	6.55	8.5
OF P2_8 - P3_8	P2_8	P3_8	0.2				4m wide gr	1.2	0.3	0.4	0.53	0		91626	6.55	6.5	9.5
OF P3_8 - TRENCH8	P3_8	TRENCH8	0.1				4m wide gr	1.2	0.3	0.4	2.00	0		99254	6.5	6.4	5
OF TRENCH8 - CHATHAM-F	TRENCH8	CHATHAM	0.1	6.700	4	1.62	4m wide gr	1.2	0.3	0.4	4.55	0		99757	6.7	6.2	11
OF P4_8 - TRENCH8	P4_8	TRENCH8	0.1				4m wide gr	1.2	0.3	0.4	2.00	0		98982	6.5	6.4	5
OF370	CHATHAM	ExP5	1.1				Gutter Flov	0.3	0.3	0.36	0.11	0		118007	6.2	6.15	44
OF P1_10 - P3_10	P1_10	P3_10	0.1				4m wide gr	1.2	0.3	0.4	1.00	0		104583	6.7	6.6	10
OF P2_10 - P3_10	P2_10	P3_10	0.1				4m wide gr	1.2	0.3	0.4	1.33	0		106203	6.7	6.6	7.5
OF P3_10 - TRENCH10	P3_10	TRENCH1	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		112022	6.5	6.4	12.5
OF TRENCH10 - CHATHAM-	TRENCH1	CHATHAM	0.1	6.700	4	1.62	4m wide gr	1.2	0.3	0.4	3.64	0		111010	6.7	6.3	11
OF P4_10 - TRENCH10	P4_10	TRENCH1	0.2				4m wide gr	1.2	0.3	0.4	0.80	0		111646	6.5	6.4	12.5
OF368	CHATHAM	CHATHAM	0.6				Gutter Flov	0.3	0.3	0.36	0.27	0		117085	6.3	6.2	36.8
OF GD3 - BRB3	GD3	HW1-BRB	0.1				PAVEMEN	0.3	0.3	0.4	5.20	0		131686	6.44	5.8	12.3
OF SandFilterSth - P5_17	SAND_FIL	P5_17	0.1				Spillway	0.3	0.3	0.36	6.63	0		848	6.8	6.27	8

PIPE COVER DETAILS					
Name	Type	Dia (mm)	Safe Cove	Cover (m)	
P4_13 - P5_13	uPVC, not	242	0.6	0.21	Unsafe
P5_13 - P6_13	uPVC, not	242	0.6	0.48	Unsafe
P6_13 - P7_13	uPVC, not	242	0.6	0.39	Unsafe
P7_13 - HW1	uPVC, not	242	0.6	-0.25	Unsafe
P1_11 - P2_11	uPVC, not	154	0.6	0.29	Unsafe
P2-11_P3-11	uPVC, not	154	0.6	0.44	Unsafe
TRENCH-11_1	uPVC, not	154	0.6	-0.16	Unsafe
P3_1 - P4_1	uPVC, und	105	0.6	0.29	Unsafe
P4_1 - P5_1	uPVC, und	239	0.6	0.20	Unsafe
P5_1 - P6_1	uPVC, und	239	0.6	0.26	Unsafe
P6_1 - P7_1	uPVC, und	303	0.6	0.26	Unsafe
P7_1 - GPT_BRB3	uPVC, not	242	0.6	0.76	
GPT_BRB3 - BRB3	uPVC, not	242	0.6	-0.25	Unsafe
P2_1 - P1_1 + GD4	uPVC, und	154	0.6	0.29	Unsafe
P1_1 - P2_6	uPVC, und	154	0.6	0.49	Unsafe
P2_6 - ExP5	uPVC, und	239	0.6	0.31	Unsafe
ExP5 - ExP4	Concrete,	375	0.6	0.64	
Pipe1059	Concrete,	375	0.6	0.64	
Pipe17	uPVC, not	154	0.6	0.60	
P3_2 - HW2	uPVC, not	154	0.6	-0.16	Unsafe
GD2 - SAND FILTER	uPVC, not	154	0.6	0.36	Unsafe
SAND_FILTER_INLET2	uPVC, not	242	0.6	-0.65	Unsafe
SAND FILTER - P4_17	uPVC, not	154	0.6	-0.16	Unsafe
P4_17 - P5_27	uPVC, not	154	0.6	0.95	
P5_17 - ExP6	Concrete,	375	0.6	0.72	
ExP6 - Chatham North	Concrete,	375	0.6	0.78	
P1_17 - P2_17	uPVC, und	239	0.6	0.36	Unsafe
P1_16 - P2_16	uPVC, not	154	0.6	0.44	Unsafe
Pipe69	uPVC, not	154	0.6	0.14	Unsafe
Pipe at Track Crossing	Concrete,	375	0.6	0.42	Unsafe
T1-B-N_P3-11	uPVC, not	154	0.6	0.25	Unsafe
T1-A-S_P4-9	uPVC, not	154	0.6	0.25	Unsafe
TRENCH-11_2	uPVC, not	154	0.6	-0.16	Unsafe
P1-9_P2-9	uPVC, not	154	0.6	0.29	Unsafe
P2-9_P3-9	uPVC, not	154	0.6	0.44	Unsafe
P196	uPVC, not	154	0.6	-0.16	Unsafe
T1-C-N_P3-9	uPVC, not	154	0.6	0.25	Unsafe
TANK-T1-B-S_P4-9	uPVC, not	154	0.6	0.25	Unsafe
P198	uPVC, not	154	0.6	-0.16	Unsafe
P1_13 - P2_13	uPVC, not	154	0.6	0.16	Unsafe
P2_13 - P3_13	uPVC, not	154	0.6	0.27	Unsafe
P3_13 - P6_13	uPVC, not	154	0.6	0.38	Unsafe
P2_3 BASIN OUTLET	uPVC, not	105	0.6	0.29	Unsafe
P3_3 - P5_3	uPVC, not	303	0.6	0.42	Unsafe
P5_3 - P6_3	uPVC, not	303	0.6	0.63	
P6_3 - P8_3	uPVC, not	303	0.6	0.71	
P8_3 - P10_3	uPVC, not	303	0.6	0.86	
P10_3 - P11_3	uPVC, not	303	0.6	0.88	
P11_3 - P5_15	uPVC, not	303	0.6	0.88	
P5_15 - ExP1	uPVC, not	303	0.6	0.68	
ExP1 - DARLING_ST_RN	Concrete,	375	0.6	0.89	
P1_15 BASIN OUTLET	uPVC, not	105	0.6	0.45	Unsafe
P1_15 - P2_15	uPVC, not	154	0.6	0.52	Unsafe
P2_15 - P3_15	uPVC, not	154	0.6	0.63	
P3_15 - P4_15	uPVC, not	154	0.6	0.74	
P4_15 - P5_15	uPVC, not	154	0.6	0.90	
P2_15 BASIN OUTLET	uPVC, not	105	0.6	0.55	Unsafe
P4_3 BASIN OUTLET	uPVC, not	105	0.6	0.50	Unsafe
P3_15 BASIN OUTLET	uPVC, not	105	0.6	0.67	
P7_3 BASIN OUTLET	uPVC, not	105	0.6	0.73	
P9_3 BASIN OUTLET	uPVC, not	105	0.6	0.87	
P4_15 BASIN OUTLET	uPVC, not	105	0.6	0.73	
block d roof - brb1	uPVC, not	154	0.6	-0.86	Unsafe
BRB1 - BRB2	uPVC, not	105	0.6	-0.11	Unsafe

P2_4 - P3_4	uPVC, not	105	0.6	-0.11	Unsafe
P3_4 - P4_4	Concrete,	375	0.6	0.54	Unsafe
P4_4 - ExP2	Concrete,	375	0.6	0.54	Unsafe
ExP2 - ExP1	Concrete,	375	0.6	0.66	
P11_3 BASIN OUTLET	uPVC, not	105	0.6	0.81	
P3_19 BASIN OUTLET	uPVC, not	105	0.6	0.73	
P3_19 - P11_3	uPVC, not	154	0.6	0.95	
P2_19 BASIN OUTLET	uPVC, not	105	0.6	0.65	
P2_19 - P3_19	uPVC, not	154	0.6	0.87	
P1_19 BASIN OUTLET	uPVC, not	105	0.6	0.57	Unsafe
P1_19 - P2_19	uPVC, not	154	0.6	0.80	
ExP3 - ExP2	Concrete,	375	0.6	0.41	Unsafe
P2_18 BASIN OUTLET	uPVC, und	105	0.6	0.78	
P2_18 - P10_3	uPVC, und	154	0.6	1.01	
P1_18 BASIN OUTLET	uPVC, und	105	0.6	0.71	
P1_19 - P2_18	uPVC, und	154	0.6	0.93	
GD1 - P3_4	Concrete,	150	0.6	0.85	
CONCOURSE - BRB1	uPVC, not	242	0.6	-0.95	Unsafe
P1_7 - P2_7	uPVC, not	154	0.6	0.29	Unsafe
P2_7 - P3_7	uPVC, not	154	0.6	0.44	Unsafe
P3_7 - TRENCH7	uPVC, not	154	0.6	-0.16	Unsafe
T1-D-NTH OVERFLOW	uPVC, not	154	0.6	0.25	Unsafe
T1-C-STH - P4_7	uPVC, not	154	0.6	0.25	Unsafe
P4_7 = TRENCH7	uPVC, not	154	0.6	-0.16	Unsafe
BRB3 - ExP4	uPVC, not	105	0.6	-0.11	Unsafe
T1 - P1_6	uPVC, und	154	0.6	0.25	Unsafe
P1_6 - P2_6	uPVC, und	154	0.6	0.27	Unsafe
T1 - P2_6	uPVC, und	154	0.6	0.27	Unsafe
P1_8 - P2_8	uPVC, not	154	0.6	0.14	Unsafe
P2_8 - TRENCH8	uPVC, not	154	0.6	0.25	Unsafe
P3_8 - TRENCH8	uPVC, not	154	0.6	-0.16	Unsafe
T2-EQPSHD - P3_8	uPVC, not	154	0.6	0.25	Unsafe
T1-E-STH - P4_8	uPVC, not	154	0.6	0.25	Unsafe
P4_8 - TRENCH8	uPVC, not	154	0.6	-0.16	Unsafe
P1_10 - P2_10	uPVC, not	154	0.6	0.29	Unsafe
P2_10 - P3_10	uPVC, not	154	0.6	0.44	Unsafe
P3_10 - TRENCH10	uPVC, not	154	0.6	-0.16	Unsafe
P1008	uPVC, not	154	0.6	0.25	Unsafe
T1-F-STH - P4_10	uPVC, not	154	0.6	0.25	Unsafe
P4_10 - TRENCH10	uPVC, not	154	0.6	-0.16	Unsafe
GD3 - P7_1	uPVC, und	154	0.6	0.49	Unsafe
P2_17 - P3_17	uPVC, und	239	0.6	0.74	
P3_17 - GPT	uPVC, not	242	0.6	0.85	
GPT - SAND FILTER	uPVC, not	242	0.6	0.87	
SAND_TANK_INLET1	uPVC, not	242	0.6	-0.65	Unsafe

These pipes have non-return valves: GPT_BRB3 - BRB3, P1_17 - P2_17, P2_3 BASIN OUTLET, P1_15 BASIN OUTLET, P2_15 BASIN OUTLET, P4_3 BASIN OUTLET, P3_15 BASIN OUTLET, P7_3 BASIN OUTLET, P9_3 BASIN OUTLET, P4_15 BASIN OUTLET, BRB1 - BRB2, P11_3 BASIN OUTLET, P3_19 BASIN OUTLET, P2_19 BASIN OUTLET, P1_19 BASIN OUTLET, P2_18 BASIN OUTLET, P1_18 BASIN OUTLET

Pit	Initial K	Revised K	Chart (2008)	Ratios
GD3	5.01	5	A1-4	H/Do=0.5, Vo2/(2gDo)=0.01
ExP4	0.94	0.94	A1-25	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
ExP5	5.93	5.93	A1-4	H/Do=0.0, Vo2/(2gDo)=0.02
P4_10	1.79	1.79	A1-4	H/Do=7.4, Vo2/(2gDo)=0.34
P3_10	1.79	1.79	A1-4	H/Do=7.5, Vo2/(2gDo)=0.80
P2_10	2.27	2.27	A1-4	H/Do=3.0, Vo2/(2gDo)=0.12
P1_10	2.84	2.83	A1-4	H/Do=2.1, Vo2/(2gDo)=0.03
P2_8	3.3	3.31	A1-4	H/Do=1.6, Vo2/(2gDo)=0.08
P1_8	4.53	4.52	A1-4	H/Do=0.7, Vo2/(2gDo)=0.02
P6_1	1.56	1.56	A1-9	Du/Do=0.79, Qg/Qo=0.37, S/Do=1.3
P5_1	5.05	5.05	A1-4	H/Do=0.4, Vo2/(2gDo)=0.12
P4_1	4.68	4.66	A1-4	H/Do=0.6, Vo2/(2gDo)=0.02
P4_7	1.79	1.79	A1-4	H/Do=7.4, Vo2/(2gDo)=0.34
P3_7	1.79	1.79	A1-4	H/Do=7.5, Vo2/(2gDo)=0.80
P2_7	2.27	2.27	A1-4	H/Do=3.0, Vo2/(2gDo)=0.12
P1_7	2.84	2.83	A1-4	H/Do=2.1, Vo2/(2gDo)=0.03
ExP2	1.95	2.03	H-O'L	Qg/Qo=0.00, S/Do=1.0
ExP1	1.92	1.92	A1-24	Dl/Do=0.81, B/Do=2.40, (Qu/Qo)(Do/Du)=0.30
ExP3	7.92	7.92	A1-4	H/Do=0.0, Vo2/(2gDo)=0.01
P1_19	0.88	0.88	A1-14	Du/Do=0.68, Qg/Qo=0.00, S/Do=1.7
P7_3	1.23	1.23	A1-25	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
P6_3	0.2	0.2	A1-5	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
P5_3	1.75	1.75	A1-25	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
P1_13	5.93	5.93	A1-4	H/Do=0.0, Vo2/(2gDo)=0.01
P2_13	5.93	5.93	A1-4	H/Do=0.0, Vo2/(2gDo)=0.06
P2_17	1.5	not calculated		
P4-9	1.79	1.79	A1-4	H/Do=7.4, Vo2/(2gDo)=0.34
P3-9	1.79	1.79	A1-4	H/Do=7.5, Vo2/(2gDo)=0.80
P2-9	2.27	2.27	A1-4	H/Do=3.0, Vo2/(2gDo)=0.12
P1-9	2.84	2.83	A1-4	H/Do=2.1, Vo2/(2gDo)=0.03
P4-11	1.79	1.79	A1-4	H/Do=7.4, Vo2/(2gDo)=0.34
SAND_FILTER_NORTH	0	0	A1-9	Du/Do=0.64, Qg/Qo=0.00, S/Do=1.0
SAND_FILTER_STH PIT	0.2	0.2	A1-5	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
ExPit_Track	7.92	7.92	A1-4	H/Do=0.0, Vo2/(2gDo)=0.05
P2_16	1.75	1.75	A1-5	Du/Do=1.00, Qg/Qo=0.42, S/Do=1.6
P1_16	5.18	5.18	A1-4	H/Do=0.0, Vo2/(2gDo)=0.17
P1_17	2.93	2.93	A1-4	H/Do=2.0, Vo2/(2gDo)=0.01
P3_17	3.02	3.02	H-O'L	Qg/Qo=0.00, S/Do=1.0
GD2_NORTH	5.93	5.93	A1-4	H/Do=0.0, Vo2/(2gDo)=0.07
P4_27	0.2	0.2	A1-5	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
P5_17	1.5	not calculated		
ExP6	0.29	0.3	A1-18	Du/Do=1.00, Qg/Qo=0.00, S/Do=0.2
P7_13	1.48	1.48	A1-6	Du/Do=1.00, Qg/Qo=0.28, S/Do=1.0
P5_13	1.5	not calculated		
P6_13	2.11	2.11	H-O'L	Qg/Qo=0.45, S/Do=1.0
P3_13	1.94	1.95	A1-9	Du/Do=1.00, Qg/Qo=0.41, S/Do=1.2
P3_8	1.79	1.79	A1-4	H/Do=6.8, Vo2/(2gDo)=0.82
P4_8	1.79	1.79	A1-4	H/Do=6.8, Vo2/(2gDo)=0.23
P2_2	5.22	5.15	A1-4	H/Do=0.4, Vo2/(2gDo)=0.01
P3_2	4.67	4.65	A1-4	H/Do=1.2, Vo2/(2gDo)=0.03
P1_6	1.2	1.2	H-O'L	Qg/Qo=0.00, S/Do=1.2
P2_6	1.81	2.72	H-O'L	Qg/Qo=0.34, S/Do=1.5
P1_1 + GD4	1.85	1.91	A1-10	Du/Do=1.00, Qg/Qo=0.20, S/Do=1.7
P2_1	4.53	4.91	A1-4	H/Do=0.4, Vo2/(2gDo)=0.13
P3_1	2.04	2.04	A1-4	H/Do=2.9, Vo2/(2gDo)=0.68
P7_1	1.25	1.25	H-O'L	Qg/Qo=0.00, S/Do=1.9
P1-11	2.84	2.84	A1-4	H/Do=2.1, Vo2/(2gDo)=0.03
P2-11	2.57	2.57	A1-4	H/Do=3.0, Vo2/(2gDo)=0.11
P3-11	1.79	1.79	A1-4	H/Do=7.5, Vo2/(2gDo)=0.80
P4_13	1.5	not calculated		
P3-3	1.5	not calculated		
P1_15	1.46	1.46	A1-18	Du/Do=0.68, Qg/Qo=0.00, S/Do=3.3
P2_15	2.1	2.1	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.37
P3_15	1.46	1.46	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.63
Pit21	2.09	2.09	H-O'L	Qg/Qo=0.00, S/Do=1.2
P2_18	1.55	1.55	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.59
P1_18	1.82	1.82	A1-18	Du/Do=0.68, Qg/Qo=0.00, S/Do=2.2
P2_19	1.78	1.78	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.52
P3_19	1.3	1.3	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.67
P11_3	1.32	1.32	A1-20	Du/Do=0.51, Qg/Qo=0.00, S/Do=1.3
Pit15	2.3	2.3	H-O'L	Qg/Qo=0.00, S/Do=1.7
P4_15	2.46	2.46	H-O'L	Qg/Qo=0.00, S/Do=2.6
P4_4	0.37	0.16	A1-18	Du/Do=1.00, Qg/Qo=0.00, S/Do=0.3
P3_4	0	0	H-O'L	Qg/Qo=0.00, S/Do=1.0

DRAINS results prepared from Version 2020.061

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivir (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
P4_13	6.25		0.000		0.46	0.000	None
P5_13	6.09		0.000		0.70	0.000	None
P6_13	6.09		0.009		0.69	0.000	None
P7_13	5.99		0.006		0.51	0.000	None
HW1_V-DRAIN	5.93		0.000				
P1-11	6.62	6.63	0.008	1.0	0.00	0.000	Outlet System
P2-11	6.62	6.63	0.008	0.9	0.00	0.000	Outlet System
P3-11	6.62	6.62	0.013	6.5	0.00	0.005	Outlet System
P3_1	6.30	6.33	0.020	1.0	0.00	0.001	Outlet System
P4_1	6.22	6.28	0.013	1.0	0.03	0.000	Inlet Capacity
P5_1	6.19	6.30	0.026	1.0	0.06	0.000	Inlet Capacity
P6_1	6.04	6.29	0.020	0.3	0.21	0.000	Inlet Capacity
P7_1	6.02		0.000		0.60		None
GPT-BRB3	6.00		0.000		0.62		None
HW1-BRB3	5.99		0.000				
P2_1	6.14	6.29	0.016	1.0	0.11	0.000	Inlet Capacity
P1_1 + GD4	5.99		0.003		0.37		None
P2_6	5.87		0.000		0.45		None
ExP5	5.33		0.000		0.82	0.000	None
ExP4	5.20	6.05	0.000	0.0	0.85	0.000	None
CHATHAM-RN-0	5.11		0.000				
P2_2	6.21	6.78	0.004	0.2	0.57	0.000	Inlet Capacity
P3_2	6.21	6.68	0.004	0.1	0.47	0.000	Inlet Capacity
HW2 (BRB2)	6.21		0.000				
GD2_NORTH	6.04		0.005		0.41	0.000	None
SAND_FILTER_NORTH	5.71		0.000		1.09	0.000	None
P4_27	5.30		0.000		1.20	0.000	None
P5_17	5.22		0.000		1.05	0.000	None
ExP6	5.15	6.26	0.000	0.0	1.11	0.000	None
Chatham St - North	5.02		0.000				
P1_17	6.61	6.61	0.024	18.8	0.00	0.000	Outlet System
P2_17	6.77	6.78	0.015	2.9	0.00	0.000	Outlet System
P1_16	6.18	6.66	0.020	0.8	0.45	0.000	Inlet Capacity
P2_16	5.98	6.56	0.010	0.5	0.57	0.000	Inlet Capacity
ExPit_Track	5.07	5.64	0.049	4.3	0.52	0.000	Inlet Capacity
JP at Track Crossing	4.88		0.000				
Tank_T1-B-N	6.62		0.014				
Tank_T1-A-S	6.62		0.014				
P4-11	6.62	6.62	0.013	6.4	0.00	0.005	Outlet System
P1-9	6.62	6.63	0.008	1.0	0.00	0.000	Outlet System
P2-9	6.62	6.63	0.008	0.9	0.00	0.000	Outlet System
P3-9	6.62	6.62	0.013	6.6	0.00	0.005	Outlet System
T1-C-N	6.62		0.014				
TANK-T1-B-S	6.62		0.014				
P4-9	6.62	6.62	0.013	6.6	0.00	0.005	Outlet System
P1_13	6.37	6.61	0.005	0.1	0.23	0.000	Inlet Capacity
P2_13	6.29	6.61	0.007	0.5	0.31	0.000	Inlet Capacity
P3_13	6.18	6.61	0.005	0.2	0.42	0.000	Inlet Capacity
BYPASS2	6.65		0.000				
BYPASS1	6.60		0.000				
P3-3	6.25		0.000		0.67		None
P5_3	6.08		0.000		0.84		None
P6_3	5.99		0.000		0.93		None
P7_3	5.89		0.000		1.03		None
Pit21	5.85		0.000		1.01		None
P11_3	5.69		0.000		0.94		None
Pit15	5.54		0.000		1.09		None
ExP1	5.13		0.000		0.99		None
DARLING_ST_RN	5.01		0.000				
P1_15	6.30		0.000		0.18		None
P2_15	6.29		0.000		0.19		None
P3_15	6.17		0.000		0.31		None
P4_15	5.82		0.000		0.66		None
BLOCK_D_ROOF	6.68		0.046				
P3_4	5.18		0.000		1.05		None
P4_4	5.17		0.000		0.83		None
ExP2	5.15		0.000		0.87		None
P3_19	5.84		0.000		0.79		None
P2_19	5.92		0.000		0.71		None

P1_19	5.93		0.000		0.70		None
N402	5.94		0.000				
N403	5.87		0.000				
N404	5.83		0.000				
N405	5.89		0.111				
N406	5.96		0.158				
ExP3	5.19	5.84	0.082	20.2	0.59	0.000	Inlet Capacity
P2_18	6.04		0.000		0.82		None
P1_18	6.12		0.000		0.74		None
GD1	5.18		0.000				
N458	6.04		0.259				
N469	6.40		0.000				
L1 CONCOURSE (SOUTH)	6.69		0.125				
N480	6.24		0.635				
P1_7	6.62	6.63	0.008	1.0	0.00	0.000	Outlet System
P2_7	6.62	6.63	0.008	0.9	0.00	0.000	Outlet System
P3_7	6.62	6.62	0.013	6.6	0.00	0.005	Outlet System
T1-D-NTH	6.62		0.014				
T1-C-STH	6.62		0.014				
P4_7	6.62	6.62	0.013	6.6	0.00	0.005	Outlet System
T1-GOODS_SHED_STH	6.01		0.018				
P1_6	6.00		0.000		0.30		None
T1-GOOD-STORAGE-NTH	5.99		0.018				
P1_8	6.59		0.006		0.01	0.000	None
P2_8	6.55		0.006		0.00	0.000	None
P3_8	6.53	6.52	0.007	1.6	0.00	0.001	Outlet System
T2-EQSHD	6.53		0.022				
T1-E-STH	6.52		0.014				
P4_8	6.52	6.52	0.007	1.4	0.00	0.001	Outlet System
CHATHAM-RN-1	6.20		0.000				
P1_10	6.62	6.63	0.008	1.0	0.00	0.000	Outlet System
P2_10	6.62	6.63	0.008	0.9	0.00	0.000	Outlet System
P3_10	6.62	6.62	0.013	6.6	0.00	0.005	Outlet System
T1-E-NTH	6.62		0.014				
T1-F-STH	6.62		0.014				
P4_10	6.62	6.62	0.013	6.6	0.00	0.005	Outlet System
CHATHAM-RN-2	6.30		0.000				
GD3	6.02		0.002		0.42	0.000	None
N197	5.85		0.000				
P3_17	5.77		0.000		1.03		None
GPT-4200	5.74		0.000		1.06		None
SAND_FILTER_STH PIT	5.71		0.000		1.09	0.000	None

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT P6_13	0.006	0.000	0.006	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT P7_13	0.004	0.000	0.004	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT_P1-11	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT_P2-11	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT_P3-11	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT P3_1	0.016	0.016	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P4_1	0.010	0.010	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P5_1	0.021	0.021	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P6_1	0.016	0.016	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P2_1	0.013	0.013	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P1_1 + GD4	0.002	0.002	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P2_2	0.003	0.003	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P3_2	0.003	0.003	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT_GD2_NORTH	0.009	0.009	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
Cat-P1_17	0.019	0.019	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
Cat_P2_17	0.012	0.012	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P1_16	0.014	0.000	0.014	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT P2_16	0.007	0.000	0.007	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT ExPit_Track	0.045	0.000	0.045	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT-T1-B-N	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT-Tank_T1-A-S	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT_P4-11	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT_P1-9	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT_P2-9	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT_P3-9	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT-T1-C-N	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT_TANK-T1-B-S	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT_P4-9	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5

CAT P1_13	0.004	0.000	0.004	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT P2_13	0.005	0.000	0.005	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT P3_13	0.004	0.000	0.004	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT P2_3 BASIN	0.007	0.006	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P1_15 BASIN	0.005	0.005	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P2_15 BASIN	0.009	0.008	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P4_3 BASIN	0.012	0.011	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P3_15 BASIN	0.008	0.007	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P7_3 BASIN	0.011	0.011	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P9_3 BASIN	0.014	0.010	0.004	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 10
CAT P4_15 BASIN	0.012	0.010	0.002	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 10
CAT BLOCK_D ROOF	0.038	0.038	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT BRB1	0.031	0.020	0.013	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 3
CAT BRB2	0.019	0.000	0.019	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 5
CAT P1_3 BASIN	0.006	0.005	0.001	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 10
CAT P3_19 BASIN	0.006	0.005	0.001	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 10
CAT P2_19 BASIN	0.006	0.005	0.001	5.00	5.00	2.00	10% AEP, 15 min burst, Storm 10
CAT P1_19 BASIN	0.006	0.006	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P2_18 BASIN	0.008	0.007	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P1_18 BASIN	0.012	0.011	0.001	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT L1 CONCOURSE	0.101	0.101	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P1_7	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT P2_7	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT P3_7	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT T1-D-NTH	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT T1-C-STH	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT P4_7	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT GOOD SHED STH	0.015	0.015	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT GOODS SHED NTH	0.015	0.015	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT P1_8	0.005	0.004	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT P2_8	0.004	0.003	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT P3_8	0.005	0.000	0.005	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT EQPTSHD	0.018	0.018	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1
CAT T1-E-STH	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT P4_8	0.005	0.000	0.005	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT P1_10	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
CAT P2_10	0.006	0.005	0.001	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 10
Cat619	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT T1-E-NTH	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT T1-F-STH	0.012	0.012	0.000	5.00	0.00	0.00	10% AEP, 5 min burst, Storm 1
CAT P4_10	0.009	0.000	0.009	5.00	5.00	0.00	10% AEP, 15 min burst, Storm 5
CAT GD3	0.002	0.002	0.000	5.00	5.00	2.00	10% AEP, 5 min burst, Storm 1

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P4_13 - P5_13	0.000	0.00	6.250	6.091	10% AEP, 5 min burst, Storm 1
P5_13 - P6_13	0.000	0.00	6.091	6.091	10% AEP, 10 min burst, Storm 7
P6_13 - P7_13	0.015	0.66	6.082	5.993	10% AEP, 15 min burst, Storm 6
P7_13 - HW1	0.018	0.75	5.988	5.930	10% AEP, 15 min burst, Storm 6
P1_11 - P2_11	0.006	0.30	6.623	6.623	10% AEP, 10 min burst, Storm 8
P2-11_P3-11	0.011	0.59	6.623	6.623	10% AEP, 10 min burst, Storm 10
TRENCH-11_1	0.029	1.56	6.621	6.620	10% AEP, 15 min burst, Storm 9
P3_1 - P4_1	0.010	1.18	6.263	6.219	10% AEP, 10 min burst, Storm 6
P4_1 - P5_1	0.015	0.34	6.197	6.192	10% AEP, 10 min burst, Storm 3
P5_1 - P6_1	0.034	0.75	6.067	6.041	10% AEP, 10 min burst, Storm 5
P6_1 - P7_1	0.049	0.68	6.024	6.015	10% AEP, 5 min burst, Storm 1
P7_1 - GPT_BRB3	0.051	1.11	6.004	6.003	10% AEP, 5 min burst, Storm 1
GPT_BRB3 - BRB3	0.053	1.16	5.994	5.993	10% AEP, 5 min burst, Storm 1
P2_1 - P1_1 + GD4	0.012	0.63	6.043	5.989	10% AEP, 5 min burst, Storm 1
P1_1 - P2_6	0.014	0.74	5.935	5.873	10% AEP, 5 min burst, Storm 1
P2_6 - ExP5	0.042	1.64	5.804	5.731	10% AEP, 5 min burst, Storm 1
ExP5 - ExP4	0.040	0.72	5.293	5.196	10% AEP, 5 min burst, Storm 1
Pipe1059	0.045	1.06	5.196	5.112	10% AEP, 20 min burst, Storm 3
Pipe17	0.003	0.14	6.211	6.211	10% AEP, 15 min burst, Storm 10
P3_2 - HW2	0.005	0.28	6.211	6.212	10% AEP, 5 min burst, Storm 1
GD2 - SAND FILTER	0.009	1.14	6.014	5.925	10% AEP, 5 min burst, Storm 1
SAND_FILTER_INLET2	0.009	1.22	5.714	5.681	10% AEP, 5 min burst, Storm 1
SAND FILTER - P4_17	0.013	1.08	5.336	5.298	10% AEP, 15 min burst, Storm 1
P4_17 - P5_27	0.013	1.25	5.298	5.245	10% AEP, 15 min burst, Storm 1
P5_17 - ExP6	0.013	0.80	5.222	5.147	10% AEP, 15 min burst, Storm 1
ExP6 - Chatham North	0.013	0.93	5.147	5.019	10% AEP, 15 min burst, Storm 10
P1_17 - P2_17	0.011	0.25	6.612	6.770	10% AEP, 5 min burst, Storm 1
P1_16 - P2_16	0.013	1.00	6.136	5.984	10% AEP, 15 min burst, Storm 5

Pipe69	0.019	2.41	5.957	5.359	10% AEP, 15 min burst, Storm 5
Pipe at Track Crossing	0.066	1.47	4.947	4.881	10% AEP, 15 min burst, Storm 5
T1-B-N_P3-11	0.012	0.63	6.623	6.623	10% AEP, 5 min burst, Storm 1
T1-A-S_P4-9	0.012	0.63	6.621	6.621	10% AEP, 5 min burst, Storm 1
TRENCH-11_2	0.019	1.01	6.620	6.620	10% AEP, 15 min burst, Storm 5
P1-9_P2-9	0.006	0.31	6.623	6.623	10% AEP, 10 min burst, Storm 5
P2-9_P3-9	0.011	0.59	6.623	6.623	10% AEP, 10 min burst, Storm 10
P196	0.029	1.56	6.621	6.620	10% AEP, 15 min burst, Storm 9
T1-C-N_P3-9	0.012	0.63	6.623	6.623	10% AEP, 5 min burst, Storm 1
TANK-T1-B-S_P4-9	0.012	0.63	6.621	6.621	10% AEP, 5 min burst, Storm 1
P198	0.019	1.01	6.620	6.620	10% AEP, 15 min burst, Storm 5
P1_13 - P2_13	0.004	0.41	6.353	6.290	10% AEP, 15 min burst, Storm 5
P2_13 - P3_13	0.008	0.79	6.250	6.179	10% AEP, 15 min burst, Storm 5
P3_13 - P6_13	0.010	0.89	6.153	6.091	10% AEP, 15 min burst, Storm 5
P2_3 BASIN OUTLET	0.006	0.98	6.316	6.261	10% AEP, 15 min burst, Storm 9
P3_3 - P5_3	0.006	0.53	6.254	6.079	10% AEP, 15 min burst, Storm 9
P5_3 - P6_3	0.017	1.04	6.079	5.991	10% AEP, 15 min burst, Storm 9
P6_3 - P8_3	0.017	1.03	5.991	5.894	10% AEP, 15 min burst, Storm 9
P8_3 - P10_3	0.028	0.82	5.894	5.846	10% AEP, 15 min burst, Storm 9
P10_3 - P11_3	0.057	1.24	5.794	5.686	10% AEP, 15 min burst, Storm 3
P11_3 - P5_15	0.078	1.50	5.654	5.542	10% AEP, 15 min burst, Storm 9
P5_15 - ExP1	0.098	2.60	5.478	5.284	10% AEP, 15 min burst, Storm 3
ExP1 - DARLING_ST_RN	0.091	1.35	5.100	5.008	10% AEP, 20 min burst, Storm 3
P1_15 BASIN OUTLET	0.005	0.55	6.329	6.305	10% AEP, 15 min burst, Storm 9
P1_15 - P2_15	0.005	0.25	6.300	6.291	10% AEP, 15 min burst, Storm 9
P2_15 - P3_15	0.013	0.68	6.245	6.169	10% AEP, 15 min burst, Storm 10
P3_15 - P4_15	0.020	1.09	6.089	5.825	10% AEP, 15 min burst, Storm 9
P4_15 - P5_15	0.023	1.22	5.639	5.542	10% AEP, 20 min burst, Storm 3
P2_15 BASIN OUTLET	0.008	0.93	6.318	6.291	10% AEP, 15 min burst, Storm 9
P4_3 BASIN OUTLET	0.011	1.30	6.165	6.079	10% AEP, 15 min burst, Storm 9
P3_15 BASIN OUTLET	0.008	0.88	6.212	6.169	10% AEP, 15 min burst, Storm 9
P7_3 BASIN OUTLET	0.010	1.20	6.004	5.894	10% AEP, 15 min burst, Storm 9
P9_3 BASIN OUTLET	0.011	1.28	5.962	5.846	10% AEP, 15 min burst, Storm 5
P4_15 BASIN OUTLET	0.007	0.75	5.912	5.825	10% AEP, 1 hour burst, Storm 2
block d roof - brb1	0.038	2.28	6.678	6.214	10% AEP, 5 min burst, Storm 1
BRB1 - BRB2	0.011	1.28	6.214	6.227	10% AEP, 3 hour burst, Storm 3
P2_4 - P3_4	0.017	1.94	5.465	5.178	10% AEP, 3 hour burst, Storm 5
P3_4 - P4_4	0.017	0.61	5.178	5.172	10% AEP, 3 hour burst, Storm 10
P4_4 - ExP2	0.017	0.56	5.172	5.149	10% AEP, 3 hour burst, Storm 8
ExP2 - ExP1	0.040	0.66	5.148	5.127	10% AEP, 3 hour burst, Storm 6
P11_3 BASIN OUTLET	0.005	0.63	5.791	5.686	10% AEP, 15 min burst, Storm 3
P3_19 BASIN OUTLET	0.005	0.63	5.928	5.843	10% AEP, 15 min burst, Storm 9
P3_19 - P11_3	0.017	0.89	5.790	5.686	10% AEP, 15 min burst, Storm 9
P2_19 BASIN OUTLET	0.005	0.63	5.994	5.918	10% AEP, 15 min burst, Storm 9
P2_19 - P3_19	0.011	0.60	5.885	5.843	10% AEP, 15 min burst, Storm 9
P1_19 BASIN OUTLET	0.006	0.67	6.007	5.934	10% AEP, 15 min burst, Storm 9
P1_19 - P2_19	0.006	0.31	5.930	5.918	10% AEP, 15 min burst, Storm 9
ExP3 - ExP2	0.023	0.40	5.152	5.149	10% AEP, 3 hour burst, Storm 4
P2_18 BASIN OUTLET	0.007	0.85	6.134	6.045	10% AEP, 15 min burst, Storm 3
P2_18 - P10_3	0.018	0.98	5.970	5.846	10% AEP, 15 min burst, Storm 9
P1_18 BASIN OUTLET	0.011	1.25	6.196	6.116	10% AEP, 15 min burst, Storm 9
P1_19 - P2_18	0.011	0.58	6.084	6.045	10% AEP, 15 min burst, Storm 9
GD1 - P3_4	0.000	0.00	5.178	5.178	10% AEP, 15 min burst, Storm 2
CONCOURSE - BRB1	0.102	3.63	6.692	6.214	10% AEP, 5 min burst, Storm 1
P1_7 - P2_7	0.006	0.31	6.623	6.623	10% AEP, 10 min burst, Storm 5
P2_7 - P3_7	0.011	0.59	6.623	6.623	10% AEP, 10 min burst, Storm 10
P3_7 - TRENCH7	0.029	1.56	6.621	6.620	10% AEP, 15 min burst, Storm 9
T1-D-NTH OVERFLOW	0.012	0.63	6.623	6.623	10% AEP, 5 min burst, Storm 1
T1-C-STH - P4_7	0.012	0.63	6.621	6.621	10% AEP, 5 min burst, Storm 1
P4_7 = TRENCH7	0.019	1.01	6.620	6.620	10% AEP, 15 min burst, Storm 5
BRB3 - ExP4	0.014	1.61	5.503	5.196	10% AEP, 1 hour burst, Storm 3
T1 - P1_6	0.014	1.02	6.009	6.005	10% AEP, 5 min burst, Storm 1
P1_6 - P2_6	0.015	1.02	5.978	5.873	10% AEP, 5 min burst, Storm 1
T1 - P2_6	0.015	1.24	5.993	5.981	10% AEP, 5 min burst, Storm 1
P1_8 - P2_8	0.005	0.26	6.561	6.548	10% AEP, 15 min burst, Storm 9
P2_8 - TRENCH8	0.009	0.50	6.535	6.525	10% AEP, 15 min burst, Storm 10
P3_8 - TRENCH8	0.029	1.58	6.524	6.523	10% AEP, 15 min burst, Storm 4
T2-EQPSHD - P3_8	0.018	0.97	6.525	6.525	10% AEP, 5 min burst, Storm 1
T1-E-STH - P4_8	0.012	0.63	6.523	6.523	10% AEP, 5 min burst, Storm 1
P4_8 - TRENCH8	0.015	0.83	6.523	6.523	10% AEP, 15 min burst, Storm 4
P1_10 - P2_10	0.006	0.31	6.623	6.623	10% AEP, 10 min burst, Storm 5
P2_10 - P3_10	0.011	0.59	6.623	6.623	10% AEP, 10 min burst, Storm 10
P3_10 - TRENCH10	0.029	1.56	6.621	6.620	10% AEP, 15 min burst, Storm 9
P1008	0.012	0.63	6.623	6.623	10% AEP, 5 min burst, Storm 1
T1-F-STH - P4_10	0.012	0.63	6.621	6.621	10% AEP, 5 min burst, Storm 1

P4_10 - TRENCH10	0.019	1.01	6.620	6.620	10% AEP, 15 min burst, Storm 5
GD3 - P7_1	0.003	0.17	6.016	6.015	10% AEP, 12 hour burst, Storm 5
P2_17 - P3_17	0.005	0.82	5.847	5.773	10% AEP, 15 min burst, Storm 10
P3_17 - GPT	0.005	0.58	5.773	5.739	10% AEP, 15 min burst, Storm 10
GPT - SAND FILTER	0.005	0.78	5.739	5.708	10% AEP, 15 min burst, Storm 10
SAND_TANK_INLET1	0.005	1.08	5.708	5.669	10% AEP, 15 min burst, Storm 10

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF P4_13 - BYPASS2	0	0	1.248	0	0	0	0	
OF P5_13 - BYPASS1	0	0	1.467	0	0	0	0	
OF P6_13 - P7_13	0	0	1.535	0	0	0	0	
OF P7_13 - TRACK2	0	0	1.264	0	0	0	0	
V-DRAIN	0.019	0.053	0.535	0.200	0.04	0.86	0.22	10% AEP, 15 min burst, Storm 5
OF P1_11 - P3_11	0	0	1.404	0	0	0	0	
OF P2_11 - P3_11	0	0	1.542	0	0	0	0	
OF P3_11 - TRENCH11	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 9
OF TRENCH11 - BYPASS2	0	0	1.404	0	0	0	0	
OF P3_1 - P4_1	0.001	0.001	3.052	0.023	0.01	0.25	0.36	10% AEP, 15 min burst, Storm 3
OF P4_1 - P5_1	0	0	3.392	0	0	0	0	
OF P5_1 - P6_1	0	0	3.298	0	0	0	0	
OF P6_1 - GD3	0	0	4.206	0	0	0	0	
OF HW1 - BRB3	0.103	0.103	1.404	0.492	0.03	3.98	0.07	10% AEP, 3 hour burst, Storm 9
OF386	0	0	0.077	0	0	0	0	
OF372	0	0	3.587	0	0	0	0	
OF374	0	0	1.020	0	0	0	0	
OF P2_2 - BRB2	0	0	1.567	0	0	0	0	
OF P3_2	0	0	1.567	0	0	0	0	
OF234	0.138	0.138	1.520	0.627	0.04	3.98	0.08	10% AEP, 9 hour burst, Storm 3
OF GD2 - ExP6	0	0	1.511	0	0	0	0	
OF SandFilterNth - P5_17	0	0	3.814	0	0	0	0	
OF SandFilter - P5_17	0	0	2.723	0	0	0	0	
OF P4_17 - P5_17	0	0	2.707	0	0	0	0	
OF P5_17 - eXp6	0	0	2.536	0	0	0	0	
OF ExP6 - ChathamSt Node	0	0	7.935	0	0	0	0	
OF P1_17 - GD2	0.000	0.009	2.695	0.005	0.00	7.50	0.26	10% AEP, 5 min burst, Storm 1
OF P2_17 - GD2	0	0	1.711	0	0	0	0	
Orifice_P2_17	0.005	0.000	0.063	0.450	0.00	20.00	0.00	10% AEP, 15 min burst, Storm 10
OF P1_16 - P2_16	0	0	2.682	0	0	0	0	
OF P2_16 - ExPt_Track	0	0	2.676	0	0	0	0	
OF_TO_TRACK1	0	0	7.970	0	0	0	0	
OF P4_11 - TRENCH11	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 9
OF P1_9 - P3_9	0	0	1.404	0	0	0	0	
OF P2_9 - P3_9	0	0	1.542	0	0	0	0	
OF P3_9 - TRENCH9	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 1(
OF TRENCH9 - BYPASS3	0	0	1.404	0	0	0	0	
OF P4-9 - TRENCH9	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 1(
OF P1_13 - P2_13	0	0	1.531	0	0	0	0	
OF P2_13 - P3_13	0	0	1.531	0	0	0	0	
OF P3_13 - P6_13	0	0	1.540	0	0	0	0	
OF BYP2 - BYP1	0	0	0.544	0	0	0	0	
OF BYP1 - P7_13	0	0	0.866	0	0	0	0	
OF1 P2_3 - P1_15	0	0	3.807	0	0	0	0	
OF P1_15 - P2_15	0.000	0.004	3.052	0.039	0.02	0.43	0.53	10% AEP, 5 min burst, Storm 1
OF P2_15 - P3_15	0.000	0.004	3.258	0.040	0.02	0.44	0.48	10% AEP, 15 min burst, Storm 10
OF P4_3 - P2_15	0	0	7.982	0	0	0	0	
OF P3_15 - P4_15 BASIN	0.000	0.005	3.258	0.045	0.02	0.84	0.40	10% AEP, 15 min burst, Storm 10
OF P7_3 - P3_15	0	0	7.982	0	0	0	0	
OF P9_3 BASIN - P11_3 BA	0	0	3.807	0	0	0	0	
OF P4_15 BASIN	0	0	3.815	0	0	0	0	
OF BRB1 - BRB2	0.440	0.440	1.404	0.239	0.12	3.98	0.52	10% AEP, 3 hour burst, Storm 6
OF BRB2 - N458	0.118	0.118	8.006	0.092	0.01	20.00	0.76	10% AEP, 3 hour burst, Storm 6
OF P11_3 BASIN	0	0	3.780	0	0	0	0	
OF P3_19 BASIN	0	0	3.814	0	0	0	0	
OF P2_19 BASIN	0	0	3.772	0	0	0	0	
OF P1_19 BASIN	0	0	1.486	0	0	0	0	
OF179	0	0	4.332	0	0	0	0	
OF181	0	0	4.270	0	0	0	0	
OF184	0	0	4.142	0	0	0	0	
OF178	0.061	0.061	4.427	0.088	0.04	5.17	0.43	10% AEP, 3 hour burst, Storm 5
OF172	0.076	0.076	4.279	0.094	0.05	5.74	0.53	10% AEP, 3 hour burst, Storm 10

OF395	0	0	13.746	0	0	0	0	
OF P2_18 BASIN - P3_19 B/	0	0	3.807	0	0	0	0	
OF P1_18 BASIN - P2_19 B/	0	0	3.807	0	0	0	0	
OF219	0.090	0.090	4.270	0.099	0.05	6.31	0.52	10% AEP, 3 hour burst, Storm 10
OF230	0	0	1.447	0	0	0	0	
OF N480 - BRB2	0.249	0.249	1.520	0.627	0.07	3.98	0.28	10% AEP, 3 hour burst, Storm 7
OF262	0	0	1.404	0	0	0	0	
OF P2_7 - P3_7	0	0	1.542	0	0	0	0	
OF P3_7 - TRENCH7	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 1(
OF243	0	0	1.404	0	0	0	0	
OF254	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 1(
OF BRB3 - ExP4	0	0	1.493	0	0	0	0	
OF P1_8 - P2_8	0	0	1.079	0	0	0	0	
OF P2_8 - P3_8	0	0	1.022	0	0	0	0	
OF P3_8 - TRENCH8	0.001	0.001	1.530	0.129	0.00	3.98	0.00	10% AEP, 4.5 hour burst, Storm 6
OF TRENCH8 - CHATHAM-F	0	0	1.508	0	0	0	0	
OF P4_8 - TRENCH8	0.001	0.001	1.530	0.129	0.00	3.98	0.00	10% AEP, 4.5 hour burst, Storm 6
OF370	0	0	2.428	0	0	0	0	
OF P1_10 - P3_10	0	0	1.404	0	0	0	0	
OF P2_10 - P3_10	0	0	1.542	0	0	0	0	
OF P3_10 - TRENCH10	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 1(
OF TRENCH10 - CHATHAM·	0	0	1.514	0	0	0	0	
OF P4_10 - TRENCH10	0.005	0.005	1.256	0.220	0.00	3.98	0.01	10% AEP, 12 hour burst, Storm 1(
OF368	0	0	3.805	0	0	0	0	
OF GD3 - BRB3	0	0	0.925	0	0	0	0	
OF SandFilterSth - P5_17	0	0	3.814	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
TRENCH_11	6.62	47.7	0.000	0.000	0.000
SAND FILTER	5.39	0.1	0.013	0.013	0.000
TRENCH9	6.62	47.7	0.000	0.000	0.000
P2_3 BASIN	6.72	0.9	0.006	0.006	0.000
P1_15 BASIN	6.49	0.8	0.005	0.005	0.000
P2_15 BASIN	6.50	1.2	0.008	0.008	0.000
P4_3 BASIN	6.73	1.4	0.011	0.011	0.000
P3_15 BASIN	6.50	1.2	0.008	0.008	0.000
P7_3 BASIN	6.73	1.3	0.010	0.010	0.000
P9_3 BASIN	6.73	2.6	0.011	0.011	0.000
P4_15 BASIN	6.49	5.8	0.007	0.007	0.000
BRB1	6.21	53.1	0.451	0.011	0.440
BRB2	6.23	145.1	0.135	0.017	0.118
P11_3 BASIN	6.49	0.9	0.005	0.005	0.000
P3_19 BASIN	6.49	0.9	0.005	0.005	0.000
P2_19 BASIN	6.49	0.9	0.005	0.005	0.000
P1_19 BASIN	6.49	0.9	0.006	0.006	0.000
Basin73	6.72	1.2	0.007	0.007	0.000
Basin76	6.73	1.4	0.011	0.011	0.000
TRENCH7	6.62	47.7	0.000	0.000	0.000
BRB3	5.99	33.8	0.014	0.014	0.000
TRENCH8	6.52	46.4	0.000	0.000	0.000
TRENCH10	6.62	47.7	0.000	0.000	0.000

Pit	Initial K	Revised K	Chart (2008)	Ratios
GD3	3.53	3.36	A1-4	H/Do=1.5, Vo2/(2gDo)=0.02
ExP4	1.22	1.18	A1-24	Dl/Do=1.00, B/Do=2.40, (Qu/Qo)(Do/Du)=0.58
ExP5	5.93	5.93	A1-4	H/Do=0.0, Vo2/(2gDo)=0.05
P4_10	1.79	1.79	A1-4	H/Do=8.1, Vo2/(2gDo)=1.11
P3_10	1.79	1.79	A1-4	H/Do=8.1, Vo2/(2gDo)=2.05
P2_10	2.04	2.04	A1-4	H/Do=3.6, Vo2/(2gDo)=0.30
P1_10	2.42	2.42	A1-4	H/Do=2.7, Vo2/(2gDo)=0.14
P2_8	2.26	2.23	A1-4	H/Do=2.9, Vo2/(2gDo)=0.21
P1_8	3.13	3.12	A1-4	H/Do=1.8, Vo2/(2gDo)=0.06
P6_1	1.61	1.65	A1-9	Du/Do=0.79, Qg/Qo=0.48, S/Do=1.9
P5_1	3.44	3.53	A1-4	H/Do=1.1, Vo2/(2gDo)=0.18
P4_1	4.01	3.96	A1-4	H/Do=1.1, Vo2/(2gDo)=0.08
P4_7	1.79	1.79	A1-4	H/Do=8.2, Vo2/(2gDo)=1.12
P3_7	1.79	1.79	A1-4	H/Do=8.2, Vo2/(2gDo)=2.06
P2_7	2.02	2.02	A1-4	H/Do=3.8, Vo2/(2gDo)=0.30
P1_7	2.34	2.35	A1-4	H/Do=2.8, Vo2/(2gDo)=0.14
ExP2	0.44	0.46	H-O'L	Qg/Qo=0.00, S/Do=2.1
ExP1	1.61	1.62	A1-24	Dl/Do=0.81, B/Do=2.40, (Qu/Qo)(Do/Du)=0.48
ExP3	4.85	4.91	A1-4	H/Do=1.1, Vo2/(2gDo)=0.00
P1_19	0.66	0.66	A1-14	Du/Do=0.68, Qg/Qo=0.00, S/Do=4.0
P7_3	1.19	1.21	A1-25	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.5
P6_3	0.2	0.2	A1-5	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
P5_3	1.62	1.62	A1-25	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
P1_13	3.99	4.08	A1-4	H/Do=1.0, Vo2/(2gDo)=0.04
P2_13	4.06	3.74	A1-4	H/Do=0.9, Vo2/(2gDo)=0.19
P2_17	1.5	not calculated		
P4-9	1.79	1.79	A1-4	H/Do=8.2, Vo2/(2gDo)=1.12
P3-9	1.79	1.79	A1-4	H/Do=8.2, Vo2/(2gDo)=2.06
P2-9	2.02	2.02	A1-4	H/Do=3.8, Vo2/(2gDo)=0.30
P1-9	2.34	2.35	A1-4	H/Do=2.8, Vo2/(2gDo)=0.14
P4-11	1.79	1.79	A1-4	H/Do=8.2, Vo2/(2gDo)=1.12
SAND_FIL	0	0	A1-9	Du/Do=0.64, Qg/Qo=0.00, S/Do=1.0
SAND_FIL	0.2	0.2	A1-5	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.0
ExPit_Trac	6.09	6.12	A1-4	H/Do=0.0, Vo2/(2gDo)=0.19
P2_16	1.42	1.33	A1-5	Du/Do=1.00, Qg/Qo=0.41, S/Do=2.6
P1_16	3.09	2.75	A1-4	H/Do=0.8, Vo2/(2gDo)=0.60
P1_17	2.74	2.74	A1-4	H/Do=2.2, Vo2/(2gDo)=0.02
P3_17	3.02	2.9	H-O'L	Qg/Qo=0.00, S/Do=1.0
GD2_NOR	4.26	4.26	A1-4	H/Do=0.0, Vo2/(2gDo)=0.29
P4_27	0.2	0.2	A1-5	Du/Do=1.00, Qg/Qo=0.00, S/Do=1.1
P5_17	1.5	not calculated		
ExP6	0.23	0.26	A1-18	Du/Do=1.00, Qg/Qo=0.04, S/Do=0.3
P7_13	1.44	1.43	A1-6	Du/Do=1.00, Qg/Qo=0.26, S/Do=1.2
P5_13	1.5	not calculated		
P6_13	2.55	2.49	H-O'L	Qg/Qo=0.42, S/Do=1.2
P3_13	1.78	1.68	A1-9	Du/Do=1.00, Qg/Qo=0.41, S/Do=2.0
P3_8	1.79	1.79	A1-4	H/Do=8.1, Vo2/(2gDo)=2.35
P4_8	1.79	1.79	A1-4	H/Do=8.1, Vo2/(2gDo)=0.67
P2_2	5.69	5.71	A1-4	H/Do=0.1, Vo2/(2gDo)=0.02
P3_2	5.33	5.27	A1-4	H/Do=0.9, Vo2/(2gDo)=0.10
P1_6	1.2	1.2	H-O'L	Qg/Qo=0.00, S/Do=3.6
P2_6	1.69	1.72	H-O'L	Qg/Qo=0.00, S/Do=1.8
P1_1 + GD	1.6	1.59	A1-10	Du/Do=1.00, Qg/Qo=0.22, S/Do=3.1
P2_1	2.79	2.68	A1-4	H/Do=1.7, Vo2/(2gDo)=0.31
P3_1	1.94	1.94	A1-4	H/Do=3.5, Vo2/(2gDo)=0.73

P7_1	1.21	1.26	H-O'L	Qg/Qo=0.00, S/Do=2.6
P1-11	2.34	2.34	A1-4	H/Do=2.8, Vo2/(2gDo)=0.14
P2-11	2.11	2.11	A1-4	H/Do=3.8, Vo2/(2gDo)=0.30
P3-11	1.79	1.79	A1-4	H/Do=8.2, Vo2/(2gDo)=2.05
P4_13	1.5	not calculated		
P3-3	1.5	not calculated		
P1_15	1.38	1.38	A1-18	Du/Do=0.68, Qg/Qo=0.00, S/Do=4.0
P2_15	2.22	2.22	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.30
P3_15	1.66	1.65	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.56
Pit21	2.01	2.02	H-O'L	Qg/Qo=0.00, S/Do=2.0
P2_18	1.67	1.68	H-O'L	Qg/Qo=0.00, S/Do=5.0
P1_18	1.38	2.3	H-O'L	Qg/Qo=0.00, S/Do=4.9
P2_19	1.77	1.76	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.52
P3_19	1.39	1.4	A1-24	Dl/Do=0.68, B/Do=5.84, (Qu/Qo)(Do/Du)=0.64
P11_3	1.32	1.32	A1-20	Du/Do=0.51, Qg/Qo=0.00, S/Do=2.1
Pit15	2.3	2.3	H-O'L	Qg/Qo=0.00, S/Do=2.4
P4_15	2.62	2.63	H-O'L	Qg/Qo=0.00, S/Do=5.8
P4_4	1.97	1.95	A1-18	Du/Do=1.00, Qg/Qo=0.00, S/Do=2.2
P3_4	1.38	1.36	H-O'L	Qg/Qo=0.00, S/Do=2.4

DRAINS results prepared from Version 2020.061

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
P4_13	6.25		0.000		0.46	0.000	None
P5_13	6.18		0.000		0.61	0.000	None
P6_13	6.18		0.017		0.60	0.000	None
P7_13	6.10		0.011		0.40	0.000	None
HW1_V-DI	6.00		0.000				
P1-11	6.74	6.74	0.014	3.2	0.00	0.001	Outlet System
P2-11	6.74	6.74	0.014	3.2	0.00	0.001	Outlet System
P3-11	6.74	6.74	0.024	12.0	0.00	0.007	Outlet System
P3_1	6.34	6.35	0.034	1.0	0.00	0.011	Outlet System
P4_1	6.32	6.35	0.029	1.0	0.00	0.007	Outlet System
P5_1	6.30	6.34	0.039	1.0	0.00	0.005	Outlet System
P6_1	6.23	6.31	0.039	0.5	0.02	0.000	Inlet Capacity
P7_1	6.18		0.000		0.44		None
GPT-BRB3	6.11		0.000		0.52		None
HW1-BRB3	6.04		0.000				
P2_1	6.29	6.33	0.028	3.9	0.00	0.000	Outlet System
P1_1 + GD	6.16		0.005		0.20		None
P2_6	6.01		0.000		0.31		None
ExP5	5.42		0.040		0.73	0.000	None
ExP4	5.28	6.05	0.002	0.5	0.77	0.000	Inlet Capacity
CHATHAM	5.17		0.000				
P2_2	6.18	6.80	0.006	0.3	0.60	0.000	Inlet Capacity
P3_2	6.17	6.70	0.006	0.2	0.51	0.000	Inlet Capacity
HW2 (BRB	6.16		0.000				
GD2_NOR	6.20		0.022		0.25	0.000	None
SAND_FIL	5.74		0.000		1.06	0.000	None
P4_27	5.35		0.000		1.15	0.000	None
P5_17	5.25		0.000		1.02	0.000	None
ExP6	5.17	6.26	0.001	0.1	1.09	0.000	Inlet Capacity
Chatham S	5.04		0.000				
P1_17	6.67	6.66	0.041	25.7	0.00	0.013	Outlet System
P2_17	6.67	6.76	0.026	2.2	0.07	0.000	Inlet Capacity
P1_16	6.54	6.67	0.037	2.2	0.09	0.000	Inlet Capacity
P2_16	6.09	6.57	0.018	0.9	0.46	0.000	Inlet Capacity
ExPit_Trac	5.43	5.68	0.094	8.1	0.16	0.000	Inlet Capacity
JP at Track	4.96		0.000				
Tank_T1-B	6.74		0.025				
Tank_T1-A	6.74		0.025				
P4-11	6.74	6.74	0.024	12.0	0.00	0.007	Outlet System
P1-9	6.74	6.74	0.014	3.2	0.00	0.001	Outlet System
P2-9	6.74	6.74	0.014	3.2	0.00	0.001	Outlet System
P3-9	6.74	6.74	0.024	12.0	0.00	0.007	Outlet System
T1-C-N	6.74		0.025				
TANK-T1-E	6.74		0.025				
P4-9	6.74	6.74	0.024	12.0	0.00	0.007	Outlet System
P1_13	6.60	6.62	0.010	0.7	0.00	0.000	Outlet System
P2_13	6.57	6.62	0.014	1.1	0.03	0.000	Inlet Capacity
P3_13	6.36	6.62	0.010	0.4	0.24	0.000	Inlet Capacity
BYPASS2	6.65		0.000				
BYPASS1	6.60		0.000				
P3-3	6.28		0.000		0.64		None
P5_3	6.22		0.000		0.70		None
P6_3	6.21		0.000		0.71		None
P7_3	6.21		0.000		0.71		None
Pit21	6.19		0.000		0.67		None
P11_3	6.06		0.000		0.57		None
Pit15	5.90		0.000		0.73		None
ExP1	5.56		0.000		0.56		None
DARLING_	5.12		0.000				
P1_15	6.49		0.000		0.00		Outlet System
P2_15	6.48		0.000		0.00		Outlet System
P3_15	6.42		0.000		0.06		None
P4_15	6.22		0.000		0.26		None
BLOCK_D_	7.88		0.081				
P3_4	5.93		0.000		0.30		None
P4_4	5.87		0.000		0.13		None
ExP2	5.74		0.000		0.28		None
P3_19	6.28		0.000		0.35		None
P2_19	6.37		0.000		0.26		None
P1_19	6.39		0.000		0.24		None

N402	5.94		0.000				
N403	5.87		0.000				
N404	5.81		0.000				
N405	5.80		0.014				
N406	5.87		0.024				
ExP3	5.74	5.78	0.007	2.4	0.04	0.000	Inlet Capacity
P2_18	6.42		0.000		0.44		None
P1_18	6.48		0.000		0.38		None
GD1	5.94		0.000				
N458	5.94		0.036				
N469	6.40		0.000				
L1 CONC	7.08		0.217				
N480	6.16		0.275				
P1_7	6.74	6.74	0.014	3.2	0.00	0.001	Outlet System
P2_7	6.74	6.74	0.014	3.2	0.00	0.001	Outlet System
P3_7	6.74	6.74	0.024	12.0	0.00	0.007	Outlet System
T1-D-NTH	6.74		0.025				
T1-C-STH	6.74		0.025				
P4_7	6.74	6.74	0.024	12.0	0.00	0.007	Outlet System
T1-GOODS	6.44		0.031				
P1_6	6.42		0.000		0.00		Outlet System
T1-GOOD-	6.06		0.031				
P1_8	6.73		0.011		0.00	0.038	Outlet System
P2_8	6.74		0.206		0.00	0.035	Outlet System
P3_8	6.72	6.72	0.076	12.0	0.00	0.053	Outlet System
T2-EQSHD	6.72		0.038				
T1-E-STH	6.72		0.025				
P4_8	6.72	6.72	0.013	12.0	0.00	0.053	Outlet System
CHATHAM	6.28		0.040				
P1_10	6.72	6.72	0.014	3.2	0.00	0.001	Outlet System
P2_10	6.72	6.72	0.014	3.2	0.00	0.001	Outlet System
P3_10	6.72	6.72	0.024	12.0	0.00	0.009	Outlet System
T1-E-NTH	6.72		0.025				
T1-F-STH	6.72		0.025				
P4_10	6.72	6.72	0.024	12.0	0.00	0.009	Outlet System
CHATHAM	6.35		0.015				
GD3	6.18		0.004		0.26	0.000	None
N197	5.85		0.000				
P3_17	5.77		0.000		1.03		None
GPT-4200	5.74		0.000		1.06		None
SAND_FIL	5.71		0.000		1.09	0.000	None

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT P6_1	0.012	0.000	0.012	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT P7_1	0.008	0.000	0.008	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT_P1-1	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT_P2-1	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT_P3-1	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT P3_1	0.027	0.027	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P4_1	0.017	0.017	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P5_1	0.037	0.037	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P6_1	0.028	0.028	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P2_1	0.022	0.022	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P1_1	0.004	0.004	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P2_2	0.005	0.005	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P3_2	0.005	0.005	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT_GD2_	0.015	0.015	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
Cat-P1_17	0.033	0.033	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
Cat_P2_17	0.021	0.021	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P1_1	0.026	0.000	0.026	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT P2_1	0.012	0.000	0.012	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT ExPit_	0.083	0.000	0.083	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT-T1-B-	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT-Tank_	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT_P4-1	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT_P1-9	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT_P2-9	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT_P3-9	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT-T1-C-	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT_TANK	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT_P4-9	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT P1_1	0.007	0.000	0.007	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT P2_1	0.010	0.000	0.010	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1

CAT P3_1	0.007	0.000	0.007	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT P2_3	0.012	0.011	0.001	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P1_1	0.009	0.008	0.001	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P2_1	0.016	0.014	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P4_3	0.022	0.019	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P3_1	0.015	0.013	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P7_3	0.020	0.018	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P9_3	0.024	0.019	0.006	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P4_1	0.021	0.018	0.003	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT BLOC	0.065	0.065	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT BRB1	0.054	0.030	0.025	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT BRB2	0.035	0.000	0.035	5.00	5.00	2.00	1% AEP, 10 min burst, Storm 1
CAT P1_3	0.011	0.008	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P3_1	0.010	0.008	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P2_1	0.010	0.008	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P1_1	0.011	0.010	0.001	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P2_1	0.014	0.012	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P1_1	0.021	0.019	0.002	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT L1 C	0.174	0.174	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P1_7	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P2_7	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P3_7	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT T1-D-	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT T1-C-	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P4_7	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT GOO	0.025	0.025	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT GOO	0.025	0.025	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT P1_8	0.009	0.007	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P2_8	0.008	0.006	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P3_8	0.009	0.000	0.009	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT EQP	0.031	0.031	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1
CAT T1-E-	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P4_8	0.009	0.000	0.009	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT P1_1	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P2_1	0.010	0.008	0.002	5.00	5.00	0.00	1% AEP, 5 min burst, Storm 1
Cat619	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT T1-E-	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT T1-F-	0.020	0.020	0.000	5.00	0.00	0.00	1% AEP, 5 min burst, Storm 1
CAT P4_1	0.017	0.000	0.017	5.00	5.00	0.00	1% AEP, 10 min burst, Storm 1
CAT GD3	0.003	0.003	0.000	5.00	5.00	2.00	1% AEP, 5 min burst, Storm 1

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P4_13 - P	0.000	0.00	6.250	6.184	1% AEP, 5 min burst, Storm 1
P5_13 - P	0.003	0.13	6.184	6.184	1% AEP, 10 min burst, Storm 7
P6_13 - P	0.030	0.85	6.134	6.095	1% AEP, 10 min burst, Storm 7
P7_13 - H	0.036	0.92	6.053	6.000	1% AEP, 10 min burst, Storm 7
P1_11 - P	0.012	0.66	6.737	6.737	1% AEP, 5 min burst, Storm 1
P2-11_P3-	0.018	0.96	6.737	6.737	1% AEP, 5 min burst, Storm 1
TRENCH-	0.046	2.49	6.737	6.737	1% AEP, 5 min burst, Storm 1
P3_1 - P4_	0.011	1.22	6.331	6.318	1% AEP, 5 min burst, Storm 1
P4_1 - P5_	0.027	0.60	6.304	6.300	1% AEP, 5 min burst, Storm 1
P5_1 - P6_	0.041	0.91	6.242	6.225	1% AEP, 5 min burst, Storm 1
P6_1 - P7_	0.064	0.89	6.194	6.178	1% AEP, 5 min burst, Storm 1
P7_1 - GP	0.068	1.47	6.115	6.110	1% AEP, 5 min burst, Storm 1
GPT_BRB	0.069	1.50	6.046	6.037	1% AEP, 5 min burst, Storm 1
P2_1 - P1_	0.018	0.98	6.223	6.155	1% AEP, 10 min burst, Storm 7
P1_1 - P2_	0.019	1.02	6.094	6.010	1% AEP, 10 min burst, Storm 1
P2_6 - ExF	0.066	1.73	5.840	5.787	1% AEP, 5 min burst, Storm 1
ExP5 - ExF	0.064	0.85	5.342	5.280	1% AEP, 5 min burst, Storm 1
Pipe1059	0.081	1.29	5.280	5.166	1% AEP, 25 min burst, Storm 5
Pipe17	0.005	0.25	6.173	6.172	1% AEP, 10 min burst, Storm 1
P3_2 - HW	0.010	0.55	6.163	6.162	1% AEP, 10 min burst, Storm 4
GD2 - SAN	0.018	1.36	6.051	5.961	1% AEP, 45 min burst, Storm 6
SAND_FIL	0.018	1.38	5.738	5.708	1% AEP, 45 min burst, Storm 6
SAND FIL	0.022	1.22	5.400	5.347	1% AEP, 45 min burst, Storm 6
P4_17 - P	0.022	1.31	5.347	5.293	1% AEP, 45 min burst, Storm 6
P5_17 - Ex	0.022	0.92	5.251	5.172	1% AEP, 45 min burst, Storm 6
ExP6 - Cha	0.022	1.09	5.172	5.040	1% AEP, 45 min burst, Storm 6
P1_17 - P2	0.014	0.31	6.672	6.675	1% AEP, 5 min burst, Storm 1
P1_16 - P2	0.025	1.35	6.290	6.086	1% AEP, 10 min burst, Storm 1
Pipe69	0.035	1.98	5.981	5.429	1% AEP, 10 min burst, Storm 1
Pipe at Tra	0.132	1.74	5.026	4.965	1% AEP, 10 min burst, Storm 7
T1-B-N_P	0.020	1.08	6.738	6.737	1% AEP, 5 min burst, Storm 1

T1-A-S_P4	0.021	1.11	6.738	6.737	1% AEP, 5 min burst, Storm 1
TRENCH-1	0.034	1.85	6.737	6.737	1% AEP, 10 min burst, Storm 1
P1-9_P2-9	0.012	0.65	6.738	6.738	1% AEP, 5 min burst, Storm 1
P2-9_P3-9	0.018	0.96	6.738	6.738	1% AEP, 5 min burst, Storm 1
P196	0.046	2.49	6.738	6.738	1% AEP, 5 min burst, Storm 1
T1-C-N_P3	0.020	1.08	6.739	6.738	1% AEP, 5 min burst, Storm 1
TANK-T1-E	0.021	1.11	6.739	6.738	1% AEP, 5 min burst, Storm 1
P198	0.034	1.85	6.738	6.738	1% AEP, 10 min burst, Storm 1
P1_13 - P2	0.007	0.37	6.582	6.566	1% AEP, 10 min burst, Storm 2
P2_13 - P3	0.014	0.77	6.457	6.364	1% AEP, 10 min burst, Storm 1
P3_13 - P6	0.020	1.09	6.264	6.184	1% AEP, 10 min burst, Storm 1
P2_3 BASI	0.011	1.35	6.337	6.285	1% AEP, 10 min burst, Storm 5
P3_3 - P5_	0.011	0.63	6.277	6.224	1% AEP, 10 min burst, Storm 5
P5_3 - P6_	0.025	0.41	6.217	6.214	1% AEP, 5 min burst, Storm 1
P6_3 - P8_	0.028	0.39	6.213	6.209	1% AEP, 10 min burst, Storm 3
P8_3 - P10	0.042	0.59	6.196	6.187	1% AEP, 5 min burst, Storm 1
P10_3 - P1	0.074	1.03	6.101	6.057	1% AEP, 5 min burst, Storm 1
P11_3 - P5	0.104	1.44	5.949	5.898	1% AEP, 10 min burst, Storm 6
P5_15 - Ex	0.129	1.79	5.598	5.555	1% AEP, 10 min burst, Storm 7
ExP1 - DAI	0.209	2.03	5.258	5.116	1% AEP, 20 min burst, Storm 7
P1_15 BAS	0.007	0.85	6.496	6.490	1% AEP, 5 min burst, Storm 1
P1_15 - P2	0.006	0.31	6.487	6.481	1% AEP, 20 min burst, Storm 10
P2_15 - P3	0.014	0.74	6.456	6.417	1% AEP, 20 min burst, Storm 1
P3_15 - P4	0.022	1.16	6.368	6.224	1% AEP, 15 min burst, Storm 8
P4_15 - P5	0.028	1.51	6.005	5.898	1% AEP, 25 min burst, Storm 9
P2_15 BAS	0.013	1.55	6.492	6.481	1% AEP, 20 min burst, Storm 6
P4_3 BASI	0.014	1.65	6.294	6.224	1% AEP, 5 min burst, Storm 1
P3_15 BAS	0.011	1.24	6.433	6.417	1% AEP, 5 min burst, Storm 1
P7_3 BASI	0.016	1.87	6.280	6.209	1% AEP, 5 min burst, Storm 1
P9_3 BASI	0.016	1.83	6.261	6.187	1% AEP, 10 min burst, Storm 8
P4_15 BAS	0.011	1.31	6.262	6.224	1% AEP, 25 min burst, Storm 7
block d roo	0.065	3.49	7.877	6.230	1% AEP, 5 min burst, Storm 1
BRB1 - BR	0.096	1.33	6.178	6.161	1% AEP, 5 min burst, Storm 1
P2_4 - P3_	0.118	1.00	5.947	5.933	1% AEP, 30 min burst, Storm 8
P3_4 - P4_	0.118	1.07	5.876	5.868	1% AEP, 30 min burst, Storm 8
P4_4 - ExF	0.118	1.07	5.810	5.738	1% AEP, 30 min burst, Storm 8
ExP2 - ExF	0.118	1.07	5.713	5.555	1% AEP, 30 min burst, Storm 8
P11_3 BAS	0.010	1.14	6.115	6.057	1% AEP, 10 min burst, Storm 1
P3_19 BAS	0.009	1.08	6.308	6.279	1% AEP, 10 min burst, Storm 6
P3_19 - P1	0.025	1.35	6.200	6.057	1% AEP, 5 min burst, Storm 1
P2_19 BAS	0.009	0.99	6.386	6.368	1% AEP, 5 min burst, Storm 1
P2_19 - P3	0.017	0.90	6.329	6.279	1% AEP, 5 min burst, Storm 1
P1_19 BAS	0.009	1.06	6.403	6.386	1% AEP, 10 min burst, Storm 7
P1_19 - P2	0.009	0.50	6.382	6.368	1% AEP, 10 min burst, Storm 7
ExP3 - ExF	0.005	0.05	5.738	5.738	1% AEP, 10 min burst, Storm 4
P2_18 BAS	0.012	1.37	6.459	6.418	1% AEP, 5 min burst, Storm 1
P2_18 - P1	0.023	1.23	6.326	6.187	1% AEP, 5 min burst, Storm 1
P1_18 BAS	0.015	1.69	6.519	6.479	1% AEP, 15 min burst, Storm 9
P1_19 - P2	0.015	0.79	6.448	6.418	1% AEP, 15 min burst, Storm 5
GD1 - P3_	0.001	0.03	5.935	5.933	1% AEP, 10 min burst, Storm 1
CONCOUF	0.177	3.85	7.084	6.230	1% AEP, 5 min burst, Storm 1
P1_7 - P2_	0.012	0.65	6.738	6.738	1% AEP, 5 min burst, Storm 1
P2_7 - P3_	0.018	0.96	6.738	6.738	1% AEP, 5 min burst, Storm 1
P3_7 - TRE	0.046	2.49	6.738	6.738	1% AEP, 5 min burst, Storm 1
T1-D-NTH	0.020	1.08	6.739	6.738	1% AEP, 5 min burst, Storm 1
T1-C-STH	0.021	1.11	6.739	6.738	1% AEP, 5 min burst, Storm 1
P4_7 = TR	0.034	1.85	6.738	6.738	1% AEP, 10 min burst, Storm 1
BRB3 - ExI	0.043	0.49	5.403	5.280	1% AEP, 25 min burst, Storm 8
T1 - P1_6	0.025	1.34	6.440	6.425	1% AEP, 5 min burst, Storm 1
P1_6 - P2_	0.025	1.34	6.313	6.010	1% AEP, 5 min burst, Storm 1
T1 - P2_6	0.025	1.43	6.057	6.025	1% AEP, 5 min burst, Storm 1
P1_8 - P2_	0.008	0.42	6.728	6.740	1% AEP, 5 min burst, Storm 1
P2_8 - TRE	0.015	0.80	6.731	6.721	1% AEP, 5 min burst, Storm 1
P3_8 - TRE	0.050	2.66	6.720	6.719	1% AEP, 10 min burst, Storm 5
T2-EQPSH	0.031	1.65	6.721	6.721	1% AEP, 5 min burst, Storm 1
T1-E-STH	0.020	1.09	6.720	6.720	1% AEP, 5 min burst, Storm 1
P4_8 - TRE	0.027	1.42	6.720	6.719	1% AEP, 5 min burst, Storm 1
P1_10 - P2	0.012	0.66	6.718	6.718	1% AEP, 5 min burst, Storm 1
P2_10 - P3	0.018	0.96	6.718	6.718	1% AEP, 5 min burst, Storm 1
P3_10 - TF	0.046	2.49	6.717	6.717	1% AEP, 5 min burst, Storm 1
P1008	0.020	1.08	6.719	6.718	1% AEP, 5 min burst, Storm 1
T1-F-STH	0.021	1.11	6.719	6.719	1% AEP, 5 min burst, Storm 1
P4_10 - TF	0.034	1.85	6.718	6.717	1% AEP, 10 min burst, Storm 1
GD3 - P7_	0.005	0.26	6.179	6.178	1% AEP, 5 min burst, Storm 1
P2_17 - P3	0.005	0.80	5.846	5.770	1% AEP, 30 min burst, Storm 6
P3_17 - GI	0.005	0.58	5.770	5.737	1% AEP, 30 min burst, Storm 6

GPT - SAN	0.005	0.78	5.737	5.707	1% AEP, 30 min burst, Storm 6
SAND_TAI	0.005	1.06	5.707	5.668	1% AEP, 30 min burst, Storm 6

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF P4_13	0	0	1.250	0	0	0	0	
OF P5_13	0	0	1.468	0	0	0	0	
OF P6_13	0	0	1.538	0	0	0	0	
OF P7_13	0	0	1.266	0	0	0	0	
V-DRAIN	0.037	0.105	1.624	0.270	0.06	1.17	0.24	1% AEP, 10 min burst, Storm 7
OF P1_11	0.001	0.001	1.406	0.037	0.00	3.98	0.01	1% AEP, 6 hour burst, Storm 8
OF P2_11	0.001	0.001	1.534	0.037	0.00	3.98	0.01	1% AEP, 6 hour burst, Storm 8
OF P3_11	0.007	0.007	1.258	0.339	0.00	3.99	0.01	1% AEP, 12 hour burst, Storm 8
OF TRENC	0	0	1.406	0	0	0	0	
OF P3_1 -	0.011	0.011	3.052	0.053	0.03	1.70	0.50	1% AEP, 20 min burst, Storm 10
OF P4_1 -	0.007	0.007	3.392	0.050	0.02	1.34	0.40	1% AEP, 20 min burst, Storm 2
OF P5_1 -	0.005	0.005	3.298	0.044	0.02	0.75	0.43	1% AEP, 20 min burst, Storm 2
OF P6_1 -	0	0	4.206	0	0	0	0	
OF HW1 -	0.103	0.103	1.406	0.537	0.03	4.00	0.06	1% AEP, 6 hour burst, Storm 7
OF386	0	0	1.645	0	0	0	0	
OF372	0	0	3.587	0	0	0	0	
OF374	0	0	1.020	0	0	0	0	
OF P2_2 -	0	0	1.567	0	0	0	0	
OF P3_2	0	0	1.567	0	0	0	0	
OF234	0.024	0.024	1.522	0.561	0.01	4.00	0.02	1% AEP, 12 hour burst, Storm 7
OF GD2 - I	0	0	1.511	0	0	0	0	
OF SandFi	0	0	3.814	0	0	0	0	
OF SandFi	0	0	2.723	0	0	0	0	
OF P4_17	0	0	2.707	0	0	0	0	
OF P5_17	0	0	2.536	0	0	0	0	
OF ExP6 -	0	0	7.935	0	0	0	0	
OF P1_17	0.013	0.018	2.695	0.008	0.00	7.50	0.37	1% AEP, 45 min burst, Storm 6
OF P2_17	0	0	1.711	0	0	0	0	
Orifice_P2_	0.005	0.000	1.348	0.450	0.00	20.00	0.00	1% AEP, 30 min burst, Storm 6
OF P1_16	0	0	2.682	0	0	0	0	
OF P2_16	0	0	2.676	0	0	0	0	
OF_TO_TI	0	0	7.970	0	0	0	0	
OF P4_11	0.007	0.007	1.258	0.337	0.00	3.99	0.01	1% AEP, 12 hour burst, Storm 2
OF P1_9 -	0.001	0.001	1.406	0.038	0.00	3.98	0.01	1% AEP, 6 hour burst, Storm 8
OF P2_9 -	0.001	0.001	1.534	0.038	0.00	3.98	0.01	1% AEP, 6 hour burst, Storm 8
OF P3_9 -	0.007	0.007	1.258	0.338	0.00	3.99	0.01	1% AEP, 12 hour burst, Storm 8
OF TRENC	0	0	1.406	0	0	0	0	
OF P4-9 -	0.007	0.007	1.258	0.354	0.00	3.99	0.01	1% AEP, 12 hour burst, Storm 9
OF P1_13	0	0	1.533	0	0	0	0	
OF P2_13	0	0	1.533	0	0	0	0	
OF P3_13	0	0	1.531	0	0	0	0	
OF BYP2 -	0	0	0.545	0	0	0	0	
OF BYP1 -	0	0	0.867	0	0	0	0	
OF1 P2_3	0	0	3.807	0	0	0	0	
OF P1_15	0.000	0.008	3.052	0.084	0.02	4.81	0.33	1% AEP, 5 min burst, Storm 1
OF P2_15	0.000	0.007	3.258	0.059	0.01	2.23	0.30	1% AEP, 5 min burst, Storm 1
OF P4_3 -	0	0	7.982	0	0	0	0	
OF P3_15	0.000	0.008	3.258	0.053	0.02	1.63	0.39	1% AEP, 5 min burst, Storm 1
OF P7_3 -	0	0	7.982	0	0	0	0	
OF P9_3 B	0	0	3.807	0	0	0	0	
OF P4_15	0	0	3.815	0	0	0	0	
OF BRB1 -	0.168	0.168	1.406	0.087	0.05	3.98	0.74	1% AEP, 10 min burst, Storm 7
OF BRB2 -	0	0	8.006	0	0	0	0	
OF P11_3	0	0	3.780	0	0	0	0	
OF P3_19	0	0	3.814	0	0	0	0	
OF P2_19	0	0	3.772	0	0	0	0	
OF P1_19	0	0	1.487	0	0	0	0	
OF179	0	0	4.332	0	0	0	0	
OF181	0	0	4.270	0	0	0	0	
OF184	0	0	4.142	0	0	0	0	
OF178	0	0	4.427	0	0	0	0	
OF172	0	0	4.279	0	0	0	0	
OF395	0	0	13.746	0	0	0	0	
OF P2_18	0	0	3.807	0	0	0	0	
OF P1_18	0	0	3.807	0	0	0	0	
OF219	0	0	4.270	0	0	0	0	
OF230	0	0	1.447	0	0	0	0	

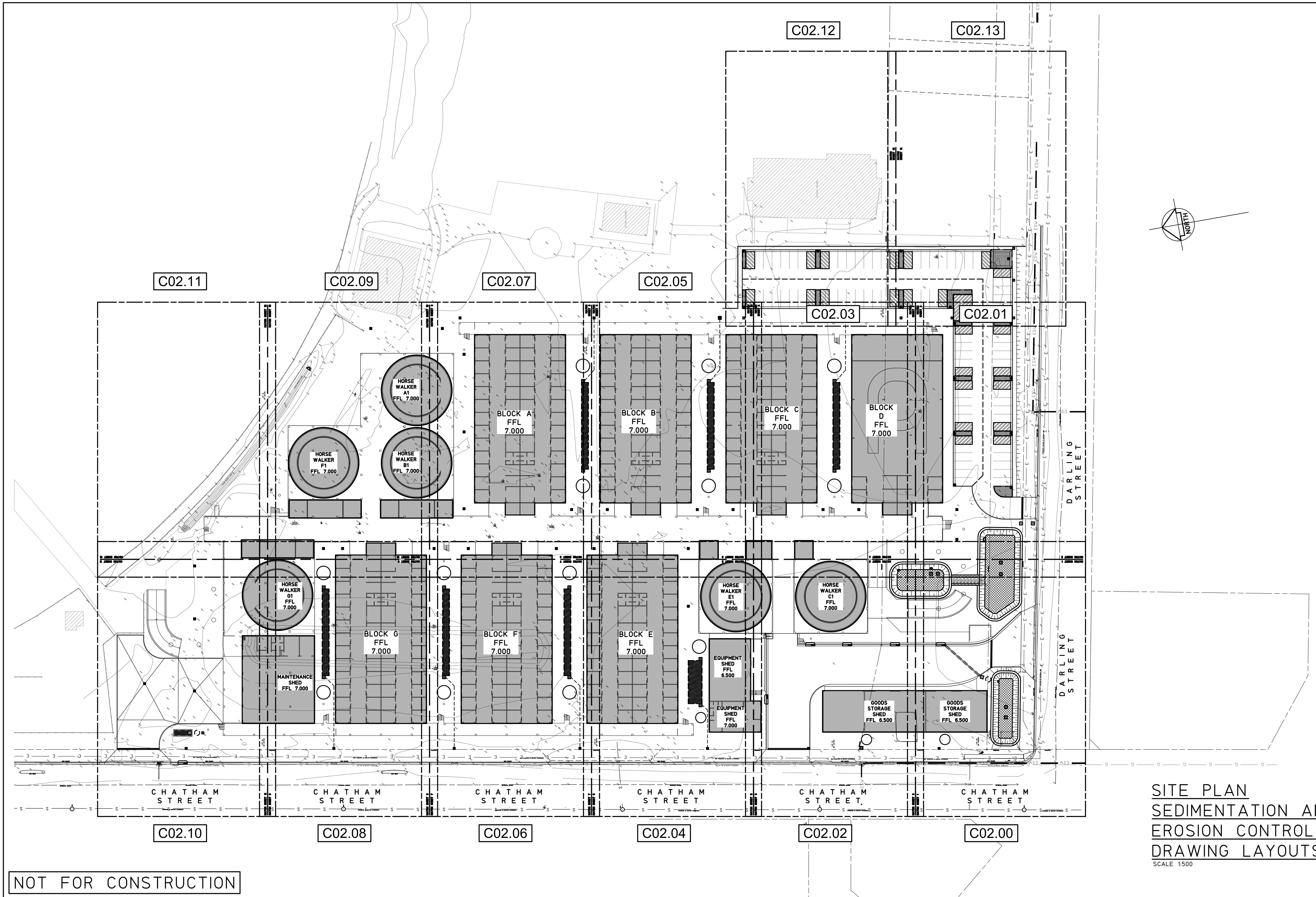
OF N480 -	0.167	0.167	1.522	0.561	0.04	4.00	0.28	1% AEP, 10 min burst, Storm 7
OF262	0.001	0.001	1.406	0.038	0.00	3.98	0.01	1% AEP, 6 hour burst, Storm 8
OF P2_7 -	0.001	0.001	1.534	0.038	0.00	3.98	0.01	1% AEP, 6 hour burst, Storm 8
OF P3_7 -	0.007	0.007	1.258	0.338	0.00	3.99	0.01	1% AEP, 12 hour burst, Storm 8
OF243	0	0	1.406	0	0	0	0	
OF254	0.007	0.007	1.258	0.354	0.00	3.99	0.01	1% AEP, 12 hour burst, Storm 9
OF BRB3 -	0	0	1.494	0	0	0	0	
OF P1_8 -	0.038	0.038	1.080	0.175	0.01	3.99	0.08	1% AEP, 12 hour burst, Storm 6
OF P2_8 -	0.035	0.035	1.024	0.181	0.01	3.99	0.05	1% AEP, 12 hour burst, Storm 2
OF P3_8 -	0.053	0.053	1.532	0.319	0.01	3.99	0.06	1% AEP, 6 hour burst, Storm 1
OF TRENC	0.009	0.009	1.509	0.073	0.01	3.98	0.34	1% AEP, 12 hour burst, Storm 8
OF P4_8 -	0.053	0.053	1.532	0.319	0.01	3.99	0.06	1% AEP, 6 hour burst, Storm 1
OF370	0.014	0.014	2.428	0.076	0.01	3.95	0.16	1% AEP, 9 hour burst, Storm 7
OF P1_10	0.001	0.001	1.406	0.017	0.00	3.45	0.04	1% AEP, 9 hour burst, Storm 6
OF P2_10	0.001	0.001	1.534	0.017	0.00	3.45	0.04	1% AEP, 9 hour burst, Storm 6
OF P3_10	0.009	0.009	1.258	0.317	0.00	3.99	0.01	1% AEP, 12 hour burst, Storm 1
OF TRENC	0.007	0.007	1.515	0.055	0.00	3.98	0.30	1% AEP, 9 hour burst, Storm 6
OF P4_10	0.009	0.009	1.258	0.317	0.00	3.99	0.01	1% AEP, 9 hour burst, Storm 5
OF368	0.007	0.007	3.805	0.065	0.01	2.89	0.26	1% AEP, 9 hour burst, Storm 6
OF GD3 - I	0	0	0.925	0	0	0	0	
OF SandFi	0	0	3.814	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
TRENCH_	6.74	105.7	0.000	0.000	0.000
SAND FIL1	5.60	0.3	0.022	0.022	0.000
TRENCH9	6.74	106.3	0.000	0.000	0.000
P2_3 BASI	6.73	1.1	0.011	0.011	0.000
P1_15 BAS	6.53	2.0	0.007	0.007	0.000
P2_15 BAS	6.56	5.0	0.013	0.013	0.000
P4_3 BASI	6.76	2.9	0.014	0.014	0.000
P3_15 BAS	6.54	3.3	0.011	0.011	0.000
P7_3 BASI	6.75	2.3	0.016	0.016	0.000
P9_3 BASI	6.76	4.4	0.016	0.016	0.000
P4_15 BAS	6.52	7.5	0.011	0.011	0.000
BRB1	6.23	55.1	0.263	0.096	0.168
BRB2	6.16	126.6	0.118	0.118	0.000
P11_3 BAS	6.50	1.0	0.010	0.010	0.000
P3_19 BAS	6.50	1.0	0.009	0.009	0.000
P2_19 BAS	6.51	1.4	0.009	0.009	0.000
P1_19 BAS	6.52	1.7	0.009	0.009	0.000
Basin73	6.74	1.7	0.012	0.012	0.000
Basin76	6.78	4.2	0.015	0.015	0.000
TRENCH7	6.74	106.3	0.000	0.000	0.000
BRB3	6.04	38.4	0.043	0.043	0.000
TRENCH8	6.72	111.8	0.009	0.000	0.009
TRENCH1	6.72	93.3	0.007	0.000	0.007

Appendix E

Soil and Water Management Plans



SITE PLAN SEDIMENTATION AND EROSION CONTROL DRAWING LAYOUTS

SCALE 1:500

NOT FOR CONSTRUCTION

ISSUE	REASON FOR ISSUE	DATE
2	DEVELOPMENT APPLICATION	12.08.21
1	ISSUED FOR APPROVAL	09.07.21
0	PRELIMINARY	02.07.21

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A.C.N. 098 542 575

CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SITE PLAN SEDIMENTATION AND EROSION CONTROL DRAWING LAYOUTS

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:500	16-548-1	C02	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 1

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

1. REFER TO DRAWING C02.11 FOR SEDIMENTATION AND EROSION CONTROL NOTES AND LEGEND

NOT FOR CONSTRUCTION

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TITLE
SEDIMENTATION AND EROSION CONTROL PLAN SHEET 1

PROJECT
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DO NOT SCALE DRAWING

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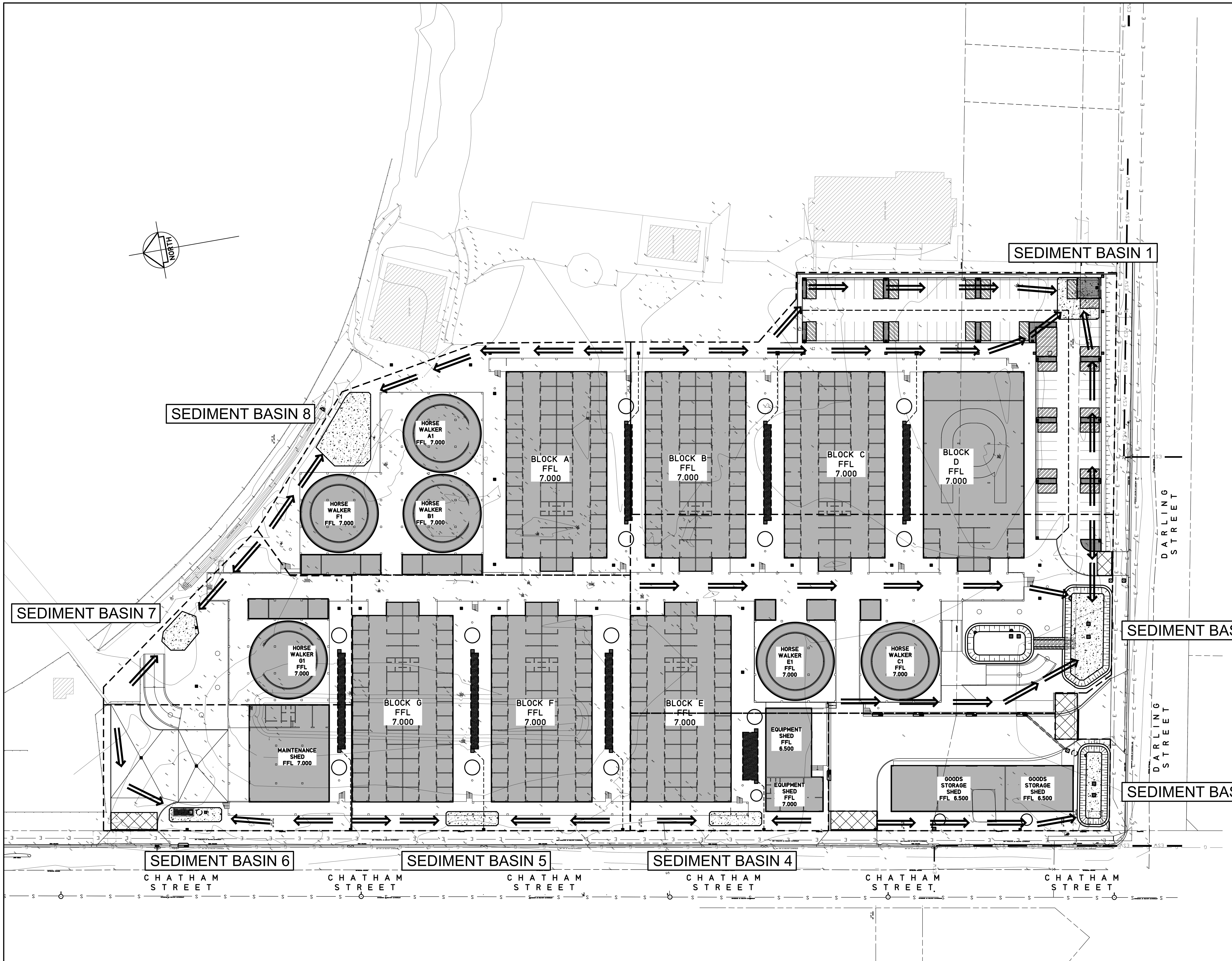
C.H.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C02.00	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION BASIN LAYOUT PLAN

SCALE 1:500



LEGEND

(cross-hatched box)	DENOTES STABILISED SITE ACCESS, REFER TO DETAIL SD6-14
(double arrow)	DENOTES EARTHBANK (HIGH FLOW), REFER TO DETAIL SD5-6
(stippled box)	DENOTES SEDIMENT BASIN, REFER TO SCHEDULE FOR SETTLING ZONE AND STORAGE AREA VOLUMES REFER TO DETAIL SD6-4
(dashed box)	DENOTES SEDIMENT BASIN, SUB-CATCHMENT EXTENTS

SEDIMENT BASIN SCHEDULE

SEDIMENT BASIN No.	PLAN AREA (m2)	SETTLING ZONE (m3)	STORAGE ZONE (m3)	TOTAL BASIN VOLUME (m3)
1	225	90	45	135
2	192	77	38	115
3	72	29	14	43
4	54	21	11	32
5	154	61	31	92
6	65	26	13	39
7	60	24	12	36
8	160	64	32	96

NOT FOR CONSTRUCTION

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TITLE
SEDIMENTATION BASIN LAYOUT PLAN

PROJECT
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DO NOT SCALE DRAWING

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C.H.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:500	16-548-1	C02.0	0

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 2

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

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TITLE
SEDIMENTATION AND EROSION CONTROL PLAN SHEET 2

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C02.01	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 3

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

1. REFER TO DRAWING C02.11 FOR SEDIMENTATION AND EROSION CONTROL NOTES AND LEGEND

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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL PLAN
SHEET 3

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C02.02	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 4

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

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CLIENT
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TITLE
SEDIMENTATION AND EROSION CONTROL PLAN SHEET 4

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C02.03	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 5

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL PLAN SHEET 5

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C02.04	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 6

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

1. REFER TO DRAWING C02.11 FOR SEDIMENTATION AND EROSION CONTROL NOTES AND LEGEND

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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL PLAN
SHEET 6

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C02.05	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 7

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL PLAN SHEET 7

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C02.06	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 8

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

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CLIENT: NEWCASTLE JOCKEY CLUB LTD

TITLE: SEDIMENTATION AND EROSION CONTROL PLAN SHEET 8

PROJECT: PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C02.07	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 9

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL PLAN
SHEET 9

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C02.08	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

ISSUE	REASON FOR ISSUE	DATE
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CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL PLAN SHEET 10

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C02.09	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 11

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

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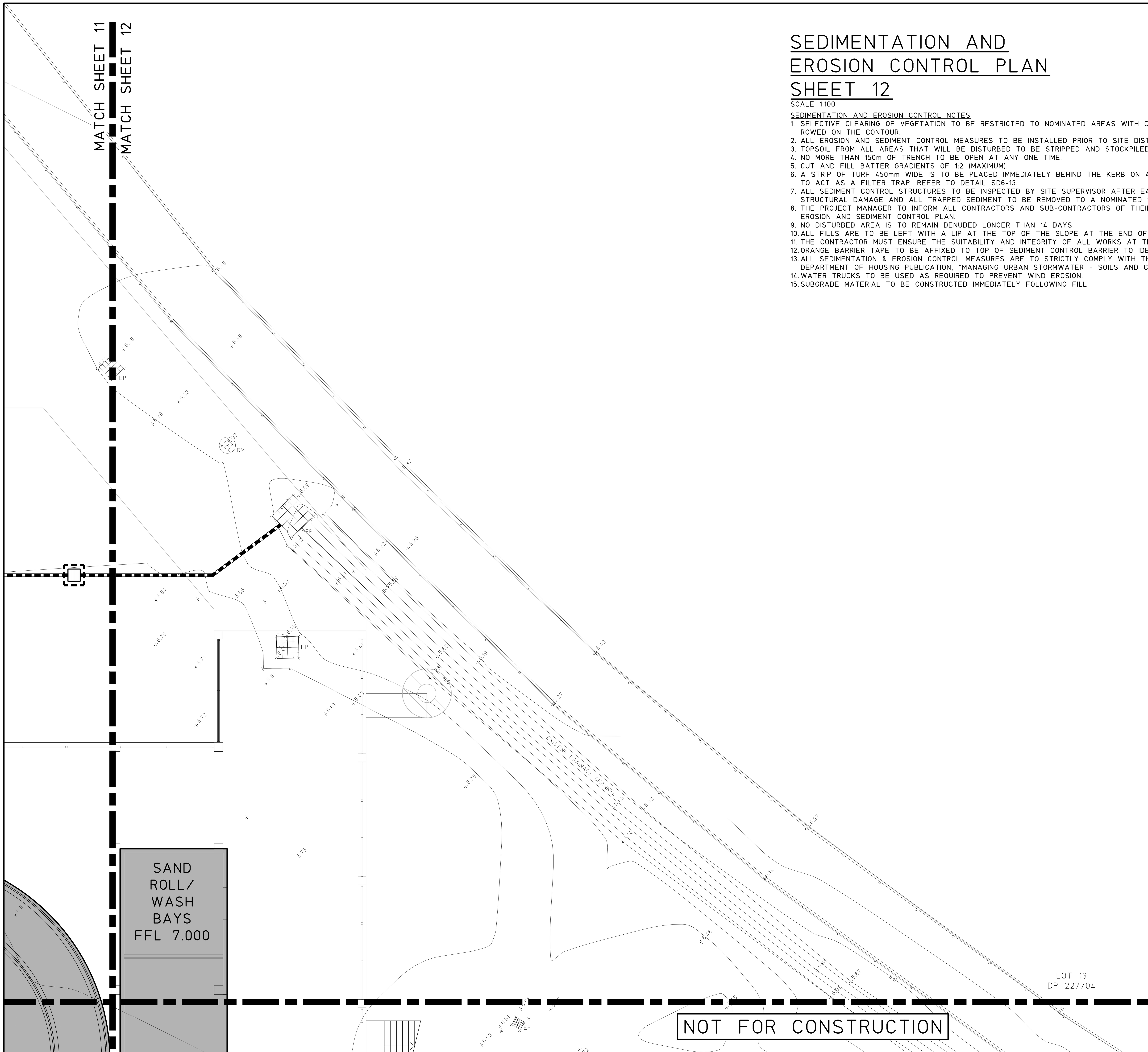
TITLE
SEDIMENTATION AND EROSION CONTROL PLAN
SHEET 11

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C02.10	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm



SEDIMENTATION AND EROSION CONTROL PLAN SHEET 12

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

1. SELECTIVE CLEARING OF VEGETATION TO BE RESTRICTED TO NOMINATED AREAS WITH CLEARED VEGETATION WIND ROWED ON THE CONTOUR.
2. ALL EROSION AND SEDIMENT CONTROL MEASURES TO BE INSTALLED PRIOR TO SITE DISTURBANCE.
3. TOPSOIL FROM ALL AREAS THAT WILL BE DISTURBED TO BE STRIPPED AND STOCKPILED AT THE NOMINATED SITE.
4. NO MORE THAN 150m OF TRENCH TO BE OPEN AT ANY ONE TIME.
5. CUT AND FILL BATTER GRADIENTS OF 1:2 (MAXIMUM).
6. A STRIP OF TURF 450mm WIDE IS TO BE PLACED IMMEDIATELY BEHIND THE KERB ON ALL NEW ROAD TO ACT AS A FILTER TRAP. REFER TO DETAIL SD6-13.
7. ALL SEDIMENT CONTROL STRUCTURES TO BE INSPECTED BY SITE SUPERVISOR AFTER EACH RAINFALL EVENT FOR STRUCTURAL DAMAGE AND ALL TRAPPED SEDIMENT TO BE REMOVED TO A NOMINATED STOCKPILE SITE.
8. THE PROJECT MANAGER TO INFORM ALL CONTRACTORS AND SUB-CONTRACTORS OF THEIR OBLIGATIONS UNDER THE EROSION AND SEDIMENT CONTROL PLAN.
9. NO DISTURBED AREA IS TO REMAIN DENUDED LONGER THAN 14 DAYS.
10. ALL FILLS ARE TO BE LEFT WITH A LIP AT THE TOP OF THE SLOPE AT THE END OF EACH DAY'S OPERATION.
11. THE CONTRACTOR MUST ENSURE THE SUITABILITY AND INTEGRITY OF ALL WORKS AT THE END OF EACH DAY'S WORK.
12. ORANGE BARRIER TAPE TO BE AFFIXED TO TOP OF SEDIMENT CONTROL BARRIER TO IDENTIFY WORK AREA.
13. ALL SEDIMENTATION & EROSION CONTROL MEASURES ARE TO STRICTLY COMPLY WITH THE GUIDELINES DETAILED IN THE DEPARTMENT OF HOUSING PUBLICATION, "MANAGING URBAN STORMWATER - SOILS AND CONSTRUCTION", 4TH EDITION.
14. WATER TRUCKS TO BE USED AS REQUIRED TO PREVENT WIND EROSION.
15. SUBGRADE MATERIAL TO BE CONSTRUCTED IMMEDIATELY FOLLOWING FILL.

LEGEND

- DENOTES ALLOWABLE AREA FOR TEMPORARY STOCKPILING OF CUT SOIL MATERIAL, REFER TO DETAIL SD4-1
- DENOTES ROCK CHECK DAM, REFER TO DETAIL SD5-4
- DENOTES EARTH BANK (LOW FLOW), REFER TO DETAIL SD5-5
- DENOTES EARTHBANK (HIGH FLOW), REFER TO DETAIL SD5-6
- DENOTES RECP: CONCENTRATED FLOW, REFER TO DETAIL SD5-7
- POND 1: DENOTES SEDIMENT POND, --m³ SETTLING ZONE, --m³ SEDIMENT STORAGE, --m³ MINIMUM STORAGE, REFER TO DETAIL SD6-4
- DENOTES STRAW BALE FILTER, REFER TO DETAIL SD6-7
- DENOTES SEDIMENT FENCE, REFER TO DETAIL SD6-8
- DENOTES MESH AND GRAVEL INLET FILTER, REFER TO DETAIL SD6-11
- DENOTES GEOTEXTILE INLET FILTER, REFER TO DETAIL SD6-12
- DENOTES STABILISED SITE ACCESS, REFER TO DETAIL SD6-14
- DENOTES LEVEL SPREADER

ISSUE	REASON FOR ISSUE	DATE
2	DEVELOPMENT APPLICATION	12.08.21
1	ISSUED FOR APPROVAL	09.07.21
0	PRELIMINARY	02.07.21

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mpc consulting engineers civil+structural
Level 1,
16 Telford Street,
NEWCASTLE EAST, NSW 2300
PO BOX 553
THE JUNCTION, NSW 2291
Tel: (02) 4927 5566
Fax: (02) 4927 5577
Email: admin@mpceng.com.au
Web: www.mpceng.com.au
A.C.N. 098 542 575

CLIENT: NEWCASTLE JOCKEY CLUB LTD

TITLE: SEDIMENTATION AND EROSION CONTROL PLAN SHEET 12

PROJECT: PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.H.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C02.11	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 13

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

1. REFER TO DRAWING C02.11 FOR SEDIMENTATION AND EROSION CONTROL NOTES AND LEGEND

NOT FOR CONSTRUCTION

ISSUE	REASON FOR ISSUE	DATE
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A.C.N. 098 542 575

CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL PLAN
SHEET 13

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.W.	B.C.	-	A1
SCALES	JOB No	DRAWING No	ISSUE
1:100	16-548-1	C02.12	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

SEDIMENTATION AND EROSION CONTROL PLAN SHEET 14

SCALE 1:100

SEDIMENTATION AND EROSION CONTROL NOTES

1. REFER TO DRAWING C02.11 FOR SEDIMENTATION AND EROSION CONTROL NOTES AND LEGEND

NOT FOR CONSTRUCTION

ISSUE	REASON FOR ISSUE	DATE
2	DEVELOPMENT APPLICATION	12.08.21
1	ISSUED FOR APPROVAL	09.07.21
0	PRELIMINARY	02.07.21

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Tel: (02) 4927 5566
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Email: admin@mpceng.com.au
Web: www.mpceng.com.au
A.C.N. 098 542 575

CLIENT
NEWCASTLE JOCKEY CLUB LTD

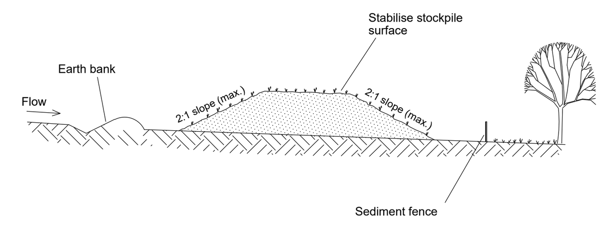
TITLE
SEDIMENTATION AND EROSION CONTROL PLAN
SHEET 14

PROJECT
PROPOSED STABLES COMPLEX AT;
NEWCASTLE JOCKEY CLUB
No.100 DARLING STREET,
BROADMEADOW

DO NOT SCALE DRAWING

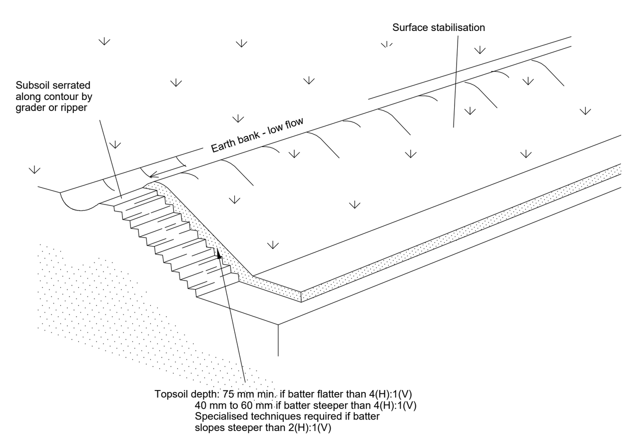
DRAWN	ENGINEER	No in SET	SHEET
C.W.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
1:100	16-548-1	C02.13	2

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm



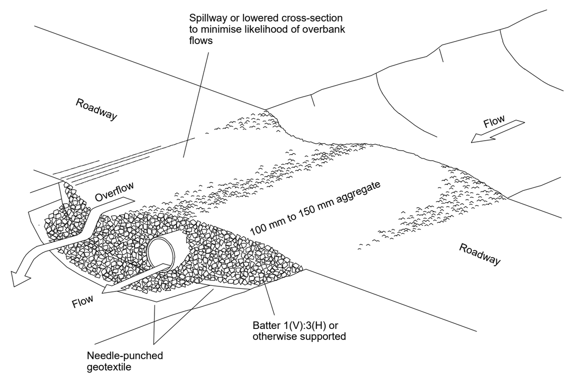
Construction Notes
1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
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 (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

STOCKPILES SD 4-1



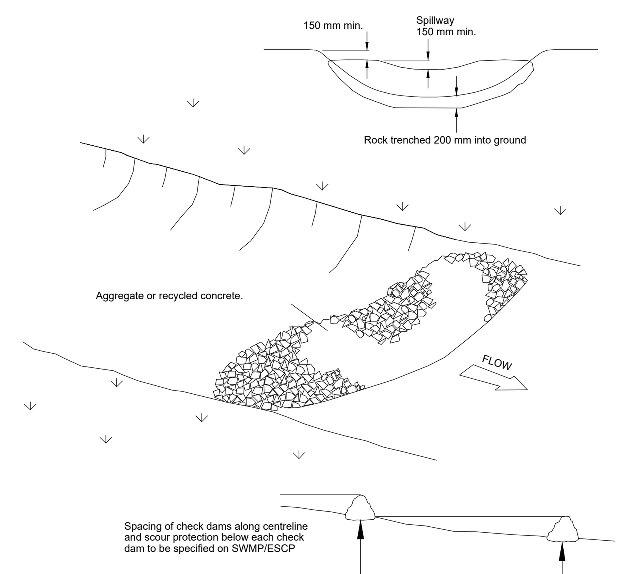
Construction Notes
1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.
2. Add soil ameliorants as required by the ESCP or SWMP.
3. Rip to a depth of 300 mm if compacted layers occur.
4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

REPLACING TOPSOIL SD 4-2



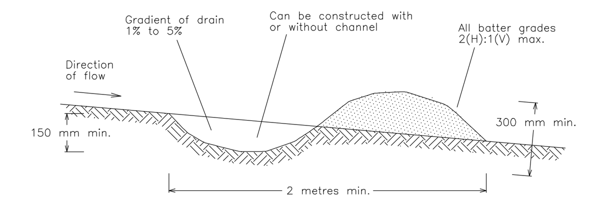
Construction Notes
1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H): 1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

TEMPORARY WATERWAY CROSSING SD 5-1



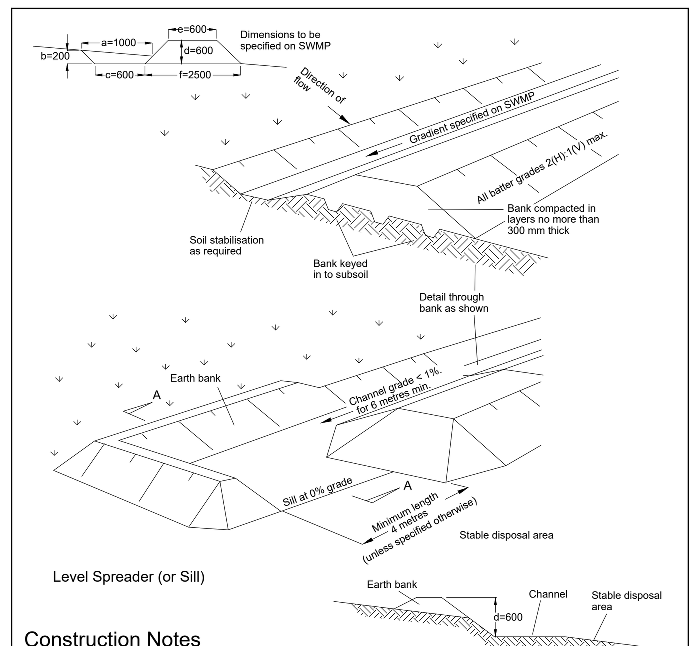
Construction Notes
1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.
4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM SD 5-4



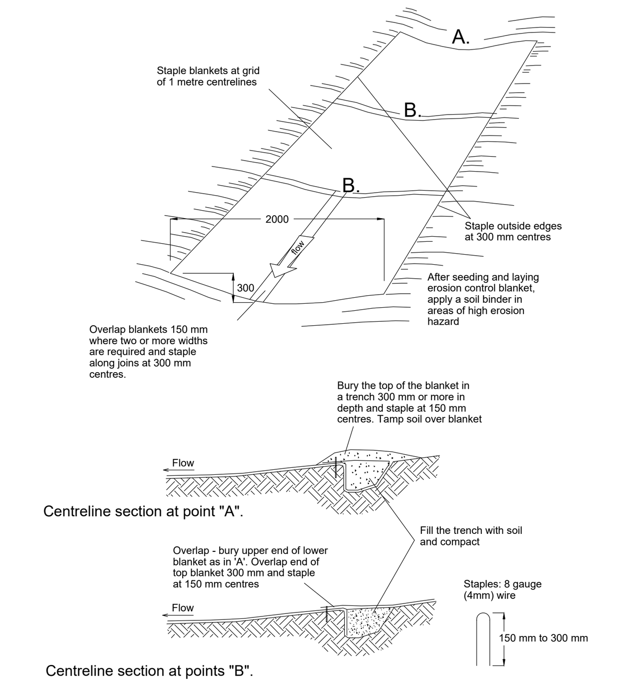
Construction Notes
1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW) SD 5-5



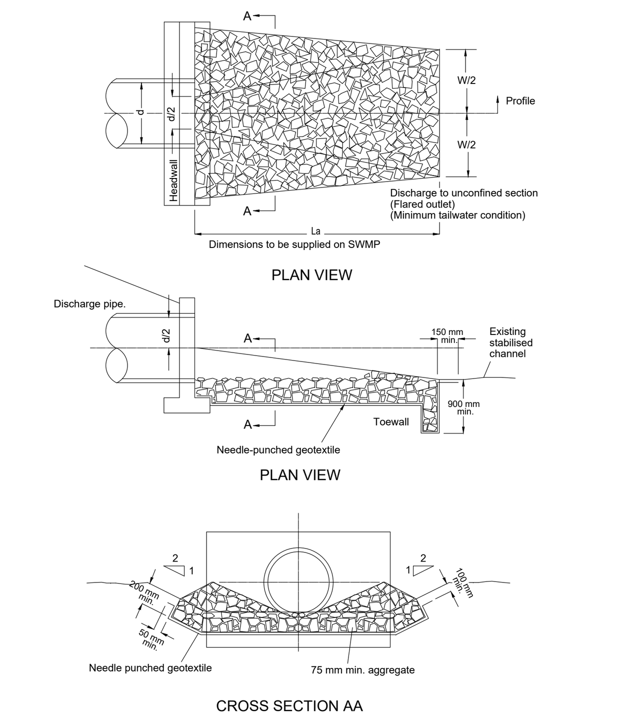
Construction Notes
1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

EARTH BANK (HIGH FLOWS) SD 5-6



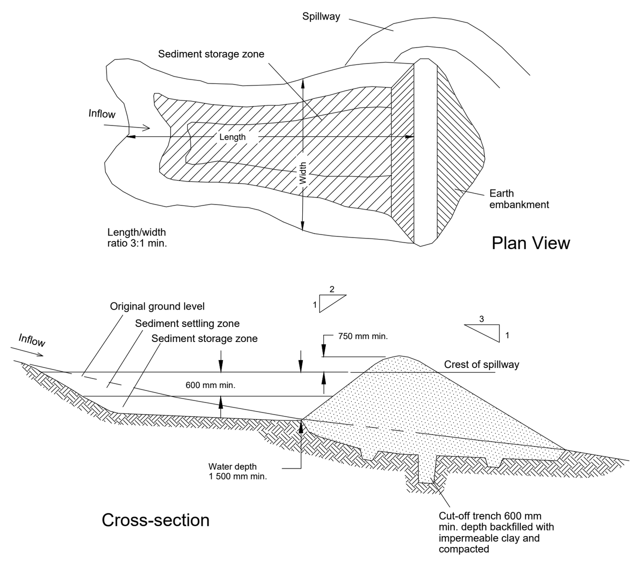
Construction Notes
1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end.
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

RECP : CONCENTRATED FLOW SD 5-7



Construction Notes
1. Compact the subgrade fill to the density of the surrounding undisturbed material.
2. Prepare a smooth, even foundation for the structure that will ensure that the needle-punched geotextile does not sustain serious damage when covered with rock.
3. Should any minor damage to the geotextile occur, repair it before spreading any aggregate. For repairs, patch one piece of fabric over the damage, making sure that all joints and patches overlap more than 300 mm.
4. Lay rock following the drawing, according to Table 5.2 of Landcom (2004) and with a minimum diameter of 75 mm.
5. Ensure that any concrete or riprap used for the energy dissipater or the outlet protection conforms to the grading limits specified on the SWMP.

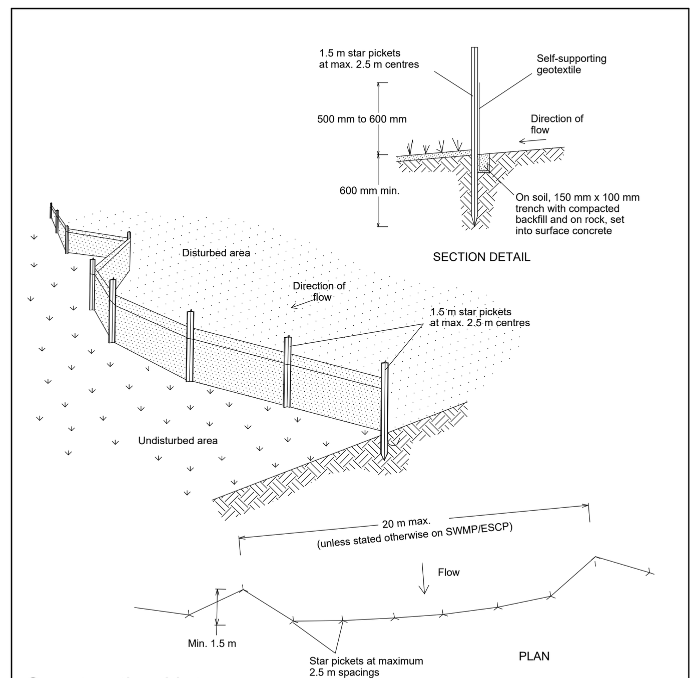
ENERGY DISSIPATER SD 5-8



Construction Notes
1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

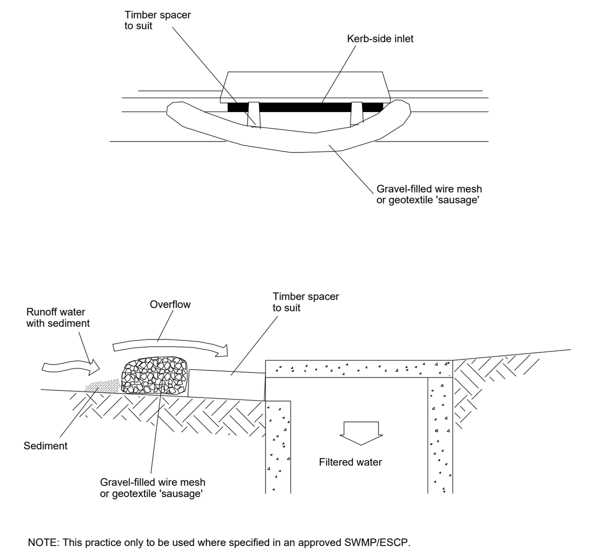
EARTH BASIN - WET SD 6-4

(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)



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 water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year 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 1.5 metre long star pickets into ground at 2.5 metre 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 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

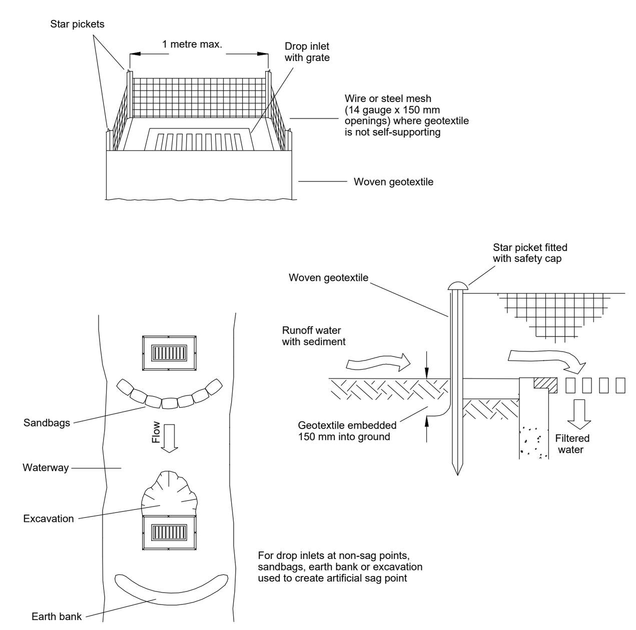
SEDIMENT FENCE SD 6-8



NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

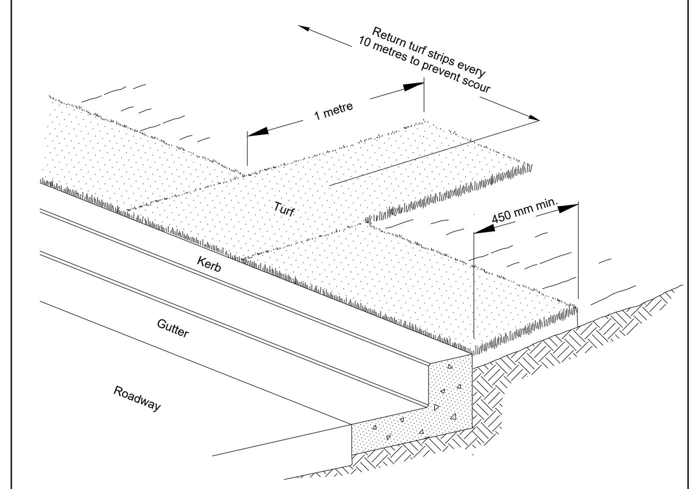
Construction Notes
1. Install filters to kerb inlets only at sag points.
2. Fabricate a sleeve made from geotextile or wire mesh longer than the length of the inlet pit and fill it with 25 mm to 50 mm gravel.
3. Form an elliptical cross-section about 150 mm high x 400 mm wide.
4. Place the filter at the opening leaving at least a 100-mm space between it and the kerb inlet. Maintain the opening with spacer blocks.
5. Form a seal with the kerb to prevent sediment bypassing the filter.
6. Sandbags filled with gravel can substitute for the mesh or geotextile providing they are placed so that they firmly abut each other and sediment-laden waters cannot pass between.

MESH AND GRAVEL INLET FILTER SD 6-11



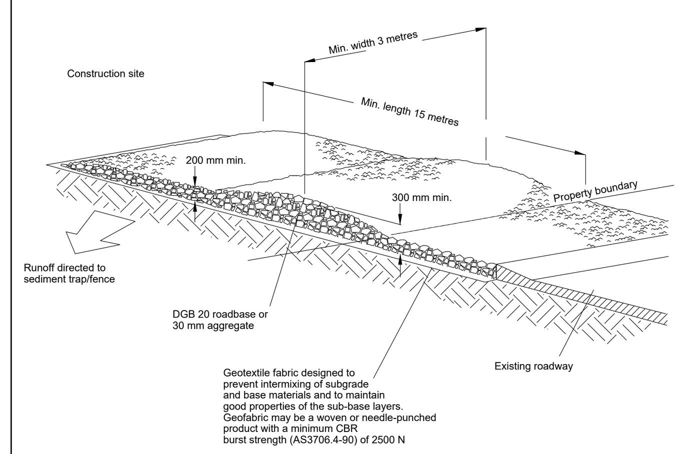
Construction Notes
1. Fabricate a sediment barrier made from geotextile or straw bales.
2. Follow Standard Drawing 6-8 for installation procedures for the straw bales or geofabric. Reduce the picket spacing to 1 metre centres.
3. In waterways, artificial sag points can be created with sandbags or earth banks as shown in the drawing.
4. Do not cover the inlet with geotextile unless the design is adequate to allow for all waters to bypass it.

GEOTEXTILE INLET FILTER SD 6-12



Construction Notes
1. Install a 450 mm minimum wide roll of turf on the footpath next to the kerb and at the same level as the top of the kerb.
2. Lay 1.4 metre long turf strips normal to the kerb every 10 metres.
3. Rehabilitate disturbed soil behind the turf strip following the ESCP/SWMP.

KERBSIDE TURF STRIP SD 6-13



Construction Notes
1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200 mm thick pad over the geotextile using road base or 30 mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence

STABILISED SITE ACCESS SD 6-14

NOT FOR CONSTRUCTION

ISSUE	REASON FOR ISSUE	DATE
0	DEVELOPMENT APPLICATION	12.08.21

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A.C.N. 098 542 575

CLIENT
NEWCASTLE JOCKEY CLUB LTD

TITLE
SEDIMENTATION AND EROSION CONTROL DETAILS

PROJECT
PROPOSED STABLES COMPLEX AT; NEWCASTLE JOCKEY CLUB No.100 DARLING STREET, BROADMEADOW

DO NOT SCALE DRAWING

DRAWN	ENGINEER	No in SET	SHEET
C.W.	B.C.	-	A1
SCALES	**JOB No**	**DRAWING No**	**ISSUE**
N.T.S.	16-548-1	C02.14	0

FULL SIZE ON ORIGINAL 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 cm

Appendix F

Soil and Water Management Calculations

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on high erosion hazard lands as identified by figure 4.6 or where the designer chooses to run the RUSLE in calculations.

1. Site Data Sheet

Site name: Newcastle Jockey Club

Site location: Chatham and Darling Streets, Broadmeadow NSW

Precinct: Newcastle

Description of site: Proposed Stables Comples and Car Park

Site area	Site						Remarks
	1	2	3	4	5	6	
Total catchment area (ha)	0.7	0.6	0.226	0.164	0.48	0.2	
Disturbed catchment area (ha)	0.7	0.6	0.226	0.164	0.48	0.2	

Soil analysis

Soil landscape	Sloping Site - Silty soils with some sand and gravel						From Geotech report for the iste
Soil Texture Group	Type D	Type D	Type D	Type D	Type D	Type D	Sections 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5	5	5	5	5	5	See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	80	80	80	80	80	80	See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	30.5	30.5	30.5	30.5	30.5	30.5	See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	10.89	10.89	10.89	10.89	10.89	10.89	See IFD chart for the site
Rainfall erosivity (R-factor)	2580	2580	2580	2580	2580	2580	Automatic calculation from above data

Comments:

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on high erosion hazard lands as identified by figure 4.6 or where the designer chooses to run the RUSLE in calculations.

1. Site Data Sheet

Site name: **Newcastle Jockey Club**

Site location: **Chatham and Darling Streets, Broadmeadow NSW**

Precinct: **Newcastle**

Description of site: **Proposed Stables Comples and Car Park**

Site area	Site						Remarks
	7	8					
Total catchment area (ha)	0.19	0.5					
Disturbed catchment area (ha)	0.19	0.5					

Soil analysis

Soil landscape	Sloping Site - Silty soils with some sand and gravel						From Geotech report for the iste
Soil Texture Group	Type D	Type D					Sections 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5	5					See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	80	80					See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	30.5	30.5					See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	10.89	10.89					See IFD chart for the site
Rainfall erosivity (R-factor)	2580	2580					Automatic calculation from above data

Comments:

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
1	0.7	7	78	122	135	154	177	195	0.76
2	0.6	7	78	122	135	154	177	195	0.76
3	0.226	5	78	122	135	154	177	195	0.76
4	0.164	4	78	122	135	154	177	195	0.76
5	0.48	6	78	122	135	154	177	195	0.76
6	0.2	4	78	122	135	154	177	195	0.76

Peak flow calculations, 2

ARI yrs	Frequency factor (F_y)	Peak flows						Comment
		1	2	3	4	5	6	
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m3/s)	
$1_{yr,\,tc}$	0.8	0.092	0.079	0.030	0.022	0.063	0.026	
$5_{yr,\,tc}$	0.95	0.171	0.147	0.055	0.040	0.118	0.049	
$10_{yr,\,tc}$	1	0.200	0.171	0.064	0.047	0.137	0.057	
$20_{yr,\,tc}$	1.05	0.239	0.205	0.077	0.056	0.164	0.068	
$50_{yr,\,tc}$	1.15	0.301	0.258	0.097	0.071	0.206	0.086	
$100_{yr,\,tc}$	1.2	0.346	0.297	0.112	0.081	0.237	0.099	

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Q_y = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
7	0.19	4	78	122	135	154	177	195	0.76
8	0.5	6	78	122	135	154	177	195	0.76

Peak flow calculations, 2

ARI yrs	Frequency factor (F_y)	Peak flows						Comment
		7	8					
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m3/s)	
$1_{yr,\,tc}$	0.8	0.025	0.066					
$5_{yr,\,tc}$	0.95	0.047	0.122					
$10_{yr,\,tc}$	1	0.054	0.143					
$20_{yr,\,tc}$	1.05	0.065	0.171					
$50_{yr,\,tc}$	1.15	0.082	0.215					
$100_{yr,\,tc}$	1.2	0.094	0.247					

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{y\text{-\%ile, x-day}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
1	0.42	30.5	0.7	89.67	45	134.505
2	0.42	30.5	0.6	76.86	38	115.29
3	0.42	30.5	0.226	28.9506	14	43.4259
4	0.42	30.5	0.164	21.0084	11	31.5126
5	0.42	30.5	0.48	61.488	31	92.232
6	0.42	30.5	0.2	25.62	13	38.43

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{y\text{-\%ile, x-day}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

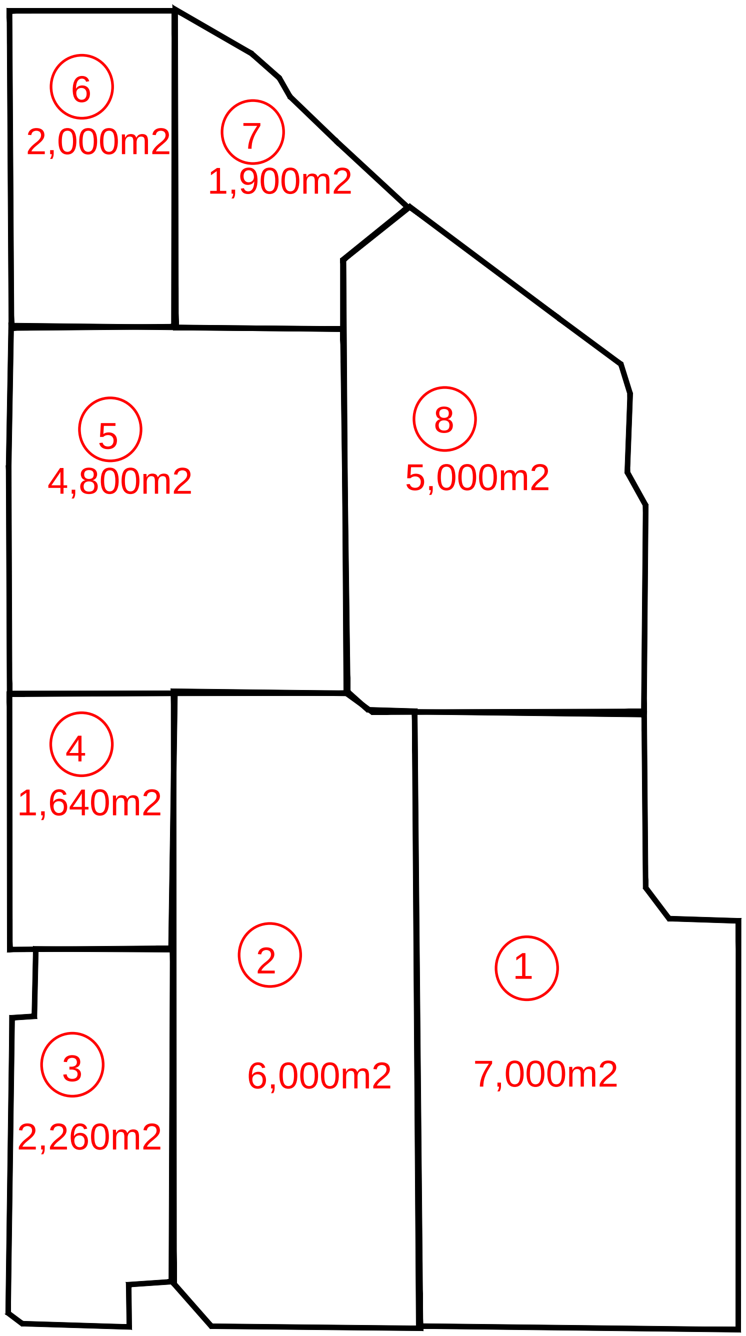
In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
7	0.42	30.5	0.19	24.339	12	36.5085
8	0.42	30.5	0.5	64.05	32	96.075

MPC Ref: 160548.1
Project: Newcastle Jockey Club - Proposed Stables Comples
Subject: Summary of Construction Phase Sediment Basin Volumes

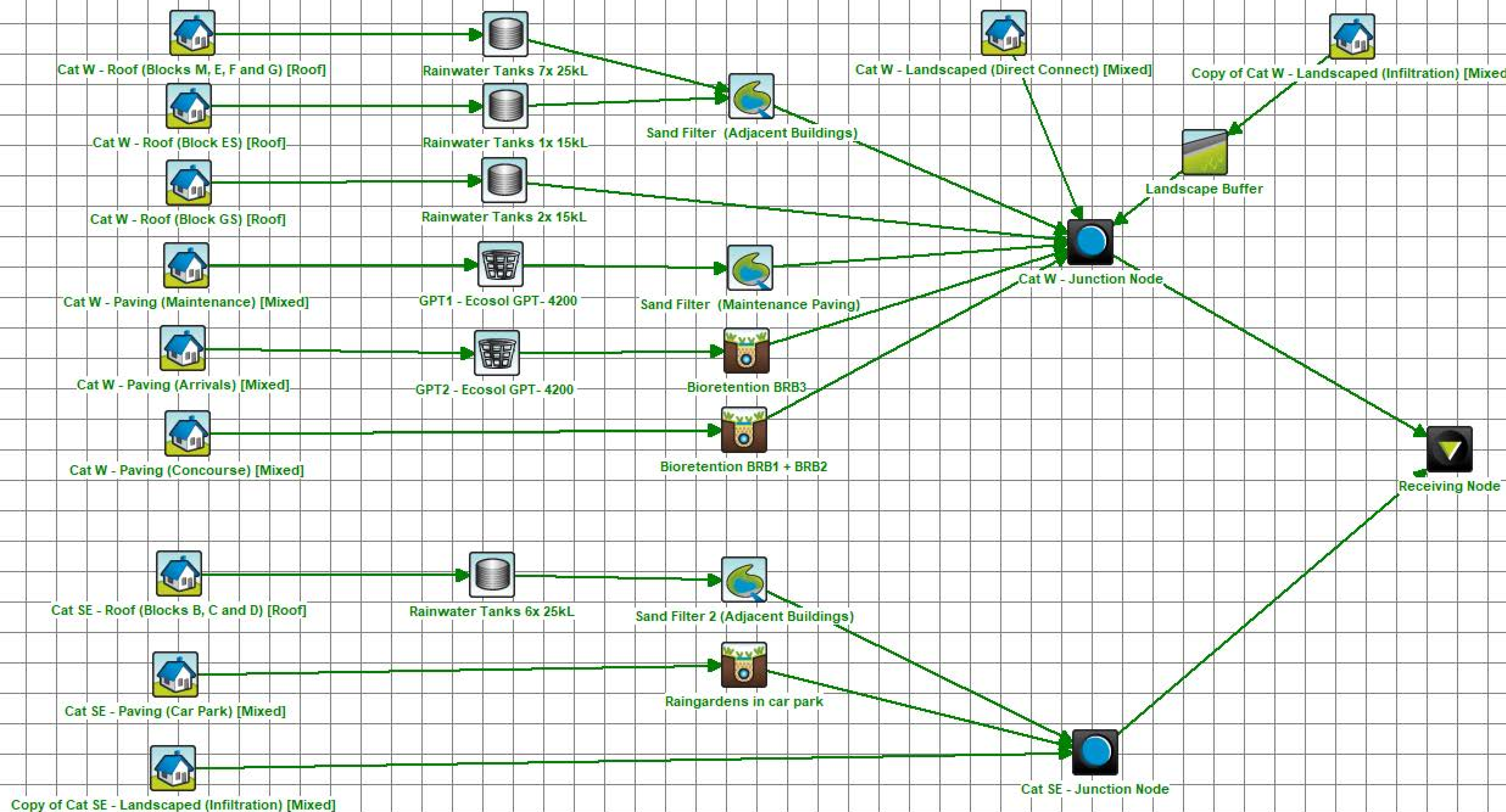
Sediment Basin No.	Plan Area of base (m2)	Settling Zone (m3)	Storage Zone (m3)	Total Basin Volume (m3)
1	225	90	45	135
2	192	77	38	115
3	72	29	14	43
4	54	21	11	32
5	154	61	31	92
6	65	26	13	39
7	60	24	12	36
8	160	64	32	96



6
2,000m2
7
1,900m2
5
4,800m2
8
5,000m2
4
1,640m2
2
6,000m2
1
7,000m2
3
2,260m2

Appendix G

Stormwater Quality (MUSICLink) Report



NEWCASTLE JOCKEY CLUB - CHATHAM ST STABLES COMPLEX
"MUSIC" MODEL SCHEMATIC

THE CITY OF NEWCASTLE

MUSIC-*link* Report

Project Details		Company Details	
Project:	NJC Stables Complex	**Company:**	MPC Consulting Engineers
Report Export Date:	22/07/2021	**Contact:**	Benjamin Curran
Catchment Name:	160548 NJC Chatham MUSIC_08.12.2021	**Address:**	Suite 3, Level 1, 16 Telford St Newcastle NSW 2300
Catchment Area:	2.382ha	**Phone:**	02 4927 5566
Impervious Area*:	70.84%	**Email:**	benjaminc@mpceng.com.au
Rainfall Station:	61078 WILLIAMTOWN		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1995 - 31/12/2008 11:54:00 PM		
Mean Annual Rainfall:	1125mm		
Evapotranspiration:	1735mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.33		
Study Area:	Newcastle		
Scenario:	Newcastle		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Receiving Node	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	57.1%	Rain Water Tank Node	4	Urban Source Node	11
TSS	91.8%	Bio Retention Node	3		
TP	83.1%	Infiltration System Node	3		
TN	80.5%	Buffer Node	1		
GP	100%	GPT Node	2		

Comments

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention BRB1 + BRB2	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention BRB1 + BRB2	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention BRB3	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Bioretention BRB3	PET Scaling Factor	2.1	2.1	2.1
Bio	Raingardens in car park	Hi-flow bypass rate (cum/sec)	None	None	100
Bio	Raingardens in car park	PET Scaling Factor	2.1	2.1	2.1
Buffer	Landscape Buffer	Proportion of upstream impervious area treated	None	None	1
GPT	GPT1 - Ecosol GPT- 4200	Hi-flow bypass rate (cum/sec)	None	None	0.051
GPT	GPT2 - Ecosol GPT- 4200	Hi-flow bypass rate (cum/sec)	None	None	0.051
Infiltration	Sand Filter (Adjacent Buildings)	Area (sqm)	None	None	162
Infiltration	Sand Filter (Adjacent Buildings)	Filter area (sqm)	None	None	162
Infiltration	Sand Filter (Adjacent Buildings)	Hi-flow bypass rate (cum/sec)	None	None	100
Infiltration	Sand Filter (Maintenance Paving)	Area (sqm)	None	None	7.8
Infiltration	Sand Filter (Maintenance Paving)	Filter area (sqm)	None	None	7.8
Infiltration	Sand Filter (Maintenance Paving)	Hi-flow bypass rate (cum/sec)	None	None	100
Infiltration	Sand Filter 2 (Adjacent Buildings)	Area (sqm)	None	None	150
Infiltration	Sand Filter 2 (Adjacent Buildings)	Filter area (sqm)	None	None	150
Infiltration	Sand Filter 2 (Adjacent Buildings)	Hi-flow bypass rate (cum/sec)	None	None	100
Rain	Rainwater Tanks 1x15kL	% Reuse Demand Met	70	None	90.9891
Rain	Rainwater Tanks 2x15kL	% Reuse Demand Met	70	None	98.1171
Rain	Rainwater Tanks 6x25kL	% Reuse Demand Met	70	None	100
Rain	Rainwater Tanks 7x25kL	% Reuse Demand Met	70	None	100
Receiving	Receiving Node	% Load Reduction	None	None	57.1
Receiving	Receiving Node	GP % Load Reduction	90	None	100
Receiving	Receiving Node	TN % Load Reduction	45	None	80.5
Receiving	Receiving Node	TP % Load Reduction	65	None	83.1
Receiving	Receiving Node	TSS % Load Reduction	85	None	91.8
Urban	Cat SE - Paving (Car Park)	Area Impervious (ha)	None	None	0.241
Urban	Cat SE - Paving (Car Park)	Area Pervious (ha)	None	None	0.050
Urban	Cat SE - Paving (Car Park)	Total Area (ha)	None	None	0.292
Urban	Cat SE - Roof (Blocks B_ C and D)	Area Impervious (ha)	None	None	0.39
Urban	Cat SE - Roof (Blocks B_ C and D)	Area Pervious (ha)	None	None	0
Urban	Cat SE - Roof (Blocks B_ C and D)	Total Area (ha)	None	None	0.39
Urban	Cat W - Landscaped (Direct Connect)	Area Impervious (ha)	None	None	0
Urban	Cat W - Landscaped (Direct Connect)	Area Pervious (ha)	None	None	0.026
Urban	Cat W - Landscaped (Direct Connect)	Total Area (ha)	None	None	0.026
Urban	Cat W - Paving (Arrivals)	Area Impervious (ha)	None	None	0.175
Urban	Cat W - Paving (Arrivals)	Area Pervious (ha)	None	None	0.022
Urban	Cat W - Paving (Arrivals)	Total Area (ha)	None	None	0.198
Urban	Cat W - Paving (Concourse)	Area Impervious (ha)	None	None	0.276

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Cat W - Paving (Concourse)	Area Pervious (ha)	None	None	0.093
Urban	Cat W - Paving (Concourse)	Total Area (ha)	None	None	0.37
Urban	Cat W - Paving (Maintenance)	Area Impervious (ha)	None	None	0.073
Urban	Cat W - Paving (Maintenance)	Area Pervious (ha)	None	None	0
Urban	Cat W - Paving (Maintenance)	Total Area (ha)	None	None	0.073
Urban	Cat W - Roof (Block ES)	Area Impervious (ha)	None	None	0.037
Urban	Cat W - Roof (Block ES)	Area Pervious (ha)	None	None	0
Urban	Cat W - Roof (Block ES)	Total Area (ha)	None	None	0.037
Urban	Cat W - Roof (Block GS)	Area Impervious (ha)	None	None	0.037
Urban	Cat W - Roof (Block GS)	Area Pervious (ha)	None	None	0
Urban	Cat W - Roof (Block GS)	Total Area (ha)	None	None	0.037
Urban	Cat W - Roof (Blocks M_ E_ F and G)	Area Impervious (ha)	None	None	0.457
Urban	Cat W - Roof (Blocks M_ E_ F and G)	Area Pervious (ha)	None	None	0
Urban	Cat W - Roof (Blocks M_ E_ F and G)	Total Area (ha)	None	None	0.457
Urban	Copy of Cat SE - Landscaped (Infiltration)	Area Impervious (ha)	None	None	0
Urban	Copy of Cat SE - Landscaped (Infiltration)	Area Pervious (ha)	None	None	0.191
Urban	Copy of Cat SE - Landscaped (Infiltration)	Total Area (ha)	None	None	0.191
Urban	Copy of Cat W - Landscaped (Infiltration)	Area Impervious (ha)	None	None	0
Urban	Copy of Cat W - Landscaped (Infiltration)	Area Pervious (ha)	None	None	0.311
Urban	Copy of Cat W - Landscaped (Infiltration)	Total Area (ha)	None	None	0.311

Only certain parameters are reported when they pass validation

Appendix H

City of Newcastle Supplied Information

Flood Certificate and Relevant Flood Maps

Existing road drainage information

22 May 2019

Avid Project Management Pty Ltd
C/- Ncle Jockey Club Ltd
Po Box 30
BROADMEADOW NSW 2292

Flood Information Certificate No:	FL2019/00101
Land:	Lot 13 DP 227704
Property Address:	125 Chatham Street Broadmeadow NSW 2292

Thank you for your recent enquiry regarding flood behaviour at the above property. This letter confirms the property is located in a flood prone area.

The pertinent features of the flood behaviour are estimated as follows:

Local Catchment Flooding

Is any part of the site affected by a floodway?	No
Is any part of the site affected by a flood storage area?	Yes (See Attachment)
Estimated 1% Annual Exceedance Probability event level: (equivalent to the "*Defined Flood Level*" in the Building Code of Australia)	6.35m AHD (North West corner) 6.35m AHD (South West corner) 6.10m AHD (middle of race track)
Estimated Maximum Flow Velocity of floodwaters (in the "*Defined Flood Event*" as per the Building Code of Australia)	0.8m/s
Highest Property Hazard Category	P2
Estimated Probable Maximum Flood Level	7.3m AHD (maximum velocity 1.10m/s)
Highest Life Hazard Category	L4 (H3)

The flood study from which the above information is derived is part of a Newcastle City Wide Floodplain Management Plan. The above advice may change in the future, however the advice is based on the best information held by Council at the time of issue of this certificate.

The Newcastle Development Control Plan 2012 addresses the issues of flood management for new development. You can view the development control plan at www.newcastle.nsw.gov.au. In summary, the following requirements apply for all future development applications on the site.

Development in a floodway is not generally allowable due to likely redistribution of flood water.	Not Applicable
Filling of a flood storage area by more than 20% is not generally allowable due to redistribution of flood water.	Applicable
Minimum floor level for occupiable rooms in a new development on this site is: (equivalent to the "*Flood Hazard Level*" in the Building Code of Australia)	6.85m AHD
Is onsite flood refuge required?	Yes

Council holds no information concerning floor levels of existing structures on the site. Site levels and floor levels should be verified by survey based on the Australian Height Datum.

Please note that:

1. No assessment of the lot's suitability for the purposes of making an application for a complying development certificate under the Housing Code or Rural Housing Code of *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*, or for a Secondary Dwelling under *State Environmental Planning Policy (Affordable Rental Housing) 2009,* has been made. This type of flood information can also be obtained from Council via a Flood Information Application. There are two services provided by Council relating to Complying Development flood criteria, as follows:

   a) Identification of lots affected by any of the flood control lot exclusions identified in subclause 3.5(1) or 3A.38(1) of *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008.* If this information is required, select Box 4. b) (i) on the Flood Information Application form and pay the required fee.

   b) An assessment of a proposal for development of the lot for compliance with the requirements of subclause 3.36(2) or 3A.38(2) of *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008.* If this information is required, select Box 4. b) (ii) on the Flood Information Application form, submit plans and other relevant documentation for the proposal and pay the required fee.

2. The information contained in this certificate may alter in the future. The applicant should at all times ensure the currency of this information.

Should you require any further clarification please contact Alastair Peddie on 4974 2788.
Yours faithfully

Alastair Peddie
SENIOR DEVELOPMENT OFFICER (ENGINEERING)

FLOODCLASSIFICATION
Flood Fringe
Flood Storage
Floodway

Additional information for the holders of Flood Information Certificates

This information explains the terms used in Newcastle City Council's Flood Information Certificates and provides some basic information on Councils requirements for future development of flood prone land.

Compliance with these requirements in the Development Control Plan does not guarantee approval, however, in most cases, the flood issues can be resolved by adhering to these guidelines.

Newcastle City-wide Floodplain Risk Management Plan 2012
Newcastle Development Control Plan

FLOOD CERTIFICATE NOTES

GENERAL:

- The information presented in the Certificate relates to the Newcastle City-wide Floodplain Risk Management Plan and the Newcastle Development Control Plan, which have been developed in accordance with the principles of the NSW Government's Flood Prone Land Policy.
- Council's flood information is compiled from a composite of data. The variability of rainfall itself is a major factor in the uncertainty of flood information and accordingly, this certificate is only an estimate of real flood characteristics. Any particular flood is likely to be different to the conditions described in this certificate.
- Council acknowledges that its flood information is incomplete and varies in accuracy, however it is the best available to Council at the time of issue.
- Where information is presently not known, it is denoted by "unknown"
- From time to time, on going research and studies will replace or add to Council's flood information. Accordingly, the information in this certificate is not warranted after the day of issue.
- Should you disagree with Council's assessment of the flood behaviour, you may conduct your own investigations or enquires and submit them to Council for consideration. Where revision of this assessment is warranted, Council is committed to making such amendments to its information.

EXPLANATIONS FOR TERMS USED IN THE FLOOD INFORMATION CERTIFICATE

Is any part of the site affected by a Floodway?

Generally, where a property is affected by a floodway, we will provide you with additional information on where we believe the floodway to be by way of a map. In some circumstances it may be possible to redirect a floodway subject to appropriate engineering advice. You should start by discussing the matter with a development officer from Council.

A ***Floodway*** is a pathway taken by major discharges of floodwaters, the obstruction or partial obstruction of which would cause a significant redistribution of floodwaters, or a significant increase in flood levels. Floodways are often aligned with natural channels and are usually characterised by deep and relatively fast flowing water.

The Newcastle DCP 2012 states:

> *"No building or structure is to be erected and no land is to be filled by way of the deposition of any material within any area identified as a floodway except for:*
>
> > *Minor alterations to ground levels for roads, parking, below ground structures and landscaping, provided that the fundamental flow patterns are not significantly altered.*
>
> *Where dividing fences across floodways are unavoidable, they are to be constructed only of open type fencing that will not restrict the flow of flood waters and be resistant to blockage. New development shall be designed to avoid fences in floodways."*

Is any part of the site affected by a flood storage area?

Where a property is wholly affected by flood storage area, we will answer "yes" to this question on the Flood Information Certificate. Where a property is partly affected, we will provide additional information by way of a map.

Flood storage area is an area where flood water accumulates and the displacement of that floodwater will cause a significant redistribution of floodwaters, or a significant increase in flood levels, or a significant increase in downstream flood frequency. Flood storage areas are often aligned with floodplains and are usually characterised by deep and slow moving floodwater.

The Newcastle DCP 2012 states:

> *"Not more than 20% of the area of any development site in a flood storage area is to be filled. The remaining 80% can generally be developed allowing for underfloor storage of floodwater by the use of suspended floor techniques such as pier and beam construction.*
>
> *Where it is proposed to fill development sites, the fill is not to impede the flow of ordinary drainage from neighbouring properties, including overland flow."*

1% Annual Exceedence Probability (AEP) event level:

The 1% AEP event is the basic benchmark for Council's development controls. It is a flood event that has a 1 in 100 chance of being exceeded in any one year. Conceptually, it is similar to a "1 in 100 year" event, except that the term 1 in 100 years conveys the notion that the event is definitely going to happen in a 100 year time frame, and will only occur once in that time frame. In fact, a 1 in 100 year event has a 67% probability of occurring once in any nominate hundred year period.

Levels are reduced to the Australian Height Datum. This means that the quoted levels are heights above sea level. They can be compared to ground levels determined by a surveyor using the same datum to ascertain the likely flood depth.

In general, the minimum requirement for development of flood prone land is to set floor levels above the **Flood planning level (FPL)**. The flood planning level is the peak flood level for the flood planning event (usually the 1% AEP flood) **plus** the appropriate freeboard (usually, but not always 500mm, depending on the circumstances) to account for uncertainty, wave action and model error.

The Newcastle DCP 2012 states:

> *"Floor levels of all occupiable rooms of all buildings are not to be set lower than the FPL."*
>
> *"Garage floor levels are to be set no lower than the 1% AEP flood event. However it is recognised that in some circumstances this may be impractical due to vehicular access constraints. In these cases, garage floor levels should be as high as practicable."*
>
> *"Basement garages may be acceptable where all potential water entry points are at or above the probable maximum flood (PMF), excepting that vehicular entry points can be at the FPL. In these cases, explicit points of refuge should be accessible from the carpark in accordance with the provisions for risk to life set out below."*
>
> *"Electrical fixtures such as power points, light fittings and switches are to be sited above the FPL unless they are on a separate circuit (with earth leakage protection) to the rest of the building."*
>
> *"Where parts of the building are proposed to be below the flood planning level, they are to be constructed of water-resistant materials. "*

Highest Property Hazard Category:

Property hazards describe the danger that flood waters might pose to the property of persons affected by flooding. Generally, the descriptions are:

- **P1** Parked or moving cars remain stable
- **P2** Parked or moving heavy vehicles remain stable
- **P3** Suitable for light construction (eg timber frame, masonry and brick veneer)

P4 Suitable for heavy construction (eg steel frame, and concrete)

P5 Hydraulically unsuitable for normal building construction

They are determined by direct correlation to the Hydraulic Behaviour Threshold (P1 relates to a Hydraulic Behaviour Threshold of H1) as determined at the flood-planning event, usually the 1% AEP flood. The Hydraulic behaviour thresholds used in the determination of these hazards are shown in the figure N1.

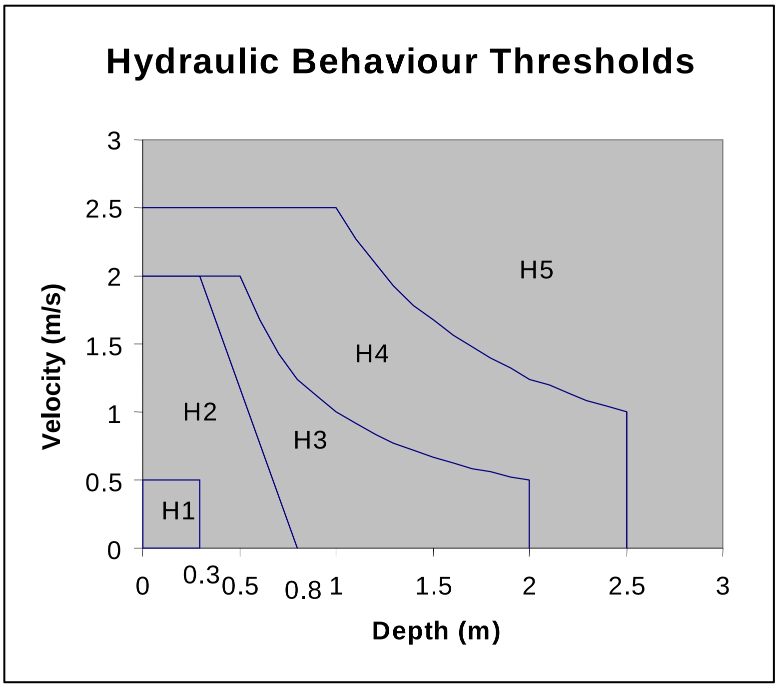


Figure N1 – Hydraulic Behaviour Thresholds

For the purposes of the flood information quoted here, the property hazard relates to the ground level as understood by Council at the time the information was collected. The property hazard cannot be used to determine the ground level of the site.

Property hazards can be reduced by filling a site, or raising floor levels as appropriate provided that the work is compatible with the applicable (if any) floodway or flood storage area.

In general, the minimum requirement for managing property risk is to set floor levels to the Flood planning level. The flood planning level is the level (usually expressed as a reduced level above the Australian Height Datum (AHD).

The Newcastle DCP 2012 states:

> "Areas where cars, vans and trailers etc are parked, displayed or stored are not to be located in areas subject to property hazard of P2 or higher. Containers, bins, hoppers and other large floatable objects also are not to be stored in these areas. Heavy vehicle parking areas are not to be located in areas subject to property hazard P3 or higher."

> "Timber framed, light steel construction, cavity brickwork and other conventional domestic building materials are generally not suitable forms of construction where the property hazard is P4 or higher. Where property hazard is P4, the structure shall be certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters."

> "Property hazards of P5 are generally unsuitable for any type of building construction and building is discouraged from these areas. Where building is necessary, the

structure is to be certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters."

Highest life Hazard Category:

Life hazards describe the danger that flood waters might pose to the lives of persons affected by flooding. Generally, the descriptions are:

Table N1 Life hazard descriptions

	HAZARD CLASSIFICATION				
HAZARD FACTOR	**L1**	**L2**	**L3**	**L4**	**L5**
Effective Warning	Y	N	N	N	N
Effictive capacity to allow evacuation to flood free land	**Y**	**Y**	**N**	**N**	**N**
Rate of rise of flood waters	Slow	Flash	Flash	Flash	Flash
Duration of Flooding	Too long for refuge enclosed by floodwaters to be appropriate.	Short enough for occupation during the entire flood to be appropriate	Short enough for occupation during the entire flood to be appropriate	Short enough for flood free refuge enclosed by floodwaters to be appropriate	Short enough for flood free refuge enclosed by floodwaters to be appropriate
Escape route	An obvious rising escape route to flood free land outside of the entire flood is available	An obvious rising escape route to flood free land outside of the entire flood is available	There is be no obvious rising escape route to flood free land outside of the entire flood.	There is be no obvious rising escape route to flood free land outside of the entire flood. An obvious rising escape route to flood free land outside of the entire flood is available	There is be no obvious rising escape route to flood free land outside of the entire flood.
Nature of enclsing floodwaters	Flood free land outside of the enture flood can be reached before the flooding affects the site itself	Reaching flood free land outside of the entire flood requires evacuation through enclosing floodwaters, and these flood waters are suitable for wading or heavy vehicles at all times	Enclosing flodwaters are suitable for waiding and for medical emegrency evacuation by waiding or heavy vehichle at all times	Enclosing floodwaters are not suitable for waiding or heavy vehicles, and require heavy construction for structural stability of buildings (eg steel frame and concrete)	No form of normal building construction would be feasible to ensure structural satbility in enclosing floodwaters
Evacuation need:	Required to flood free land otuside of the entire flood	Required to flood free land otuside of the entire flood	Not Required	Required to a suitable flood free refuge within the enclosed flood waters	Normally not possible (therefore normally unsuitable for development)
Evacuation problems	Still need to ensure that any proposed development in these areas will not cause additional burden on emergency response services	Still need to ensure that any proposed development in these areas will not cause additional burden on emergency response services	Nil (for abled bodied adults)	Evacuation shall be self directed and fail safe.	Enclosing flood waters are so hazardous that evacuation by normal means to flood free land outside the entire flood would not be contemplated. The structural stability of an an on-site refuge cannot be assured by normally available building types, and therefore a refuge enclosed by floodwaters cannot (normally) be provided

Life hazards are used to manage risks to life and accordingly, are determined by considering the hydraulic behaviour threshold (see figure N1) at the Probable Maximum Flood (PMF).

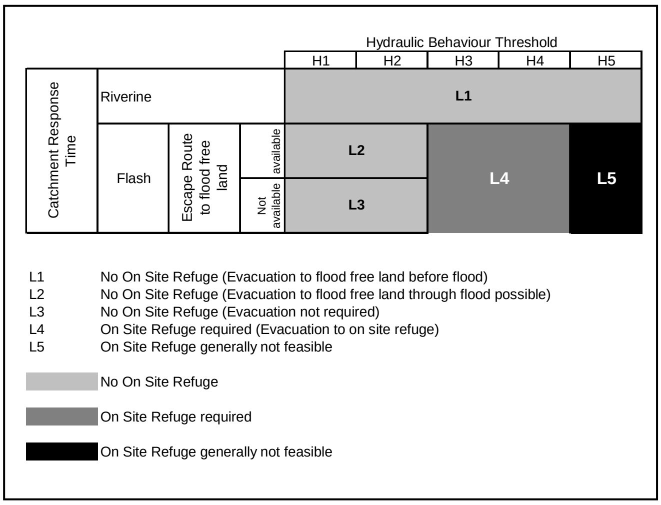


Figure N2 – Life Hazard determination

Figure N2 shows how the life hazard categories are determined in accordance with the methodology of the Newcastle City-wide Floodplain Risk Management Plan.

The Newcastle DCP 2012 states:

> "On site refuge is to be provided for all development where the life hazard category is L4 or higher unless the proposed development is less than 40m from the perimeter of the PMF extent and the higher ground is accessible. "
>
> "The minimum on-site refuge level is to be the level of the PMF. On site refuges are to be designed to cater for the number of people reasonably expected to be on the development site and are to be provided with emergency lighting."
>
> "On site refuges are to be of a construction type able to withstand the effects of flooding. Design certification by a practising structural engineer that the building is able to withstand the hydraulic loading due to flooding (at the PMF) is required. "

The requirement for on site refuge (where applicable) will generally be satisfied by a two storey building form. However, for residential properties, an attic access ladder and suitable small platform will usually also suffice.

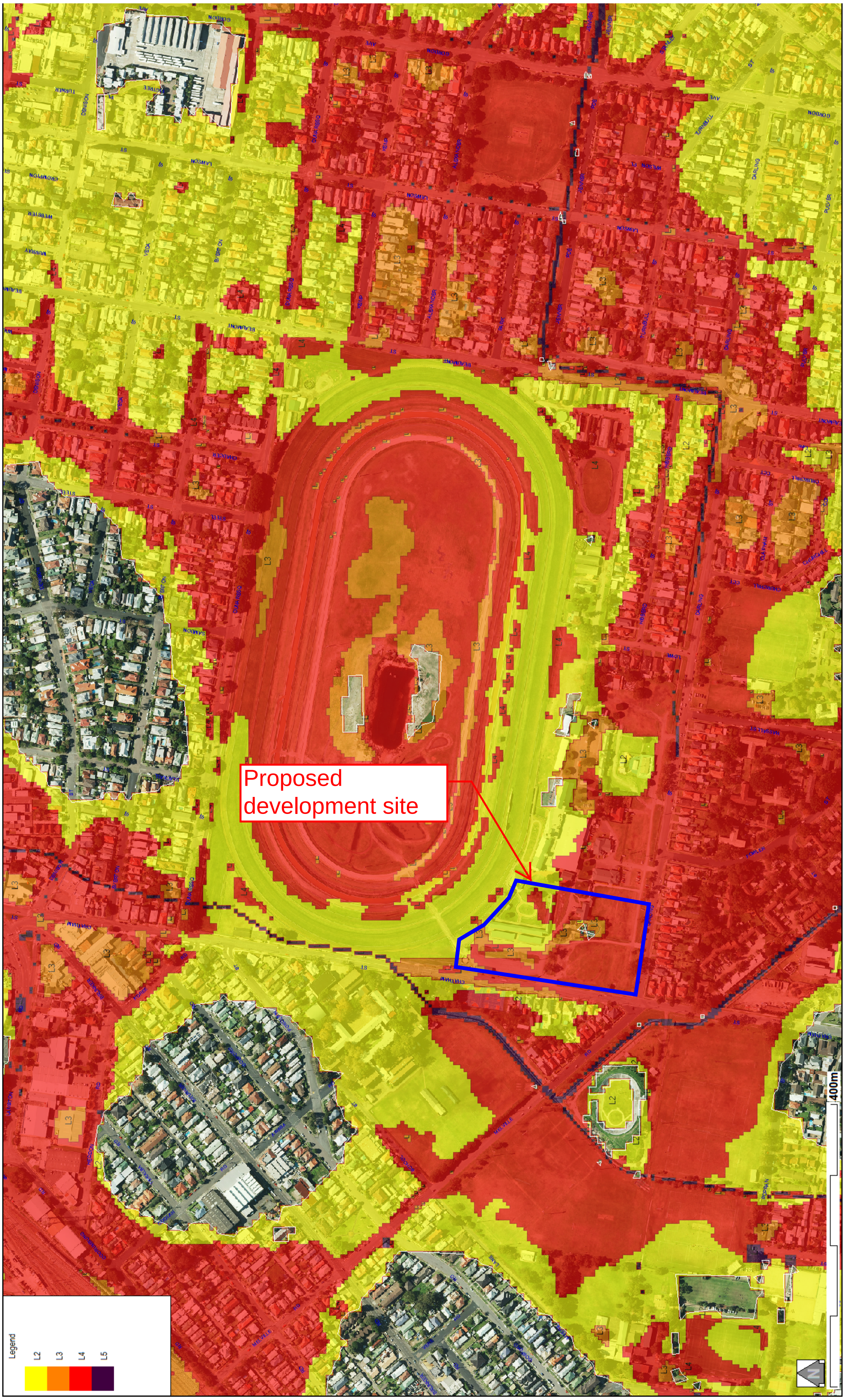
In most cases where on site refuge is required, the duration of the peak flood event is short and accordingly, it is not expected to have to utilise flood refuge areas for long periods of time, especially when their use the chance of them being used is generally less than 1% in any given year. Accordingly, comfort factors are not of large concern to owners, occupiers or Council in determining the suitability of flood refuges.

FLOOD CLASSIFICATION MAP

(Extract from the City of Newcastle Floor certificate No. FL2019/00101)

"RISK TO LIFE" MAP

(Extract from the City of Newcastle Floor certificate No. FL2019/00101)



"RISK TO PROPERTY" MAP

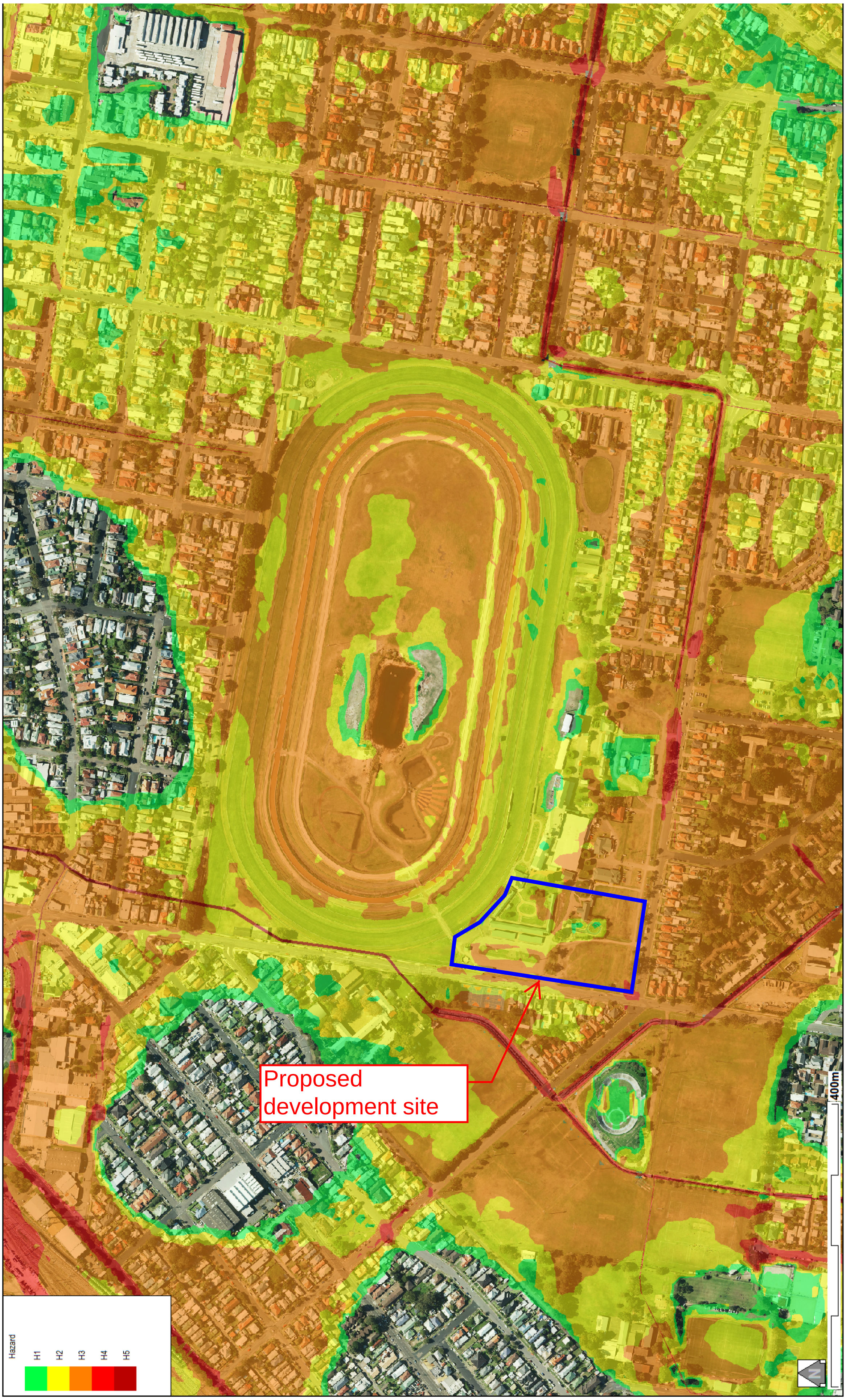
(Extract from the City of Newcastle Floor certificate No. FL2019/00101)

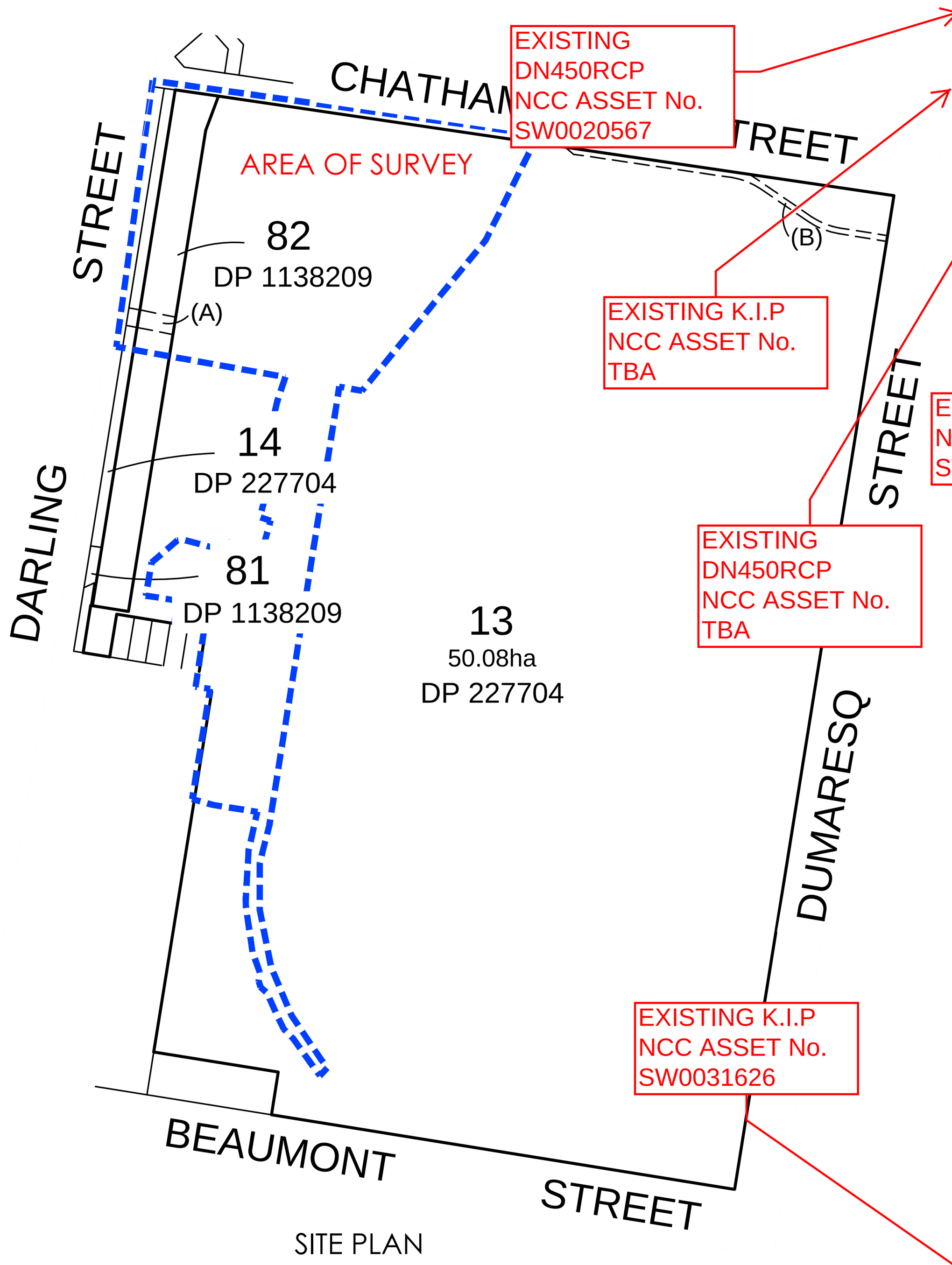
"FLOW VELOCITIES" MAP

(Extract from the City of Newcastle Floor certificate No. FL2019/00101)

"PMF STABILITY" MAP

(Extract from the City of Newcastle Floor certificate No. FL2019/00101)





SITE PLAN
SCALE 1:5000

DIAL BEFORE YOU DIG
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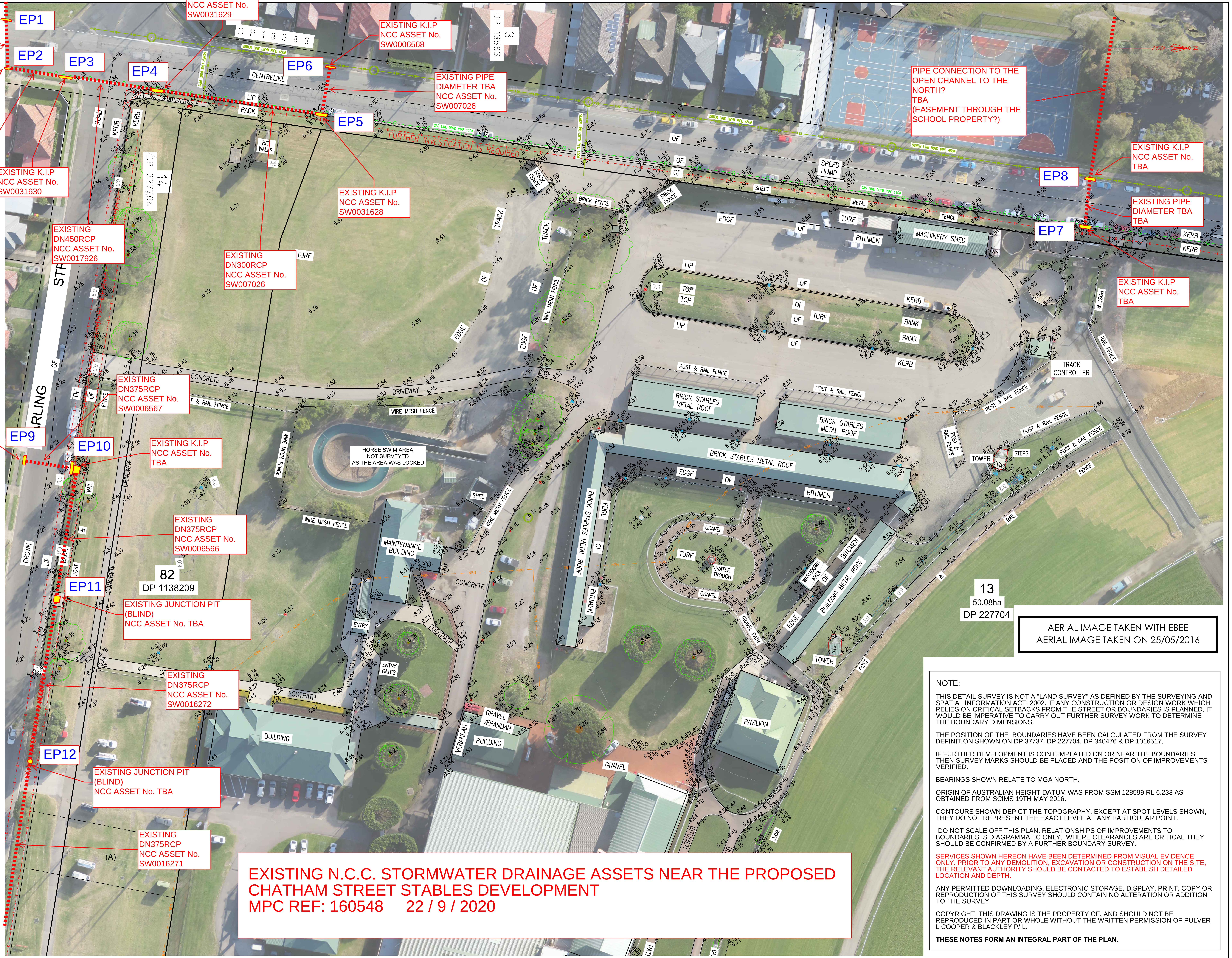
(A) EASEMENT FOR ELECTRICITY CABLES AND SUBSTATION 15 WIDE (DP 638744)

(B) EASEMENT FOR COVERED STORMWATER CHANNEL RESUMED BY GOVT GAZ. 29/5/1936 FOL 2101 (DP 227704)



LEGEND

- SIGN
- COMMS PIT
- ELECTRICITY PIT
- FUSE PILLAR
- POWER POLE
- LIGHT POLE
- FLOOD LIGHT
- WATER HYDRANT
- WATER STOP VALVE
- GRATED DRAINAGE PIT
- DRAINAGE MANHOLE
- IRRIGATION CONTROL BOX
- IRRIGATION SPRINKLER
- DRAINAGE KERB INLET PIT
- GRATED KERB INLET PIT
- SEWER VENT
- SEWER MANHOLE
- LOUD SPEAKER POLE OR CAMERA POLE
- W (D) APPROXIMATE LOCATION OF WATER PIPE DBYD
- APPROXIMATE LOCATION OF DRAINAGE CHANNEL
- E APPROXIMATE LOCATION OF UNDERGROUND ELECTRICITY FURTHER INVESTIGATION IS REQUIRED
- E APPROXIMATE LOCATION OF A/G LOW VOLTAGE ELECTRICITY CABLE
- E(HV) APPROXIMATE LOCATION OF A/G HIGH VOLTAGE ELECTRICITY CABLE
- NBN APPROXIMATE LOCATION OF U/G NBN DBYD
- S (D) APPROXIMATE LOCATION OF SEWER DBYD
- G APPROXIMATE LOCATION OF GAS DBYD

NOTE:

THIS DETAIL SURVEY IS NOT A "LAND SURVEY" AS DEFINED BY THE SURVEYING AND SPATIAL INFORMATION ACT, 2002. IF ANY CONSTRUCTION OR DESIGN WORK WHICH RELIES ON CRITICAL SETBACKS FROM THE STREET OR BOUNDARIES IS PLANNED, IT WOULD BE IMPERATIVE TO CARRY OUT FURTHER SURVEY WORK TO DETERMINE THE BOUNDARY DIMENSIONS.

THE POSITION OF THE BOUNDARIES HAVE BEEN CALCULATED FROM THE SURVEY DEFINITION SHOWN ON DP 37737, DP 227704, DP 340476 & DP 1016517.

IF FURTHER DEVELOPMENT IS CONTEMPLATED ON OR NEAR THE BOUNDARIES THEN SURVEY MARKS SHOULD BE PLACED AND THE POSITION OF IMPROVEMENTS VERIFIED.

BEARINGS SHOWN RELATE TO MGA NORTH.

ORIGIN OF AUSTRALIAN HEIGHT DATUM WAS FROM SSM 128599 RL 6.233 AS OBTAINED FROM SCIMS 19TH MAY 2016.

CONTOURS SHOWN DEPICT THE TOPOGRAPHY. EXCEPT AT SPOT LEVELS SHOWN, THEY DO NOT REPRESENT THE EXACT LEVEL AT ANY PARTICULAR POINT.

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JOB NUMBER: 16/80
FILE ID: ID 112285
SURVEYED: LJB
DESIGNED:
DRAWN: DKH
CHECKED: BDK
DATUM: AHD
CONTOUR INTERVAL: 0.2m

NO.	DESCRIPTION	DRAWN	DATE
C	ADDITIONAL SURVEY WORK ADDED	DKH	17/11/2016
B	ADDITIONAL SHEET ADDED WITH DAMS DETAIL	DKH	03/06/2016
A	INITIAL ISSUE	DKH	01/06/2016

pcb
PULVER COOPER & BLACKLEY
SURVEYORS
TOWN PLANNERS
CIVIL ENGINEERS
PROJECT MANAGERS
P.O. Box 729 NEWCASTLE 2300 Ph (02) 4929 3882
98 LAWES STREET EAST MAITLAND 2323 Ph (02) 4934 3026

PLAN:
PARTIAL DETAIL SURVEY OF LOTS 13 & 14 DP 227704 LOTS 81 & 82 DP 1138209 DARLING STREET HAMILTON

CLIENT:
NEWCASTLE JOCKEY CLUB BROADMEADOW

10 5 0 10 20 30
Horizontal Scale 1:500 (A1) 1:1000 (A3)

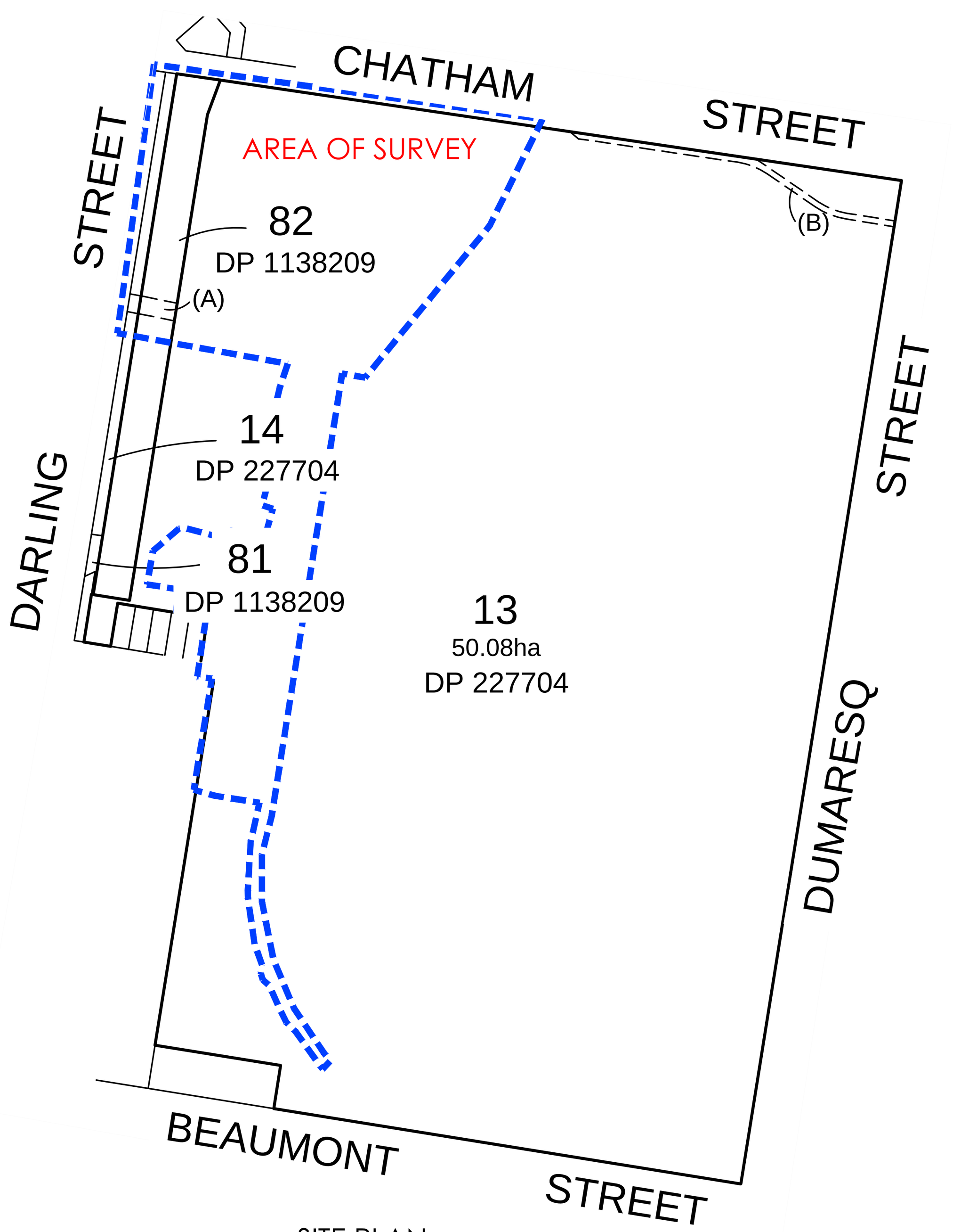
TOTAL SHEETS 8

SHEET No. 2

Plot Date: 21/11/2016 Cad File: 16_80 – Detail Survey Plan Partial Detail cnr Chatham & Darling Streets (ID 112215)

Appendix I

Site Survey



SITE PLAN
SCALE 1:5000

DIAL BEFORE YOU DIG www.1100.com.au

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- APPROXIMATE LOCATION OF U/G NBN DBYD
- APPROXIMATE LOCATION OF SEWER DBYD
- APPROXIMATE LOCATION OF GAS DBYD

AERIAL IMAGE TAKEN WITH EBEE
AERIAL IMAGE TAKEN ON 25/05/2016

PROPOSED EXTENT OF THE CHATHAM STREET STABLES DEVELOPMENT
MPC REF: 160548 27 / 7 / 2021

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Horizontal Scale 1:500 (A1) 1:1000 (A3)

TOTAL SHEETS 8

SHEET No. 2

Plot Date: 21/11/2016 Cad File: 16_80 – Detail Survey Plan Partial Detail cnr Chatham & Darling Streets (ID 112215)

Appendix J

Flood Study

A part of BMT in Energy and Environment

BMT WBM

Throsby, Cottage and CBD

Flood Study

R.B15058.002.01.doc
August 2008

Throsby, Cottage and CBD Flood Study

Offices

Brisbane
Denver
Karratha
Melbourne
Morwell
Newcastle
Perth
Sydney
Vancouver

Prepared For:	Newcastle City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

DOCUMENT CONTROL SHEET

BMT WBM Pty Ltd BMT WBM Pty Ltd Level 11, 490 Upper Edward Street Brisbane 4000 Queensland Australia PO Box 203 Spring Hill 4004 Tel: +61 7 3831 6744 Fax: + 61 7 3832 3627 ABN 54 010 830 421 www.wbmpl.com.au	***Document :*** R.B15058.002.01.doc ***Project Manager :*** Bill Syme ***Client :*** Newcastle City Council ***Client Contact:*** David Gibbins ***Client Reference***

Title :	Throsby, Cottage and CBD Flood Study
Author :	Bill Syme, Phillip Ryan
Synopsis :	Presents the findings from the Throsby, Cottage and CBD Flood Study in Newcastle.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	15th Aug 2008	WJS		PAR	

DISTRIBUTION

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	0	1	2	3
Newcastle City Council	PDF			
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1 INTRODUCTION

1.1 Background

Throsby and Cottage Creeks, and to a lesser extent the Newcastle CBD, have an established history of flooding. The catchments are steep around their perimeter, but drain onto low-lying, flat areas, where it is difficult for floodwaters to escape. In response to the flooding problems, the creeks have been heavily engineered into concrete lined stormwater channels, or replaced by underground pipes and box culverts. In a number of areas, the creek lines have become non-existent, with the pipes and culverts being relied upon to carry the floodwaters. Roads also act as flowpaths once the capacity of the channels and culverts is exceeded. A number of rail, road and other embankments exacerbate the flood problem by diverting and blocking floodwaters.

While the engineering works have reduced the flood risk, problem areas remain and it is not unfeasible for floods to exceed the capacity of the channels and culverts, with the potential for wide-spread flooding, risk to life-and-limb and damage to buildings and infrastructure. This was demonstrated during the April 1988, February 1990 and June 2007 floods.

This Flood Study of Throsby and Cottage Creeks, and the Newcastle CBD area, was carried out to better understand the flood behaviour and the flood risk to the community. A product of the study is leading-edge computer based models that simulate the flooding processes of the whole catchment, and also the potential interaction between catchments in the low-lying areas, hence the combining of the three catchments into one study. The study is carried out in preparation for a Flood Risk Management Study that will investigate options and planning strategies for reducing the flood risk and minimising damage to buildings and infrastructure. Drawing 1-1 shows the locality and coverage of the study area.

The computer models were developed to quantify flood discharges, the speed of floodwaters, flood heights and the flood depths. As part of their development process, the models were calibrated to historical flood events, to demonstrate their ability to reproduce reality. Calibrated computer models were used with statistically generated rainfall estimates to represent possible future flood scenarios and their likelihoods (such as a 1 in 100 annual chance flood). These design flood events were simulated and mapped.

On the Queens Birthday long weekend in 2007 the Newcastle district experienced a devastating flood. Heavy rainfall was experienced on the afternoon and evening of the 8/6/2007. This resulted in severe flooding within the Newcastle area, including the Throsby, Cottage and CBD catchments. This flood occurred towards the end of the study, after the computer models had been calibrated and design flood modelling completed.

After the 2007 flood a major data collection exercise was conducted by Newcastle City Council and BMT WBM staff, providing the opportunity for further validation of the computer models. Due to the near completion status of this study, it was decided to incorporate the June 207 flood validation of the models into the early stages of the flood risk management investigations rather than this present study.

A Flood Risk Management Study is scheduled to start in 2008. This risk management study will investigate measures to reduce the flood risk. Possible measures vary from community education to building modifications to voluntary house raising and voluntary purchase schemes. The computer models will be verified to the data collected from the June 2007 flood events as part of the study.

The sensitivity of model results to a number of factors such as blockages to pipes and structures, increased rainfalls, structure losses and roughness will also be investigated as part of the floodplain risk management study.

1.2 Funding

This study is being carried out under the State Government's flood programme, with State and Commonwealth Grant assistance for flood investigations and implementation of flood risk management measures. To receive implementation funding, the State Government requires councils to carry out the necessary studies so that informed decisions are made in consultation with the community.

1.3 Previous Studies

A number of investigations have addressed the issues of flooding in the catchment and/or elevated ocean levels. Studies relevant to the current flood study are:

- Lawson and Treloar (1994), *Lower hunter River Flood Study (Green Rocks to Newcastle)*
- Newcastle City Council (1997), *Brief: Cottage Creek Flood Study*
- Newcastle City Council (1997), *Brief: Newcastle City Wide – Historic Flood Date Collection Study*
- Newcastle City Council (1997), *Brief: Newcastle City Wide – Design of Flood Data Collection System*
- Lawson and Treloar (1999), *Design Water Levels in Newcastle Harbour – Joint Probability Study*
- Lawson and Treloar (2000), *Design of a City-Wide Flood Data Collection System*
- WBM Oceanics Australia (2000), *Newcastle City Wide Flood Studies – Data Collection Study*
- WBM Oceanics Australia (2004), *Cottage Creek Flood Study – Final Report*

1.4 About This Report

This report documents the Throsby, Cottage and CBD Flood Study objectives, results and conclusions. All A3 drawings are included in a separate volume. The report consists of the following sections:

Volume 1 of 2: Main Body of Report

1 Introduction

Introduces the background of the study.

2 Methodology Overview

Presents a general discussion on the study methodology.

3 Available Data

Details of the topographic, hydrographic and GIS data available for the flood study.

4 Computer Model Development

Details the hydrologic and hydraulic models developed for the flood study.

5 Model Calibration

Discusses the calibration of the hydrologic and hydraulic models.

6 Design Floods

Presents the derivation of design floods and discusses design flood results.

7 Conclusions and Recommendations

Presents the general conclusions and recommendations of the study.

8 References

Reference list

Volume 2 of 2: A3 Drawing Addendum

Volume 2 is an addendum of A3 drawings which accompanies this report.

1.5 Provision of Electronic Data

Hydraulic modelling results have been provided to Newcastle City Council in WaterRIDE format. Both time-varying and peak results have been provided.

Modelling files in MapInfo and TUFLOW format are provided on DVD to accompany this report.

Newcastle City Council has been provided with a location specific version of TUFLOW. This allows Newcastle City Council to use the hydraulic model, developed as part of the Throsby, Cottage and CBD Flood Study.

2 METHODOLOGY OVERVIEW

The general approach and method employed to achieve the study objectives involved the following steps (as shown in Figure 2-1).

- Compilation and review of available information
- Acquisition of additional data required for flood study
- Development of hydrological and hydraulic models
- Calibration and verification of models
- Selection of design event combinations
- Modelling of design events under existing conditions
- Reporting and mapping

Selection of calibration events was based on the availability of historic rainfall, river and flood level data. This is discussed in more detail in Section 5.1.

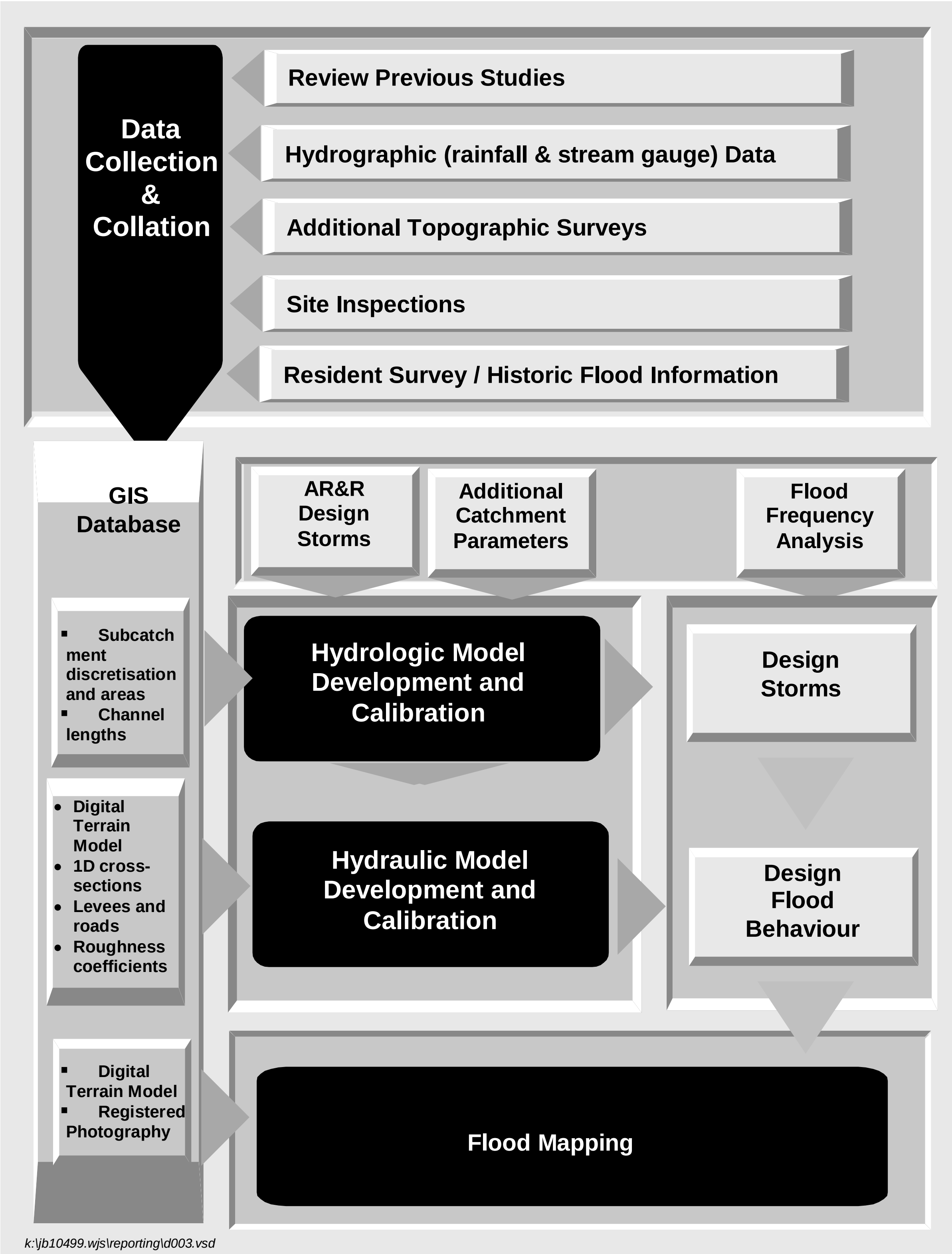

Figure 2-1 Study Approach

3 AVAILABLE DATA

3.1 Topographic Data

This section of the report details the topographical, hydrographic and GIS data used as part of the flood study.

3.1.1 Photogrammetry

Photogrammetry was collected by QASCO in 2000. It covers the majority of the study area and has a vertical accuracy ±0.2m.

2004 photogrammetry is of lower vertical accuracy (higher plane flying level) than 2000 photogrammetry. The vertical accuracy of the 2004 photogrammetry is ± 0.5m.

The photogrammetry extents are presented in Drawing 3-1.

3.1.2 Bathymetry

Current bathymetric survey of the tidal areas was provided by Newcastle Port Corporation. The data was provided as points with easting, northing and levels, and is a compilation of surveys over various years.

3.1.3 Ground Surveys

A number of different surveys using ground based techniques were utilised to supplement the DEM data due to civil works since 2000, where an improved vertical accuracy was beneficial (eg. along the creeks and concrete lined drains) or the aerial survey was inadequate (eg. through the Kotara shopping centre carpark). Ground survey is used in both the calibration and design modelling. Details of ground survey used in modelling are presented in Table 3-1 and their locations are presented in Drawing 3-1.

Table 3-1 Ground Survey Details

Area	Year	Source
Stewart Avenue	2005	NCC
Linwood St	2005	NCC
Carrington	2005	NCC
Honeysuckle	2005	NCC
Wickham	2005	NCC
Kotara	2005	NCC
Waratah Rail	2005	NCC
Glebe Road	2005	NCC
Kotara	1998	NCC
Maryville Pre Subdivision	1990	NCC
Broadmeadow Soccer Fields	1990	NCC

I:\B15058_I_BRH_ Throsby Cottage_WJS\MPI\[Topography_Sources_TUFLOW.xls]Ground_Survey

3.1.4 Structure Data

Structure details were provided by Newcastle City Council. These included a comprehensive database of photographs, each annotated with field measurements of the structure's openings, deck and handrails. Examples of the structure details are provided in Figure 3-1. Drawing 3-3 illustrates the location of the structures measured and photographed.

3.2 Hydrographic Data

3.2.1 Rainfall

Historic rainfall data was primarily obtained from data collected by Hunter Water Corporation (HWC) during the 1980s and early 1990s. In addition to these data, Bureau of Meteorology data was available from the Nobby's Head gauge. Locations of rainfall pluviograph data are presented in Drawing 3-3.

For design flood events, the estimated rainfall volumes and distribution were based on Australian Rainfall and Runoff, 1987.

3.2.2 Streamflow Gauging

HWC also operated a number of stream gauging stations during the same period as the rainfall monitoring. This data was also extracted from data collected by Hunter Water Corporation. The locations of the stream flow gauges are presented in Drawing 3-3.

3.2.3 Tidal

Recorded tidal data was available from a tidal gauge at Dyke Point in Throsby Basin. This gauge data is provided by the National Tidal Facility. Recordings are taken on an hourly basis.

3.3 GIS Data

3.3.1 Aerial Photos

Three aerial photo sets were available. These are all geographically registered.

- 1983 aerial photography
- 1990 aerial photography
- 2004 aerial photography

The 1990 aerial photography is presented in Drawing 3-4, and the 2004 photography in Drawing 3-5.

3.3.2 Cadastre

Newcastle City Council provided cadastral data to BMT WBM in GIS format (MapInfo). Newcastle City Council also provided GIS format data of suburb boundaries, street names and house numbers.

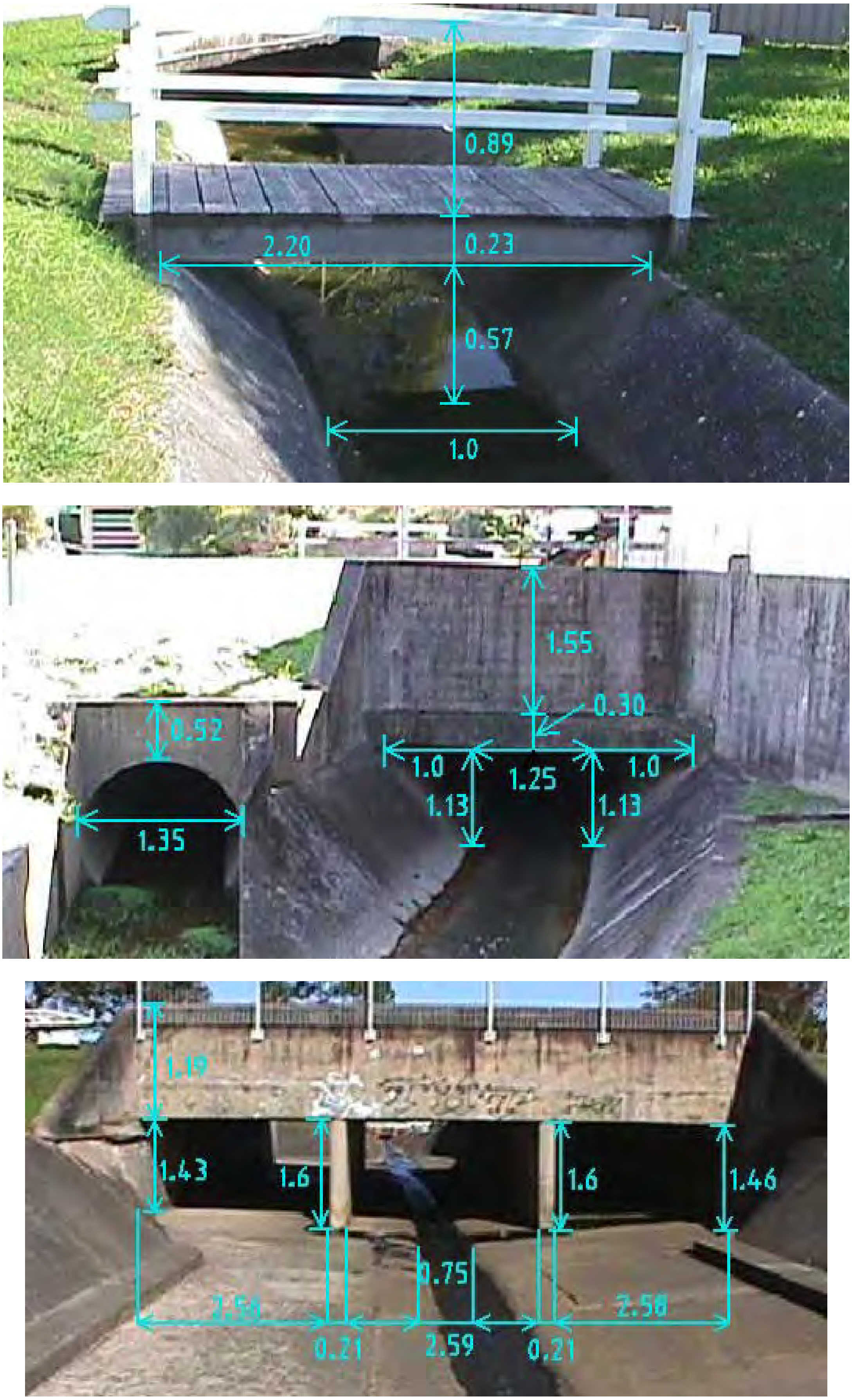

Figure 3-1 Example Structure Details

4 COMPUTER MODEL DEVELOPMENT

4.1 DEMs

A digital elevation model (DEM) is a three dimensional (3D) representation of the ground surface. A number of different DEMs were utilised in the current flood study. These were derived from various topographical data sources and have varying accuracies. The DEMs utilised in the Throsby, Cottage and CBD flood study are listed and described below.

4.1.1 DEM 2000

The DEM of conditions in the year 2000 was prepared by WBM for the purpose of this flood study. The DEM is based on various data sources including low level (higher accuracy) photogrammetry, ground survey and bathymetry. Of note is the use of ground survey to accurately define concrete lined drains using surveyed breaklines along the channel (eg. top of bank, toe, low flow drains). The ground surveys were merged with the photogrammetry to produce a high quality DEM. It was decided that the DEM should include bridge decks and other obstructions picked up by the aerial survey so as to aid in identifying evacuation routes, rather than replace the decks with the ground surveys.

This is the most accurate representation of the topography of the Throsby, Cottage and CBD catchments. The DEM of 2000 conditions is presented in Drawing 4-1.

For more information on this DEM see Appendix A.

4.1.2 DEM Modified for hydrology

An automated process of delineating the sub-catchments for the hydrologic was used. This process required that the DEM did not include obstructions across flow paths, such as bridge decks, and that major culverts (eg. the 1.6km racecourse culvert) be incised so as to delineate the low flow paths. Therefore, the DEM was artificially incised to create low flow paths, allowing automated delineation of these low flow routes and sub-catchments emanating from them.

The 2000 DEM also does not cover the whole of the Throsby, Cottage and CBD catchments. This is also necessary for sub-catchment delineation, so the 2000 DEM was extended to the catchment boundaries using a DEM created from 2m contour data.

The catchment delineation process is further described in Section 4.2.1. The modified DEM used for sub-catchment delineation is presented in Drawing 4-2.

4.1.3 DEM 2004

This DEM was created from the photogrammetry flown in 2004. This photogrammetry is of lower vertical accuracy than the 2000 photogrammetry, hence, the 2000 DEM is preferred for flood modelling. A section of this DEM was used in Hamilton South, where major changes have occurred to the topography between 2000 and 2004 due to a residential estate that was previously a dog racing track.

4.2 WBNM Hydrologic Model

Hydrologic modelling calculates the quantity and rate of catchment runoff from rainfall during a flood event. The model produces estimates of the discharges in the creeks and tributaries during the course of a flood. The Watershed Bounded Network Model (WBNM) software was utilised for the hydrological modelling. WBNM is distributed by the University of Wollongong.

WBNM requires input for each subcatchment of:

- Catchment area
- Percentage impervious

Calibration parameters within the WBNM model are:

- Initial loss
- Continuing loss
- Stream Lag Factor

4.2.1 Sub-Catchment Delineation

The hydrological model was split into 198 subcatchments. The sub-catchments are delineated using an automated process. The software package Streambuilder (Avantra Geosystems Pty Ltd) was used for the catchment delineation. A modified version of the DEM of 2000 conditions was used for the catchment delineation. Section 4.1.2 describes the modifications the 2000 DEM for hydrological modelling.

The modified DEM and catchment delineation are presented in Drawing 4-2.

4.2.2 Land-Use Types

Land use types were digitised from aerial photos, and a percentage impervious for each land use type was assigned. The average percentage impervious for each subcatchment was based on field inspections and the aerial photography. Percentage impervious is used as an input to the WBNM model.

4.3 TUFLOW Hydraulic Model

4.3.1 Model Extent

The complicated nature of flow patterns in the urban study area required the use of advanced modelling techniques and software. During low flows, stormwater is mostly restricted to the underground piped drainage and concrete lined drains, and is relatively simple to model. However, once the capacity of these conduits are exceeded, as amply demonstrated in April 1988, February 1990 and June 2007, the flow patterns become highly complex with flow into and out of drains, surcharging of manholes, along streets, and through houses, gardens and commercial properties. This requires a more advanced modelling approach to simulate the flow interaction between pipes, open channels and overland areas. As such, TUFLOW (www.tuflow.com), a fully 2D/1D dynamically linked hydraulic modelling system was used to model flooding behaviour in the Throsby/Cottage Creek catchments.

Pipes smaller than 900mm in diameter were generally excluded from the model to keep the model simulation times manageable and pipe survey costs within budget. Similarly, broad assumptions on gully traps and manholes were assumed as data on these were not available. This does not significantly reduce the accuracy of the hydraulic model for the study objectives, because in large flood events the majority of flow is carried in overland areas, open channels or larger conduits. It is noted however, that for detailed local drainage assessments into the future, that the sub-900mm pipe drainage and surface/pipe flow exchange via gully-traps may need to be added to the model for a more accurate representation.

The hydraulic model covers an extent of 28.2km^2. The extent of hydraulic modelling is shown in Drawing 4-3.

There may be areas subject to flooding that are outside the extent of the hydraulic modelling. This may occur for a variety of reasons, including:

- The area is outside the extent of the 2000 photogrammetry.
- Pipe sizes less than 900mm need to be included.
- Broad assumptions associated with gully traps.
- Blockages in drains and culverts due to debris and other obstructions.
- Vertical inaccuracies associated with DEM data.
- Uncertainties associated with data inputs, modelling and rainfall estimates.

4.3.2 2D Grid Dimensions and Cell Size

The 2D domain of the hydraulic model is based on a 10m square grid. This results in approximately 280,000 2D cells over the hydraulic model. Approximately 195,000 2D cells are active or wet near the peak of a large flood (PMF).

4.3.3 Topography in Hydraulic Model

TUFLOW allows topographic data to be inputted sequentially. This facilitates changes to be made easily, for example, ground survey data can be inputted to overwrite the DEM data. This is particularly useful to model changes in the floodplain, where development has occurred after the photogrammetry.

The base data for the hydraulic model is the DEM of 2000 conditions. Changes are made to this topography to represent the calibration (1988/1990) and existing (2005) conditions. Topographic changes for the calibration and design are discussed in Section 5.2.1 and 6.1 respectively.

4.3.4 1D Domains

The 10m cell size of the 2D model is too coarse to accurately model some sections of the drainage network, particularly the open drains. These and the underground pipe drainage network are modelled as 1D elements. Cross-sections were used to define the geometry of the open channel 1D elements, and measured dimensions of bridges, culverts and pipes were used for 1D hydraulic structure elements. The model includes over 2,000 1D elements. The three main types of 1D elements are described below.

4.3.4.1 Open Stormwater Channels

Open stormwater channels are modelled as 1D elements. The geometry of these open channels is defined by assigning a cross-section to each channel. Bed resistance is varied across the section based on land-use mapping to allow for changes in construction type and vegetation to be represented.

The DEM of the open channels is based on ground survey break lines along the channels at key points in the section. The survey, which consists of break-lines along the top of bank, toe of batter, low flow channels, etc, was built into the 2000 DEM, and is sufficiently detailed to allow cross-sections to be extracted from the DEM.

4.3.4.2 Underground Conduits

Underground conduits of greater than 900mm in size were included in the hydraulic model based on surveys carried out by Newcastle City Council. Details required for accurate representation include:

- Size
- Shape
- Inverts
- Number of barrels

The underground pipe network is connected to the surface via pits, which are modelled as an upright rectangular channel. The pit inlet is dynamically connected to the 2D model, see Section 4.3.5.

4.3.4.3 Bridges, Culverts and Weirs

The many structures play a major role in determining flood behaviour in the study area. It is important to represent these structures correctly in the hydraulic model. These structures were typically modelled as 1D elements.

Bridges are modelled using depth varying energy losses to simulate extra losses associated with piers and the bridge deck. Losses were calculated using the standard techniques outlined in AustRoads (1994).

Culverts can be either rectangular or circular in shape, and can accommodate all inlet and outlet controlled flow regimes including uni-directional flow due to flap-gates.

Flow over structures are modelled as 1D weir channels. Cross-sections were used to define the shape of the 1D weirs.

4.3.5 1D / 2D Dynamic Linking

1D elements are dynamically linked to the 2D model. The 2D/1D hydraulic model layout is shown in Drawing 4-3.

The underground pipe network is linked to the 2D model via a pit inlet, allowing flow in both directions. A schematic diagram of this linkage is presented in Figure 4-1.

1D open channels are linked to the 2D domain, usually along the top of bank of the open channel to ensure the exchange of water between open channel and overland area occurs at the correct height. The arrangement allows for both flows into and out of the open channel. The 2D cells within the open channel are deactivated, to prevent conveyance being duplicated. A schematic diagram for this type of linkage is presented in Figure 4-2. An example of the linkages utilised in the hydraulic model are presented in Drawing 4-4.

4.4 Hydrologic / Hydraulic Model Linkage

Flows into the hydraulic model are generated using the hydrological model. At the upstream of the hydraulic model cumulative flows (from multiple subcatchments) are added to the 1D pipe/open channel model. For subcatchments within the hydraulic model extent, flows are either added directly to 2D cells or split evenly between 1D nodes within the subcatchment. Hydrological inflow boundaries for the hydraulic model are presented in Drawing 4-5.

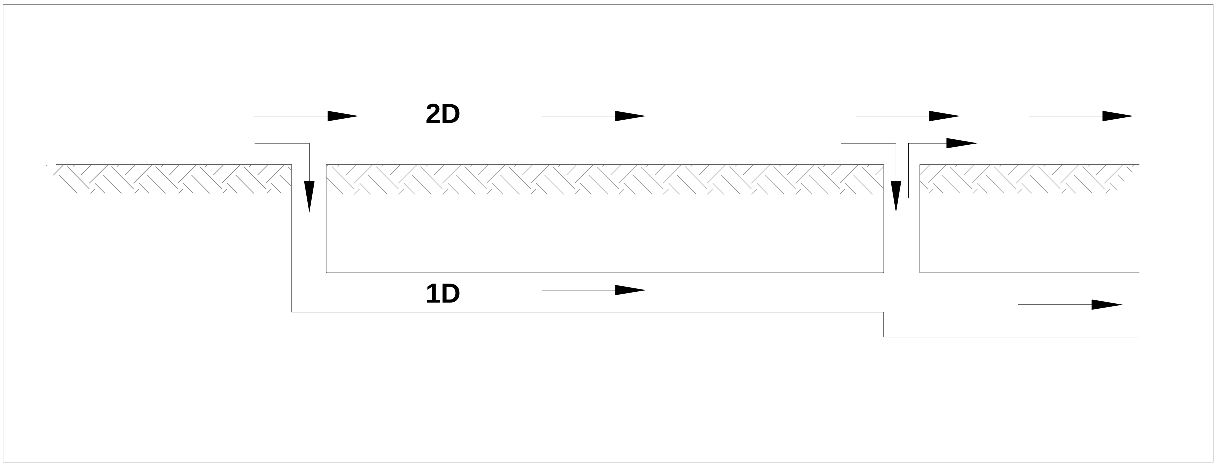

Figure 4-1 Schematic TUFLOW 2D / 1D Link in Urban Pipe Networks

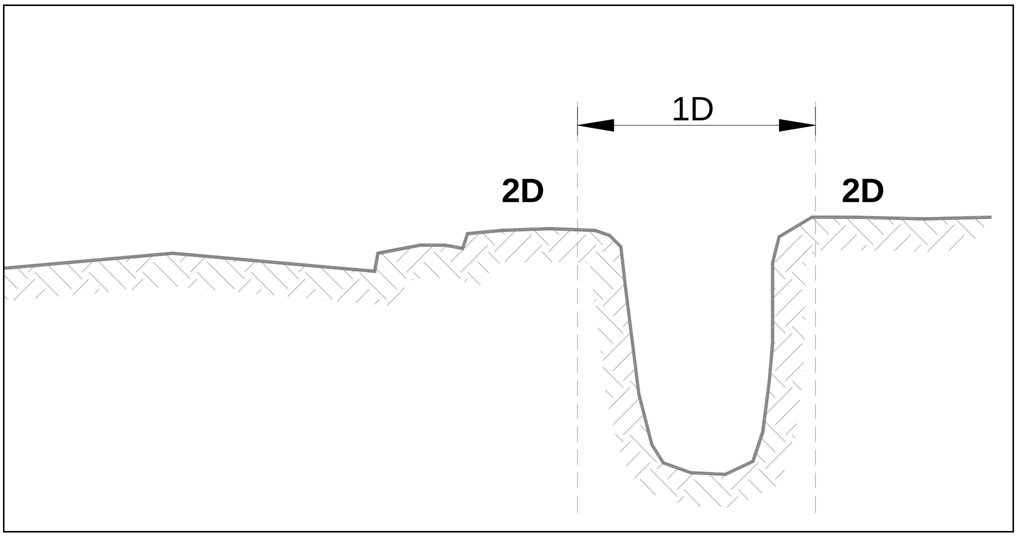

Figure 4-2 Modelling an Open Channel in 1D and Floodplain in 2D

5 MODEL CALIBRATION

5.1 Selection of Calibration / Verification Events

Data from known flood events were collated and reviewed to select events from which to calibrate and verify the computer models. The main criteria for a flood event to be a useful calibration/verification event are:

- pluviograph (a recorder that records rainfall over short time intervals) data are available in or close to the study area;
- preferably daily rainfall totals from other gauges within and/or close to the study area; and
- recorded flood levels are available.

Two floods, those in April 1988 and February 1990, stand out from other floods based on the criteria above. Two minor floods in 1992 in the Cottage Creek area are also potentially useful should further model verification be required.

The June 2007 flood, which occurred after the hydraulic model was calibrated, also has the potential to be an excellent calibration or verification event due to the large volume of flood marks that have been recorded and available for survey. Unfortunately the HWC rain and streamflow gauges were decommissioned in the 1990s, so there will be much greater uncertainty over the rainfall timing, depths and distribution for this flood compared with the 1988 and 1990 events. It is planned to validate the computer models to the June 2007 event during the following flood risk management study.

5.1.1 February 1990 Flood

Around 300 mm in a 48 hour period fell over the study area on the 2nd and 3rd of February 1990 in several bursts. The rainfall records show that the rainfall across the catchments was relatively uniform varying from around 316 mm in the west to 250 mm in the east. Six pluviograph recordings within the study area were available, of which one was discarded due to suspected malfunctioning.

Five flood height gauges recorded the rises and falls of the flood within the stormwater channels. There is some doubt over the actual water level heights for one or two of these gauges, however, the gauges clearly show the timing of when the flood peaks occurred. The first and largest peak, which caused the worst overland flooding, occurred around 3pm on the 2nd of February, 1990.

From previous investigations commissioned by Council, around 160 sites within the study area provided information on flooding. Of these, around 70 have identified a potential flood height to assist in the model calibration. These flood marks provide valuable information on flood levels away from the stormwater channels. In addition, there are a number of photographs and recollections that also assist in the model calibration process.

Drawing 5-1 shows the rainfall totals recorded and the location of the flood height information. Due to the comprehensive data set available for the February 1990 flood, it was selected as the primary calibration event.

5.1.2 April 1988 Flood

Unlike the February 1990 flood, the April 1988 flood rainfall was extremely varied over the study area. For the 48 hour period from 9:00am, 27th April, 141 mm of rain fell at Rankin Park Hospital, 101 mm to the south at Kotara Bowling Club, 44 mm in Waratah, 22 mm in Merewether and just 8 mm at Nobbys Head. At Rankin Park Hospital 75 mm (3 inches) of rain fell in just one hour from 9:30pm to 10:30pm on the 27th causing flash flooding in nearby creeks.

Only one of the Hunter Water Cooperation flood height gauges at Jellicoe Parade recorded the rise and fall of the flood within the stormwater channels. The second flood peak, which occurred around 11:00pm on the 27th, caused the worst overland flooding.

From previous investigations commissioned by Council, around 180 sites provided information on flooding. Of these, around 80 have identified a potential flood height to assist in the model calibration. These flood marks provide valuable information on flood levels away from the stormwater channels. In addition, there are a number of photographs and recollections that also assist in the model verification process.

Drawing 5-2 shows the rainfall totals recorded and the location of the flood height information. Due to the less comprehensive data set and greater uncertainty associated with the high variation in rainfall over the catchments, the April 1988 flood was selected as a verification event.

5.2 Model Calibration and Verification

5.2.1 Changes to 2000 Topography

A number of changes have occurred in the catchment since the calibration events. As the DEM is based on the conditions as of 2000, a number of layers were added (overwriting the 2000 topography) to adjust the calibration model so as to reflect conditions in 1988/1990. Layers added to modify the elevations sampled from the 2000 DEM are listed below in Table 5-1. The location of these modifications is presented in Drawing 5-3.

Table 5-1 Modifications to 2000 Topography for Calibration Modelling

Description/Source	Area	Change
DEM 2000	Hydraulic Modelling Area	Base
Harbour Data	Harbour	Missing in DEM 2000
Harbour Data	Harbour	Missing in DEM 2000
Harbour Data	Harbour	Missing in DEM 2000
Allworth St DEM (NCC)	Glebe Road	Missing in DEM 2000
Based on 1998 Ground Survey	Kotara	Changes to Homemaker Centre
DEM (NCC)	Maryville	Pre Subdivision
DEM (NCC)	Broadmeadow Soccer Fields	Pre Soccer Fields
Cowper St Bridge pre 1993	Harbour	Changes to bridge arrangement and isthmus
Elevations of Cycleway along Throsby Ck	Cycleway Maryville	No bund along cycleway
Harbour area pre-fill	Edges of Harbour	Pre-fill conditions
RTA Carpark above Cottage Ck	Newcastle West	DEM picks up channel
Ground Survey	Waratah Rail	More Accurate Ground Survey
Ground Survey	Glebe Road	More Accurate Ground Survey

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5.2.2 Interpretation of Calibration Data and Model Predictions

Calibration of computer models involves the adjustment of model parameters within industry-accepted ranges. It also requires having an understanding of uncertainties in the data sets used to build the model.

Reasons for differences between model results and recorded information are important to understand and appreciate when reviewing comparisons between the model and historical observations. Key areas of uncertainty are:

- Rainfall recorders (pluviographs) only represent a record of the rainfall at their exact location. Therefore, the rainfall used in the modelling away from the pluviograph sites is an estimate using interpolation or extrapolation techniques. A good example of a difficult rainfall event is the 1988 flood, where there are major variations in rainfall over relatively short distances, making it difficult to confidently estimate the rainfall at locations away from the pluviographs.

  It is noted that the New Lambton pluviograph was not used for modelling the 1988 and 1990 events on the basis that it's recordings were not consistent with the other pluviographs (this could be due to malfunctioning, an error in storing the data or other reason).

- Flood marks vary greatly in quality depending on how they are recorded (or recollected). Most of the flood marks available were derived and documented in previous studies, during which they were graded from 1 to 5 in terms of their reliability (i.e. accuracy). A Grade 1 level is one that is considered to be well defined (eg. a watermark on a wall) and should be representative of the flood peak. A Grade 4 level is considered to have considerable uncertainty associated with it. A Grade 5 has no level associated with it, but some recollections or observations of flooding were noted.

The general approach to calibrating the model is that the model's predicted levels are at or around Grade 1 levels (preferably within +/- 0.2m, i.e. 20cm). For lesser grades, the flood model should be predicting levels at or above these levels as the recorded levels are not necessarily indicative of the flood peak.

- The flood gauges in the open stormwater channels not only provide information on the flood peak, but also the rate of rise and fall of the floodwaters. The gauges record the depth of water over time in the stormwater channel, however, the datum (the height of the gauges relative to a fixed survey mark) is not known, so there is some uncertainty over the level of the gauges. There is also believed to be considerable uncertainty of the Bates St gauge (see Figure 5-1) as desktop analyses have shown that the gauge was underestimating the depth of water. However, the gauge clearly shows the rise and fall of the floodwaters which is still of considerable use. The average speed of the water in the channel at Bates St gauge is very high at around 6 m/s (over 20 km/h), which may cause problems with the gauge's performance.
- As discussed previously, the hydraulic model only includes the underground pipe drainage system for pipes 900 mm diameter or larger. Consequently, some areas are modelled as having no underground drainage and may show considerable extents of quite shallow inundation that may not have occurred.
- The ground level data over the floodplain is from photogrammetry (a technique that uses aerial photography to determine the level of the ground surface). The vertical accuracy of the photogrammetric ground levels on clearly visible surfaces is as a rule no more than 0.1 metres (about 4 inches) higher or lower than the real ground level. This is a very high accuracy that was needed to support the prediction of past and future flood levels. In some areas, such as under vegetation and other obstructions, the accuracy can be considerably less. This uncertainty affects the extent of flooding predicted, particularly where wide shallow inundation is displayed.

  Also of note, is that photogrammetry cannot "see" underneath building roofs, therefore, if the building is on a built up pad or the floor is elevated above the ground, the information on the floor level is not known. This means that buildings may appear as flooded, when they may not have experienced flooding above the floor. Conversely, some larger buildings have been modelled as a total blockage to floodwaters, and therefore appear not to have been flooded when they may have experienced inundation above their floors.
- Any debris build-up and partial blockage of bridges, culverts and pipes, which maybe the cause of more extensive flooding, were not included in the computer model simulations.
- The computer models themselves have uncertainties, as no computer model can be a perfect representation of reality. The hydraulic model presented in this report simulates flooding down to a resolution of 10 metres. Therefore, fine-scale obstructions to floodwaters such as fences, small buildings, etc are only roughly represented, and any localised flood affects (eg. water surcharging against a wall) are not necessarily depicted.

5.2.3 Presentation Formats of Model Calibration

The performance of the computer models to reproduce the 1988 and 1990 floods are presented in several formats as follows:

- Maps showing information at the flood peak including:
  - Predicted maximum extent and depths of inundation (the darker blue shades indicate greater depths of inundation – refer to the legend on the map).
  - Small coloured circles indicating the location of a recorded flood mark. Next to some circles is a number representing the difference in metres between the model's prediction and the flood mark. The circles and numbers are colour coded according to their grade (Magenta for Grade 1, Orange for Grade 2, Yellow for 3 and Green for 4 – no recorded flood marks are available for Grade 5 sites). A positive number indicates the model is above the recorded level, while a negative number indicates the model is below the recorded level. Refer to the discussion in Section 5.2.2 on reasons why there may be a difference. If no number appears next to the flood mark, the flood mark is located outside the area covered by the model, or the model did not predict any inundation at that site.
  - The predicted speed and direction of the water illustrated by the size and direction of the red arrows.
  - Predicted water level contours, shown as blue lines, on a half metre interval.
- Graphs showing a comparison between the recorded levels at the Hunter Water Cooperation gauges and the model's predictions. These show the rise and fall of the flood. Of particular interest here is the timing of the flood rise and fall, and whether the model is reproducing this.
- A profile of the peak water level down Throsby Creek is provided along with any recorded flood marks within 100 m of the creek centreline.
- Profiles down the major tributaries are presented with the design modelling results. This has been done to avoid replication and wastage. See Section 6.4 for detail on long sections.

Calibration to February 1990 Flood

The adopted rainfall isohyets for the February 1990 event are presented in Drawing 5-7.

Five maps, as described in Section 5.2.3, are provided in Drawing 5-8 to Drawing 5-12, to illustrate the predicted flood extent, depths and flow patterns. The first map is a key map showing the locations of the local map sheets. The local map sheets present the difference between the model's predicted level and the recorded level.

Figure 5-1 shows the model predictions at the five HWC gauges. Figure 5-2 presents the profile of peak water levels along Throsby Creek along with the recorded levels within 100 m of the creek centreline.

Observed and predicted flood levels for the 1990 calibration are presented in Table 5-2. A statistical analysis of flood marks by region is presented in Table 5-3.

Table 5-2 Feb 1990 Calibration to Flood Marks

Flood ID	Recorded Flood Level (mAHD)	Modelled Level (mAHD)	Difference [Modelled - Recorded] (m)	Data Grade
tc008a	12.70	12.88	0.18	1
tc207b	8.03	8.28	0.25	1
tc214	8.61	8.29	-0.32	1
tc404b	8.31	8.28	-0.03	1
tc601	15.73	15.65	-0.08	1
tc604	13.83	13.68	-0.15	1
tc702a	5.71	5.91	0.19	1
tc707	5.80	5.85	0.05	1
tc707b	5.68	5.84	0.16	1
tc708a	5.52	5.57	0.05	1
tc713	12.47	12.61	0.14	1
tc725c	17.39	17.55	0.15	1
tc743	9.34	9.30	-0.04	1
tc799b	12.06	12.13	0.06	1
tc804a	5.25	5.25	0.00	1
tc1207a	8.51	8.27	-0.24	1
tc1210	12.62	12.61	-0.01	1
tc1303	13.86	13.69	-0.17	1
tc1304b	13.15	13.04	-0.12	1
tc1306	12.68	12.80	0.12	1
tc1306a	12.69	12.65	-0.04	1
tc1307	14.62	14.64	0.02	1
tc1308	12.89	12.81	-0.08	1
cc3010	19.32	19.75	0.43	1
tc203	8.15	8.38	0.22	2
tc707a	5.87	5.64	-0.23	2
tc1304a	12.97	12.79	-0.18	2
tc1521	5.64	6.03	0.39	2
tc1604	2.58	3.04	0.46	2
tc1702	23.53	23.51	-0.02	2
cc011	9.83	9.59	-0.24	2
cc021	3.59	3.52	-0.07	2
cc058a	5.24	5.65	0.41	2
cc076	6.74	6.59	-0.15	2
tc218	7.98	8.32	0.34	3
tc219	7.79	8.29	0.5	3
tc717	13.60	13.65	0.05	3
tc725	16.83	16.99	0.16	3
tc725a	16.68	16.80	0.12	3
tc729	15.87	16.00	0.13	3
tc748	8.96	9.19	0.24	3
tc750	10.72	11.00	0.28	3
tc767	29.44	29.64	0.2	3
tc768	23.03	23.10	0.07	3
tc771	29.65	29.64	-0.01	3
tc772	30.29	30.40	0.11	3
tc774	32.41	32.43	0.02	3

tc781	32.28	32.31	0.03	3
tc782	8.10	8.41	0.31	3
tc787	11.55	11.50	-0.05	3
tc1014	18.68	19.08	0.4	3
tc1101	5.42	13.08	7.66	3
tc769	22.88	23.75	0.87	4
tc1526	11.28	11.50	0.22	4
cc012	8.56	8.65	0.09	4
cc016	8.56	8.71	0.15	4
cc1040	4.79	5.58	0.79	4

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Table 5-3 Regional Statistical Analysis of Feb 1990 Flood Marks

Region/Grade	% Levels Within ±0.1m	% Levels Within ±0.2m	Average Deviation (m)	Total Number of Levels
Total				
Grade 1	46%	83%	0.02	24
Grade 2	20%	40%	0.06	10
Grade 3	33%	56%	0.59	18
Grade 4	20%	40%	0.42	5
All Grades	33%	61%	0.24	57
Merewether				
Grade 1	0%	0%	0.43	1
Grade 2	25%	50%	-0.01	4
Grade 3	N/A	N/A	N/A	0
Grade 4	50%	100%	0.12	2
All Grades	29%	57%	0.09	7
Kotara				
Grade 1	N/A	N/A	N/A	0
Grade 2	100%	100%	-0.02	1
Grade 3	57%	71%	0.12	7
Grade 4	0%	0%	0.87	1
All Grades	56%	67%	0.19	9
Mayfield				
Grade 1	50%	100%	0.11	4
Grade 2	0%	0%	0.12	2
Grade 3	N/A	N/A	N/A	0
Grade 4	N/A	N/A	N/A	0
All Grades	33%	67%	0.11	6
ISC				
Grade 1	25%	25%	-0.09	4
Grade 2	0%	0%	0.22	1
Grade 3	0%	0%	0.42	2
Grade 4	N/A	N/A	N/A	0
All Grades	14%	14%	0.10	7
Lambton				
Grade 1	50%	100%	0.00	14
Grade 2	0%	100%	-0.18	1
Grade 3	14%	57%	0.18	7
Grade 4	N/A	N/A	N/A	0
All Grades	36%	86%	0.05	22

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5.2.4 April 1988 Verification

The April 1988 flood event was simulated through the model as a verification of the 1990 flood calibration. As discussed previously, the 1988 event is more problematic given the large variation and uncertainty in the rainfall that fell over the catchment, and was therefore selected for verification purposes. The objective of the verification stage is to check the model performs satisfactorily to another flood event, using the same parameters as adopted for the calibration stage. The same level of agreement as achieved during the model calibration stage is not necessarily expected for the verification stage.

The adopted rainfall isohyets for the April 1988 calibration are presented in Drawing 5-13.

As for the 1990 flood calibration, the 1988 verification is presented using the same map arrangement. These maps are presented in (Drawing 5-14 to Drawing 5-18).

Figure 5-3 shows the model predictions at the Jellicoe Parade HWC gauge, the only gauge for which information was available. Figure 5-4 presents the profile of peak water levels along Throsby Creek, along with the recorded levels within 100 m of the creek centreline.

Observed and predicted flood levels for the 1988 verification are presented in Table 5-4. A statistical analysis of flood marks by region is presented in Table 5-4.

Table 5-4 Apr 1988 Calibration to Flood Marks

Flood ID	Recorded Flood Level (mAHD)	Modelled Level (mAHD)	Difference [Modelled - Recorded] (m)	Data Grade
tc006	8.34	8.21	-0.13	1
tc006a	8.28	8.24	-0.04	1
tc010	10.21	10.22	0.01	1
tc017	14.65	14.19	-0.46	1
tc765	12.21	11.84	-0.37	1
tc765a	11.80	11.84	0.05	1
tc1017	20.80	20.40	-0.4	1
tc1308b	12.31	12.29	-0.02	1
tc021	8.62	8.06	-0.55	2
tc776	29.59	29.39	-0.2	2
tc1308a	12.39	12.39	0.01	2
tc1018	8.11	8.08	-0.03	3

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Table 5-5 Regional Statistical Analysis of Apr 1988 Flood Marks

Region/Grade	% Levels Within ±0.1m	% Levels Within ±0.2m	Average Deviation (m)	Total Number of Levels
Total				
Grade 1	50%	63%	-0.17	8
Grade 2	33%	33%	-0.25	3
Grade 3	100%	100%	-0.03	1
Grade 4	N/A	N/A	N/A	0
All Grades	50%	58%	-0.18	12
Merewether				
Grade 1	N/A	N/A	N/A	0
Grade 2	N/A	N/A	N/A	0
Grade 3	N/A	N/A	N/A	0
Grade 4	N/A	N/A	N/A	0
All Grades	N/A	N/A	N/A	0
Kotara				
Grade 1	N/A	N/A	N/A	0
Grade 2	0%	0%	-0.20	1
Grade 3	N/A	N/A	N/A	0
Grade 4	N/A	N/A	N/A	0
All Grades	0%	0%	-0.20	1
Mayfield				
Grade 1	N/A	N/A	N/A	0
Grade 2	N/A	N/A	N/A	0
Grade 3	N/A	N/A	N/A	0
Grade 4	N/A	N/A	N/A	0
All Grades	N/A	N/A	N/A	0
ISC				
Grade 1	50%	75%	-0.12	4
Grade 2	0%	0%	-0.55	1
Grade 3	100%	100%	-0.03	1
Grade 4	N/A	N/A	N/A	0
All Grades	50%	67%	-0.18	6
Lambton				
Grade 1	50%	50%	-0.22	4
Grade 2	100%	100%	0.01	1
Grade 3	N/A	N/A	N/A	0
Grade 4	N/A	N/A	N/A	0
All Grades	60%	60%	-0.17	5

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5.2.5 Public Exhibition and Fine-Tuning

The calibration/verification of the computer models was placed on public exhibition and presented at community workshops. No negative feedback or changes in the models' calibration/verification resulted from the community feedback, although on-going investigation and fine-tuning occurred in localised areas (Broadmeadow/Adamstown area at start of racecourse culvert, Waratah Railway Station, Glebe Road, and upper areas of New Lambton) based on feedback from committee meetings.

5.3 Calibrated Model Parameters

5.3.1 Hydrological Parameters

The main calibration parameters in the WBNM hydrological model are the lag parameter, the initial rainfall loss and the continuing rainfall losses.

A number of other parameters in WBNM can be changed if justification for modifying these exist. For the Throsby, Cottage and CBD hydrological model these remained at the recommended default values. The calibrated model parameters are presented in Table 5-6.

Table 5-6 Calibrated Hydrologic Parameters

Parameter	1988 Calibration	1990 Calibration
Initial Loss (mm)	5.0	10.0
Continuing Losses (mm/hr)	2.0	2.0
Lag Parameter	1.3	1.3

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5.3.2 Hydraulic Model Parameters

The focus of the hydraulic model calibration was on varying hydraulic roughness (Manning's n). The calibrated Manning's n values are listed in Table 5-7.

Table 5-7 Calibrated Manning's n Values

Land Use	Manning's n Value
2D Areas	
Grass (maintained)	0.030
Parkland	0.040
Roads / Railway	0.020
Open Concrete/Asphalt	0.020
Riparian Vegetation	0.100
Dense Land Vegetation / Forest	0.090
Building	1.000
Urban Block	0.300
Concrete Lined Channel	0.018
Bare Earth / unkempt low-level foliage	0.045
Harbour, dams, water	0.022
1D Areas	
Channel overbank	0.030
Parkland	0.040
Roads	0.020
Open Concrete/Asphalt	0.020
Riparian Vegetation	0.100
Dense Land Vegetation / Forest	0.090
Building	1.000
Urban Block	0.300
Concrete Lined Channels	0.018
Tidal Creek Bed	0.022
Fences	0.300
Bare Earth / unkempt low-level foliage	0.045

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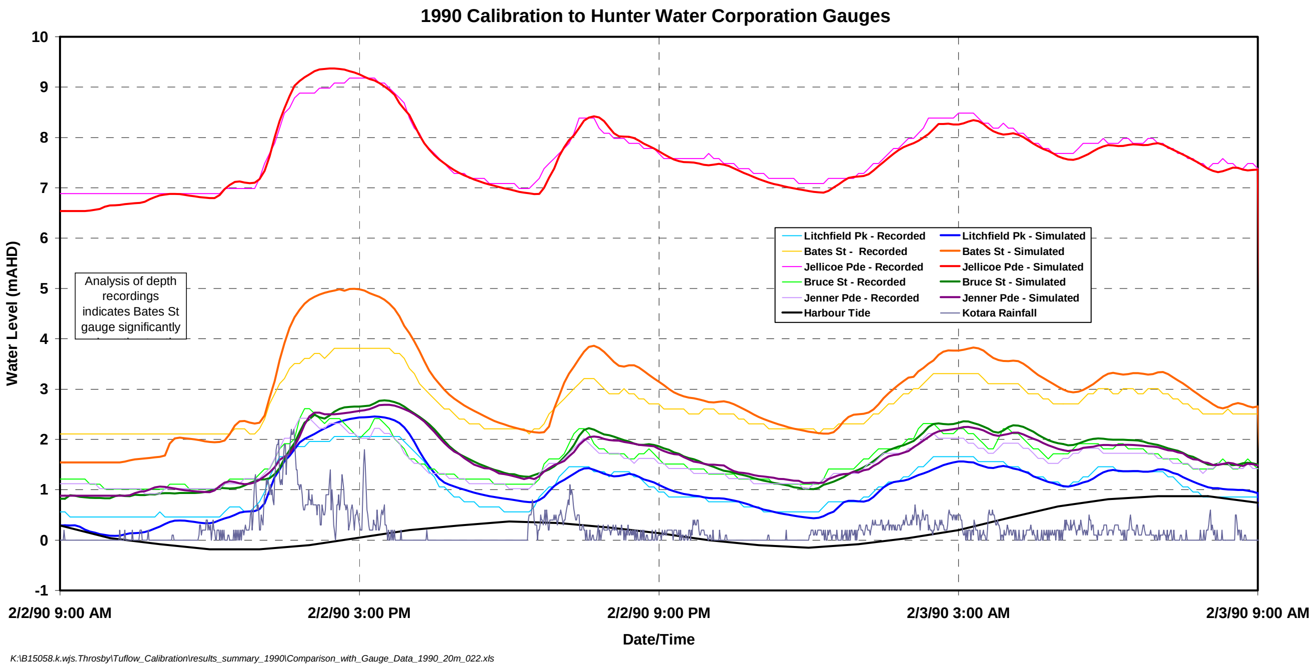

Figure 5-1 1990 Calibration to Flood Level Gauges

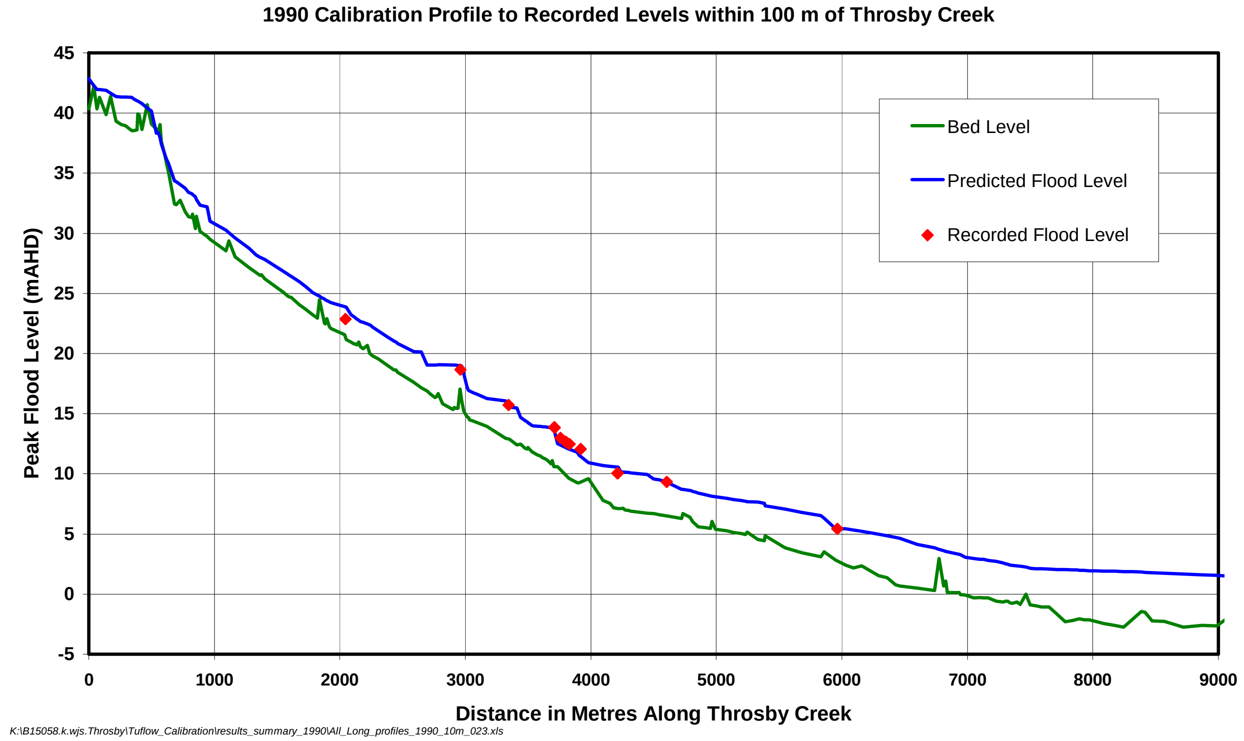

Figure 5-2 1990 – Calibration Profile to Recorded Levels with 100m of Throsby Creek

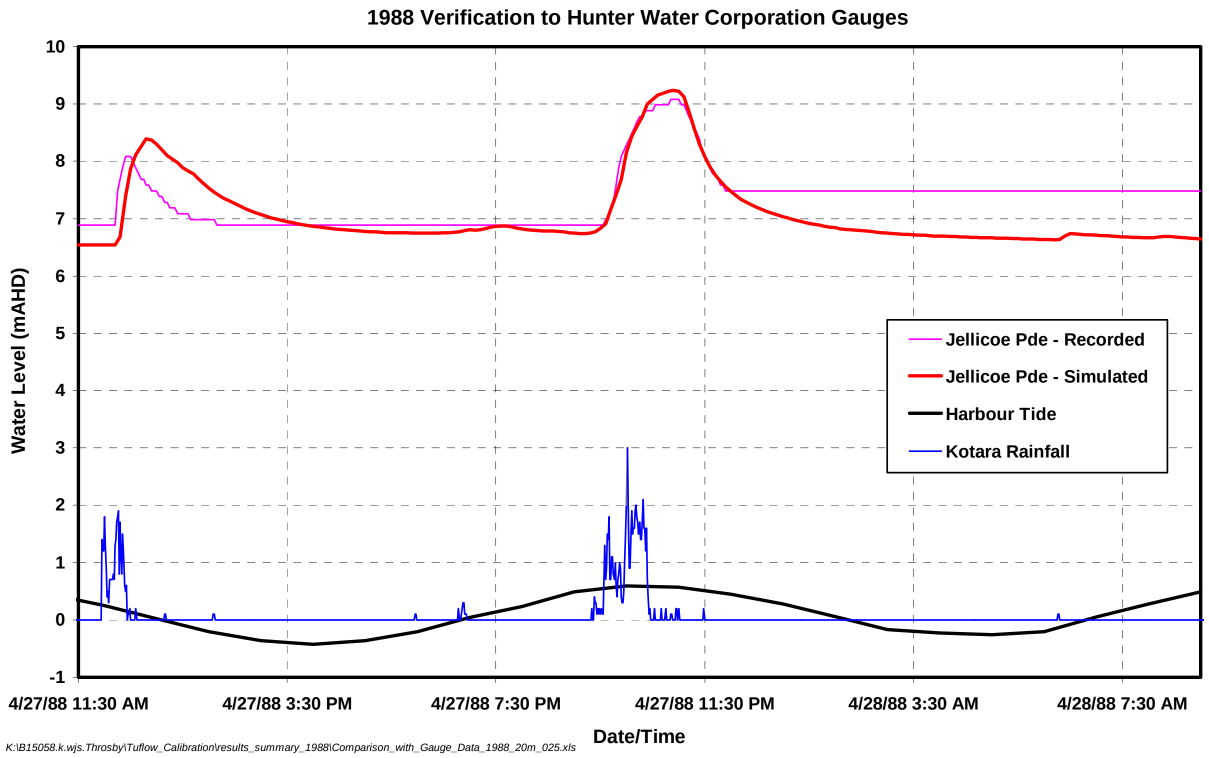

Figure 5-3 1988 Verification to Flood Level Gauges

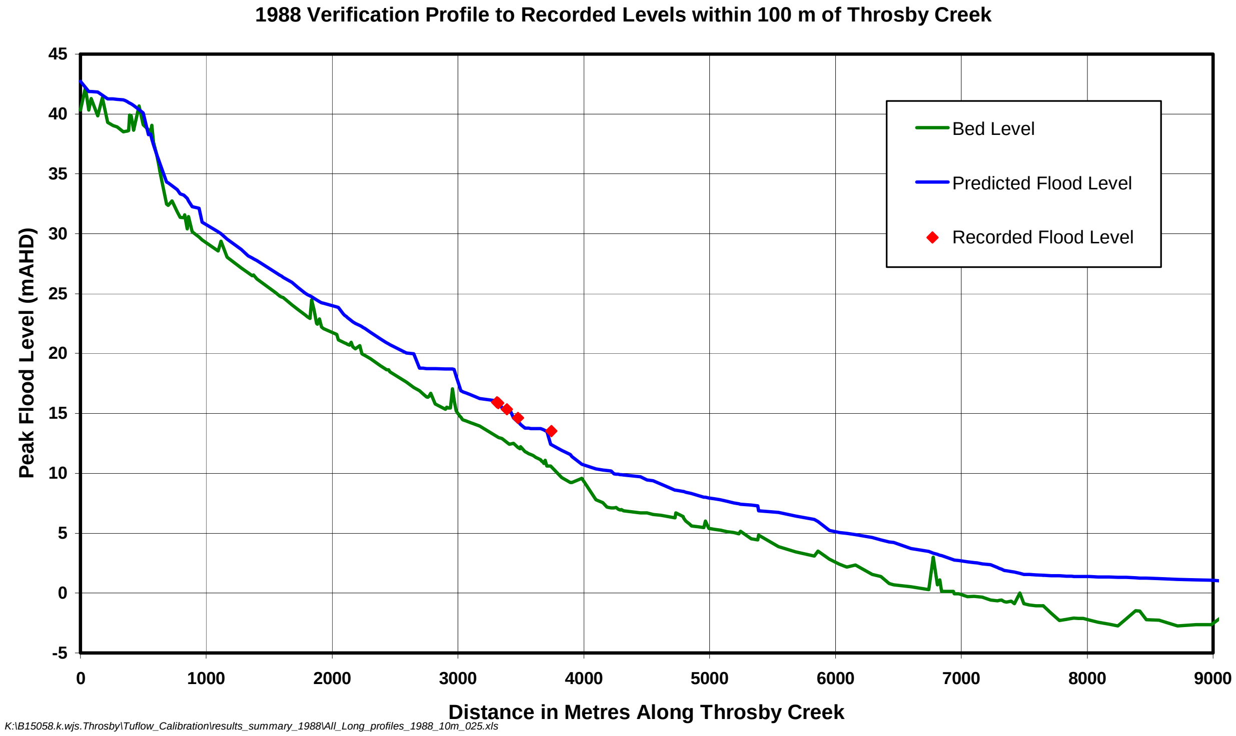

Figure 5-4 1988 Verification Profile to Recorded Levels within 100m of Throsby Creek

6 DESIGN FLOODS

6.1 Topography Adjustments (1990 to 2005)

There have been a number of changes to the catchment since the 1990 calibration event that need to be incorporated as the design modelling is based on existing (2005) topography. The topography of the calibrated model was updated to ensure that the design model was reflective of the existing topography.

6.1.1 DEM and Bathymetry

The primary DEM is based on the conditions as of 2000. Changes made to reflect conditions as of 1988/1990 were removed from the design model, and changes to the topography between 2000 and 2005 included. Layers added to modify the DEM of 2000 are listed below in Table 6-1. The locations of these modifications are presented in Drawing 6-1.

Table 6-1 Modifications to 2000 Topography for Design Modelling

Description	Area	Change
DEM 2000	Hydraulic Modelling Area	Base
Bathymetry	Harbour	Missing in DEM 2000
Bathymetry	Harbour	Missing in DEM 2000
Bathymetry	Harbour	Missing in DEM 2000
Allworth St DEM (NCC)	Glebe Road	Missing in DEM 2000
2005 Ground Survey	Stewart Avenue	Development Since DEM 2000
2005 Ground Survey	Linwood St	Development Since DEM 2000
2005 Ground Survey	Carrington	Development Since DEM 2000
2005 Ground Survey	Honeysuckle	Development Since DEM 2000
2005 Ground Survey	Wickham	Development Since DEM 2000
2005 Ground Survey	Kotara	Development Since DEM 2000
DEM 2004 Photogrammetry	Hamilton South	Development Since DEM 2000
Ground Survey	Waratah Railway	More Accurate Ground Survey
Ground Survey	Glebe Road	More Accurate Ground Survey

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6.1.2 Cross-Sections

The lower sections of Throsby Creek and the harbour are modelled in 2D. Changes to topography caused by dredging and development in these areas are represented.

6.1.3 Land-Use

The 2004 aerial photographs were used to digitise the current land uses in areas that have changed since the calibration events. The land uses used in the design modelling are presented in Drawing 6-2.

6.1.4 Hydraulic Structures

The rail bridge over Styx Creek was replaced in 2004. Newcastle City Council provided details of both bridges. The model was updated to reflect the current arrangement.

Details for the hydraulic structures are based on the drawings provided by Newcastle City Council. These structures were surveyed / measured in the years 2000 and 2001. It is assumed that these are reflective of the current structures.

6.2 Design Flood Behaviour

6.2.1 Flood Mechanisms

In general, the flooding behaviour in the Throsby, Cottage and CBD areas in its current developed state can be summarised as follows:

- Rainfall on the catchment initially drains via the underground drainage network to the network of concrete lined open channels that discharge to the harbour.
- When runoff exceeds the capacity of the underground drainage and open channel network, floodwaters primarily travel along the road system as a network of flowpaths draining the catchment into the open channels or parallel to open channels.
- In some areas, the major overland flowpaths are through residential/commercial buildings and grounds and parkland.
- Flooding in the lower areas (Carrington in particular) can result as a back up from Throsby Basin either from a Hunter River flood, an elevated ocean level (eg storm surge) or from a combination of both.

6.2.2 Critical Duration Analysis

The hydrological model was used to simulate 11 rainfall durations for the 1% AEP event to ascertain the critical duration storm periods. Flows generated were input to the hydraulics model to determine the design rainfall durations that result in the highest modelled water level at locations throughout the study area.

To ensure that the timing of the tide in the harbour did not influence the critical duration analysis, the downstream water level for the critical duration simulations was held constant at 0.0mAHD. Results of the critical duration analysis are presented in Drawing 6-3. This figure shows where the various rainfall durations yield the highest predicted water level.

The rainfall durations used in the critical duration and the area that each of these is critical is presented in Table 6-2. It should be noted that while the 1 and 1.5 hour durations have a greater percentage than the 9 hour, the depth is generally very close in value to the 2 hour duration. In lower areas, the longer durations are critical and these are significantly deeper than the 2 hour duration.

The locations where the depth of the 2 and 9 hour durations is within 50mm of the critical depth was calculated. Drawing 6-5 shows areas where the 2 and 9 hour events are within 50mm of the critical duration. This drawing shows that over the extent of the model the 2 and 9 hour events are generally either critical or within 50mm of the critical depth.

In consultation with the flood study technical committee it was decided that two and nine hour rainfall durations would be used for design flood simulations.

Table 6-2 Results Critical Duration Analysis of 1% AEP

Duration	Area km^2	Percentage of Area Critical
0.5 hour	0.28	3.0%
1 hour	1.25	13.5%
1.5 hour	1.53	16.5%
2 hour	**3.97**	**42.9%**
3 hour	0.32	3.5%
4.5 hour	0.22	2.4%
6 hour	0.22	2.4%
9 hour	**0.71**	**7.6%**
12 hour	0.26	2.8%
18 hour	0.16	1.7%
24 hour	0.35	3.8%
Total	**9.26**	**100.0%**

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6.3 Design Flood Combinations

6.3.1 Design Event Abbreviations

The following abbreviations are used for the design event section of the Throsby, Cottage and CBD Flood study:

Table 6-3 Design Event Abbreviations

Abbreviation	Description
Topography	
TEX	Topography as at 2005 (ie. existing conditions)
TFD	Fully developed topography
Event Probability	
QPMF	PMF Flood Event
Q200	200 year ARI or 0.5% AEP Event
Q100	100 year ARI or 1% AEP Event
Q050	50 year ARI or 2% AEP Event
Q020	20 year ARI or 5% AEP Event
Q010	10 year ARI or 10% AEP Event
Q005	5 year ARI or 20% AEP Event
Q002	2 year ARI or 50% AEP Event
Duration	
D0030m	30 minute critical duration
D01.0h	1 hour critical duration
D01.5h	90 minute critical duration
D02.0h	2 hour critical duration
D03.0h	3 hour critical duration
D04.5h	4.5 hour critical duration
D06.0h	6 hour critical duration
D09.0h	9 hour critical duration
D12.0h	12 hour critical duration
D18.0h	18 hour critical duration
D24.0h	24 hour critical duration
Harbour Conditions (Hunter River / Ocean Combinations)	
RPMF	Hunter River PMF flood event with a 1.3m ocean storm tide. The two peaks are timed to coincide within the harbour.
H0.5e	0.5% exceedance for any given hour harbour boundary from L&T joint probability study.
H01e	1% exceedance for any given hour harbour boundary from L&T joint probability study.
H02e	2% exceedance for any given hour harbour boundary from L&T joint probability study.

H05e	5% exceedance for any given hour harbour boundary from L&T joint probability study.
H10e	10% exceedance for any given hour harbour boundary from L&T joint probability study.
H20e	20% exceedance for any given hour harbour boundary from L&T joint probability study.
H50e	50% exceedance for any given hour harbour boundary from L&T joint probability study.
Climate Change	
C01	Climate Change Scenario 01: 0.4m sea level rise.

6.3.2 Design Event Probabilities

Flooding was simulated using the hydraulic model for eleven combinations of design event probabilities for the TEX (Existing) and TFD (Future) topographic scenarios as follows.

- Existing (TEX) conditions: PMF, Q200, Q100, Q50, Q20, Q10, Q5 and Q2.
- Future (TFD) conditions: PMF, Q100 and Q10.

6.3.3 Design Event Combinations

The selection of rainfall event durations (two and nine hour) was based on the critical duration analysis, see Section 6.2.2. The following combinations were simulated for the design probabilities listed in Table 6-4.

All design events have a 1 hour, 1% AEP time varying tailwater condition, based on the joint probability study of water levels in Newcastle Harbour (Lawson and Treloar, 1999). The fully developed condition simulations have an allowance of 0.4m on tailwater levels to account for possible sea level rise in the future.

Table 6-4 Design Flood Combinations

Design Flood Probability	Combinations
Existing Condition (TEX) Combinations	
PMF	1. TEX_QPMF_D02.0h_ H01e
Q200	2. TEX_Q200_D02.0h_H01e 3. TEX_Q200_D09.0h_H01e
Q100	4. TEX_Q100_D02.0h_H01e 5. TEX_Q100_D09.0h_H01e
Q050	6. TEX_Q050_D02.0h_H01e 7. TEX_Q050_D09.0h_H01e
Q020	8. TEX_Q020_D02.0h_H01e 9. TEX_Q020_D09.0h_H01e
Q010	10. TEX_Q010_D02.0h_H10e 11. TEX_Q010_D09.0h_H10e
Q005	12. TEX_Q005_ D02.0h _H01e 13. TEX_Q005_ D09.0h _H01e
Q002	14. TEX_Q002_ D02.0h _H01e 15. TEX_Q002_ D09.0h _H01e
Fully Developed Condition (TFD) Combinations	
PMF	16. TFD_QPMF_ D02.0h _H01e_C01
Q100	17. TFD_Q100_D02.0h_H01e_C01 18. TFD_Q100_D02.0h_H01e_C01
Q010	19. TFD_Q010_D02.0h _H01e_C01 20. TFD_Q010_D09.0h_H01e_C01

6.4 Presentation of Results

Design flood levels and depths are presented for the eight existing design event probabilities. The results for each design probability are the maximum envelope of two critical durations (two and nine hour durations).

The peak water level does not occur everywhere at the same time, therefore, values presented are based on the maximum that occurred at each computational point in the model during a combination of event durations. Hence, results do not represent an instantaneous point in time, but rather an envelope of the maximum values that have occurred.

Unless otherwise stated, presentations in this report are based on peak values, not at an instant in time. Peak velocity and peak velocity-depth products are those that occur at the time of the peak water level.

Long sections down each of the major tributaries are presented for all the design and calibration events. An index of the long profiles is presented in Table 6-5. A map of the location of profiles is presented in Drawing 6-5.

Table 6-5 Index Of Long Profiles

Branch	Drawing Number
Location Plan	Drawing 6-4
Adamstown	Drawing 6-5
Broadmeadow East	Drawing 6-6
Broadmeadow	Drawing 6-7
Cottage Creek	Drawing 6-8
Georgetown	Drawing 6-9
Griffiths Flat	Drawing 6-10
Kotara	Drawing 6-11
Lambton	Drawing 6-12
Mayfield	Drawing 6-13
New Lambton	Drawing 6-14
Orchardtown	Drawing 6-15
Racecourse	Drawing 6-16
Throsby Upper	Drawing 6-17
Throsby Lower	Drawing 6-18
Waratah	Drawing 6-19

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Five drawings are presented for each design event probability and output type, as a keysheet (A3) and four A3 maps. An index of the design mapping is presented in Table 6-6.

Table 6-6 Index of Design Flood Maps

Event	Levels	Depths
Q002_TEX	Drawing 6-20 to Drawing 6-24	Drawing 6-25 to Drawing 6-29
Q005_TEX	Drawing 6-30 to Drawing 6-34	Drawing 6-35 to Drawing 6-39
Q010_TEX	Drawing 6-40 to Drawing 6-44	Drawing 6-45 to Drawing 6-49
Q020_TEX	Drawing 6-50 to Drawing 6-54	Drawing 6-55 to Drawing 6-59
Q050_TEX	Drawing 6-60 to Drawing 6-64	Drawing 6-65 to Drawing 6-69
Q100_TEX	Drawing 6-70 to Drawing 6-74	Drawing 6-75 to Drawing 6-79
Q200_TEX	Drawing 6-80 to Drawing 6-84	Drawing 6-85 to Drawing 6-89
QPMF_TEX	Drawing 6-90 to Drawing 6-94	Drawing 6-95 to Drawing 6-99

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6.5 Design Flood Peak Envelopes

6.5.1 2 year ARI Event

The following comments are made with respect to the 50% AEP (2 year ARI) flood probability combination:

- There are significant areas predicted to experience shallow flooding, these include New Lambton, The Junction, Hamilton North and Carrington. Many of these are likely to be as a result of the sub-900mm pipes not being included.

- Velocity and velocity-depth products are typically low for overland areas, the exception being Merewether.
- The railway embankment at Kotara acts as a significant restriction to flow with a head drop of approximately 1.5m at the culverts.
- There is no interaction between the Throsby and Cottage Creek catchments.
- Predicted area inundated is 5.9km^2.

6.5.2 5 year ARI Event

The following comments are made with respect to the 5 year ARI (20% AEP) probability design event combination:

- Significant increases to flood extent (compared with the 2 year ARI event) occur in New Lambton (Bridges Road and Errington Ave / Mackie Ave) and the CBD (Hunter and King Streets).
- A flow path is created along Bridges Road, New Lambton (between Longworth Ave and Russell Rd).
- A small interaction between the Throsby and Cottage Creek catchments occurs. A peak flow of approximately 0.5m^3/s from the Cottage Creek catchment to the Throsby Creek occurs in the nine hour event. The flow occurs along Fowler and Coady Streets in Hamilton South.
- Predicted area inundated is 7.3km^2.

6.5.3 10 year ARI Event

The following comments are made with respect to the 10 year ARI (10% AEP) probability design event combination:

- Significant increases to flood extent (compared to the 5 year ARI event) occur in Mayfield and New Lambton.
- Proportion of flow along Bridges Road / Penman Avenue / Fairfield Avenue increases. Velocities of greater than 1m/s are predicted.
- Approximately 40% of flow in overland areas along Selwyn and Wilton Streets (Merewether).
- Predicted area inundated is 7.9km^2.

6.5.4 20 year ARI Event

The following comments are made with respect to the 20 year ARI (5% AEP) probability design event combination:

- Increases in flood extent and overland flow.
- Flowpath along Silsoe Street / Dangar Park in Mayfield develops.
- Overland flow path along Dawson, Queen and Darby Streets in Cooks Hill develops.
- Overland flow path along Mitchell St (between Llewellyn and Robert Streets) in Merewether develops.
- Predicted area inundated is 8.7km^2.

6.5.5 50 year ARI Event

The following comments are made with respect to the 50 year ARI (2% AEP) probability design event combination:

- General increases in flood extent and overland flow, notably in Hamilton North, Broadmeadow, Adamstown and Cooks Hill.
- Overland flowpath along Griffiths Road and Broadmeadow Road into Hamilton North develops.
- Overland flowpath north along Brunker, Chatham and Broadmeadow Roads develops.
- Overland flowpath along Mowbray and Wood Streets Adamstown develops.
- Overland flowpath along St James Road (east of Evenscourt Road) develops.
- Peak flow between the Throsby and Cottage Creek catchments is 2.6m^3/s from Throsby Creek to Cottage Creek catchment.
- Predicted area inundated is 9.6km^2.

6.5.6 100 year ARI Event

The following comments are made with respect to the 100 year ARI (1% AEP) probability design event combination:

- General increases in flood extent and overland flow, notably in New Lambton, Hamilton, Hamilton South and Newcastle West.
- Overland flow occurs north along Orchardtown Road, Birdwood Street and Knight Street.
- 75% of flow occurs in overland areas (as opposed to underground conduits) along Selwyn and Wilton Streets (Merewether).
- Predicted area inundated is 10.2km^2.

6.5.7 200 year ARI Event

The following comments are made with respect to the 200 year ARI (0.5% AEP) probability design event combination:

- General increases in flood extent and overland flow.
- A significant number of streets have velocities of greater than 1m/s, particularly in Merewether and New Lambton.
- Predicted area inundated is 10.8km^2.

6.5.8 PMF Event

The following comments are made with respect to the Probable Maximum Flood (PMF) event combination:

- The PMF event combination results in very large areas being inundated.

- Large portions of Broadmeadow, Hamilton, Hamilton North, Hamilton South, Hamilton East, The Junction, Wickham, Islington, Maryville, Carrington and New Lambton are predicted to experience flooding.
- Numerous roads have peak velocities of greater then 1m/s and a significant number have predicted velocities greater than 2m/s.
- Predicted area inundated is 19.3km^2.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The following points summarise the findings for the Throsby, Cottage and CBD Flood Study:

- A hydrological model of the Throsby, Cottage and CBD catchments has been developed. The model uses industry standard parameters.
- A dynamically linked two-dimensional/one-dimensional (2D/1D) TUFLOW hydraulic model of the Throsby, Cottage and CBD areas was developed and calibrated/verified to the 1988 and 1990 flood events
- The models have successfully been used to derive a detailed representation of flooding in creek/channel and urban areas for the 50%, 20%, 10%, 5%, 2%, 1% and 0.5% AEP design flood events as well as the probable maximum flood.
- The models are considered to form a reliable and representative base from which to carry out flood risk management investigations and quantitatively assess impacts of flood mitigation options.

7.2 Recommendations

The following recommendations are made with respect to the Throsby, Cottage and CBD flood study:

- The computer models developed of the Throsby, Cottage and CBD catchments should be verified against the June 2007 flood event.
- The computer models should form the basis of all future floodplain risk management investigations for the study area.

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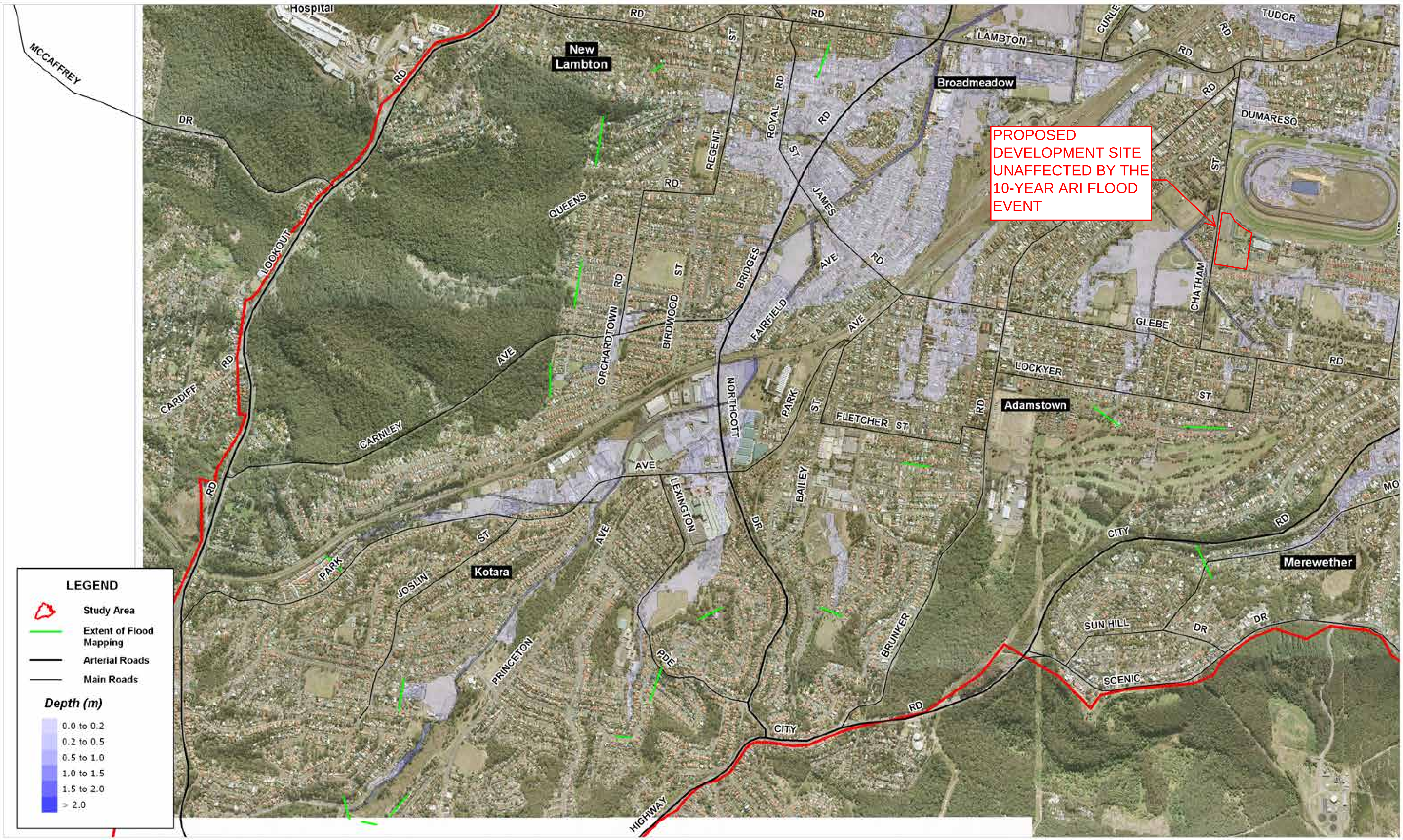
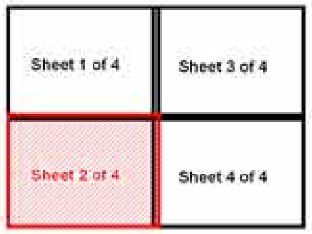
BMT WBM Brisbane	**Level 11, 490 Upper Edward Street Brisbane 4000** **PO Box 203 Spring Hill QLD 4004** **Tel +61 7 3831 6744 Fax +61 7 3832 3627** **Email wbm@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Denver	**14 Inverness Drive East, #B132** **Englewood Denver Colorado 80112 USA** **Tel +1 303 792 9814 Fax +1 303 792 9742** **Email wbmdenver@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Melbourne	**Level 5, 99 King Street Melbourne 3000** **PO Box 604 Collins Street West VIC 8007** **Tel +61 3 8620 6100 Fax +61 3 8620 6105** **Email wbmmelbourne@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Morwell	**Cnr Hazelwood Drive & Miners Way Morwell 3840** **PO Box 888 Morwell VIC 3840** **Tel +61 3 5135 3400 Fax +61 3 5135 3444** **Email wbmmorwell@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Newcastle	**126 Belford Street Broadmeadow 2292** **PO Box 266 Broadmeadow NSW 2292** **Tel +61 2 4940 8882 Fax +61 2 4940 8887** **Email wbmnewcastle@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Perth	**1 Brodie Hall Drive Technology Park Bentley 6102** **Tel +61 8 9328 2029 Fax +61 8 9486 7588** **Email wbmperth@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Sydney	**Suite 206, 118 Great North Road Five Dock 2046** **PO Box 129 Five Dock NSW 2046** **Tel +61 2 9713 4836 Fax +61 2 9713 4890** **Email wbmsydney@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Vancouver	**1190 Melville Street #700 Vancouver** **British Columbia V6E 3W1 Canada** **Tel +1 604 683 5777 Fax +1 604 608 3232** **Email wbmvancouver@wbmpl.com.au** **Web www.wbmpl.com.au**





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10 Year ARI Event Maximum Depths - Existing Conditions

Figure: 6-48

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Approx. Scale

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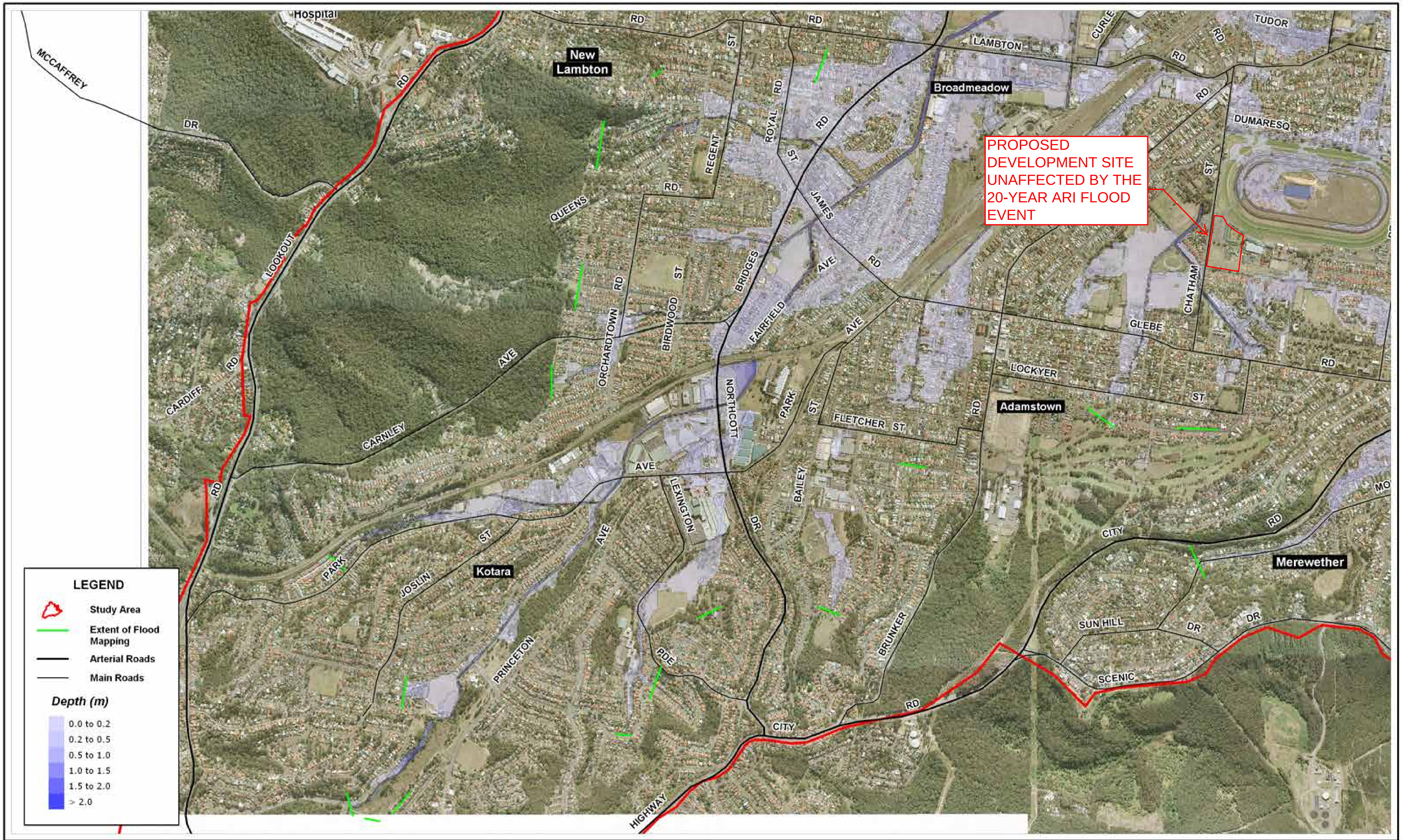

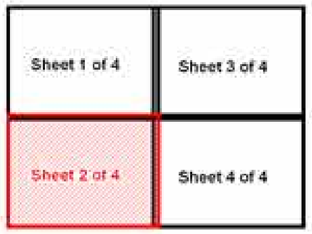

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20 Year ARI Event Maximum Depths - Existing Conditions

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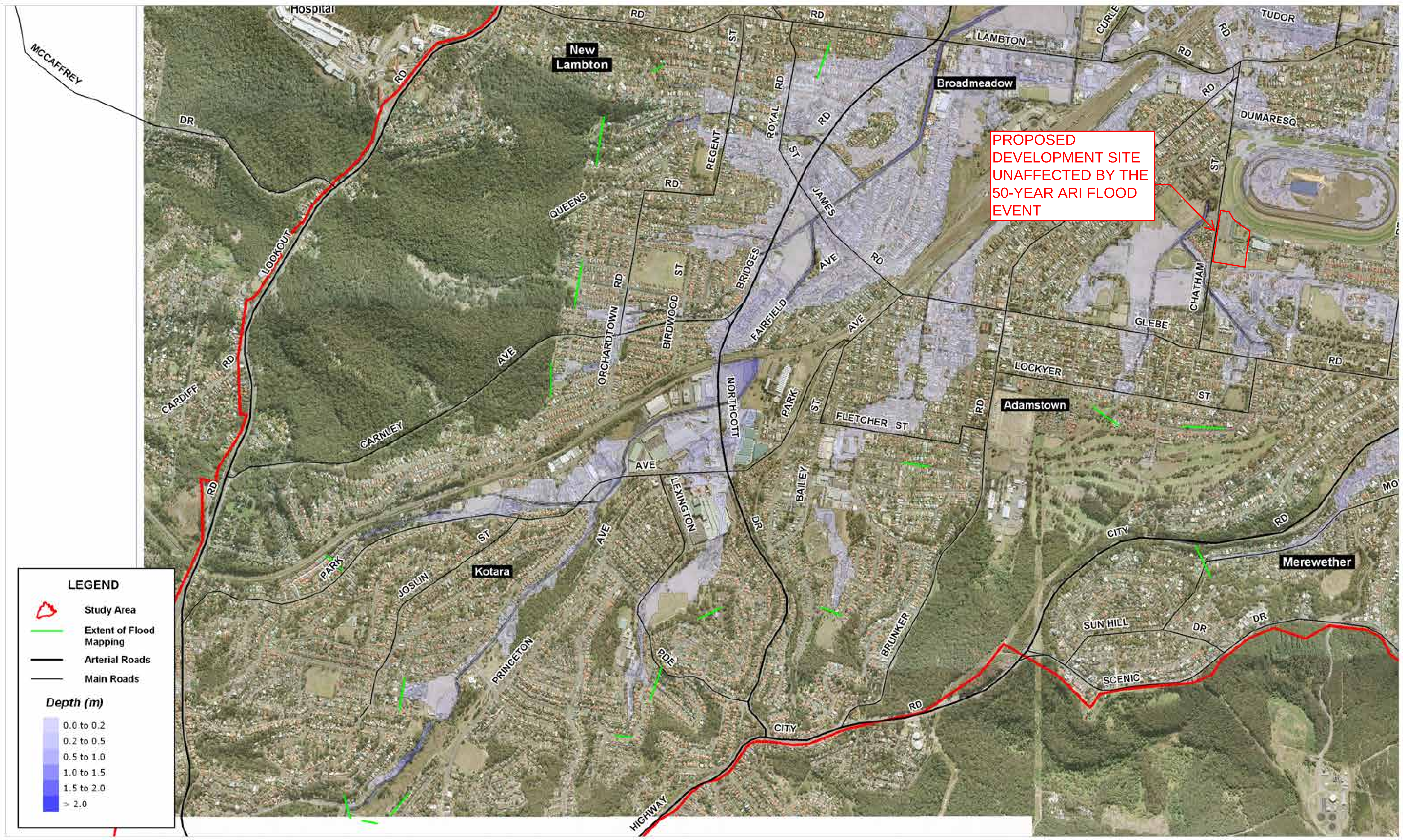

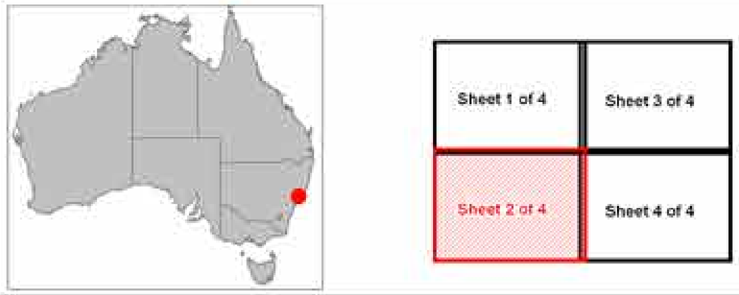

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50 Year ARI Event Maximum Depths - Existing Conditions

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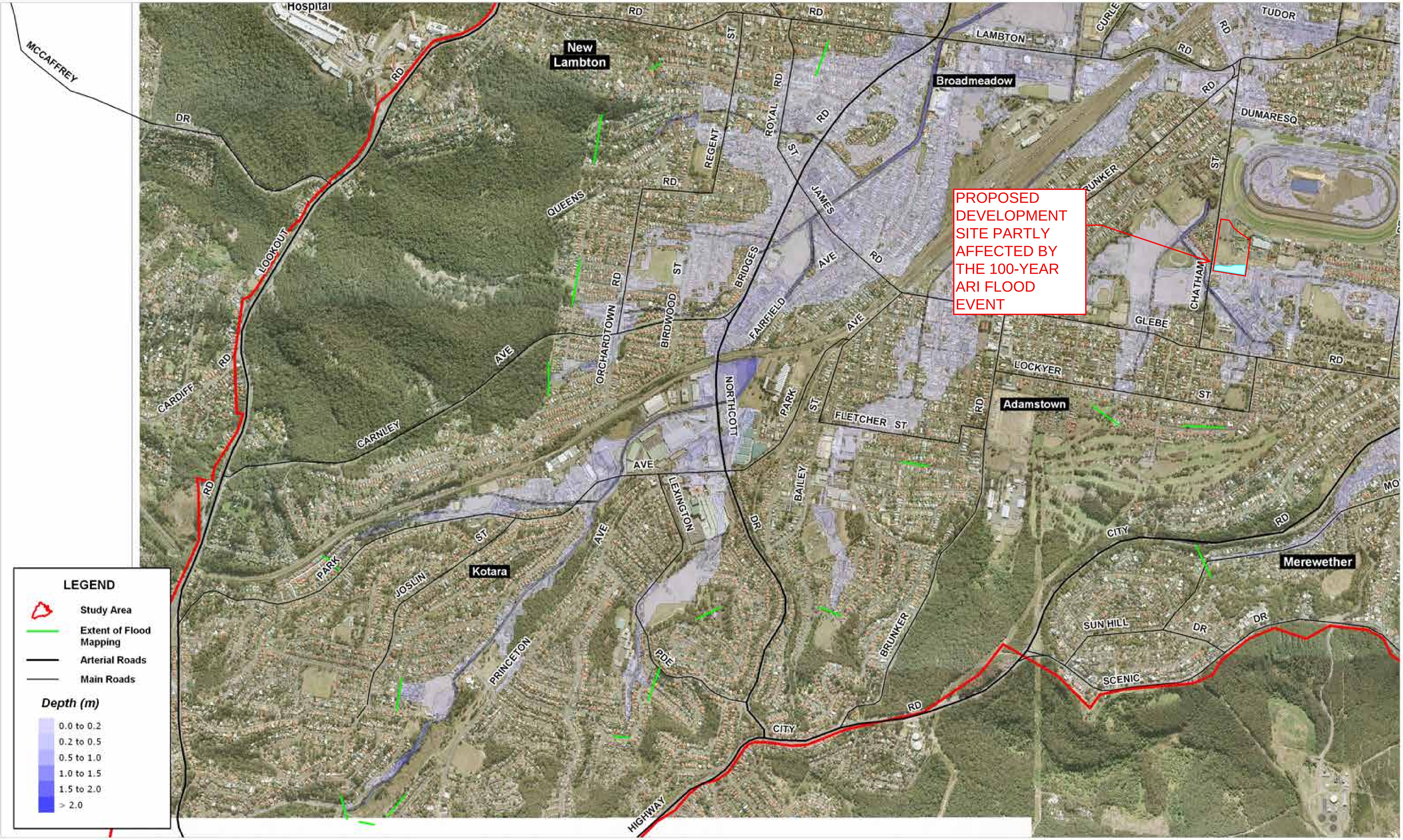

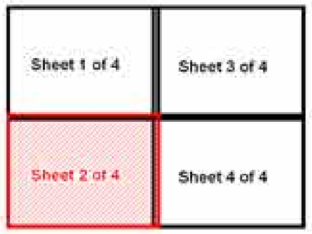

Title:
100 Year ARI Event Maximum Depths - Existing Conditions

Figure: 6-78

Rev: A

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N

0 400 800m
Approx. Scale

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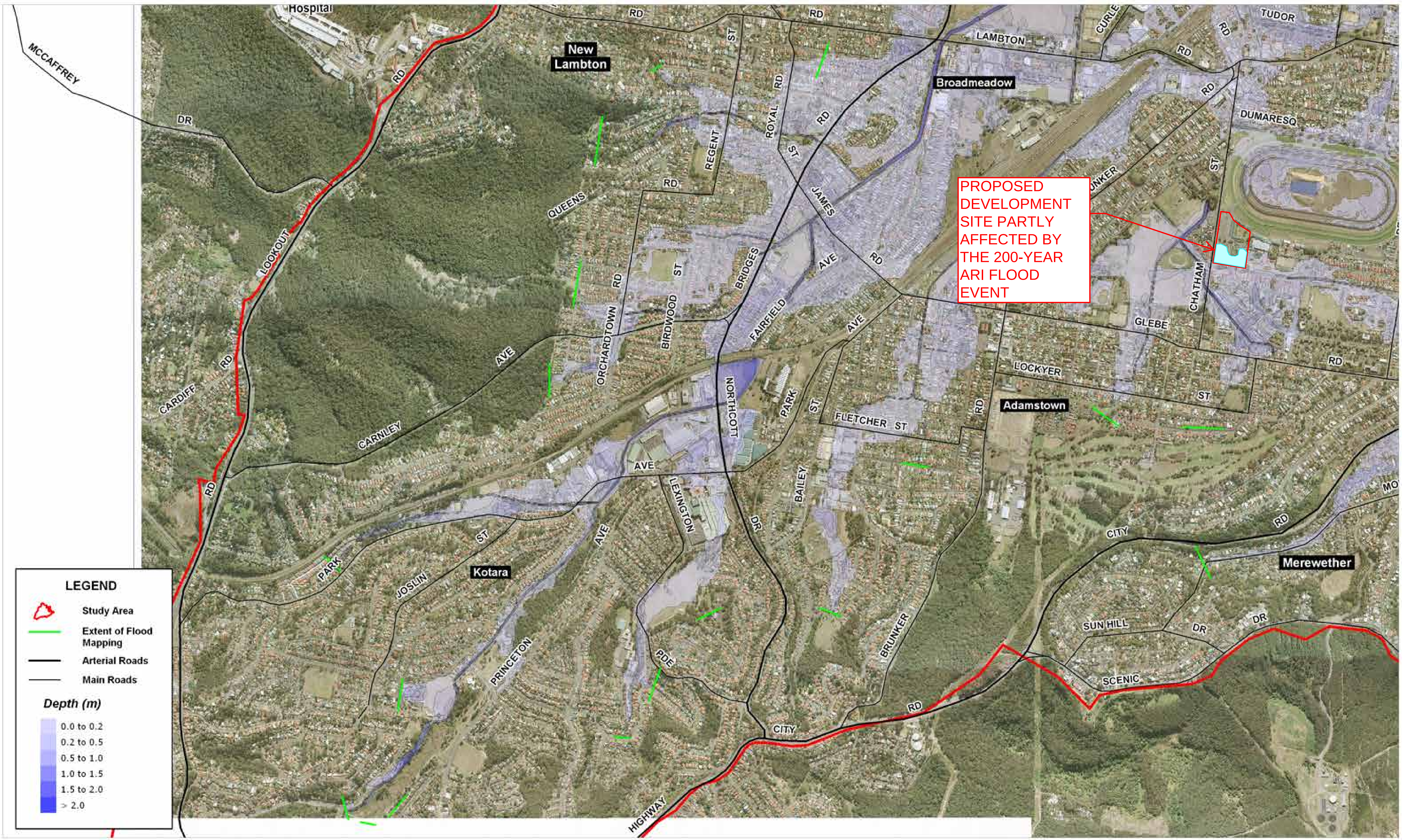

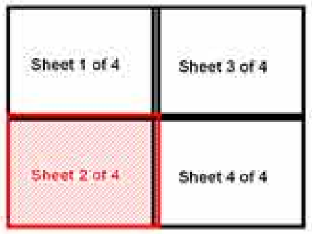

Title:

200 Year ARI Event Maximum Depths - Existing Conditions

Figure: 6-88

Rev: A

N

0 400 800m

Approx. Scale

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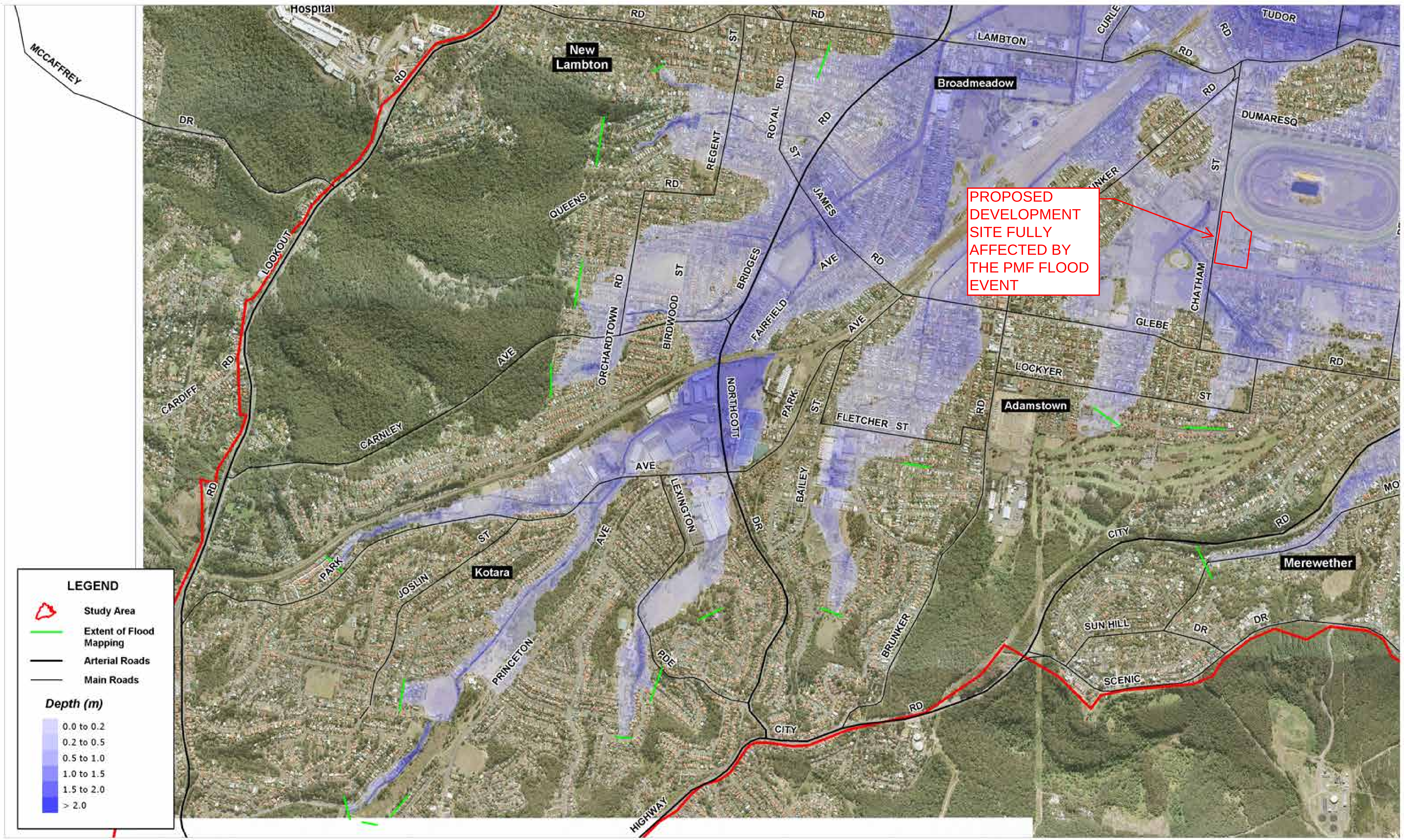

Sheet 1 of 4	Sheet 3 of 4
Sheet 2 of 4	Sheet 4 of 4

Title:

PMF Event Maximum Depths - Existing Conditions

Figure: **Drawing 6-98**

Rev: **A**

N

0 400 800m

Approx. Scale

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