WESTERN SYDNEY PARKLANDS TRUST

CIVIL ENGINEERING REPORT LIGHT HORSE INTERCHANGE BUSINESS HUB, EASTERN CREEK STATE SIGNIFICANT DEVELOPMENT APPLICATION (SSD 9667)

Revision 6 – Amended to address Agency comments
May 2020

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Project Verification

Project Title	Light horse Interchange Business Hub
Document Title	Civil Engineering Report for State Significant Development Application (SSD 9667)
Project Number	18652
Description	Civil Engineering Report
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Issued by	Nicholas Wetzlar	
File Name	Civil Engineering Report_18652_SSDA	

Document History

Date	Revision	Purpose	Recipients	Format	Checked
04/04/2019	1	DRAFT	Mr Luke Wilson	PDF	A.F
09/04/2019	2	FOR SSDA	Mr Luke Wilson	PDF	A.F
24/05/2019	3	FOR SSDA	Mr Luke Wilson	PDF	A.F
21/06/2019	4	FOR SSDA	Mr Luke Wilson	PDF	A.F
31/01/2020	5	Amended for RTS Phase	Mr Luke Wilson	PDF	A.F
05/05/2020	6	Amended for Council Review	Mr Luke Wilson	PDF	A.F

1. INTRODUCTION

1.1. General

Henry & Hymas has been engaged by Western Sydney Parklands Trust (WSPT) to prepare this Civil Engineering Report (Report) to satisfy civil engineering matters in support of the proposed State Significant Development Application for the Light Horse Interchange Business Hub.

This Report aims to provide a summary on key civil engineering design elements of the proposed development application:

- General site locality, topography and existing characteristics;
- Proposed and existing infrastructure and services;
- Roads and transportation ;
- Proposed Site Works – earthworks and retaining walls;
- Stormwater management – flooding, water quality and quantity;
- Sediment and Erosion;
- Specific items raised in the Secretary's Environmental Assessment Requirements (SEARs) and authority submissions.

This Report has been prepared in conjunction with a set of Civil Engineering Drawings which show the general proposed infrastructure design for the development.

As the development is deemed a State Significant Development (SSD), the consenting authority is the NSW Department of Planning, Industry and Environment. The development is located within the local government area of Blacktown City Council (BCC), and whilst the Council development control plans (DCP) does not apply to the SSDA, the DCP and policy requirements pertaining to the Council were considered in the design. BCC was consulted several times during the early approval design phase of the development, particularly relating to matters regarding stormwater and flooding.

The NSW Department of Planning, Industry and Environment has provided Secretary's Environmental Assessment Requirements (SEARs) dated 7th November 2018 (Ref: SSD 9667). In addition to providing a general summary of civil engineering aspects of the project, this report addresses the following relevant SEARs items below. Detailed on how these SEARs items have been addressed can be found in this report:

- Suitability of the Site – Sections 2.5 and 6.3
- Traffic and Transport – Section 4.1 - 4.8
- Flooding – Sections 2.5 and 6.3
- Soils and Water – Sections 6 and 7
- Infrastructure Requirements – Section 3.1 – 3.5
- Bulk Earthworks – Sections 5.1 and 5.2
- Stormwater management (quantity and quality) – Section 6.1 – 6.8.

2. SITE CHARACTERISTICS

2.1. Location

The site is located on the south east corner of the Light Horse Interchange between the M4 Western Motorway and the M7 Westlink as shown in Figure 2.1. The site forms part of the overall Western Sydney Parklands. The development portion of the site has an area of 29.4 Hectares (Lots 1-7) and is designated for Industrial Development including associated infrastructure, roads, basins, utilities and creek realignment. The remainder of the study area which is not being developed is in the Western Sydney Parklands bushland corridor. The study area is bounded by Motorways to the north and west, Suez treatment plant the south, and Eastern Creek Raceway the east. The study area spans between two lots, Part of Lot 10 DP 1061237 (165 Wallgrove Road, Eastern Creek); and Part of Lot 5 DP 804051 (475 Ferrers Road, Eastern Creek).

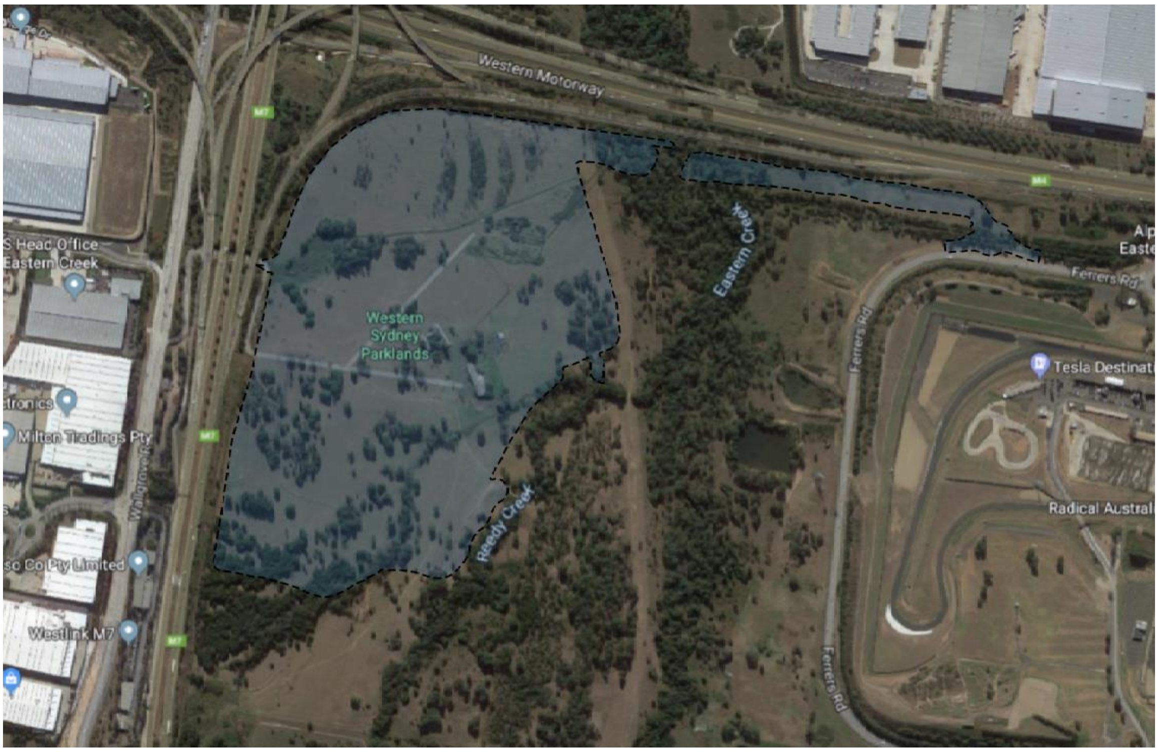

Figure 2.1 – Site Location

2.2. Topography

The site is located to the west of Eastern Creek which is an ephemeral creek that drains from south to north. Two smaller ephemeral creeks drains from the west of the site beneath the M7 those being Reedy Creek and Eskdale Creek. These two creeks converge with Eastern Creek to the east of the development portion of the site. The portion of the site to be developed generally has moderate falls from west to east.

2.3. Existing Site Conditions

The site was previously used by the Australian Army for numerous purposes as well as a waste water treatment plant (WWTP) and as such there are several small buildings located on-site. The majority of the site is vacant sparsely vegetated land with the exception of more densely vegetated riparian vegetation along the lines of the existing creeks particularly Eastern Creek. The site is currently being used as grazing land and has so for over 10 years.

2.4. Access

The site is currently accessed via an access road from Wallgrove Road to the west of the site. Wallgrove Road is located west of and parallel to the M7. The access road is an underpass beneath the M7. There are currently no formalised vehicular access points from the north, east or south of the site. Additional paths are present, however these typically for the purpose of maintaining infrastructure onsite, for example Jemena's Gas Line or on-grade creek crossings.

2.5. Flooding

Eastern Creek drains through the site and as such, the overall site is affected by the 100 year ARI flood as well as the Probable Maximum Flood (PMF). The development portion of the site is located to the west of Eastern Creek and will be filled to ultimately be positioned above both the 100 year ARI flood and the PMF.

2.6. Proposed Development

The proposed industrial development comprises seven (7) industrial lots that will be accessed via a sealed access road connecting through from Ferrers Road located to the east of the site. Ferrers Road is situated between the site and Eastern Creek Raceway. The access from Ferrers Road will require the construction of a new road and bridge crossing over Eastern Creek. Refer Figure 2.2 below for details of the Masterplan development layout by Nettleton Tribe Architects.

Figure 2.2 – Masterplan Site Layout by Nettleton Tribe

3. INFRASTRUCTURE

Infrastructure works (Stage 1) for the development aim to provide fully accessible, prepared, and benched Lots, which are fully serviced with essential infrastructure. An overview of existing and proposed infrastructure works to achieve the above are outlined in the following sections. The following services have been considered in the assessment:

- Water (potable)
- Sewer
- Gas
- Electrical and Lighting
- Telecommunications

3.1. Water

The site will require a potable water supply from Sydney Water mains. Based on preliminary advice from Rose Atkins Rimmer (RAR), the Sydney Water Servicing Coordinator (WSC), it has been identified that the minimum watermain size requirements for a development of this nature is expected to be a 150mm diameter main.

RAR has identified that the site is able to be serviced adequately by an existing 250mm diameter main located in Wallgrove Road or a 200mm diameter main in Ferrers Road with the 250mm diameter main in Wallgrove Road being the preferred option. Details of the connections to these existing mains would be provided at a later stage, however the site connections would need to either be from Ferrers Road across Eastern Creek or from Wallgrove Road via the underpass beneath the M7.

Typical water demand rates for industrial and commercial land uses are provided in Figure 3.1 below:

Development Type	Development Sub-type	Key unit	Average Daily Demand	Max Daily Demand
Industrial & Logistics	Light Industrial	kL/ha/Day (floor Area)	28.2	40
	Medium industrial	kL/ha/Day (floor Area)	41.25	66
	Heavy Industrial & Processing		As required by end user	As required by end user
	Manufacturing		As required by end user	As required by end user
	Transportation/Depot	kL/ha/Day (Site Area)	9.1	15

Figure 3.1. Typical Water Demand Rates – Based on; Sydney water reporting and surveys, Water Supply Code of Australia (WSA) 2011.

Assuming the majority of the development will be warehousing, light industrial or "like developments" a rate of 40 kL/Ha/day can be applied to the developable floor area of 16.55ha resulting in a max daily demand of 662kl. Using a similar methodology, the average daily demand is estimated to be 465.3kL

Although rainwater tanks are to be integrated into the developments water balance, under Water Supply Code of Australia (WSA) Guidelines it is currently recommended that no allowance (reduction) in design peak demands, for drinking or non-drinking water supply systems, be made for the presence of rainwater tanks. This is due to the likelihood that some rainwater tank top-up, or bypass of some rainwater tanks will occur during the peak hour.

To further elaborate on the capacity of the existing water mains ability to service the development a extract of the WSA empirical guide for pipe sizing (2011) is provided in Figure 3.2 below:

Nominal size of main DN		Capacity of main (single direction feed only)			
Cast iron outside diameter series	ISO series	Residential (lots)	Rural residential (lots)	General/ light industrial (ha)	High usage industrial (ha)
100	125	40	10	N/A	N/A
150	180	160	125	23	N/A
200	250	400	290	52	10
225	280	550	370	66	18
250	315	650	470	84	24

Figure 3.2 – Empirical Guide for Pipe Sizing (Extract from WSA – 2011-3.1)

Using the above Figure, it can be determined the main located in Wallgrove Road has sufficient capacity to service 84Ha of general/light industrial development with the main in Ferrers road capable of servicing 52Ha of similar development. The strategy and detailed design for the development connection/extensions will need to be performed by a Sydney Water Service Coordinator.

Notwithstanding the further investigations and applications required with Sydney Water, it is considered that water supply will be able to be provided to the development site in the required timeframe.

In accordance with State Environmental Planning Policy (SEPP) for Western Sydney Parklands (WSP) 2009 Clause 13 relating to bulk water supply, the impact of the proposed development on regional bulk water supply infrastructure was assessed. Based on a review of SEPP WSP bulk water supply infrastructure mapping (Map Sheet BWS_003) it was determined the proposed development would have no impact on bulk water supply infrastructure. This is due to the proposed development's location being situated a sufficient distance from regional bulk water supply infrastructure and outside of any water supply catchments.

3.2. Sewer

The site will require a gravity sewer connection to Sydney Water mains. RAR has advised that an industrial development of this nature would need to be serviced by 225mm diameter reticulation sewers. RAR has also identified that there is a 600mm diameter sewer main that drains from south to north through the site. There is also a 375mm diameter sewer main that drains around the north western corner of the site to the east and connects to the 600mm diameter sewer main at the northern end of the site.

There appears to be limited inlet junctions to the existing sewer main, therefore additional inlets may be required. The proposed internal road layout has been designed taking into account the location of this sewer main such that the existing sewer will remain within the building setbacks of the proposed lots which is the conventional location of gravity sewer mains.

It is proposed to retain the existing sewer mains in their current locations and utilise the mains for the sewer connections for the development. Sewer Maintenance Holes (MH) will be adjusted as required to cater for the change in surface levels.

Notwithstanding the further investigations and applications required with Sydney Water, it is considered that sewer supply will be able to be provided to the development site in the required timeframe.

3.3. Gas

A 500mm diameter Jemena high pressure gas main is located within a 20m wide easement that runs through the site in a north-south direction. The gas main generally runs along the western side of the Eastern Creek watercourse. The gas main easement forms the eastern most edge at the northern end of the development site.

Discussions were held with Jemena in relation to the potential impact of the proposed development on the gas main. The main issues related to limiting building structures within the gas easement and ensuring that access to the gas main would be possible in the future without undermining any structures that are constructed outside the easement. The below sketches (Fig 3.3) shows how the excavation to the gas main would still be possible without affecting adjacent structures.

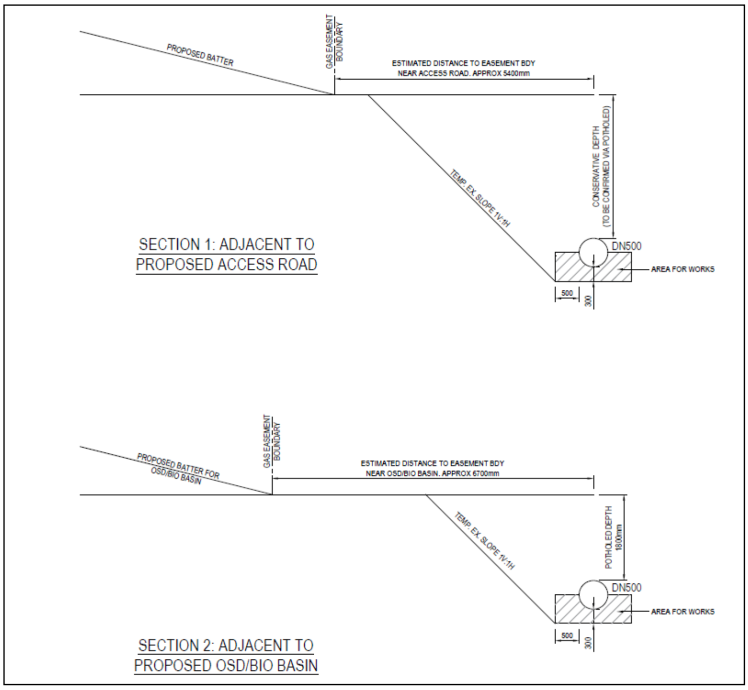

Figure 3.3 – Indicative Sections through Gas Easement

Note that the proposed access road will cross the gas main in one location and restrictions may be placed on this access road in terms of structural requirements to ensure no significant loads are placed on the gas main. In addition to the limitation of loading, It's is understood vibration should be minimised during the construction of any proposed structures in or within close proximity to the easement. Both the structure for the single road crossing and earthworks in close proximity to the easement are proposed to be constructed in a manner and method that reduces vibration. Additionally, the applicant is committed to further consultation of with Jemena for the coordination of works within the easement and the provision of access to monitor vibration during construction.

Natural gas supply is usually a low priority for industrial warehouse/distribution type development however this would need to be assessed on an individual needs basis as part of future development applications. Supply of gas is not proposed as part of the current estate infrastructure application.

3.4. Power

Endeavour Energy is the servicing authority for energy in the region. The subject site is located in a previous rural residential area with minimal load. An enquiry to the service provider will be necessary to confirm the ability of local cables to service the site. Endeavour Energy will require the engagement of a Level 3 Service Provider to further assess the capacity of the existing system and the requirements for the infrastructure to service the proposed development.

Preliminary advice from Ultegra suggests that the likely method of supply would be to connect with an existing feeder near Brabham Drive. Notwithstanding the further investigations and applications required with Endeavour Energy, it is considered that power supply will be able to be provided to the development site substation.

The substation for the development is proposed to be outside the north east corner of Lot 1 adjacent to the corner of the proposed access road. Considering the Flood Impact Assessment prepared by BMT it should be noted that the proposed location has flood immunity from mainstream flooding in the PMF flood event (in excess of 1% AEP storm event).

3.5. Street Lighting

Street lighting is proposed to be provided throughout the development as it plays an important role in creating a safe night-time environment for pedestrians and vehicles. In accordance with council policy, lighting should be easily maintained, vandal resistant and have particular regard to the specific environment in which it serves. Street and pedestrian lighting throughout the development should generally be provided in accordance with Council’s Street Lighting Policy, Endeavour Energy requirements and relevant sections of Australian Standard AS1158.

To keep an aesthetic consistency throughout the Western Sydney Parklands, street lighting along the access road and shared path external to the estate is proposed to incorporate the principles of WSPT Design Manual, specifically section 11.0 - Lighting. Specific lighting locations, pole type and materials are to be determined by a lighting or electrical consultant in close co-ordination with the Trust. Street lighting is to be designed and specified in accordance with relevant documentation by Blacktown City Council e.g. Engineering Guide for Development etc. Lighting levels are to be suitably designed to achieve levels of luminosity as specified by WSPT Design Manual and Australian Standard AS1158.3.

3.6. Telecommunications

Telecommunications from the National Broadband Network (NBN) are not yet available for the site, but the NBN is available to the east of the site and currently under construction to the west of the site. Telecommunications for the site will be serviced by the local copper or fibre optic supply network until such time as the NBN is available. Note that since the NBN is available in the vicinity of the site, it may be a requirement to install NBN infrastructure within the development but this will be determined at Construction Certificate stage.

4. ROADS AND TRANSPORTATION

4.1. General Access Layout

As previously stated, it is proposed to provide vehicular access to the site via an access road from Ferrers Road. This access road will be located along the northern end of the development running parallel to the M4 and will cross Eastern Creek via a section of bridge. This access road then bends and runs in a north-south direction. The access road will provide direct access to the seven lots within the development. Since there is no through link from the development site, a cul-de-sac will be provided at the southern end of the access road to cater for turning movements for a B-Double articulated vehicle which is the largest vehicle that will use the access road.

Initial investigations were undertaken to ascertain whether a second access to the site could be provided from Wallgrove Road however it was established that there was no improvement in the level of service as a result of this second access in addition to the access from Ferrers Road and therefore WSPT decided not to pursue a secondary access any further. For additional information regarding site access and levels of service, please refer separate Traffic Report by Ason Group.

The access road has been designed to comply with the requirements of Blacktown City Council both in terms of pavements and geometry as it is the intention of WSPT for the road to be dedicated as a public road at some stage in the near future. A swept path analysis has been conducted on the development's road layout to confirm the layout caters for B- Double articulated vehicle turning movements. Plans of the vehicle swept paths are provided on Henry & Hymas civil engineering drawing 18652_SSDA_C600-C607, found in Appendix A. Refer below for description of road geometry and pavement thicknesses.

A review of the turning paths for a B-Double truck has been provided for each loading dock within each site. From these turning paths it was justified that a B-Double is able to forward into each site, reverse into the loading docks and exit the site in a forward direction. However, it is generally accepted that it is unlikely that B-Doubles will be required to reverse into the docks and the rear trailer is usually removed from the truck prior to reversing. Swept paths of the review can be found on Henry & Hymas engineering drawing 18652_SSDA_C608.

4.2. Bridge and Access Road from Ferrers Road Intersection

As stated above, a bridge will be required where the access road crosses Eastern Creek. This bridge will be constructed using an RMS type plank system with a concrete topping slab on six rows of piles/columns. The bridge will span 61.5m with individual spans ranging from 10-15m. The bridge has been designed with a full width of the access road carriageway.

This type of construction allows for maximum spans to minimise the potential for blockages in the flow of Eastern Creek. The flood modelling for the development has taken into account the locations of the proposed piles/columns. The bridge has been designed with 500mm freeboard to the underside of the bridge during a 100 year ARI flood which not only caters for potential blockages but also permits access across the bridge even during a 100 year ARI flood if required.

4.3. Ferrers Road Intersection

A roundabout is proposed where the access road intersects with Ferrers Road. The roundabout has been designed in accordance with Council's Engineering Guidelines and relevant clauses of Austroads. Traffic studies undertaken by Ason Group take into account future growth to 2030 and have established that the intersection can operate efficiently as a single lane roundabout. However, as part of discussions with Council, intent was expressed by Council Engineers for the design to cater for a two-lane roundabout at some stage into the future. For this reason, the centre of the roundabout was adjusted slightly from the original design to cater for the future two lanes as part of any future road upgrades performed by Council.

The roundabout has been designed to cater for all turning movements for a B-Double articulated vehicle which is the largest vehicle expected to negotiate the roundabout.

A 2.4m x 1.2m box culvert has been designed for where the access road crosses an existing swale to cater for the estimated 3.5m^3/s flow derived from Council's hydrographs.

4.4. Existing Wallgrove Road Access

As stated above, it is not proposed to use the existing access to the site from Wallgrove Road as a primary access to the site. This existing access will only be used by vehicles for emergency purposes and as such can cater for the turning movements of these vehicles. Site survey has been obtained to investigate vehicle swept paths and height clearance of the underpass. Review of the existing geometric constrains confirm that both the head clearance and the existing geometry can cater for emergency vehicles. The existing underpass beneath the M7 will remain and will offer not only emergency access but also cycleway connectivity as described in the design guidelines by Nettleton Tribe. The existing underpass also features drainage infrastructure for conveyance of run-off from upstream catchment, this is further covered in Section 6.3. Minor civil works are required to allow emergency vehicle access to the development, maintain site security and provide cycleway connectivity through the existing underpass. As such ongoing consultation with the Motorway land stakeholders will be required to develop the detailed design of the works.

4.5. Estate Access Road

The proposed site access road has been designed in accordance with Blacktown City Council's standard for industrial roads in regards to widths, cross falls and grades. Due to the minimum amount of fall in the existing terrain in the north-south direction which is the direction that the road is proposed, the longitudinal falls in the roads have been designed at 0.7% which is acceptable in accordance with Council's standards. The road has been designed to incorporate a "saw tooth" pattern with crests and falls, each successive ridge is slightly lower than the adjacent ridge and overall fall is maintained towards the north to an ultimate spill point for the road being low points just west of the proposed bridge

The bend in the road has been designed based on a 60km/h assumed speed limit and the turning movements have been designed to cater for a B-Double articulated vehicle which is the largest vehicle expected to use the access road.

4.6. Carriageway Widths

The access road and bridge have been designed with an overall road reserve width of 23m with a carriageway width as per Council's standards. Although the site would be compatible with a 20.5m wide reserve, WSPT have selected the industrial collector option to provide a better design outcome. Refer Figure 4.1 below.

Road Type	Carriageway (in metres)	Footway each side (in metres)	Total Road Reserve (in metres)	Number of Lanes
SUB-ARTERIAL within Zone No. 5(c)	12.5 separated by 4m median	4.25	Generally 25	4 travel lanes and no parking
INDUSTRIAL Collector within new industrial areas	15.5	3.75	23	2 travel lanes and 2 parking lanes
Other Industrial	13.5	3.5	20.5	2 travel lanes and 2 parking lanes

Figure 4.1 – Access Road Width

4.7. Road Pavements

The access road pavement has been design as a flexible pavement with an asphaltic concrete wearing course in accordance with Council's requirements. Since the pavement is being designed to Council specifications, a design traffic load of $1x10^7$ ESAs has been adopted as per heavy industrial road types shown in Figure 4.2 below. Based on geotechnical testing, it has been established that the subgrade CBR of the site materials is 3% should be used for the purpose of pavement design.

Road Type	AADT	N(ESA)	Kerb Type #
SUB-ARTERIAL	Based on Traffic Counts		150mm kerb & gutter
INDUSTRIAL * Collector & Heavy Duty	-	1×10^7	150mm kerb & gutter
* Light Duty	-	5×10^6	150mm kerb & gutter
COMMERCIAL	-	2×10^6	150mm kerb & gutter

Figure 4.2 – Pavement Thickness Design Criteria

4.8. Pedestrian Facilities and Transportation

The development can be accessed by pedestrian and bicycle traffic from both Ferrers Road to the east of the site and the M7 cycleway to the west. There will be a continuous shared path link from both these roads to the site which will provide safe amenity for pedestrians and cyclists who will be accessing the site for employment or passing through the parklands for leisure.

Similarly to infrastructure throughout the Study Area, pedestrian facilities adjacent to the estate access road or providing connectivity for the greater Western Sydney Parklands cycleway are proposed to incorporate the design principles of Western Sydney Parklands Design Manual, specifically Section 7 -Tracks. Material options, finish and widths are proposed to be finalised with close co-ordination between the Architect, Motorway land stakeholders, Blacktown City Council and the Trust. The shared pedestrian and cyclist access path is proposed from the M7 Westlink shared path to Ferrers Road to the east. The shared path is proposed to be provided in multiple stages. The first, Stage 1 infrastructure works, will include construction of the path parallel and adjacent to the estate access road. The portion of shared path between the estate access road and the M7 Westlink shared path is proposed to be connected at a future stage. The pedestrian and cyclist connectivity is further elaborated on by the development Architects, Nettleton tribe.

5. SITE WORKS

5.1. Bulk Earthworks

The cut and fill quantities for the site result in a site import/shortfall of material in the order of 833484m^3. The distribution of cutting and filling on-site are shown on civil engineering drawings 18652_SSDA_BE01-BE02, Appendix A.

Given geometric site constrains relating to access and layout and the nature of filling within a floodplain the development requires a considerable import of fill. The importing of fill is driven by the disparity between design surface levels and existing site levels. Design surface levels are largely dictated by the stormwater system and major flooding. Where possible, adjustments to site layout and intentional oversizing of stormwater pipe networks and hydraulic features were made to lower design surface levels and thus, lower filling within the development. It is the opinion of the designer that filling onsite is in optimal balance with other engineering factors, and that significant reduction of site levels would negatively impact the stormwater drainage system.

Whilst this is a large amount of shortfall, the amount of fill is required to accommodate the development and at the same time, the development does not place a strain on landfill resources as there will be no soil waste generated from the site and the importing of material from external sources further reduces the impacts on local landfill resources as material that would have otherwise been disposed of can be imported to site.

5.2. Embankment Stability/ Retaining Walls

Given the large size of the masterplan pad sites, we are not proposing to provide retaining walls between the pad sites at this stage. Retaining walls may be required at a later stage but these will be designed as part of any future Development Applications for each individual lot. In this respect, earthworks batters are provided wherever possible as part of the proposed Stage 1 Works. Earthworks batters will be provided at maximum slopes of 1 in 3 as per geotechnical advice by Dirt Doctors PTY LTD, and where short-term construction batters are implemented, these will be protected from erosion by appropriately installed sediment and erosion control measures.

Whilst earthworks batters will be provided wherever possible, retaining walls will be required in some instances where there are significant level changes including where stormwater structures such as channels and basins are proposed. These walls are predominately located adjacent to; the access road, the north-western boundary and the northern emergency overland flow channel. The locations and heights of these retaining walls are shown on the engineering drawings located in Appendix A.

6. STORMWATER MANAGEMENT

6.1. Introduction

In general, the engineering objectives of stormwater management systems is to create a system which based on the architectural layout, incorporates the natural topography and site constraints to produce a cost-effective and appropriate drainage system that meets best industry practice and governing water quality and quantity objectives.

The infrastructure works drainage system was designed to accommodate the concept masterplan layout by Nettleton Tribe with grading and drainage of each individual lot to be co-ordinated with the infrastructure works.

In terms of preparation of the infrastructure works package, each individual lot is proposed to be finished with a prepared, and benched pad. Each lot will be graded to intermediate catch drains which direct stormwater runoff in the interim to sediment and erosion control basins. The sediment and erosion control basins will be located at the downstream end of each individual lot. Each basin is proposed to be maintained, flocculated and dewatered in accordance with the publication "Landcom – Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition March 2004" and Blacktown City Council requirements.

Stub drainage lines will be provided to the individual lots based on predicted internal grading and stormwater layout of the lot based on the masterplan layout, with each lot having between 2-3 stub drainage lines. In the future, each individual lot will connect the local drainage system to the developments drainage system which will drain to the communal basin. Based on the aforementioned road grading and access requirements, the development's concept masterplan layout is graded to form two major drainage catchments, these catchments can be noted on drawing Henry & Hymas civil engineering drawing 18652_SSDA_C250, found in Appendix A.

The southernmost catchment, 24.93 Ha in area, drains via the trunk drainage system beneath the proposed access road to a dual culvert drainage line located between Lots 6 and 7. The line continues to the communal water management basin located at the eastern most extent of the site. Similarly, the northern catchment, 4.71 Ha in area, drains the northern portion of the site via a trunk drainage system that continues beneath the estate access road to enter the water management basin from a northerly direction. Detailed information regarding the design of the aforementioned drainage systems and catchment distributions can be found on drawing Henry & Hymas civil engineering drawing 18652_SSDA_C250-C251 and 18652_SSDA_C101-C109. It is proposed that when the internal access road is dedicated to Council, a right of way easement over the proposed drainage infrastructure that conveys stormwater from the estate road to the communal basin is formed for access.

It is proposed to provide vehicular access to the site via an access road from Ferrers Road. Excluding area inside the development footprint the access road reserve from Ferrers Road encompasses an approximate additional catchment area of 1.626ha. The catchment is proposed to be collected by inground road drainage system and discharged at four outlet locations. Water quality for the external access road catchment is proposed to be managed by end-of-line GPTs fitted with oil baffles to achieve the best balance between the ease of maintenance for Council and the best outcome from an ecological perspective.

In terms of water quality and water quantity, the infrastructure works include a communal water management basin. The basin features a combined on-site stormwater detention storage (OSD) and bioretention basin. The basin has been designed in close coordination with Council's drainage engineers as well as in accordance with Council's water sensitive urban design standard drawings and best industry practice for water management basins.

The development is subject to both minor and major external overland flows originating from run off from upstream catchments. The magnitude of each instance of overland flow has been matched with the precautionary reaction taking with the design, ranging from the formation of boundary bunding to in depth and detailed flood modelling. Located within the 100 ARI flood zone of eastern creek, the development has the potential to be subject to major inundation from flooding. The response to major flooding from Eastern Creek has been detailed in a flood analysis report prepared by BMT. A short summary of the results of the flood analysis will be provided in Section 6.4 below.

Overland flow originating from upstream developments and infrastructures is present on site. Currently, the upstream catchment to the west drains beneath the Westlink M7 motorway via catch drains on either side of the Wallgrove Road access underpass. It is proposed that overland flow originating from this catchment is captured and discharge to former Eskdale Creek Line via a pipe network through the development. An emergency overland flow path will be provided, so as in the event of major flooding events or blockages, upstream overland flow be directed around the development to Eastern creek. It is proposed a right of access to benefit Council be formed over the pipe network.

6.2. Design Criteria

The proposed stormwater system for the development will be designed in accordance and in consideration of the following;

- Institution of Engineers, Australia publication "Australian Rainfall and Runoff" (1987 Edition), Volumes 1 and 2 (AR&R);
- AS 3500.3: National Plumbing and Drainage Code Part 3 – Stormwater Drainage;
- Australian Disaster Resilience Guideline 7-3: Technical flood risk management guideline: Flood hazard, 2014, Australian Institute for Disaster Resilience CC BY-NC;
- Blacktown City Councils relevant planning policies and control plans, specifically;
    - Development Control Plan Part J – Water sensitive urban design and integrated water cycle management;
    - Blacktown City Council's Engineering Guide for Development 2005;
    - Council's Water Sensitive Urban Design Standard Drawings.

The site's stormwater system has been designed in accordance with design recurrence intervals adopted from Council's Engineering Guide for Development, with minor systems designed to convey flows induced by 20-year average recurrence interval (ARI) storm event. As there is no overland flow path proposed between Lots 6 & 7, the in-ground drainage system between the road drainage system and the water management basins has been sized to accommodate stormwater flows up unto the 100-year storm. The road grading is configured with a declining sawtooth arrangement which directs emergency overland flow from the development via the main access road. Major system drainage, such as the stormwater line intercepting overland flows originating from Wallgrove Road, has be designed to convey the 100-year ARI storm event with a 50% blockage factor applied to all inlet pits/headwalls. The grading of the infrastructure works has been formed in such a manner where overland flows induced by the 100 ARI storm event are safely conveyed towards the proposed access road reserve without negatively impacting any proposed flood levels or access paths.

6.3. Drains Modelling Data

For the above-mentioned model, the IFD data used for the rainfall generation is;

	2 ARI	50 ARI		
1hr	30.6(mm/hr)	56.4(mm/hr)	**G**	0.01
12hr	6.67(mm/hr)	12.8(mm/hr)	**F2**	4.30
72hr	2(mm/hr)	4.3(mm/hr)	**F50**	15.81

Figure 6.1 – IFD Data Used for Rainfall Generation

The standard parameters used in the DRAINS model are as follows;

Description	Value
Model for Design and Analysis Run	Rational Method
Rational Method Procedure	ARR87
Soil Type - Normal	3.0
Paved (Impervious) Are Depression Storage	1mm
Supplementary Area Depression Storage	1mm
Grassed (Pervious) Area Depression Storage	5mm (15mm for pre-dev)
Antecedent Moisture Condition (ARI = 1-5 years)	2.5
Antecedent Moisture Condition (ARI = 10-20 years)	3.0
Antecedent Moisture Condition (ARI = 50-100 years)	3.5
Sag Pit Blocking Factor	0.5
On Grade Pit Blocking Factor	0.2

Figure 6.2 – Standard Parameters for Drains Model

6.4. Flooding

As previously discussed, the Study Area is located in a known floodplain area of Eastern Creek, and as such has the potential to be inundated by floodwaters. On this background, a detailed assessment of the surrounding site areas was developed to provide a detailed representation of the local flooding behaviour of the study area as well as the relative impact of the proposed developed in terms of potential changes to existing flood behaviour.

The key outcomes of the detailed assessment provided by BMT Eastern Australia Pty Ltd (BMT) are summarised below:

- All Lot’s finished levels are above the peak 1% AEP flood level from local catchment flooding (with a 0.5 m freeboard allowance). The proposed finish levels of the development provide all Lots with flood immunity up to the Extreme Event.
- The detention basin located at the eastern perimeter of the site has flood immunity at the design 1% AEP flood level. However, the detention basin would be subject to inundation at the Extreme Event flood level.

- Flood impacts are typically confined to within the Site boundaries with no significant impacts on adjacent and upstream/downstream property. Based on the impacts being confirmed to within the WSPT land, flood offset investigation was not performed.
- Whilst there are relative increases in peak flood level for the Extreme Event within the M4 Western Motorway corridor, it is important to recognise that under existing conditions there is still significant depth of flow over the road. Flood Hazard mapping for the Extreme Event under existing conditions showing an extended width of the M4 Western Motorway subject to the highest hazard classes (H5 and H6), which was also prevalent in the post developed scenario. Modelling results of the 0.2% AEP/500ARI event shows that flood immunity to the M4 motorway was maintained with an overall reduction in flood levels directly adjacent to the the M4 southern embankment.
- The development access road provides a minimum 1% AEP flood immunity (up to 0.2% AEP immunity) with a minimum 0.5m to underside of the bridge structure (excluding columns). The service road at the western boundary of the Site linking through to Wallgrove Road provides an alternative emergency flood access route which is flood free up to the Extreme Event.

The effect of flooding on the surrounding ecology have also been investigated by Ecoplanning Pty Ltd. It was concluded that the proposed changes to peak flood levels are unlikely to cause a widespread shift from the existing ecological community which is adapted to periodic flooding to another distinct ecological community. Furthermore, it was generally regarded that the risk to the existing ecology imposed by potential flood offsetting was not outweighed by the possible reduction in flood impacts and associated ecological benefits.

Further investigations were conducted by BMT and Henry and Hymas to determine the impact of the development on the duration of inundation due to flooding. Negligible changes to the overall duration of flood inundation during the major flood event were recorded throughout the flood plain, including heavily vegetated areas. As a result of the investigation it is concluded that the change in the duration of inundation during the 1% AEP event will have minimal impact on the ecology within the 1% AEP floodplain.

6.5. Creek Diversion

The proposed development encroaches into the existing creek line of Eskdale Creek. As such a concept creek-realignment plan has been developed by Henry & Hymas Water Engineering, together with Ecoplanning Pty Ltd, to produce a naturalised meadow with additional benefits over that of the Eskdale Creek prior to the anthropogenic creek which current operates as an artificial watering point for livestock.

The re-alignment proposed to introduce the geomorphology of a wide and flat flow path with semi-regular interspersed with deep pools. Shallow marsh is proposed to dominate the re-alignment's flow path with areas of deep marsh and submerged march confined to the margins of the interspersed pools. The grading has been formed in such a way to activate the flood plain where possible, whilst minimising impacts to existing vegetation that currently provides shade to protect against possible invasion of invasive species such as Typha.

The general concept of the re-alignment is to confine the flow to the swampy meadow area in low flow events and for larger events to activate the surrounding Eastern Creek flood plan similar to the creek conditions prior to existing development on-site. A hydraulic assessment of the existing creek was undertaken to determine the existing creeks hydraulic conditions. In parallel with the existing

creek the proposed realignment was conceptually designed to maintain the conveyance functions for low flow channel (Eskdale Creek) and high flow channel (Eastern Creek floodplain) with no profound hydraulic impact to neighbouring creeks, ecology and developed areas.
For further details regarding the proposed creek realignment design please review the Creek Realignment Design Report prepared by Henry & Hymas Water Engineering dated April 2020.

6.6. Wallgrove Road Overland Flow

It is understood from early consultation with Council's on the 3rd of December 2018 that BCC noted the potential for overland flooding from the upstream catchment west of Wallgrove Road (refer Appendix A, Henry & Hymas engineering drawing 18652_SSDA_EX01). In summary, the proposed strategy below has been prepared to mitigate the risk of flooding from the upstream catchment conveyed to the site by the Wallgrove Road M7 Underpass by providing both an adequately sized drainage line and proposed emergency flow path around the development.

The upstream catchment measures approx. 39.9Ha in area and is highly developed, in addition to the upstream catchment, the downstream systems controlling and retarding run-off from the catchment are likewise, highly developed. The majority of the upstream catchment drains through a trunk drainage system within the catchment to a series of large communal basins. These communal basins discharge via a control structure to the 1050mm diameter stormwater line traversing beneath Wallgrove Road.

The flow from the 1050mm diameter line is then met by several minor flows from the surrounding access areas, controlled flows discharging from M7 retardation basins and further local flows from Wallgrove Road itself. Stormwater is collected in a small sump located immediately downstream of the outlet of the 1050 diameter stormwater line. This small sump connects to, and is drained by a large drainage channel that runs parallel to the existing access road to Wallgrove Road (Refer Figure 6.3 below).

Figure 6.3 – View to Site under M7 Underpass Facing East.

Flow data obtained from hydrographs of Council's XP-RAFTS base model for Eastern Creek place the flow rate at the end of the underpass at 4.4 m^3/s (refer to Appendix E for additional details).

It is proposed to transition the existing drainage channel to a large drainage sump located adjacent to the emergency access point and right of access to the development. The transition channel will be sized to fully accommodate the upstream flow and any flows collected from run-off originating from the underpass itself. The topography in the area will be designed in a way where grading, specifically cross fall across the proposed Wallgrove Road light access road directs any additional flow not wholly contained in the existing channel be directed to the proposed drainage sump. To aid in this, a ridge may need to be formed along the existing boundary in this area. In addition to the major drainage channel, the sump will also collect additional stormwater flows from the surrounding remaining M7 retention basins as well as a small drainage line running beneath the M7 and a small v-drain. The combined flow from the drainage channel and the surrounding minor catchments was 5.2m^3/s (obtained from hydrographs of Council's XP-RAFTS base model for Eastern Creek). It is proposed, where possible, that any works required to collect and convey the aforementioned run-off is restricted to WSPT land.

From preliminary pipe sizing analysis, a 1500mm diameter stormwater line will be proposed to convey the overland flow collected in the proposed sump, through the development, to a proposed channel that discharges into the former Eskdale Creek line. The channel discharge location aims to minimise disruption to the natural environment while introducing regular flows to the disconnect creek section. This outlet can be viewed on Henry & Hymas engineering drawing 18652_SSDA_C101-C109.

Whilst contained within the subdivision, the 1500mm diameter stormwater line will be located within a 3.5m right of access easement that runs within Lot 2 to the proposed estate road access road. The stormwater line will follow the proposed estate road before turning east via Lot 8 (dedicated lot for communal water management basin) to the outlet location. The 1500mm diameter stormwater line, conveyance channel and associated inlet structure will be designed to convey 100-year ARI flow (5.2m^3/s) with a 50% blockage at the pipe inlet.

In the event of a severe blockage (50% or more) or extreme storm event (100 year ARI event and above) the overland flow originating for the upstream catchment will overtop a weir in the proposed drainage sump and flow around the site to the north in an emergency drainage channel. The channel will only be 'active' under the aforementioned conditions as the inlet structure to the 1500dia stormwater line will be appropriately sized. The emergency overland flow channel will connect back to the ultimate original discharge location, Eastern Creek, between the proposed bridge and the existing M4 bridges (refer to Henry & Hymas civil engineering drawings 18652_SSDA_C101-C109, Appendix A). The incorporation of the emergency overland flow channel around the perimeter of the development negates the need for external flows to be directed through the development, further protecting the lots from upstream flooding. The emergency overland flow channel is proposed to be approx. 7.6m in width, with a 2m base and 1 in 4 batters. The channel is proposed to be generally grass lined and accessible for regular maintenance.

6.7. On-site Stormwater Detention

On-site Stormwater Detention (OSD) will be provided to control the peak stormwater flows from the site by temporarily detaining stormwater from major storms in an underground tank which is then discharged to the downstream drainage system at a controlled rate.

As minuted in the aforementioned Pre-SSDA meeting and noted in the SEARS, the development should comply with the BCC's on-site stormwater detention (OSD) policy. In this case, OSD shall be provided to control the peak flow of stormwater generated from the development in accordance with Development Control Plan (DCP) Part J 2015, and with Blacktown City Council's Deemed to Comply OSD spreadsheet tool. For planning purposes, the catchments draining to the OSD (including the entire OSD area itself) total 33.36ha with 1.813Ha of area bypassing the OSD (approx. 5.4%).

Using the Deemed to Comply OSD spreadsheet tool, the proposed disturbed areas detailed on drawing 18652_SSDA_C250-C251 yield a required OSD volume of 15,576m^3 for the new development. The required OSD volumes are proposed to be detained in an above-ground basin located at the easterly extent of the proposed development, adjacent to the high-pressure gas main. It is proposed that the detention tank be constructed from earth batters and specifically design concrete outlet structures in accordance with best industry practice and Blacktown City Council - Water Sensitive Urban Design (WSUD) standard drawings. As detailed in the Deemed to Comply OSD spreadsheet tool the OSD volume is managed according to ARI discharge (1.5 year and 100 year) with a dual orifice and weir system. Where 15576m^3 of OSD storage is detained below the 100-year ARI emergency overflow weir and 10270m^3 below the 1.5-year ARI weir. Details regarding the proposed water management basin are provided on drawing 18652_SSDA_C240-C241. The basin's discharge overflow weir will be constructed with a concrete cut of wall and heavy scour protect/armoured embankment, and connected to a specially designed outlet channel which connects to Reedy Creek. The spreadsheet has been adjusted to take into account the downstream water level imposed by the 100 year ARI flood event, with input denoted "RL of obvert of outlet pipe" modified to be 150mm below the 100 year ARI flood level at the discharge area. The impact of applying this flood level increased the OSD storage volume by 1.8%.

Where possible and within site constrains, the design of the on-site detention storage area in water management basins was designed in accordance with, and to fulfil the intent of BCC's Water Sensitive Urban Design (WSUD) Standard Drawings, with particular reference to:

- Surface of bioretention filter system elevated 1m above the basin outlet.
- 1.5-year ARI detention volumes retarded with orifice and weir arrangement which later drains through the 100-year ARI sized orifice (sized with deemed to comply spreadsheet, for the 1.5-year orifice allowances were made for flows exiting the bioretention system and the subsoil draining the OSD base which bypass the orifices.).
- 1.5-year ARI orifices protected by maxi mesh track screen 20 x orifice area.
- 100-year ARI inlet pit protected by custom formed hinged surcharge style grate. Following discussions with Blacktown City Council's Drainage Engineers a trash rack was not placed in-front of the 100-year orifice.
- Appropriate access path (minimum 4m) provided for maintenance purposes, refer engineering drawing 18652_SSDA_C241. Concrete heavy-duty accessways are to be specified for all corners, ramps and turning bays in consideration for in-frequent tracked maintenance vehicles accessing Lot 8 from the access road. Road has been designed to

accommodate an 8.9m eductor truck/combi service vehicle, turning paths are provided on engineering drawing 18652_SSDA_C609.

- Appropriately sized emergency overflow weir with rip rap scour protection designed in accordance with Landcom – Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition March 2004.

6.8. Water Quality

6.8.1. Targets

Pollution and contamination dislodged or inherent to and in stormwater and stormwater run-off from urban developments have the potential to damage the ecology and health of local creeks and waterways. As such stormwater quality improvement devices (SQIDs) that aim to minimise pollution during construction and operation of the development have been incorporated into the overall stormwater management design. These devices have been sized, specified and designed in accordance with Council's (DCP) Part J 2015, and Council's water sensitive urban design standard drawings. A summary of the implements SQIDs can be seen in later sections.

The performance of the stormwater quality improvement devices (SQIDs) in mitigating pollution from urban development can be assessed by simulating a post developed pollutant reduction rate for the stormwater system as a whole. In accordance with part J (2016) all commercial developments must achieve a minimum percentage reduction of the post developed average annual loads of pollutants in accordance with the Table 6.4 below:

Pollutant	% Post Development Reduction Target Blacktown City Council
Litter / Gross pollutants	90
Total Suspended Solids	85
Total Phosphorous	65
Total Nitrogen	45

Table 6.4 – Water Quality Targets

As previously mentioned, the external access road providing vehicular access to the development has been excluded from the catchments included in the MUSIC model. In lue of a full treatment train approach the proposed external access road catchment is proposed to be treated via GPTs fitted with oil baffles in an end of line arrangement. The strategy aims to draw on a current industry practice approach rather than meeting specific target removal rates. We believe this option provides the best balance between the ease of maintenance for Council and the best outcome from an ecological perspective. Specification for the different GPTs has been listed in the revised design report as well as information regarding the specific catchments and GPT treatable flow rates.

6.8.2. SQIDs – Stormwater Quality Improvement Devices

6.8.2.1. Primary Treatment - Gross Pollutant Traps (GPTs)

As part of an effective treatment train for the site and greater stormwater system as a whole, newly developed hardstand and landscaped areas as well as existing areas will be primarily treated via a proprietary gross pollutant trap (GPT) or custom combined GPT and Siltation Pond. As the body of the development is roughly divided into two catchments, north and south. A GPT is proposed for each of the inlets to the on-site stormwater detention basin prior to the bioretention basin to protect gross pollutants and suspended solids from clogging the filter media. Areas not draining to the proposed estate water management basin, such as the access road reserve, will be treated for gross pollutants, suspended solids and hydrocarbons by GPTs. All GPTs draining to either the bioretention filter media or estate access road will be fitted with an oil battle to remove hydrocarbons within the stormwater run-off generated by developed site areas.

The GPTs have been appropriately located following discussions with Council's Drainage Engineers. To accommodate for the GPTs, the stormwater lines throughout the development have been designed to direct stormwater flows, with minimal bypass to the GPTs. The stormwater lines meet at a diversion pit which will split the treatable flow from the full piped flow for treatment by the GPT. In accordance with Council's WSUD standard drawings, the GPTs are opportunely placed to both direct the treatable flow rate to the bioretention and protect gross pollutants and suspended solids from clogging the bioretention. The custom GPT protecting the southern inlet to the bioretention basin has been designed in close cooperation with Council's Drainage Engineers. The GPT features a long custom track rack and oil/hydrocarbon baffle and retention structure. Details for the custom GPT are shown on engineering drawings 18652_SSDA_C107, C242, C201.

The GPTs selected are based on commercial availability, treatable flow rates, treatment efficiency, maintainability and respective catchment sizes. The proposed GPTs to primarily treat the stormwater flows are listed in the table below as well as corresponding information relating to their respective catchments and designations on engineering drawings.

Number of GPT	Catchment designation - name	Catchment Area	GTP Specification
WQ-2	Subdivision North	4.712ha	Rocla CDS P2018
WQ-13	Access Road Reserve - C7	0.187ha	Rocla CDS P0708
WQ-14	Access Road Reserve - C9	0.378ha	Rocla CDS P0708
WQ-15	Access Road Reserve - C10	0.759ha	Rocla CDS P1012
WQ-16	Access Road Reserve - C11	0.488ha	Rocla CDS P1009
Custom GPT, refer drawing C242	Subdivision South	24.926ha	NA

Notes:

- Number of GPT can be found on engineering drawings C101-C109, drawing C200 and C242.
- Catchment Designation can be found on engineering drawing C250-C251.
- Full calculations table including treatable flow rates and diversion flow rates can be found in Appendix B.

An appropriate maintenance schedule which details the specific removal method and frequency of gross pollutants from the GPTs is provided in Appendix B. In conjunction with Optimal Stormwater, a signed and dated maintenance schedule specially tailored for each specific CDS Unit has been provided in Appendix B. A maintenance schedule specially tailored for ongoing operation of the custom GPT, siltation trap and oil retention structure has also been provided in Appendix B.

6.8.2.2. Bio-retention

Where possible and within site constrains, the design of the bioretention filter system within the water management basins was designed in accordance with, and to fulfil the intent of BCC's Water Sensitive Urban Design Standard Drawings, with particular reference to:

- Surface of bioretention filter system elevated 1m above outlet level;
- Flows directed to the bioretention limited to the treatable flow rate of the treatment system (aforementioned);
- Partially permanently saturated transition zone to increase the longevity and establishment of biofilm, in addition to ensuring adequate water sources for planted macrophilic plant species;
- Appropriate depth of filter media, transition and drainage layers as outlined in typical bioretention filter detail in Council's Water Sensitive Urban Design Standard Drawings (refer to Figure 6.5). Filter media is to be tested as Measurement of Hydraulic Conductivity manual in Appendix C;
- Appropriate access and maintenance paths (minimum 4m), refer to engineering drawings C107 and C242, C608, standard drawings and maintenance schedule;
- Adequate dispersal and retarding distribution systems in the form of a system of up-flow pits, as well as, permeable stormwater pipes.

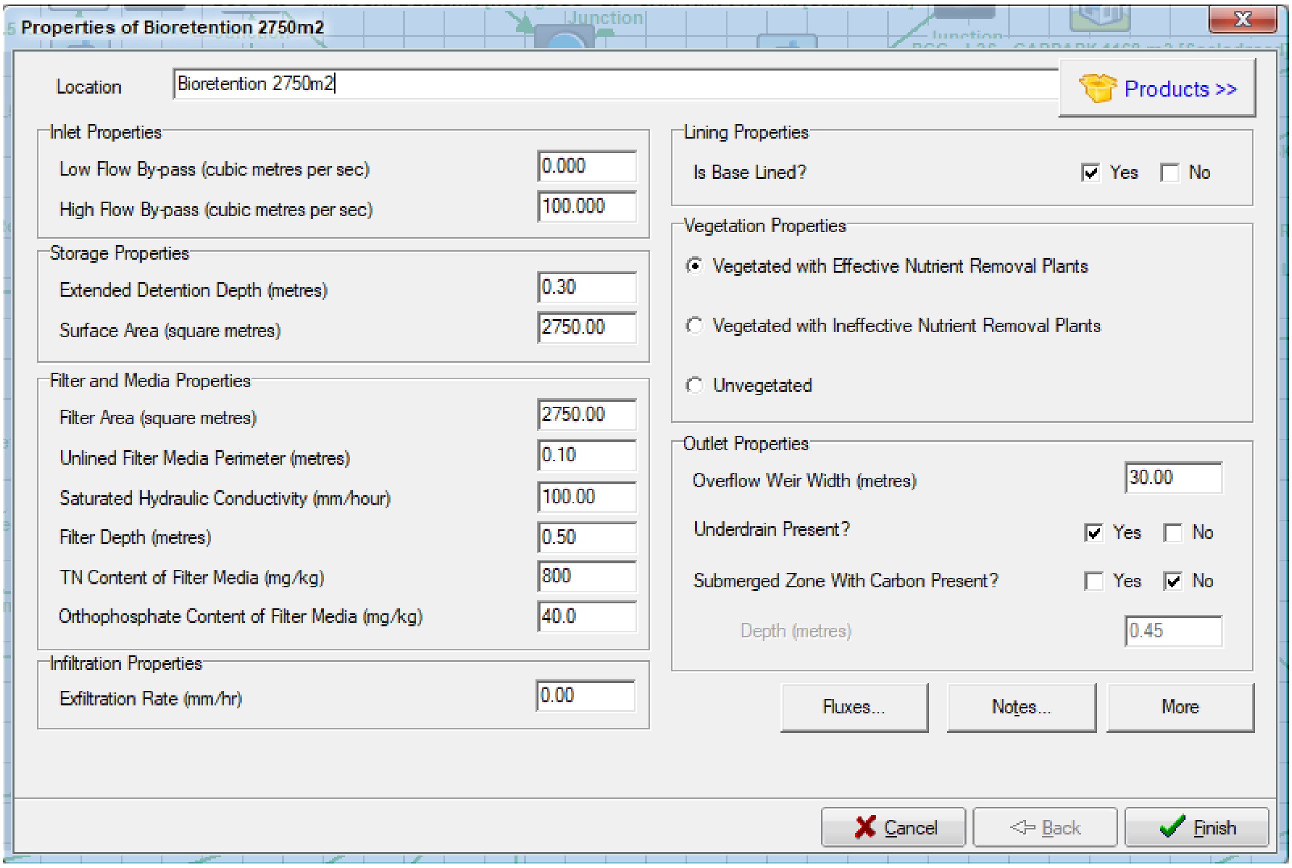

Figure 6.5: Inputs for bioretention in MUSIC

Adequate dispersal and retarding distribution systems have been provided for the bioretention system, specified in the in the form of upstream inlet/siltation pits/sumps, up-flow distribution systems and permeable piped low flow dispersal systems. The north and south inlets to the water quality management basin are different hydraulically due to the quantity of stormwater entering the basin, and their level respective to the bioretention surface. As such the bioretention's distribution system has been customised to fit the underlining hydraulic conditions of entry. The south bioretention entrance, substantially larger in treatable flow rate, proposes to distribute stormwater using multiple permeable pipes and up-flow pits. The up-flow pits' surface level is proposed to decline in height from the first up-flow pit to the last to promote equal distribution of stormwater at the bioretention surface. The north bioretention, smaller in area, has a more traditional and simplistic stormwater distribution system with permeable stormwater pipes and up flow pits which sit at a single level. Both the northern and southern bioretention inlet systems have been designed in accordance with Council's WSUD standard drawings.

Additional information and details regarding the bioretention systems is detailed on Henry & Hymas engineering drawing 18652_SSDA_C107, 18652_SSDA_C201 and 18652_SSDA_C240.

Preliminary sizing using water quality modelling software estimates surface area of bioretention required to fulfil Council's water quality targets is 2,750m^2.

6.8.3. Water Quality Modelling - MUSIC

In order to better determine the conceptual design of the water quality treatment trains and to ensure the treatment trains satisfy the reduction parameters outlined in Table 6.4, a Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was developed.

The MUSIC model was set up with the in-built rainfall station, time period data, evapotranspiration data, source node data, treatment node data and run-off parameters provided by the BCC council MUSIC link system. A schematic of the MUSIC model can be viewed above in Figure 6.6.The schematic illustrates the interrelationship between source nodes (catchments) and treatment nodes (water quality treatment measures) for the catchment.

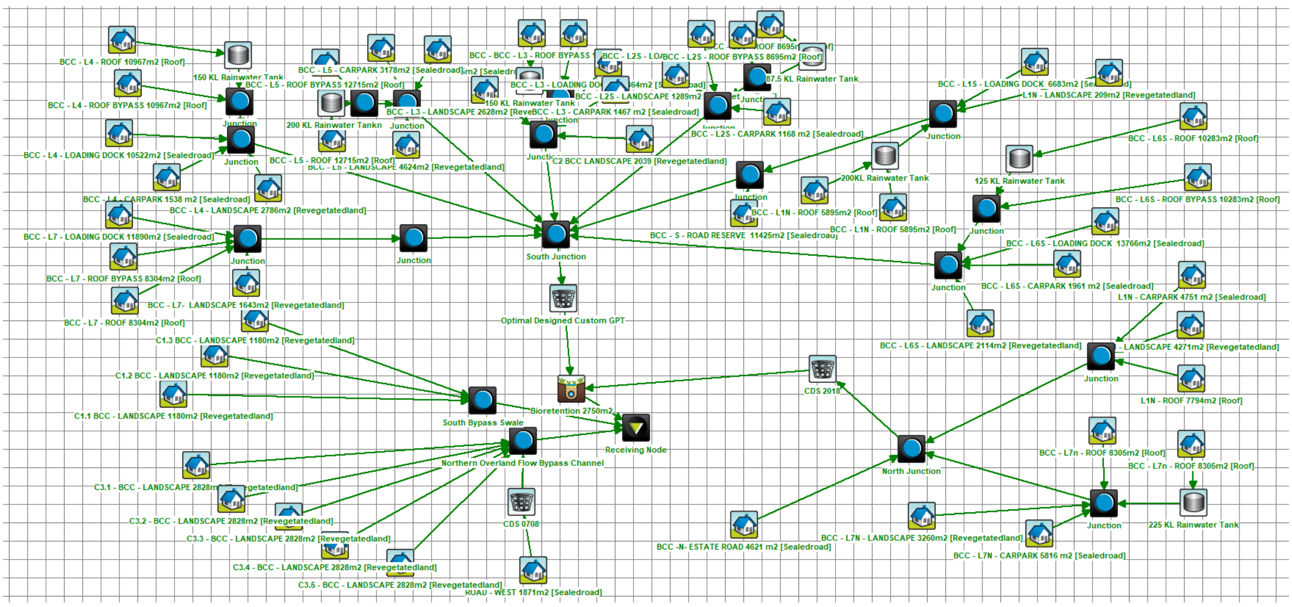

Figure 6.6 Schematic of Music Model.

For non-standard GPT a treatment rate for Total Suspended Solids (TSS) and Gross Pollutants (GP) is required to quantify the systems effectiveness in removing pollutants in the MUSIC model. Following discussions with Council's Drainage Engineers on the removal effectiveness of the 25% for GP and 20% for TSS was agreed and used for MUSIC modelling. Whilst it is understood the systems will capture pollutants at a higher efficiently than that rates agreed with Council, the comparatively low removal rates are attributed to the systems novel/custom nature and to ensure the bioretention is appropriately sized.

A electronic copy of the Model for Urban Stormwater Improvement Conceptualisation MUSIC model is provided in Appendix F for review.

6.8.3.1. Results

The resultant post developed pollutants calculated by the simulation in Table 6.7 below. With the implementation of the aforementioned stormwater quality improvement (SQIDs) devices, the resultant post developed pollutant loads have been reduced below the reduction target for all targeted pollutants.

Pollutant	% Post Development Reduction Target Blacktown City Council	% Post Development Reduction Reached
Litter / Gross pollutants	90	100
Total Suspended Solids	85	85.4
Total Phosphorous	65	66.2
Total Nitrogen	45	51.4

Table 6.7– Resultant post development pollutant reductions

6.8.3.2. Rainwater Tanks - Water Reuse

To assist with water conservation, water reuse is generally required for all new developments as outlined in Council's Development Control Plan Part J. The requirements state that for industrial/commercial developments a minimum of 80% of the non-potable water demand on site is to be met through rainwater. Water demand must allow for internal rainwater reuse at the rate of 0.1 KL/day per toilet/urinal and external landscape watering (excluding turf areas) at rate of 0.4 kL/year/m^2 as PET-Rain.

As water reuse will likely form part of any effective water quality treatment train for the proposed development, rainwater tanks that harvest and store rainwater for re-use were estimated to improve the accuracy the overall water quality modelling for the site. Using MUSIC water quality modelling software, a rainwater tank size that satisfies 80% of the non-potable water demand of the development was estimated. Several assumptions were made when sizing the rainwater tanks. These assumptions are fundamental for determining the water demand of each building layout concept, and thus the storage volume. These assumptions include;

- Roof catchments and potential irrigation areas are in similar size and arrangement to the concept masterplan by Nettleton Tribe.
- 50% of the roof area of a specific roof catchment will drain to the rainwater tank;

- 100% of landscaped area within a lot boundary will be drip irrigated using harvested water. Remaining landscaped areas throughout the development are assumed to be turfed, mulched or planted with matured trees that do not required irrigation;
- Approximately 28 toilets/urinals within each newly development lot are proposed to operate with harvested water;
- To allow for anaerobic zones in the rainwater tank, a 20% loss in tank volume is assumed in the water quality model.

A summary of the potential estimated rainwater tank size for each lot can be seen in Figure 6.8 below. Please note the below tank sizes are estimations formed to improve the accuracy of the water quality modelling, and are conceptual in nature.

Lot number	Estimated Rainwater tank size
1	**200KL**
2	**100KL**
3	**150KL**
4	**150KL**
5	**200kl**
6	**125kl**
7	**225KL**

Figure 6.8– Estimated rainwater tank size

A electronic copy of the Model for Urban Stormwater Improvement Conceptualisation MUSIC model is provided in Appendix F.

7. SEDIMENT AND EROSION CONTROL

During construction, appropriate sediment and erosion control measures need to be implemented to ensure that downstream receiving waters are not adversely impacted as a result of construction activities. The engineering drawings 18652_SSDA_SE01-SE03 by Henry & Hymas outline appropriately designed and detailed measures to mitigate against this risk. These measures have been designed in accordance with the requirements of the publication “Landcom – Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition March 2004” and Blacktown City Council requirements.

8. APPENDICES

APPENDIX A
Engineering Drawings

APPENDIX B
GPT treatable flow rate calculation table
GPT Maintenance Manuals

- *CDS Unit 2018*
- *CDS Unit 1012*
- *CDS Unit 1009*
- *CDS Unit 0708*
- *Maintenance Schedule South GPT 06.05.2020 (custom)*
- *Bioretention (General)*

APPENDIX C
In Situ Measurement of Hydraulic Conductivity for Bioretention

APPENDIX D
OSD Deemed to Comply Spreadsheet PDF and EXCEL

APPENDIX E
Hydrographs of BCC XP-RAFTS base model for Eastern Creek

APPENDIX F
Electronic model of Model for Urban Stormwater Improvement Conceptualisation (MUSIC)

Appendix A

Appendix B

henry&hymas

Document Name: GPT Sizing Spreadsheet - 05.05.2020
Project Number: 18652
Project Name: Light Horse Interchange
Engineer (lead): Andrew Francis
Date: 05.05.2020

Number of GPT	Catchment designation - name	Catchment Area	1- Year Flow (m^3/s)	6 Month Flow (m^3/s)	3 Month Flow (m^3/s)	GTP Specification	GPT Tested Treatable flow rate (m^3/s)	Diversion flow rate (m^3/s)
WQ-2	Subdivision North	4.712	0.942	0.693	0.471	Rocla CDS P2018	0.530	0.693*
WQ-13	Access Road Reserve - C7	0.187ha	0.039	0.029	0.020	Rocla CDS P0708	0.053	0.03*
WQ-14	Access Road Reserve - C9	0.378ha	0.079	0.059	0.040	Rocal CDS P0708	0.053	0.06*
WQ-15	Access Road Reserve - C10	0.759ha	0.159	0.119	0.080	Rocal CDS P1012	0.140	0.12*
WQ-16	Access Road Reserve - C11	0.488ha	0.102	0.077	0.051	Rocal CDS P1009	0.110	0.076*

* Denoted diversion flow rate requested by Council Drainage Engineers, dated 20 March 2020

South Bio GPT, Refer Drawing C242	Subdivision South	24.926	4.61	3.46	2.31	NA	NA	2.31*

* Denoted diversion flow rate requested by Council Drainage Engineers, dated 20 March 2020

optimal stormwater

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CDS Unit Cleaning: P2018

Property: Light Horse Interchange Business hub
Location: North of OSD basin
Designer: Henry & Hymas Consulting Engineers – NW

GPS: 301860.114, 6257801.958
Signature: [signature]
23/4/2020.

Monitoring:

Remove circular 600mm diameter manhole in the centre of the CDS lid. It will likely have 2 bolts requiring a 17 or 19mm socket, plus a gatic lifter. It could also have a checkerplate steel lid, requiring a Council key to open the padlock. Or it could have gatics.

Use a ***Survey Staff*** (7m is best) to measure the depth from ground to pollution.

Use the ***Data Sheet*** for the device to determine how full it is, and if cleaning is required.

Regular Cleaning: (to be confirmed through monitoring, usually every 3-6 montths)

Open 600mm manhole lid, or other manhole access over the device (depends on device)

Use the ***Survey Staff*** and ***Data Sheet*** to measure and record the volume of pollution.

Decant water to grassed area nearby if possible (water the largest area possible, don't concentrate)(or find a nearby area for decanting water to, or remove then decant back into device). Take a photo before you start suction cleaning. If there is a low flow, enter the diversion chamber and open the "**capped Low Flow Bypass Pipe**", and put a sandbag or two over the CDS inlet to bypass low flows. NOTE: this is a confined space, so use a gas detector and full confined spaces entry procedures.

Suck pollution from the sump (via **sucker truck**). You shouldn't have to clean the screens, but jet them if required.

Alternatively, don't dewater, remove the full lid, and just use a clamshell grab to remove the pollution.

Replace lids, then recycle or dispose of waste.

optimal stormwater

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Annual or Comprehensive Clean: (once per year)

23.04.2020

Remove the CDS lid. Remove the diversion chamber lid.

Suction clean as per a "regular suction clean". Take photo after dewatering showing pollution, take another photo after cleaning to show an empty sump and clean screens.

Using a gas detector and full confined spaces entry procedures, enter the diversion chamber and inspect for any debris or sediment in upstream pipes and diversion chamber. Using the survey staff, measure the height of sediment (if any) behind the screens. If more than 20% of the way up the screens, send a man and suction hose behind the screens to suck it clean.

Grease lids annually, both CDS lids and any gatic lids.

Replace the lids, recycle or dispose of waste.

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CDS Unit Cleaning: P1012

Property: Light Horse Interchange Business hub
Location: External Access Road
Designer: Henry & Hymas Consulting Engineers – NW

GPS: 302178.568, 6257857.455
Signature:

NICHOLAS WETZLAR

Monitoring:

Remove circular 600mm diameter manhole in the centre of the CDS lid. It will likely have 2 bolts requiring a 17 or 19mm socket, plus a gatic lifter.

Use a ***Survey Staff*** (7m is best) to measure the depth from ground to pollution.

Use the ***Data Sheet*** for the device to determine how full it is, and if cleaning is required.

Regular Cleaning:

Open 600mm manhole lid.

Use the ***Survey Staff*** and ***Data Sheet*** to measure and record the percentage full.

Decant water to grassed area nearby if possible (water the largest area possible, don't concentrate it, or find a site nearby for decanting water to, or remove then decant back into device). Take a photo before you start suction cleaning. If there is a low flow, enter the diversion chamber and open the "**Capped Lowflow Bypass Pipe**", and put a sandbag over the CDS inlet to bypass low flows. NOTE: this is a confined space, so use a gas detector and full confined spaces entry procedures.

Suck pollution from the sump (via **sucker truck**). You shouldn't have to clean the screens, but jet them if required. Take a photo again when the sump is clean.

Replace lids, (make sure the site is clean) then recycle or dispose of waste.

Annual or Comprehensive Clean: (once per year)

Remove the smaller central lid, and the larger outer lid. Remove the diversion chamber lid.

Suction clean as per a "regular clean". Take photo after dewatering showing pollution, take another photo after cleaning to show an empty sump and clean screens.

Using a gas detector and full confined spaces entry procedures, enter the diversion chamber and inspect for any debris or sediment in upstream pipes and diversion chamber. Using a survey staff, measure the height of sediment (if any) behind the screens. If more than 20% of the way up the screens, then suck out, or raise the screen cage and clean behind it.

Grease any gatic lids, ensure all bolts are present, ensure cap is back on.

Replace the lids, (ensure the site is clean) recycle or dispose of waste.

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CDS Unit Cleaning: P1009

Property: Light Horse Interchange Business hub
Location: External Access Road
Designer: Henry & Hymas Consulting Engineers – NW

GPS: 302340.211, 6257836.686
Signature:
NICHOLAS WETZLAR

Monitoring:

Remove circular 600mm diameter manhole in the centre of the CDS lid. It will likely have 2 bolts requiring a 17 or 19mm socket, plus a gatic lifter.

Use a ***Survey Staff*** (7m is best) to measure the depth from ground to pollution.

Use the ***Data Sheet*** for the device to determine how full it is, and if cleaning is required.

Regular Cleaning:

Open 600mm manhole lid.

Use the ***Survey Staff*** and ***Data Sheet*** to measure and record the percentage full.

Decant water to grassed area nearby if possible (water the largest area possible, don't concentrate it, or find a site nearby for decanting water to, or remove then decant back into device). Take a photo before you start suction cleaning. If there is a low flow, enter the diversion chamber and open the "**Capped Lowflow Bypass Pipe**", and put a sandbag over the CDS inlet to bypass low flows. NOTE: this is a confined space, so use a gas detector and full confined spaces entry procedures.

Suck pollution from the sump (via **sucker truck**). You shouldn't have to clean the screens, but jet them if required. Take a photo again when the sump is clean.

Replace lids, (make sure the site is clean) then recycle or dispose of waste.

Annual or Comprehensive Clean: (once per year)

Remove the smaller central lid, and the larger outer lid. Remove the diversion chamber lid.

Suction clean as per a "regular clean". Take photo after dewatering showing pollution, take another photo after cleaning to show an empty sump and clean screens.

Using a gas detector and full confined spaces entry procedures, enter the diversion chamber and inspect for any debris or sediment in upstream pipes and diversion chamber. Using a survey staff, measure the height of sediment (if any) behind the screens. If more than 20% of the way up the screens, then suck out, or raise the screen cage and clean behind it.

Grease any gatic lids, ensure all bolts are present, ensure cap is back on.

Replace the lids, (ensure the site is clean) recycle or dispose of waste.

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CDS Unit Cleaning: P0708 – 2 Units

Property: Light Horse Interchange Business hub
Location: External Access Road

GPS: 301839.061, 6257938.534
GPS: 301910.387, 6257927.138

Designer: Henry & Hymas Consulting Engineers – NW

Signature:

NICHOLAS WETZLER

Monitoring:

Remove circular 600mm diameter manhole in the centre of the CDS lid. It will likely have 2 bolts requiring a 17 or 19mm socket, plus a gatic lifter.

Use a ***Survey Staff*** (7m is best) to measure the depth from ground to pollution.

Use the ***Data Sheet*** for the device to determine how full it is, and if cleaning is required.

Regular Cleaning:

Open 600mm manhole lid.

Use the ***Survey Staff*** and ***Data Sheet*** to measure and record the Percentage full.

Decant water to grassed area nearby if possible (water the largest area possible, don't concentrate the water, or find a site that's close for decanting water to, or remove then decant back into device).

Take a photo once dewatered. Suck pollution from the sump (via **sucker truck**). Take a photo when empty.

Replace lids, (make sure site is clean including 10m around device), then recycle or dispose of waste.

Annual or Comprehensive Clean: (once per year)

Smaller central lid, and larger outer lid to both be removed.

Use the ***Survey Staff*** and ***Data Sheet*** to measure and record the percentage full.

Remove the internal fibreglass or polymer riser, so you can inspect the weir and outlet hole in the slab. Use the survey staff to measure any accumulated sediments behind the screen. If there is more than 200mm of sediment, this needs to be sucked out as well.

Suction clean as per a "regular clean". Take photo after dewatering showing pollution, take another photo after cleaning to show an empty sump and clean screens.

Inspect and clean the weir and surrounds, and behind the screens if required. Replace the riser, replace the lids, (clean the site), then recycle or dispose of waste. **Grease** lids annually.

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Custom GPT Cleaning

Property: Light Horse Interchange Business hub
Location: Southern end of OSD/Bioretention
Designer: Henry & Hymas Consulting Engineers – NW

Signature: 06.05.20.

Monitoring: **Trash Rack & Oil Retention Structure.**

Trash Rack

View the racks from upstream and downstream.

Use the ***Data Sheet*** for the device to determine how full it is, and if cleaning is required.

Oil Retention Structure

Open the sealed access lid and visually inspect quantity of oils. Inspect orifice opening adjacent to baffle.

Use the ***Data Sheet*** for the device to determine how full it is, and if cleaning is required.

Unblocking: **Trash Rack & Oil Retention Structure.**

Trash Rack

If time permits when monitoring, use a rake or broom to push the pollution away from the rack. This is to free up rack area for the start of the next event.

Clear an area of rack. Clear pollution to the sides if possible.

Oil Retention Structure

Inspect orifice opening adjacent to baffle. Remove debris from maxi-mesh screen and ensure orifice is free flowing. Inspect outlet of structure that drains to bioretention. Ensure outlet is free of debris and free flowing.

Regular Cleaning: **Defined as 3 Month Trash rack and 6 Month Oil Retention Structure.**

Trash Rack

Use details on the ***Data Sheet*** to measure and record the volume of pollution. Estimate the volume of pollution in m^3. Take a photo before cleaning.

Clear pollution from the rack, and allow any pooled water to drain through so water levels either side of the rack stabilise Ideally, unblock the device the day before cleaning.

Suck/skim pollution from the rack, predominately offline storage area (via **sucker truck**). Take a photo after the cleaning. Perform unblocking procedures.

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Oil Retention Structure

Use details on the ***Data Sheet*** to measure and record the volume of pollution. Estimate the volume of pollution removed in Litres. Take a photo before cleaning.

Suck oils and hydrocarbons from the retention device (via **sucker truck or equivalent**). Take a photo after the cleaning. This may be enhance by the use of oil absorbent material.

Perform unblocking procedures.

Comprehensive Clean: **Defined as every 2 years for Trash rack and Oil Retention Structure**

Clean oil retention structure first.

Use details on the ***Data Sheet*** to measure and record the volume of pollution. Estimate the volume of pollution removed in Litres. Take a photo before cleaning.

Suck oils and hydrocarbons from the retention device (via **sucker truck or equivalent**).

Carefully access oil retention structure and pressure/manually wash baffles, inlets and outlets. Ensure to trap material to avoid oils entering the bioretention.

Suck oils and hydrocarbons from the retention device (via **sucker truck or equivalent**).

Perform unblocking procedures.

Trash Rack

As per above for regular clean.

Remove large materials for drying on ramp. Dry materials and remove from site.

De-water GPT. Drain water to OSD outlet or if water is suitable, water the bioretention plants. Using a skimming method drain from top down to only a sucker truck capacity of water remains. Avoid draining gross pollutants and sediments to OSD outlet.

Remove remaining sediments and gross pollutants via sucker truck. Remove heavier sediments via manual means following maximum removal via sucker truck. Remove sediments and gross pollutants from site.

Pressure wash and broom remaining sediments and gross pollutants to deep sump areas and remove via sucker truck. Pressure wash screen and remove lodged debris.

Additionally, spend 30 minutes tidying up the local vegetation around the device and on any access tracks.

Additionally, spend 30 minutes in the creek downstream doing a litter pick of bypassed litter.

Note any rack damage, corrosion, vandalism, areas of bypassing, etc. Photograph and report to Council for their action.

1 LONG TERM MAINTENANCE TASKS

1.1 Schedule of visits

1.1.1 Schedule of Site Visits (Regular Inspec & Maint)	
Purpose of visit	Frequency
Inspection	Regular inspection and maintenance should be carried out to ensure the system functions as designed. It is recommended that these checks be undertaken on a three monthly basis during the initial period of operating the system. A less frequent schedule might be determined after the system has established.
Maintenance	

1.2 Tasks

The scope of maintenance tasks should include verifying the function and condition of the following elements:

- Filter media
- Horticultural
- Drainage infrastructure
- Other routine tasks

1.2.1 FILTER MEDIA TASKS	
Sediment deposition	Remove sediment build up from forebays in raingardens and from the surface of bioretention street trees. Frequency – 3 MONTHLY AFTER RAIN
Holes or scour	Infill any holes in the filter media. Check for erosion or scour and repair, provide energy dissipation (e.g. rocks and pebbles at inlet) if necessary. Frequency – 3 MONTHLY AFTER RAIN
Filter media surface porosity	Inspect for the accumulation of an impermeable layer (such as oily or clayey sediment) that may have formed on the surface of the filter media. A symptom may be that water remains ponded in the raingarden or tree pit for more than a few hours after a rain event. Repair minor accumulations by raking away any mulch on the surface and scarifying the surface of the filter media between plants. For bioretention tree pits without understorey vegetation, any accumulation of leaf litter should be removed to help maintain the surface porosity of the filter media. Frequency – 3 MONTHLY AFTER RAIN
Litter Control	Check for litter (including organic litter) in and around treatment areas. Remove both organic and anthropogenic litter to ensure flow paths and infiltration through the filter media are not hindered. Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS

1.2.2 HORTICULTURAL TASKS	
Pests and Diseases	Assess plants for disease, pest infection, stunted growth or senescent plants. Treat or replace as necessary. Reduced plant density reduces pollutant removal and infiltration performance. Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS
Maintain original plant densities	Infill planting: Between 6 and 10 plants per square metre should (depending on species) be adequate to maintain a density where the plant's roots touch each other. Planting should be evenly spaced to help prevent scouring due to a concentration of flow. Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS
Weeds	It is important to identify the presence of any rapidly spreading weeds as they occur. The presence of such weeds can reduce dominant species distributions and diminish aesthetics. Weed species can also compromise the systems long term performance. Inspect for and manually remove weed species. Application of herbicide should be limited to a wand or restrictive spot spraying due to the fact that raingardens and bioretention tree pits are directly connected to the stormwater system. Frequency – 3 MONTHLY OR AS DESIRED FOR AESTHETICS
1.2.3 DRAINAGE TASKS	
Perforated pipe	Ensure that perforated pipes are not blocked to prevent filter media and plants from becoming waterlogged. A small steady clear flow of water may be observed discharging from the perforated pipe at its connection into the downstream pit some hours after rainfall. Note that smaller rainfall events after dry weather may be completely absorbed by the filter media and not result in flow. Remote camera (e.g. CCTV) inspection of pipelines for blockage and structural integrity could be useful. Frequency – 6 MONTHLY AFTER RAIN
High flow inlet pits, overflow pits and other stormwater junction pits	Ensure inflow areas and grates over pits are clear of litter and debris and in good and safe condition. A blocked grate would cause nuisance flooding of streets. Inspect for dislodged or damaged pit covers and ensure general structural integrity. Remove sediment from pits and entry sites etc. (likely to be an irregular occurrence in mature catchment). Frequency – MONTHLY AND OCCASIONALLY AFTER RAIN
1.2.4 OTHER ROUTINE TASKS	
Inspection after rainfall	Occasionally observe raingarden or bioretention tree pit after a rainfall event to check infiltration. Identify signs of poor drainage (extended ponding on the filter media surface). If poor drainage is identified, check landuse and assess whether is has altered from design capacity (e.g. unusually high sediment loads may require installation of a sediment forebay). Frequency – TWICE A YEAR AFTER RAIN

1.2.5 FORM (REGULAR INSPECTION & MAINTENANCE)			
Location	Raingarden/Tree Pit		
Site Visit Date:		Site Visit By:	
Weather:			
Purpose of the Site Visit	Routine Inspection	☐	Complete section 1 (below)
	Routine Maintenance	☐	Complete sections 1 and 2 (below)

NOTE: Where maintenance is required ('yes' in Section 2), details should be recorded in the 'Additional Comments' section at the end of this document.

1. Filter media	Section 1		Section 2	
*In addition to regular inspections, it is recommended that inspection for damage and blockage is made after significant rainfall events that might occur once or twice a year.	Maintenance Required?		Maintenance Performed	
	Yes	No	Yes	No
Filter media (CIRCLE – pooling water/accumulation of silt & clay layer/scour/holes/sediment build up)	☐	☐	☐	☐
Litter (CIRCLE – large debris/accumulated vegetation/anthropogenic)	☐	☐	☐	☐
2. Vegetation				
Vegetation health (CIRCLE – signs of disease/pests/poor growth)	☐	☐	☐	☐
Vegetation densities (CIRCLE – low densities– infill planting required)	☐	☐	☐	☐
Build up of organic matter, leaf litter (CIRCLE – requires removal) BIORETENTION TREE PITS ONLY	☐	☐	☐	☐
Weeds (CIRCLE – isolated plants/infestation) (SPECIES – ……………………………………………………………..)	☐	☐	☐	☐

3. Pits, pipes and inflow areas				
	Section 2		Section 3	
	Maintenance Required?		Maintenance Performed	
	Yes	No	Yes	No
Perforated pipes (CIRCLE – full blockage/partial blockade/damage)	☐	☐	☐	☐
Inflow areas (CIRCLE – scour/excessive sediment deposition/litter blockage)	☐	☐	☐	☐
Over flow grates (CIRCLE – damage/scour/blockage)	☐	☐	☐	☐
Pits (CIRCLE – poor general integrity/sediment build up/litter/blockage)	☐	☐	☐	☐
Other stormwater pipes and junction pits (CIRCLE – poor general integrity/sediment build up/litter/blockage)	☐	☐	☐	☐

4. Additional Comments

Note: Each year on the 1st September the occupier or body corporate is to provide to Council's Assets Design Services Section an annual collation of all maintenance carried out from the previous year. This includes the bio retention maintenance as well as the Enviropod Pit basket maintenance.

Appendix C

CONDITION ASSESSMENT AND PERFORMANCE EVALUATION OF BIORETENTION SYSTEMS

PRACTICE NOTE 1: *In Situ* Measurement of Hydraulic Conductivity

Belinda Hatt, Sebastien Le Coustumer

April 2008

The Facility for Advancing Water Biofiltration (FAWB) aims to deliver its research findings in a variety of forms in order to facilitate widespread and successful implementation of biofiltration technologies. This Practice Note for *In Situ* Measurement of Hydraulic Conductivity is the first in a series of Practice Notes being developed to assist practitioners with the assessment of construction and operation of biofiltration systems.

1. SCOPE OF THE DOCUMENT

This Practice Note for *In Situ* Measurement of Hydraulic Conductivity is designed to complement FAWB's Guidelines for Soil Filter Media in Bioretention Systems, Version 2.01 (visit http://www.monash.edu.au/fawb/publications/index.html for a copy of these guidelines). However, the recommendations contained within this document are more widely applicable to assessing the hydraulic conductivity of filter media in existing biofiltration systems.

For new systems, this Practice Note ***does not*** remove the need to conduct laboratory testing of filter media prior to installation.

2. DETERMINATION OF HYDRAULIC CONDUCTIVITY

The recommended method for determining *in situ* hydraulic conductivity uses a single ring infiltrometer under constant head. The single ring infiltrometer consists of a small plastic or metal ring that is driven 50 mm into the soil filter media. It is a constant head test that is conducted for two different pressure heads (50 mm and 150 mm). The head is kept constant during all the experiments by pouring water into the ring. The frequency of readings of the volume poured depends on the filter media, but typically varies from 30 seconds to 5 minutes. The experiment is stopped when the infiltration rate is considered steady (i.e., when the volume poured per time interval remains constant for at least 30 minutes). This method has been used extensively (e.g. Reynolds and Elrick, 1990; Youngs *et al.*, 1993).

Note: This method measures the hydraulic conductivity at the surface of the soil filter media. In most cases, it is this top layer which controls the hydraulic conductivity of the system as a whole (i.e., the underlying drainage layer has a flow capacity several orders of magnitude higher than the filter media), as it is this layer where fine sediment will generally be deposited to form a "clogging layer". However this shallow test would not be appropriate for systems where the controlling layer is not the surface layer (e.g. where migration of fine material down through the filter media has caused clogging within the media). In this case, a 'deep ring' method is required; for further information on this method, please consult FAWB's report "Hydraulic performance of biofilter systems for stormwater management: lessons from a field study", available at www.monash.edu.au/fawb/publications/index.html.

2.1 Selection of monitoring points

For bioretention systems with a surface area less than 50 m^2, *in situ* hydraulic conductivity testing should be conducted at three points that are spatially distributed (Figure 1). For systems with a surface area greater than 50 m^2,an extra monitoring point should be added for every additional 100 m^2. It is ***essential*** that the monitoring point is flat and level. Vegetation should not be included in monitoring points.

Figure 1. Spatially distributed monitoring points

2.2 Apparatus

The following is required:

- 100 mm diameter PVC rings with a height of at least 220 mm. The bottom edge of the ring should be bevelled and the inside of the ring should be marked to indicate 50 mm and 150 mm above the filter media surface (Figure 2).
- 40 L water
- 100 mL, 250 mL and 1000 mL measuring cylinders
- Stopwatch
- Thermometer

- Measuring tape
- Spirit level
- Hammer
- Block of wood, approximately 200 x 200 mm

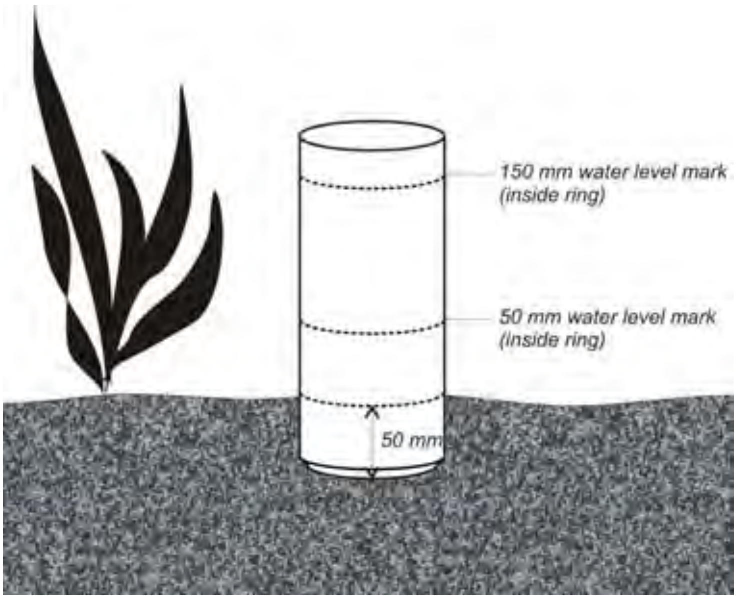


Figure 2. Diagram of single ring infiltrometer

2.3 Procedure

a. Carefully scrape away any surface covering (e.g. mulch, gravel, leaves) ***without disturbing*** the soil filter media surface (Figure 3b).

b. Locate the ring on the surface of the soil (Figure 3c), and then place the block of wood on top of the ring. Gently tap with the hammer to drive the ring 50 mm into the filter media (Figure 3d). Use the spirit level to check that the ring is level.

   Note: It is ***essential*** that this the ring is driven in slowly and carefully to minimise disturbance of the filter media profile.

c. Record the initial water temperature.

d. Fill the 1000 mL measuring cylinder.

e. Using a different pouring apparatus, slowly fill the ring to a ponding depth of 50 mm, taking care to minimise disturbance of the soil surface (Figure 3f). Start the stopwatch when the water level reaches 50 mm.

f. Using the 1000 mL measuring cylinder, maintain the water level at 50 mm (Figure 3g). After 30 seconds, record the volume poured.

g. Maintain the water level at 50 mm, recording the time interval and volume required to do so.

Note: The time interval between recordings will be determined by the infiltration capacity of the filter media. For fast draining media, the time interval should not be greater than one minute however, for slow draining media, the time between recordings may be up to five minutes.

Note: The smallest measuring cylinder that can pour the volume required to maintain a constant water level for the measured time interval should be used for greater accuracy. For example, if the volume poured over one minute is 750 mL, then the 1000 mL measuring cylinder should be used. Similarly, if the volume poured is 50 mL, then the 100 mL measuring cylinder should be used.

h. Continue to repeat Step f until the infiltration rate is steady i.e., the volume poured per time interval remains constant for at least 30 minutes.

i. Fill the ring to a ponding depth of 150 mm (Figure 3h). Restart the stopwatch. Repeat steps e – g for this ponding depth.

Note: Since the filter media is already saturated, the time required to reach steady infiltration should be less than for the first ponding depth.

j. Record the final water temperature.

k. Enter the temperature, time, and volume data into a calculation spreadsheet (see "Practice Note 1_Single Ring Infiltration Test_Example Calculations.xls", available at www.monash.edu.au/fawb/publications/index.html, as an example).

2.4 Calculations

In order to calculate K_{fs} a 'Gardner's' behaviour for the soil should be assumed (Gardner, 1958 in Youngs *et al.*, 1993):

$$K(h) = K_{fs} e^{\alpha h} \qquad \text{Eqn. 1}$$

where K is the hydraulic conductivity, α is a soil pore structure parameter (large for sands and small for clay), and h is the negative pressure head. K_{fs} is then found using the following analytical expression (for a steady flow) (Reynolds and Elrick, 1990):

$$K_{fs} = \frac{G}{a}\left(\frac{Q_2 - Q_1}{H_2 - H_1}\right) \qquad \text{Eqn. 2}$$

where a is the ring radius, H_1 and H_2 are the first (50 mm) and second (150 mm) pressure heads, respectively, Q_1 and Q_2 are the steady flows for the first and second pressure heads, respectively, and G is a shape factor estimated as:

$$G = 0.316\frac{d}{a} + 0.184 \qquad \text{Eqn. 3}$$

where d is the depth of insertion of the ring and a is the ring radius.

G is nearly independent of soil hydraulic conductivity (i.e. K_{fs} and α) and ponding, if the ponding is greater than 50 mm.

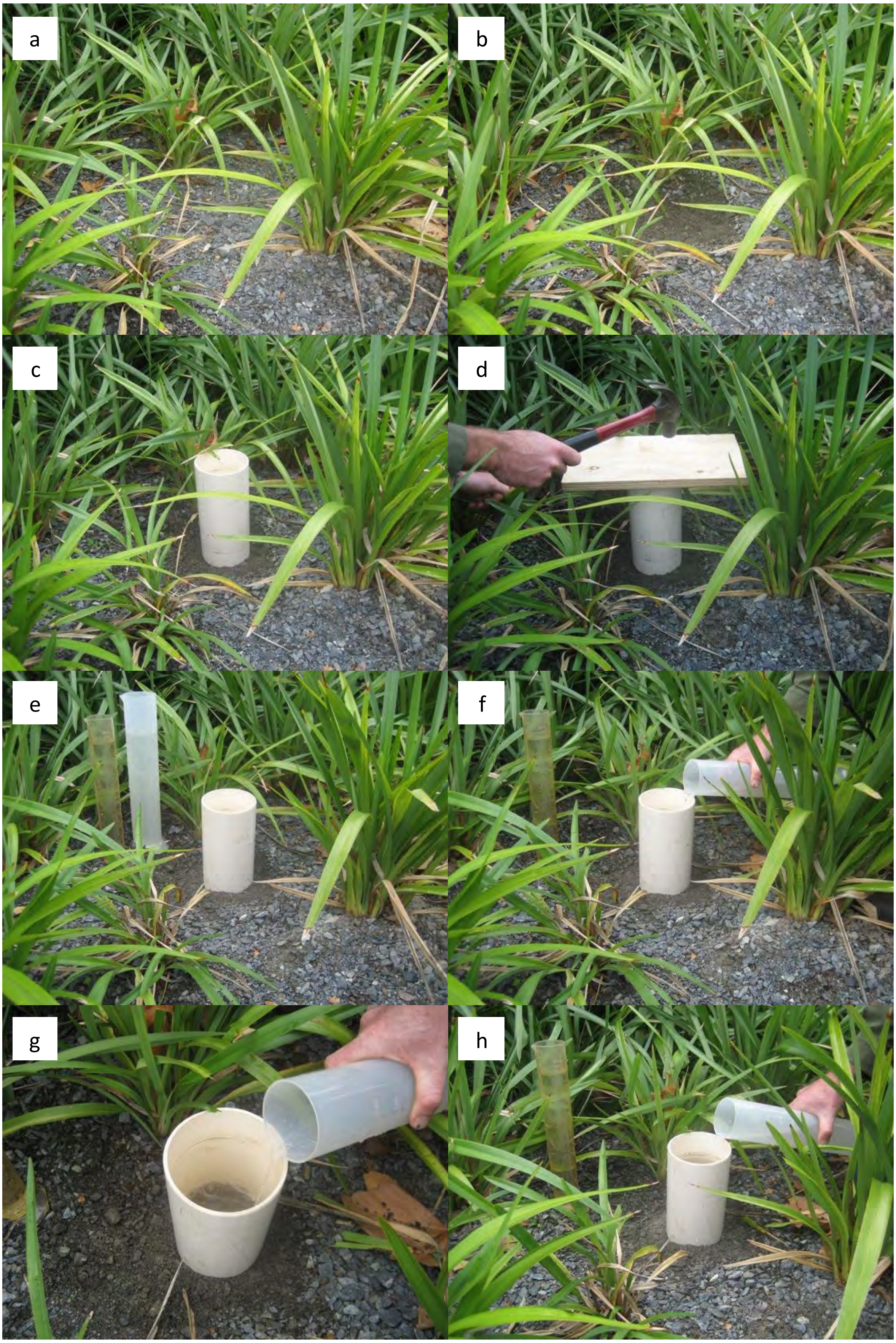


Figure 3. Measuring hydraulic conductivity

The possible limitations of the test are (Reynolds *et al.*, 2000): (1) the relatively small sample size due to the size of the ring, (2) soil disturbance during installation of the ring (compaction of the soil), and (3) possible edge flow during the experiments.

3 INTERPRETATION OF RESULTS

This test method has been shown to be relatively comparable to laboratory test methods (Le Coustumer *et al.*, 2008), taking into account the inherent variability in hydraulic conductivity testing and the heterogeneity of natural soil-based filter media. While correlation between the two test methods is low, results are not statistically different. In light of this, laboratory and field results are deemed comparable if they are within 50% of each other. In the same way, replicate field results are considered comparable if they differ by less than 50%. Where this is not the case, this is likely to be due to a localised inconsistency in the filter media, therefore additional measurement should be conducted at different monitoring points until comparable results are achieved. If this is not achieved, then an area-weighted average value may need to be calculated.

4 MONITORING FREQUENCY

Field testing of hydraulic conductivity should be carried out at least twice: (1) One month following commencement of operation, and (2) In the second year of operation to assess the impact of vegetation on hydraulic conductivity. Following this, hydraulic conductivity testing should be conducted every two years or when there has been a significant change in catchment characteristics (e.g., construction without appropriate sediment control).

REFERENCES

Gardner, W. R. (1958). Some steady-state solutions of the unsaturated moisture flow equation with application to evaporation from a water table. *Soil Science* **85**: 228-232.

Le Coustumer, S., T. D. Fletcher, A. Deletic and M. Potter (2008). Hydraulic performance of biofilter systems for stormwater management: lessons from a field study, Melbourne Water Corporation.

Reynolds, W. D., B. T. Bowman, R. R. Brunke, C. F. Drury and C. S. Tan (2000). Comparison of tension infiltrometer, pressure infiltrometer, and soil core estimates of saturated hydraulic conductivity. *Soil Science Society of America journal* **64**(2): 478-484.

Reynolds, W. D. and D. E. Elrick (1990). Ponded infiltration from a single ring: Analysis of steady flow. *Soil Science Society of America journal* **54**: 1233-1241.

Youngs, E. G., D. E. Elrick and W. D. Reynolds (1993). Comparison of steady flows from infiltration rings in "Green and Ampt" and "Gardner" soils. *Water Resources Research* **29**(6): 1647-1650.

Single Ring Infiltration Test

Site: ____

Date: ____

Constant water level = 50 mm		
Time (min)	Volume (mL)	Q (mL/s)

Constant water level = 150 mm		
Time (min)	Volume (mL)	Q (mL/s)

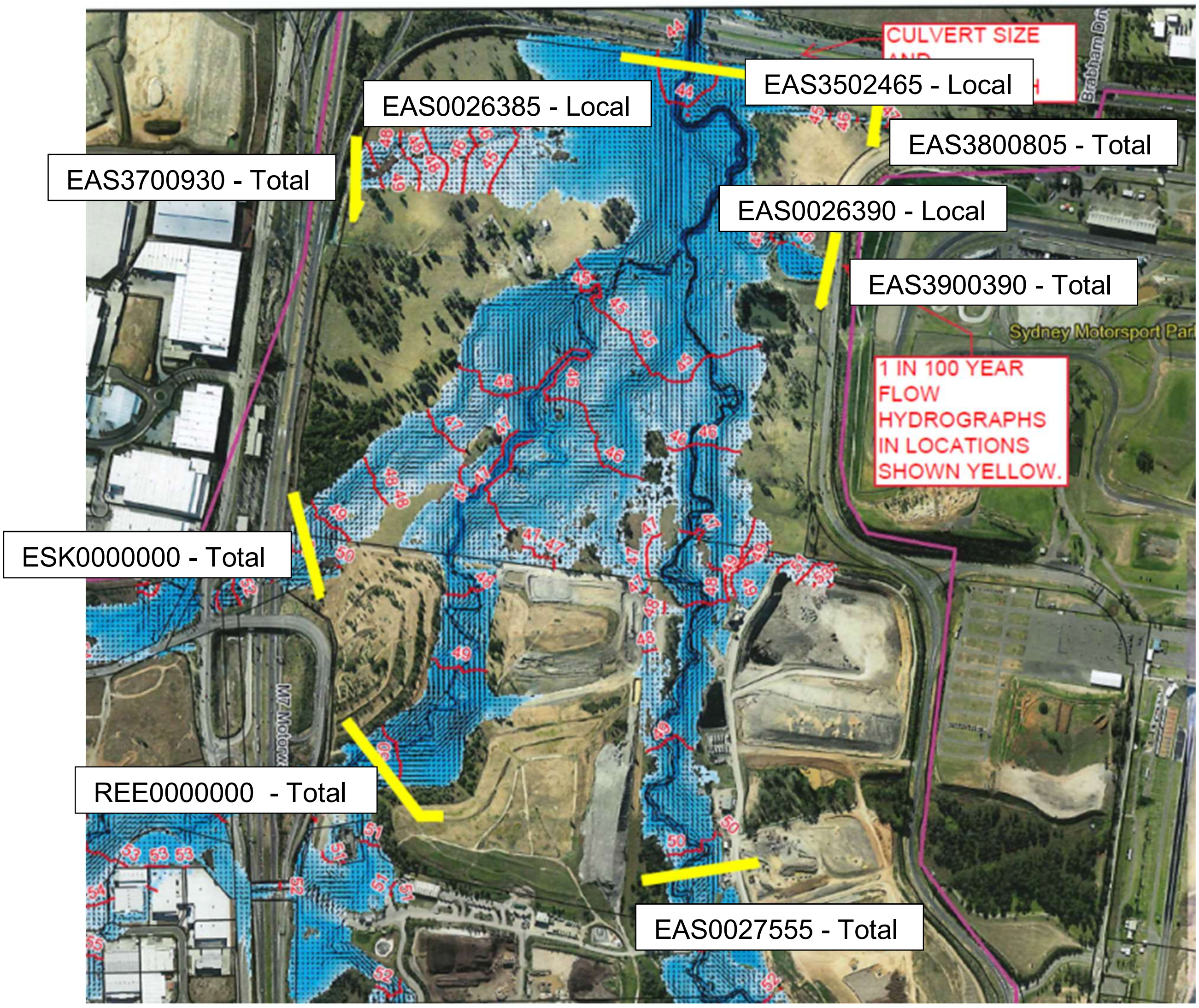
Appendix D

Above Ground OSD Summary with calculated values	
Site:	
Site Area	336294 m^2
Site Area NOT Draining to OSD	18128 m^2
Reduced Levels (AHD):	
RL of Top of Tank	47.22
RL of Bottom of OSD Tank	45
RL of 1.5 Year ARI Overflow Weir	46.22
RL of Emergency Overflow Weir	46.85
RL of 1.5 Year ARI Orifice Centerline	44.906
RL of 100 Year ARI Orifice Centreline	45.047
RL of Invert of Discharge to Council Drainage Pit	0
RL of obvert of Pit outlet pipe	44.95
Minium RL of Garage Floor	47.31
Minium RL of House Floor	47.41
OSD Volume:	
Required Storage BELOW 1.5 Year ARI Overflow Weir	10270.4 m^3
Required Storage BELOW Emergency Overflow Weir	15576.8 m^3
Discharge Details:	
Using Filter Cartridges to Manage Water Quality	No
Discharge Location	Council Drainage Pit
Length of Emergency Overflow Weir	35.00 m
Maximum 1.5 Year ARI Site Discharge	1236.41 L/s
1.5 Year ARI Orifice Discharge	1236.41 L/s
Maximum 100 Year ARI Site Discharge	5374.418
100 Year ARI Orifice Discharge	5374.42 L/s
Orifice Details:	
Number of 1.5 Year ARI Orifices	3
Number of 100 Year ARI Orifices	3
1.5 Year ARI Orifice Size (mm)	411.5 mm
100 Year ARI Orifice Size (mm)	793.0 mm
Notifications:	

Due to the Outlet Orifice being drowned by 2.4% during 100 ARI event an extra 1.8% of Storage volume has been added.

Appendix E

EAS0026380 – Total D/S of M4



Hydrographs shown as “Total” are the total upstream hydrograph at the yellow locations.

Hydrographs shown as “Local” are the local hydrographs for the areas inside (D/S) the yellow locations.

EAS0026380 is the total D/S of the M4 and is the total of the other hydrographs shown.

All hydrographs are from Council’s XP-Rafts base model for Eastern Creek.

Time	EAS0027555	EAS3900390	EAS3700930	REE0000000	ESK0000000	EAS3800805	EAS0026380
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0.002	0	0	0	0
9	0	0	0.004	0	0	0	0
10	0	0	0.007	0	0	0	0
11	0	0	0.01	0	0	0	0
12	0	0	0.019	0	0	0	0
13	0	0	0.029	0	0	0	0
14	0	0	0.038	0	0	0	0
15	0	0	0.048	0	0.019	0	0
16	0	0	0.057	0	0.115	0	0.025
17	0	0	0.067	0	0.25	0	0.151
18	0	0	0.078	0	0.326	0	0.33
19	0	0	0.088	0	0.334	0	0.434
20	0	0	0.099	0	0.327	0	0.447
21	0	0	0.107	0	0.393	0	0.437
22	0	0	0.114	0	0.439	0	0.437
23	0	0	0.122	0	0.582	0	0.458
24	0	0	0.129	0.7	0.673	0	0.555
25	0	0	0.136	0.635	0.72	0	0.692
26	0	0	0.145	0.576	0.762	0	0.771
27	0	0	0.154	0.523	0.8	0	0.783
28	0.01	0.012	0.164	0.478	0.824	0.005	0.795
29	0.049	0.06	0.173	0.452	0.857	0.023	0.916
30	0.101	0.122	0.183	0.441	0.915	0.044	1.031
31	0.183	0.228	0.194	0.443	1.035	0.075	1.279
32	0.286	0.368	0.208	0.452	1.217	0.108	2.203
33	0.356	0.477	0.225	0.453	1.375	0.127	2.287
34	0.396	0.555	0.243	0.449	1.495	0.134	2.334
35	0.424	0.644	0.263	0.453	1.547	0.135	2.35
36	0.445	0.731	0.283	0.457	1.584	0.134	2.345
37	0.472	0.86	0.305	0.463	1.614	0.134	2.365
38	0.505	1.037	0.327	0.471	1.641	0.134	2.448
39	0.524	1.205	0.35	0.482	1.664	0.134	2.647
40	0.538	1.332	0.369	0.999	1.774	0.134	2.939
41	0.563	1.459	0.389	1.025	1.948	0.134	3.371
42	0.595	1.599	0.41	1.055	2.035	0.134	3.9
43	0.655	1.701	0.431	1.086	2.051	0.134	4.231
44	0.725	1.759	0.452	1.116	2.055	0.134	4.45
45	0.787	1.783	0.472	1.148	2.069	0.134	4.672
46	0.837	1.789	0.492	1.191	2.11	0.134	4.876
47	0.873	1.789	0.512	1.27	2.177	0.134	5.092
48	0.926	1.788	0.532	1.483	2.233	0.134	5.936
49	0.985	1.788	0.552	1.749	2.276	0.134	6.341
50	1.075	1.788	0.571	1.959	2.317	0.134	6.633
51	1.191	1.788	0.591	2.109	2.348	0.134	6.859
52	1.285	1.788	0.609	2.266	2.376	0.134	7.071
53	1.346	1.788	0.626	2.447	2.406	0.134	7.256
54	1.419	1.788	0.642	2.598	2.439	0.134	7.448
55	1.555	1.788	0.659	2.717	2.482	0.134	7.68
56	1.699	1.788	0.675	2.828	2.55	0.134	8.041
57	1.905	1.789	0.692	2.925	2.636	0.135	8.449

58	2.17	1.794	0.708	3.037	2.722	0.137	8.799
59	2.385	1.801	0.725	3.172	2.802	0.139	9.075
60	2.528	1.809	0.741	3.291	2.875	0.143	9.341
61	2.642	1.858	0.758	3.418	2.948	0.159	9.694
62	2.747	1.944	0.775	3.557	3.027	0.187	10.061
63	2.824	2.018	0.795	3.688	3.098	0.207	10.427
64	2.882	2.078	0.815	3.831	3.159	0.219	10.818
65	2.927	2.122	0.837	3.997	3.211	0.226	11.174
66	2.966	2.157	0.859	4.179	3.259	0.233	11.506
67	3.022	2.243	0.883	4.365	3.304	0.242	11.871
68	3.094	2.379	0.908	4.544	3.349	0.251	12.281
69	3.165	2.498	0.932	4.716	3.394	0.26	12.711
70	3.237	2.591	0.956	4.884	3.519	0.27	13.234
71	3.314	2.7	0.981	5.096	3.692	0.28	13.962
72	3.402	2.833	1.005	5.434	3.789	0.29	14.738
73	3.521	2.953	1.029	5.863	3.836	0.301	15.334
74	3.665	3.056	1.053	6.182	3.884	0.312	15.828
75	3.826	3.141	1.077	6.361	3.942	0.323	16.296
76	3.999	3.217	1.1	6.483	4.02	0.334	16.733
77	4.17	3.293	1.124	6.589	4.115	0.346	17.196
78	4.339	3.372	1.148	6.698	4.195	0.358	17.769
79	4.51	3.454	1.172	6.827	4.268	0.37	18.416
80	4.72	3.537	1.197	6.991	4.346	0.382	19.106
81	4.968	3.623	1.222	7.174	4.424	0.394	19.869
82	5.205	3.71	1.247	7.378	4.502	0.407	20.549
83	5.428	3.799	1.271	7.602	4.583	0.419	21.086
84	5.663	3.89	1.295	7.813	4.667	0.432	21.576
85	5.918	3.982	1.319	8.022	4.764	0.444	22.06
86	6.176	4.077	1.343	8.23	4.875	0.457	22.553
87	6.511	4.172	1.367	8.441	4.989	0.469	23.088
88	6.917	4.269	1.392	8.689	5.114	0.481	23.681
89	7.306	4.367	1.416	8.972	5.256	0.493	24.308
90	7.674	4.466	1.44	9.255	5.404	0.504	24.956
91	8.177	4.76	1.468	9.61	5.623	0.579	25.826
92	8.814	5.237	1.505	10.038	5.914	0.705	26.88
93	9.376	5.634	1.551	10.446	6.179	0.786	27.906
94	9.837	5.902	1.601	10.844	6.4	0.821	28.866
95	10.239	6.069	1.659	11.249	6.587	0.842	29.74
96	10.644	6.209	1.733	11.68	6.762	0.87	30.633
97	11.141	6.61	1.826	12.13	6.938	0.899	31.604
98	11.712	7.248	1.923	12.588	7.118	0.925	32.605
99	12.25	7.764	2.018	13.049	7.301	0.952	33.755
100	12.754	8.115	2.112	13.516	7.847	0.978	35.193
101	13.253	8.53	2.204	14.007	8.602	1.003	37.386
102	13.766	9.087	2.294	14.617	8.945	1.028	39.933
103	14.383	9.575	2.383	15.325	9.091	1.052	41.762
104	15.089	9.939	2.476	15.971	9.315	1.076	43.33
105	15.834	10.202	2.567	16.553	9.58	1.099	45.03
106	16.603	10.44	2.649	17.122	9.911	1.121	46.676
107	17.317	10.687	2.73	17.685	10.328	1.142	48.456
108	18	10.934	2.809	18.313	10.663	1.163	50.804
109	18.68	11.176	2.888	19.013	10.976	1.183	53.279
110	19.543	11.414	2.966	19.807	11.363	1.202	55.384
111	20.569	11.65	3.05	20.672	11.744	1.22	57.54
112	21.506	11.881	3.121	21.618	12.108	1.237	59.833
113	22.325	12.107	3.191	22.664	12.472	1.254	62.017
114	23.169	12.329	3.259	23.656	12.832	1.269	64.128
115	24.097	12.545	3.327	24.59	13.235	1.284	66.227

116	24.997	12.756	3.397	25.471	13.694	1.297	68.383
117	26.214	12.961	3.468	26.347	14.177	1.31	70.679
118	27.756	13.159	3.539	27.372	14.717	1.321	73.177
119	29.161	13.351	3.608	28.526	15.352	1.332	75.754
120	30.366	13.537	3.675	29.605	16.013	1.342	78.335
121	31.296	13.565	3.739	30.639	16.552	1.303	80.812
122	32.099	13.477	3.795	31.69	17	1.233	83.087
123	32.981	13.459	3.843	32.796	17.467	1.196	85.594
124	33.931	13.508	3.886	33.996	17.958	1.183	88.324
125	34.916	13.601	3.919	35.282	18.473	1.177	91.014
126	35.911	13.706	3.944	36.66	18.999	1.168	93.795
127	36.848	13.608	3.965	38.085	19.506	1.158	96.817
128	37.746	13.361	3.986	39.512	19.948	1.148	99.848
129	38.682	13.211	4.006	40.914	20.347	1.139	102.67
130	39.649	13.148	4.028	42.239	20.487	1.129	105.674
131	40.635	13.004	4.05	43.658	20.537	1.118	108.539
132	41.635	12.778	4.07	45.622	20.836	1.108	111.173
133	42.579	12.619	4.09	48.034	21.24	1.098	114.139
134	43.496	12.524	4.109	50.095	21.608	1.088	117.149
135	44.409	12.474	4.127	51.819	21.943	1.078	120.078
136	45.327	12.438	4.144	53.47	22.219	1.068	123.003
137	46.313	12.397	4.161	55.033	22.464	1.059	125.731
138	47.34	12.349	4.178	56.63	22.766	1.05	127.998
139	48.389	12.299	4.193	58.421	23.065	1.041	130.36
140	49.317	12.247	4.209	60.214	23.332	1.032	133.54
141	50.161	12.192	4.224	61.992	23.599	1.024	137.138
142	51.088	12.135	4.238	63.734	23.868	1.016	140.295
143	52.087	12.077	4.252	65.386	24.13	1.008	143.174
144	53.055	12.017	4.267	67.056	24.384	1.001	146.002
145	53.983	11.957	4.282	68.721	24.601	0.994	148.767
146	54.949	11.897	4.297	70.381	24.784	0.987	151.58
147	55.662	11.836	4.311	72.045	24.967	0.981	154.549
148	56.185	11.775	4.325	73.607	25.097	0.976	157.477
149	56.858	11.715	4.338	75.11	25.149	0.97	160.389
150	57.662	11.656	4.351	76.687	25.189	0.965	163.331
151	58.457	11.475	4.363	78.215	25.202	0.922	166.078
152	59.223	11.203	4.37	79.69	25.183	0.854	168.748
153	60.052	10.989	4.369	81.213	25.177	0.81	171.304
154	60.935	10.83	4.361	82.789	25.18	0.785	173.786
155	61.86	10.715	4.343	84.38	25.184	0.77	176.391
156	62.804	10.625	4.318	85.925	25.186	0.757	178.932
157	63.701	10.385	4.289	87.429	25.188	0.743	181.307
158	64.555	10.03	4.26	88.92	25.184	0.73	183.706
159	65.426	9.752	4.231	90.422	25.173	0.717	186.066
160	66.308	9.545	4.203	91.923	24.944	0.705	188.052
161	67.189	9.285	4.175	93.312	24.625	0.693	189.48
162	68.061	8.974	4.146	94.289	24.491	0.681	190.939
163	68.859	8.726	4.118	94.976	24.452	0.67	192.869
164	69.6	8.532	4.09	95.856	24.406	0.659	194.944
165	70.298	8.382	4.063	96.99	24.329	0.649	197.01
166	70.963	8.257	4.036	98.223	24.195	0.639	199.124
167	71.65	8.142	4.011	99.503	24.039	0.629	201.147
168	72.345	8.029	3.986	100.721	23.926	0.62	202.88
169	73.038	7.92	3.96	101.866	23.815	0.611	204.5
170	73.615	7.814	3.928	102.976	23.687	0.603	205.912
171	74.106	7.711	3.898	104.086	23.56	0.595	207.026
172	74.643	7.611	3.867	105.167	23.438	0.587	208.285
173	75.22	7.514	3.838	106.219	23.317	0.58	209.842

174	75.758	7.421	3.809	107.338	23.195	0.572	211.496
175	76.251	7.33	3.78	108.498	23.047	0.566	213.21
176	76.755	7.242	3.752	109.682	22.876	0.559	214.863
177	77.023	7.157	3.725	110.885	22.711	0.553	216.398
178	77.104	7.075	3.698	112.002	22.508	0.547	217.846
179	77.265	6.996	3.672	113.041	22.244	0.542	219.264
180	77.49	6.92	3.646	114.105	21.977	0.536	220.688
181	77.738	6.83	3.62	115.124	21.731	0.526	222.081
182	77.984	6.729	3.594	116.101	21.498	0.513	223.526
183	78.225	6.636	3.567	117.087	21.275	0.502	224.884
184	78.449	6.553	3.537	118.05	21.057	0.495	226.171
185	78.655	6.479	3.506	118.967	20.837	0.489	227.538
186	78.84	6.412	3.474	119.824	20.618	0.484	228.824
187	78.995	6.328	3.443	120.62	20.407	0.479	229.94
188	79.12	6.229	3.413	121.339	20.2	0.475	231.038
189	79.223	6.141	3.384	122.05	19.993	0.47	232.13
190	79.303	6.063	3.357	122.75	19.74	0.466	232.957
191	79.36	5.983	3.33	123.36	19.477	0.462	233.562
192	79.39	5.897	3.304	123.626	19.244	0.459	234.204
193	79.383	5.821	3.278	123.614	19.032	0.455	234.907
194	79.338	5.754	3.254	123.693	18.827	0.452	235.611
195	79.257	5.695	3.23	123.93	18.622	0.449	236.278
196	79.14	5.642	3.206	124.2	18.414	0.446	236.87
197	78.997	5.593	3.183	124.441	18.206	0.443	237.424
198	78.826	5.546	3.161	124.615	18.008	0.441	237.89
199	78.63	5.501	3.139	124.704	17.815	0.438	238.247
200	78.394	5.458	3.118	124.723	17.624	0.436	238.268
201	78.125	5.416	3.097	124.7	17.435	0.434	238.001
202	77.841	5.376	3.077	124.641	17.252	0.432	237.805
203	77.544	5.338	3.057	124.55	17.074	0.43	237.758
204	77.227	5.302	3.038	124.441	16.9	0.428	237.726
205	76.889	5.267	3.019	124.311	16.728	0.426	237.651
206	76.536	5.234	3.001	124.156	16.556	0.424	237.491
207	76.138	5.202	2.983	123.968	16.39	0.423	237.22
208	75.697	5.172	2.966	123.729	16.222	0.421	236.848
209	75.25	5.143	2.949	123.438	16.051	0.42	236.405
210	74.795	5.115	2.932	123.108	15.882	0.419	235.909
211	74.333	5.088	2.916	122.734	15.721	0.417	235.361
212	73.861	5.063	2.901	122.318	15.567	0.416	234.779
213	73.376	5.039	2.885	121.866	15.418	0.415	234.142
214	72.879	5.016	2.871	121.378	15.277	0.414	233.449
215	72.37	4.994	2.856	120.852	15.141	0.413	232.718
216	71.851	4.973	2.842	120.29	15.009	0.412	231.926
217	71.324	4.953	2.828	119.695	14.88	0.412	231.061
218	70.79	4.934	2.815	119.071	14.741	0.411	230.14
219	70.251	4.916	2.802	118.421	14.58	0.41	229.172
220	69.708	4.899	2.789	117.748	14.424	0.409	228.126
221	69.162	4.883	2.777	117.039	14.273	0.409	227.011
222	68.614	4.867	2.764	116.262	14.127	0.408	225.861
223	68.064	4.852	2.753	115.42	13.987	0.408	224.676
224	67.511	4.838	2.741	114.569	13.851	0.407	223.453
225	66.956	4.825	2.73	113.724	13.72	0.407	222.193
226	66.398	4.812	2.719	112.87	13.593	0.406	220.884
227	65.839	4.8	2.708	111.998	13.471	0.406	219.516
228	65.277	4.789	2.698	111.109	13.353	0.406	218.12
229	64.715	4.778	2.688	110.199	13.238	0.405	216.687
230	64.152	4.768	2.678	109.278	13.126	0.405	215.183
231	63.59	4.759	2.668	108.35	13.019	0.405	213.616

232	63.029	4.75	2.659	107.414	12.915	0.404	212.04
233	62.47	4.741	2.65	106.471	12.814	0.404	210.475
234	61.914	4.733	2.642	105.526	12.717	0.404	208.902
235	61.362	4.725	2.634	104.58	12.624	0.404	207.317
236	60.813	4.718	2.627	103.633	12.534	0.404	205.717
237	60.269	4.711	2.619	102.686	12.447	0.403	204.099
238	59.73	4.705	2.612	101.739	12.364	0.403	202.471
239	59.196	4.699	2.605	100.794	12.283	0.403	200.841
240	58.668	4.693	2.598	99.849	12.206	0.403	199.206
241	58.125	4.662	2.59	98.896	12.121	0.394	197.538
242	57.57	4.609	2.581	97.939	12.028	0.379	195.846
243	57.031	4.565	2.57	96.987	11.941	0.369	194.167
244	56.509	4.532	2.558	96.044	11.861	0.363	192.502
245	56.002	4.509	2.544	95.109	11.786	0.359	190.853
246	55.508	4.493	2.529	94.182	11.717	0.357	189.217
247	55.014	4.448	2.514	93.262	11.653	0.355	187.591
248	54.52	4.376	2.498	92.351	11.595	0.352	185.975
249	54.038	4.316	2.483	91.45	11.538	0.35	184.349
250	53.569	4.271	2.469	90.558	11.436	0.347	182.707
251	53.113	4.215	2.456	89.678	11.31	0.345	180.988
252	52.667	4.149	2.443	88.809	11.225	0.343	179.236
253	52.217	4.095	2.43	87.952	11.169	0.341	177.57
254	51.767	4.052	2.417	87.109	11.121	0.338	175.953
255	51.32	4.02	2.404	86.279	11.069	0.336	174.362
256	50.877	3.994	2.392	85.463	11.005	0.334	172.804
257	50.452	3.973	2.38	84.663	10.934	0.332	171.242
258	50.041	3.953	2.369	83.868	10.874	0.33	169.634
259	49.643	3.933	2.358	83.081	10.817	0.328	168.037
260	49.231	3.913	2.346	82.298	10.766	0.326	166.505
261	48.81	3.893	2.335	81.523	10.717	0.324	165.004
262	48.406	3.874	2.324	80.753	10.669	0.322	163.525
263	48.021	3.856	2.313	79.987	10.625	0.321	162.081
264	47.64	3.837	2.303	79.247	10.581	0.319	160.663
265	47.262	3.819	2.292	78.529	10.532	0.317	159.274
266	46.898	3.801	2.282	77.834	10.476	0.315	157.909
267	46.496	3.784	2.271	77.16	10.419	0.314	156.558
268	46.063	3.766	2.261	76.487	10.353	0.312	155.221
269	45.656	3.749	2.251	75.817	10.276	0.311	153.9
270	45.274	3.733	2.241	75.171	10.198	0.309	152.603
271	44.925	3.729	2.232	74.541	10.132	0.312	151.344
272	44.604	3.738	2.223	73.926	10.078	0.318	150.138
273	44.293	3.743	2.215	73.329	10.026	0.323	148.933
274	43.988	3.743	2.208	72.739	9.973	0.325	147.73
275	43.687	3.739	2.202	72.15	9.918	0.325	146.561
276	43.39	3.73	2.196	71.564	9.862	0.325	145.4
277	43.105	3.736	2.191	70.984	9.806	0.325	144.234
278	42.83	3.757	2.187	70.415	9.751	0.325	143.094
279	42.56	3.773	2.182	69.863	9.697	0.325	141.998
280	42.293	3.782	2.178	69.332	9.667	0.325	140.895
281	42.028	3.796	2.173	68.803	9.654	0.326	139.83
282	41.768	3.816	2.169	68.218	9.623	0.326	138.829
283	41.516	3.83	2.165	67.586	9.576	0.326	137.821
284	41.273	3.839	2.161	66.992	9.527	0.327	136.819
285	41.035	3.844	2.157	66.461	9.483	0.327	135.84
286	40.801	3.844	2.153	65.964	9.446	0.327	134.883
287	40.565	3.843	2.149	65.486	9.414	0.328	133.966
288	40.328	3.841	2.145	65.024	9.378	0.328	133.112
289	40.091	3.84	2.141	64.573	9.342	0.329	132.279

290	39.868	3.84	2.138	64.133	9.307	0.329	131.378
291	39.658	3.839	2.134	63.707	9.273	0.33	130.429
292	39.448	3.839	2.131	63.297	9.239	0.33	129.528
293	39.236	3.839	2.128	62.905	9.206	0.331	128.693
294	39.028	3.839	2.125	62.521	9.173	0.331	127.898
295	38.827	3.839	2.121	62.146	9.145	0.332	127.125
296	38.626	3.84	2.118	61.779	9.121	0.332	126.37
297	38.451	3.841	2.115	61.418	9.1	0.333	125.632
298	38.298	3.842	2.112	61.071	9.083	0.333	124.913
299	38.14	3.843	2.109	60.738	9.074	0.334	124.212
300	37.975	3.845	2.107	60.406	9.066	0.335	123.526
301	37.771	3.807	2.103	60.066	9.039	0.322	122.815
302	37.536	3.737	2.098	59.722	8.996	0.301	122.077
303	37.312	3.681	2.09	59.386	8.957	0.285	121.38
304	37.1	3.639	2.081	59.062	8.923	0.276	120.723
305	36.9	3.611	2.07	58.755	8.895	0.27	120.086
306	36.71	3.593	2.056	58.461	8.872	0.267	119.476
307	36.51	3.53	2.042	58.179	8.852	0.264	118.897
308	36.3	3.428	2.027	57.904	8.834	0.261	118.33
309	36.1	3.347	2.012	57.634	8.817	0.258	117.738
310	35.909	3.285	1.999	57.366	8.729	0.255	117.138
311	35.727	3.205	1.986	57.106	8.602	0.252	116.427
312	35.551	3.109	1.973	56.885	8.532	0.249	115.652
313	35.361	3.033	1.961	56.701	8.502	0.246	114.984
314	35.163	2.974	1.949	56.507	8.484	0.244	114.366
315	34.959	2.929	1.937	56.289	8.462	0.241	113.771
316	34.754	2.894	1.925	56.061	8.419	0.238	113.206
317	34.565	2.865	1.913	55.833	8.365	0.235	112.609
318	34.391	2.84	1.902	55.591	8.326	0.233	111.916
319	34.226	2.815	1.89	55.343	8.289	0.23	111.223
320	34.034	2.791	1.879	55.083	8.25	0.227	110.632
321	33.818	2.767	1.867	54.815	8.214	0.225	110.088
322	33.621	2.744	1.856	54.531	8.18	0.222	109.538
323	33.441	2.721	1.844	54.232	8.146	0.22	108.99
324	33.257	2.698	1.833	53.95	8.113	0.217	108.436
325	33.069	2.675	1.822	53.681	8.071	0.215	107.892
326	32.896	2.653	1.811	53.423	8.017	0.213	107.347
327	32.657	2.631	1.8	53.174	7.96	0.211	106.796
328	32.363	2.609	1.789	52.908	7.889	0.208	106.231
329	32.102	2.588	1.779	52.629	7.798	0.206	105.661
330	31.869	2.567	1.768	52.368	7.706	0.204	105.094
331	31.65	2.533	1.758	52.104	7.618	0.198	104.512
332	31.441	2.487	1.746	51.834	7.531	0.188	103.946
333	31.25	2.445	1.735	51.575	7.458	0.18	103.36
334	31.073	2.408	1.722	51.313	7.391	0.174	102.755
335	30.906	2.375	1.709	51.039	7.325	0.169	102.179
336	30.747	2.346	1.696	50.753	7.259	0.166	101.592
337	30.588	2.303	1.682	50.458	7.196	0.163	100.973
338	30.427	2.247	1.668	50.163	7.135	0.16	100.37
339	30.269	2.197	1.654	49.876	7.076	0.157	99.783
340	30.113	2.153	1.641	49.6	6.992	0.155	99.122
341	29.959	2.104	1.627	49.314	6.894	0.152	98.383
342	29.805	2.05	1.614	48.93	6.813	0.15	97.649
343	29.644	2.003	1.599	48.461	6.747	0.147	96.96
344	29.474	1.962	1.585	48.032	6.689	0.145	96.298
345	29.298	1.926	1.572	47.68	6.631	0.143	95.657
346	29.115	1.895	1.561	47.373	6.565	0.14	95.044
347	28.933	1.867	1.549	47.082	6.495	0.138	94.438

348	28.752	1.841	1.538	46.791	6.429	0.136	93.818
349	28.571	1.817	1.526	46.497	6.364	0.134	93.187
350	28.379	1.793	1.515	46.195	6.3	0.132	92.481
351	28.177	1.77	1.504	45.888	6.238	0.131	91.697
352	27.979	1.748	1.493	45.578	6.177	0.129	90.959
353	27.785	1.726	1.482	45.268	6.114	0.127	90.308
354	27.59	1.705	1.472	44.97	6.048	0.125	89.701
355	27.392	1.684	1.461	44.682	5.981	0.124	89.113
356	27.198	1.664	1.451	44.403	5.913	0.122	88.526
357	26.979	1.644	1.44	44.129	5.846	0.121	87.934
358	26.739	1.625	1.43	43.848	5.775	0.119	87.33
359	26.505	1.606	1.42	43.559	5.699	0.118	86.717
360	26.276	1.587	1.41	43.273	5.623	0.117	86.105
361	26.037	1.552	1.4	42.978	5.538	0.11	85.475
362	25.79	1.503	1.389	42.674	5.451	0.099	84.842
363	25.55	1.459	1.378	42.375	5.369	0.09	84.213
364	25.316	1.421	1.367	42.076	5.291	0.084	83.587
365	25.086	1.388	1.354	41.775	5.216	0.079	82.977
366	24.859	1.36	1.34	41.47	5.141	0.075	82.366
367	24.627	1.312	1.326	41.163	5.069	0.072	81.743
368	24.392	1.248	1.312	40.856	5	0.069	81.123
369	24.159	1.194	1.298	40.551	4.927	0.067	80.491
370	23.929	1.148	1.284	40.249	4.822	0.065	79.821
371	23.702	1.093	1.269	39.942	4.7	0.063	79.073
372	23.476	1.032	1.254	39.599	4.602	0.061	78.298
373	23.243	0.979	1.239	39.219	4.521	0.059	77.566
374	23.004	0.935	1.224	38.846	4.449	0.057	76.848
375	22.761	0.897	1.21	38.496	4.381	0.056	76.14
376	22.513	0.864	1.195	38.162	4.307	0.054	75.453
377	22.27	0.836	1.181	37.832	4.223	0.053	74.755
378	22.03	0.811	1.167	37.494	4.128	0.051	74.018
379	21.792	0.787	1.152	37.151	4.032	0.05	73.272
380	21.541	0.766	1.139	36.797	3.939	0.048	72.518
381	21.279	0.746	1.125	36.44	3.837	0.047	71.731
382	21.024	0.726	1.112	36.083	3.73	0.045	70.955
383	20.776	0.708	1.099	35.716	3.581	0.044	70.22
384	20.525	0.691	1.087	35.357	3.531	0.043	69.504
385	20.273	0.674	1.075	35.004	3.477	0.042	68.792
386	20.027	0.657	1.064	34.66	3.422	0.041	68.059
387	19.753	0.641	1.052	34.319	3.364	0.039	67.318
388	19.456	0.626	1.04	33.968	3.297	0.038	66.567
389	19.172	0.611	1.029	33.61	3.223	0.037	65.804
390	18.899	0.597	1.018	33.256	3.148	0.036	65.042
391	18.635	0.583	1.007	32.897	3.078	0.035	64.233
392	18.379	0.569	0.996	32.536	3.004	0.034	63.534
393	18.13	0.555	0.985	32.179	2.948	0.033	62.826
394	17.886	0.542	0.974	31.824	2.852	0.032	62.116
395	17.647	0.53	0.963	31.463	2.817	0.031	61.414
396	17.413	0.517	0.953	31.097	2.699	0.031	60.701
397	17.182	0.505	0.942	30.726	2.692	0.03	59.972
398	16.954	0.494	0.932	30.353	2.559	0.029	59.246
399	16.729	0.482	0.922	29.982	2.556	0.028	58.529
400	16.507	0.471	0.912	29.615	2.415	0.027	57.778
401	16.286	0.46	0.902	29.244	2.416	0.027	57.028
402	16.068	0.45	0.892	28.829	2.281	0.026	56.251
403	15.851	0.439	0.882	28.375	2.267	0.025	55.545
404	15.634	0.429	0.873	27.936	2.12	0.025	54.757
405	15.418	0.419	0.864	27.529	2.113	0.024	54.086

406	15.202	0.41	0.856	27.143	1.948	0.023	53.294
407	14.986	0.401	0.847	26.77	1.909	0.023	52.639
408	14.771	0.391	0.839	26.406	1.717	0.022	51.857
409	14.556	0.383	0.831	26.047	1.689	0.021	51.217
410	14.341	0.374	0.821	25.691	1.564	0.021	50.402
411	14.128	0.366	0.812	25.338	1.586	0.02	49.672
412	13.916	0.357	0.802	24.988	1.486	0.02	48.829
413	13.705	0.349	0.793	24.641	1.522	0.019	48.16
414	13.497	0.341	0.784	24.297	1.43	0.019	47.357
415	13.29	0.334	0.776	23.958	1.466	0.018	46.695
416	13.085	0.326	0.767	23.622	1.376	0.018	45.891
417	12.881	0.319	0.758	23.289	1.41	0.017	45.258
418	12.679	0.312	0.75	22.958	1.321	0.017	44.532
419	12.478	0.305	0.741	22.628	1.357	0.016	43.956
420	12.279	0.298	0.733	22.3	1.269	0.016	43.262
421	12.081	0.292	0.725	21.972	1.305	0.016	42.708
422	11.883	0.285	0.717	21.646	1.22	0.015	42.032
423	11.687	0.279	0.709	21.322	1.257	0.015	41.488
424	11.493	0.273	0.701	21.001	1.172	0.014	40.823
425	11.299	0.267	0.693	20.681	1.209	0.014	40.286
426	11.108	0.261	0.685	20.365	1.126	0.014	39.631
427	10.918	0.256	0.678	20.052	1.164	0.013	39.102
428	10.73	0.25	0.67	19.742	1.082	0.013	38.455
429	10.545	0.245	0.663	19.434	1.119	0.013	37.934
430	10.362	0.239	0.655	19.129	1.041	0.012	37.294
431	10.182	0.234	0.649	18.827	1.074	0.012	36.782
432	10.004	0.229	0.642	18.527	1.001	0.012	36.152
433	9.829	0.224	0.636	18.23	1.031	0.011	35.648
434	9.657	0.22	0.629	17.935	0.963	0.011	35.028
435	9.488	0.215	0.623	17.642	0.991	0.011	34.534
436	9.32	0.211	0.617	17.353	0.926	0.011	33.924
437	9.156	0.206	0.611	17.065	0.952	0.01	33.437
438	8.993	0.202	0.605	16.78	0.891	0.01	32.84
439	8.833	0.198	0.599	16.498	0.915	0.01	32.36
440	8.675	0.193	0.593	16.219	0.857	0.01	31.777
441	8.519	0.189	0.587	15.943	0.88	0.009	31.303
442	8.365	0.186	0.581	15.67	0.825	0.009	30.735
443	8.214	0.182	0.575	15.401	0.846	0.009	30.269
444	8.065	0.178	0.57	15.135	0.795	0.009	29.715
445	7.918	0.174	0.564	14.875	0.814	0.009	29.258
446	7.774	0.171	0.559	14.622	0.765	0.008	28.719
447	7.632	0.167	0.553	14.372	0.783	0.008	28.272
448	7.493	0.164	0.548	14.127	0.737	0.008	27.749
449	7.357	0.161	0.543	13.885	0.754	0.008	27.312
450	7.223	0.157	0.537	13.647	0.71	0.008	26.804
451	7.092	0.154	0.532	13.413	0.726	0.007	26.378
452	6.963	0.151	0.527	13.182	0.685	0.007	25.885
453	6.838	0.148	0.523	12.955	0.699	0.007	25.471
454	6.714	0.145	0.519	12.731	0.66	0.007	24.998
455	6.594	0.142	0.515	12.511	0.673	0.007	24.598
456	6.476	0.14	0.51	12.294	0.636	0.007	24.141
457	6.361	0.137	0.506	12.08	0.649	0.007	23.753
458	6.248	0.134	0.502	11.87	0.614	0.006	23.311
459	6.138	0.131	0.498	11.662	0.625	0.006	22.934
460	6.03	0.129	0.494	11.459	0.592	0.006	22.507
461	5.924	0.126	0.49	11.258	0.603	0.006	22.142
462	5.821	0.124	0.486	11.062	0.571	0.006	21.73
463	5.72	0.122	0.482	10.868	0.581	0.006	21.376

464	5.621	0.119	0.478	10.679	0.551	0.006	20.978
465	5.523	0.117	0.474	10.493	0.561	0.005	20.636
466	5.428	0.115	0.471	10.311	0.532	0.005	20.253
467	5.335	0.113	0.467	10.132	0.541	0.005	19.922
468	5.243	0.11	0.463	9.957	0.514	0.005	19.553
469	5.154	0.108	0.459	9.786	0.522	0.005	19.235
470	5.066	0.106	0.456	9.618	0.496	0.005	18.881
471	4.979	0.104	0.452	9.454	0.504	0.005	18.575
472	4.895	0.102	0.448	9.293	0.479	0.005	18.234
473	4.812	0.101	0.443	9.136	0.487	0.005	17.94
474	4.73	0.099	0.439	8.982	0.463	0.005	17.613
475	4.65	0.097	0.435	8.831	0.47	0.004	17.331
476	4.571	0.095	0.431	8.683	0.447	0.004	17.017
477	4.494	0.093	0.427	8.538	0.454	0.004	16.746
478	4.419	0.092	0.423	8.396	0.432	0.004	16.446
479	4.345	0.09	0.419	8.257	0.439	0.004	16.185
480	4.272	0.088	0.415	8.121	0.418	0.004	15.897
481	4.2	0.087	0.411	7.988	0.424	0.004	15.646
482	4.13	0.085	0.408	7.857	0.404	0.004	15.37
483	4.061	0.084	0.404	7.729	0.41	0.004	15.13
484	3.993	0.082	0.4	7.603	0.391	0.004	14.864
485	3.927	0.081	0.396	7.48	0.396	0.004	14.633
486	3.862	0.079	0.393	7.359	0.378	0.004	14.378
487	3.798	0.078	0.389	7.24	0.383	0.003	14.156
488	3.735	0.077	0.386	7.124	0.366	0.003	13.91
489	3.673	0.075	0.382	7.01	0.371	0.003	13.696
490	3.613	0.074	0.379	6.898	0.354	0.003	13.46
491	3.553	0.073	0.375	6.788	0.358	0.003	13.253
492	3.495	0.071	0.372	6.68	0.343	0.003	13.026
493	3.438	0.07	0.369	6.574	0.347	0.003	12.827
494	3.382	0.069	0.365	6.47	0.332	0.003	12.609
495	3.326	0.068	0.362	6.368	0.336	0.003	12.417
496	3.272	0.067	0.359	6.268	0.321	0.003	12.207
497	3.219	0.066	0.355	6.17	0.325	0.003	12.022
498	3.167	0.064	0.352	6.074	0.311	0.003	11.82
499	3.116	0.063	0.349	5.98	0.315	0.003	11.642
500	3.065	0.062	0.346	5.887	0.302	0.003	11.447
501	3.016	0.061	0.343	5.796	0.305	0.003	11.275
502	2.967	0.06	0.34	5.707	0.292	0.003	11.088
503	2.92	0.059	0.337	5.619	0.295	0.003	10.922
504	2.873	0.058	0.334	5.534	0.283	0.003	10.742
505	2.827	0.057	0.331	5.449	0.286	0.002	10.583
506	2.782	0.056	0.328	5.366	0.275	0.002	10.409
507	2.738	0.055	0.325	5.285	0.277	0.002	10.255
508	2.694	0.055	0.322	5.206	0.266	0.002	10.088
509	2.652	0.054	0.32	5.127	0.269	0.002	9.94
510	2.61	0.053	0.317	5.051	0.258	0.002	9.778
511	2.569	0.052	0.314	4.975	0.261	0.002	9.636
512	2.528	0.051	0.311	4.902	0.25	0.002	9.48
513	2.489	0.05	0.309	4.829	0.253	0.002	9.343
514	2.45	0.05	0.306	4.758	0.243	0.002	9.193
515	2.412	0.049	0.303	4.688	0.245	0.002	9.06
516	2.374	0.048	0.301	4.619	0.236	0.002	8.916
517	2.337	0.047	0.298	4.552	0.238	0.002	8.788
518	2.301	0.047	0.296	4.486	0.229	0.002	8.649
519	2.265	0.046	0.293	4.421	0.231	0.002	8.526
520	2.231	0.045	0.291	4.358	0.222	0.002	8.392
521	2.196	0.044	0.288	4.295	0.224	0.002	8.273

522	2.163	0.044	0.286	4.234	0.216	0.002	8.144
523	2.129	0.043	0.283	4.174	0.218	0.002	8.03
524	2.097	0.042	0.281	4.115	0.209	0.002	7.905
525	2.065	0.042	0.278	4.057	0.211	0.002	7.795
526	2.034	0.041	0.276	4	0.203	0.002	7.675
527	2.003	0.04	0.273	3.944	0.205	0.002	7.568
528	1.973	0.04	0.27	3.889	0.198	0.002	7.453
529	1.943	0.039	0.267	3.836	0.199	0.002	7.35
530	1.914	0.039	0.264	3.783	0.192	0.002	7.239
531	1.885	0.038	0.261	3.731	0.194	0.002	7.14
532	1.857	0.038	0.258	3.68	0.187	0.002	7.033
533	1.829	0.037	0.255	3.629	0.188	0.002	6.937
534	1.802	0.036	0.253	3.58	0.181	0.002	6.834
535	1.775	0.036	0.25	3.532	0.183	0.002	6.742
536	1.749	0.035	0.247	3.484	0.176	0.001	6.642
537	1.723	0.035	0.245	3.438	0.178	0.001	6.553
538	1.698	0.034	0.242	3.392	0.172	0.001	6.456
539	1.673	0.034	0.239	3.347	0.173	0.001	6.371
540	1.649	0.033	0.237	3.302	0.167	0.001	6.278
541	1.625	0.033	0.234	3.259	0.168	0.001	6.195
542	1.601	0.032	0.232	3.216	0.162	0.001	6.105
543	1.578	0.032	0.229	3.174	0.164	0.001	6.024
544	1.555	0.032	0.227	3.133	0.158	0.001	5.937
545	1.532	0.031	0.224	3.092	0.159	0.001	5.859
546	1.51	0.031	0.222	3.052	0.154	0.001	5.774
547	1.489	0.03	0.22	3.013	0.155	0.001	5.699
548	1.467	0.03	0.217	2.974	0.15	0.001	5.617
549	1.446	0.029	0.215	2.936	0.151	0.001	5.545
550	1.426	0.029	0.213	2.899	0.146	0.001	5.466
551	1.406	0.029	0.21	2.862	0.147	0.001	5.396
552	1.386	0.028	0.208	2.826	0.142	0.001	5.32
553	1.366	0.028	0.206	2.791	0.143	0.001	5.252
554	1.347	0.027	0.204	2.756	0.138	0.001	5.178
555	1.328	0.027	0.201	2.722	0.139	0.001	5.113
556	1.31	0.027	0.199	2.688	0.134	0.001	5.042
557	1.291	0.026	0.197	2.655	0.135	0.001	4.978
558	1.273	0.026	0.195	2.622	0.131	0.001	4.91
559	1.256	0.026	0.193	2.59	0.132	0.001	4.848
560	1.238	0.025	0.191	2.559	0.128	0.001	4.782
561	1.221	0.025	0.189	2.528	0.129	0.001	4.723
562	1.204	0.025	0.187	2.497	0.124	0.001	4.659
563	1.188	0.024	0.185	2.467	0.125	0.001	4.601
564	1.172	0.024	0.183	2.438	0.121	0.001	4.539
565	1.156	0.024	0.181	2.409	0.122	0.001	4.484
566	1.14	0.023	0.179	2.38	0.118	0.001	4.424
567	1.124	0.023	0.177	2.352	0.119	0.001	4.37
568	1.109	0.023	0.175	2.324	0.115	0.001	4.312
569	1.094	0.022	0.174	2.297	0.116	0.001	4.26
570	1.08	0.022	0.172	2.27	0.112	0.001	4.204
571	1.065	0.022	0.17	2.244	0.113	0.001	4.153
572	1.051	0.022	0.168	2.218	0.11	0.001	4.099
573	1.037	0.021	0.166	2.193	0.11	0.001	4.05
574	1.023	0.021	0.165	2.168	0.107	0.001	3.998
575	1.01	0.021	0.163	2.143	0.108	0.001	3.95
576	0.996	0.02	0.161	2.118	0.104	0.001	3.899
577	0.983	0.02	0.16	2.094	0.105	0.001	3.854
578	0.97	0.02	0.158	2.071	0.102	0.001	3.804
579	0.957	0.02	0.157	2.048	0.102	0.001	3.76

580	0.945	0.019	0.155	2.025	0.099	0.001	3.712
581	0.933	0.019	0.153	2.003	0.1	0.001	3.67
582	0.921	0.019	0.152	1.981	0.097	0.001	3.623
583	0.909	0.019	0.151	1.959	0.098	0.001	3.582
584	0.897	0.019	0.149	1.938	0.095	0.001	3.537
585	0.885	0.018	0.148	1.917	0.095	0.001	3.497
586	0.874	0.018	0.146	1.896	0.092	0.001	3.453
587	0.863	0.018	0.145	1.876	0.093	0.001	3.414
588	0.852	0.018	0.143	1.855	0.09	0.001	3.372
589	0.841	0.017	0.142	1.836	0.091	0.001	3.335
590	0.83	0.017	0.141	1.816	0.088	0.001	3.294
591	0.82	0.017	0.139	1.797	0.089	0.001	3.257
592	0.809	0.017	0.138	1.778	0.086	0.001	3.218
593	0.799	0.017	0.137	1.76	0.087	0.001	3.183
594	0.789	0.016	0.135	1.741	0.084	0.001	3.145
595	0.779	0.016	0.134	1.723	0.085	0.001	3.11
596	0.77	0.016	0.133	1.705	0.082	0.001	3.073
597	0.76	0.016	0.131	1.688	0.083	0.001	3.04
598	0.751	0.016	0.13	1.67	0.08	0.001	3.004
599	0.741	0.015	0.129	1.653	0.081	0.001	2.972
600	0.732	0.015	0.128	1.637	0.078	0.001	2.937

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4	0	0	0
5	0	0	0
6	0.025	0	0
7	0.151	0	0
8	0.33	0	0
9	0.434	0	0
10	0.447	0	0
11	0.437	0	0
12	0.437	0	0
13	0.439	0	0
14	0.438	0	0
15	0.438	0	0
16	0.438	0	0
17	0.438	0	0
18	0.438	0	0
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22	0.438	0	0
23	0.438	0	0
24	0.438	0	0
25	0.438	0	0
26	0.438	0	0
27	0.438	0	0
28	0.438	0.005	0.007
29	0.438	0.024	0.033
30	0.438	0.048	0.068
31	0.555	0.085	0.126
32	0.76	0.129	0.206
33	0.86	0.157	0.271
34	0.865	0.17	0.31
35	0.852	0.173	0.328
36	0.854	0.173	0.333
37	0.856	0.173	0.333
38	0.854	0.173	0.333
39	0.855	0.173	0.333
40	0.855	0.173	0.333
41	0.855	0.173	0.333
42	0.855	0.173	0.333
43	0.855	0.173	0.333
44	0.859	0.173	0.333
45	0.864	0.173	0.333
46	0.871	0.173	0.333
47	0.879	0.173	0.333
48	0.887	0.173	0.333
49	0.896	0.173	0.333

50	0.906	0.173	0.333
51	0.916	0.173	0.333
52	0.927	0.173	0.333
53	0.938	0.173	0.333
54	0.95	0.173	0.333
55	0.962	0.173	0.333
56	0.975	0.173	0.333
57	0.987	0.174	0.334
58	1	0.178	0.339
59	1.014	0.185	0.346
60	1.027	0.193	0.354
61	1.147	0.217	0.387
62	1.331	0.256	0.442
63	1.414	0.289	0.491
64	1.428	0.314	0.53
65	1.438	0.334	0.558
66	1.46	0.352	0.581
67	1.478	0.372	0.601
68	1.493	0.393	0.624
69	1.51	0.415	0.647
70	1.524	0.437	0.671
71	1.538	0.46	0.696
72	1.551	0.484	0.721
73	1.563	0.509	0.748
74	1.574	0.534	0.775
75	1.583	0.56	0.802
76	1.592	0.587	0.831
77	1.6	0.614	0.86
78	1.607	0.642	0.89
79	1.614	0.67	0.92
80	1.619	0.699	0.951
81	1.624	0.728	0.982
82	1.629	0.758	1.014
83	1.632	0.789	1.046
84	1.636	0.819	1.079
85	1.638	0.851	1.113
86	1.641	0.883	1.146
87	1.643	0.915	1.181
88	1.644	0.948	1.216
89	1.646	0.981	1.251
90	1.647	1.014	1.287
91	2.13	1.131	1.441
92	2.897	1.323	1.71
93	3.118	1.474	1.938
94	3.069	1.576	2.099
95	3.091	1.653	2.202
96	3.147	1.733	2.286
97	3.166	1.82	2.375
98	3.197	1.907	2.468
99	3.231	1.994	2.562

100	3.257	2.084	2.658
101	3.288	2.175	2.755
102	3.315	2.266	2.853
103	3.341	2.359	2.952
104	3.367	2.453	3.053
105	3.389	2.548	3.154
106	3.411	2.643	3.256
107	3.43	2.74	3.359
108	3.446	2.836	3.463
109	3.461	2.934	3.567
110	3.474	3.031	3.672
111	3.484	3.129	3.777
112	3.493	3.227	3.882
113	3.5	3.325	3.987
114	3.506	3.422	4.092
115	3.511	3.52	4.197
116	3.515	3.616	4.301
117	3.518	3.713	4.405
118	3.52	3.808	4.508
119	3.522	3.902	4.61
120	3.524	3.996	4.711
121	3.178	4.021	4.716
122	2.71	3.997	4.646
123	2.573	4.004	4.616
124	2.583	4.037	4.625
125	2.574	4.082	4.661
126	2.541	4.126	4.709
127	2.522	4.166	4.755
128	2.505	4.203	4.797
129	2.483	4.239	4.837
130	2.467	4.273	4.875
131	2.449	4.304	4.91
132	2.433	4.334	4.943
133	2.419	4.361	4.974
134	2.405	4.386	5.003
135	2.392	4.408	5.029
136	2.381	4.429	5.053
137	2.37	4.447	5.074
138	2.361	4.463	5.093
139	2.353	4.478	5.111
140	2.346	4.49	5.126
141	2.34	4.5	5.138
142	2.335	4.509	5.149
143	2.33	4.515	5.158
144	2.326	4.52	5.165
145	2.323	4.524	5.17
146	2.32	4.525	5.174
147	2.318	4.526	5.176
148	2.316	4.525	5.176
149	2.314	4.522	5.175

150	2.313	4.519	5.173
151	2.027	4.458	5.09
152	1.627	4.353	4.943
153	1.476	4.272	4.825
154	1.46	4.21	4.735
155	1.46	4.162	4.669
156	1.438	4.117	4.616
157	1.418	4.072	4.568
158	1.405	4.027	4.521
159	1.388	3.981	4.473
160	1.373	3.936	4.425
161	1.359	3.891	4.377
162	1.345	3.846	4.329
163	1.333	3.801	4.282
164	1.321	3.757	4.234
165	1.309	3.713	4.187
166	1.299	3.669	4.141
167	1.289	3.626	4.095
168	1.28	3.583	4.049
169	1.272	3.541	4.004
170	1.265	3.5	3.96
171	1.258	3.459	3.916
172	1.252	3.418	3.872
173	1.247	3.379	3.83
174	1.242	3.339	3.788
175	1.237	3.301	3.746
176	1.233	3.263	3.706
177	1.23	3.226	3.666
178	1.227	3.19	3.627
179	1.225	3.154	3.588
180	1.222	3.119	3.55
181	1.182	3.077	3.503
182	1.121	3.03	3.447
183	1.092	2.986	3.395
184	1.087	2.946	3.347
185	1.087	2.909	3.304
186	1.084	2.873	3.264
187	1.08	2.838	3.227
188	1.078	2.805	3.19
189	1.075	2.771	3.154
190	1.072	2.739	3.119
191	1.07	2.708	3.085
192	1.068	2.677	3.051
193	1.066	2.647	3.018
194	1.064	2.617	2.987
195	1.062	2.589	2.955
196	1.06	2.561	2.925
197	1.058	2.534	2.896
198	1.056	2.508	2.867
199	1.055	2.482	2.839

200	1.054	2.457	2.812
201	1.052	2.433	2.785
202	1.051	2.409	2.759
203	1.05	2.386	2.734
204	1.049	2.364	2.71
205	1.048	2.342	2.686
206	1.048	2.321	2.663
207	1.047	2.3	2.641
208	1.046	2.281	2.619
209	1.046	2.261	2.598
210	1.045	2.243	2.577
211	1.045	2.225	2.557
212	1.044	2.207	2.538
213	1.044	2.19	2.519
214	1.044	2.173	2.501
215	1.044	2.157	2.483
216	1.043	2.142	2.466
217	1.043	2.127	2.45
218	1.043	2.112	2.434
219	1.043	2.098	2.418
220	1.043	2.085	2.403
221	1.043	2.072	2.389
222	1.043	2.059	2.375
223	1.043	2.047	2.361
224	1.043	2.035	2.348
225	1.042	2.023	2.335
226	1.042	2.012	2.323
227	1.042	2.001	2.311
228	1.042	1.991	2.3
229	1.042	1.981	2.289
230	1.042	1.971	2.278
231	1.042	1.962	2.268
232	1.042	1.953	2.258
233	1.042	1.945	2.248
234	1.042	1.936	2.239
235	1.042	1.928	2.23
236	1.042	1.92	2.221
237	1.042	1.913	2.213
238	1.042	1.906	2.205
239	1.042	1.899	2.197
240	1.042	1.892	2.19
241	0.978	1.874	2.166
242	0.879	1.846	2.127
243	0.831	1.822	2.094
244	0.82	1.803	2.067
245	0.821	1.787	2.045
246	0.818	1.774	2.027
247	0.813	1.762	2.013
248	0.81	1.75	2
249	0.807	1.738	1.986

250	0.803	1.726	1.974
251	0.8	1.715	1.961
252	0.796	1.703	1.949
253	0.793	1.692	1.937
254	0.79	1.682	1.925
255	0.787	1.671	1.914
256	0.785	1.661	1.902
257	0.782	1.651	1.891
258	0.779	1.641	1.88
259	0.777	1.631	1.87
260	0.775	1.621	1.859
261	0.773	1.612	1.849
262	0.771	1.603	1.839
263	0.769	1.594	1.829
264	0.767	1.585	1.819
265	0.766	1.576	1.81
266	0.764	1.568	1.801
267	0.763	1.559	1.792
268	0.762	1.551	1.783
269	0.761	1.543	1.774
270	0.76	1.535	1.765
271	0.791	1.533	1.765
272	0.842	1.537	1.773
273	0.869	1.539	1.779
274	0.873	1.539	1.782
275	0.871	1.537	1.782
276	0.873	1.533	1.78
277	0.875	1.53	1.777
278	0.876	1.527	1.774
279	0.877	1.524	1.77
280	0.879	1.521	1.767
281	0.88	1.518	1.764
282	0.882	1.515	1.761
283	0.884	1.513	1.758
284	0.885	1.51	1.755
285	0.886	1.508	1.752
286	0.888	1.505	1.75
287	0.889	1.503	1.747
288	0.891	1.501	1.745
289	0.892	1.499	1.742
290	0.893	1.497	1.74
291	0.894	1.495	1.738
292	0.895	1.493	1.736
293	0.896	1.491	1.734
294	0.897	1.489	1.732
295	0.898	1.488	1.73
296	0.899	1.486	1.728
297	0.9	1.485	1.726
298	0.9	1.483	1.725
299	0.901	1.482	1.723

300	0.901	1.481	1.722
301	0.805	1.462	1.695
302	0.656	1.428	1.647
303	0.58	1.4	1.606
304	0.556	1.378	1.573
305	0.554	1.361	1.547
306	0.551	1.348	1.528
307	0.545	1.336	1.512
308	0.539	1.325	1.498
309	0.535	1.313	1.486
310	0.53	1.302	1.474
311	0.525	1.291	1.462
312	0.52	1.28	1.45
313	0.515	1.269	1.438
314	0.511	1.258	1.426
315	0.507	1.248	1.415
316	0.503	1.237	1.404
317	0.499	1.227	1.392
318	0.495	1.217	1.381
319	0.492	1.207	1.371
320	0.488	1.197	1.36
321	0.485	1.187	1.349
322	0.482	1.177	1.339
323	0.479	1.168	1.329
324	0.477	1.158	1.318
325	0.474	1.149	1.308
326	0.472	1.14	1.298
327	0.47	1.131	1.289
328	0.468	1.122	1.279
329	0.466	1.113	1.269
330	0.464	1.104	1.26
331	0.429	1.089	1.242
332	0.373	1.069	1.216
333	0.339	1.051	1.192
334	0.323	1.034	1.171
335	0.319	1.019	1.152
336	0.317	1.006	1.135
337	0.314	0.994	1.12
338	0.312	0.982	1.106
339	0.309	0.97	1.093
340	0.307	0.958	1.08
341	0.304	0.947	1.068
342	0.302	0.936	1.056
343	0.3	0.925	1.044
344	0.298	0.914	1.032
345	0.296	0.903	1.02
346	0.294	0.892	1.009
347	0.293	0.882	0.997
348	0.291	0.871	0.986
349	0.289	0.861	0.975

350	0.288	0.851	0.964
351	0.286	0.841	0.953
352	0.285	0.831	0.943
353	0.284	0.821	0.932
354	0.282	0.812	0.922
355	0.281	0.802	0.912
356	0.28	0.793	0.902
357	0.279	0.784	0.892
358	0.278	0.775	0.882
359	0.277	0.766	0.872
360	0.276	0.757	0.863
361	0.23	0.741	0.843
362	0.158	0.719	0.814
363	0.113	0.699	0.787
364	0.088	0.682	0.764
365	0.074	0.667	0.744
366	0.066	0.653	0.725
367	0.061	0.64	0.709
368	0.057	0.628	0.694
369	0.054	0.616	0.68
370	0.051	0.605	0.667
371	0.049	0.594	0.654
372	0.047	0.583	0.642
373	0.045	0.573	0.63
374	0.043	0.563	0.619
375	0.041	0.553	0.608
376	0.039	0.543	0.597
377	0.038	0.533	0.586
378	0.036	0.524	0.576
379	0.035	0.515	0.566
380	0.033	0.505	0.556
381	0.032	0.497	0.546
382	0.03	0.488	0.536
383	0.029	0.479	0.527
384	0.028	0.471	0.518
385	0.027	0.462	0.509
386	0.026	0.454	0.5
387	0.025	0.446	0.491
388	0.024	0.438	0.482
389	0.023	0.43	0.474
390	0.022	0.423	0.466
391	0.021	0.415	0.457
392	0.02	0.408	0.449
393	0.019	0.401	0.442
394	0.018	0.394	0.434
395	0.018	0.387	0.426
396	0.017	0.38	0.419
397	0.016	0.373	0.411
398	0.016	0.367	0.404
399	0.015	0.36	0.397

400	0.014	0.354	0.39
401	0.014	0.348	0.383
402	0.013	0.342	0.377
403	0.013	0.336	0.37
404	0.012	0.33	0.364
405	0.012	0.324	0.358
406	0.011	0.318	0.351
407	0.011	0.313	0.345
408	0.01	0.307	0.339
409	0.01	0.302	0.333
410	0.01	0.297	0.328
411	0.009	0.292	0.322
412	0.009	0.286	0.316
413	0.009	0.281	0.311
414	0.008	0.277	0.306
415	0.008	0.272	0.3
416	0.008	0.267	0.295
417	0.007	0.263	0.29
418	0.007	0.258	0.285
419	0.007	0.254	0.28
420	0.007	0.249	0.276
421	0.006	0.245	0.271
422	0.006	0.241	0.266
423	0.006	0.237	0.262
424	0.006	0.233	0.257
425	0.006	0.229	0.253
426	0.005	0.225	0.249
427	0.005	0.221	0.245
428	0.005	0.217	0.24
429	0.005	0.213	0.236
430	0.005	0.21	0.232
431	0.005	0.206	0.229
432	0.004	0.203	0.225
433	0.004	0.199	0.221
434	0.004	0.196	0.217
435	0.004	0.193	0.214
436	0.004	0.19	0.21
437	0.004	0.186	0.207
438	0.004	0.183	0.203
439	0.004	0.18	0.2
440	0.003	0.177	0.197
441	0.003	0.174	0.194
442	0.003	0.172	0.19
443	0.003	0.169	0.187
444	0.003	0.166	0.184
445	0.003	0.163	0.181
446	0.003	0.161	0.178
447	0.003	0.158	0.175
448	0.003	0.155	0.173
449	0.003	0.153	0.17

450	0.003	0.15	0.167
451	0.002	0.148	0.164
452	0.002	0.146	0.162
453	0.002	0.143	0.159
454	0.002	0.141	0.157
455	0.002	0.139	0.154
456	0.002	0.137	0.152
457	0.002	0.134	0.149
458	0.002	0.132	0.147
459	0.002	0.13	0.145
460	0.002	0.128	0.142
461	0.002	0.126	0.14
462	0.002	0.124	0.138
463	0.002	0.122	0.136
464	0.002	0.12	0.134
465	0.002	0.118	0.132
466	0.002	0.117	0.13
467	0.002	0.115	0.128
468	0.002	0.113	0.126
469	0.002	0.111	0.124
470	0.001	0.109	0.122
471	0.001	0.108	0.12
472	0.001	0.106	0.118
473	0.001	0.105	0.116
474	0.001	0.103	0.115
475	0.001	0.101	0.113
476	0.001	0.1	0.111
477	0.001	0.098	0.11
478	0.001	0.097	0.108
479	0.001	0.095	0.106
480	0.001	0.094	0.105
481	0.001	0.093	0.103
482	0.001	0.091	0.102
483	0.001	0.09	0.1
484	0.001	0.089	0.099
485	0.001	0.087	0.097
486	0.001	0.086	0.096
487	0.001	0.085	0.094
488	0.001	0.083	0.093
489	0.001	0.082	0.092
490	0.001	0.081	0.09
491	0.001	0.08	0.089
492	0.001	0.079	0.088
493	0.001	0.078	0.087
494	0.001	0.076	0.085
495	0.001	0.075	0.084
496	0.001	0.074	0.083
497	0.001	0.073	0.082
498	0.001	0.072	0.081
499	0.001	0.071	0.079

500	0.001	0.07	0.078
501	0.001	0.069	0.077
502	0.001	0.068	0.076
503	0.001	0.067	0.075
504	0.001	0.066	0.074
505	0.001	0.065	0.073
506	0.001	0.064	0.072
507	0.001	0.064	0.071
508	0.001	0.063	0.07
509	0.001	0.062	0.069
510	0.001	0.061	0.068
511	0.001	0.06	0.067
512	0.001	0.059	0.066
513	0.001	0.059	0.065
514	0.001	0.058	0.065
515	0.001	0.057	0.064
516	0.001	0.056	0.063
517	0.001	0.055	0.062
518	0.001	0.055	0.061
519	0.001	0.054	0.06
520	0	0.053	0.06
521	0	0.053	0.059
522	0	0.052	0.058
523	0	0.051	0.057
524	0	0.05	0.056
525	0	0.05	0.056
526	0	0.049	0.055
527	0	0.048	0.054
528	0	0.048	0.054
529	0	0.047	0.053
530	0	0.047	0.052
531	0	0.046	0.052
532	0	0.045	0.051
533	0	0.045	0.05
534	0	0.044	0.05
535	0	0.044	0.049
536	0	0.043	0.048
537	0	0.043	0.048
538	0	0.042	0.047
539	0	0.042	0.047
540	0	0.041	0.046
541	0	0.041	0.045
542	0	0.04	0.045
543	0	0.04	0.044
544	0	0.039	0.044
545	0	0.039	0.043
546	0	0.038	0.043
547	0	0.038	0.042
548	0	0.037	0.042
549	0	0.037	0.041

550	0	0.036	0.041
551	0	0.036	0.04
552	0	0.035	0.04
553	0	0.035	0.039
554	0	0.034	0.039
555	0	0.034	0.038
556	0	0.034	0.038
557	0	0.033	0.037
558	0	0.033	0.037
559	0	0.032	0.036
560	0	0.032	0.036
561	0	0.032	0.036
562	0	0.031	0.035
563	0	0.031	0.035
564	0	0.031	0.034
565	0	0.03	0.034
566	0	0.03	0.034
567	0	0.03	0.033
568	0	0.029	0.033
569	0	0.029	0.032
570	0	0.029	0.032
571	0	0.028	0.032
572	0	0.028	0.031
573	0	0.028	0.031
574	0	0.027	0.031
575	0	0.027	0.03
576	0	0.027	0.03
577	0	0.026	0.03
578	0	0.026	0.029
579	0	0.026	0.029
580	0	0.025	0.029
581	0	0.025	0.028
582	0	0.025	0.028
583	0	0.025	0.028
584	0	0.024	0.027
585	0	0.024	0.027
586	0	0.024	0.027
587	0	0.024	0.026
588	0	0.023	0.026
589	0	0.023	0.026
590	0	0.023	0.026
591	0	0.023	0.025
592	0	0.022	0.025
593	0	0.022	0.025
594	0	0.022	0.024
595	0	0.022	0.024
596	0	0.021	0.024
597	0	0.021	0.024
598	0	0.021	0.023
599	0	0.021	0.023

600	0	0.02	0.023