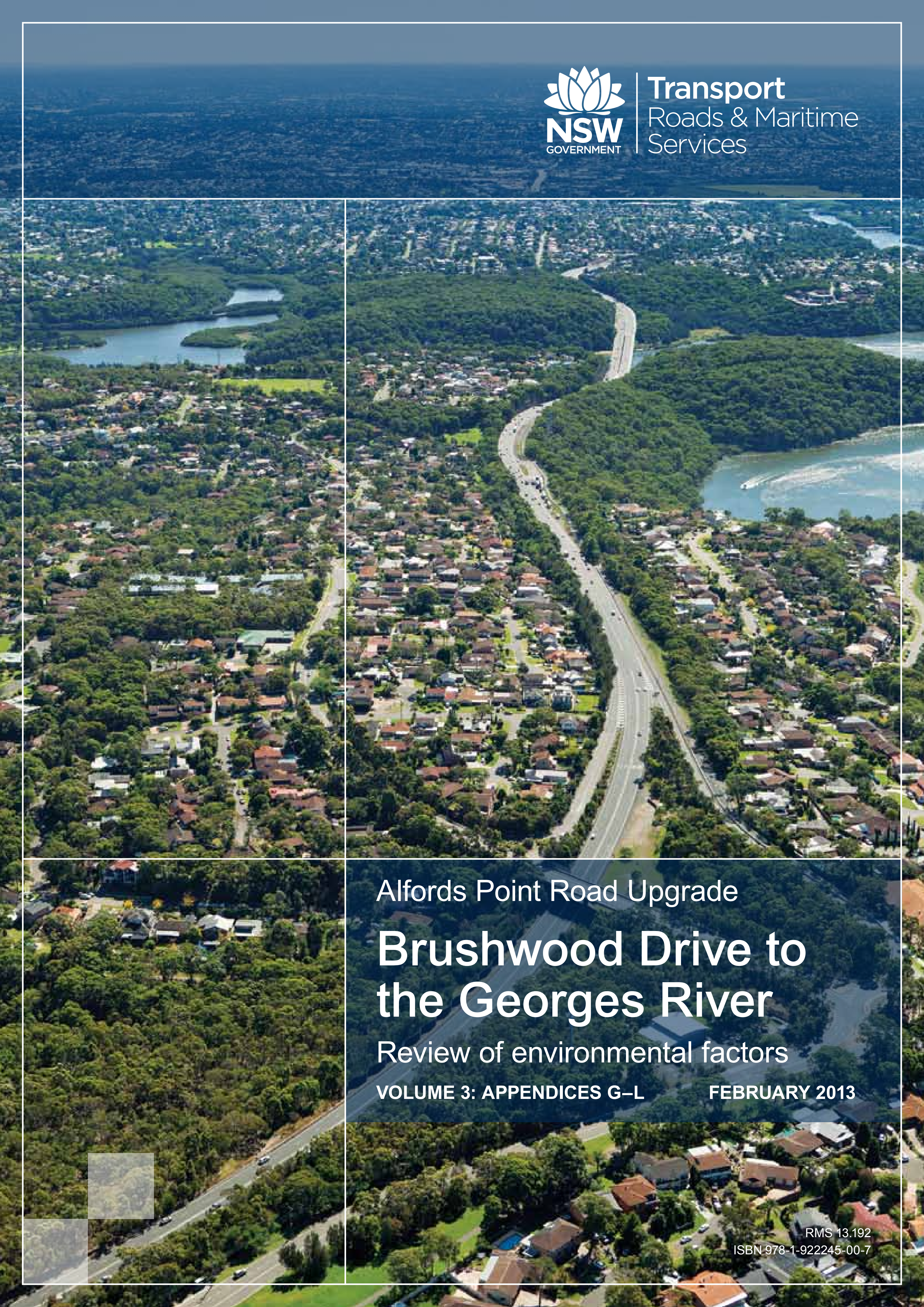
Transport
Roads & Maritime Services



Alfords Point Road Upgrade

Brushwood Drive to the Georges River

Review of environmental factors

VOLUME 3: APPENDICES G–L **FEBRUARY 2013**

RMS 13.192
ISBN 978-1-922245-00-7

Appendix G

Hydrology and drainage assessment

CLIENTS | PEOPLE | PERFORMANCE

Roads and Maritime Services

Report for MR190 - Alfords Point Road Upgrade (REF)

Brushwood Drive to Georges River, Concept Design - Drainage

November 2012

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

This Report for MR190 - Alfords Point Road Upgrade between Brushwood Drive and Georges River REF Concept Design - Drainage ("Report"):

1. *has been prepared by GHD Pty Ltd ("GHD") for NSW Roads and Maritime Services;*
2. *may only be used and relied on by NSW Roads and Maritime Services;*
3. *must not be copied to, used by, or relied on by any person other than NSW Roads and Maritime Services without the prior written consent of GHD;*
4. *may only be used for the purpose of understanding conceptual post-development drainage (and must not be used for any other purpose).*

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than NSW Roads and Maritime Services arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report:

- *were limited to those specifically detailed in section 1.2 of this Report;*
- *did not include CCTV inspections of existing pipework or assessment of the age or suitability of the existing storm water assets.*

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), including (but not limited to):

- *delineation of catchments on the basis of survey information provided by others;*
- *Details of the existing drainage system provided by others.*

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until 6 months, after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

Contents

Table Index

Figure Index

Appendices

1. Introduction

1.1 Project Background

The existing Alfords Point Road south of the southern abutment of Alfords Point Bridge consists of a dual carriageway with two (3.3m) lanes in both directions. Alfords Point Road is a primary arterial road (commuters and freight) and is used as a Strategic Bus Corridor between Miranda and Bankstown. The northbound on ramp from Brushwood Drive merges with the existing two northbound lanes on Alfords Point Road, whilst the southbound off ramp for Old Illawarra Road diverges from the existing two southbound lanes of Alfords Point Road. The site location plan for the proposed works is provided in Figure 1.

The Roads and Maritime Services (RMS) are presently investigating a proposal to widen the Alfords Point Road from the southern bridge abutment to Brushwood Drive for approximately 2.1 kilometres in length. The proposal consists of upgrading the existing undivided four (4) lane dual carriage way to a six (6) lane divided carriageway with a Type F concrete median barrier in between the northbound and southbound lanes. The road widening is proposed to be undertaken on the eastern side of the existing southbound carriageway. The proposed third lane to be incorporated in each direction would align with the Brushwood Drive ramps and thus eliminate the existing northbound merge. The northbound on ramp from Brushwood Drive will also be widened locally to accommodate a bus stop.

The proposal also includes a 3m shared path adjacent to the southbound carriageway and relocation of the existing heavy vehicle inspection bay further south along Alfords Point Road under Old Illawarra Road overbridge. This report should be read in conjunction with the drawings provided in Appendix C

1.2 Scope of Report

This report will review and assess the existing drainage measures and assess their adequacy in relation to the proposed six (6) lane pavement works. The report documents a concept drainage design that addresses identified drainage changes and incorporates RMS standard criteria and specific requirements documented in their brief.

The DRAINS (drainage) and 12D (civil design) computer software packages were used to assess and develop the respective design requirements.

The report has been developed in consideration of the following scope outlined in the project brief.

1.2.1 Stage 1 – REF Drainage Investigation

Delineate the appropriate existing catchment boundaries on the basis of ground survey;

Estimate existing runoff characteristics using a simplified DRAINS model;

Determine changes to the flow distribution resulting from the proposed pavement and upgrade works including superelevation transitions, particularly with consideration of the Type F median barrier.

Document the changes in the magnitude of flows as a result of the proposed upgrade works for a range of design storm events;

Develop a strategy to separate the pavement runoff from adjacent catchments (where practical) and mitigate the effects of both quantity and quality;

Provide provisions for permanent spill control measures up to 25m^3 (cubic metres) and assess potential temporary basin locations for temporary (construction) requirements;

Mitigate any impacts from the upgrade works in terms of the road corridor;

General consideration of constructability related requirements in relation to the design.

1.2.2 Stage 2 – Concept Drainage Investigations and Design

Assess the performance of the existing drainage system in terms of RMS standard criteria and requirements;

Design the necessary works to upgrade/comply with current standards if the system was deemed to be deficient;

Prepare concept design works required to discharge stormwater runoff captured by the pavement of the roadway to the shoreline of the Georges River;

Prepare a concept design of the measures to treat stormwater runoff prior to discharging to the Georges River;

Incorporate measures for containing up to 25m^3 of spill control;

Prepare a concept design for the six (6) lane widened road to ensure the bridge approaches have sufficient capacity; and

Investigate any cross drainage requirements.

1.3 Design Criteria

The following design criteria were adopted in assessing and developing the drainage design elements:

The pavement drainage system should be capable of capturing and conveying runoff generated by short duration storms with an average recurrence interval (ARI) of up to 10 years.

The design width of gutter flow should not to exceed 1.0m perpendicular to the kerb face during storm events with frequencies of up to and including the 10 year ARI. It is noted that the documented flow width of 1.5m for storm events with frequencies of up to and including the 20 year ARI was amended following consultation with RMS (Refer Appendix F - minutes dated 22nd June 2012).

The design of the road and pavement drainage system for the bridge approaches must ensure that depths of sheet flow across the road surface do not exceed 5 mm during a storm with an intensity of 50 mm/hr.

Inline pollution control devices and sediment retention ponds are to be incorporated into the design of the pavement drainage system.

Incident management control measures capable of intercepting and temporarily storing up to 25m^3 of spill material to be implemented into the design of the pavement drainage system where feasible and where no such facility is available nearby.

1.4 Available Data

The following documentation and information was provided to GHD in preparation of the drainage report:

1. Lyall & Associates. *"Alfords Point Bridge Duplication. Pavement Drainage Design Report"* 2006 Registration Number 0190.411.RC.2510
2. Hughes Trueman, MR190 – *"Alfords Point Road Reconstruction and Widening from Alma Road to Alfords Point Bridge and New Off-Road Shared Path Alfords Point Bridge to Fowler Road, Detail Design Report"* 2008 *including extracts from Registration Number 0190.026.RC.2517*
3. Sutherland Shire Council *"Sutherland Shite Specification Stormwater Management"* 2009

Note: In addition to the above documentation RMS has provided various models including road alignment, survey (2m contours) and additional drainage related surveys.

The Lyall and Associates drainage concept design which was consistent with the alignment (MX genio) model developed in 2006 has subsequently been superseded

The current concept MX genio model (gen_design_121015.txt) was provided by RMS on 15 October 2012 and has subsequently been adopted by GHD in developing the current drainage concept design.

GHD has also obtained various plans from Sutherland Shire Council relating to surrounding drainage infrastructure.

1.5 Design Development

A number of aspects of the drainage design have developed over the REF and concept design phases. These design evolutions have been a result of:

- feedback from the RMS;
- updates to the road alignment; and
- subsequent information being made available.

Pavement Drainage Design (Carrier in front of Type F barrier)

On the south bound carriageway, GHD originally tried to minimise the number of pits required by allowing for slots under the Type F barriers where possible, with flows collected in an SO drain on the eastern side of the pedestrian path. The flows in the SO drain were collected by a carrier main that ran along the eastern side of the pedestrian path. Based on comments provided by the RMS, the slots under the Type F barriers were removed and Type F pits were added. These pits discharge to the proposed carrier main running along the eastern side of the pedestrian path. Further RMS comments resulted in the carrier main being moved to its current proposed location in front of the Type F barrier on the eastern side of the trafficable lanes.

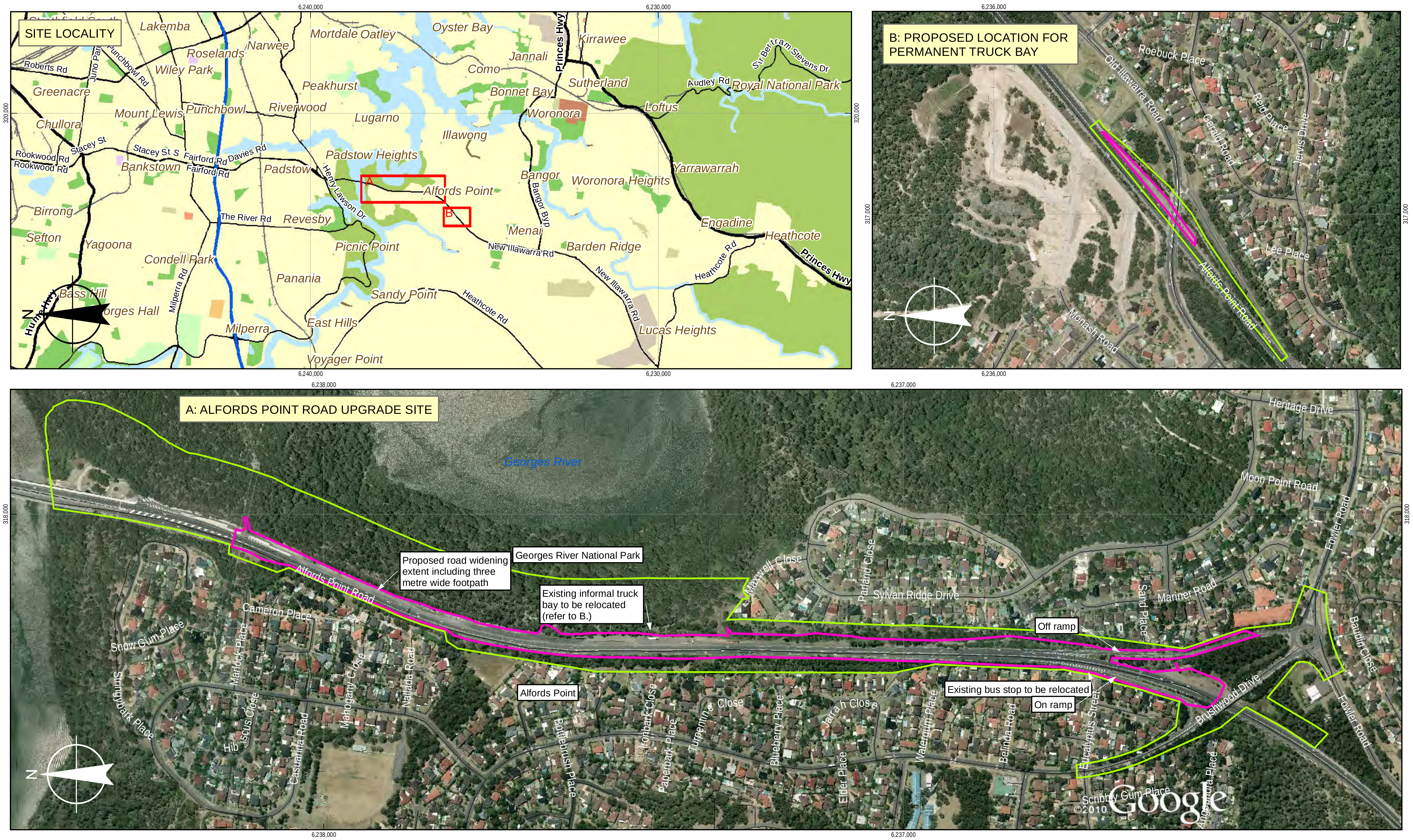
Potential basins (in consideration of National Park)

Prior to receiving the National Park Boundary, GHD proposed to utilise the depression under the power lines at STN 800. Once it was confirmed that this location was inside the National Park, the basin was moved closer to the road corridor at STN 780. In discussion with the RMS it was agreed that the terrain at the currently proposed location at STN 860 was more suitable.

Investigation of Adjoining Council Drainage Systems

Based on the information made available to GHD by the RMS, an original assumption was made regarding the upstream catchment to the existing DN 600 cross culvert at STN 1620. As part of further investigations into the downstream drainage networks, GHD received details from Sutherland Shire Council (SSC) on the existing upstream council stormwater network that allowed the assumed catchment area to the existing cross culvert to be dramatically reduced.

As discussed in Section 2.4, downstream of the existing DN 600 cross culvert is an SSC owned DN 375 piped headwall. This is the receiving point for the surrounding sub catchment. Originally no information was made available to GHD about the size or nature of this pipe. Hydraulic calculations suggest that peak flows for both the 10 year and 100 year ARI storms to this discharge point are not being increased under the proposed design. Subsequent investigations into this downstream network have revealed that it is unable to convey or contain flows from the 10 year ARI event. As such, further investigation is required to confirm the current egress route for flows unable to be conveyed by the current system, and any possible rectification measures.



Paper Size A3
0 30 60 120 180 240
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

- Study Area
- Proposal Disturbance Footprint

GHD
CLIENTS | PEOPLE | PERFORMANCE

Roads & Maritime Services
Alfords Point Road Upgrade

Job Number	21-21268
Revision	D
Date	14 Aug 2012

Site Features and Location — Figure 1

G:\21\21268\GIS\Maps\MXD\21_21268_Z001_SiteLocation_RevD.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Google Earth Professional/SKM; Imagery. Copyright Navigate, NAVTEQ and PSMA Australia 2010; Street Map. GHD 2012; Site Features. Prepared by CWilson

2. Design Description

This section provides a description of the elements of the drainage system including a discussion on the hydrological and hydraulic aspects of the assessment.

2.1 General

The widening works are proposed on the eastern side of Alfords Point Road, extending approximately 2.1 km from the southern abutment of Alfords Point Bridge to Brushwood Drive in the south. The works are entirely within the LGA of Sutherland Shire Council and the road reserve is generally bordered by the residential areas of Alfords Point and Illawong. The proposal involves widening the existing four lane undivided road to a six lane divided carriageway, resulting in three lanes in each direction.

2.1.1 Horizontal and Vertical Alignment

The horizontal alignment of the proposal would follow the existing road alignment with widening to occur on the eastern side of the existing Alfords Point Road.

The vertical alignment would follow the vertical profile of the existing road. The finished road surface would be approximately 150 millimetres above the existing road surface as the existing road pavement requires additional layers of asphalt for strengthening.

2.1.2 Typical Cross Section

The traffic lanes would be 3.3 metres wide, with 2.5 metre wide road shoulders. The central median would be about 1.6 metres wide and include a Type F barrier. An off-road shared path would be provided along the eastern side of Alfords Point road, separated from the southbound carriageway by a second type F barrier. The shared path would generally be three metres wide.

The Type F (slip formed) barrier in the central median is typically 0.82 metres high, 0.6 metres wide (at the base) and 1.7 kilometres long. There would be an opening in the central median at the southern abutment to Alfords Point Bridge to allow emergency vehicles to cross between carriageways. The Type F barrier separating the southbound lanes and the shared path would be 0.82 metres high with a rail on top to extend the height to 1.4 metres. The total length of this barrier is 1.96 kilometres with openings at various locations for access purposes. A typical cross section of the proposal is provided in Figure 2 below.

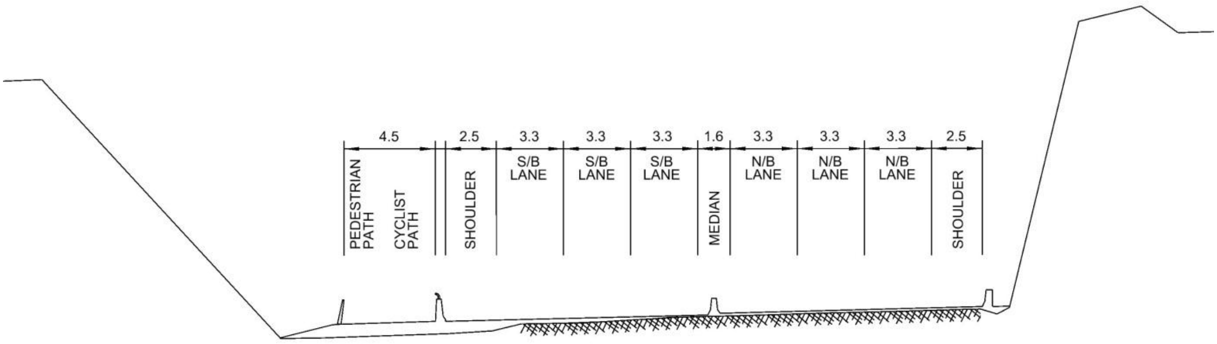


Figure 2 Typical Alignment Cross Section

2.2 Hydrological Modelling

The catchments associated with the existing pavement and proposed pavement widening are generally confined to the road corridor and thus have been represented hydrologically using the widely accepted urban drainage package DRAINS.

The design storm intensities (IFD) for Alfords Point have been derived from the online calculator/procedure available from The Bureau of Meteorology (BOM) website (www.bom.gov.au) The coordinates adopted for Alfords Point were -33.9867 latitude, 151.027 longitude.

Table 1 represents the coefficients consistent with the IFD calculation method undertaken by the BOM calculation. The full list of intensities adopted in the DRAINS model is located in Appendix A.

Table 1 IFD Coefficients - Rainfall Intensity (mm/h)

Duration		1 Hour	12 Hour	72 Hour
Storm Event	2 Year	36.76	8.09	2.52
	50 Year	74.46	15.95	5.18
Geographic Factors		Skew	F2	F50
		0	4.29	15.83

2.3 Catchments

The existing and proposed catchments are provided in Appendix D.

The overall catchment regime of the site will not be significantly altered by the upgrade works. Generally the site drains to the Georges River via various routes. The main discharge points are described as follows:

Runoff Intercepted on the northern approach to the bridge is piped to a discharge point under the Alfords Point Road Bridge, via a Gross Pollutant Trap (GPT) constructed as part of the bridge duplication works to provide operational water quality treatment. Information made available to GHD[1] indicates that this existing GPT has sufficient capacity to cater for the existing and proposed runoff being conveyed to it (see discussion in Section 4.4.1). No consideration has been given towards the existing condition of this GPT and it is recommended that the condition of the device be investigated as part of the detailed design phase.

At proposed STN 300, runoff from pavement and external catchments discharges overland via an established drainage path.

At proposed STN 780, runoff from the catchments discharging to the western side of the road is conveyed to the Sutherland Shire Council stormwater network via a formalised overland drainage path.

A small external catchment on the eastern side of the road discharges toward the Georges River in the vicinity of the overhead power lines at proposed STN 800.

Runoff discharging to the east at proposed STN 1000 makes its way via an informal drainage path to the Georges River.

At proposed STN 1620 runoff from the pavement and upstream external catchments discharge to an existing 375 diameter pipe (asset owned by Sutherland Shire Council).

Runoff from the southbound exit ramp connects into the existing drainage network in the triangle between Alfords Point Road, the southbound off ramp and Brushwood Drive.

Runoff from Alfords Point Road immediately to the north of the Brushwood Drive Overpass, as well as the northbound on ramp connects into the existing drainage network in Alfords Point Road which drains in a southerly direction. Note, no consideration has been given to the potential external catchments from the residential area to the north west of the north bound on ramp or from Brushwood Drive. Further evaluation of this area could be investigated during detailed design if deemed appropriate

Runoff from the proposed truck inspection bay is conveyed to the south by an existing pipe network.

The road widening works have not resulted in significantly increased flows. A summary of the existing and proposed catchment discharges for a range of design ARIs can be seen in Table 2.

[1] Hughes Trueman drawing number 78 of Alfords Point Road Road Reconstruction and Widening Alma Road to Alfords Point Bridge Spill Control (registration number 0190.026.RC.2517) IFC issue

Table 2 - Catchment Hydrology Comparison

Catchment			2yr ARI		5yr ARI		10 yr ARI		20 yr ARI		50 yr ARI		100 yr ARI	
No.	E. (ha)	P. (ha)	E.(m^3/s)	P.(m^3/s)	E.(m^3/s)	P.(m^3/s)	E.(m^3/s)	P.(m^3/s)	E.(m^3/s)	P.(m^3/s)	E.(m^3/s)	P.(m^3/s)	E.(m^3/s)	P.(m^3/s)
1	1.78	1.71	0.43	0.53	0.61	0.64	0.67	0.72	0.74	0.82	0.79	0.89	0.84	0.98
2	10.97	10.81	1.94	2.09	2.71	2.94	3.18	3.42	3.81	3.95	4.39	4.39	5.01	4.87
3	2.63	2.42	0.25	0.27	0.39	0.39	0.48	0.48	0.60	0.58	0.73	0.69	0.85	0.79
4	0.37	1.60	0.09	0.39	0.12	0.48	0.14	0.52	0.17	0.57	0.19	0.60	0.22	0.64
5	2.12	1.35	0.23	0.30	0.36	0.40	0.44	0.46	0.55	0.54	0.66	0.68	0.77	0.83
6	1.97	1.81	0.35	0.38	0.51	0.53	0.62	0.62	0.74	0.75	0.84	0.84	0.97	0.95
7	0.75	0.75	0.19	0.21	0.25	0.27	0.29	0.31	0.34	0.35	0.37	0.39	0.42	0.43
8	1.95	2.18	0.22	0.35	0.35	0.51	0.44	0.63	0.56	0.77	0.66	0.88	0.79	1.01
9[2]		0.43		0.13		0.16		0.19		0.22		0.23		0.26

Table Notes:

E. = Existing

P. = Proposed

Flows listed are the Q_{max} for each catchment

[2] No existing catchment analysis has been carried out for the proposed truck inspection bay.

2.4 Cross/Transverse Culverts

There are two existing cross culverts. One is a DN 1050 and is located at Station 310, while the other has been observed by the RMS to be a DN 600 and is located at station 1620. Both pipes discharge stormwater runoff in an easterly direction under the existing pavement. Both culverts convey runoff from the road pavement as well as external residential catchments on the western side of Alfords Point Road. The hydrology of the catchments has been determined and is provided in Table 3.

The inlet to the 1050 mm diameter culvert is via a headwall, with runoff from the contributing catchment making its way to the pipe via overland flow. RMS site inspections have observed the upstream inlet of the 600 mm diameter culvert to be an inlet pit. Inspection of survey information, Sutherland Shire Council Plans and information provided by the RMS indicate that flows arrive at this pit via a combination of piped and overland flow.

Whilst the proposed pavement widening is not envisaged to alter the drainage regime for these culverts, a sensitivity check of the transverse pipe capacity was undertaken for their appropriateness in terms of satisfying current RMS design criteria. It is evident from comparison of the last two columns in Table 3 that the pipes have sufficient capacity to cater for the 100 yr ARI event for both the existing and proposed scenarios. Note: At this time the type of grated inlet has not been confirmed and as such the hydraulic behaviour of this drainage line is controlled by the pipe capacity and not controlled by the grate arrangement and inlet capacity of the pit.

It should be noted that the class of these transverse pipes is unknown. No consideration has been given towards the general design life of any of the drainage elements (including structural or suitability from a durability perspective) . It is recommended that design life is considered during the detailed design phase.

Downstream of the DN 600 diameter cross culvert is a DN 375 headwall. This pipe running from the headwall is part of the Sutherland Shire Council stormwater network and runs from the trapped low point on the eastern side of Alfords Point Road in a 2.5m wide easement, where it connects to the stormwater network in Sylvan Ridge Drive. In addition to the flows received from the upstream DN 600 culvert, this pipe also receives overland flows directly from a catchment comprised of road pavement and a vegetated batter. Hydraulic analysis indicates that this pipe and surrounding depression has insufficient capacity to contain / convey flows from both the minor (10 year) and major (100 year) storm events. It is assumed that flows unable to be conveyed by the existing pipe would discharge via an overland flow path in the above mentioned easement, however at this stage there is insufficient information available to confirm this. In consultation with Sutherland Shire Council, this issue along with any potential rectification measures will require further investigation during detailed design. Sutherland Shire Council has indicated that they are not aware of any existing drainage issues at this location.

Table 3 Hydrology of Transverse drainage catchments

Transverse pipe Station	Pipe dia (mm)	Area (ha)		Qmax (m^3/s) 10yr ARI		Qmax (m^3/s) 20yr ARI		Qmax (m^3/s) 100yr ARI		Qmax* (m^3/s) for pipe
		Exist.	Prop.	Exist.	Prop.	Exist.	Prop.	Exist.	Prop.	
310	1050	8.17	8.05	2.41	2.46	2.88	2.97	3.77	3.87	7.1
1620	600	1.13	1.15	0.423	0.45	0.492	0.54	0.622	0.69	1.8

Table Notes:

*Hydraulic capacity for 1050 diameter culvert based on a headwater calculation, adopting 300 mm freeboard below edge of pavement as the controlling headwater level. Hydraulic capacity for 600 diameter pipe based on the Manning's calculation (pipe full)

Refer to Appendix D for existing and proposed catchments.

^ Diameter of existing transverse drainage pipe at STN 1620 confirmed by visual inspection by RMS.

2.5 Hydraulic Considerations

The 12D Civil engineering package was used to represent both the existing and proposed drainage network of pits and pipes. As described previously the software package DRAINS was used to assess the hydraulic behaviour of the proposed pit and pipe network modelled in 12D.

Pit Inlet Capacities

The DRAINS program contains an inherent library of pit types which vary in hydraulic performance in terms of inlet capture (flow rate) and related bypass. The standard RMS pits (such as SA, SO & F) and kerbs with the appropriate approach grade and grate types have been considered in the drainage assessment. One of the major influences on pit spacing (particularly Type F median pits) is ensuring the allowable flow width (1.0 m) beyond the kerb face is maintained.

Blockage Factors

The following blockage factors have been adopted and consistent with current RMS practice:

Pits on-grade: 20%

Pits in a sag: 50%

DRAINS Hydrological – ILSAX Model

Grassed (pervious) depression storage = 10 mm [3]

Pavement (impervious area) depression storage = 1 mm

Soil Type (assumed slow infiltration rate) = 3

Pipe Friction (Colebrook) = 0.3 mm

[3] GHD utilised a 10 mm storage value which is consistent with the RMS provided model by Lyall & Associates

2.6 Flooding Considerations

The pavement and drainage report prepared by Lyall and Associates indicates that the 100 year ARI flood level at the Georges River is RL 2.6 m AHD.

All works associated with the pavement widening works are well above the 100 year flood level and the proposed works are not considered to pose any adverse impact on downstream conditions in relation to the Georges River.

The existing and proposed outlets of the system are not affected by a tail water condition (submergence of outlets) induced by flooding or tidal influence from the Georges River.

2.7 Proposed Drainage Strategy

2.7.1 Station 0 ≈ Station 300m (Control String MC00)

This section of road drains in a northerly direction via a spill containment system, discharging to the Georges River under the Alfords Point Bridge. Details of the existing spill containment system are contained in Appendix E and discussed in Section 4.4.1.

Existing drainage pipes are to be retained, generally with pits to be adjusted to the new kerb line. Refer to the summary of proposed drainage works in Table 4 and the concept drainage drawings in Appendix C.

Table 4 Proposal summary from STN 0 ≈ 300m

North bound arrangement	South bound arrangement
A new dish drain is required on the western side of the road, behind the Type F barrier to collect flows from the external catchment. On the western side of the northern carriageway, three (3) existing pits up to STN 100 are to be converted to grated inlet pits behind the Type F barrier to drain runoff from the rock face collected in the proposed dish drain. Type F pits are to be constructed at the new kerb line and connected to the existing line. From STN 165 the line is to be extended to STN 260. Four (4) new Type F pits and pipe to be added to this new section of line to control flow widths. An additional pit is proposed at STN 220 behind the Type F barrier to pick up external catchment flows. At STN 260 a new pit is proposed at the upstream end of the Type F barrier to capture road and external catchment flows. Two (2) temporary pits previously constructed in the vicinity of the median around STN 75 are to be converted to buried junction pits, with new pits constructed at the median and connected to these existing pits.	An existing drainage channel to the east of the road is to be retained / reinstated. One (1) pit on the eastern side of the southbound carriage way at STN 60 is to be converted to a buried junction pit. Additional pits are required on the eastern side of the central median to control flow widths.

2.7.2 Station 300m ≈ Station 850m

This section of road drains in a northerly direction where it currently discharges towards the Georges River to the east at STN 300. Minimal formal existing drainage infrastructure is present in this section of road. A carrier line is proposed to run along the type F barrier on the eastern side of the carriageway, ultimately discharging via a proposed head wall to a formed swale drain containing a series of pervious rock check dams. The new swale drain will connect to an existing gully that currently drains to the east towards the Georges River (refer to Section 4.4.1 for further detail). For a summary of the proposed drainage works refer to Table 5 and the concept drainage drawings in Appendix C.

Table 5 Proposal summary from STN 300 ≈ 800m

North bound arrangement	South bound arrangement
At STN 310 an existing DN 1050 cross culvert passes east under the road and discharges toward the Georges River. The existing pit at STN 340 requires adjusting to the new surface level and a new grated inlet. This existing line discharges via a headwall to the western side of the road, towards the cross culvert.	A new carrier line is proposed from STN 300 to STN 850. The line generally runs under the Type F barrier, where it collects runoff from the southbound carriageway captured by regularly spaced Type F pits. The line discharges to the east at the same location where the cross culver from the west discharges toward the Georges River.
From STN 340 to STN 500 runoff from the northern carriageway falls away from the central median to the west. A new carrier line is proposed to be extended from STN 340 to STN 400. Several Type F pits are also proposed to maintain acceptable flow widths. At STN 440 an existing DN 375 cross culvert passes east under the road and discharges into an existing pipe to the east of the carriageway. The existing pit requires replacement with a Type F pit on the new barrier. From STN 500 to STN 800, runoff from the northbound carriageway way is to be collected at the Type F median barrier and drained by single Type F pits spaced at regular intervals to maintain acceptable flow widths.	Runoff from the shared path and road verge is collected in the drainage swale to the east of the shared path and collected in field inlet pits that connect to the carrier line. Note: Between STN 350 and STN 700 and there is an existing carrier line running to the east of the carriageway. It is thought that this line is a DN 600; however as no WAE drawings confirm the diameter this needs to be confirmed by a survey. For the purpose of preparing the concept design, this line is presumed to be of insufficient diameter and as such is proposed to be exhumed and replaced with a new line with sufficient capacity to carry the necessary flows.

2.7.3 Station 850 ≈ Station 1600

This section of road drains in a northerly direction where it currently discharges towards the Georges River to the east at STN 800. Minimal formal existing drainage infrastructure is present in this section of road. A carrier line is proposed to run along the eastern side of the carriageway, ultimately discharging via a proposed head wall to a water quality basin (refer to Section 4.4.1 for further detail). For a summary of the proposed drainage works refer to Table 6 and the concept drainage drawings in Appendix C.

Table 6 Proposal summary from STN 800 ≈ 1600m

North bound arrangement	South bound arrangement
From STN 850 to STN 1000 runoff from the northbound carriageway way is to be collected at the central Type F median barrier and drained by numerous Type F pits. From STN 1000 to STN 1400, the cross fall switches back to the west and runoff from the northbound carriage way is to be collected at the western Type F barrier and drained by numerous Type F pits This runoff is to be discharged via a headwall to the west at STN 1000. From STN 1375 to STN 1500, runoff from the northbound carriage way is to be collected at the central Type F barrier, where numerous Type F pits collect the runoff and pipe the flow to the eastern carrier line. From STN 1500 to 1600 the cross fall switches back to the west and runoff from the northbound carriage way is to sheet off the pavement to an existing drainage swale on the western side of the road. At STN 1620 an existing DN 600 cross culvert directs surface water to the east, where it discharges towards an existing downstream DN 375 pipe. The upstream inlet pit and the downstream headwall of this DN 600 culvert will require adjusting to suit the proposed surface level.	From STN 8750 to STN 1630 a Type F barrier is proposed on the eastern side of the road. Numerous Type F pits are located along the barrier to manage the gutter flow width on the south bound carriageway. Generally from STN 800 to 1620 runoff from the shared path is proposed to be collected in a table drain on the eastern side of the shared path. From STN 1100 to STN 1200, the shared path fall toward the Type F barrier. Here several pits will be used to collect the runoff. From STN 950 to 980 there is a break in the Type F barrier on the eastern side allowing a portion of the roadway to sheet flow to the east. In this section runoff will be collected by an SA kerb and gutter. The existing line at STN 975 is to be exhumed. At STN 1100, an existing drainage pipe under the existing shared path is to be removed. The existing culvert under the access road at STN 1150 is to be removed and replaced with a culvert in the new location.

2.7.4 Station 1600m ≈ Station 1775m

A high point exists on Alfords Point road at STN 1775.

Runoff from the northbound carriageway sheets off to the existing drainage swale to the west of the road.

Runoff from the southbound carriageway is collected at the central Type F median barrier from STN 1775 to STN 1620. These flows are then discharged to the existing collection point at STN 1620 to the east of the road.

2.7.5 Main Carriageway beyond Station 1775m

An existing pit is present at STN 1900. This pit is to be adjusted to the proposed surface level, while three (3) pits are to be constructed upstream of this to maintain acceptable flow widths.

A new pit is also proposed to be constructed over the existing stormwater line at STN 1945

The existing pit at STN 1975 is to be adjusted to the new kerb line.

Further survey is required around STN 1900 ≈ 1950 to confirm some pipe locations and sizes between existing pits.

2.7.6 Northbound Carriageway On ramp

All existing pits are to be adjusted to the new kerb line. No additional drainage works are thought to be required.

As above, further survey of pipe locations and sizes may be required in this location during the next phase of design.

2.7.7 Southbound Carriageway Off ramp

The existing drainage lines at STN 1950 and 2050 are to be retained and require no actions.

A carrier line is to be extended north from the cross culvert at STN 1950; Type F pits are required along the eastern side of the road to maintain flow widths and to follow the bend in the road. This line discharges to the west of the off ramp to an existing collection point at STN 1950.

2.7.8 Heavy Vehicle Inspection Station

Only minor drainage works are required in this area. Runoff will be collected by a proposed SO gutter on the south eastern side of the inspection area. Two existing pits within the inspection bay are to be converted into junction pits with new pits to be constructed in the adjacent (proposed) SO kerb and connected to these pits. At the lowpoint in the SO gutter at the inspection areas southern end, an SO turnout is to be provided to allow runoff to discharge to the adjacent swale.

3. Aquaplaning

Runoff from road pavement surfaces can sometimes create sheet flow which could be hazardous to motorists (in the form of aquaplaning) if flow depths become excessive. This hazard is commonly present at superelevation transitions, where the length of the flow path is extended due to the change of cross fall (from positive to negative) found at these locations. The following design criteria have been adopted to ensure aquaplaning is maintained to acceptable levels:

For the 50 mm/hr rainfall event, the maximum water depth at any point on the pavement is to not be greater than 5 mm in the through lanes.

The maximum change in the depth of flow across the pavement must not exceed 5mm over any 10 metres.

Using the adopted aquaplaning relationship below the derived depths of surface sheet flow shall be included in Appendix B.

$$d_w = \frac{0.10286\, T_{xd}^{\;0.11} L^{0.43} I^{\;0.59}}{S^{0.42}} - T_{xd}$$

Where:

D_w = surface water depth above the macrotexture asperites (mm)

T_{xd} = pavement macrotexture depth (mm)

L = drainage path length (m)

S = average slope of the drainage path (%)

I = rainfall intensity (mm/hr)

4. Water Quality

There are two separate phases of the project that will be considered for the purposes of stormwater quality. These include the construction and operational phases of the works. For both phases, appropriate measures shall be provided where feasible to ensure stormwater runoff from the construction area and ultimately from the road pavement is treated to remove pollutants so as to not adversely impact on downstream aquatic and riparian environments.

4.1 Construction Staging

The proposal would be constructed in three stages to ensure traffic flow along Alfords Point Road is maintained at all times and impacts are kept to a minimum. The proposed stages for construction are outlined below however this would be confirmed by the construction contractor during detailed design. The construction staging has a direct impact on the temporary drainage mitigation measures required.

The overall catchment regime of the site will not be significantly altered during construction as seen in the comparison of the existing and proposed catchment plans provided in Appendix D. The transition of the existing catchments to the proposed catchments during construction is entirely dependent on the staging of the works and as such a catchment plan summarising the entire construction phase cannot be developed at this time. This will need to be developed during detailed design along with any temporary drainage works and erosion and sediment control plans required as part of the construction phasing.

Stage 1

Relocate and reinstate a temporary path from the southern abutment of Alfords Point Road to Maxwells Close. Reduce the width of the path to a maximum of two metres;

Construct the new southbound carriageway including the shared path on the eastern side of Alfords Point Road from the southern abutment of Alfords Point Road to STN 1360. Traffic on Alfords Point Road would remain in its current location during Stage 1, with two lanes in each direction during peak periods;

Widen the western side of the Illawong/Alfords Point off ramp to the round-a-bout.

Stage 2

Switch traffic onto the new widened section of the Illawong/Alfords Point off ramp;

Close the shared path between Maxwells Close and Brushwood Drive roundabout for the duration of Stage 2. Divert pedestrian and cyclists to/from Fowlers Road via Maxwells Close, Sylvan Ridge Drive and Heritage Drive;

Construct the new southbound carriageway including the shared path on the eastern side of Alfords Point Road from STN 1360 to the Illawong/Alfords Point off ramp. Through traffic would remain in its current location while this occurs.

Stage 3

Switch traffic onto the newly constructed lanes and shoulder on the eastern side of Alfords Point Road to construct median works. Existing capacity maintained with two lanes in each direction on Alfords Point Road.

4.2 Constraints to Placement of Water Quality Devices

The placement of temporary and permanent water quality control devices is environmentally constrained by:

National Park: The eastern side of the site is bounded by the Georges River National Park from Station 0 to Station 1150.

Vegetation: The majority of the eastern and western periphery of the alignment contains established native vegetation.

RMS has noted that no water quality devices are to be located within the National Park boundary which was confirmed in the latter stages of the REF assessment.

4.3 Construction Phase Water Quality Controls

During construction, there is potential for site run-off from disturbed lands to be a source of pollutants in downstream waterways. Overland flow can carry sediment and associated pollutants from disturbed and unprotected land surface areas.

As part of the detailed design a Soil and Water Management Plan (SWMP) will need to be prepared. This plan will:

- Identify activities that may contribute to erosion, sedimentation and water quality impacts;
- Identify management practices to minimise the adverse water quality and sedimentation impacts by the construction operations on surrounding environment;
- Prescribe organised, integrated and systematic processes that effectively manage erosion, sedimentation and water quality during the term of the project.

The SWMP will include an Erosion and Sediment Control Plan which will identify locations where structural controls are required to achieve the aforementioned outcomes. These controls can include, but are not limited to:

- Sediment Basins;
- Silt Fences;
- Rock Check Dams;
- Filter Socks; and
- Straw Bale Sediment Traps.

Temporary Sediment Basins

Sediment basins are designed to intercept run-off and retain the sediment and attached pollutants.

The proposed construction phase sediment basins will provide environmental protection of the downstream waterways against any potential export of sediments and other pollutants from disturbed construction areas.. All temporary basins on this project will be referred to as Sediment Basins. The design criteria for sediment basins shall be consistent with the ‘Blue Book’ (*Managing Urban Stormwater: Soils and Construction*, Volume 1, Landcom, March 2004).

The most suitable location to create a temporary sediment basin in terms of topography is on the eastern side of the road at STN 870. The site is relatively flat, has sufficient access to allow construction and maintenance and does not encroach on the National Park Boundary. Refer to design and catchment plans in Appendix C and Appendix D respectively for the location of the proposed basin.

During road construction the basin would receive surface flows from the roadway by directing the flows to the basin via a diversion bund constructed on the eastern side of the road works. The estimated capture of the basin for each stage of construction is provided in Table 7 below.

Table 7 Temporary Basin Capture Staging near STN 820

Road Component	Construction Stage	Contributing Road Segment
South bound	Stage 1	STN 870 to STN 1360 once pits and Type F barrier installed
	Stage 2	STN 870 to STN 1625 once pits and Type F barrier installed
	Stage 3	As above
North bound	Stage 1	Existing conditions retained
	Stage 2	Existing conditions retained
	Stage 3	STN 870 to STN 1030 and STN 1300 to STN 1500 once pits and Type F barrier installed

Pending construction phasing, the total contributing catchment area to this basin has been calculated at approximately 1.8 ha. Based on the requirements of the 'Blue Book' (*Managing Urban Stormwater: Soils and Construction*, Volume 1, Landcom, March 2004), a basin of 135 m^3 is required This basin would outlet to the north, towards the Georges River. The volume of this basin is based on the following assumptions:

- Sediment Basin for Type D and F soils;
- the sediment storage zone is 50% of the settling zone;
- volumetric runoff coefficient is 0.5; and
- a 2 day rainfall depth 75th percentile for Sutherland.

The size of this basin will require further development during the detailed design phase once site conditions and constraints have been additionally quantified. It is important to note that due to site constraints, at this stage a 2 day rainfall depth has been adopted in lieu of the 5 day rainfall depth. This may result in more frequent discharge requirements and or the use of flocculants etc to facilitate more appropriate settling of suspended solids.

Potential constraints to installing a basin at this location include:

Working in close proximity to national park;

The likely presence of sandstone rock inhibiting excavation;

The need to potentially clear native vegetation; and

The location of this basin will be further investigated and confirmed during detailed design. Due to its large space requirements, construction in this location will result in the required relocation of the pedestrian footpath.

It is important to note that it is intended to convert the construction phase sediment basin into a permanent, operational phase water quality and spill control basin once construction works have been completed.

4.4 Operational Phase - Water Quality Controls

During the operational phase of the project, there is potential for stormwater runoff to affect existing local water quality due to the generation of additional pollutants directly attributable to the road from associated vehicle traffic. The most important pollutants of concern relating to road runoff are:

Suspended sediment from the paved surface;

Heavy metals attached to particles washed off the paved surface;

Oil and grease and other hydrocarbon products; and

Litter.

In addition, elevated levels of sediment bound nutrients such as nitrogen and phosphorus are also found in road runoff, primarily from atmospheric deposition of particles.

The water quality control measures will consider permanent water quality basins from a practical aspect or vegetated/grassed swales with rock check dams and accidental spill management basins. These measures will provide ongoing protection of downstream waterways against pollutants contained in stormwater runoff generated over the new highway pavement.

Water quality basins are permanent basins for the capture and treatment of stormwater runoff and accidental spills. The emphasis in stormwater quality management for road runoff is that of managing the export of suspended solids and associated sediment bound contaminants; namely heavy metals, nutrients and organic compounds. With this in mind the design shall consider the following:

Where possible, all pavement runoff shall pass through a treatment measure before discharging into receiving waters;

Where possible, vegetated swales with rock check dams shall be used as water quality control alternatives in order to minimise the number of permanent water quality basins and reduce ongoing maintenance requirements; and

Water quality basins shall be converted from construction phase sediment basins where other alternatives such as swales with rock check dams are not possible or do not meet the water quality design criteria.

4.4.1 Operational Mitigation Measures

Existing GPT and Spill Containment System

The existing spill containment system and GPT located near the southern abutment of the Alfords Point Bridge on the eastern side of the road is to be retained as part of the upgraded system.

Sheet 78 of the Hughes Trueman (2008) detailed design specified a GPT P1009R CDS unit [Rocla]. Rocla quotes a catchment area range of 2 to 8 hectares for this unit. It is noted from the Hughes Trueman (2008) Report that the proposed GPT and spill containment system was required to have a treatable flow rate of 150 L/s and a bypass flow rate of 600 L/s. The catchment area was not documented on the design documentation.

Under the proposed stormwater system arrangement the total contributing catchment is approximately 0.33ha. The treatable flowrate is typically for the 3 month ARI event; with the bypass flow needing to convey the minor system design ARI (in the case 10 years). For the proposed stormwater network, the GPT unit specified on the Hughes Trueman drawings would have more than sufficient capacity to adequately deal with the treatable and bypass flows resulting from the proposed works

From the site inspection conducted by GHD and RMS representatives, the installed GPT consisted of Humeceptor cast iron manhole covers so it is assumed a Humeceptor unit has been installed, however the model number is not known and GHD has not sighted WAE documentation to confirm the specification of the unit installed.

At this time the exact proprietary product installed in this location requires confirmation in order to determine its treatment and bypass capacities.

The spill containment system was required to have a holding capacity of 25kL which meets the requirements of the RMS brief for the upgrade project.

Water Quality Basin

There is an opportunity to convert the above temporary sediment basin at STN 870 (refer to Section 4.3) into a water quality basin. Site constraints would be resolved for the construction of the temporary basin prior to converting to a permanent basin. Refer to Dwg 21-21268-03-C004 in Appendix C for the potential location of the proposed basin.

A water quality basin in this location would accept flows from the:

North bound road catchments from STN 870 to STN 1000, STN 1375 to STN 1500; and

South bound road catchments from STN 870 to STN 1620.

The total contributing catchment to the basin would be approximately 1.8 ha. The required 25m^3 volume can be accommodated in this location as the requirements for the construction phase basin are far more onerous. The basin would outlet to the north, towards the Georges River.

It is recommended that the water quality basin serve the dual purpose of sediment and gross pollutant capture as well as spill control of insoluble pollutants. This can be achieved by the use of a design originally put forth by the RMS, whereby a negatively graded discharge pipe (also known as an 'ellis arrangement') allows a design volume of insoluble pollutant (that can be heavier or lighter than water) to be retained in the basin. (Refer to Figure 3 below for the general arrangement).

The basin would also provide some attenuation of flows. However given the size of the catchment the basin is discharging to (the Georges River) compared to the contributing road catchment, there is not considered to be any value in designing the basin specifically for this purpose. Additionally the magnitude of additional flows due to the road upgrades is not considered significant.

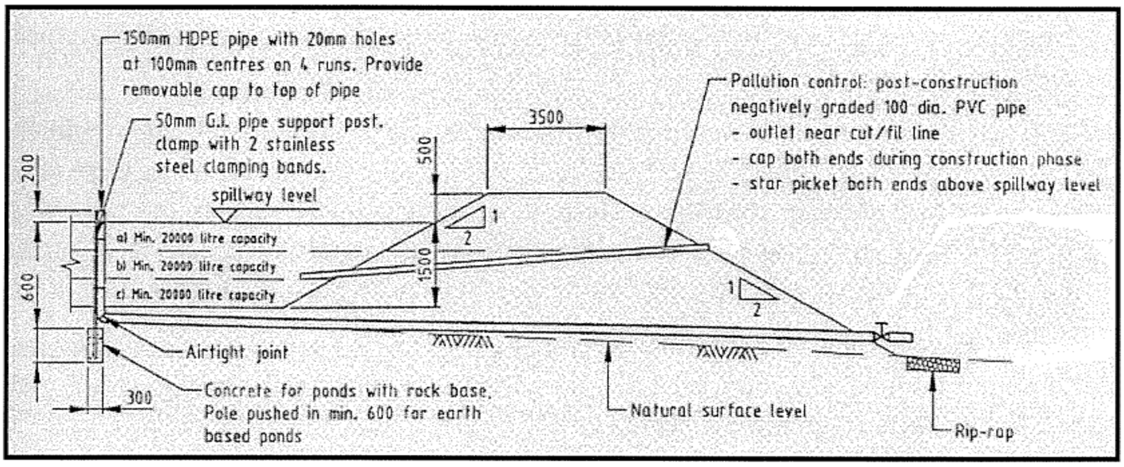


Figure 3 Cross section of a sediment pond incorporating insoluble pollutant control (source: NSW RTA)

This style of basin is able to retain a given volume of pollutant until the basin begins to overflow from the vertical riser discharge pipe. Oil baffles can be fitted to the vertical riser to prevent the loss of pollutant during high flow events.

Vegetated Swales and Rock Check Dams

There is an opportunity to create a series of rock check dams at the outlet of the stormwater system at STN 310 on the eastern side of the road. This site is just to the south of an existing gully which directs flows to the east towards the Georges River. There is direct access to the site from the eastern side of the roadway. Refer to Dwg 21-21268-03-C002 in Appendix C for the location of the rock check dams.

Rock check dams in this location would accept flows from the:

North bound road catchments from STN 450 to STN 800; and

South bound road catchments and eastern road reserve catchments from STN 310 to STN 800.

The eastern road reserve catchments would initially be treated by a vegetated swale along the eastern side of the carriageway, before being collected in stormwater pits and discharging with the road runoff to the rock check dams via a new concrete headwall outlet. Sufficient energy dissipation will be required at this outlet in the form of rock rip-rap. The total contributing catchment at this outlet would be approximately 1.9 ha.

Additionally, the existing vegetated swales will be either retained or reinstated in the following locations:

Western side of the roadway between STN 1500 and 775; and

Eastern side of the road from STN 1500 to 1800.

Rock check dams can be used within these swales to help distribute flows across the swale to avoid preferential flow paths and maximise contact with vegetation. Check dams also assist to slow the surface flow velocity, thereby providing an opportunity to capture some sediment upstream of their discharge points.

5. Conclusion

The proposed stormwater system requires a considerable number of additional pits due to the proposal to install solid slip formed Type F barrier along the eastern, central and a portion of the western side of the carriageway. The solid formed eastern barrier prevents water sheet flowing across the shared path, which would have alternatively been picked up by the field inlet pits within the swale drain in the road reserve. Instead the field inlet pits largely cater for the catchments external to the roadway surface.

Additionally the requirement for a maximum flow width of one metre from the invert of the Type F barrier (for a 10yr ARI event) requires the installation of single grated Type F pits at regular intervals of approximately 10 m to 27 m spacing, depending upon the longitudinal gradient of the road. Single grate Type F pits have generally been proposed as the double-grate Type F pits are twice as wide perpendicular the Type F barrier and would subsequently protrude into the trafficable lane, especially along the northbound central median.

A temporary / permanent water quality basin is proposed around STN 870 as an alternative to the original proposal to utilise the existing depression near STN 820 within the National Park. The basin would be constructed behind the Type F barrier in the road reserve with the long dimension of the basin parallel with the roadway. The detailed design will need to ensure the outer side of the batter on the eastern side of the basin is kept outside of the National Park boundary.

To facilitate detailed design of the roadway and associated infrastructure the following additional survey, provision of WAE documentation or other information will be required by the designer:

- Existing GPT and spill containment system on the south east corner of the Alfords Point Bridge. Specifically clarification of the make and model of the proprietary devices installed. This will confirm the adequacy of the existing treatment system.
- Further survey is required around STN 1900 ≈ 1950 to confirm some pipe locations and sizes between existing pits.
- Further survey and inspection of the council owned DN 375 headwall downstream of the existing DN 600 culvert to ascertain the current egress path for flows unable to be conveyed by the existing drainage infrastructure.