TENDER COPY

Statement of Derek MILLAR

Dated: 17 October 2011

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STATEMENT OF DEREK MILLAR

I, Derek Millar of Lot 1 Chalk Street, Redbank in the State of Queensland, Project Manager (SEQ Projects Branch), Major Infrastructure Projects Division of the Department of Transport and Main Roads, state as follows:-

Qualifications and experience

1. I am currently the Project Manager (SEQ Projects Branch) | Project Delivery DTMR Project Manager for the Ipswich Motorway Upgrade Project (Dinmore to Goodna). I have worked on the project since September 2007 and have been Project Manager since February 2008.
2. In this role, I report to the Project Director, [redacted]
3. The primary functions and duties of my role include:
   - plan, coordinate and manage the concept planning, development and implementation phases of the project within specified time-frames and budget;
   - ensure the delivery of the project provides value for money;
   - ensure that project team has the necessary systems and people capability to meet current and future demands and risks;
   - prepare and deliver submissions and reports relating to planning and technical issues;
   - identify appropriate mitigation strategies to overcome problems or obstacles related to the project;
   - contribute to public consultation activities and ensure that effective liaison is undertaken with community, local governments and other major stakeholders;
   - act as "Representative of the Principal" for the delivery contracts, as defined and delegated at respective development / implementation phases; and
   - lead the development of best practice technology and project management methodology within the department.
4. I hold the following professional qualifications: Bachelor Degree: Civil Engineering (1996); National Higher Diploma: Civil Engineering (1991); and National Diploma: Civil Engineering (1989). I am a Chartered Engineer - 3065504 (Engineers Australia) and a Registered Professional Engineer Queensland - 09907 (Board of Professional Engineers Queensland).
5. I have twenty years experience in design, construction, supervision and project management (infrastructure delivery) of civil engineering contracts namely road projects and related structures projects using a variety of delivery methodologies.

Ipswich Motorway Upgrade Project (Dinmore to Goodna)

6. The Ipswich Motorway Upgrade: Dinmore to Goodna (the project) started construction in June 2009 as part of the Federal Government's $1.95 billion commitment to upgrading the Ipswich Motorway. The Department of Transport and Main Roads

[redacted] . . . . [redacted] . . . . . .

Derek Millar **Witness**

(DTMR) together with Abigroup, Fulton Hogan, Seymour Whyte, SMEC Australia and Parsons Brinckerhoff formed the Origin Alliance to deliver the project.

7. The Alliance Manager (AM) leads and manages the Alliance. The AM formed the Alliance Management Team (AMT) of which I am a member. The AMT and AM report to the Alliance Leadership Team ([redacted] is a member of the ALT).
8. The Monash Road overpass formed part of the scope of the project.
9. The new motorway has been designed to remain trafficable for both local and regional Q100 flood events.
10. **Local Event**

    Localised and/or flash flooding typically occurs when intense rainfall falls over a small sub-catchment which responds to that rainfall in six hours or less. Inundation is expected to last only for a limited period of time until the run-off is able to drain away. In urban or rural areas where drainage is poor, the risk of localised flooding is high under such circumstances. Often a local flood event is more extreme in its impact than a regional flood event.

    Regional Event

    Widespread flooding, by contrast, occurs following rainfall of high intensity or long duration over the whole, or a large proportion of a catchment. Continuous heavy rainfall across a number of river catchments is likely to cause inundation across an extensive area. It may take a number of days for these floodwaters to subside.

General

11. The drainage system for the project has been designed to ensure an acceptable level of flood immunity for the Ipswich Motorway, including the adjacent service roads. The system must ensure that the works do not have an unacceptable impact on the hydraulic regime of the area including also adjacent properties. This is achieved by including adequately sized and located culverts, water diversions and other works in the design.
12. The project brief (Scope of Works and Technical Criteria – SWTC) requires that the Ipswich City Council (ICC) controlled service roads and ramps be designed so that the lowest point of each carriageway's pavement surface is protected from flooding and is 100 mm above the 20 year Average Recurrence Interval (ARI) flood level for cross drainage. This includes all locations where the works intercept runoff, floodplains, watercourses, depressions or drainage lines. The cross drainage structures have therefore been designed to convey the peak flows from the 20 year ARI storm event as a minimum.

Design Methodology

13. Generally, the proposed service road transverse culverts have been sized to ensure peak water levels upstream and downstream of structures do not exceed existing flood levels by more than 10 mm (10 – 20mm is not considered measurably significant given the factors / uncertainties in modelling). The culverts also provide flood immunity to the service roads for the 20 year Average Recurrence Interval (ARI) storm for the local catchment. Two scenarios were considered as follows:

[redacted] . . . . . [redacted] . . . . . .

Derek Millar **Witness**

(a) Base scenario – The hydrology of, and hydraulic calculations for the existing culverts were undertaken to estimate the existing 20 year ARI, 100 year ARI and Probable Maximum Flood (PMF) water levels and velocities upstream and downstream of the culverts. In this scenario, sub-catchment characteristics were assumed to be fully developed. A typical blockage factor of 20% was included in the analysis.

(b) Upgrade scenario – The hydrology of, and hydraulic calculations for the upgraded service roads and culverts were undertaken to estimate the water levels and velocities upstream and downstream of each culvert for the 20 year ARI and 100 year ARI. The Probable Maximum Flood (PMF) event was modelled at the culverts installed under the Monash Road embankment (culvert C-FS950) as requested by ICC to ensure that the proposed works do not adversely impact neighbouring residents. Sub-catchment characteristics were assumed to be fully developed. A minimum of 20% and maximum of 50% blockage is included in the analysis, depending on the inlet type.

14. The project brief states that any new infrastructure constructed must not generate additional afflux (increase the existing flood levels) that may impact on property not owned by DTMR. In some cases it is not possible to completely contain additional afflux and an analysis is carried out to understand the nature of the impact. Accordingly the project designers modelled (local flood modelling) the impact of the construction of the Monash Road overpass and provided a design that does not impact (increase the flood risk) on adjacent residential properties by installing 5 pipe culverts under the newly constructed road embankment. This design also accounts for any storage that was lost by the construction of the new embankment.

15. The motorway alignment was designed for regional flooding using the Brisbane River Flood Model (2006), provided by the Brisbane City Council. The data/information from this model was used to develop local flood models for the works undertaken by the project. Flood modelling of this nature (eg. for very large rivers such as the Brisbane River) remain current for a considerable period of time subject to changes in modelling procedures, significant changes in the river alignment / catchment and or rainfall. This type of modelling is not normally undertaken for local projects and was only considered given the relative proximity to the Brisbane River.

Upgrade culvert FS950

16. A 25 hectare catchment contributes flows to the proposed culvert C-FS950. This includes a portion of the Queensland Rail (QR) workshops, Brisbane Terrace, the QR railway corridor to the north and the residential area (Jabiru Place) at the lower end.

17. An existing 1050mm diameter RCP conveys flows under Brisbane Terrace. In addition, 3 x 300mm diameter RCP stormwater pipes convey runoff from an open area adjacent to Brisbane Terrace.

18. Flows pass beneath the QR rail line through a single 18m long 1050mm diameter concrete pipe. Additional QR subcatchments contribute to the flow at the upstream and the downstream side of this culvert. A natural channel then conveys flows to the McAuliffe Street culvert. Runoff from nearby residential areas is discharged via a pipe in the vicinity of the existing culvert inlet.

[redacted] . . . . . [redacted] . . . . . .

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19. The existing culvert across McAuliffe Street consists of a single 1050 mm diameter RCP, approximately 11 m long. The existing culvert collects runoff from the entire catchment west of McAuliffe Street and discharges into a pond to the east within the Pan Pacific Peace Gardens. This pond level is controlled via a spillway that discharge flows to Goodna Creek approximately 150m away.

20. When the headwater level exceeds approximately 17.0m, flows in excess of the QR culvert capacity can spill to a channel/ overland flow path along the northern side of the railway embankment. This diversion of flows can reduce the impact of flooding on downstream properties for large flood events. However in extreme and rare events, it is expected that a portion of flows will overtop the QR rail embankment and flow towards the culverts at McAuliffe Street.

21. The Monash Road upgrade incorporates an overpass crossing the QR track and a significant road embankment a short distance upstream of the retained McAuliffe street roadway. The embankment will remove the existing overland flow path for the catchment. The provision of the upgrade accordingly required the construction of a new culvert at this location.

22. A meeting was held with ICC to discuss the impact of the embankment on local flood risk. A copy of the IMU Drainage-ICC minutes of meeting dated 21st September 2009 are attached and marked **Attachment A**. The outcome of the meeting was a request from ICC to:

    (a) Specifically consider a 50% blockage* of the culvert in a 100 year flood event;

    (b) Provide a positive overflow, such as a channel, for an emergency bypass should the culvert become excessively blocked.

    * Blockage factor means that the pipe culvert capacity is reduced by 50% due blockages caused by debris. There are no exact quantitative guidelines for the application of blockage factors.)

23. This approach differed from that specified in the Drainage Design Criteria Report (DGRODR101) and the approach used on all other culverts through out the corridor, which was a 50% screen blockage and a 20% culvert blockage. However as requested by the Ipswich City Council (ICC) a conservative 50% blockage factor was adopted for the proposed culvert for the 100 year flood event. It was found that the provision of a new 'non-structural' flood relief point was not feasible because of the upgrade embankment road levels, so a 'structural' solution using oversized culverts was required. In order to assess the worse case impacts, the upgrade design for this culvert includes an extreme event assessment using the Probable Maximum Flood (PMF).

24. Culvert C-FS950 was deemed to be a Class B culvert, according to Queensland Drainage Manual (QUDM), because it is close to a park and residential areas. It is therefore provided with an inlet screen.

25. The adopted culvert solution was 5x 2100mm diameter reinforced concrete pipes (RCP).

26. Localised regrading (approximately 1m depth) was required to form the upgraded culvert inlet area. Refer Drawing No.D-1034 for details. The proposed works include

[redacted] . . . . [redacted] . . . . . .

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Witness

scour protection at the upstream side of McAuliffe Street but not an upgrade of the McAuliffe Street roadway or culverts.

27. The relief channel suggested by the ICC was not physically possible given the constraints arising from the height of the road embankment and the surrounding surface levels. Accordingly, the project designers ran the drainage model again using more conservative assumptions which lead to the provision of two additional culverts and increasing the diameter of all the culverts.

28. This resulted in the provision of hydraulic capacity that exceeded the runoff from the local catchment area for the range of design flood events. In addition the culverts had conservative factors applied for blockage which is very conservative particularly given the nature of this catchment (being clear of aspects that might generate debris).

29. The relief channel would not have provided any additional flood mitigation given the nature (regional flood) of the January floods

Discussion

30. A new 5x2100 mm diameter RCP culvert arrangement was proposed at this location. The discharge from this arrangement will pass through the existing McAuliffe Street culvert and over the roadway which will remain unchanged, except for additional scour protection.

31. The afflux at the upstream end of the proposed culvert system (location C-FS950A) was checked and a water level increase of 96mm for the 20 year ARI and an increase of 127mm for the 100 year ARI event was predicted (based on a 50% blockage factor being applied). This was based on the conservative assumption that the inlet screen and culverts would both have 50% blockage. The predicted ultimate 100 year flood level is 10.749 m at the culvert inlet and provides over 1.45m freeboard to the ground level (lowest level) at the nearest housing area located at 12.20 m. The properties adjacent to the culvert and the QR culvert will not be affected by the 100 year ARI flood event. The land immediately upstream of the culvert between Monash Road and the Queensland Rail embankment is owned by DTMR.

32. The predicted flood level in the PMF event of 11.604 m represents an increase in water level of 473mm. At this level no flooding of the existing property structure floor levels are expected.

33. The depth / velocity (dv product) value for the McAuliffe Street overtopping flow was calculated for the 20 year and 100year ARI events. The width of the overtopping part of the road was taken as 32m. It was found that the estimated value for ultimate case of 0.12 m2/s for 20 year ARI is slightly higher than the existing value of 0.11 m2/s. The 100 year ARI depth by velocity product was estimated as 0.2m2/s. Both satisfy the QUDM allowable depth by velocity product of 0.4m2/s.

34. At this stage (100% final design) the hydraulic calculations for the culverts provides an acceptable design.

35. A safety analysis was performed in accordance with QUDM to determine the need for safety screens or fencing at the culvert inlet. An inlet screen has been incorporated into this design. Scour protection and pipe loading and bedding calculations have been included

[redacted]

Derek Millar

[redacted]

Witness

36. A copy of the Final Design Report -Transverse Drainage - Zone 2, Other Culverts - Report No. D2G-BASD-RERODR206-R-1000 dated 30 September 2010 is attached and marked **Attachment B.**

I make this statement of my own free will believing its contents to be true and correct.

Dated at REDBANK this 17 day of October 2011

[redacted] . . . . [redacted] . . . .

Derek Millar Wit[redacted]ess

Attachment A

IMU Drainage-ICC minutes of meeting dated 21st September 2009

[redacted]

Derek Millar

[redacted]

Witness

Document No:

Attachment B

Final Design Report -Transverse Drainage - Zone 2, Other Culverts -Report No. D2G-BASD-RERODR206-R-1000 dated 30 September 2010

[redacted]

Derek Millar

[redacted]

Witness

Document No:

IMU Drainage - ICC

Minutes of Meeting
21 September 2009

Attendees:

[redacted]

Ipswich City Council
Ipswich City Council
Origin Alliance
Origin Alliance
Origin Alliance
Origin Alliance
Origin Alliance

Summary:

Item No.	Action Items/Agreements	Responsible Person	Date Due
1	**Zone 1 - Drainage mitigation** A proportion of the IMU catchment in Zone 1 (Goodna) discharges to the Church Street stormwater system. The Alliance has undertaken a RAFTS and SWMM analysis that indicates that the existing pipe system in Church Street has capacity to cater for the 1 year ARI storm event. The Church Street system discharges to an open channel adjacent to Evan Marginson Park. The IMU catchment is increased by around 4% and this results in a minor impact to the existing ICC system. The Alliance believes that there are three potential options to mitigate the slight increase in peak flows: 1. Upgrade a small section of the existing system (within Evan Marginson Park) and drop the HGL along Church Street to existing pre-developed levels; 2. Provide a storage volume within the network to attenuate flows to pre-developed levels; or 3. Review existing access chambers / manhole structures to see if they can be retrofitted to lower structure losses and lower the pre-developed HGL. *ICC advised that they have no issue with any of the proposed options (including upgrading the existing underground network) as long as the HGL is not worsened after the construction of the IMU.* The Alliance enquired if Council had any safety concerns with the existing outlet of the piped system within the park. *Council advised that any works would need to consider safety issues and that the proposed works should not decrease safety.* [redacted] *advised that a fence around the channel may not be appropriate as it may be washed/knocked over in a major flood and that the local*		

	Councillor would probably oppose any infrastructure that detracted from the aesthetics of the area. [redacted] *will discuss the issue with the local Councillor and forward any relevant advice.*		
2	**William Street Drainage** William Street (adjacent to Goodna MacDonalds) currently has a fairly low level of flood immunity. The Alliance proposes to upgrade the existing drainage and improve the level of immunity for the portion of William Street that is within the IMU limit of works. There is however an existing problem upstream of the limit of works that results. Initial modelling indicates that a fair proportion of bypass flow is discharged across the intersection with Barram Street before ponding at the intersection of William Street and the service road. The Alliance proposes to only undertake works within the current limit of works. [redacted] *stated that the IMU does not need to fix existing local drainage issues, however if traffic flow has changed significantly then the drainage system should match the expected traffic volumes and provide an appropriate level of immunity.* The Alliance will review the proposed changes to traffic flows/volumes (if any) at this location and confirm that the proposed drainage system is appropriate. The Alliance will design drainage works within the limit of works to cater for the entire upstream catchment and allow provision for ICC or developers to upgrade the existing network (e.g. provision of an upstream access chamber / manhole / pit for future upgrade of the upstream network). This may include upgrading the underground pipe across Barram Street but may not include all upstream inlet gully pits.		
3	**Bridge Street / Francis Street – Townhouses** Bridge Street / Francis Street will be upgraded to provide a link to Monash Road. As a result, a high embankment will be proposed adjacent to McAuliffe Street. This embankment will restrict an existing flowpath that directs water from an upstream catchment (that includes QR land) across McAuliffe Street and into the Pan Pacific Peace Gardens. The catchment will therefore only be drained by the culverts as no weir flow over the proposed service road is possible. Should a complete culvert blockage or an extreme flood event occur, water will pond to the lowest section of Francis Street before flows can be discharged downstream. This would result in a number of existing townhouses being inundated. *ICC recommended a minimum blockage factor of 50% when reviewing the expected 100 year ARI flood levels. This is based on historical experience in other parts of the*		

	city. Council also recommended the provision of a positive overflow such as a channel to provide an emergency bypass should the culvert become excessively blocked. *Council suggested that the Alliance review two existing documents for advice on designing for climate change:* 1. *Draft South East Queensland Climate Change Management Plan (DIP); and* 2. *an EPA document that addresses sea level rise, sea temperature, intensity of storm events etc.*		
4	**Previous comments** An email dated 13/7/09 sent from [redacted] requested that the Alliance provide a suction relief point at/near the entry for culverts with a low head. [redacted] *indicated that this was to prevent air entrapment within the culvert that would limit the capacity of the culvert to convey flood flows. QUDM provides some guidance.* *The Alliance will review the culvert designs to determine if any culverts are expected to behave in this manner. Any proposed mitigation measures will be provided where required.*		
5	**James Street Culvert** [redacted] highlighted the progress of the design of the IMU culvert at James Street adjacent to Goodna School. He highlighted the existing flooding problem and the constraints to providing a solution. The Alliance has presented DTMR with an options paper covering 4 possible mitigation options. 1. Upstream detention basin 2. Additional storage by widening the existing channel adjacent to the Goodna School 3. Replacing the culverts with a bridge structure; and 4. Providing a new piped outlet directly to the Brisbane River. [redacted] *indicated that Council has received some funding to look at a regional solution for this catchment. The funding is only for the first stage of works that includes an initial study to review the problem and review potential options.* [redacted] *believes that a pipeline directly discharging to the Brisbane River would require consultation with DERM and the EPA to receive all relevant approvals and permits. Quentin believes that the stability of the river bank should be reviewed to determine any potential geotechnical constraints.*		

OriginAlliance Connecting Dinmore to Goodna	**Meeting Agenda**	Form No. MP40-F-0003 Rev Num. A Rev Date 12/12/08

Meeting Name:	Drainage issues		
Meeting No:		**Date of Meeting:**	21 September 09
		Time of Meeting:	2:00pm
		Location:	Hayden Centre
		ICC [redacted]	**Origin Alliance** Derek Millar [redacted]

#	Item	Action by
1	Zone 1 - Drainage mitigation ▪ Expected impacts from IMU ▪ Potential options to mitigate impacts ▪ Safety concerns with existing outlet at park	
2	Zone 1 – William Street drainage ▪ Extent of existing problem ▪ Extent of IMU works ▪ Proposed solution ▪ Allowance for ICC future upgrades	
3	Zone 1 – Francis Street culvert ▪ New service road adjacent to existing townhouse development ▪ Adoption of design criteria	
4	Previous comments close out	
5	Miscellaneous Items	

OriginAlliance

Connecting Dinmore to Goodna

Ipswich Motorway Upgrade

Dinmore to Goodna

Final Design Report
Transverse Drainage - Zone 2
Other Culverts

Report No.: D2G-BASD-RERODR206-R-1000
Date: 30 September 2010

Job title	**IPSWICH MOTORWAY UPGRADE** **Dinmore to Goodna**	**DMR No.148/17A/59**
Document title	Final Design Report Transverse Drainage - Zone 2 Other Culverts	File reference
Document ref	D2G-BASD-RERODR206-R-1000	

File name:P:\10-DESIGN MANAGEMENT\10.01-Submission Control\DC\DCs To Issue\RERODR206 - Transverse Drainage - Other Culverts - IFC\IFC\Report Parts\Report\RERODR206-R-1000.doc

Revision	Revision Date	Details	Authorised			
			Prepared by	Checked by:	Verified by:	Approved by:
01	29/10/09	85% Design	[redacted]			
02A	08/12/09	100%Final Design–AV Approval				
02	21/01/10	100%Final Design				
03A	18/3/10	100%Final Design-AV Approval				
03	14/4/10	100% Final Design (Hold Cloud Removal)				
04A	12/5/10	100%Final Design-AV Approval (Hold Cloud Removal)				
04	24/5/10	100% Final Design (Hold Cloud Removal)				
05A	7/9/10	100% Final Design -AV Approval (Design Amendment)				
05	30/9/10	100% Final Design - (Design Amendment)				

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1 Introduction

1.1 Background

The Ipswich Motorway Upgrade – Dinmore to Goodna involves the upgrade of 8km of extremely constrained urban motorway from four lanes to a minimum of six lanes and also includes two motorway to motorway interchanges. This is one of the largest roads projects ever undertaken in Queensland.

The Ipswich Motorway Upgrade – Dinmore to Goodna is being delivered through an Alliance framework by the Department of Main Roads. The Origin Alliance has been formed to meet the unique challenges of this project.

1.2 Scope of this Report

This report has been compiled to outline design development during the Final Design (100%) stage of the Project Delivery phase.

This report focuses on the transverse drainage for Francis Street in Zone 2 and the culvert at the intersection of Collingwood Drive and Smiths Road. The transverse drainage design for the other culverts on Smiths Road is contained in a separate report (D2G-BASD-RERO207-R-1000) and the mainline transverse drainage is contained in a separate report (D2G-BASD-RERO205-R-1000).

The local flood model results were used to determine tail water levels, where applicable, and are contained in the Goodna Creek local flood model document D2G-BASD-REFHKS100-R-1000

1.3 Description of this Package

This package is being reissued to document a design change at C-FS950. For further information on the design, refer to Section 4 of this report.

This design lot includes the transverse drainage infrastructure required for the intersection of Collingwood Drive and Smiths Road and Francis Street between CH 0 and CH 1300 (Zone 2). Transverse drainage is provided at existing watercourses and gullies to prevent localised flooding of upstream areas and inundation of the road.

This package includes the construction of new culverts in locations where culverts did not previously exist and the upgrade of existing culverts. The culvert locations are presented in Table 1-1.

Table 1-1 Proposed transverse culverts

Culvert	Crossing
C-SR100	Collingwood Drive/ Mine Street
C-FS620	Francis Street
C-FS750	Francis Street
C-FS950	Francis Street

1.3.1 Design Documentation

This package consists of the following design documentation:

- Detailed design report (this report)
- Appendix A – Design drawings
- Appendix B – Technical Standards and Specifications
- Appendix C – Reference drawings
- Appendix D – Reference documents
- Appendix E – Environmental Requirements Checklist
- Appendix F – IV Comments and Closeouts
- Appendix G – DMR Comments and Closeouts
- Appendix H – Third Party Comments and Closeouts
- Appendix I – Community Requirements checklist
- Appendix J – Value Engineering Outputs
- Appendix K – SIDR Outputs
- Appendix L – XP-SWMM Outputs
- Appendix M – Pipe Class Outputs
- Appendix N – Sub-catchment land use break-up

2 Reference Documents

This design report should be read in conjunction with the reference documents detailed in Table 2-1.

Table 2-1 History of Package Development

Stage	Document Title	Document Reference
15%	Concept design report – 15% transverse drainage – Zone 2	D2G-BASD-RERODR200-R-1000
85%	Detailed design report – 85% transverse drainage – Zone 2 – Other Culverts	D2G-BASD-RERODR206-R-1000
100%	Final design report – 100% transverse drainage – Zone 2 – Other Culverts	D2G-BASD-RERODR206-R-1000
100% - Post IFC Review	Final design report – 100% transverse drainage – Zone 2 – Other Culverts FS-950 revised	D2G-BASD-RERODR206-R-1000

Refer to Appendix C for the list of reference drawings.

Refer to SWTC (Scope of Works and Technical Criteria) - Appendix 16 for the list of general Reference Documents. Refer to Appendix D of this submission for any additional reference documents.

3 Compliance with the SWTC

3.1 General

Except where detailed below, it is expected all aspects of the Final Design (100%) stage of the transverse drainage design will fully comply with the requirements of the SWTC with design development.

3.2 Proposed SWTC Non-Compliances

There are no non-compliances at this stage of design.

Table 3-1 Schedule of non-compliances

Non-Conformance No.	Description	DMR Correspondence Reference
NIL		

3.3 Non-Compliances closed-out since previous Design Lot Stage Submission

The following non-compliances have been closed out since the previous stage of design (85% Detailed Design).

Table 3-2 Schedule of closed-out non-compliances

Non-Conformance No.	Description	DMR Correspondence Reference of Acceptance
RERODR206 – 1	Afflux downstream of C-FS950	RFI 0446
RERODR206 – 2	Afflux and modelling approach of C-FS950	RFI 0674

3.3.1 RERODR206 – 1 Afflux at Downstream of C-FS950

The area between the outlet of culvert C-FS950 and the inlet of the existing culvert at McAuliffe Street (CH 950) results in minor afflux at the culvert inlet for the 20 year ARI, 100 year ARI and PMF events. The issue has been raised in RFI-446. This has been closed out.

3.3.2 RERODR206 – 2 Afflux and modelling approach C-FS950

Due to the sensitive nature of C-FS950 and the range of events modelled the blockages factors and affluxes have been raised with the appropriate stakeholders to accept the modelling approach and conditions used. The issue has been raised in RFI-674 and has been closed out.

4 Design Description

4.1 Performance Criteria

The requirements of the Project Brief and SWTC have been summarised into the Design Criteria Report. This report forms the principal reference for the design team and has been submitted separately (D2G-BASD-DGRODR101-R-1000).

4.2 Technical Details

The following section discusses the Detail Design undertaken for Zone 2 Other Culverts C-SR100, C-FS620, C-FS750 and C-FS950.

4.2.1 General

The transverse drainage system has been designed to ensure an acceptable level of flood immunity for the proposed motorway and service roads and to ensure that the works do not have unacceptable impact on the hydraulic regime of the area. This is achieved by including adequately sized and located culverts, water diversions and other works in the design.

The design brief (Scope of Works and Technical Criteria – SWTC) requires that the Ipswich City Council controlled service roads and ramps must be designed so that the lowest point of each carriageway's pavement surface is protected from flooding and is 100 mm above the 20 year Average Recurrence Interval (ARI) flood level for cross drainage. This includes all locations where the works intercept runoff, floodplains, watercourses, depressions or drainage lines. The cross drainage structures have therefore been designed to convey the peak flows from the 20 year ARI storm event as a minimum.

This report only includes details for service road culvert crossings listed above.

The design relies on various data supplied from a number of sources as identified below:

- Field survey of existing structures and channels including Queensland Rail culverts (Alliance/DMR surveyors).
- Existing level of catchment development (taken from recent aerial photography).
- Future development conditions (based on Ipswich City Council planning scheme land uses).
- Current road design
- Local Goodna Creek flood model, for tailwater levels, where appropriate.

4.2.2 Existing Transverse Drainage

The details of the existing culverts are as follows:

Table 4-1 Existing Transverse Culverts on Service Roads

Culvert ID Chainage.	US IL (m)	DS IL (m)	Grade (%)	Culvert Size (mm Dia)	Existing Culvert Length (m)
Mine Street/Collingwood Drive, (Ch. 100 on Smiths Street)	11.53	11.35	0.5	2x 1500W x 900H RCBC	38.0
Existing Motorway (Francis Street at Ch. 620)	11.30	10.91	1.1	2 x 600 RCP	36.0
CH 16150 – Chalk St	9.47	9.38	0.51	1x1050 RCP	17.4
Existing McAuliffe Road (Francis Street at Ch. 950)	8.60	8.24	3.2	1x1050 RCP	11.2

4.2.3 Design Methodology

Generally, the proposed service road transverse culverts in Zone 2 have been sized to ensure peak water levels upstream and downstream of the structures do not exceed existing flood levels by more than 10 mm. The culverts also provide flood immunity to the service roads for the 20 year Average Recurrence Interval (ARI) storm for the local catchment. Two scenarios were considered as follows:

Base scenario – The hydrology of, and hydraulic calculations for the existing culverts were undertaken to estimate the existing 20 year ARI, 100 year ARI and PMF water levels and velocities upstream and downstream of the culverts. In this scenario, sub-catchment characteristics were assumed to be fully developed. A typical blockage factor of 20% was included in the analysis.

Upgrade scenario – The hydrology of, and hydraulic calculations for the upgraded service roads and culverts were undertaken to estimate the water levels and velocities upstream and downstream of each culvert for the 20 year ARI and 100 year ARI. The Probable Maximum Flood (PMF) event was modelled at culvert C-FS950 as requested by ICC to ensure that the proposed works do not adversely impact neighbouring residents. Sub-catchment characteristics were assumed to be fully developed. A minimum of 20% and maximum of 50% blockage is included in the analysis, depending on the inlet type.

Baseline and upgrade scenario flow hydrographs were estimated using the XP-RAFTS computer program. The hydraulic calculations for the culverts have been carried out using the XP-SWMM program. XP-SWMM uses the inflow hydrographs generated in XP-RAFTS and exported as an interface file. Outputs from XP-RAFTS were compared with the Rational Method for selected events to verify design flows.

The dimensions used for the design, including inlet and outlet levels and downstream channel properties were based on field survey where it was available. The tailwater levels for the culverts were based on the 20 year and 100 year Goodna Creek flood levels respectively.

Hydrology – XP-RAFTS & Rational Method

Hydrology describes the estimation of stormwater runoff volumes that are expected to traverse the service roads. This analysis only considers the flows from local catchments, not regional flows or flooding from major waterways.

The XP-RAFTS hydrological model was chosen to estimate design hydrographs as it is capable of representing a range of physical characteristics that influence runoff behaviour, such as rainfall patterns, catchment shape, catchment slope, drainage features, channel and floodplain storage, and variations in catchment land use. The XP-RAFTS model converts rainfall to runoff by applying rainfall losses to both the impervious and pervious catchments within the model to produce effective rainfall hyetographs. An initial and continuing loss model was adopted for this study, based on regional values recommended in Australian Rainfall and Runoff 2001 (AR&R). Standard temporal patterns and Intensity Frequency Duration (IFD) parameters were derived for the catchments using Volume 2 of AR&R. Detailed IFD data were generated for the entire project to ensure consistency as summarised in Table 4-2.

Table 4-2 Design Event – Intensity Frequency Duration Information

Parameter	Values
2 Year A.R.I. - 1 hour duration	46.27 mm/hr
2 Year A.R.I. - 12 hour duration	7.40 mm/hr
2 Year A.R.I. - 72 hour duration	2.20 mm/hr
50 Year A.R.I. - 1 hour duration	95.16 mm/hr
50 Year A.R.I. - 12 hour duration	15.41 mm/hr
50 Year A.R.I. - 72 hour duration	4.62 mm/hr
Geographic Factor F2	4.35
Geographic Factor F50	17.25
Location Skew	0.18
Temporal Pattern	Zone 3

The catchment areas were determined from the survey design models in the 12d earthworks and surveying computer package. This topographical information is based on aerial survey, detailed field survey and 1m contours obtained from Ipswich City Council (ICC) GIS information. Relevant percent imperviousness, Manning's roughness coefficients and catchment slopes were determined from the 12d model aerial photographs of the catchment and ICC development planning maps.

XP-RAFTS consider pervious and impervious sub areas separately. Each sub catchment has been divided into a pervious sub-area and an impervious sub-area. The pervious and impervious sub areas were estimated based on the land use. An Excel spreadsheet was developed to break-up the catchment and determine input data for the XP-RAFTS model.

The land use for the base and upgrade scenarios was based on ultimate catchment development in accordance with the ICC development planning maps. This yields conservatively high flows for the purposes of design. XP-RAFTS estimates runoff from the sub-catchments from the fraction impervious and the Manning's coefficients for each sub-catchment. The fraction impervious values were adopted from the XP-RAFTS Manual for the various land uses and the adopted fraction impervious and roughness coefficients are presented in Table 4-3.

Table 4-3 Fraction Impervious and Roughness coefficients

Land use Category	Fraction Impervious	Roughness 'n'(pervious)
Rural	0.1	0.07
Rural Residence	0.2	0.05
Commercial	0.9	0.03
Roads and Driveway	1	0.015
Urban	0.6	0.025
Open Space	0	0.04

Each sub-catchment has different loss parameters to account for the various level of imperviousness. The adopted loss parameters are based on recommended regional values from AR&R as summarised in Table 4-4.

Table 4-4 Rainfall Infiltration Losses

Loss rates	Pervious areas	Impervious areas	Reference
Initial losses (mm)	25	1.5	XP-RAFTS Reference/ AR&R Book 2 Sec. 3
Continuing losses (mm/hr)	2.5	0	XP-RAFTS Reference/ AR&R Book 2 Sec. 3

The XP-RAFTS model was run for a range of durations from 10 to 180 minutes for the 20 year ARI and 100 year ARI to determine peak flow rates for each individual culvert. As there is no recorded streamflow data to calibrate the models, the results were compared against peak flows estimated by the Rational Method. This was done to provide confidence in the results only, not to calibrate the models against the Rational Method estimates.

Design coefficients of runoff for the Rational Method calculations for different design average recurrence intervals were determined using Tables 3.7 and 3.8 on page 3-28 from the Road Drainage Design Manual (RDDM) – June 2002. The time of concentration was determined using standard inlet times and an estimate of pipe or channel flow assuming average flow velocities as presented in Section 3.5.3 of the RDDM.

The PMP estimates were derived in accordance with the Bureau of Meteorology's (BOM) guidelines, 'The estimation of Probable Maximum Precipitation in Australia: Generalised Short –Duration Method (June 2003), known as GSDM, for both base and ultimate scenarios. The Probable Maximum Flood (PMF) was estimated using XP-RAFTS model and XP-SWMM model.

Culvert Hydraulics – SWMM

The culverts are designed to ensure flood immunity of the service roads in a 20 year ARI event and to ensure that flood levels do not adversely impact on the adjoining properties and drainage systems upstream or downstream of the roads in a 100 year ARI event. This was done by determining flood levels for peak flows and velocities for each upgrade culvert structure and comparing results against the base scenario.

Hydraulics

The culvert and channel hydraulics were analysed using XP-SWMM. XP-SWMM is a one-dimensional unsteady state hydraulic model that can determine flood levels and velocities of stormwater systems (both underground pipe systems and overland flow paths) including detention basins and flood storages.

The model performs both inlet and outlet hydraulic calculations for culverts as explained below:

Inlet Control - For inlet control, the required headwater is calculated by assuming that the culvert inlet controls the upstream water level. Therefore, the inlet control capacity depends primarily on the geometry of the culvert entrance.

Outlet Control - For outlet control flow, the required headwater is calculated considering several conditions within the culvert and the downstream tailwater. For culverts flowing full, the total energy loss through the culvert is computed as the sum of friction losses, entrance losses, and exit losses. Friction losses are based on the Manning's equation. Entrance losses are calculated as a coefficient times the velocity head in the culvert at the upstream end. Exit losses are calculated as a coefficient times the change in velocity head from just inside the culvert (at the downstream end) to outside the culvert. The culvert entrance and exit losses are normally taken to be 0.5 and 1.0 respectively.

Blockage

The RDDM (Road Drainage Design Manual) indicates that the likelihood of blockage should be considered when designing culverts. Blockage can occur through a build up siltation or vegetation. Where blockage is considered to be likely due to the catchment containing significant woody riparian vegetation, larger culvert sizes may be required.

The culverts were modelled with blockage to determine impacts on existing flood levels for both the base and upgrade cases to ensure consistency between the scenarios. The blockage factor varied based on the catchment characteristics, sensitivity to blockage and requirement for an inlet screen. Where an inlet screen was not required a typical value of 20% was adopted and was applied at the base of the culverts.

Where an inlet screen is required the screen has been designed in accordance with QUDM guidance and a 50% blockage applied. It should be noted that the screen waterway area is required to be a minimum of 3 times the protected culverts waterway area. In effect a 50% blockage of the screen is unlikely to have a significant impact on the ability of the culvert arrangement to achieve its design capacity (i.e. 150% waterway area still available). For purposes of modelling, a blockage value of 20% was applied at the base of any culverts with an inlet screen to simulate sediment build-up.

Upgrade culvert C-FS950 represents a special case in that a suitable overland flow path will not be feasible for the upstream catchment as a result of the Francis Street/ Monash Road railway overpass embankment. The culverts have therefore been designed to cater for the PMF.

Tailwater

Modelling undertaken for Goodna Creek (refer report D2G-BASD-RERHK100-R-1000) was utilised to determine the tailwater levels in the 20 year and 100 year events. The adopted tailwater levels for the culverts C-SR100, C16150 and C-FS950 are given in the respective report sections.

Time-stage boundary conditions are used at the Goodna Creek nodes. This time-stage information for Q20 and Q100 flows for 60min durations were obtained from the dynamic HEC-RAS model, which was developed for Goodna Creek flood studies. The tailwater for the PMF scenario has been set at the 100 year flood level. Use of the PMF tailwater level would fully inundate the culverts and their upstream catchments.

Model Scenarios

Two model scenarios were developed in XP-SWMM:

- Base culvert case (ultimate development) – allowance for blockage
- Upgrade culvert case with the proposed IM upgrading case (ultimate development) – allowance for blockage

Water level, flow rate and velocity results were compared for both cases to confirm that the proposed culvert does not adversely impact adjacent property owners upstream and downstream. A description of the model for each culvert is provided below.

4.2.4 Upgrade Culvert C-SR100

The urban stormwater drainage system from the northern side of the Ipswich Motorway crosses the motorway through a series of pipes running adjacent to Mine Street. Stormwater discharges from Redbank Plaza and nearby catchments are added to these flows before discharging to Goodna Creek.

The two existing 1500W x 900H box culverts, crossing Mine Street and Collingwood Drive will be replaced as part of the road works proposed at the intersection of Mine Street and Smiths Road. The culverts are required to provide 20 year ARI immunity.

The upgrade of the motorway culverts and the models are discussed in the Zone 3 Transverse Drainage report (D2G-BASD-RIRODR300-R-1000). A summary of the information is provided below.

Hydrology –XP SWMM

The majority of the catchment is zoned as Major Centres, Residential Medium Density and Residential Low Density according to Ipswich City Council's PD (Planning & Development) Online. The catchment also includes some percentage of open space, road and commercial areas.

The total catchment area contributing to this culvert is 25.7 ha in the base case. The catchment area in the upgrade case is 0.9ha less than the base case due to the proposed motorway upgrading and culvert realignment. Runoff from the sub catchment C16500I1 with an area of 8.4 ha is collected at roadside gully pits and flows through a 2x 900 mm diameter RCP to the existing culvert outlet. Similarly, the runoff from the sub catchment C16500H1 with an area of 2.3 ha is collected at roadside gully pits and flows through a 750 mm diameter RCP to the existing culvert outlet. The upgrade of these two pipes are considered in the longitudinal drainage of the Mine Street and Collingwood Streets. The catchment plans are shown in Appendix A, D2G-BASD-RERODR203-K-2467 and 2468.

Refer to Zone 3 Transverse Drainage report (D2G-BASD-RIRODR300-R-1000) for the breakdown of catchment landuse for each sub–catchment for the base and upgrade case. The catchment break-up for the base case and ultimate case are shown on drawings K-2467 and K-2468.

Currently all flow from the catchment is diverted to the culvert in the upgrade case, an additional culvert outlet is provided just downstream of the Mine Street underpass. This results in less flow reporting to C-SR100. Both culverts have been modelled in one system to determine flow hydrographs at each culvert outlet.

The existing culvert network under the Redbank Plaza carpark will remain unchanged with no upgrade required. Culvert C-SR100 will be realigned and extended to suit the upgraded road alignment as the existing discharge location will be in the middle of the proposed Mine Street/Smiths Road Intersection.

The 20 year ARI storm event was run in XP-SWMM for storm durations ranging from 10 minutes to 2 hours. Table 4-5 shows the peak flow for each storm duration. The duration of 25 minute storm produced the largest outflow of 9.36 m^3/s for base case and 60 min produced 7.57 m^3/s for ultimate case at the culvert inlet.

The 100 year ARI storm event was run in XP-SWMM for storm durations ranging from 10 minutes to 2 hours. Table 4-5 shows the peak flow for each storm duration. The duration of 60 minute storm produced the largest outflow of 9.51 m^3/s for base case and 25 min produced 8.42 m^3/s for ultimate case at the culvert inlet. Peak flows have decreased in the ultimate case due to the upstream bypass just downstream of the Mine Street underpass.

Table 4-5 Peak flows at the culvert inlet – Base and Ultimate Scenarios – 20 and 100 year ARI

Storm Duration	Base Model		Ultimate Model	
	20 year ARI Flows (m^3/s)	100 year ARI Flows (m^3/s)	20 year ARI Flows (m^3/s)	100 year ARI Flows (m^3/s)
10 min	8.37	9.41	5.32	7.85
15 min	9.05	9.49	7.30	7.99
20 min	9.03	9.48	7.16	8.28
25 min	**9.36**	9.51	7.22	**8.42**
30 min	9.20	9.50	7.00	8.41
45 min	8.44	9.45	6.62	8.00
60 min	9.25	**9.51**	**7.57**	8.26
1.5 hr	8.35	9.25	5.63	7.88
2 hr	8.92	8.92	5.07	6.32

It is found that the 20year 25min flow is 9.36m^3/s and the 100year 60min flow is 9.51m^3/s through the existing box culverts. There is not much increase in the 100 year flows through the box culvert. And this reduction is due to diversion upstream.

The existing system comprises 800mm longitudinal RCP plus 2x1500x900 transverse RCBC plus flow overtopping Mine Street in 20 and 100 year ARI events. The bypass flows along the existing link pc16500H1 (800mm RCP+ Overland flow) are given in the Table below:

Table 4-6 Peak flows (existing scenario) along the link pc 16500H1

Flows (m^3/s)	20 year ARI 25min	100 year ARI 60min
Pipe flow	1.44	1.45
Overland flow (road) across Mine street and Collingwood drive	1.33	4.84
Total flow	**2.77**	**6.29**

This indicates that most of the existing flows bypass the culvert by overtopping the road. Increase in flow from 20 year ARI event to 100 year ARI event is accommodated by increasing overtopping flows only and the flows in RCP and RCBC are not increased. The proposed system includes a diversion upstream such that flows do not overtop Mine Street in both events.

Hydrology – Rational Method

The stormwater runoff results from XP-SWMM were compared against peak flows estimated by the Rational Method. The 20 year ARI flow was estimated using the fully developed catchment runoff coefficients, intensity of rainfall and the catchment area.

The area of the catchment is 25.7 ha (upstream of the culvert). A fraction impervious was derived for each sub-catchment, with an average of 0.70 for the total upstream (fully developed) catchment.

The time of concentration for the catchment was estimated using a standard inlet time and average flow velocity for the pipe flow path. A standard inlet time of 13 minutes was adopted based on the upstream sub-catchment slope. The pipe flow time was found to be 4.9 minutes using the average flow velocity of 3.0 m/s for the pipe length of 874m. Consequently, the total time of concentration was estimated to be 18 minutes.

The Rational Method estimate for peak flow for the 20 year ARI event is $9.1m^3/s$, which is slightly lower than the XP-SWMM peak flow of $9.4m^3/s$.

There is a fair comparison between XP-SWMM and Rational Method giving confidence in the XP-SWMM hydrology. The XP-SWMM peak flow is considered conservative as it is greater than the Rational Method peak flow. The assumptions used in the Rational Method analysis (e.g. standard inlet time used in the estimation of the time of concentration, fraction impervious and flow velocity used in the pipe flow etc.) would contribute to the discrepancy.

Hydraulics – SWMM

The hydraulics of the entire system was modelled using XP-SWMM. The Base model starts at Brisbane Road north of the motorway. The culvert network crosses the motorway main alignment, Redbank Plaza car park area, Mine Street and Collingwood Drive before discharging into Goodna Creek on the south–east corner of Redbank Plaza approximately 180m south of the motorway.

A new outlet has been designed upstream of Redbank Plaza, which discharges flows in excess of the downstream network capacity so that no upgrades are required to the pipe network under Redbank Plaza. However, two box culverts are required to pass the design flows across Mine Street in order to provide 20 year ARI immunity.

The construction of a new access chamber within the road reserve is required at a location 10m away from an existing manhole. The existing pipe culverts will be retained between the manholes.

A time-stage boundary condition was used at culvert outlet at Goodna Creek. This time-stage information for Q20 and Q100 flows was obtained from the HEC-RAS model developed for Goodna Creek flood studies. The time-stage information is given in the following table:

Table 4-7 The tailwater elevations at Goodna Creek

Time (hrs)	Base Case Stage (m)- Q20	Ultimate Case Stage (m)-Q20	Base Case Stage (m)-Q100	Ultimate Case Stage (m)-Q100
0	11.06	10.56	11.06	10.56
0.5	11.07	10.64	11.20	10.98
1.0	11.53	11.26	11.73	11.55
1.5	11.92	11.70	12.15	12.15
2.0	12.01	11.89	12.52	12.84
2.5	11.81	11.56	12.27	12.47
3.0	11.57	11.31	11.76	11.68
3.5	11.39	11.15	11.45	11.17
4.0	11.05	10.74	11.07	10.68
4.5	10.75	10.37	10.79	10.34

The upstream inlet gully pits were modelled as an orifice/weir with a blockage factor of 50% and the road culverts were modelled without any blockage.

For detailed SWMM outputs, refer to the Zone 3 report mentioned above.

Results

The adopted culvert solution is presented below:

- 2x 1800W x 900H RCBCs

Table 4-8 Results for existing and proposed culverts at C-SR100 – 20 year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (m)	Water Level (m)	Ground Level (m)	Afflux (m)
C16500A7	Existing	9.36	3.44	15.0[1]	14.287	11.53	-0.919
(RB Plaza Manhole)	Proposed	-	-	15.0[1]	13.368	11.53	
C-SR100A	Existing	-	-	-	-	-	
(Inlet Manhole)	Proposed	7.57	2.33	13.2	12.691	11.50	
C-SR100B	Existing	9.36	-	-	12.141	11.04	-0.120
(Outlet)	Proposed	7.57	-	-	12.021	11.00	

Note: 1- refers to the Redbank Plaza Car Park Level

Table 4-9 Results for existing and proposed culverts at C-SR100 – 100 year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (m)	Water Level (m)	Ground Level (m)	Afflux (m)
C16500A7	Existing	9.51	3.48	15.0[1]	14.346	11.53	-0.400
(RB Plaza Manhole)	Proposed	-	-	15.0[1]	13.746	11.53	
C-SR100A	Existing	-	-	-	-	-	
(Inlet Manhole)	Proposed	8.45	2.60	13.2	12.904	11.50	
C-SR100B	Existing	9.51	-	-	12.207/12.522*	11.04	-0.139
(Culvert outlet)	Proposed	8.45	-	-	12.068/12.846*	11.00	

Note: 1- refers to the Redbank Plaza Car Park Level

* afflux caused by increase in Goodna Creek water level

The peak water levels in Goodna Creek do not coincide with peak flows in local drainage

Discussion

The upgraded culverts are required to discharge stormwater flows to the southern side of Smiths Road. Stormwater flows originate from the urban areas north of the motorway and the properties west of Mine Street including Redbank Plaza.

The culvert upgrade at C-SR100 requires two 1800W x 900H RCBCs. As this is a local road, the culverts are sized for 20 year ARI design flows so that the upstream flows can be discharged to Goodna Creek without causing afflux or allowing runoff to overtop the road.

A 200m long 5m wide vegetated channel is required to convey the flows from the culvert outlet to Goodna Creek.

The estimated water levels before and after the motorway upgrade have been compared at the existing manhole no.C16500A7, which is located in the Redbank Plaza compound. A water level reduction of 919 mm for the 20 year ARI design event is estimated. A reduction in upstream flood level is preferred to ensure that the road upgrade has no impact on upstream properties.

At the proposed culvert inlet location C-SR100A, the predicted water level is 12.691m, which is lower than the foot path finished level of 13.05m.

Scour protection will be required downstream of the proposed culvert based on the expected outlet velocity (Section 4.2.13).

The ultimate model was run with the 100 year ARI flow and it was found that the transverse flows do not overtop Mine Street/Collingwood Drive as flows are reduced because of the diversion upstream at the new proposed drain parallel to the motorway.

The intersection of Smiths Road and Collingwood Drive is underlain by mine workings associated with the new Redbank colliery; refer to new Redbank interpretive report for a discussion on foundation treatment details.

At this stage (100% final detailed design) the hydraulic calculations for the culverts provides an acceptable design.

4.2.5 Upgrade Culvert C-FS620 and C16150

The existing culvert consists of twin 600 mm diameter RCPs 36 m long crossing the existing Ipswich Motorway (IM), and a 1050 mm diameter 17m long RCP crossing Chalk Street. The runoff from the catchment on the northern side of the motorway flows into a detention basin located upstream of the IM, which is currently designated as a recreation area, before entering the culverts.

A new local road configuration connecting the Brisbane Terrace/ Bridge Street roundabout with the Francis Street upgrade requires the existing two culverts to be replaced by new culverts known as C-FS620 and C16150. Culvert C-FS620 will cross Francis Street (formally IM) and discharge to a 3m wide open channel that connects to the proposed IMU culvert C16150. Culvert C-FS620 will be designed to provide a 20 year level of immunity to the local road while culvert C16150, which crosses the motorway, is required to provide a 100 year level of immunity. The details of culvert C16150 are contained within Detailed Design Report, Transverse Drainage – Zone 2, Early Works Culverts (D2G-BASD-RERO205-R-1000).

Culvert C-FS620 was deemed to be a Class B culvert, according to QUDM, because it is close to a park and residential areas. It is therefore provided with an inlet screen.

Hydrology – XP-RAFTS

Two hydrology models were developed for the design. The first is the base scenario with the existing motorway and culverts with the assumed ultimate catchment development. The second model included the upgraded Ipswich Motorway and proposed culverts with the ultimate catchment development.

The majority of the extensive upstream catchment is zoned as *Residential Low Density* and *Recreation* according to Ipswich City Council's *PD (Planning & Development) Online.* XP-RAFTS was used to generate catchment flows upstream of the culverts. The sub-catchment characteristics are provided in Table 4-11, and were assumed to be fully developed. The catchment breakup is shown in Appendix A, Sketch no. D2G-BASD-RERODR200-K-2452 and the sub-catchment land-use break up are shown on Appendix N.

Table 4-10 C-FS620/ C16150 sub-catchment characteristics – Base Scenario

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
C16150/a	1	0.00	3.1	IL25CL2.5	0.02	0
	2	0.78	3.1	IL1.5CL0	0.015	100
C16150/b	1	2.03	4.6	IL25CL2.5	0.036	0
	2	0.41	4.6	IL1.5CL0	0.015	100
C16150/c	1	1.00	4.0	IL25CL2.5	0.032	0
	2	0.60	4.0	IL1.5CL0	0.015	100
C16150/rd1	1	0.00	1.6	IL25CL2.5	0.02	0
	2	0.30	1.6	IL1.5CL0	0.015	100
C16150/rd2	1	0.00	0.9	IL25CL2.5	0.02	0
	2	0.11	0.9	IL1.5CL0	0.015	100
C16150/g1	1	0.43	2.5	IL25CL2.5	0.031	0
	2	0.33	2.5	IL1.5CL0	0.015	100

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
C16150/g2	1	0.77	2.8	IL25CL2.5	0.033	0
	2	0.40	2.8	IL1.5CL0	0.015	100
C16150/rd3	1	0.00	1.8	IL25CL2.5	0.02	0
	2	0.29	1.8	IL1.5CL0	0.015	100
Total		**7.45**				**43%**

The total catchment area contributing to the existing Ipswich Motorway culvert is 5.12 ha (Sub-catchment C16150/a + C16150/b + C16150/c + C16150/rd1). The sub-catchments have a typical slope of 5% and the road has a slope of approximately 1%. Flow from this area then passes through to the Chalk Street culvert with the addition of road areas (sub catchments C16150/rd2, C16150/g1 and C16150/g2). The sub catchment C16150/rd3 is added at the culvert outlet to give a total catchment area of 7.45 ha.

The 20 year and 100 year ARI storm events were run in XP-RAFTS for storm durations ranging from 10 minutes to 6 hours. Table 4-12 shows the peak flow for each storm duration. The 60 minute duration storm produced the largest outflow of 2.0 m^3/s and 3.1 m^3/s for the 20 year and 100 year ARI storms respectively.

Table 4-11 Peak flows at the culvert inlets – Base Scenario- 20 year and 100 year ARI

Storm Duration	20 year ARI Flow at Culvert Inlet (m^3/s)	100 year ARI Flow at Culvert Inlet (m^3/s)
10 min	1.3	1.8
15 min	1.5	2.2
20 min	1.5	2.4
25 min	1.9	2.7
30 min	1.8	2.6
45 min	1.4	2.3
60 min	**2.0**	**3.1**
1.5 hr	1.9	2.5
2 hr	1.5	2.2
3 hr	1.4	1.8
6 hr	0.9	1.2

The upgrade scenario sub-catchment characteristics are provided in Table 4-13, and the catchment break-up is shown in Appendix A, Sketch no. D2G-BASD-RERODR200-K-2455. The land-use break up within each sub-catchment is detailed in Appendix N.

Table 4-12 C-FS620/ C16150 sub-catchment characteristics – Upgrade Scenario

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
C16150/a	1	0.00	3.1	IL25CL2.5	0.02	0
	2	0.78	3.1	IL1.5CL0	0.015	100
C16150/b	1	1.72	4.6	IL25CL2.5	0.036	0
	2	0.35	4.6	IL1.5CL0	0.015	100
C16150/r71	1	0.00	1.0	IL25CL2.5	0.02	0
	2	0.22	1.0	IL1.5CL0	0.015	100
C16150/r72	1	0.00	1.0	IL25CL2.5	0.02	0
	2	0.27	1.0	IL1.5CL0	0.015	100
C16150/h	1	1.89	2.1	IL25CL2.5	0.04	0
	2	0.00	2.1	IL1.5CL0	0.015	100
C16150/z	1	0.10	4.2	IL25CL2.5	0.028	0
	2	0.15	4.2	IL1.5CL0	0.015	100
Total		**5.47**				**32%**

The total catchment area draining to C-FS620 and subsequently C16150 is reduced to 5.47 ha in the upgrade scenario. Sub catchment C16150/c now discharges to culvert C-FS750 to the west. Culvert C-FS750 is discussed in Section 4.2.6. The breakdown for each upgrade culvert is as follows:

- C-FS620 (sub-catchments C16150/a and C16150/b) – 2.85 ha
- C16150 (sub-catchments C16150/a, C16150/b, C16150/r71, C16150/r72 and C1610/h) – 5.22 ha

The 20 and 100 year ARI storm events were run in XP-RAFTS for storm durations ranging from 10 minutes to 6 hours. Table 4-14 shows the peak flow for each storm duration for each culvert inlet. The 60 minute duration storm produced the largest outflow for the culverts.

Table 4-13 Peak flows at the culvert inlet – Upgrade Scenario-20 and 100 year ARI

Storm Duration	20 year ARI Flow at Culvert Inlet (m^3/s)	100 year ARI Flow at Culvert Inlet (m^3/s)
10 min	0.8	1.1
15 min	1.0	1.4
20 min	0.9	1.5
25 min	1.2	1.7
30 min	1.1	1.6
45 min	0.8	1.4
60 min	**1.3**	**1.9**
1.5 hr	1.1	1.6
2 hr	0.9	1.3
3 hr	0.8	1.0
6 hr	0.6	0.7

Hydrology – Rational Method

The stormwater runoff results from XP-RAFTS were compared against peak flows estimated by the Rational Method. The 100 year ARI flow was estimated using the fully developed catchment runoff coefficients, intensity of rainfall and the catchment area. The area of the catchment (ultimate case) draining to the culvert inlet is 2.85 ha. A fraction of imperviousness was derived for each sub-catchment, with of average of 0.6 for the total upstream (fully developed) catchment.

The time of concentration for the catchment was estimated using the standard inlet time and an estimated pipe flow time. A standard inlet time of 13 minutes was used based on the headwater sub-catchment slope. The pipe flow time was found to be 2.0 minutes using an average flow velocity of 2 m/s for the pipe/surface flow length of 250 m. Consequently, the total time of concentration was estimated to be 15 minutes.

The Rational Method estimate peak flow for the 20 year ARI is 1.1m^3/s, which is slightly lower than the XP-RAFTS peak flow of 1.3 m^3/s in the existing scenario. Given that the Rational Method does not account for any storage on a catchment, a higher value would be expected. The XP-RAFTS estimate is considered suitable for design purposes.

Hydraulics – XP-SWMM

Culvert hydraulics was modelled using XP-SWMM. The model includes the sub-catchment upstream of the existing culvert and extends downstream to Goodna Creek.

Under existing conditions there is detention storage upstream of the existing motorway which has been formed by the motorway embankment crossing a natural depression. The storage is located at the inlet of the existing culvert/culvert C-FS-620 and the stage/discharge relationship for the existing and upgrade scenarios are given in the Tables 4-15 and 4-16. The motorway upgrade reduces the storage because of the construction of the local access road.

Table 4-14 Stage-storage relationships for detention storage in Base Scenario

Detention basin upstream of existing motorway			
Contour Level (m AHD)	**Water Depth (m)**	**Area (ha)**	**Cumulative Volume (m^3)**
11.3	0.0	0.000	0
12.0	0.7	0.003	10
13.0	1.7	0.050	280
14.0	2.7	0.320	2130

Table 4-15 Stage storage relationships for detention storage in the upgrade scenario

Detention basin upstream of existing motorway			
Contour Level (m AHD)	**Water Depth (m)**	**Area (ha)**	**Cumulative Volume (m^3)**
12.3	0.0	0.000	0
13.0	0.7	0.009	30
14.0	1.7	0.131	730
15.0	2.7	0.356	4960

Blockage factors of 20% were adopted for upstream culverts in the base and upgrade scenarios and a blockage factor of 10% was adopted for the upgrade culvert C16150 given its location downstream of culvert C-FS620. An additional entrance loss factor of 1.0 was applied to estimate approximately the partially blocked screen hydraulic losses.

A time-stage boundary condition was used for the tailwater at Goodna Creek. This time-stage information for 20 year ARI 100 year ARI flows was obtained from the HEC-RAS model developed for Goodna Creek. The time-stage information is given in the following table:

Table 4-16 Tailwater elevations at Goodna Creek

Time (hrs)	Base Case Stage (m)- Q20	Ultimate Case Stage (m)-Q20	Base Case Stage (m)-Q100	Ultimate Case Stage (m)-Q100
0	9.30	9.29	9.30	9.29
0.5	9.29	9.28	9.33	9.32
1.0	9.42	9.42	9.54	9.54
1.5	9.59	9.59	9.85	10.06
2.0	9.81	10.07	10.81	11.25
2.5	9.69	10.00	11.37	11.73
3.0	9.54	9.58	10.74	11.19
3.5	9.46	9.46	9.53	10.1
4.0	9.35	9.35	9.35	9.35
4.5	9.28	9.28	9.27	9.27

Results

The adopted upgrade culvert solution is presented below:

- C-FS620 – 2x 750 mm diameter RCP (Francis Street)
- C16150 – 2x 1200 mm diameter RCP (Main Line)
- Localised regrading (approximately 1m depth) will be required to form the upgrade culvert inlet area. Refer Drawing No.D-1034 for details.

Flow, water level and velocity results from the XP-SWMM hydraulic model for the base case and upgraded case are summarized in Table 4-18 and Table 4-19. The model output is contained in Appendix L.

Table 4-17 Results for existing and proposed culverts at C-FS620 – 20 year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (mAHD)	Water Level (mAHD)	Ground Level (mAHD)	Afflux (m)
C-FS620A (Francis St. culvert Inlet)	Base	1.32	2.88	15.20	13.020	11.28	-0.004
	Upgrade	1.07	2.06	15.50	13.016	12.25	
C16150B (IMU Culvert outlet)	Base (Chalk Street)	1.60	NA	11.00	10.10	9.38	-
	Upgrade (IMU)	1.43	NA	16.00 (IMU road level)	9.81	8.83	

Table 4-18 Results for existing and proposed culverts at C-FS620 – 100 year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (mAHD)	Water Level (mAHD)	Ground Level (mAHD)	Afflux (m)
C-FS620A (Francis St. culvert Inlet)	Base	1.56	3.38	15.20	13.651	11.28	-0.317
	Upgrade	1.39	2.22	15.50	13.334	12.25	
C16150B (IMU Culvert outlet)	Base (Chalk Street)	2.00	NA	11.00	10.190/10.370*	9.38	-
	Upgrade (IMU)	2.15	NA	16.00 (IMU road level)	9.320/11.730*	8.83	

* afflux caused by increase in Goodna Creek water level

The peak water levels in Goodna Creek do not coincide with peak flows in local drainage

The flows in the upgrade case were slightly higher than the base case because of the modified retention basin storage.

The upstream side of the culvert arrangement will incorporate inlet screen fitted to the concrete headwall. Details of the screens are provided on the drawing nos. D-2115 & D-2116.

Discussion

New twin 750 mm diameter RCPs will replace the existing twin 600 mm diameter RCPs under the existing motorway (and become Francis Street culverts). The existing culverts under Chalk Street will be replaced with twin 1200 mm diameter RCPs (and become the IMU culverts).

The afflux at the upstream end of the proposed culvert system (Francis Street culvert) was checked and a flood level decrease of 4 mm and 317mm for the 20 year and 100 year ARI event are predicted. The predicted ultimate 100 year flood level is 13.33 m at the Francis Street culvert inlet with the ground level (lowest level) at the nearest housing area at 16.00 m. The properties upstream of the culvert will not be affected by the 100 year ARI.

In flood events larger than the 100 year ARI event, it is expected that upstream floodwaters will breach over Francis Street to the southeast of the proposed culvert and flow east towards Goodna Creek. The lowest road level of Francis Street is 15.5m and it is not expected to impact the upstream properties which are above 16.0m.

At this stage (100% final design) the hydraulic calculations for the culverts provides an acceptable design.

A safety analysis was performed in accordance with QUDM to determine the need for safety screens or fencing at the culvert inlet. An inlet screen has been incorporated into this design.

Scour protection and pipe loading and bedding calculations have been included in sections 4.2.13 and 4.2.10 respectively.

4.2.6 Upgrade Culvert C-FS750

The proposed alignment of the Francis Street upgrade commences at Francis Street /Brisbane Road junction crosses the QR railway line via an overpass and joins the existing Monash Road at the Monash Road-Brisbane Terrace junction.

The existing service road (McAuliffe Street), which is providing access to the existing Ipswich sewerage pumping station and Pan Pacific Peace Gardens, is being maintained with a new junction at Francis Street. The geometry of the proposed Francis Street upgrade requires two new culverts (C-FS750 and C-FS950) to drain the upstream catchments from the western side of Francis Street to Goodna Creek. Culverts are required to provide 20 year ARI immunity to Francis Street. The details of culvert C-FS750 is provided in this section. The other two culverts are discussed in Sections 4.2.7 and 4.2.8.

At present, the runoff from this catchment drains towards Goodna Creek along the road side drain between the Ipswich Motorway and Bridge Street.

Hydrology – RAFTS

Base and upgrade hydrological models were developed for the design, which assume a fully developed catchment.

The majority of the extensive upstream catchment is zoned as road reserve/recreation according to Ipswich City Council's PD (Planning & Development) Online. XP-RAFTS was used to generate catchment flows upstream of the culverts. The base scenario sub-catchment characteristics are provided in Table 4-20, and the catchment break-up is shown in Appendix A, D2G-BASD-RERODR203-K-2465. The land-use break up within each sub-catchment is detailed in Appendix O.

Table 4-19 C-FS750 sub-catchment characteristics – Base Scenario

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
FS750/a	1	0.41	3.9	IL25CL2.5	0.032	0
	2	0.27	3.9	IL1.5CL0	0.02	100
FS750/b	1	0.92	3.9	IL25CL2.5	0.031	0
	2	0.59	3.9	IL1.5CL0	0.02	100
Total		**2.19**				**40%**

Under existing conditions, only the sub catchment FS750/a with an area of 0.7 ha and 40% imperviousness drains to the outlet channel. Catchment FS750/b currently discharges via a 1050 mm diameter culvert towards the existing motorway culvert with overland flow towards catchment FS750/a. This overland flow has been included in the modelling, but no flows were observed in both 20 and 100 year ARI flow scenarios.

The 20 and 100 year ARI design event was run in XP-RAFTS for storm durations ranging from 10 minutes to 6 hours. Table 4-21 shows the peak flow for each storm duration. The 60 minute duration storm produced the largest outflow of 0.32 m^3/s at the inlet location. No overland flow from catchment FS750/b drains to the culvert in the 20 year or 100 year ARI event.

Table 4-20 Peak flows at the culvert inlet – Base Scenario- 20/ 100 year ARI

Storm Duration	20 year ARI Inlet Flows (m^3/s)	100 year ARI Inlet Flows (m^3/s)
10 min	0.16	NM
15 min	0.21	NM
20 min	0.23	0.43
25 min	0.30	0.43
30 min	0.28	0.41
45 min	0.22	0.35
60 min	**0.32**	**0.47**
90 min	0.28	0.36
120 min	0.24	NM
180 min	0.20	NM
360 min	0.13	NM

Note: NM- not modelled

The ultimate scenario sub-catchment characteristics are provided in Table 4-22, and the catchment break-up is shown in Appendix A, D2G-BASD-RERODR203-K-2466.

Table 4-21 C-FS750 sub-catchment characteristics – Ultimate Scenario

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
FS750/a	1	2.03	3.4	IL25CL2.5	0.035	0
	2	0.52	3.4	IL1.5CL0	0.02	100
FS750/rd	1	0.0	2.7	IL25CL2.5	0.020	0
	2	0.43	2.7	IL1.5CL0	0.02	100
Total		**2.98**				**32%**

The 20 year and 100 year ARI storm event was run in XP-RAFTS for storm durations ranging from 10 minutes to 6 hours. Table 4-23 shows the peak flow for each storm duration. The 60 minute duration storm produced the largest outflow of 0.98 m^3/s and 1.55 m^3/s at the culvert inlet for the 20 and 100 year flood events respectively.

Table 4-22 Peak flows at the culvert inlet – Upgrade Scenario-20 year/ 100 year ARI

Storm Duration	20 year ARI Flow at Culvert Inlet (m^3/s)	100 year ARI Flow at Culvert Inlet (m^3/s)
10 min	0.58	NM
15 min	0.71	NM
20 min	0.69	1.16
25 min	0.91	1.35
30 min	0.84	1.28
45 min	0.78	1.15
60 min	**0.98**	**1.55**
90 min	0.93	1.36
120 min	0.78	1.11
180 min	0.79	1.00
360 min	0.46	NM

Note: NM- not modelled

Hydrology – Rational Method

The stormwater runoff results from XP-RAFTS were compared against peak flows estimated by the Rational Method. The 20 year ARI flow was estimated using the fully developed catchment runoff coefficients, intensity of rainfall and the catchment area

The area of the catchment is 2.98 ha (ultimate case upstream of the basin). A fraction impervious was derived for sub-catchment, with an average of 32% for the total upstream (fully developed) catchment.

The time of concentration for the catchment was estimated using a standard inlet time and average flow velocity for the channel flow path method. A standard inlet time of 13 minutes was used based on the upstream sub-catchment slope. The pipe flow time was found to be 3 minutes using the average flow velocity of 2 m/s for the surface flow length of 330 m. Consequently, the total time of concentration was estimated to be 16 minutes.

The Rational Method estimate for peak flow for the 20 year ARI event is $1.1m^3/s$, which is higher than the XP-RAFTS peak flow of $0.98m^3/s$. Given that the Rational Method does not account for any storage on a catchment, a higher value would be expected. The XP-RAFTS estimate is considered suitable for design purposes.

Hydraulics - SWMM

Culvert hydraulics were modelled using XP-SWMM. The model extends from approximately 300m upstream of the culvert and includes a section of the existing natural channel.

The proposed culvert C-FS750 was added into the upgrade scenario. Blockage factors of 20% were adopted for the culverts to account for siltation. As the culvert inlet is depressed an additional field inlet structure (Type 2 double gully inlet pit) to the culvert was modelled with a 50% blockage factor. The inlet pit has been designed in accordance with QUDM guidance (QUDM Section 7.05.4) and a blockage factor of 50% of the clear opening area was used.

The culvert discharges into a new vegetated channel located along the base of the Francis Street embankment, which directs the outflows towards Goodna Creek.

Results

Table 4-24 and Table 4-25 present the results of the XP-SWMM hydraulic model.

The adopted culvert solution is presented below:

- 1x 900mm diameter RCP
- Type 1 double field inlet

Model output is contained in Appendix N.

Table 4-23 Results for existing and proposed culverts-20 year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (mAHD)	Water Level (mAHD)	Ground Level (mAHD)	Afflux (m)
C-FS750A (Culvert inlet)	Base	0.28	0.84	-	13.339	13.0	-0.595
	Upgrade	0.89	1.79	13.30	12.744	12.50(ground) 11.00(invert)	
C-FS750B (Culvert outlet)	Base	0.28	0.84		13.339	12.9	-2.109
	Upgrade	0.88	0.84	13.30	11.23	10.75	

Table 4-24 Results for existing and proposed culverts-100 year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (mAHD)	Water Level (mAHD)	Ground Level (mAHD)	Afflux (m)
C-FS750A (Culvert inlet)	Base	0.42	0.94	-	13.393	13.0	-0.445
	Upgrade (culvert)	1.26	2.48	13.30	13.509	12.50(ground) 11.00(invert)	
C-FS750B (Culvert outlet)	Base	0.42	0.94		13.393	12.9	-2.053
	Upgrade	1.25	0.94	13.30	11.324	10.75	

Discussion

A culvert is required to discharge stormwater flows to the southern side of Francis Street at this location. The culvert flows originate from the open areas north of the existing motorway and the urban development areas south of the railway line.

The culvert upgrade at this location requires one 900mm diameter RCP. As this is a local road, the culvert is designed for 20 year ARI flows so that the upstream flood levels are unaffected and the roadway is immune from over topping. A type 1 double field inlet was proposed at the culvert inlet as no space was available for a conventional culvert inlet.

The base and upgrade flood levels been compared upstream of the culvert C-FS 750A inlet. Flood level reduction of 595 mm has been predicted for the 20 year ARI design event with 556 mm freeboard to the road carriageway. This reduction in upstream flood level ensures that there is no impact on upstream properties. The proposed culvert invert level is 2.7m below the original ground level of 13.7m, which is the reason for the large water level reduction.

As a further check on flood impacts, the ultimate model was run with the 100 year ARI flow and no impacts on the upstream properties or overtopping of the carriageway are predicted.

In flood events larger than the 100 year ARI event (or if the culvert is fully blocked), it is expected that upstream floodwaters will breach over Francis Street to the southeast of the proposed culvert and flow east towards Goodna Creek. The lowest road level of Francis Street is 13.30 m at this location and it is not expected to impact the upstream properties which are above 14.60 m.

Scour protection will be required downstream of the proposed culvert as discussed in section 4.2.13.

At this stage (100% final design) the hydraulic calculations for the culverts provides an acceptable design.

4.2.7 Upgrade Culvert C-FS950

A 25 ha catchment contributes flows to the proposed culvert C-FS950. This includes a portion of the QR workshops, Brisbane Terrace, the QR railway corridor and a residential area at the lower end.

An existing 1050mm diameter RCP conveys flows under Brisbane Terrace. In addition, 3 x 300mm diameter RCP stormwater pipes convey runoff from an open area adjacent to Brisbane Terrace.

Flows pass beneath the QR through a single 18m long 1050mm diameter RCP. Additional QR sub-catchments contribute to the flow at the upstream and the downstream side of this culvert. A natural channel then conveys flows to the McAuliffe Street culvert. Runoff from nearby residential areas is discharged via a pipe in the vicinity of the existing culvert inlet.

The existing culvert across McAuliffe Street consists of a single 1050 mm diameter RCP, approximately 11 m long. The existing culvert collects runoff from the entire catchment west of McAuliffe Street and discharges into a pond to the east within the Pan Pacific Peace Gardens. This pond level is controlled via a spillway that discharge flows to Goodna Creek approximately 150m away.

When the headwater level exceeds approximately 17.0m, flows in excess of the QR culvert capacity can spill to a channel/ overland flow path along the northern side of the railway embankment. This diversion of flows can reduce the impact of flooding on downstream properties for large flood events. However in extreme and rare events, it is expected that a portion of flows will overtop the QR rail embankment and flow towards the culverts at McAuliffe Street.

The Monash Road upgrade, which incorporates an overpass crossing the QR track, will result in a significant road embankment being constructed, a short distance upstream of the retained McAuliffe street roadway. The embankment will remove the existing overland flow path for the catchment. The provision of the upgrade requires a new culvert to be constructed at this location.

A meeting was held with ICC to discuss the impact of the embankment on local flood risk (Refer IMU Drainage-ICC, meeting minutes dated 21st September 09). The outcome of the meeting was a request from ICC to:

- Specifically consider a 50% blockage of the culvert in a 100 year flood event;
- Provide a positive overflow, such as a channel, for an emergency bypass should the culvert become excessively blocked.

This approach differed from that specified in the Drainage Design Criteria Report (DGRODR101) and the approach used on all other culverts through out the corridor, which was a 50% screen blockage and a 20% culvert blockage. However as requested by ICC a conservative 50% blockage factor was adopted for the proposed culvert for the 100 year flood event. It was found that the provision of a new 'non-structural' flood relief point was not feasible because of the upgrade embankment road levels, so a 'structural' solution using oversized culverts was required. In order to assess the worse case impacts, the upgrade design for this culvert includes an extreme event assessment using the Probable Maximum Flood (PMF).

Culvert C-FS950 was deemed to be a Class B culvert, according to QUDM, because it is close to a park and residential areas. It is therefore provided with an inlet screen.

Hydrology - RAFTS

Base and upgrade hydrological models were developed for the design, and assume a fully developed catchment.

The majority of the large upstream catchment is zoned as a mixture of residential/business/industrial uses according to Ipswich City Council's PD (Planning & Development) Online. XP-RAFTS was used to generate catchment flows upstream of the culverts. The base scenario sub-catchment characteristics are provided in Table 4-25, and the catchment break-up is shown in Appendix A, D2G-BASD-RERODR203-K-2465. The land-use break up within each sub-catchment is detailed in Appendix O.

Table 4-25 C-FS950 sub-catchment characteristics – Base Scenario

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
C-FS950/a	1	0.86	6.2	IL25CL2.5	0.028	0
	2	0.85	6.2	IL1.5CL0	0.015	100
C-FS950/b	1	1.07	4.4	IL25CL2.5	0.025	0
	2	1.61	4.4	IL1.5CL0	0.015	100
C-FS950/qr1	1	0.001	1.6	IL25CL2.5	0.020	0
	2	0.46	1.6	IL1.5CL0	0.015	100
C-FS950/qr2	1	0.03	2.8	IL25CL2.5	0.022	0
	2	1.3	2.8	IL1.5CL0	0.015	100
C-FS950/d	1	0.14	4.3	IL25CL2.5	0.03	0
	2	1.28	4.3	IL1.5CL0	0.015	100
C-FS950/e	1	0.36	1.7	IL25CL2.5	0.029	0
	2	0.41	1.7	IL1.5CL0	0.015	100
C-FS950/f	1	0.75	2	IL25CL2.5	0.04	0

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
	2	0.001	2	IL1.5CL0	0.015	100
C-FS950/g	1	4.74	0.5	IL25CL2.5	0.025	0
	2	7.12	0.5	IL1.5CL0	0.015	100
C-FS950/h	1	1.63	4.2	IL25CL2.5	0.025	0
	2	2.45	4.2	IL1.5CL0	0.015	100
Total		**25.06**				**58%**

Under existing conditions, the total catchment is approximately 25 ha with 58% imperviousness. The sub-catchments slope varies between 0.5 % and 7 %.

The 20, 100 year ARI and PMF design event were run in XP-RAFTS for storm durations ranging from 10 minutes to 6 hours. Table 4-27 shows the peak flow for each storm duration. The 25 minute duration storm produced the largest flow of 6.9 m^3/s in the 20 year ARI event and the 60min duration storm produced the largest flow of 10.9 m^3/s in the 100 year event.

The PMP estimates were derived in accordance with Bureau of Meteorology's (BOM) guidelines, 'The estimation of Probable Maximum Precipitation in Australia: Generalised Short –Duration Method (June 2003)', known as GSDM, for both base and ultimate scenarios. As the catchment is less than a square kilometre, the PMP values were interpolated and estimated. The following values were used to calculate the PMP rainfall estimates:

- Rainfall duration: checked for 15 min – 360 mins
- The PMF Initial Rainfall Depth (IRD) from the Depth Duration-Area (DDA) curve in Figure 4 (refer GSDM document): 555mm (smooth terrain)
- Elevation Adjustment Factor (EAF): 1.00
- Moisture Adjustment Factor (MAF): 0.85

PMP was estimated by the following relationship:

PMP = Initial Rainfall Depth x MAF x EAF

The value of PMP for 45 minute duration event was estimated as 519mm. This rainfall was used in XP-RAFTS for both base and ultimate scenarios. The following loss values were used in XP-RAFTS model:

Loss rates	Pervious areas	Impervious areas
Initial losses (mm)	0	0
Continuing losses (mm/hr)	0	0

The PMF rainfall was then run to generate the water levels and flows both base and ultimate XP-SWMM models.

Table 4-26 Peak flows at the culvert inlet – Base Scenario - 20 year, 100 year ARI and PMF

Storm Duration	20 year ARI Inlet Flows (m^3/s)	100 year ARI Inlet Flows (m^3/s)	PMF Inlet Flows (m^3/s)
10 min	5.5	NM	NM

Storm Duration	20 year ARI Inlet Flows (m^3/s)	100 year ARI Inlet Flows (m^3/s)	PMF Inlet Flows (m^3/s)
15 min	6.2	NM	64.3
20 min	6.3	9.4	NM
25 min	**6.9**	9.4	NM
30 min	6.7	8.8	62.6
45 min	6.1	8.6	**58.3**
60 min	6.8	**10.9**	41.7
90 min	6.0	7.9	33.1
120 min	5.6	6.5	28.3
180 min	5.3	6.0	41.8
360 min	4.0	NM	26.5

Note: NM- not modelled

The ultimate scenario sub-catchment characteristics are provided in Table 4-28, and the catchment break-up is shown in Appendix A, D2G-BASD-RERODR203-K-2466.

Table 4-27 C-FS950 sub-catchment characteristics – Ultimate Scenario

Sub-catchment	Sub-catchment Number	Total Area [ha]	Catchment Slope [%]	Init/Cont Rainfall Loss	Catchment Mannings 'n'	Percentage Impervious [%]
C-FS950/a	1	0.71	6.2	IL25CL2.5	0.028	0
	2	0.63	6.2	IL1.5CL0	0.015	100
C-FS950/b	1	0.89	4.4	IL25CL2.5	0.025	0
	2	1.34	4.4	IL1.5CL0	0.015	100
C-FS950/d	1	0.14	4.3	IL25CL2.5	0.03	0
	2	1.28	4.3	IL1.5CL0	0.015	100
C-FS950/qr1	1	0.01	1.6	IL25CL2.5	0.020	0
	2	0.46	1.6	IL1.5CL0	0.015	100
C-FS950/qr2	1	0.03	2.8	IL25CL2.5	0.022	0
	2	1.3	2.8	IL1.5CL0	0.015	100
C-FS950/e	1	0.36	1.7	IL25CL2.5	0.029	0
	2	0.41	1.7	IL1.5CL0	0.015	100
C-FS950/f	1	0.75	2	IL25CL2.5	0.04	0
	2	0.001	2	IL1.5CL0	0.015	100
C-FS950/g	1	4.74	0.5	IL25CL2.5	0.025	0
	2	7.12	0.5	IL1.5CL0	0.015	100
C-FS950/h	1	1.63	4.2	IL25CL2.5	0.025	0
	2	2.45	4.2	IL1.5CL0	0.015	100
C-FS950/i	1	0.86	4.8	IL25CL2.5	0.04	0
	2	0.001	4.8	IL1.5CL0	0.015	100
Total		**25.1**				**59%**

Under ultimate conditions, the total catchment is approximately 25 ha with 59% imperviousness. The sub-catchments slope varies between 0.5 % and 7 %. A minor reduction in catchment area results from the separate collection and discharge of the road upgrade drainage.

The 20 year and 100 year ARI storm events were run in XP-RAFTS for storm durations ranging from 10 minutes to 6 hours. Table 4-29 shows the peak flow for each storm duration. The 60 minute duration storm produced the largest outflow of 6.6 m^3/s and 10.5 m^3/s for the 20 and 100 year events respectively.

Table 4-28 Peak flows at the culvert inlet – Upgrade Scenario- 20 year, 100 year ARI and PMF

Storm Duration	20 year ARI Flow at Culvert Inlet (m^3/s)	100 year ARI Flow at Culvert Inlet (m^3/s)	PMF Inlet Flows (m^3/s)
10 min	5.3	NM	NM
15 min	5.8	NM	63.1
20 min	6.1	9.0	NM
25 min	6.6	9.4	NM
30 min	6.3	8.8	61.5
45 min	5.9	8.7	**57.2**
60 min	**6.6**	**10.5**	41.2
90 min	5.9	7.9	32.4
120 min	5.6	6.5	27.9
180 min	5.3	6.0	41.1
360 min	3.9	NM	26.1

Note: NM- not modelled

Hydrology – Rational Method

The stormwater runoff results from XP-RAFTS were compared against peak flows estimated by the Rational Method. The 20 year ARI flow was estimated using the fully developed catchment runoff coefficients, intensity of rainfall and the catchment area

The area of the catchment is 25.0 ha (upstream of the basin). A fraction impervious was derived for each sub-catchment, with an average of 62% for the total upstream (fully developed) catchment.

The time of concentration for the catchment was estimated using a standard inlet time and average flow velocity for the channel flow path method. A standard inlet time of 15 minutes was used based on the upstream sub-catchment slope. The assumed pipe/channel flow time was found to be 7 minutes using the average flow velocity of 2 m/s for the surface flow length of 820 m. Consequently, the total time of concentration was estimated to be 22 minutes.

The Rational Method estimate for peak flow for the 20 year ARI event is 7.7 m^3/s, which is higher than the XP-RAFTS peak flow of 6.6 m^3/s. Given that the Rational Method does not account for any storage on a catchment, a higher value would be expected. The XP-RAFTS estimate is considered suitable for design purposes.

Hydraulics – SWMM

Culvert hydraulics was modelled using XP-SWMM. The model extends from the Queensland Railway yard at Redbank, which is located north of Brisbane Terrace, to the artificial lakes located at the western side of the Pan Pacific Peace Garden.

The existing stormwater network was incorporated into the base scenario. The proposed culvert arrangement was added into the ultimate scenario.

A blockage factor of 20% was adopted for all crossing culverts in the base and ultimate scenarios with the exception of the new culvert arrangement (C-FS950) which was assumed to be 50% up to the 100 year ARI storm event. This was done based on advice from ICC to ensure that the adjacent town houses are protected.

It should be noted that the inlet of culvert C-FS950 will incorporate an inlet screen designed in accordance with QUDM. This inlet screen has a clear screen waterway area approximately three times that of the proposed culverts. In the unlikely event of a 50% blockage of this screen, the full culvert waterway area (i.e. 150%) will still be available. For purposes of modelling, a blockage value of 50% was applied at the base of the culverts up to the 100 year event and a blockage value of 20% for the PMF event, to simulate debris or sediment build-up. An additional screen loss was calculated for the partially blocked screen hydraulic losses using the method provided in QUDM.

A time-stage boundary condition was used for the tailwater at the Goodna Creek. This time-stage information for Q20 and Q100 flows for 60min durations was obtained from the HEC-RAS model developed for Goodna Creek. The time-stage information is given in the following table:

Table 4-29 Tail water elevations at Goodna Creek

Time (hrs)	Base Case Stage (m)- Q20	Ultimate Case Stage (m)-Q20	Base Case Stage (m)-Q100	Ultimate Case Stage (m)-Q100
0	7.01	7.01	7.01	7.01
0.5	6.99	6.98	7.06	7.04
1.0	7.40	7.36	7.60	7.53
1.5	7.80	7.75	8.35	8.19
2.0	8.52	8.37	9.52	9.38
2.5	8.77	8.83	10.23	10.37
3.0	8.43	8.56	10.06	10.33
3.5	8.03	8.12	9.09	9.55
4.0	7.58	7.68	7.96	8.33
4.5	7.08	7.14	7.14	7.39

The tailwater for the PMF scenario has been set at the 100 year ARI scenario levels.

Results

Table 4-31, Table 4-32 and Table 4-33 present the results of the XP-SWMM hydraulic model.

The adopted culvert solution is presented below:

- 5x 2100mm diameter RCPs

Localised regrading (approximately 1m depth) will be required to form the upgraded culvert inlet area. Refer Drawing No.D-1034 for details. The proposed works include scour protection at the upstream side of McAuliffe Street but not an upgrade of the McAuliffe Street roadway or culverts. Model output is summarised in Appendix N.

Table 4-30 Results for existing and upgrade culverts- 20year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (mAHD)	Water Level (mAHD)	Ground Level (mAHD)	Afflux (m)	d V product (m^2/s)
C-FS950A (Proposed culvert inlet)	Base	5.48	1.06	-	10.610	10.50	0.096	-
	Upgrade	5.51	1.81	13.7 (low spot)	10.706*	9.40		-
C-FS950C (Existing culvert inlet)	Base (Culvert)	1.89	2.83	10.2		8.60	0.014	-
	Base (Road)	3.39	-	10.2	10.364	8.60		0.11
	Upgrade (Culvert)	1.91	2.85	10. 2		8.60		-
	Upgrade (Road)	3.85	-	10.2	10.378	8.60		0.12

* Incorporating 5mm of Headloss.

The above results for the upgraded scenario are based on a 50% screen blockage and 50% culvert blockage for the proposed new culverts.

A more typical arrangement of 50% screen blockage and 20% culvert blockage would result in an upstream flood level of approximately 10.400m. This would result in no afflux and a lowering of flood levels by approximately 200mm from existing flood levels.

The culvert arrangement provides 20 year flood immunity to the upgraded carriageway. An increase of 14mm in flow depths passing over the McAuliffe Street roadway occurs as a result of the change in flow conveyance. This flow depth increase is localised to the road only and does not affect adjacent properties.

Table 4-31 Results for existing and proposed culverts- 100 year ARI

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (mAHD)	Water Level (mAHD)	Ground Level (mAHD)	Afflux (m)	d V product (m^2/s)
C-FS950A (Proposed culvert inlet)	Base	6.51	1.14	-	10.622	10.50	0.127	-
	Upgrade	7.1	1.99	13.7 (low spot)	10.749*	9.40		-
C-FS950C (Existing culvert inlet)	Base (Culvert)	1.93	2.90	10.2		8.60	0.042	-
	Base (Road)	4.93	-	10.2	10.410	8.60		0.15
	Upgrade (Culvert)	1.95	2.92	10.2		8.60		-
	Upgrade (Road)	5.52	-	10.2	10.452	8.60		0.20

Note: levels don't include backwater from Goodna Creek

* Incorporating 5mm of Headloss.

The above results for the upgraded scenario are based on a 50% screen blockage and 50% culvert blockage for the proposed new culverts.

The lowest surveyed floor level of the adjacent townhouses is approximately 12.2m and the predicted flood level of 10.749m will not inundate the structure floor levels. This increase in flood level does not extend upstream to the QR culverts, and their capacity will not be impacted by the predicted afflux if the screen and culverts are blocked to 50% of their respective surface areas. The predicted small downstream afflux is a product of the new culvert arrangement that is designed for the PMF and the 100 year ARI event with 50% blockage. This flow depth increase is localised to the road only and does not affect properties.

If the culvert inlet screen was 50% blocked and the culvert was 20% blocked as per all other IMU culvert designs, there would be no afflux and the resultant water level at the culvert inlet would be 10.454mm, a reduction in flood levels.

The peak 100 year flood and PMF flood levels in Goodna Creek are 10.453m and 10.556m respectively. These floodwaters will act as "backwater" to McAuliffe Street and inundate the road. The levels in Table 4-24 are based on local flows only and do not include any backwater effect from Goodna Creek. Therefore, the predicted 100 year flood level of McAuliffe Street may be slightly higher (1mm) than the documented flood level, however the road will still be trafficable and the flood depth will be lower than 300mm.

Table 4-32 Results for existing and proposed culverts- PMF flows

Location	Scenario	Flow (m^3/s)	Velocity (m/s)	Road Formation Level (mAHD)	Water Level (mAHD)	Ground Level (mAHD)	Afflux (m)	d V produc t (m^2/s)
C-FS950A (Proposed culvert inlet)	Base	39.24	2.66	-	11.131	10.50	0.473	-
	Upgrade	35.70	2.56	13.7 (low spot)	11.604*	9.20		-
C-FS950C (Existing culvert inlet)	Base (Culvert)	2.43	3.58	10.2		8.60	-0.221	-
	Base (Road)	36.86	-	10.2	11.003	8.60		0.58
	Upgrade (Culvert)	2.26	3.35	10.2		8.60		-
	Upgrade (Road)	35.53	-	10.2	10.782	8.60		0.56

Note: levels don't include backwater from Goodna Creek

* Incorporating 60mm of Headloss.

The above results for the upgraded scenario are based on a 50% screen blockage and 20% culvert blockage for the proposed new culverts.

The culvert arrangement provides PMF flood immunity to the upgraded carriageway and results in an increased water level of 473 mm upstream of the upgraded road embankment. This raises water levels to 11.604m AHD which will not result in flooding of existing property which has floor levels at 12.20 m or higher. The screen loss / blockage is approximately 60mm which is low due to the area of

the screen which is approximately 65m^2. The lowest section of the driveway access is believed to be approximately 11.4m, therefore the access would be inundated in a PMF, however it would still be trafficable. Downstream flood levels are expected to decrease slightly due to the increased storage upstream of the new road embankment.

The upstream side of the culvert arrangement will incorporate inlet screen fitted to the concrete headwall. Details of the screens are provided on the drawing no. D-2115 & D-2116.

Discussion

A new 5x2100 mm diameter RCP culvert arrangement is proposed at this location. The discharge from this arrangement will pass through the existing McAuliffe Street culvert and over the roadway which will remain unchanged, except for additional scour protection.

The afflux at the upstream end of the proposed culvert system (location C-FS950A) was checked and a water level increase of 96mm for the 20 year ARI and an increase of 127mm for the 100 year ARI event was predicted. This was based on the conservative assumption that the inlet screen and culverts would both have 50% blockage. The predicted ultimate 100 year flood level is 10.749 m at the culvert inlet and provides over 1.45m freeboard to the ground level (lowest level) at the nearest housing area located at 12.20 m. The properties adjacent to the culvert and the QR culvert will not be affected by the 100 year ARI flood event. The land immediately upstream of the culvert between Monash Road and the Queensland Rail embankment is owned by DTMR.

The predicted flood level in the PMF event of 11.604 m represents an increase in water level of 473mm. At this level no flooding of the existing property structure floor levels are expected.

The depth x velocity (dv product) value for the McAuliffe Street overtopping flow was calculated for the 20 year and 100year ARI events. The width of the overtopping part of the road was taken as 32m. It was found that the estimated value for ultimate case of 0.12 m^2/s for 20 year ARI is slightly higher than the existing value of 0.11 m^2/s. The 100 year ARI depth by velocity product was estimated as 0.2m^2/s. Both satisfy the QUDM allowable depth by velocity product of 0.4m^2/s.

At this stage (100% final design) the hydraulic calculations for the culverts provides an acceptable design.

A safety analysis was performed in accordance with QUDM to determine the need for safety screens or fencing at the culvert inlet. An inlet screen has been incorporated into this design.

Scour protection and pipe loading and bedding calculations have been included in sections 4.2.13 and 4.2.10 respectively.

4.2.8 Upgrade Culvert C-FS1250

Culvert C-FS1250, was included in the previous submission of this design package. As a result of design development and scope resolution regarding the limit of works in the vicinity of Brisbane Terrence and Francis Street the culvert has been removed from the scope of this package.

4.2.9 Zone 2 Service Roads Culvert Summary

Table 4-32 and Table 4-33 present a summary of the water levels, velocities and afflux that occur at the upgrade culverts which form part of this design lot.

Table 4-32 Transverse drainage Zone 2- Other Culverts summary

Culvert	Description	Culverts	Road Level (m)	20 year ARI Water Level (m)	20 year ARI Free Board (m)	Upstream culvert invert (m AHD)	Downstream culvert invert (m AHD)	Culvert Length (m)	Blockage factor	20/100 year Downstream Tailwater Level
C-SR100	Culverts at Mine Street and Collingwood Drive intersection	2 x 1800Wx900H RCBC	13.2	12.69	0.5	11.50	11.00	42.0	0%	Goodna Creek
C-FS620	Culvert at Francis Street CH 620	2 x 750 RCP	15.2	13.01	2.2	12.25	11.00	48.8	20%	Goodna Creek
C-FS750	Culvert at Francis Street CH 750	1x 900 RCP	13.3	12.74	0.6	11.00	10.75	37.20	20%	Free Discharge
C-FS950	Culvert at Francis Street CH 950	5 x 2100 RCP	18.8	10.70	8.3	9.40	8.70	48.8	20-50%	Goodna Creek

Table 4-33 Comparison of the 20 year peak water levels, velocities and afflux

Culvert	20 year ARI, water level U/S of culvert (m AHD)		Channel Velocity D/S of culvert (m/s)		Afflux (mm)		Remarks
	Base	Upgrade	Base	Upgrade	U/S of culvert	D/S of culvert	
C-SR100	14.287	13.368	0.84	1.61	-919	Goodna Ck	Refer section 4.2.4
C-FS620	13.020	13.016	NA	NA	-004	Goodna Ck	Refer section 4.2.5
C-FS750	13.339	12.744	0.84	0.84	-595	N/A	Refer section 4.2.6
C-FS950	10.610	10.706	NA	NA	+96	+14	Refer section 4.2.7

4.2.10 Structural Adequacy Analysis

The transverse culvert structures have been designed to accommodate the relevant design fill loads and traffic loading during operation and construction.

The design criteria stipulated by the DMR PSTS25 which is based on AS 5100 – 2004 has been applied to the design of the culverts. The relevant criteria for structural design of culverts is summarised below:

- Accommodate finished surface level of fill material
- W80, A160, SM1600 and HLP 400 vehicular loadings
- Live load surcharge
- Construction loads
- Earth pressure
- Be designed for ease of maintenance
- Be structurally safe at all times
- Not suffer any loss of performance due to uniform and/ or differential settlement.

The software program PipeClassV1.2 developed by Concrete Pipe Association of Australasia was used to determine the pipe class of each pipe culvert. The program includes standard classifications and bedding types as set out in the Concrete Pipe Selection and Installation Guide.

The construction loads were selected from the Pipe Class library and are summarized in Table 4-34.

Table 4-33 Construction loads from Pipe Class Library

Vehicle	Description	Vehicle Load
CPAAVR-10T	Smooth drum vibratory roller	19.5 tons
CAT 140H	Motor grader	17 tons
CATD 300E	Articulated truck	50 tons
CAT621F	Scraper	54 tons
CAT 815F	Soil compactor	21 tons

The design assumed an average pavement thickness of 0.6m that has been applied as a surcharge load at the top of the embankment fill. The embankment fill properties were assumed to be:

- Density – 20 kN/m^3
- Angle of internal friction (Phi) – 30 deg
- Cohesion (c) – 5 kPa
- Ku – 0.1924

Bedding Type H2 has been adopted for all culverts with the exception of C-FS950 which will be bedding type HS3. The construction team have indicated that all culverts will be laid in a trench (possitive projection) i.e. the embankment fill will be compacted to an appropriate level and then trenched rather than the pipe laid and embankment filled around the pipe.

The summary of the analysis are shown in the following Table 4-35:

Table 4-34 Type of pipe class required for transverse culverts

Culvert ID	Pipe diameter (mm)	Type of bedding	Class of pipes	Comment
C-SR100	2 x 1800W x 900H RCBC	-	-	Supplier to design
C-FS620	2 x 750 RCP	H2	Class 3	
C-FS750	1 x 900 RCP	H2	Class 3	
C-FS950	5 x 2100 RCP	HS3-modified	Class 4	Stabilised sand bedding and backfill

The details of the model analyses are included in Appendix M.

4.2.11 Environmentally Friendly Culverts

There are no specific fauna-friendly requirements for the culverts detailed in this submission.

4.2.12 Bridge Crossings

There are no water way bridge crossings in this design package.

4.2.13 Scour Protection at Culvert outlets

Scour protection has been designed for the 50 year ARI design event where required. The need for scour protection depends on the culvert outlet velocity and the erosion potential of the downstream environment.

The flow through a culvert can either be inlet or outlet controlled. For inlet control the water surface profile converges toward normal depth. Therefore, normal depth is used to define the flow area at the outlet and determine the outlet velocity.

In outlet control, the flow area is defined by the geometry of the outlet and tailwater depth.

The design has included an assessment of the downstream tailwater level, culvert normal depth and critical depth. The adopted outlet velocity is based on the following:

- Tailwater level greater than the culvert obvert – adopt culvert full flow and velocity
- Tailwater level less than obvert but greater than normal depth – adopt tailwater level and calculate part full velocity based on tailwater level
- Tailwater level less than normal depth and normal depth is less than critical depth – adopt normal depth and calculate part full velocity based on normal depth
- Tailwater level less than critical depth and flow in the culvert is supercritical – adopt critical depth and calculate part full velocity based on critical depth.

The selection of scour protection type is outlined in Table 4–36.

Table 4-36 Scour protection selection based on outlet velocity

Outlet Velocity Range	Scour Protection Type
Less than 1.5 m/s	No protection required
Between 1.5 to 3.5 m/s	Either rock pad or steel wire mattress
Between 3.5 to 5.0 m/s	Steel wire mattress
Greater than 5.0 m/s	Type A Energy Dissipater as specified in Section 8 of the Road Design Guide (RTA)

The design of rock pads is based on page 8-24 QUDM Volume 1 second edition 2007.

The Table 4-37 shows the type of scour protection required for the culverts.

Table 4-37 Type of scour protection required for transverse culverts

Culvert ID	Q50-Outlet velocity (m/s)	Mattress/ Apron Length (m)*	Mattress/ Apron Width (m)	Rock size, d_{50} (mm)	Thickness (mm)	Comment
C-SR100B	2.9	32.0	14.0	300	600	Rock Protection
C-FS620A	3.8	12.0	10.0	-	170	Steel wire Mattress
C-FS750B	2.4	2.2	5.4	-	170	Steel wire Mattress
C-FS950A	2.8	6.0	10.6	-	170	Steel wire Mattress
C-FS950B	2.8	13.0	10.6	-	170	Steel wire Mattress
C-FS950D	-	4.0	35	-	170	Steel wire Mattress

*The length of the culvert outlet apron has been subtracted.

4.2.14 Open Channels and Waterway Diversions

A channel is required at the SR100 pipe culvert outlet in order to discharge flows into Goodna Creek. This new channel replaces the existing outlet channel due to the alignment changes. The proposed channel will be 200m long 5m wide trapezoidal vegetated channel and designed for 20 year ARI event flows.

A 5m long concrete channel will be constructed to protect the 900mm diameter existing sewer line, which crosses the channel with shallow cover.

A trapezoidal channel, 3m wide 1m deep with 1:2 batters, was designed between the outlet of the culvert C-620 and the inlet of the culvert C16150. This channel is shown on the drawing number RERODR203-D 1034. The proposed channel will be approximately 27m long and designed for 100 year ARI event flows.

A channel is required at the C-FS750 outlet in order to discharge flows into Goodna Creek. This new channel replaces the existing channel due to the alignment changes. The proposed channel will be 250m long trapezoidal vegetated channel and designed for 20 year ARI event flows.

4.3 Design Changes

4.3.1 Changes between Reference Design and Concept Design

The Origin Alliance has undertaken a Due Diligence Review of the reference design.

As part of the design development of the Concept Design a Value Engineering review has also been undertaken. Outputs of this review are included in Appendix J.

The reference design did not include any drainage infrastructure therefore no assessment of differences can be made.

4.3.2 Changes between Concept Design and Detailed Design

Table 4-38 Changes between Concept Design and Detail Design

Culvert ID	Design Element	Description of Adjustment	Reason for Adjustment	Supporting Information
C-SR100	Culvert	Culvert has been redesigned. Pipe culverts changed to box culverts.	Change of Smith Street horizontal road alignment.	Appendix A
C-FS620	Culvert Replaced	Culvert has been redesigned.	Change of horizontal and vertical alignment of the road.	Appendix A
C-FS750	New Culvert	A new culvert has been introduced	New Road Alignment	Appendix A
C-FS950	New Culvert	A new culvert has been introduced	New Road Alignment	Appendix A

4.3.3 Changes between Detailed Design and Final Design

Table 4-39 Changes between Detail Design and Final Design

Culvert ID	Design Element	Description of Adjustment	Reason for Adjustment	Supporting Information
Nil				

4.3.4 Changes between Final Design and This Submission

Table 4-40 Changes between Detail Design and Final Design

Culvert ID	Design Element	Description of Adjustment	Reason for Adjustment	Supporting Information
C-FS950	Culvert	Additional 2 cells added to culvert	Review of high flow bypass upstream based on extreme events	This report

4.4 Items for Resolution

There are no items for resolution at the current stage of this design package.

4.5 Verification and Reviews

4.5.1 Internal Design Verification

Comments from the Internal Verifier and designer's responses have been closed out.

4.5.2 Independent Verifier

Independent verifier comments have been received and addressed in Appendix F.

4.5.3 DMR Reviews

DMR comments have been received and addressed in Appendix G.

4.5.4 Third Party Reviews

There were no third party comments received.

4.6 Design Drawings

Refer to Appendix A for the design drawings that apply to this design lot.

4.7 Technical Standards and Specifications

Refer to Appendix B for the list of Technical Standards and Specifications that apply to of this design lot.

5 Safety in Design

Safety in Design is an integral part of the Origin Alliance Risk Management process.

5.1 Safety in Design and Constructability Review (SIDR)

The purpose of the SIDR is to identify any significant construction, operation, maintenance and demolition risks inherent in the design of the project as a workplace that may prove significant. Specifically, the identification and understanding of these risks early in the project allows risk controls to be established to ensure that, if the risks cannot be eliminated by design, they are mitigated and managed in the design process so that they are as low as practicable. Risks identified are to be documented in the design report at the conclusion of the detailed design.

A Global SIDR on the Concept Design has been undertaken and forms a separate design submission. (Report ref D2G-DPSM-R-0001)

During the Detailed Design, a SIDR for this package has been convened as part of Zone 2/3 SIDR Workshop on 21/05/09. Outputs of the SIDR including identified risks as well as mitigation status, if any, are included in Appendix K.

The SIDR, as mentioned above, has been updated to clearly identify the following:

- design mitigation measures applied for the hazards as identified in the original SIDR workshop
- residual risks following design mitigation for the hazards as identified in the original SIDR workshop
- responsible group for mitigation and recipient group for transfer of residual risk
- any additional hazards, control and mitigations for items that were identified through design that may not have been captured in the original SIDR workshop

Details of the revised SIDR for this particular design lot are attached in Appendix K.

A Global SIDR focussed on the operation and maintenance phase of the project was held on 24/3/10. The outputs of this review are reported separately; however key aspects have been considered in the design.

5.2 Design to Facilitate Safe Use

5.2.1 Normal Use – Road Safety Audits

A Road Safety Audit (RSA) of the project has been undertaken on the Concept Design and has been submitted separately. Refer to report number 2108208A-RPT007-A.

The RSA of the Detailed Design for Zone 2 has been undertaken. Refer to Road Safety Audit Ipswich Motorway Upgrade – Dinmore to Goodna: Zone 2 – 85%, 2108208A-RPT015. The audit findings have been addressed and closed out. This will be the subject of a separate design submission.

5.2.2 Emergency Use

Origin Alliance facilitates a forum with emergency services personnel to obtain input to the safe emergency use of the facility.

An Emergency Response Management Plan (Report Ref D2G-MPPL-V-016) has been developed by the Alliance in consultation with emergency services and DMR and is the subject of a separate submission.

A summary of specific features incorporated into this design package to facilitate safe emergency use is detailed in Table 5-1 below.

Table 5-1 Summary of specific features addressing Design for Safe Maintenance

Elements	Design Response
Culvert/Gully Inlets	The design allows for blockage factor to reduce maintenance frequencies. The design uses dome top grates for field inlets to identify during maintenance and perform better with debris. Vehicle access to major culvert headwalls is provided where practical.
Culvert Outlets	Vehicle access provided for inspection and rehabilitation of downstream scour protection where practical
Pipe Inlet and Outlet channels	The design uses low velocities in channels to prevent scour and regular maintenance. Flatter side slopes have been used where possible to assist with maintenance activities.

5.2.3 Design for Safe Maintenance

Origin Alliance facilitates a forum with DMR maintenance personnel to obtain input to the design process to ensure the design is safe for maintenance. This review and input occurs as part of the design development process in formal and informal meetings etc. and at staged reviews of major design submissions at Concept Design and Detailed Design.

The principal method adopted by the design to address safety during maintenance is to reduce or eliminate maintenance requirements.

Details addressing specific issues relating to the operation and maintenance aspects of the design are addressed in the revised SIDR contained in Appendix K.

6 Design Integration

The detailed design involves the integration of requirements from all relevant design disciplines and is the subject of 'spatial fit' and other interface checks as each design lot develops.

A summary of the key disciplines that have impacted on this design package are provided below.

6.1 Roadworks and Alignment

Cross drainage structures have been designed to convey stormwater flows within waterways that traverse the proposed motorway and service roads. The culverts have been designed to provide immunity for the motorway from the 100 year ARI event and the service roads have been designed to have 20 year ARI immunity. The culverts along the service roads have been designed to these design criteria. The culverts are designed with minimum cover requirements that exceed the nominated pavement depths.

Table 6-1 Roadworks and alignment design integration summary

Element	Description
Flooding	The regional flood model includes the road alignment, bridge structures and local roads for the motorway upgrade. Flood modelling was run for the 20 year and 100 year ARI events. The road alignment has been designed to consider the required flood immunity of the pavement, and ongoing development of the alignment will be undertaken as design progresses to ensure required immunities are met.

6.2 Geotechnical

Table 6-2 Geotechnical design integration summary

Element	Description
Earthworks	N/A
Mines	The intersection of Smiths Road and Collingwood Drive is underlain by mine workings associated with the new Redbank colliery; refer to New Redbank Mine Subsidence Report: D2G-BASD-DGMSIR102-R-1001 for further details on the treatment.

6.2.1 Design Assumptions

The minimum allowable bearing capacity of the culvert foundations has been calculated to be 150kPa for all culverts except culvert C-FS950 which requires minimum 250kPa.

6.2.2 Design Details

General

The primary geotechnical issue with respect to construction of the culvert structures is the potential impact of foundation settlement on the serviceability of the structure. The foundation settlements underneath the pipe culverts in Zone 2 will be managed by removing any compressible soil layers present at or near the ground surface and beneath the invert level of the culvert and designing the culvert grade to suit the conditions.

Geotechnical Models

The geotechnical models used for the assessment of foundation settlements at culvert locations were derived from the boreholes/test pits listed in Table 6-3, and their locations are shown on Geotechnical Investigation Plans (refer to Package No. DGGOKS100).

The settlement calculations apply only to the soil layers beneath the invert levels of the culverts. The settlements of the soil layers above the proposed culvert invert level are ignored. Where the proposed invert level of the culvert is higher than the nearest borehole collar level, the soil layer between the levels are interpolated accordingly.

Design Outputs

The results of the assessment of foundation treatments for the culverts are presented in Table 6-3. The table includes the culvert locations, subsoil profiles interpreted from representative boreholes/ test pits, the estimated total settlements of the culverts over 100 years in associating with the recommended foundation treatments.

For culvert C-FS620, the subsoil profile is based on TP049 and a remote borehole IMU225 for the indication of the rock level.

Except for culvert C-FS950, the total residual settlements of the culverts without foundation treatments are estimated to be less than 50mm, therefore, at this stage the culverts can be installed prior to construction of the embankment fill.

The subsoil profile at culvert C-FS950 location is based on borehole.IMU229E. It is estimated that the total settlement of culvert C-FS950 under 10.3m fill height is 81mm including 64mm of primary settlement. In order to reduce the primary settlement, construction of the fill to 5m and preloading for one month are required to allow the ground to settle 31mm, and then cut back to invert level and construct the culvert, As a result, the total residual settlements of the culvert over 100 years can be reduced to 50mm.

Unless otherwise specified, any material worse (softer) than stiff clay or medium dense sands on the top of the foundation shall be removed and be replaced with engineered fill compacted to a compaction ratio of 97% to ensure that the minimum required bearing capacity is achieved.

Other Issues

The founding material will be inspected on site by an experienced geotechnical engineer or engineering geologist to confirm the bearing capacity of the foundation material at each culvert location.

Table 6-3 Summary of Foundation Treatments for Culvert Locations

Culvert No.	Approx Station (km)	Available Boreholes and Test-pits in the Vicinity of Culvert Locations	Represent-ative Boreholes and Test-pits	Subsurface Profile Interpreted beneath Culvert Invert Levels	Maximum Embankment Fill Height at Culvert Locations (m)	Primary Settlement with Foundation Treatment (mm)	Total Residual Settlement with Foundation Treatment (mm)	Recommendation for Foundation Treatments
C-SR100	0-80 (MCS0)	TP236, TP321 MWRB345, MWRB347B, MWRB347C	MWRB345 + TP321	3.5m stiff to very stiff clay underlain by 9.0m hard clay and 2.0m dense gravel on top of rock	2.7	23	30	No treatment.
C-FS620	610-620 (MCR0)	TP049, TP050, TP220, TP313,, IMU316A	TP220 + IMU316A	4.3m stiff to hard clay underlain by rock	3.8	16	28	Remove all unsuitable materials estimated to be up to 0.3m firm silt.
C-FS750	800-810 (MCR0)	IMU228D, IMU316A	IMU228D	8.5m very stiff to hard clay underlain by rock	2.0	9	9	No treatment.
C-FS950	950-960 (MCR0)	TP216, TP702, IMU228C, IMU228D, IMU229D, IMU229E	IMU229E	5.7m stiff to hard clay underlain by rock	10.3	33	50	Preload 5m fill for 1 month, and then cut and place the culvert before the embankment construction to FSL.

Note:

The settlements are estimated based on the highest embankment height at culvert's locations to estimate the maximum settlements.

Unsuitable materials such as loose sand, soft or firm clay must be replaced by compacted engineering fill after inspection by an experienced engineering geologist / geotechnical engineer.

6.3 Structures

6.3.1 Bridges

There are no bridges that can impact on the areas where the upgrade culverts are proposed.

6.3.2 Retaining Walls

There are no retaining wall clashes with the other culverts in Zone 2.

6.3.3 Other

The clashes between transverse drainage and the following structural items have been addressed in this detailed design:

- Gantries
- Signs
- Noise Barriers
- There are no clashes between transverse culverts and the above structural elements.

6.4 Intelligent Transport Systems (ITS)

There are no ITS clashes with the Zone 2 –Other culverts.

6.5 Temporary Traffic Management (TTM)

Drainage for temporary traffic configurations will be detailed in the separate TTM design lots. To facilitate operation of the permanent drainage in temporary stages of construction transverse crossings have been located at cut-to-fill lines wherever possible.

6.6 Environment

This package is compliant with applicable Environmental and Approvals requirements identified in the Environmental Requirements Checklist as evidenced in Appendix E, where authorisations for derivations are referenced or explained. All Environmental requirements are to be summarised in the Environmental Design Report (EDR).

The environmentally sensitive areas that have been identified relevant to transverse drainage in Zone 2 are summarised in Table 6-4.

6.6.1 Approvals

All environment and current approval requirements have been identified and summarised on the Environmental Requirements Checklist included in Appendix E. Future approval requirements will result from:

- The removal of soil from lots listed under the Department of Environment and Resource Management (DERM) Environment Management Register is subject to approvals under the *Environmental Protection Act 1994*; and
- Vegetation Clearing Permits: Approval is required under the *Vegetation Management Act 1999* and the *Nature Conservation Act 1992* (NC Act 1992) for vegetation removal on state and freehold land respectively. The Permit under the NC Act 1992 has been received from DERM; permit number WICL05811509.

The environmental requirements relating to this design lot are detailed in Table 6-4 below and Appendix E

Table 6-4 Zone 2 Transverse Drainage Design Brief Environmental Input

Name	Chainage	Description	Comments	Category	Design Requirement (Environmental Requirements Checklist)
SR100	100	Culvert	Goupong Park	Indigenous heritage	To be managed during the construction phase in accordance with the Cultural Heritage Management Plan (D2G-MPPL-V-012).
C-FS620/ C16150	620/ 16175	Culvert	Cultural heritage monitoring area	Indigenous heritage	To be managed during the construction phase in accordance with the Cultural Heritage Management Plan (D2G-MPPL-V-012).
			UXO	No-go zone	UXO high risk area subject to investigation and removal of ordinances prior to works commencing. High risk area is soft ground in and around the creek and drainage lines. This area is known to be impacted by a mortar range.
		Open channel swale	UXO	No-go zone	UXO high risk area subject to investigation and removal of ordinances prior to works commencing. High risk area is soft ground in and around the creek and drainage lines. This area is known to be impacted by a mortar range.
			Discharging to Goodna Creek	Flora, fauna and ecology	Disturbance to the bed or banks of Goodna Creek will be subject to approvals. Surface flows that are concentrated by an open channel or conduit should be controlled prior to discharge on a downstream system or owner. Concentrated flows should be dissipated by the use of detention and energy dissipaters. Swales and drainage channels longitudinal alignments to gently meander reflecting natural landform and to be of a more naturalised appearance with maximum side slope of 1:3. All outlets of the surface drainage system must incorporate energy dissipation, erosion and sediment

Name	Chainage	Description	Comments	Category	Design Requirement (Environmental Requirements Checklist)
					control. Water discharged must comply with water quality provisions of the Environmental Protection (Water) Policy 1997, as well as ANZECC and/or locally relevant water quality guidelines.
		Sed basin and bio-retention basin	UXO	No-go zone	UXO high risk area subject to investigation and removal of ordinances prior to works commencing. High risk area is soft ground in and around the creek and drainage lines. This area is known to be impacted by a mortar range.
			Goodna Creek	Flora, fauna and ecology	Disturbance to the bed or banks of Goodna Creek will be subject to approvals. All outlets of the surface drainage system must incorporate energy dissipation, erosion and sediment control. Incorporate a filtration system into the drainage design in order to minimise pollutants entering Goodna Creek. Stormwater Quality Management Achieve the following reductions in total pollutant load: 90% reduction in gross pollutants; 80% reduction in TSS; 60% reduction in Total Phosphorous; 45% reduction in Total Nitrogen.
			Sensitive vegetation	Flora, fauna and ecology	Avoid disturbance to sensitive vegetation. Investigate potential to integrate into existing wetland system.
C-FS750	750	Culvert	No environmental constraints		
C-FS950	950	Culvert	Pan Pacific Peace Gardens	Public area sensitive receptor	Potential impacts associated with construction will be managed during the construction phase in accordance with the Construction Environmental Management Plan (D2G-MPPL-V-017).
				Sensitive vegetation	Minimise the removal of existing native vegetation to the extent necessary only for construction and permanent design footprint (clearing is subject to a statutory approval which may detail additional controls to be applied).

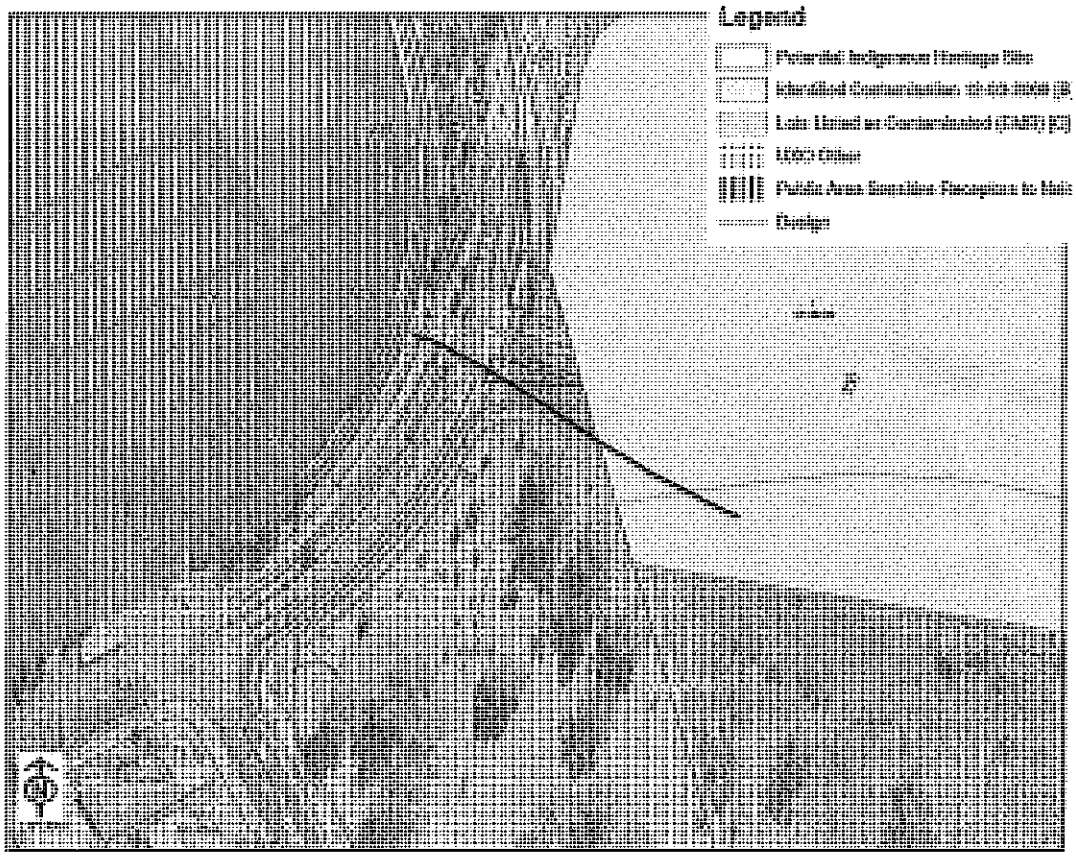

Figure 6-1 C-SR100

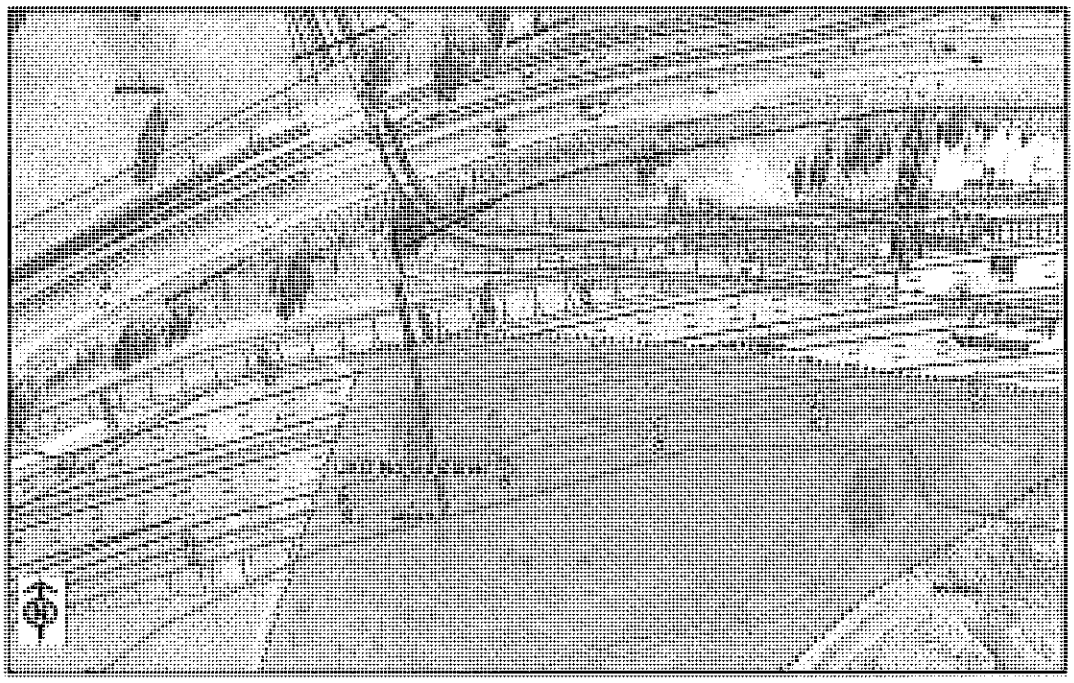

Figure 6-2 C-FS620/ C16150

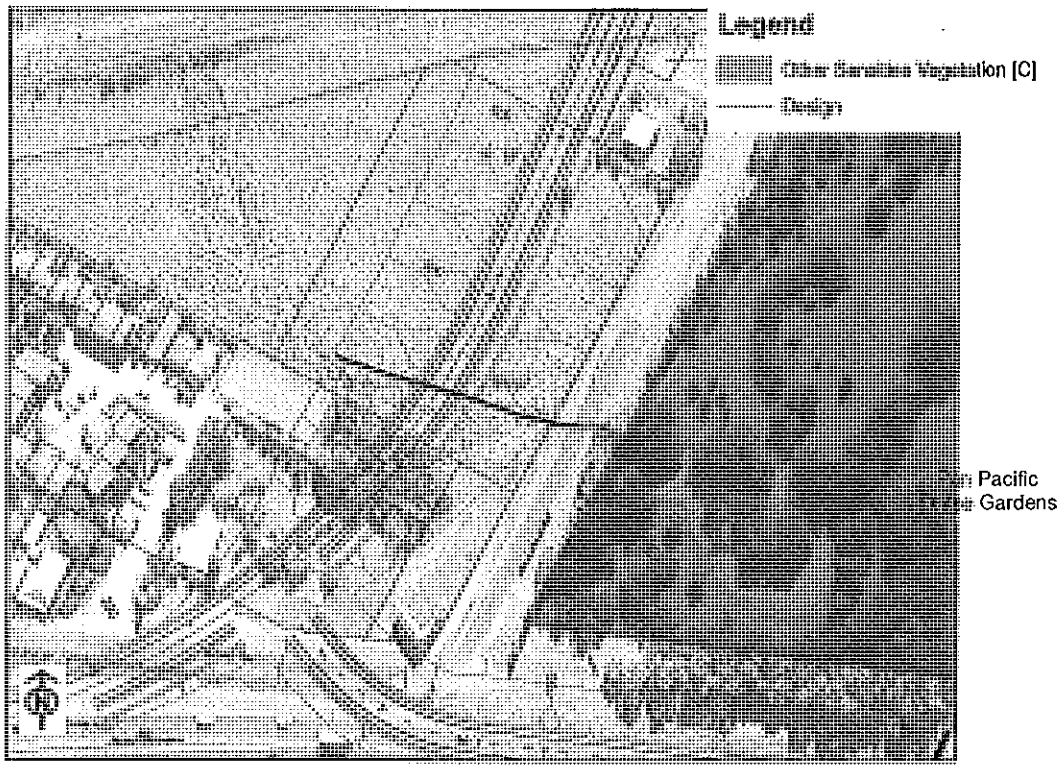

Figure 6-3 C-FS950

6.7 Urban and Landscape Design

Landscape and Urban Design treatments have taken into account the locations of transverse drainage pipes and swales. No conflicts currently exist between drainage and landscape requirements.

6.8 Community

Community requirements have been identified and summarised on the Community Requirements Checklist included in Appendix I.

6.9 Public Utilities

The proposed longitudinal drainage has been reviewed against the existing services and proposed service locations. Near the proposed Collingwood Drive and Smiths Road intersection, the proposed culvert structures (C-SR100) are in conflict with the existing water supply and sewerage pipes and the valve chambers. PUP will be relocated prior to construction so there will be no clashes with proposed transverse drainage. At time of submission, only the horizontal alignment of PUP was available.

There are existing overhead electricity & Optus services, underground Telstra optic fibre mains in the locality of the proposed culverts. The Telstra, Optus and electricity services will remain in place until such time as the bulk earthworks are complete for the northern service road and at such time these services will be relocated to the new service road verge area. The construction staging and design of the proposed culverts should include consideration of the existing Telstra, Optus and ENERGEX services that will be in conflict with the proposed culvert at certain stages during construction.

6.10 Queensland Rail

The drainage line crossing QR is passing through the QR culvert and reaches the proposed culvert C-FS950. The upstream catchment area at the QR culvert has not changed. As such, there will not be any increase in the flow through the QR culvert and the flow in the railway channel.

7 Durability Considerations

7.1 General

A comprehensive sampling programme and durability assessment is currently being finalised to ensure that the proposed design, technical and construction standards are adequate to meet the durability standards outlined in the SWTC and to meet the minimum design life for the various asset types associated with this project. A summary of the assessment for drainage associated structures at C-SR100, C-FS620, C-FS750 and C-FS950 is detailed below:

Based on sampling undertaken in borehole and test pits adjacent to these structures the following is noted.

For structure C-SR100 relevant sampling from boreholes IMU236B and IMU269B show pH levels in excess of 6.9 and critical values for sulphate of 110ppm and chloride of 790ppm.

For structures CFS620, relevant sampling from test pits TP218C and TP220 shows pH levels in excess of 7.6 and critical values for sulphate of 46ppm and chloride of 720ppm.

For structure CFS750, relevant sampling from test pits TP215 and TP216 show pH levels in excess of 7.4 and critical values for sulphate of 55ppm and chloride of 1400ppm.

For structure CFS950, relevant sampling from test pits TP702 and TP216 show pH levels in excess of 8.0 and critical values for sulphate of 27ppm and chloride of 1400ppm.

The critical values from these samples show the soils to be non-aggressive and are all well below the concentrations which are considered detrimental to concrete and reinforcing steel. These results have been reviewed and discussed with our specialist consultant Mahaffey.

In accordance with Clause 7.6.2 of the SWTC, a minimum exposure classification of B2 is required. As the environment is not deemed to be tidal or saline, no special measures are required and this minimum required exposed classification is adequate for these drainage structures.

The durability design for all works is covered by a separate design durability report D2G-BASD-DGDUKS100-R-1000. The test sample results and further discussion are included in this report.

8 Items on HOLD

Formal review of the design lot is to occur on all drawings included in this design package.

HOLD clouds have been used to identify those areas of the Drawings awaiting further design development or PSTR revisions. The HOLD clouds for review are outlined in Table 8-1.

8.1 Holds Closed

Table 8-1 lists the HOLDS Closed.

Table 8-1 Summary of HOLDS Closed

HOLD No.	Description	Package where Hold Cloud were Removed
HOLD 1	Longitudinal drainage (works not part of this design submission) Hold cloud released with IFC issue of Longitudinal Drainage	RERODR201
HOLD 3	Safety Screens on culverts C-FS620 and C-FS950	RERODR206
HOLD 7	Culvert C-SR100A-inlet structure	RERODR206
HOLD 4	Francis Street / Monash Road & Brisbane Terrace Intersection, Culvert C1250 – removed from scope.	RERODR206
HOLD 10	Francis Street / Brisbane Road Intersection	RERODR201

8.2 Holds for Review, Verification and Certification

Not applicable at this stage.

8.3 Holds Not for Verification and Certification

The items listed in Table 8-2 are on HOLD and are not for Verification and Certification. These HOLDS should be considered in the integrated design and can be reviewed and commented on, but they are not subject to the IV certification at this stage, as they do not necessarily comply with the PSTR as it currently stands. Subsequent design submissions will be presented to remove these HOLDS.

Table 8-2 Summary of HOLDS not for review, verification and certification

HOLD No.	Description	Package where Hold Cloud will be Removed
HOLD 9	Limit of Works at Francis Street	RERODR201

Appendix A – Relevant Design Drawings (Transmittal Number TC 342)

Appendix B – Technical Standards and Specifications

List of Specifications applying to this design lot

Number	Description	Version	Tick if Applicable to this Package
Project Specific Technical Specifications			
PSTS01	Introduction to Technical Standards	Aug 09	☒
PSTS02	Provision for Traffic	Aug 09	☐
PSTS03	Drainage, Retaining Structures and Protective Treatments	Aug 09	☒
PSTS04	General Earthworks	Aug 09	☒
PSTS05	Unbound Pavements	Aug 09	☐
PSTS06	Reinforced Soil Walls	Aug 09	☐
PSTS07A	In Situ Stabilised Sub-grades Using Quicklime or Hydrated Lime	Aug 09	☐
PSTS07B	In Situ Stabilised Pavements Using Cement or Cementitious Blends	Aug 09	☐
PSTS07C	In Situ Stabilised Pavements Using Foamed Bitumen	Aug 09	☐
PSTS08	Plant-Mixed Stabilised Pavements	Aug 09	☐
PSTS11	Sprayed Bituminous Surfacing (Excluding Emulsions)	Aug 09	☐
PSTS14	Road Furniture	Aug 09	☐
PSTS15	Noise Barriers	Aug 09	☐
PSTS16	Landscape and Revegetation Works	Aug 09	☒
PSTS17	Bitumen	Aug 09	☐
PSTS18	Polymer Modified Binder	Aug 09	☐
PSTS19	Bitumen Cutter Oil and Flux Oil	Aug 09	☐
PSTS20	Cutback Bitumen	Aug 09	☐
PSTS21	Bituminous Emulsion	Aug 09	☐
PSTS22	Supply of Cover Aggregate	Aug 09	☐
PSTS23	Supply and Delivery of Quicklime and Hydrated Lime for Road Stabilisation	Aug 09	☐
PSTS24	Manufacture of Precast Concrete Culverts	Aug 09	☒
PSTS25	Manufacture of Precast Concrete Pipes	Aug 09	☒
PSTS26	Manufacture of Fibre Reinforced Concrete Drainage Pipes	Aug 09	☒
PSTS27	Geotextiles (Separation and Filtration)	Aug 09	☒
PSTS30	Dense Graded Asphalt Pavements	Aug 09	☐
PSTS31	Heavy Duty Asphalt	Aug 09	☐
PSTS34	Open Graded Asphalt Surfacing	Aug 09	☐
PSTS38	Pavement Drains	Aug 09	☐
PSTS39	Lean Mix Sub-base for Pavements	Aug 09	☐
PSTS40	Concrete Base in Pavements – Jointed Un-reinforced, Jointed Reinforced, Concrete Reinforced and Steel Fibre Reinforced Pavements.	Aug 09	☐
PSTS42	Supply of Wax Emulsion Curing Compound for Concrete	Aug 09	☐
PSTS45	Pavement Marking	Aug 09	☐
PSTS45A	Audio Tactile Line Marking	Aug 09	☐
PSTS50	Specific Quality System Requirements	Aug 09	☐
PSTS51	Environmental Management	Aug 09	☐
PSTS57	Geotextiles for Paving Application	Aug 09	☐
PSTS61	Mounting Structures for ITS Devices	Aug 09	☐
PSTS62	Bridge Substructures	Aug 09	☐
PSTS63	Cast-In-Place Piles	Aug 09	☐
PSTS65	Precast Prestressed Concrete Piles	Aug 09	☐
PSTS67	Bitumen Slip Layer on Piles	Aug 09	☐
PSTS68	Dynamic Testing of Piles	Aug 09	☐
PSTS70	Concrete	Aug 09	☒
PSTS71	Reinforcing Steel	Aug 09	☒
PSTS71A	Stainless Steel Reinforcing	Aug 09	☐
PSTS72	Manufacture of Precast Concrete Elements	Aug 09	☒
PSTS73	Manufacture of Prestressed Concrete Members and Stressing Units	Aug 09	☐
PSTS74	Supply and Erection of Prestressed Concrete Deck and Kerb Units	Aug 09	☐
PSTS75	Supply and Erection of Prestressed Concrete Girders	Aug 09	☐
PSTS76	Supply and Erection of Steel Girders (Yet to be supplied)	Aug 09	☐
PSTS78	Fabrication of Structural Steelwork	Aug 09	☐
PSTS79	Fabrication of Aluminium Components	Aug 09	☐
PSTS80	Supply and Erection of Bridge Barrier	Aug 09	☐

Number	Description	Version	Tick if Applicable to this Package
PSTS81	Bridge Bearings	Aug 09	☐
PSTS82	Bridge Deck Expansion Joints	Aug 09	☐
PSTS83	Anti-Graffiti Protection	Aug 09	☐
PSTS84	Deck Wearing Surface	Aug 09	☐
PSTS84A	Cold Milling Bridge Deck Wearing Surface	Aug 09	☐
PSTS85A	Repainting Existing Steel Bridges and New Steel Bridges – Zinc Metal Systems	Aug 09	☐
PSTS86	Preparation for Bridge Widening	Aug 09	☐
PSTS88	Painting New Work	Aug 09	☐
PSTS89	Post Tensioned Concrete	Aug 09	☐
PSTS90	Modular Bridge Expansion Joints	Aug 09	☐
PSTS91	Ducts and Pits	Aug 09	☐
PSTS92	Traffic Signal and Road Lighting Footings	Aug 09	☐
PSTS93	Traffic Signals	Aug 09	☐
PSTS94	Road Lighting	Aug 09	☐
PSTS95	Switchboards and Cables Layer,	Aug 09	☐
PSTS101	Checking Subgrade, Capping Layer, Drainage Layer, Controlled Subgrade, Working Platform, Temporary Pavement, Verge	Aug 09	☐
PSTS101B	Temporary Pavements	Aug 09	☐
PSTS201	General Equipment Requirements	Aug 09	☐
PSTS202	Provision of Variable Message Signs	Aug 09	☐
PSTS203	Provision of Weigh-in-Motion System	Aug 09	☐
PSTS204	Provision of Vehicle Loop Detectors	Aug 09	☐
PSTS206	Provision of Variable Speed Limit and Lane Control Signs	Aug 09	☐
PSTS210	Provision of Mains Power	Aug 09	☐
PSTS221	Provision of Help Telephones	Aug 09	☐
PSTS225	Provision of Imaging Equipment	Aug 09	☐
PSTS226	Provision of Telecommunications Field Cabinets	Aug 09	☐
PSTS227	Provision of Changeable Message Signs	Aug 09	☐
PSTS228	Provision of Electronic Switchboards	Aug 09	☐
PSTS231	Provision of Road Weather Monitors	Aug 09	☐
PSTS232	Provision of Field Processors	Aug 09	☐
PSTS234	Provision of Telecommunications Cables	Aug 09	☐
PSTS239	Provision of Mounting Structures for ITS Devices	Aug 09	☐
PSTS245	Principal's Telecommunications Network	Aug 09	☐
PSTS248	Provision of Travel Time Signs	Aug 09	☐
PSTS250	Provision of Automatic Number Plate Recognition System	Aug 09	☐
PSTS251	Provision of Traffic Counter/Classifier	Aug 09	☐
Project Specific Supplementary Specifications			
MRS 11.91	Ducts and Pits	Aug 09	☐
MRS 11.92	Traffic Signal and Road Lighting Footing	Aug 09	☐
MRS 11.94	Road Lighting	Aug 09	☐
MRS 11.95	Switchboards and Cables	Aug 09	☐
ITS 10	Mains Power Supply	Aug 09	☐
Miscellaneous Specifications			
MCE-SR-002	Requirements for Work in or about QR Property	Aug 09	☐
MCE-SR-003	Requirements for Work adjacent to Overhead Line Equipment	Aug 09	☐
R57	Design of Reinforced Soil Walls	Aug 09	☐
MDSS 987	Hot-Mixed Asphalt Pavement – Bikeway	Aug 09	☐
MCE-SR-0015	Queensland Railways - Track Clearances (Draft)	Aug 09	☐

Appendix C – Reference Drawings

List of DMR Reference Drawings applying to this design lot.

Author	Drawing number	Description	Revision	Tick if Applicable to this package
DMR	881	Cane Railway Crossings – Asphalt Paved and Concrete	Rev B 9/00	☐
DMR	1033	Kerb and Channel – Kerbs, Channels and Ramped Vehicular Crossing	Rev J 10/05	☒
DMR	1043	Reinforcing Steel – Standard Bar Shapes Drawing 1 of 2 and Drawing 2 of 2	Rev M 9/06	☒
DMR	1044	Reinforcing Steel – Standard Hook, Lap and Bend Details and General Steel Reinforcement Information	Rev J 9/06	☒
DMR	1045	Revegetation – Treatment of Cut Batters	Rev D 10/03	☒
DMR	1063	Standard Date Plate – General Arrangement	Rev F 1/04	☐
DMR	1116	Subsoil Drains – Outlets and Cleanouts	Rev F 9/02	☒
DMR	1117	Drainage Structures – Abutment Protection	Rev G 8/02	☒
DMR	1131	R C Slab Deck Culvert - 2500 Span – Construction of Foundations, Aprons, Walls and Wings	Rev F 11/05	☒
DMR	1132	R C Slab Deck Culvert - 2500 Span – Construction of Reinforced Concrete decks and Kerbs	Rev F 5/06	☒
DMR	1145	Standard P.V.C. Scupper – Details for Cast In Situ Deck	Rev D 8/02	☒
DMR	1148	R C Slab Deck Culvert - 2500 Span – Steel Schedule for Reinforced Concrete Deck, Foundations, Aprons, Walls and Wings	Rev F 3/02	☒
DMR	1149	Traffic Signals/Road Lighting/ITS – Ducts for Underground Electrical and Communications Conduit	Rev G 1/07	☐
DMR	1170	Flood Depth Indicators – Installation	Rev B 10/00	☐
DMR	1172	Retaining Structures – Bridge Approach Relieving Slab	Rev H 9/06	☐
DMR	1174	R C Box Culverts – Construction of End Structures H = 150 – 600	Rev F 2/04	☒
DMR	1178	Diversion of Water – Diversion of water from Roadway and Table Drains	Rev E 10/03	☒
DMR	1179	R C Slab Deck Culvert - 2500 Span – Construction of Base, Aprons, Walls and Wings	Rev D 6/02	☒
DMR	1284	R C Slab Deck Culvert - 2500 Span – Steel Schedule for Reinforced Concrete Deck, Foundations, Aprons, Walls and Wings	Rev C 3/02	☒
DMR	1290	Traffic Signals – Lamp State Coding Philips PTF Traffic Controllers	Rev D 7/02	☐
DMR	1291	Sign – Guide Sign – Finger Board, Geographical Feature and Street Name Signs Extrusion Detail	Rev C 9/90	☐
DMR	1292	Sign – Roadworks Sign Support Y Stand	Rev D 12/92	☐
DMR	1294	Sign – Roadwork Delineators	Rev B 12/92	☐
DMR	1295	Sign – Fingerboard, Geographical Feature and Street Name Signs and Bracket Details	Rev C 9/90	☐
DMR	1301	Sign – Roadworks Sign Details and Assembly of Crossbars and Supports	Rev D 12/92	☐
DMR	1303	R C Box Culverts & Slab Link Box Culverts – Construction of Reinforced Concrete Wingwalls and Headwalls	Rev F 4/06	☒
DMR	1304	Pipe Culverts - Construction of Reinforced Concrete Wingwalls and Aprons for Pipe Diameter up to 2400	Rev F 11/05	☒

Author	Drawing number	Description	Revision	Tick if Applicable to this package
DMR	1305	Ends to Pipe Culverts – General Arrangement and Installation of Wingwalls, Headwalls and Aprons	Rev C 9/96	☒
DMR	1306	Ends to Pipe Culverts – Construction of Unreinforced Wingwalls, Headwalls and Aprons	Rev C 9/97	☒
DMR	1307	Access Chamber – Details 1050 to 2100 Dia.	Rev B 3/07	☒
DMR	1308	Access Chamber – Roof Slabs 1050 to 2100 Dia.	Rev B 3/07	☒
DMR	1309	Concrete Gully – Field Inlet Type 1	Rev A 9/99	☒
DMR	1310	Concrete Gully – Field Inlet Type 2	Rev A 9/99	☒
DMR	1311	Concrete Gully – Roadway Type Channel Lip in Line	Rev B 1/04	☒
DMR	1312	Concrete Gully – Roadway Type Kerb in Line	Rev B 1/04	☒
DMR	1313	Concrete Gully – Precast Lintel Details	Rev A 5/99	☒
DMR	1314	Traffic Signals/Road Lighting – Pit – Drainage Details	Rev D 2/00	☐
DMR	1315	Road Lighting Pole – Lighting Design parameters	Rev F 2/00	☐
DMR	1316	R C Box Culverts & Slab Link Box Culverts – General Arrangement and Installation of Precast Units	Rev H 5/06	☒
DMR	1317	R C Box Culverts & Slab Link Box Culverts – Construction of Bases with Nibs and Aprons	Rev H 3/07	☒
DMR	1318	R C Box Culverts & Slab Link Box Culverts – Construction of Bases with Recesses and Aprons	Rev G 3/07	☒
DMR	1319	R C Box Culverts & Slab Link Box Culverts – Construction of Unreinforced Wingwalls and RC Headwalls H = 750 – 2400	Rev I 5/06	☒
DMR	1320	R C Box Culverts & Slab Link Box Culverts – Crown Unit Holding Down Anchors	Rev B 10/96	☒
DMR	1321	Concrete Gully – Precast Concrete Side Inlet Gilley with Precast Shaft	Rev D 10/99	☒
DMR	1322	Concrete Gully – Precast Concrete Side Inlet Gilley with Cast In Situ Pit	Rev D 5/99	☒
DMR	1323	Road Lighting Pole – Luminaire Terminal Panel for Fixed Base Poles and Bridge Balustrade	Rev F 7/97	☐
DMR	1327	Traffic Signals/Road Lighting – Mains Connection	Rev D 5/99	☐
DMR	1328	Road Lighting Pole – Anchor Cage fabrication Details	Rev H 9/03	☐
DMR	1329	Road Lighting Pole and Pit – Typical Physical Arrangement	Rev F 1/04	☐
DMR	1330	Underbridge Road Lighting Bracket – General Arrangement	Rev D 1/04	☐
DMR	1331	Wall Mounted Road Lighting Bracket – 1500mm – Fabrication Detail	Rev D 1/04	☐
DMR	1332	Road Lighting Switchboard Pole Mounted – Typical Layout Circuit Diagram and Parts List Men System	Rev E 1/07	☐
DMR	1333	Traffic Signals/Road Lighting – Minimum Clearance Overhead Electric Lines from Ground and Structures	Rev E 11/06	☐
DMR	1334	Pedestrian Crossing Lighting – GEC Solarflood Flood Light Installation and Aiming	Rev C 1/04	☐
DMR	1335	Pedestrian Crossing Lighting – Floodlight Mounting Bracket for Use with a Street Light Luminaire	Rev C 1/04	☐
DMR	1336	Pedestrian Crossing Lighting – Floodlight Mounting Bracket	Rev E 8/99	☐

Author	Drawing number	Description	Revision	Tick if Applicable to this package
DMR	1351	Road Furniture – Motor Grid	Rev D 2/04	☐
DMR	1352	Road Furniture – Motor Grid with Vermin & Road Fencing	Rev C 2/04	☐
DMR	1353	Road Furniture – Vermin & Dog Fencing at Motor Grid	Rev B 8/99	☐
DMR	1353	Road Furniture – Vermin & Dog Fencing at Motor Grid	Rev B 8/99	☐
DMR	1354	Standard Bicycle Safe Fitting to Existing Motor Grid	Rev C 9/99	☐
DMR	1356	Road Edge guide Posts – Timber and Tubular Steel Post and installation Details	Rev D 1/02	☐
DMR	1358	Maintenance Marker Posts – Post and installation Details	Rev A 9/92	☐
DMR	1359	Culverts – Installation, Bedding and Filling/Backfilling Against/Over Culverts	Rev E 10/03	☒
DMR	1363	Traffic Sign – Multiple traffic Sign Support	Rev F 7/02	☐
DMR	1364	Traffic Sign – Connection Strap and Erection Cleat Details	Rev C 7/02	☐
DMR	1365	Traffic Sign – Traffic Sign Support Breakaway Post details (two or more supports)	Rev D 9/95	☐
DMR	1366	Traffic Sign – Traffic Sign Support Detail Truss Type Breakaway	Rev F 9/95	☐
DMR	1367	Traffic Sign – Traffic Sign Support Detail Truss Type Breakaway Bracing Details	Rev E 7/02	☐
DMR	1368	Traffic Sign – Single Traffic Sign Support	Rev C 7/02	☐
DMR	1369	Traffic Sign – Details of Sign Stiffening Extrusion	Rev A 7/02	☐
DMR	1370	Road Lighting Pole – General Arrangements	Rev C 7/97	☐
DMR	1371	Road Lighting Pole – Fixed Base	Rev C 7/97	☐
DMR	1372	Road Lighting Pole – Slip Base	Rev C 7/97	☐
DMR	1373	Road Lighting Pole – Fixed base in Concrete Median Barrier	Rev C 7/97	☐
DMR	1374	Road Lighting Pole – Impact Absorbent	Rev C 7/97	☐
DMR	1375	Road Lighting Pole – High Mast	Rev C 7/97	☐
DMR	1376	Road Lighting Pole – Fixed Base with Pedestrian Crossing Floodlight	Rev C 7/97	☐
DMR	1377	Road Lighting Pole – Joint Use Traffic Signal and Road Lighting Pole	Rev C 7/97	☐
DMR	1378	Road Lighting Pole – Combination Traffic Signals Mast Arm and Road Lighting Pole	Rev C 7/97	☐
DMR	1379	Road Lighting Pole – Pole Mounted Road Lighting Luminaire	Rev C 7/97	☐
DMR	1380	Road Lighting Pole – Slip base Pole Installation Details for no Crossfall	Rev D 2/04	☐
DMR	1381	Road Lighting Pole – Slip base Pole Installation Details for Crossfalls Not Exceeding 1:6	Rev D 2/04	☐
DMR	1382	Road Lighting Pole – Slip base Pole Installation Details for Crossfalls of Between 1:6 and 1:3	Rev D 2/04	☐
DMR	1388	Road Lighting Pole – Slip Base Pole Remedial Ramping treatment	Rev D 2/04	☐
DMR	1389	Road Lighting Pole – Slip base Pole Male/Female Connectors Installation Details	Rev C 3/04	☐
DMR	1390	Road Lighting Pole – Fixed Base Pole Aerial Connection Wiring Details	Rev B 7/97	☐
DMR	1392	Road Lighting Pole – Fixed Base Pole Installation Details for Crossfalls Up to 1:2	Rev D 2/04	☐
DMR	1393	Road Lighting Pole – Fixed Base Pole Installation Details for Crossfalls Up to 1:2	Rev D 2/04	☐
DMR	1394	Road Lighting Pole – Impact Absorbent Pole Installation Details for	Rev D 2/04	☐

Author	Drawing number	Description	Revision	Tick if Applicable to this package
		Crossfalls Up to 1:3		
DMR	1395	Road Lighting Pole – Fixed Base in Concrete Median Barrier Installation Details	Rev D 3/04	☐
DMR	1396	Road Lighting Pole – Joint Use Traffic Signal and Road Lighting Pole Installation Details	Rev F 10/06	☐
DMR	1397	Road Lighting Pole – Impact Absorbent Pole Internal Cabling Installation Details	Rev E 1/04	☐
DMR	1398	Road Lighting Pole – Impact Absorbent Pole Wiring Details	Rev D 5/99	☐
DMR	1399	Road Lighting Pole – Fixed Base Pole Wiring Details	Rev D 5/99	☐
DMR	1400	Road Lighting Pole – Slip Base Pole Wiring Details	Rev C 7/97	☐
DMR	1401	Road Lighting Pole – Fixed Base Pole Single Phase Junction Box Wiring Details No Protection	Rev B 7/97	☐
DMR	1402	Road Lighting Pole – Slip Base Pole and Impact Absorbent Pole Single Phase Junction Box Wiring Details Fuse-Switch protection	Rev C 7/97	☐
DMR	1403	Traffic Signals – Mast Arm Footing Installation Details	Rev F 10/06	☐
DMR	1404	Traffic Signals – Mast Arm Anchor Cage fabrication Details	Rev E 9/02	☐
DMR	1406	Pedestrian Crossing Lighting – GEC Sentry PX Flood Light Installation And Aiming	Rev B 1/04	☐
DMR	1407	Road Lighting Pole – Traffic Signal Terminal Panel for Joint Use Poles	Rev C 2/07	☐
DMR	1408	Road Lighting Pole – Traffic Signal Terminal Panel for Joint Use Poles Wiring Details	Rev C 7/03	☐
DMR	1409	Road Lighting Pole – Luminaire Headframes Wiring Details for Fixed Base Poles	Rev C 1/04	☐
DMR	1410	Road Lighting Pole – Luminaire Headframes Wiring Details for Slip Base and Impact Absorbent Poles	Rev B 1/04	☐
DMR	1411	Traffic Signals – Mast Arm Terminal Panel Road Lighting Junction Box (Type B)	Rev B 7/97	☐
DMR	1412	Traffic Signals – Road Lighting Junction Box (Type B) Wiring Details	Rev C 5/99	☐
DMR	1413	Traffic Signals – Terminal Panel Traffic Signal Junction Box (Type A)	Rev D 1/07	☐
DMR	1414	Traffic Signals – Traffic Signal Junction Box (Type A) Wiring Details	Rev D 2/07	☐
DMR	1415	Traffic Signals/Road Lighting – Circular Cable Joining Pit 600 Diameter	Rev B 3/04	☐
DMR	1416	Traffic Signals/Road Lighting – Collar for 600 Diameter Circular Cable Joining Pit	Rev B 11/03	☐
DMR	1417	Traffic Signals/Road Lighting – Collar for 600 Diameter Circular Cable Joining Pit Drawing 1 of 2 and Drawing 2 of 2	Rev B 11/03	☐
DMR	1418	Traffic Signals/Road Lighting – Cable Junction Box Supporting Strap	Rev B 12/03	☐
DMR	1420	Traffic Signals – Traffic Signals Components	Rev C 5/99	☐
DMR	1421	Traffic Signals – Traffic Signals Post Footing Installation Details	Rev D 11/06	☐
DMR	1422	Traffic Signals – Ragbolt Sub-Assembly Fabrication Details	Rev D 6/02	☐
DMR	1423	Traffic Signals – Controller Base Installation Details	Rev D 8/02	☐
DMR	1424	Traffic Signals – Detector Loops Installation Details in Asphalt Pavement	Rev D 11/06	☐
DMR	1425	Traffic Signals – Detector Loops Placement Details	Rev D 7/016	☐
DMR	1426	Traffic Signals – Standard Loop Configurations	Rev B 7/97	☐
DMR	1427	Traffic Signals – 'U' Series Mast Arm Installation Details	Rev C 5/99	☐
DMR	1428	Traffic Signals – Base Mounted Signals Post Installation Details	Rev C 5/99	☐

Author	Drawing number	Description	Revision	Tick if Applicable to this package
DMR	1429	Road Lighting Pole – Slip Base Pole Installation Details for Crossfalls of Between 1:6 and 1:3 Using Concrete Step Thread	Rev B 2/04	☐
DMR	1430	Road Lighting Switchboard Pillar Mounted – Typical Layout Circuit Diagram and Parts List Men System	Rev C 1/07	☐
DMR	1431	Road Lighting Pole – Fixed Base Pole Loop In/Loop Out Wiring Details	Rev A 7/97	☐
DMR	1432	Road Lighting Pole – Fixed Base Pole Three Phase Junction Box Wiring Details No Protection	Rev A 7/97	☐
DMR	1433	Road Lighting Pole – Slip Base Pole and Impact Absorbent Pole Three Phase Junction Box Wiring Details Fuse – Switch Protection	Rev A 7/97	☐
DMR	1434	Traffic Signals/Road Lighting – Cable Guard Manufacturing Details	Rev A 5/99	☐
DMR	1436	Traffic Signals – Symbols	Rev C 5/06	☐
DMR	1437	Traffic Signals – Hinged Base Plate for Traffic Signal Post Fabrication Details	Rev B 5/99	☐
DMR	1438	Traffic Signals – Hinged Base Plate for Traffic Signal Post Installation Details	Rev B 5/99	☐
DMR	1439	Traffic Signals – Lantern Designations, Functions and Aiming	Rev C 11/06	☐
DMR	1440	Traffic Signals/Road Lighting – Pit-Concrete Surround	Rev B 1/00	☐
DMR	1441	Access Chamber – Step Irons	Rev A 5/99	☒
DMR	1442	Concrete Gullies – Roadway Type at Concrete Barriers	Rev A 5/99	☒
DMR	1443	Concrete Gully – Roadway Type Precast Inlet Units on Grade	Rev A 5/99	☒
DMR	1444	Concrete Gully – Roadway Type Precast Inlet Units in Sag	Rev A 5/99	☒
DMR	1445	Concrete Gully – Roadway Type for Type 28 Channel	Rev A 6/02	☒
DMR	1446	Kerb ramp – Ramped Pedestrian Crossing	Rev A 10/00	☐
DMR	1447	Median and Island Crossings – Ramped and Cut Through Pedestrian Crossings	Rev A 10/00	☐
DMR	1448	Road Furniture – Motor Grid (RHS Rails)	Rev D 7/06	☐
DMR	1449	Road Furniture – Motor Grid (RHS Rails) with Vermin & Dog Fencing	Rev C 2/04	☐
DMR	1450	Traffic Sign – Traffic Sign Support Timber Posts	Rev B 9/95	☐
DMR	1451	Traffic Sign – Timber Support Details	Rev D 9/95	☐
DMR	1459	Concrete Gully – Roadway Type Channel Lip in Line Anti-Ponding in Sag	Rev A 6/02	☒
DMR	1460	Type F Concrete Barrier – Extruded Median Barrier – Barrier, Reinforcing and Expansion Joint Details	Rev E 3/04	☐
DMR	1461	Type F Concrete Barrier – Extruded Median Barrier – Details of Road Lighting Pole Cover Plates	Rev D 3/04	☐
DMR	1462	Type F Concrete Barrier – Transition between Median Barrier and W Beam Guardrail	Rev E 3/04	☐
DMR	1463	Type F Concrete Barrier – Reinforcing Details for Median Barrier Terminal with Lighting	Rev C 7/02	☐
DMR	1464	Type F Concrete Barrier – Reinforcing Details for Median Barrier Terminal without Lighting	Rev B 1/00	☐
DMR	1465	Type F Concrete Barrier – Fabrication Details for W Beam Guardrail Connection Brackets	Rev B 12/99	☐
DMR	1466	Concrete Barriers – Delineator Bracket Details	Rev C 7/02	☐

Author	Drawing number	Description	Revision	Tick if Applicable to this package
DMR	1467	Concrete Barrier/Bridge Parapet – Cast-In Anchor Assembly for W and Thrie Beam Guardrail Connection	Rev C 3/02	☐
DMR	1468	Single Slope Concrete Barrier – Extruded Median Barrier – Barrier, Reinforcing and Expansion Joint Details	Rev D 3/04	☐
DMR	1469	Single Slope Concrete Barrier – Extruded Median Barrier – Details of Road Lighting Pole Cover Plates	Rev C 3/04	☐
DMR	1470	Single Slope Concrete Barrier – Transition between Median Barrier and Thrie Beam Guardrail	Rev D 3/04	☐
DMR	1471	Single Slope Concrete Barrier – Reinforcing Details for Median Barrier Terminal with Lighting	Rev B 2/02	☐
DMR	1472	Single Slope Concrete Barrier – Reinforcing Details for Median Barrier Terminal without Lighting	Rev B 2/02	☐
DMR	1473	Single Slope Concrete Barrier – Precast Concrete Barrier	Rev C 8/02	☐
DMR	1474	Steel Beam Guardrail – Installation and Set out	Rev E 6/06	☐
DMR	1475	Steel Beam Guardrail – Installation on Bridge and Barrier Approaches	Rev D 11/01	☐
DMR	1476	Steel Beam Guardrail – Terminal Components	Rev E 8/06	☐
DMR	1477	Steel Beam Guardrail – Posts and Block outs, Soil and Bearing Plates, Slip Base Plate	Rev E 4/06	☐
DMR	1478	Steel Beam Guardrail – W Beam Anchor Bracket Delineation Unit Post on Base Plate Abraham Blockout	Rev D 3/04	☐
DMR	1479	Steel Beam Guardrail – Bolts, nuts, Screws and Washers Cable Assembly with Fasteners	Rev C 12/01	☐
DMR	1480	Steel Beam Guardrail – fabrication Details for W Beam Rails and Rail Components	Rev B 1/04	☐
DMR	1481	Steel Beam Guardrail – fabrication Details for Thrie Beam Rails and Rail Components	Rev B 1/04	☐
DMR	1482	Steel Beam Guardrail – W Beam and Thrie Beam Assemblies	Rev B 7/02	☐
DMR	1483	Steel Beam Guardrail – Thrie Beam Layouts	Rev B 4/01	☐
DMR	1484	Steel Beam Guardrail – Batter Slope Terminals (1 on 1 and Steeper)	Rev A 8/02	☐
DMR	1485	Steel Beam Guardrail – Reinforcing Details for Concrete Terminal Block	Rev A 2/02	☐
DMR	1486	Single Slope Concrete Barrier – Concrete Terminal with Thrie Beam Guardrail Connection General Details	Rev A 6/02	☐
DMR	1487	Single Slope Concrete Barrier – Concrete Terminal with Thrie Beam Guardrail Connection Reinforcement Details	Rev A 2/02	☐
DMR	1488	Steel Beam Guardrail – Thrie Beam Bullnose Installation and Setout	Rev A 10/03	☐
DMR	1489	Steel Beam Guardrail – Thrie beam Bullnose Components	Rev A 3/04	☐
DMR	1490	Steel Beam Guardrail – Installation and Setout Footing Details	Rev A 12/06	☐
DMR	1491	Steel Beam Guardrail – Standard Guardrail Attachments to Culverts, Fabrication and Assembly Details	Rev A 1/07	☐
DMR	1493	Steel Beam Guardrail – W Beam Connections for Concrete End Posts	Rev B 6/02	☐
DMR	1494	Steel Beam Guardrail – Thrie Beam Connections for Concrete End Posts	Rev B 6/02	☐
DMR	1495	Wire Rope Barrier – Transition Between Steel Beam Guardrail and Brifen Wire Rope Barrier on One Way Road	Rev A 8/02	☐

Author	Drawing number	Description	Revision	Tick if Applicable to this package
DMR	1496	Wire Rope Barrier – Transition Between Steel Beam Guardrail and Flexfence Wire Rope Barrier on One Way Road	Rev A 8/02	☐
DMR	1497	Wire Rope Barrier – Transition Between Concrete Barrier and Brifen/Flexfence Wire Rope Barrier on One Way Road	Rev A 8/02	☐
DMR	1500	Bridges – Octagonal PSC Pile	Rev B 9/03	☐
DMR	1508	Bridge Barriers – Steel Bridge Traffic Rail Intermediate Post and Rails	Rev D 3/07	☐
DMR	1509	Bridge Barriers – Steel Bridge Traffic Rail End Post W Beam Connection	Rev C 3/07	☐
DMR	1510	Bridge Barriers – Steel Bridge Traffic Rail End Post Thrie Beam Connection	Rev C 3/07	☐
DMR	1511	Bridge Barriers – Bridge Safety Rail	Rev B 9/03	☐
DMR	1512	Bridge Barriers – Bridge Balustrade	Rev A 9/03	☐
DMR	1600	Fencing – Rural Fence and Gates Timber Posts and Stays	Rev A 12/00	☐
DMR	1601	Fencing – Rural Fence and Gates CHS Posts and Stays	Rev B 7/03	☐
DMR	1602	Fencing – Chainwire Fence and Gates	Rev B 6/02	☐
DMR	1603	Fencing – Koala Proof Fence and Gate	Rev A 6/02	☐
DMR	1604	Fencing – Galvanized Welded Mesh Fencing	Rev A 6/02	☐
DMR	1608	Noise Barriers – Structural Detail Universal Beam Posts Concrete Panels Steel Panels	Rev A 4/04	☐
DMR	1700	Traffic Signals – VID Detector Loops Installation Details	Rev A 10/06	☐
DMR	1701	Traffic Signals – Detector Loops Details Counting Loops and Diode Connection	Rev A 1/07	☐
DMR	1702	Traffic Signals – Detector Loops Motorways and Ramp Placement, and Installation Details	Rev A 1/07	☐
DMR	1703	Traffic Signals – Red Light Camera Cable and Loop Details	Rev A 1/07	☐
DMR	1704	Traffic Signals – Red Light Camera Wiring Details	Rev A 1/07	☐
DMR	1707	Road Lighting Pole – Fixed Base Poles Mounted on Bridges Wiring Details	Rev A 3/07	☐
DMR	1519	Pre-cast Units – Design assumptions for standard deck and kerb units	Rev A 03/08	☐
QR	2567	Track Formation	Passed 29.5.04	☐
ICC	SR.02	Typical Cross Sections – Residential Streets	Rev C	☐
ICC	SR.03	Typical Cross Sections – Industrial Streets	Rev C	☐
ICC	SR.04	Typical Cross Sections – Sub-Arterial and Arterial Roads with Kerbs and Channel	Rev C	☐
ICC	SR.05	Typical Cross Sections – Sub-Arterial and Arterial Roads without Kerbs and Channel	Rev C	☐
ICC	SR.06	Standard Verge and Access Profiles – Access Streets, Collector Streets and Industrial Streets	Rev B	☐
ICC	SR.07	Standard Verge Profiles – Trunk Collector Streets, Sub-Arterial and Arterial Roads with Kerb and Channel	Rev B	☐
ICC	SR.08	Standard Verge Profiles – Sub-Arterial and Arterial Roads without Kerb and Channel	Rev A	☐

Author	Drawing number	Description	Revision	Tick if Applicable to this package
ICC	SR.09	Typical Cross Sections – Rural Roads	Rev B	☐
ICC	SR.10	Standard Verge Profiles – Rural Roads	Rev B	☐
ICC	SR.11	Standard Kerb and Channel Profiles Including Edge Restraints, Median and Inverts	Rev C	☐
ICC	SR.12	Standard Residential Driveway – Driveway Invert and Slab or Tracks	Rev B	☐
ICC	SR.13	Standard Commercial Driveway Invert and Slab Type A – Two Way Access	Rev A	☐
ICC	SR.14	Standard Commercial Driveway Invert and Slab Type B – Two Way Access	Rev A	☐
ICC	SR.15	Standard Invert Crossing for Areas without Kerb and Channel	Rev A	☐
ICC	SR.16	Standard Rural Road Driveway Pipe Crossing	Rev A	☐
ICC	SR.17	Standard Kerb and Channel Roofwater Drainage Connections	Rev B	☐
ICC	SR.18	Standard Kerb Ramp	Rev C	☐
ICC	SR.19	Standard Concrete Strip Pathways	Rev C	☐
ICC	SR.20	Subsurface Drainage	Rev B	☒
ICC	SR.21	Subsurface Drainage Flushing Points	Rev B	☒
ICC	SR.22	Public Utilities in Subdivisions – Typical Service Corridors and Alignments	Rev C	☐
ICC	SR.23	Public Utilities in Subdivisions – Typical Service Conduit Sections	Rev C	☐
ICC	SR.24	Standard Brass Indicator Disc for Service Crossings	Rev A	☐
ICC	SR.25	Typical Single Post Traffic Sign	Rev B	☐
ICC	SR.26	Standard Street Name Sign	Rev B	☐
ICC	SR.28	Typical Concrete Threshold Treatment	Rev B	☐
ICC	SR.29	Standard Roundabout Details	Rev B	☐
ICC	SR.30	Overland Flow Path	Rev A	☐
ICC	SR.31	Stone Work at Floodways – Rural Roads	Rev A	☐
ICC	SR.32	Weld Mesh Fencing and Control Fence	Rev B	☐
ICC	SR.33	Tubular Steel Fence with and without Chain Wire	Rev B	☐
ICC	SR.34	Chain Wire Security Fencing	Rev A	☐
ICC	SR.35	Log Barrier Fencing	Rev A	☐
ICC	SR.36	Fencing – Locking Rail	Rev A	☐
ICC	SR.37	4 & 6 Strand Barbed Wire Fence	Rev A	☐
ICC	SR.38	Installation of Field Gate and Posts	Rev A	☐
ICC	SR.39	Typical Bus Bay Indent	Rev A	☐

Appendix D – Reference Documents

List of Reference Documents applying to this design lot.

Number	Description	Revision
	Queensland Urban Drainage Manual	2nd Ed 2007
	Road Drainage Design Manual	June 2002
	Australian Rainfall and Runoff	2001
D2G-BASD-DGRODR101-R-1000	Design Criteria Report	1
D2G-DP-SM-R-001	Safety in Design CHAIR 1Report	1
D2G-BASD-DGFHKS100-R-1000	Regional flood model	1
D2G-BASD-REFHKS100-R-1000	Goodna Creek local flood model	1
DGGOKS100	Geotechnical Investigation Plans	1

Appendix E – Environmental Requirements Checklist

	Zone 2	Drainage	Design Response	Status (Compliant/ Partially compliant/ Non-compliant/ Not applicable)	Date Closed
All permanent water quality treatment structures should be designed for the adequate control of pollution and sediment in the one year Average Recurrence Interval (ARI) peak flow as a minimum, and also designed for stability for at least the 20 year ARI peak storm event.	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
Implement WSUD measures in accordance with design objectives in the Healthy Waterways' WSUD Action Plan (Section 3.3.1).	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
Design sedimentation ponds with sufficient holding times to reduce suspended solids to at or less than the suspended solid concentration of the receiving watercourse before release or use on site.	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
Any dewatering of trenches containing exposed acid sulphate soils shall be discharged to a holding pond and not directly into local waterways. Water testing and treatment, if necessary, is to be performed prior to water reuse or release.	Y	Y	Addressed during construction in accordance with the Construction Environmental Management Plan (D2G-MPPL-V-017).	Compliant	24.11.09
Carry out weekly inspections of water quality treatment devices and implement regular maintenance regimes through operational phase.	Y	Y	Weekly inspections will be carried out during construction and a maintenance plan for the operational phase of the devices are contained within the design report. Applicable to the water quality package only (RERODR202)	Not applicable	24.11.09
Outfalls should meet the requirements of QUDM Chapter 3.02 – Lawful points of discharge.	Y	Y	New outlets are generally located where existing outlets discharge to established watercourses and drainage systems, or to park, drainage or road reserve and stormwater easements. Designs for individual outlets ensure that they do not cause actionable nuisance. The assessment of actionable nuisance includes potential changes to the quantum of flow and the concentration of flow at the point of discharge.	Compliant	22.12.09
Surface flows that are concentrated by an open channel or conduit should be controlled prior to discharge on a downstream system or owner. Concentrated flows should be dissipated by the use of detention and energy dissipaters.	Y	Y	Addressed. All flow are discharged in a controlled manner refer to the detailed design drawings.	Compliant	24.11.09
Summary of the Water Quality Objectives applicable to the IMU. • Frequent Flow Management: Capture the first 15mm/d of Runoff. • Waterway Stability Management: Limit post development 1-year ARI to pre-development (undeveloped) 1-Year ARI; Limit post development 100-year ARI to pre-development (undeveloped) 100-Year ARI. • Stormwater Quality Management Achieve the following reductions in total pollutant load: 90% reduction in gross pollutants; 80% reduction in TSS; 60% reduction in Total Phosphorous; 45% reduction in Total Nitrogen.	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
It is recommended that, where feasible, all permanent water quality treatment structures should be designed for the adequate control of discharge, pollution, and sediment in the 1-year Average Recurrence Interval (ARI) event and 100 year ARI event.	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
All water quality works designed for the IMU should be developed with an operation and maintenance plan for the construction and operational phases of the project. These plans should be provided to ICC's maintenance department to ensure the long term operation of constructed water quality facilities.	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09

	Zone 2	Drainage	Design Response	Status (Compliant/ Partially compliant/ Non-compliant/ Not applicable)	Date Closed
Waterway habitat degradation: • Incorporate a filtration system into the drainage design in order to minimise pollutants entering Goodna and Six Mile Creeks. (Chainage 15000 to 16300 and 17700 to 18200) • Revegetate creek banks with local provenance	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
Incorporate fauna underpass into road design at Goodna Creek (Chainage 15000 to 16300)	Y	Y	Not applicable to this design lot. Refer to Smiths Road transverse design package (RERODR207).	Not applicable	24.11.09
Establish fauna friendly culverts catering for a variety of faunal groups (Chainage 15000 to 16300)	Y	Y	Not applicable to this design lot. Refer to Smiths Road transverse design package (RERODR207).	Not applicable	24.11.09
Capture of road runoff in sedimentation/detention basins reducing the likelihood of seeds passing into nearby riparian areas (assuming adequate weed monitoring and control is carried out at each basin)	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
Swales and drainage channels longitudinal alignments to gently meander reflecting natural landform and to be of a more naturalised appearance with maximum side slope of 1:3. Investigate the use of rock lined wet, macrophyte planted and grass swale types.	Y	Y	Not applicable to this design lot. No swales are incorporated into the design. For longitudinal drainage details refer to RERODR201.	Not applicable	24.11.09
In the event of a spill, Emergency Services to be contacted immediately. Construction of settling ponds along the road corridor for the capture of any dangerous goods or hazardous substances. Contaminated water to be disposed of at a licensed waste transfer station.	Y	Y	Spill containment basins have been designed in accordance to spill capture requirements and risk based approach where there are no space constraints. Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
DMR shall insist on the use of recycled material, where they are available and cost-competitive, by all contractors. Furthermore, recycling shall be utilised where available and cost-competitive for the disposal of all waste materials.	Y	Y	Opportunities to minimise waste and use recycled materials have been considered as part of the design process, such as incorporation of existing culverts during temporary construction staging.	Compliant	24.11.09
Contractors are to develop and implement a Stormwater Management Plan (SMP) that clearly identifies potential flood sections along the upgrade corridor. The SMP must include emergency procedures, contact numbers and an action plan outlining 'what to do in the event of a flood'.	Y	Y	To be addressed by construction team. To be addressed during the construction phase of the project in accordance with the Construction Environmental Management Plan (D2G-MPPL-V-017).	Compliant	24.11.09
All contractors must, where possible, provide sandbag and/or bunding protection at the points of intersections of the construction site and the Six Mile and Goodna Creeks. Use of additional ITS in notifying vehicles travelling along the corridor and adjoining motorways of the delays in traffic movement and the location of the flooding.	Y	Y	To be addressed by construction team. Control measures during construction will be in accordance with the Construction Environmental Management Plan (D2G-MPPL-V-017) and the Emergency and Incident Response Management Plan (D2G-MPPL-V-16).	Compliant	24.11.09

	Zone 2	Drainage	Design Response	Status (Compliant/ Partially compliant/ Non-compliant/ Not applicable)	Date Closed
The durability portions of the Project Plans and the Maintenance Manual must demonstrate how the selected design, materials, construction, operation and maintenance will achieve the durability objectives of each Asset, in conjunction with the specified Design Life for that Asset in section 5.2 of this Scope of Works and Technical Criteria. For each Asset which comprises part of the Upgrade, the Project Plans must: (i) define the characteristics of the environment; (ii) identify the potential deterioration mechanisms in that environment; (iii) determine the likely rate of deterioration; (iv) assess the material life; (v) define the required material performance; (vi) assess the need for further protection; (vii) if appropriate, develop procedures for replacement of Asset Items and Asset Sub-Items at intervals consistent with the Design Life specified in section 5.2 of this Scope of Works and Technical Criteria; (viii) determine inspection and monitoring requirements for both critical and non-critical Assets; and (ix) if appropriate, outline possible remedial measures.	Y	Y	The durability assessment has been carried out (refer to D2G-BASD-DGDUKS100-R-1000) and the recommendations incorporated into the design of culverts.	Compliant	24.11.09
The results of the Condition Surveys must be taken into account during design, construction and operation of the Upgrade	Y	Y	To be addressed by construction team.	Compliant	24.11.09
Except as specified in Appendix 36, the various Assets must have the following minimum Design Life: Drainage elements that are accessible for refurbishment, including building drainage, sedimentation and detention ponds, 20 years;	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0). In developing the design, a durability assessment has been undertaken and all transverse drainage crossings have been designed for 100yr design life.	Partially compliant	24.11.09
The Contractor must develop, maintain and operate a drainage system and develop design solutions which avoid or minimise any potential damage or loss that may result from, or may be contributed to by water discharge from the Project Works and Temporary Works.	Y	Y	Not applicable to this package. Addressed as part of the TTM works as temporary construction staging drainage design has been shown on these drawings.	Not applicable	24.11.09
The Contractor must provide a water management system that requires a minimum of maintenance consistent with the need to ensure appropriate water quality discharge from the Project Works and Temporary Works.	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
The drainage system must: (i) preserve the existing elements such as natural channels, wetland and riparian vegetation; (ii) manage both the quality and quantity of runoff such that it is as close to its sources as possible and include the installation of devices which treat the stormwater and retain the run-off so that the system changes the existing water regime to the smallest amount practicable; (iii) be integrated with the construction process so that the total investment in drainage infrastructure is minimised and access is available to all devices which need on-going maintenance during both the construction phase, operation phase and the maintenance phase; (iv) be capable of being partitioned to contain spillage from incidents; (v) be designed for ease of maintenance; and (vi) be structurally safe in any storm.	Y	Y	(i) Addressed. (ii) for water quality management refer to RERODR202. Flow regime has been impacted to the smallest amount practicable, while ensuring that afflux is mitigated both upstream and downstream of the local roads. (iii) Access to drainage elements has considered in the design process. (iv) Not applicable to this design lot, refer water quality design package RERODR202. (v) see (iii) (vi)Addressed.	Partially compliant	24.11.09
Bridge drainage, bridge scuppers and underpass drainage must be connected to the road drainage system.	Y	Y	Not applicable to this design package.	Not applicable	24.11.09

	Zone 2	Drainage	Design Response	Status (Compliant/ Partially compliant/ Non-compliant/ Not applicable)	Date Closed
The drainage system must prevent any flooding inside underpasses for a 10 year ARI.	Y	Y	Not applicable to this design package.	Not applicable	24.11.09
The Upgrade must be designed so that the motorway carriageways are protected by physical means to prevent flooding of the Upgrade such that the lowest point of each carriageway's pavement surface is 100mm above the 100 year ARI flood level for cross drainage.	Y	Y	Not applicable to this design package.	Not applicable	24.11.09
The Upgrade must be designed so that the above requirement of sub-section (a) is maintained for the design life of the Assets. Flood levels must be measured during representative storm events immediately following completion of construction of relevant sections of the Project Works to verify the likely compliance of the Project Works with the predicted inundation limits and inundation times. In the event that the measurements required in sub-section (b) demonstrate flood levels and/or inundation times greater than those predicted, the Contractor must immediately commence a process to modify the Project Works to the meet the required limits, unless otherwise agreed by Main Roads.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0). This level of protection achieved from this design.	Compliant	24.11.09
A high standard environmental design must be developed for the Project Works, including provision for: (i) erosion, sedimentation and water quality infrastructure (ii) groundwater movements (iii) fauna underpasses and fauna fencing (iv) fish-friendly structures, including waterway design (v) management and mitigation measures for environmentally sensitive areas, including marine environments, and (vi) construction and operational noise and vibration measures.	Y	Y	Fish friendly structures are not required at this location. Refer to Zone 2 Water Quality design lot RERODR202.	Not applicable	24.11.09
Concrete safety barriers must not be used in areas where fauna habitat is adjacent to the Project Site and fauna has not been effectively prevented from crossing the Project Site, or where a concrete safety barrier could adversely impact the effects of floods.	Y	Y	Not applicable to this design package. Addressed as part of the road design and fencing and accommodation works. It should be noted that fauna exclusion fencing is proposed in all areas of significant fauna habitat.	Not applicable	24.11.09
Bridge drainage over streams shall satisfy the requirements of the Environmental Management Plan (EMP). In general, collection and treatment of drainage water is not required unless specified in the EMP. Where drainage pipes are required, they must be able to be cleaned effectively, and placed between beams or behind an edge skirt to maintain clean lines on the bridge profile. Drainage system shall be hot dip galvanized steel. PVC drains are not permitted.	Y	Y	Not applicable to this design package.	Not applicable	24.11.09
The drainage design must comply with the following requirements: (a) The drainage design must be in accordance with Reference Documents, the Main Roads Road Drainage Design Manual, Australian Rainfall and Runoff (AR&R) 2001 and the requirements of all relevant Authorities.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Compliant	24.11.09
The drainage design must comply with the following requirements: (b) The Contractor must obtain approval for the drainage design from all relevant Authorities.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0). Consultation with the relevant Authorities is ongoing.	Compliant	24.11.09
The drainage design must comply with the following requirements: (c) The drainage design must hydraulically model watercourses which are crossed by the Project Works for flooding and impact of the PMF, and must provide flood mitigation measures where required.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Compliant	24.11.09
The drainage design must comply with the following requirements: (d) For all drainage design, the storm modelled must be the one producing the largest peak discharge for the required storm event.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Compliant	24.11.09

	Zone 2	Drainage	Design Response	Status (Compliant/ Partially compliant/ Non-compliant/ Not applicable)	Date Closed
The drainage design must comply with the following requirements: (e) The Project Works must not increase inundation levels more than those contained in section 5.13 of this Scope of Works and Technical Criteria or the Environmental Documents.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0). Inundation levels are not increased as a result of this design.	Compliant	24.11.09
The drainage design must comply with the following requirements: (f) Runoff from/along ramps or turning roadways must not flow beyond noses and across the main carriageway for a 2 year ARI storm event.	Y	Y	Not applicable to this design lot, refer longitudinal drainage RERODR201.	Compliant	24.11.09
The drainage design must comply with the following requirements: (g) Where the pipe system is not self-cleaning, the drainage design must make provision for acceptable alternative cleaning strategies.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0). Minimum velocities have been achieved for all culverts to allow for self cleaning.	Compliant	24.11.09
The drainage design must comply with the following requirements: (h) If embankment or formation settlement occurs, the required waterway areas must be maintained.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Compliant	24.11.09
The drainage design must comply with the following requirements: (i) The design of waterway areas must accommodate any embankment or formation settlement.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0), and Geotechnical Investigation included in this report.	Compliant	24.11.09
The drainage design must comply with the following requirements: (j) The part(s) of the drainage system that deal(s) with general pavement drainage must incorporate methods for retention of 40,000 litres of polluted run-off (including oil and chemical pollutants, and oil and chemical spills) at each point of discharge from the Project Site and the Local Road Works, including discharges into existing wetlands or tidal channels.	Y	Y	Not applicable to this design lot. Refer to water quality design package (RERODR202).	Not applicable	24.11.09
The drainage design must comply with the following requirements: (k) The drainage system must separate cross-drainage systems from pavement drainage systems and from longitudinal drainage systems.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0).	Compliant	24.11.09
The drainage design must comply with the following requirements: (l) Oil and chemical spill collection and treatment must be provided at water crossings nominated by Main Roads.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0) and the water quality design lot RERODR202	Not applicable	24.11.09
Drainage of surface run-off from pavement wearing surfaces must be designed for a 1 in 10 year ARI. A 1 in 100 year ARI must be modelled and a check made of flow levels to ensure that nuisance flooding is avoided. A drainage system must be provided to pick up all pavement water, including any drainage layers.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Compliant	24.11.09
Watercourses must be modelled and have impacts assessed for 50 year and 100 year ARIs and the PMF	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Compliant	24.11.09
The following minimum ARI must be applied to the drainage design: (i) cross highway drainage - 100 year ARI (ii) channels and open drains - 10 year ARI (iii) gutter flow spread limited to width of shoulder - 10 year ARI (iv) piped system (including pits) - 10 year ARI (v) major storm event check for no property damage - 100 year ARI (vi) major storm event check for no structure damage - 2000 year ARI (vii) surface run-off from pavement - as per Clause 7.12.1.2 and Clause 7.12.1.5.	Y	Y	(i) refer transverse drainage package RERODR205 - It should be noted that transverse drainage for the local roads has been designed for 20 year ARI. (ii) refer longitudinal drainage package RERODR201 (iii) refer longitudinal drainage package RERODR201 (iv) refer longitudinal drainage package RERODR201 (v)Addressed, major storm 100year floods were checked. (vi) Addressed PMF floods for C-FS950. (vii) refer longitudinal drainage package RERODR201	Partially compliant	24.11.09

	Zone 2	Drainage	Design Response	Status (Compliant/ Partially compliant/ Non-compliant/ Not applicable)	Date Closed
A catchment drawing must be provided within the design report and must show: (a) existing and design contours, gullies/pits, manholes, culverts, bridges and pipes (b) catchment areas (c) pervious and impervious percentages (d) coefficients of runoff (e) overland flow times, including times of concentration, and (f) extent of proposed work.	Y	Y	Catchments plans are included in this design package, refer to Appendix A.	Compliant	24.11.09
Continuity of ground water flow from one side of tunnel or underpass structures (including approach structures) to the other side of tunnel or underpass structures must be provided. The infrastructure to accommodate the groundwater flow across the tunnel or underpass and its approaches must be designed to address the chemical properties of the groundwater and the potential for iron compound precipitation from the groundwater to block pipe work, making any provisions necessary to facilitate maintenance activities and removal of blockages from the pipes.	Y	Y	Not applicable to this design lot as no tunnels are present in this design lot.	Compliant	24.11.09
All outlets of the surface drainage system must incorporate energy dissipation, erosion and sediment control.	Y	Y	All outlets have energy dissipation, erosion and sediment controls.	Compliant	24.11.09
Construction of the drainage system must be consistent with the acid sulphate soils management plan.	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (DGRODR101-R-1000). Also refer to the Construction Environmental Management Plan (D2G-MPPL-V-017).	Compliant	24.11.09
The Contractor must design scour protection for all areas susceptible to scouring, including batters and bridge abutments. Scour protection must be designed for a minimum maintenance-free life of 50 years. Scour protection for waterway areas must be designed in consultation with the relevant Authorities, address fauna access requirements, and comply with the requirements of Appendix 21 (if used) of this Scope of Works and Technical Criteria.	Y	Y	Scour protection incorporated into the culvert designs.	Compliant	24.11.09
Water to be discharged from the Project Site must meet EPA requirements.	Y	Y	Not applicable to this design lot. Refer to the water quality package RERODR202 and the Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Not applicable	24.11.09
Further to the requirements of sections 5.5 and 5.13 of the SWTC, service roads must be designed so that the lowest point of each carriageway's pavement surface is above the 20-year ARI flood level (target) or the 10-year ARI flood level (minimum).	Y	Y	Addressed during design process. Refer to Design Criteria Report - Drainage (DGRODR101-R-1000).	Compliant	24.11.09
Consideration shall be given to the following: (i) identification of potentially affected water bodies or sensitive receiving areas (ii) construction activities and their potential impact on water quality (iii) monitoring location(s), triggers and frequency (iv) water quality objectives (performance criteria).	Y	Y	Not applicable to this design lot. Refer to the water quality package RERODR202.	Not applicable	24.11.09
All permanent and temporary water quality treatment measures shall be reviewed from the scenario presented within the interim EAR in Exhibit C. This review shall consider the purpose, design, placement and size of those measures.	Y	Y	Not applicable to this design lot. Refer to the water quality package RERODR202.	Not applicable	24.11.09
Consideration shall be given to the need for temporary or permanent water treatment devices to treat first flush events and the collection of runoff from bridges.	Y	Y	Not applicable to this design lot. Refer to the water quality package RERODR202.	Not applicable	24.11.09
Water discharged from site or from any water treatment devices must comply with water quality provisions of the Environmental Protection (Water) Policy 1997, as well as ANZECC and/or locally relevant water quality guidelines.	Y	Y	Not applicable to this design lot. Refer to the water quality package RERODR202, and the Design Criteria Report - Drainage (D2G-BASD-DGRODR000-R-001-A0)	Not applicable	24.11.09

	Zone 2	Drainage	Design Response	Status (Compliant/ Partially compliant/ Non-compliant/ Not applicable)	Date Closed
Consideration shall be given to the following information in all relevant documentation: (i) identification of significant habitat areas (ii) identification of fauna known or likely to occur within the area (iii) identification of significant habitat features such as hollows, nests (iv) methods available to minimise impacts, such as: A. preserving areas by prohibiting disturbance or construction activities B. preserving habitat logs, rock, other shelters and subsequent re-instatement C. minimising clearing within the construction zone D. implementation of two-stage clearing procedures E. procedures to treat fauna injured by the construction activities. (v) use of an EPA-authorised "fauna spotter-catcher" during works (vi) inclusion of contact details for emergency wildlife care on the project's emergency contact list (vii) detail of procedures implemented to treat fauna injured by construction activities (viii) immediate reporting of any fauna injured or dead, which are known as rare, endangered or vulnerable, to Main Roads and the EPA. (ix) implementation of fauna mitigation measures such as underpasses and exclusion fencing.	Y	Y	Significant habitat areas in the vicinity of this design include Goodna Creek and surrounding riparian vegetation, and the Pan Pacific Peace Gardens. These habitat areas have been avoided where possible. Any clearing and fauna handling (if required) will be in accordance with the Construction Environmental Management Plan (D2G-MPPL-V-017).	Compliant	24.11.09
The design of the motorway bridges [over Goodna Creek] considers the Brisbane River floodplain; with the motorway bridges desined to provide Q100 immunity (Brisbane River).	Y	Y	Not applicable to this design package.	Not applicable	24.11.09
Local roads and/or service roads are designed to provide Q20 immunity (Brisbane River) [Goodna Creek].	Y	Y	Addressed in this package. All design achieves 20 year ARI.	Compliant	24.11.09
All clearing of native vegetation within the approved clearing limit.	Y	Y	Clearing will be in accordance with the construction Environmental Management Plan (D2G-MPPL-V-017)	Compliant	24.11.09
Construction of a permanent five (5) cell box culvert crossing over Goodna Creek that is part of the extension of Smiths Road. To be constructed in accordance with the attached Origin Alliance drawing D2G-BASD-RIRODR203-D-2470 Ipswich Motorway Upgrade - Dinmore to Goodna ch13200 to ch20770, Transverse Drainage Zone 2 Fish Culvert Typical Section dated 11/06/2009.	Y	Y	Not applicable to this design package.	Not applicable	24.11.09
The realignment of Goodna Creek as per proposal detail 4 is to be constructed such that the realignment provides for upstream and downstream fish passage and fish habitat including riparian vegetation.	Y	Y	Not applicable to this design package. Refer to Smiths Road transverse drainage package RERODR207	Not applicable	24.11.09
The site [Goodna Creek] (including all disturbed areas such as slopes, borrow pits, stockpile and screening areas) must be rehabilitated in a manner such that: (c) the quality of stormwater, other water and seepage released from the site will not cause environmental harm;	Y	Y	Not applicable to this design package. Refer to Smiths Road transverse drainage package RERODR207	Not applicable	24.11.09
The site [Goodna Creek] (including all disturbed areas such as slopes, borrow pits, stockpile and screening areas) must be rehabilitated in a manner such that: (e) the final landform is stabol and not subject to slumping; and	Y	Y	Not applicable to this design package. Refer to Smiths Road transverse drainage package RERODR207	Not applicable	24.11.09
All clearing of native vegetation within the approved clearing limit.	Y	Y	[ST] To be addressed by construction team in accordance with the Construction Environmental Management Plan (D2G-MPPL-V-017).	Compliant	24.11.09

Appendix F – Independent Verification Comments and Closeout

[redacted]

From: [redacted]
Sent: Friday, May 21, 2010 3:36 PM
To: [redacted]
Cc: [redacted]
Subject: RERODR206: Transverse Drainage Other Culverts - Zone 2 (Draft IFC-hold removal)

[redacted]

The above package has been discussed with the designer today and we have been made aware of the following changes:

1. Culvert CS1250 (north Brisbane Terrace) has been removed from the scope of works due to the finalisation of the limit of works.
2. The removal of aforementioned culvert has no impact on existing culverts.
3. No other changes have been made since IFC.

Based on these information we don't have any further comments on this package.
Note: The verification is to the current SWTC Version F - December 2009.
Kind Regards

[redacted]
Deputy Design Verification Manager
Ipswich Motorway Upgrade D2G
Hyder Consulting Pty Ltd
199 Grey St South Brisbane QLD 4101 Australia
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International advisory and design consultancy

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR200
Title: Redbank - Drainage - Transverse Drainage
Stage: Zone 2
Issue: 15% design

Alliance Verifier:
Date Distributed:
Date Compiled:
Date of Comments:

Ref No	Item	Reviewer	Reference	Reviewer Comment	Designer Comment
101	**Report**	Hyder AV	D2G-BASD-RERODR200-R-1000 Appendix	Some of the page numbers appear inconsistent or incorrect within the appendix of the report. Example: Appendix G is numbered as "page F-73" and for consistency should be "page G-73". Appendix H also appears incorrect.	This has been corrected in the 85% design report.
102	**Report**	Hyder AV	General Comment	Design Criteria Report (Appendix L) is not provided. Please provide. This review does not include verification in respect to the design criteria.	It is submitted as a separate report.
103	**Report**	Hyder AV	General Comment	Concept design is to be mindful of requirements for maintenance access such as turning movements, hard stand areas and space for these configurations at all water treatment/retention locations as per 5.8 of SWTC.	This has been considered and is included in water quality packages.
104	**Vertical**	Hyder AV	General Comment	No vertical geometry/longitudinal sections have been provided and as such no detailed review of vertical clashes such as with services, culverts and drainage lines have been made.	This has been corrected in the 85% design report.
105	**Report**	Hyder AV	D2G-BASD-RERODR200-R-1000 Cl 3.2	Non-compliances are noted in Cl3.2. Changes to the SWTC will require Main Roads approval/sign-off.	Non-compliances have been identified and discussed with DMR and ICC. Issues have been closed-out. This is discussed within the report in 3.2
105A				Has there been a response to RFI 446	RFI 446 has been closed. Reported in the 100% design report.
106	**Report**	Hyder AV	Cl 4.4	Items for resolution are noted in Cl4.4. These items should be addressed appropriately.	This have been resolved
106A				Items for resolution are still open.	1. New tail water levels from the latest Goodna Creek flood studies, have been used to update the SWMM models.This have been reported in the 100% design report. Fences have been proposed along channels with steep slopes.e.g channel south of Smiths Rd.
106b				No fence has been shown on the drawings.	Fences are not shown on the drainage drawings. Please refer to design package DGRORF101-Fencing and Accomodation Works for fence location and details.
107	**Report**	Hyder AV	Cl 3.2.2	The report identifies at Lower Cross Street an afflux non-compliance at Ch300. Transverse Drainage Sheet 8 and the Road long section for control line M2X0 appears to show the location would be better described as circa Ch380 as it appears to be the location where the overland flow path funnels and the location of the 750mm diameter cross culvert.	Noted. The Lower Street has been removed from the scope of works in 85% design.

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR200
Title: Redbank - Drainage - Transverse Drainage
Stage: Zone 2
Issue: 15% design

Alliance Verifier:
Date Distributed:
Date Compiled:
Date of Comments:

Ref No	Item	Reviewer	Reference	Reviewer Comment	Designer Comment
108	**Report**	Hyder AV	Cl 3.2.2	The afflux at "Lower Cross Street Ch 300" is identified as a non compliance within the report. The afflux is identified as being 1.56m at the design 750mm diameter culvert after construction which is located where the existing conditions are that of an unobstructed natural flow path. This afflux level appears very high. Should greater capacity be provided for the culvert crossing?	Noted. The Lower Street has been removed from the scope of works in 85% design.
109	**Report**	viewed in the 85% design	Cl 3.2.4	Table4-10 indicates that the water level is reduced upstream of the basin inlet (C14800A) and down stream of the QR culverts(C14800E), however a large increase in the water level appears at the points in between. In particular a large increase in water level of 0.8m occurs at the pit at the basin outlet (C14800B). Is this considered to be compliant with the requirements?	The water levels were compared at two different points. This has been updated in the 85% design.
110	**Report**	Hyder AV	Cl 3.2.5	The afflux at "Lower Cross Street Ch 200" is identified as a non compliance within the report. The actual afflux is not identified in either Cl3.2.5 or Cl4.2.7of the discussion. It is noted that the maximum pond depth would be 0.9m. Please provide this in Cl3.2.5 if the afflux cannot be provided.	Noted. The Lower Street has been removed from the scope of works in 85% design.
111	**Report**	Hyder AV	Table 4.1	Table 4.1 indicates that culvert lengths, grades and levels vary. Please provided the range of the values and indicate how these varying values were used in the design.	The SWMM model generates the slopes from the IL, OL and the length of the culverts.
112	**Report**	Hyder AV	Table 4-4	Table 4-4 indicates the initial losses. Please clarify the selection of 1.5mm.	Reference: XP RAFTS reference and ARR Vol 2, 1988.
113	**Report**	Hyder AV	Cl 4.2.3	Table 4-3 states Manning's for road as 0.02 however directly below the table it is stated "Manning coefficient for impervious sub catchments such as roads and concrete driveways is taken to be 0.015." Please explain why the values stated differ.	Noted. Manning's n for roads have been changed to 0.015.
114	**Report**	Hyder AV	Section 4.2.3	Section 4.2.3 indicates that levels must not exceed more than 10mm. Please clarify the source from where this value was obtained.	This issue was resolved under RFI-281. 10mm is the target maximum increase in afflux with a 20mm tolerance in areas of state and council controlled land.
115	**Report**	Hyder AV	Section 4.2.3	Please indicate if the culvert hydraulics will be tested.	Please provide more detail on this.

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR200
Title: Redbank - Drainage - Transverse Drainage
Stage: Zone 2
Issue: 15% design

Alliance Verifier:
Date Distributed:
Date Compiled:
Date of Comments:

Ref No	Item	Reviewer	Reference	Reviewer Comment	Designer Comment
116	**Report**	Hyder AV	Section 4.2.3	Page 10 indicates that culverts were modelled without blockage and then in the later section it is indicated as modelled with blockage. Please clarify application of blockage.	Typing error. All culverts have been designed with blockage.
117	**Report**	Hyder AV	Various tables	Tables 4-5, 4-7, 4-11, 4-13, 4-19, 4-21, 4-27, 4-29, 4-32, 4-34, 4-41,4-43,4-47and 4-49 indicates only a 0 and 100% value in the last column. Please clarify how these values were derived.	Each catchment was divided into Sub-catchments 1 and 2 in XP-Rafts. Sub-catchment 1 represents the pervious area, thus 0% impervious. Sub-catchment 2 represents the impervious area, thus 100% impervious.
118	**Report**	Hyder AV	Cl 4.2.4	Table 4-5 & 4-7 states various Manning's values with corresponding %impervious values of 0% and 100%, but in general states Manning's as 0.025 for 0% impervious and 0.015 for 100% impervious. These values stated do not match up with the values stated in table 4-3, which indicate Manning's as 0.04 for 0% impervious and 0.02 for 100% impervious Please explain why the values stated differ or amend.	Sub-catchment 1 represents the pervious area, thus 0% impervious. To estimate the average pervious area 'n' , the value of 0.02 have been used for roads. Sub-catchment 2 represents all 100% impervious area, thus a manning 'n' of 0.015 have been used.
119	**Report**	Hyder AV	Cl 4.2.5	Table 4-11 & 4-13 states various Manning's values with corresponding %impervious values of 0% and 100%, but in general states Manning's as 0.025 for 0% impervious and 0.015 for 100% impervious. These values stated do not match up with the values stated in table 4-3, which indicate Manning's as 0.04 for 0% impervious and 0.02 for 100% impervious Please explain why the values stated differ or amend.	Same as above
120	**Report**	Hyder AV	Cl 4.2.6	Table 4-19 & 4-21 states various Manning's values with corresponding %impervious values of 0% and 100%. These values stated do not match up with the values stated in table 4-3, which indicate Manning's as 0.04 for 0% impervious and 0.02 for 100% impervious Please explain why the values stated differ or amend.	Same as above

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR200
Title: Redbank - Drainage - Transverse Drainage
Stage: Zone 2
Issue: 15% design

Alliance Verifier:
Date Distributed:
Date Compiled:
Date of Comments:

Ref No	Item	Reviewer	Reference	Reviewer Comment	Designer Comment
121	**Report**	Hyder AV	Cl 4.2.7	Table 4-27 & 4-29 states Manning's as 0.03 for 0% impervious and 0.015 for 100% impervious. These values stated do not match up with the values stated in table 4-3, which indicate Manning's as 0.04 for 0% impervious and 0.02 for 100% impervious Please explain why the values stated differ or amend.	Same as above
122	**Report**	Hyder AV	Cl 4.2.8	Table 4-32 & 4-34 states various Manning's values with corresponding %impervious values of 0% and 100%. These values stated do not match up with the values stated in table 4-3, which indicate Manning's as 0.04 for 0% impervious and 0.02 for 100% impervious Please explain why the values stated differ or amend.	Same as above
123	**Report**	Hyder AV	Cl 4.2.9	Table 4-41 & 4-43 states various Manning's values with corresponding %impervious values of 0% and 100%. These values stated do not match up with the values stated in table 4-3, which indicate Manning's as 0.04 for 0% impervious and 0.02 for 100% impervious Please explain why the values stated differ or amend.	Same as above
124	**Report**	Hyder AV	Cl 4.2.11	Why is Manning's stated as 0.0 for a number of the catchment areas in table 4-47? Also table 4-47 & 4-49 states various Manning's values with corresponding %impervious values of 0% and 100%. These values stated do not match up with the values stated in table 4-3, which indicate Manning's as 0.04 for 0% impervious and 0.02 for 100% impervious Please explain why the values stated differ or amend appropriately.	Same as above
125	**Report**	Hyder AV	Cl 4.2.4	Table 4-5 refers to sub catchment numbers. This is not shown on the Catchment Plan Base plans, hence unable to check if areas and percentage pervious appear correct.	This has been incorporated in the 85% design drawings
126	**Report**	Hyder AV	Table 4-26	Table 4-26 indicates an increase in discharge velocity of 2.46m/s with a decreased flow of 1.42m3/s. Please confirm that this higher velocity could not be mitigated and clarify the decreased flow.	This has been addressed in the 85% design report.

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR206
Title: Detailed Design Report – Transverse Drainage Zone 2 (Other Culverts)
Stage: Zone 2
Issue: 85%

Alliance Verifier:
Date Distributed:
Date Compiled:
Hyder AV & Contact Details:

[redacted]

OA Designer & Contact Details:

Ref No	Reviewer	Reference	Verifier's Reviewer Comment	Alliance Designer Comment	Status - Originator Comments Internal Use Only
145	Hyder AV	Report - Section 4.2.4	The report identifies that C-SR100 is included in the zone 3 transverse drainage report. No details have been found in this report. There appears no reference to this culvert within the reference noted in this report. Please include the full details in section 4.2.4.	Zone 3 Transverse Drainage Report D2G-BASD-RIRODR300-R-1000, Section 4.2.4 Culvert C16500 describes the hydraulic model used for the entire catchment, with SR 100 outlet culvert crossing Mine St/ Collingwood Drive.	**Closed 17/12/09**
146	Hyder AV	Report - Section 4.2.4 and Appendix L	There are no SWMM details for this culvert provided in the Appendix including inlet capacities, system head losses, pipe losses and other details associated with the hydraulic capacity of the system. Please provide full hydraulic details for the culvert C-SR100 system.	Refer above report for the whole hydraulic model. All losses were determined in accordance with QUDM. Refer Appendix L for inlet capacities and pit head losses used in C-SR 100 RCBC culvert.	
146a			Refer to comments 100% 160 and 100% 166.	The flows for this culvert passes through Zones 2 and 3. The upper portion is in Zone 3 and he lower portion C-SR100 is in Zone 2. Refer to the zone 3 transverse package RIRODR300-R-1000 for full details of the Zone 3 portion. Full hydraulic details are provided for C-SR100 in Appendix L.	**Closed 22/12/09**
147	Hyder AV	Report - Section 4.2.5	There are no details regarding the PMF flows for the culvert. Please clarify why no flow assessment were completed for this event.	Design brief does not require PMF flows quantitatively. But, the escape route for higher flows were analysed and discussed in the report.	**Closed 17/12/09**
148	Hyder AV	Report - Section 4.2.6	The report compares the upgrade to a base case. However, the new road layout and drainage significantly alters the existing flow regime. Please confirm the level of the cul-de-sac head.	The ground elevation at the head of cul-de-sag is 14.60m, and the water level elevation at the culvert inlet for Q20 and Q100 are 12.74m and 12.95m respectively.	**Closed 17/12/09**
149	Hyder AV	Report - Section 4.2.6	There are no details regarding the PMF flows for the culvert. Please clarify why no flow assessment were completed for this event.	Design brief doesnot require PMF flows quantitatively. But, the escape route for higher flows were analysed and discussed in the report.	
149a			It appears no discussion details as per response added in report	Discussion on flows above Q100 has been added. Please refer to the discussion section of the Upgrade Culvert C-FS750.	**Closed 22/12/09**
150	Hyder AV	Report - Section 4.2.7	For inlet FS950A in both the 20 Yr and 100 Yr scenarios, the water level for the base case is higher than the upgrade despite greater inflows for the upgrade. Please clarify how the base scenario calculations were determined.	The invert level at the culvert inlet location has been lowered in the upgrade scenario in order to drop the water level elevations for both Q20 and Q100 events. The original ground elevation is El. 10.50m and the upgrade ground elevation is El. 9.40m	**Closed 17/12/09**
151	Hyder AV	Drawing - D-1034	There are no details of the swale/channel flowing into inlet FS750A. Please provide details.	The grassed channel has been designed with 1m deep, 1m wide and 1:2.5 and 1:4 batters at the right bank and left bank respectively	
151a			This does not match the details on the drawing.	The details given in ref. no 151 are for the outlet channel. The inlet channel has been designed as a grassed channel with 1m deep, 0.5m wide and 1:2 batter, and it is shown on the drawing D-1034.	**Closed 22/12/09**
152	Hyder AV	Drawing - D-1035	There are no details of the swale/channel flowing from outlet FS1250B. Please provide details.	The grassed channel has been designed with 1m deep, 1m wide and 1:3 and 1:2 batters at the right bank and left bank respectively	
152a			The drawing indicates both batters as 1:3. Please indicate both side slopes on the drawing.	The minimum batter of 1:2 is shown on the drawing D-1035. The batter slopes of the channel are specified in the design terrain model, which will be used for channel set outs.	**Closed 22/12/09**
153	Hyder AV	Appendix G	DMR comments. Comments have not been closed out. Please clarify the status of the comments.	Closed out	

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR206
Title: Detailed Design Report – Transverse Drainage Zone 2 (Other Culverts)
Stage: Zone 2
Issue: 85%

Alliance Verifier:
Date Distributed:
Date Compiled:
Hyder AV & Contact Details:

[redacted]

OA Designer & Contact Details:

Ref No	Reviewer	Reference	Verifier's Reviewer Comment	Alliance Designer Comment	Status - Originator Comments Internal Use Only
153a	-		Appendix G does not show that the comments have been closed out.	Closed out on 15/12/2005. A copy is attached in Appendix G.	**Closed 22/12/09**
154	Hyder AV	Appendix L	Results from XP-SWMM have been provided . Please provide details of the inputs (i.e. inlet capacities, pipe losses, pit head losses)	The XP-SWMM input details are included in the 100% design report. All losses were determined in accordance with QUDM. Refer Appendix L for inlet capacities and pit losses etc.	
154a			Appendix L shows the XP-SWMM model outputs and not the inputs. Please supply the inputs.	General inputs have been discussed within the design report and the transverse drainage design note (appendix to design criteria report). Where non-typical inputs have been adopted thay have been included in Appendix L. Inlet capacities are based on a typical entrance loss of 0.5 unless noted otherwise and field inlets are modelled as inlet weirs and are based on the pit dimensions with an allowance for 50% blockage. Please refer to comments 161.	**Closed 22/12/09 - It is strongly recommended that all INPUTS are provided in Appendix L as has been requested on a number of occassions**
155	Hyder AV	D2G-BASD-RERODR203-D-1029	See comment 160.	Due to environmental reasons (adjacent Indigenous Heritage Site), the road side batter has been designed at 1:2. This limits the land used for the drainage path.	**Closed 17/12/09**
156	Hyder AV	Section 8.3	It is noted that the outlet structure for C-SR100 is on hold, please clarify the status of the longitudinal drainage package.	Longitudinal drainage has been finalised now. A special outlet structure has been designed which incorporates the 2x 1800Wx900H RCBC's and 2x 900 dia. RCP longitudinal outlet pipes.	
156a			Drawing 1029 & Section 8.3 identify that this is still on hold. Longitudinal drainage is identified as 85%. Please clarify the status.	85% detailed design report for the longitudinal drainage package has been issued now. Longitudinal drainage is on hold in this transverse package. All drainage elements outside this package (Other Culverts) are on hold. The drawing 2121 has been included in the design package now. The headwall is not on hold but the longitudinal system is as this is an IFC package and any items that are not IFC must be on hold.	**Open 22/12/09**
156b			Updated report/drawings 2121 not provided	Drawing no. 2121 has been forwarded on 22/12/09	**CLOSED 23/12/09**
157	Hyder AV	Section 3	Non-compliance has been noted and is subject to DMR's approval	Non -compliance RFI-446 has been closed out	**Closed 17/12/09**

Opportunities for Improvement

1	Reviewer's Initials				

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Hyder

[illegible] [illegible]
[illegible] [illegible]
[illegible] [illegible]
[illegible] [illegible]

[illegible] [redacted]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]			[illegible]		[illegible]

Package: [redacted]
Title: [redacted]
Stage: [redacted]
Issue: [redacted]

Alliance Verifier: [redacted]
Date Distributed: [redacted]
Date Completed: [redacted]
Hyder IUF & Contact Details: [redacted]

Updated:
Updated:
QA Designer & Contact Details: [redacted]

Ref No	Reviewer	Reference	Verifier's Reviewer Comment	Alliance Designer Comment	Status - Designer Comments Internal Use Only
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR206
Title: Draft Final Design Report – Transverse Drainage Zone 2 (Other Culverts)
Stage: Zone 2
Issue: 100% (Draft IFC) Design

Alliance Verifier:
Date Distributed:
Date Compiled:
Hyder AV & Contact Details:

updated:
updated:
OA Designer & Contact Details:

Ref No	Reviewer	Reference	Verifier's Reviewer Comment	Alliance Designer Comment	Status - Originator Comments Internal Use Only
168	Hyder AV	D2G-BASD-RERODR203-D-1034 & D2G-BASD-RERODR203-D-2353	Pit 4/208A is on top of C-FS620. There does not appear to be a cross connection. Please clarify the clearance between the pit & pipe and include the location on the appropriate longsection/s.	There is no cross conection and the longitudinal drainage passes over the top of the transverse dralange system. The cover from the obvert of the transverse line to the invert of the longitudinal line is 1.3m.	Open 21/12/09

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR206
Title: Final Design Report - Drainage – Transverse Drainage Zone 2 (Other Culverts)
Stage: Zone 2
Issue: 100% - Draft IFC - Submission 02

Alliance Verifier:
Date Distributed:
Date Compiled:
IV Designer Contact Details:
[redacted]
OA Designer Contact Details:

Ref No	Reviewer	Reference	Verifier's Reviewer Comment	Category (Minor/ Moderate/ Major)	Alliance Designer Comment	Status - Originator Comments Internal Use Only
173	Hyder AV	D-2462, D-1034 & D-1035	The "culvert dimensions and inlet screen details" lists C-FS620 as a 750 mm diameter pipe & C-FS950 as 2100 mm diameter pipe. However D-1034 & D-1035 shows this pipes as multiple pipes (i.e. C-FS620 is a 2x750 mm diameter pipe). Further, the global drawing for inlet screen details (DGRODR100 -D-0084) includes a reference to "P", the culvert inlet width. However, this is not included in the inlet screens table. Please include the culvert inlet width dimension.	Moderate	The Table in drg. No RERODR203-D-2462 has been updated with the following figures: For the culvert C-FS620, P=2208mm. For the culvert C-FS950, P=8686mm.	[OB] Closed 30/03/10
174	Hyder AV	D-2354	The culvert length for SR 100 is shown as 42.054 m on the longitudinal section. This does not match the length nominated in Table 4-32 (48m). Please clarify the correct length for the culvert.	Minor	Typing error. The correct culvert length is 42.0m . It has beed corrected from 48.0m to 42.0m in the Table 4.2.	[OB] Closed 30/03/10
175		Section 5.1	Section outdated. Please amend	Minor	Section 5.1 revised and updated.	[OB] Closed 30/03/10
176		Section 8.3	It is noted that still two holds are present. Re-verification will be required to remove holds.	Minor	Hold1-Longitudinal drainage -not part of this package. It will be removed after the long. drainage package RERODR201 submitted for IFC. Hold 4- Culvert C-SR1250. Recent discussions with road designers indicated	[OB] Closed 30/03/10

Opportunities for Improvement

1	Reviewers Initials	General comment				
2	Reviewers Initials	General comment				

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: **RERODR206**
Title: Final Design Report - Drainage – Transverse Drainage Zone 2 (Other Culverts)
Stage: Zone 2
Issue: 100% - Draft IFC - Submission 03 - Hold Removal

Alliance Verifier:
Date Distributed:
Date Compiled:
IV Designer Name & Contact Details: [redacted]

OA Designer Name & Contact Details:

Ref No	Reviewer	Reference	Reviewer Comment	Cateory (Minor / Moderate / Major)	Designer Comment	Status - Originator Comments Internal Use Only
	Hyder AV		As discussed with the Alliance designer today and we have been made aware of the following changes: 1. Culvert CS1250 (north Brisbane Terrace) has been removed from the scope of works due to the finalisation of the limit of works. 2. The removal of aforementioned culvert has no impact on existing culverts. 3. No other changes have been made since IFC. Based on these information we don't have any further comments on this package.		n/a	Closed - OB - 21/05/2010

Opportunities for Improvement

1	Reviewers Initials	General comment				
2	Reviewers Initials	General comment				

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR206
Title: Final Design Report - Drainage – Transverse Drainage Zone 2 (Other Culverts)
Stage: Zone 2
Issue: 100% - Draft IFC - Submission 03 - Hold Removal

Alliance Verifier: [redacted]
Date Distributed:
Date Compiled:
IV Designer Name & Contact Details:

OA Designer Name & Contact Details:

Ref No	Reviewer	Reference	Reviewer Comment	Cateory (Minor / Moderate / Major)	Designer Comment	Status - Originator Comments Internal Use Only
	Hyder AV		As discussed with the Alliance designer today and we have been made aware of the following changes: 1. Culvert CS1250 (north Brisbane Terrace) has been removed from the scope of works due to the finalisation of the limit of works. 2. The removal of aforementioned culvert has no impact on existing culverts. 3. No other changes have been made since IFC. Based on these information we don't have any further comments on this package.		n/a	Closed - OB - 21/05/2010

Opportunities for Improvement

1	Reviewers Initials	General comment				
2	Reviewers Initials	General comment				

Ipswich Motorway Upgrade
Dinmore to Goodna Alliance Verification

Package: RERODR206
Title: Final Design Report - Drainage – Transverse Drainage Zone 2 (Other Culverts)
Stage: Zone 2
Issue: 100% - Draft IFC - Submission 04 - Design change

Alliance Verifier:
Date Distributed:
Date Compiled:
updated:
IV Designer Name & Contact Details:

[redacted]

OA Designer Name & Contact Details:

Ref No	Reviewer	Reference	Reviewer Comment	Category (Minor / Moderate / Major)	Designer Comment	Status - Originator Comments Internal Use Only
177	Hyder AV	Table 3-1	It is noted that RFI-674 has been raised with DMR in regards to the afflux & modelling at C-FS950. Closure of this comment will be subject to TMRs approval of this RFI.	Moderate	The RFI has been closed out.	**Closed - we recommend to liase with TMR to obtain their acceptance on the afflux values.**
178	Hyder AV	Appendix G	It is noted that DMR has not provided any comments on the resubmission. Please clarify DMR's comments on the increased afflux.	Major	DTMR have no further comments on the package	Closed - SE - 28/09/10
179	Hyder AV	Sec. 4.2.7 & Appendix H	It is noted that ICC requested the 50% blockage factor for C-FS950. No minutes have been provided. Further, please clarify if ICC has provided any comments on the updated upstream afflux.	Major	Icc has been sent the package and no further comments have been received.	Closed - SE - 28/09/10
180	Hyder AV	Table 4-28 & Appendix L	It is noted that the peak Q20 flow in Table 4-28 is 6.6 cumecs. Whilst Appendix L does not clearly identify the flow in the conduit C-FS950. Please clarify the flow in this link.	Moderate	This comment is under clear. Please confirm information you are requesting to be clarified or changed. It should be noted that the flows have not changed for the 20 year ARI, between this submission and the IFC submission. This revision is based on the assumptions made regarding the PMF event only	Closed - SE - 28/09/10

Opportunities for Improvement

1	Reviewers Initials	General comment				
2	Reviewers Initials	General comment				

Appendix G – DMR Comments and Closeout

[redacted]

From: [redacted]
Sent: Thursday, May 20, 2010 4:33 PM
To: [redacted]
Cc:
Subject: FW: DIFC No Comments - Various packages
Follow Up Flag: Follow up
Flag Status: Red

FYI

[redacted]
Assistant Project Manager
P [redacted]
F
E

OriginAlliance
Connecting Dinmore to Goodna

Chalk Street, Redbank Q 4301
PO BOX 505, Booval Business Centre Q 4304

Safe Work, Safe Travel, Safely Home

Think before you print, embrace the green office

From: [redacted]
Sent: Thursday, 20 May 2010 4:20 PM
To: [redacted]
Subject: DIFC No Comments - Various packages

Hi [redacted]

Please be advised TMR have not reviewed and/or have no comments on the following DIFC

packages:

GOSTBR142
RIRORF300
DIRORF400
DISTRW042
DGPUKS100
RISTRW037
RIRORF303
RERODR206

Kind regards,

[redacted]
Project Officer | Project Delivery - MR Projects
Major Infrastructure Projects Division | Department of Transport and Main Roads

Floor 1 | Redbank Origin Alliance Project Office | Lot 1 Chalk Street | Redbank Qld 4301
PO Box 70 | Spring Hill Qld 4004
P: [redacted]
E: [redacted]
W: www.tmr.qld.gov.au
Tomorrow's Queensland: strong, green, smart, healthy and fair – www.towardQ2.qld.gov.au
Please consider the environment before printing this email

[redacted]

From: [redacted]
Sent: Monday, September 27, 2010 5:26 PM
To: [redacted]
Cc:
Subject: FW: Draft IFC - RERODR206 - Design Change
Importance: High
Attachments: pic30382.gif

[redacted]

No DTMR comments on this package. We need to obtain closure to Hyder comments then we can issue as IFC.

Regards

[redacted]
Area Design Manager (East)

[redacted]

P [redacted]
M
F
E

Chalk Street, Redbank, Qld, 4301
P.O. Box 505, Booval Business Centre, Qld, 4304
Safe Work, Safe Travel, Safely Home

From: [redacted]
Sent: Monday, September 27, 2010 11:13 AM
To: [redacted]
Cc:
Subject: Re: Draft IFC - RERODR206 - Design Change
Importance: High

Please be advised TMR have no comment on this package.

Kind regards,

[redacted]
Project Officer | Project Delivery - MR Projects
Major Infrastructure Projects Division | Department of Transport and Main Roads

---

Floor 1 | Redbank Origin Alliance Project Office | Lot 1 Chalk Street | Redbank Qld 4301
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Tomorrow's Queensland: strong, green, smart, healthy and fair – www.towardQ2.qld.gov.au

OriginAlliance
Connecting Dinmore to Goodna

MAIN ROADS COMMENT & RESPONSE FORM

This form is used for Checks and Reviews. It is NOT used for Internal Verification

Design Lot No.	GEN:MR-MR#260	Zone	2	Design Stage	Detailed Design	Review Level:	Overall Compliance with PAA and SWTC
Description:	Detailed Design Report, Transverse Dranage – Zone 2, Other Culverts - Nimal						

Issue Reference No.	Notes by Reviewer			Notes by Designer in response	Close out
	Document No. (list specific drawing or page number)	Issues or observations (list adequate details to enable review)	Category (Major/minor observation)	Designer's response (ensure adequate details to enable acceptance)	Reviewer Acceptance (initial)
1.	D2G-BASED-RERODR206-R-1000	**Section 4.2.7 Upgrade Culvert C-FS950** Agreement with ICC needs at this location	Minor	ICC has agreed to the complete culvert design at this location	[redacted] 15/12/2009
2.					
3.					
4.					
5.					

Categories:
Major Issues: Develop Design Further – correction mandatory before completion of Stage (Close-out required)
Minor Issues: Correct and Close-out – correction mandatory before completion of Stage
Observations: are noted and work should be revised

[redacted] 15/12/09

OriginAlliance
Connecting Dinmore to Goodna

MAIN ROADS COMMENT & RESPONSE FORM

This form is used for Checks and Reviews. It is NOT used for Internal Verification

Design Lot No.	D2G-BASD-RERODR206-R-1000	Zone	2	Design Stage	85%	Review Level:	Overall Compliance with PAA and SWTC
Description:	Detailed Design Report – Transverse Drainage – Zone 2 - Other Culverts_DCW						

Issue Reference No.	Notes by Reviewer			Notes by Designer in response	Close out
	Document No. (list specific drawing or page number)	Issues or observations (list adequate details to enable review)	Category (Major/minor observation)	Designer's response (ensure adequate details to enable acceptance)	Reviewer Acceptance (initial)
1.	D2G-MP13-F-4080 Designers correspondence	Page 1. Zones should be 'Zone 2' not 'Zone 3'		Typing error. Corrected in 100% design report.	[redacted]
2.	DDR Page 51	Clause 6.3.1. 'pproposed' to be changed to 'proposed'.		Typing error. Corrected in 100% design report.	
3.	Drg 1029	1. Concerned that 2 x 750 dia pipes inlet at structure 11/212A yet outlet is only 1 x 750 dia. 2. Confirm that inlet pipes from structures 1/212D and 1/212E do not demand larger outlet pipe at structure 15/212A.		1. The drainage lines of concern have been revised and there is one pie into and out of the gully, this will be updated in future longitudinal design submissions. As this comment is not applicable to this design lot. 2. The lines 212D and 212E and 212A have been hydraulically modelled an are correct, please refer to the latest longitudinal design submission for information as this comment is not applicable to this design lot.	
4.	Drg 0142	Layout of Expected Levels of Mine Workings. More details and/or titles required on inset drawing following Drg 0142.		This drawing was attached in Appendix C as a reference drawing to indicate that culvert C-SR100 is not affected by the Mine Workings. Refer to Report D2G-BASD-DGMSIR102-R-1001 for further details.	
5.	Appendix L - XP-SWMM Outputs	1 in 20 year ARI Ultimate Scenario SWMM Results. Maximum velocity at catchment p C16500F1 is 8.74 m/s which has increased from base scenario velocity of 5.26 m/s. Ultimate velocity appears very excessive. Explanation required for increase. Have noted		Revised in the final (100%) report. The max. velocity in p C16500F1 is 3.06m/s in the base model and 2.92 m/s in the ultimate model. The max. velocity in pC16500C1 is 3.83m/s in the base model and 2.69 m/s in the ultimate model.	

[redacted] 15/12/09

Issue Reference No.	Notes by Reviewer			Notes by Designer in response	Close out
	Document No. (list specific drawing or page number)	Issues or observations (list adequate details to enable review)	Category (Major/minor observation)	Designer's response (ensure adequate details to enable acceptance)	Reviewer Acceptance (initial)
		that others such as pC16500C1 have also increased from base scenario. Concerned with scouring with extreme velocities.			

Categories:
Major Issues: Develop Design Further – correction mandatory before completion of Stage (Close-out required)
Minor Issues: Correct and Close-out – correction mandatory before completion of Stage
Observations: are noted and work should be revised

Appendix H – Third Party Reviews and Closeouts

Issue Reference No.	Notes by Reviewer			Notes by Designer in response	Close out
	Document No. (list specific drawing or page number)	Issues or observations (list adequate details to enable review)	Category (Major/minor observation)	Designer's response (ensure adequate details to enable acceptance)	Reviewer Acceptance (initial)
6.		**"Culverts"** typically drw 3003326-DD-TD-0056/2 & 62/2 • See comment above re. dispersive soils • Culverts with low head cf culvert depth - provide a suction relief point at/near entry • Nov 2008 storms showed that even very large culvert configurations blocked - many cases 50% - appropriate blockage factor needs to be applied along with suitable management of overflows. • Risk assessment required for exit control structure/behaviour • Placement of grates inlet /outlet subject to risk assessment (see QUDM 2007)		• Dispersive soils have been identified on site and where the proposed design has a potential detrimental effect to the existing conditions, appropriate geotechnical investigations and landscaping treatments will be applied to rectify the problem. • Noted but not applicable. • A blockage factor of 50% was adapted to the C-FS950 culvert. Please refer the report for details. • During the modelling process, an assessment of the outlet flows was performed and no conditions warranted any risk assessment or additional mitigation measures. • A QUDM analysis has been performed for culvert inlet screens. Details in report.	[redacted]

Categories:
Major Issues: Develop Design Further – correction mandatory before completion of Stage (Close-out required)
Minor issues: Correct and Close-out – correction mandatory before completion of Stage
Observations: are noted and work should be revised

21/12/09

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Connecting Dinmore to Goodna

DESIGN COMMENT AND RESPONSE (DCR) D2G-MP13-F-4033

This form is used for Checks and Reviews. It is NOT used for Internal Verification

DRR No.	xxx	Section:	Zone 2	Design Lot No.	D2G-BASD-RERODR206-R-206	Review Level:	ICC REVIEW
Description:	Transverse Drainage Zone 2- Other Culverts						

Issue Reference No.	Notes by Reviewer			Notes by Designer in response	Close out
	Document No. (list specific drawing or page number)	Issues or observations (list adequate details to enable review)	Category (Major/minor observation)	Designer's response (ensure adequate details to enable acceptance)	Reviewer Acceptance (initial)
1.		Upstream/downstream adverse effects should be advised. Modelling should be undertaken to determine whether there are substantive adverse effects and/or whether the adverse effects are from motorway or pre-existing; where adverse effects from motorway are expected, ICC would expect to be advised of adverse effects and reasons why they cannot be attenuated/remediated.		Our models take into account upstream and downstream water levels, flows and velocities in order to zero-in and minimise any adverse effect that the motorway upgrade has. The report contains this information.	[redacted]
2.		Road surface flows designed in accordance with brief. The lateral cross/longitudinal drainage must be able to remove enough water to meet the 100 year requirements.		All motorway culverts have been designed to fully convey Q100 flows. Road surface flows are dealt with in longitudinal drainage design. All local roads were designed to 20yr ARI immunity (i.e. Q20 flows).	
3.		Alignment of drainage at corner Collingwood Drive/Smiths Road questioned, under consideration of change.		Transverse culvert design (C-SR100) and the outlet drainage have been discussed in the report D2G-BASD-RERODR206-R-1000.	
4.		The two separate and adjacent Water Quality ponds on Goodna Creek culvert under review.		Not dealt with in this design lot.	
5.		Noted that blockage factor of only 20% was used; DMR based requirement. Consequences/ sensitivity of blockage should be analysed and advice included in the design report.		There is no guidance in RDDM as to required level of blockage. We have adopted 20% based on similar projects. 20% blockage is applied in base and upgrade scenarios therefore afflux issues should be consistent regardless of what blockage is applied. A blockage factor of 50% was adapted to the C-FS950 culvert as requested by ICC.	

Appendix I – Community Requirements Checklist

Community Issues and concerns

Zone	Area/Street/Issue	Stakeholder	Impact/ weighting	Issues	Mitigation measures
2	Traffic Impacts on safety and amenity of Smiths Rd	Goodna residents who currently use Stuart Street on and off ramps	H	1. Concerned that Smiths Road extension will not be opened before Stuart Street on and off ramps are permanently closed - this will severely limit their travel movements if an alternative is not in place. 2. Residents are concerned about the speed of motorists travelling along Smiths Road and are constantly asking if there will be traffic lights connecting between the old section and into the new extension of the road.	Intention is that Williams St ramp intersection is open before Stuart St connection is closed. ICC suggested at meeting held 10 June 09 that Stuart/Smith intersection signalisation may not now be funded by them, and that they are considering signalisation of Smith/William and /or Smith/Albert in Bcu. Issue will need to be clarified following receipt of pending letter from ICC re their funding contribution. Signalisation of Smith/Stuart Street intersection is confirmed, subject to resolution of Smith Road funding. Ongoing community engagement.
2	Traffic Impacts on safety and amenity of Smiths Rd	Local resident	L	Increased traffic, accidents & vehicle speed on Smiths Road.	Signalisation of Smith/Stuart Street intersection will contribute to traffic management in Smith Road.
2	Access to Sport Complex	ICC officers	L	Access arrangements of Mine Street	Meeting held with ICC 10 June 09 included discussion on access to Sports complex from Smiths Road. Ongoing consultation with ICC and sporting complex.
3&4	Traffic Impacts on safety and amenity of Southern Service Road	Local resident	M	Noise barriers along the Service Road in Riverview be increased to match increased elevation of bridges.	Confirm strategy for advising the community of the final placement of noise barriers.
1	[illegible]	[illegible]	M	[illegible]	[illegible] CLOSED
3	Proximity of Construction Works	Local resident (x2)	L	Traffic volumes on Brisbane Road	Concerns will be addressed by ongoing community engagement. No need for specific response.
3&4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] CLOSED
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] CLOSED
2	[illegible]	[illegible]	M	[illegible]	[illegible] CLOSED
2	Alignment of Monash Road	QR	M	Alignment of Monash Road and associated property impacts	Design being developed to confirm extent of splay required at SE corner of QR land.
2	Alignment of Monash Road	Units	M	Alignment of Monash Road and associated property impacts	Design options being considered for the affected tennis court which will either be re-oriented N-S or a retaining wall constructed. Ongoing consultation.
1	[illegible]	QR	H	[illegible]	[illegible] CLOSED
1	Staging of Pedestrian Access to Goodna Station	Pedestrians / local elected reps	H	Concerned about the demolition of BR140 before the completion of the new pedestrian bridge - potentially utilising bus service during construction could be drawn out because of length of time between operational bridges	Construction team current position is to closely match the programs for demolition of old and opening of new. Any gap will be addressed by temporary use of buses.
1	Safe access to the motorway	Local Goodna residents	L	Local Goodna residents do not believe closing Stuart Street (which is considered a safe and long ramp) to be a good idea. However most are appeased with the Smiths Road extention alternative	Concern is addressed by program decision to open Williams st connection before Stuart St is closed. The situation would be further improved by opening of Smiths Rd but timing/funding is uncertain.
3	[illegible]	[illegible]	H	[illegible]	[illegible] CLOSED
1	Traffic Congestion at Williams Street	Goodna local residents Vivienne Stanbury (Goodna RSL)	L	Are concerned that by opening William Streat access to the motorway, the on ramp will not be able to cope with increased traffic and are concerned it will cause congestion in front of the Caltex service station and McDonalds. Residents believe there will be an increased traffic volume at the Church Street / Queen Street roundabout intersection that is already very congested after the closure of Stuart Street, as more local residents will be forced to use this access point to get onto the motorway	Based on the traffic modelling and analysis completed for the William Street/Southern Service Road left-in /left-out type priority intersection, the traffic operations based on the predicted traffic volumes at "day of opening" are adequate and indicate that the predicted delay and queue for the traffic accessing the westbound entry ramp will be minimal. Although there will be an overall increase in traffic volumes at Church Street (at year of opening compared to current volumes), traffic wishing to access the motorway in the westbound direction can utilise the William Street connection to the Church Street westbound entry ramp (i.e. do not need to access the motorway in the westbound direction via the roundabout). Traffic exiting the motorway in the westbound direction will need to exit back at the Ipswich/ Logan Motorway Interchange and use the Southern Service Road for accessing Church Street roundabout. However, there are also alternative routes available if they do not wish to travel through the roundabout.
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] CLOSED

Community issues and concerns

Zone	Area/Street/Issue	Stakeholder	Impact/ weighting	Issues	Mitigation measures
2	Traffic congestion due to ramp closures	Local resident	L	Riverview resident believes there will be an increased traffic volume at the Mine Street intersection and it will become similar to Church Street / Queen Street roundabout intersection at Goodna that is already very congested, as more local residents will be forced to use this access point to get onto the motorway	Based on the traffic modelling and analysis completed for the two ramp junctions at Mine street, the intersections will operate with a suitable level of service at "day of opening. The key traffic signals along the Mine Street corridor will be coordinated to minimise the delay and queue lengths for the key movements along this corridor.
[illegible]	[illegible]	[illegible]	L	[illegible]	[illegible] Item CLOSED
[illegible]	[illegible]	[illegible]	L	[illegible]	[illegible] Item CLOSED
3	Dust concern at Redbank School	Rodbank School	H	Concern over dust impacts from construction	Ongoing consultation with the school has resulted in installation of air conditioning units, increased use of water carts, and applying additives to water used for dust suppression. Letter sent to school about mitigation of dust impacts. Not a design issue.
3	Vehicle access to Riverview	Mayor Paul Pisasale	L	Very supportive of project. Wants a design Entry Statement into Ipswich	Consultation ongoing with ICC re use of BR450 and adjacent retaining walls as entery statement.
2	Vehicle Access from Smiths Road	[redacted]	L	Smiths Road - concerns about residents needing to do a left turn into the Christian College.	A left turn from Smith's Road onto Bellevue Road has been provided.
1	[illegible]	[illegible]	H	[illegible]	[illegible]
	Vehicle access to Riverview	[redacted]	L	1. Traffic impacts where Southern Service Road goes into Law Street. 2. Traffic impacts at intersection of Law Street and Collingwood Drive dua to connection of Southern Service Road to Law Street 3. Issues with residents access to Southern Service Road.	Ongoing community engagement
3	Traffic Congestion et Mine St	[redacted]	M	1. Limited Riverview access 2. Concerned that Northern Service Road does not extend to River Road. Council would like this for commercial access. Have suggested a 1-way ramp off Brisbane Road	Ongoing community engagement. Inclusion of a service road access from River Road would require demolition of existing Warrego Highway bridge which is planned to be retained and would result in substandard geometric design. Follow up with briefings for local member(s) and councilors.
4	Monuments at Dinmore Park	Cr Trevor Nardi Cr Victor Attwood Dinmore Neighbourhood Watch Dinmore Primary School Cr Trevor Nardi's community group	M	Concerned about the exisiting monument stone, loss of green space. Removal of remaining monuments at Dinmore Primary School and placement at Dinmore Park with the monument stone.	Meeting held with ICC and Cr Trevor Nardi. Meeting needs to be organised for consultation with immediate stakeholders.
3	Design of school oval	Redbank School	H	Concern by the school that the existing alignment of the school oval is encouraging children to kick the ball onto the motorway.	Meeting to be held with Redbank Primary School on Monday 5 October. At this meeting will be discussed the finalisation of the oval, mitigation for stopping balls entering the motorway. Letter to be sent to Queensland Education on the agreed outcome of meeting.
4	Numerous	[redacted]	L	1. Pedestrian overpass at St Peter Claver College 2. Would like old motorway to remain four lanes from site office area east. 3. Wants ramp to remain into Brisbane Road (north side) going east.	Ongoing community engagement
	Noise barrier extents	Redbank School	L	Need to consider where the Law Street ped bridge will land and how students enter the school	Ongoing consultation with school with development of design to accommodate agreed outcomes.
All	Location of noise walls with respect to property boundaries.	Community DMR ICC	M	Where noise walls are to be constructed on the boundary of an existing property there is an issue regarding location of the wall. Whilst the posts and panels may be located close to the boundary the footings are larger and also need to be considered. A noise fence on the actual boundary alignment would mean that part of the footings encroach into private property, whereas if the footings are placed outside the beundary then the wall impinges on the road reserve (very narrow in places) and also creates a remnant portion of crown land excised by the wall. Maintenance access to the rear of the wall (for inspection or repairs) must also be considered.	Generally noise walls are located clear of a property boundary and where required, a Type 2B open channel for surface drainage will be installed between the noise wall and property fence.
2	Concerned about visibility during construction	Charlton's Bait and Tackle shop	L	Business owner is concerned about visibility of his business being obstructed during construction. Also concerned that new noise walls will be constructed as part of the project that are not currently there. Had significant influence in the community (also politically) in the past and should be managed carefully.	Community engagement team currently preparing for initial consultation with property owners potentially impacted by noise walls proposed on existing boundaries.
1	Noise wall provision during construction	Businesses and Goodna State School	L	1. Demolition and construction of replacement noise wall (parallel to Barram Street and up to Goodna State School 2. Noise issues during construction during school hours, but main issue will be the timing of the removal of the old noise wall and the period prior to construction of replacement	Being followed up by Construction team in conjunction with Comms team. No concerns - business as usual.
2	Noise wall provision during construction	Residents and properties that back along Enfield Street that back onto Francis Street on ramp		1. Relocation of noise wall along Francis Street - may be an issue during the removal of old noise wall and construction of its replacement. 2. Relocation of "mural" noise wall is of personal interest to JoAnne Miller - there is the expectation this will be temporarily removed and replaced in same condition	Community engagement team currently preparing for initial consultation with property owners potentially impacted by noise walls proposed on existing boundaries.

Community Issues and concerns					
Zone	**Area/Street/Issue**	**Stakeholder**	**Impact/ weighting**	**Issues**	**Mitigation measures**
1	Parking provisions & street arangements Permanent noise walls	Hinton Street residents	L	1. Have been promised by former DMR Minister that there will be no impact to their properties as a result of the project. 2. Are aware that local road will be upgraded with access not being affected. 3. There may also be issues during the removal of the old noise wall and construction of its replacement. 4. Is any parking being removed? 5. They need to be consulted re the proposed noise walls	Following up drainage design to quantify impacts on private property (afflux). Will require signoff to any non-conformance with the brief (ICC via DMR). Alternatively, the two affected properties could be resumed. To be followed up. Parking and access to properties has been assessed. It has been proven that vehicles can access driveways from Hinton St. Whilst there is no designated on-street parking it is possible for residents to access their properties even if vehicles are parked in the street provided that at least one lane remains clear. Comms team currently preparing for initial consultation with property owners potentially impacted by noise walls proposed on existing boundaries.
1	Noise wall provision during construction	Hinton Street residents	L	1. Have been promised by former Main Roads Minister that there will be no impact to their properties as a result of the project. 2. Are aware that local road will be upgraded with access not being affected. 3. There may also be issues during the removal of the old noise wall and construction of its replacement. 4. Is any parking being removed? 5. They need to be consulted re the proposed noise walls	Comms team currently preparing for initial consultation with property owners potentially impacted by noise walls proposed on existing boundaries.
1	Impact of M'way construction on construction of stadium	Goodna State School	L	Goodna State School will be receiving a $2m grant from Dept of Education to contruct an indoor stadium. They are concerned about the construction of this facility at the same time as the motorway upgrade and the uncertainty of the impact to the school from the project over the coming years.	Construction team request that Comms team ask the school to nominate their construction access location so that it can be built into TCPs. Comms team to follow up.
All	ICC liaison	ICC	M	1. Establishing ongoing point of contact 2. Selection of design standards (can/should local government standards be adopted in lieu of DMR?) 3. Identification of assets to be transferred to ICC on completion ("Limit of Responsibility" map, usually produced by DMR).Need to identify reliable and appropriately authorised ICC point of contact for ongoing liaison.	Identified issues being followed up. ICC is sharing funding for Smiths Rd extension and will also be adopting significant assets delivered by the project overall. ICC typical details and standards to be used where appropriate. ICC to appoint Liaison Officer as primary point of contact for project. Pat Dennehy to be approached re identification of assets for handover.
1	Vehicle access during construction	Caltex / Hungry Jack's / Mc Donalds / Car Wash	L	1. Concerned about access to these businesses during completion of Brisbane Rd on ramp at Goodna. 2. There may be a need to place a pit / storage facility on Caltex land which could be costly, either through a lease or partial resumption 3. Potential connection of motorway transverse drainage into existing water quality pond within private property	Options for motorway transverse drain being considered with intention of avoiding works within private property (associated with connecting to existing water quality/detention pond). Designers considering upgrading motorway footprint section only, or justification for leaving existing culverts untouched (cf 100yr design life requirement). Case to be developed for submission to DMR (Derek Millar).
4	[illegible]	[illegible]	L	[illegible]	[illegible]
4	Entry statement	Acinl	M	Concerned about impacts of construction on their lab testing work. Need at least 8 weeks notice of works. Additional concerns regarding access and car parking.	Main concerns addressed. Greg Wilson to follow up compensation aspect.
4	Reduced access	Local resident	L	Access from Riverview to Warrego Highway	Ongoing community engagement. Designers to advise Comms team of outcome of design considerations. Follow up with briefings for local member(s) and councillors.
4		QR	L	Very long lead times for approvals. Currently re-designing Dinmore carpark - need to engage with community. Need to finalise Woogaroo St funding from DMR	Details of future Dinmore carpark to be inserted into drawings to avoid clash with future carpark formations and roads. Community Team to discuss with QR regarding community engagement requirements
3	Construction Impacts	Redbank School	H	Concerned about construction staging, noise, disruption.	Ongoing community engagement.

Appendix J – Value Engineering Outputs

IPSWICH MOTORWAY UPGRADE
DINMORE TO GOODNA

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Drainage
Action List

[redacted]

Givens

No.	Description	Evaluation 1	Action By	Due Date	Comment
1	Standard precast components (maximised use) and standard types	Yes			
2	Q100 on the motorway, Q20 service roads (target and Q10 minimum)	Yes			
3	Q2 for temporary surface drainage (pavement)	CH *	[redacted]	21/11/2008	
4	Cross drainage during construction is no worse than existing	Yes			
5	40,000l spill capture at every discharge point	CH		21/11/2008	Water Quality report under discussion
6	Zero afflux at boundaries	CH		28/11/2008	Discussed with ICC. Some allowance for afflux acceptable
7	Main roads drainage specifications	Yes			
8	EPA water requirements for discharge	CH		21/11/2008	Water Quality report under discussion
9	Can't increase flows for downstream systems	CH		28/11/2008	
10	Q100 for QR embankments	Yes			

Assumptions

No.	Description	Evaluation 1	Action By	Due Date	Comment
1	Predominantly gravity except where least cost outcome is pumping system	OK			
2	Staging is fully considered and cross and longitudinal drainage can be maintained during construction	OK			
3	Goodna Ck will be rehabilitated	CH	[redacted]	28/11/2008	Goodna Creek will be re-instated
4	Can't reuse existing culverts	CH		21/11/2008	RFI returned to confirm this
5	New culverts will be in same location (assumes 4)	CH		21/11/2008	Nre culverts will be at or close to existing location, depending on conflicts
6	New culverts will be in same location (staging or construction reason)	CH		21/11/2008	Staging to be considered
7	During construction water will be treated to normal temporary processes (ERSC)	OK			
8	All roads need runoff treatment	CH		21/11/2008	Motorway drainage requries treatment. Local roads do not
9	DMR standards apply to both local and services roads	CH		28/11/2008	
10	Flooded width to accommodate skinny eight	OK			Road drainage undertaken for ultimate lane configuration
11	Extent of flooded width into traffic lane in ultimate configuration (1.2m assumed to date)	CH		28/11/2008	Road drainage undertaken for ultimate lane configuration
12	All future works is included in hydraulic analysis	CH		21/11/2008	
13	Use existing hydrology from ICC and BCC (	OK			
14	Model the PMF for cross drainage structures (RFI submitted)	CH		28/11/2008	RFI returned. PMF will be modelled
15	Bridge drainage will be Q20	CH		28/11/2008	
16	Capture shared path off the bridges	CH		28/11/2008	
17	Flows will increase with development upstream (effects some areas)	OK			
18	Permanent transverse drainage has to be installed to allow earthworks	CH		28/11/2008	15% transverse concept design report due Xmas 08
19	Modelling is based on adequate and accurate survey (continuing updates happening)	OK			

Zone 1 and 2

No.	Description	Evaluation 1	Action By	Due Date	Comment
	Can we.....(by).....				
14	**Zone 2**				
15	Use existing C4 culverts (check vertical of motorway)	P1	[redacted]	28/11/2008	
16	Remove humeceptors at northern service road because it comes from local roads (DMR) (Check ICC objectives(	P1		28/11/2008	
17	Adopts swales where guardrails used on local roads (footpath will have kerb and channel)	P1		28/11/2008	
18	Use scuppers to break the concrete barrier and capture in swales to treat water? (need to check brief)	P1		28/11/2008	
19	Remove the need for pipes across the structure by adding additional need for treatment	P2		5/12/2008	
20	Use the area between west off ramps & motorway to locate with treatment to prevent pipes over bridge	P2		5/12/2008	
21	Increase the flow width capability on local roads	P1		28/11/2008	
22	Use Acco drains where longitudinal levels suit for construction staging	P1		28/11/2008	
23	Use Acco drains where longitudinal levels suit for permanent	P1		28/11/2008	
24	Reuse culvert C8 and C10	P1		28/11/2008	

Appendix K – SIDR Outputs

"SAFETY IN DESIGN" RISK SCHEDULE

Applicable Design Lot: RERODR206

Note: Parts of the SIDR highlighted in grey have been added after the original workshop date

[redacted]

Design Package: Zone 2 Transverse Drainage - Other Culverts

Project Name: Ipswich Motorway Upgrade – Dinmore to Goodna

Date: 21 May 2009 / 09 July 2009 / 21 July 2009

S.I.D. Report No: SIDR#16

Zone 1 – 21/07/2009	Zone 2/3 – 21/05/2009	Zone 4 – 21/07/2009	Zone 4 Basin – 09/07/2009

[redacted]

	Consequence				How Likely is it to Occur?				
Rating	Safety	Environment	Quality	Community	Almost Certain (A) Expected in most circumstances	Likely (L) Will probably occur in most circumstances	Possible (P) Might occur at some time	Unlikely (U) Could occur at any time	Rare (R) May occur, only in exceptional circumstances
5	Catastrophic (Death/Permanent Injury)	Environmental Disaster	Huge financial loss (> $100k)	Adverse national media or public attention	9 A	8 A	7 A	6 H	5 H
4	Major (Extensive Injuries) (Major Plant Damage)	Environmental Harm (Loss of Protection)	Major financial loss ($50k - $100k)	Attention from media or heightened concern from the community	8 A	7 A	6 H	5 H	4 M
3	Moderate (Medical Treatment) (Minor Plant Damage)	Environmental Nuisance (Spill contained with outside help)	Moderate financial loss ($5k - $50k)	Local public or media attention and complaints	7 A	6 H	5 H	4 M	3 L
2	Minor (First Aid Treatment)	Insignificant Event (Spill contained by site)	Minor financial loss (< $5k)	Public concern limited to complaints	6 H	5 H	4 M	3 L	2 L
1	Insignificant (No Injuries)	No environmental impact	No financial loss	No complaints or concerns	5 H	4 M	3 L	2 L	1 N

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

Date: 21 May 2009 / 09 July 2009 / 21 July 2009 **S.I.D. Report No:** SIDR#16

No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
Construction and Demolition – Risk Assessment (CHAIR 2)						
1.0	ZONE 3					
1.1	**Construction of drainage crossing of IM East of Endeavour Rd**	• Damage to existing buried 1050mm dia. drain o Struck by plant o Struck by jacking pipes	5H	• Develop Integrated Work Method Statement (includes Permit To Excavate)	3L	Construction
1.2	**Retaining Wall / Drainage interface**	• Introduction of constant water path to retaining structure o Potential for retaining wall failure due to erosion	6H	• Retaining wall solution to link to drainage requirements	4M	Design, Construction
1.3	**Construction of drainage crossing IM West of Mine St underpass (BR280/285)**	• Proximity to traffic o Struck by vehicle o Struck by object	7A	• Develop Integrated Work Method Statement • Investigate alternative option to dual 1050mm dia., e.g. single 1650mm dia. to reduce boring length and construction time (hence exposure)	3L	Design, Construction
		• Location of cast-in-place chamber on service road ramp (proximity to traffic) o Struck by vehicle o Struck by object	7A	• Develop Integrated Work Method Statement • Investigate relocating chamber out of road way (South side)	3L	Design, Construction

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

Date: 21 May 2009 / 09 July 2009 / 21 July 2009 **S.I.D. Report No:** SIDR#16

No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
		• Proximity of manhole to northern IM retaining wall and traffic o Struck by vehicle o Struck by object	7A	• Investigate manhole configuration to north of motorway – from 3 no. to 2 no. • Investigate options to remove the need for manhole against retaining wall • Develop Integrated Work Method Statement	3L	Design, Construction
1.4	**Construction of channel drain over buried gas pipe**	• Working in/adjacent gas pipe exclusion zone o Struck by plant o Damage to infrastructure o Explosion / ignition	7A	• Develop Integrated Work Method Statement • Install protection slab over gas main incorporated into works • Confirm that channel works consistent with protection slab	3L	Construction
1.5	**Cross drain along Endeavour Rd to cross QR**	• Proximity to traffic o Struck by vehicle o Struck by object	7A	• Investigate alternative route for crossing rail corridor: o Thrust/jack from council land on south through to Moggill Ferry Rd (Eastern side of Endeavour Rd) • Develop Integrated Work Method Statement	3L	Design, Construction
		• Cranage and lifting underneath QR bridge o Struck by vehicle o Struck by object o Electrification	7A	• Carry out under a QR SCA (Safety Clarification Advice)	4M	Construction

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No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
		• Excavation under QR bridge o Potential for undermining of bridge abutments o Conflict with existing buried services under bridge	7A	• Develop Integrated Work Method Statement (includes Permit To Excavate)	4M	Construction
1.6	**Construction of Longitudinal Drainage**	• Working adjacent traffic: o Construction of pipe work and pits o Installation of water quality devices o Public entering open excavations	7A	• Develop Integrated Work Method Statements • Develop and implement Traffic Control Plans as required • Review construction of permanent exclusion fencing prior to drainage works where practical • Fence off construction works securely	3L	Construction
		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Electrocution o Open excavations within/adjacent the rail corridor o Public access to rail corridor o Personnel safety	7A	• Develop Integrated Work Method Statements • Carry out work under a QR SCA (Safety Clarification Advice) or closure if required • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Construction

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2.0	ZONE 2					
2.1	**Construction of Monash Rd**	• Potential dam effect between Monash Rd and adjacent housing estate during significant rain event o Damage to property o Drowning	7A	• Investigate drainage capacity / high flow culverts	3L	Design
2.2	**Construction of culverts adjacent housing and motorway**	• Localised flooding at upstream side of key culverts o Damage to property o Drowning	7A	• Consider over-sizing of key culverts to provide additional flood protection to residents	3L	Design
2.3	**Construction of Smiths Rd**	• Working within power easement o Electrification	7A	• Compliance with asset owner requirements regarding encroachment and exclusion zones • Develop Integrated Work Method Statement	3L	Construction
		• Working in UXO clearance area o Explosion	6H	• Develop Integrated Work Method Statement (incorporate UXO precautions)	3L	Construction

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2.4	**Construction of drainage adjacent the rail corridor**	• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Construction of chamber at tie in to existing QR culvert and potential undermining of rail embankment, tracks and other infrastructure o Electrocution o Public access to rail corridor	7A	• Develop Integrated work Method Statements • Carry out under a QR SCA (Safety Clarification Advice) or closure if required • Review design to utilise the existing upstream headwall as part of the new tie in chamber, or join the existing to new to minimise risk of undermining the rail formation • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Design, Construction
2.5	**Retaining Wall / Drainage interface**	• Introduction of constant water path to retaining structure o Potential for retaining wall failure due to erosion	6H	• Retaining wall solution to link to drainage requirements	4M	Design, Construction
2.6	**Construction of Longitudinal Drainage**	• Working adjacent traffic: o Construction of pipe work and pits o Installation of water quality devices o Public entering open excavations	7A	• Develop Integrated Work Method Statements • Develop and implement Traffic Control Plans as required • Review construction of permanent exclusion fencing prior to drainage works where practical • Fence off construction works securely	3L	Construction

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		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Electrocution o Open excavations within/adjacent the rail corridor o Public access to rail corridor o Personnel safety	7A	• Develop Integrated Work Method Statements • Carry out work under a QR SCA (Safety Clarification Advice) or closure if required • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Construction
3.0	ZONE 1					
3.1	Construct culverts around Church St	• Damage to existing services: o Telstra, power, sewer, signalling	7A	• Develop an Integrated Work Method Statement • Undertake potholing to prove service locations to incorporate during design, and construction	3L	Design, Construction
		• Working adjacent traffic: o Construction of pipe work and pits (large in size) o Installation of water quality devices	7A	• Develop and implement a Traffic Control Plan • Develop an Integrated Work Method Statement • Use precast structures to minimise time excavations are open as much as practical	3L	Design, Construction

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		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Electrocution o Public access to rail corridor o Personnel safety	7A	• Develop Integrated work Method Statements • Carry out work under a QR SCA (Safety Clarification Advice) or closure if required • Review design to utilise the existing upstream headwall as part of the new tie in chamber, or join the existing to new to minimise risk of undermining the rail formation • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Design, Construction
		• Access to pipes after construction o Public safety around outlets (CPTED) o Public safety during storm events	6H	• Investigate the use of screw or lock down grates • Review use of personnel exclusion fencing around inlets/outlets verses screens to structures	4M	Design, Construction
3.2	**Construct culverts around William St**	• Working adjacent traffic: o Construction of pipe work and pits (large in size) o Potential flooding issues during construction due to closure of existing open channel o Public access to open excavations	7A	• Use precast pits to minimise time excavations are open as much as practical • Develop Integrated Work Method Statements • Develop and implement Traffic Control Plans as required • Review construction of permanent exclusion fencing prior to drainage works where practical • Fence off construction works securely	3L	Design, Construction

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		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Construction of chamber at tie in to existing QR culvert and potential undermining of rail embankment, tracks and other infrastructure o Electrocution o Public access to rail corridor	7A	• Develop Integrated work Method Statements • Carry out under a QR SCA (Safety Clarification Advice) or closure if required • Review design to utilise the existing upstream headwall as part of the new tie in chamber, or join the existing to new to minimise risk of undermining the rail formation • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Design, Construction
		• Damage to culverts during installation of subsequent works: o Construction of TL5 pile foundation could clash with and damage new culvert	6H	• Review as built information as part of Integrated Work Method Statement	3L	Construction
		• Access to pipes after construction o Public safety around outlets (CPTED) o Public safety during storm events	6H	• Investigate the use of screw or lock down grates • Review use of personnel exclusion fencing around inlets/outlets verses screens to structures	4M	Design, Construction

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3.3	**Construct culvert 3 at the eastern end of Hinton St**	• Working adjacent traffic: o Construction of pipe work and pits (large in size) o Installation of water quality devices o Public access to open excavations	7A	• Use precast pits to minimise time excavations are open • Develop Integrated Work Method Statements • Develop and implement Traffic Control Plans as required • Review construction of permanent exclusion fencing prior to drainage works where practical • Fence off construction works securely	3L	Design, Construction
		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Construction of chamber at tie in to existing QR culvert and potential undermining of rail embankment, tracks and other infrastructure o Electrocution o Public access to rail corridor	7A	• Develop Integrated Work Method Statements • Carry out under a QR SCA (Safety Clarification Advice) or closure if required • Review design to utilise the existing upstream headwall as part of the new tie in chamber, or join the existing to new to minimise risk of undermining the rail formation • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Design, Construction
		• Working adjacent Goodna State School o Public entering open excavations o Public entering culverts	6H	• Securely fence work areas to prevent public accessing worksites • Review permanent protection to culverts to prevent public from accessing pipes	4M	Design, Construction

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		• Damage to culverts during installation of subsequent works: o Construction of TL5 pile foundation could clash with and damage new culvert	5H	• Review as built information as part of Integrated Work Method Statement	3L	Construction
		• Access to pipes after construction o Public safety around outlets (CPTED) o Public safety during storm events	6H	• Investigate the use of screw or lock down grates • Review use of personnel exclusion fencing around inlets/outlets verses screens to structures	3L	Design
3.4	**Construction of Longitudinal Drainage**	• Working adjacent traffic: o Construction of pipe work and pits o Installation of water quality devices o Public entering open excavations	7A	• Develop Integrated Work Method Statements • Develop and implement Traffic Control Plans as required • Review construction of permanent exclusion fencing prior to drainage works where practical • Fence off construction works securely	3L	Design, Construction
		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Construction of chamber at tie in to existing QR culvert and potential undermining of rail embankment, tracks and other infrastructure o Electrocution o Open excavations within/adjacent the rail corridor o Public access to rail corridor	7A	• Develop Integrated Work Method Statements • Carry out under a QR SCA (Safety Clarification Advice) or closure if required • Review design to utilise the existing upstream headwall as part of the new tie in chamber, or join the existing to new to minimise risk of undermining the rail formation • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Design, Construction

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3.5	**Retaining Wall / Drainage interface**	• Introduction of constant water path to retaining structure o Potential for retaining wall failure due to erosion	6H	• Retaining wall solution to link to drainage requirements	4M	Design, Construction
4.0	**ZONE 4**					
4.1	**Construction of transverse drainage, including upgrading of McEwen and Verral St drainage**	• Working adjacent traffic: o Construction of pipe work and pits o Installation of water quality devices o Public entering open excavations	7A	• Develop Integrated Work Method Statements • Develop and implement Traffic Control Plans as required • Review construction of permanent exclusion fencing prior to drainage works where practical • Fence off construction works securely	3L	Design, Construction
		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Construction of chamber at tie in to existing QR culvert and potential undermining of rail embankment, tracks and other infrastructure o Electrocution o Open excavations within/adjacent the rail corridor o Public access to rail corridor	7A	• Develop Integrated Work Method Statements • Carry out under a QR SCA (Safety Clarification Advice) or closure if required • Review design to utilise the existing upstream headwall as part of the new tie in chamber, or join the existing to new to minimise risk of undermining the rail formation • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Design, Construction
		• Access to pipes after construction o Public safety around outlets (CPTED) o Public safety during storm events	6H	• Investigate the use of screw or lock down grates • Review use of personnel exclusion fencing around inlets/outlets verses screens to structures	3L	Design, Owner

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4.2	**Construction of Longitudinal Drainage**	• Working adjacent traffic: o Construction of pipe work and pits o Installation of water quality devices o Public entering open excavations	6H	• Develop Integrated Work Method Statements • Develop and implement Traffic Control Plans as required • Review construction of permanent exclusion fencing prior to drainage works where practical • Fence off construction works securely	3L	Construction
		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Electrocution o Open excavations within/adjacent the rail corridor o Public access to rail corridor	7A	• Develop Integrated Work Method Statements • Carry out under a QR SCA (Safety Clarification Advice) or closure if required • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Construction
4.3	**Retaining Wall / Drainage interface**	• Introduction of constant water path to retaining structure o Potential for retaining wall failure due to erosion	6H	• Retaining wall solution to link to drainage requirements	4M	Design, Construction
5.0	**ZONE 4 RETENTION BASIN**					

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5.1	**Retention Basin Bulk Earthworks in proximity to Bridge construction, and existing rail formation**	• Space Constraints o Proximity to large plant o Struck by plant	5H	• Bridge and basin construction are programmed to minimise interference between construction activities. Bulk Earthworks for basin will occur prior to bridge construction. • Integrated Work Method Statement • Origin Alliance site access rules apply – permission from site supervisor, sign-on to IWMS, JHA and daily pre-start.	4M	Construction
		• Flooding in QR access track o Localised ponding of water against rail formation o Overtopping of rail formation	5H	• Basin designed to retain Q100 water levels, therefore expect ponding to be caused from rainfall within small catchment of access track • QR may consider an emergency response procedure in the case of ponding	4M	Design, Construction
		• Working adjacent/within rail corridor: o Damage to rail equipment or infrastructure o Damage to plant, equipment or work force o Electrocution o Open excavations within/adjacent the rail corridor o Public access to rail corridor	7A	• Develop Integrated Work Method Statements • Carry out under a QR SCA (Safety Clarification Advice) or closure if required • Securely fence work areas to prevent public accessing rail corridor from worksite, and to protect rail workers from accessing worksite	3L	Construction
6.0	**FLOODING**					

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6.1	**Construction during flood events**	• Flooding of the work areas and traffic areas • Electrical hazards • Public/environmental health hazards due to waste products/pollution • Emergency vehicle access restrictions • Drowning	7A (5P)	• Flood modelling to be undertaken to assess flood extents • Drainage designs to consider flood impacts and design storm events • Construction to consider weather reports/BOM reports • Traffic control plans as required, Develop integrated work method statements. • Temporary bunding	5H (3P)	Design Construction

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
Construction and Demolition – Mitigation (CHAIR 2)						
1.0	Zone 3					
1.1	Damage to existing buried 1050mm dia. Drain Alignment of the proposed transverse drainage system at Endeavour underpass has been moved to avoid the potential conflict during construction. Existing services have been potholed to locate the service prior to construction. Existing service locations are shown on design drawings.	• Struck by plant • Damage to existing culverts through construction activity • Harm to people and/or equipment	4M (3U)	Design – 12/2/10 [redacted]	Construction	[redacted]
1.2	Introduction of constant water path to retaining structure Catch drains and toe drains have been provided where required to control stormwater runoff. Local drainage requirements have been incorporated in the design of the retaining walls. Wall drainage is shown on the structural retaining wall drawings	• Potential for retaining wall failure due to erosion • Potential for overtopping drainage system due to abnormally large rainfall event • Potential for erosion around wall following large rainfall event • Harm to people and/or equipment	4M (3U)	Design – 12/2/10 [redacted]	Construction	

ST : SANTHOSH THERAKAM

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
1.3	Proximity to traffic Options for culvert crossing investigated and a single culvert has been designed to minimise the construction risk. The alignment of the drainage system has been offset to assist in construction staging.	• Harm to people and/or equipment • Struck by vehicle • Struck by object	5H (5R)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Location of cast-in-place chamber on service road ramp (proximity to traffic) Not able to be mitigated through design. Options for the manhole location were investigated and the manhole was required to be installed directly behind the kerb and channel to achieve cover and maintenance requirements, as well as provide connectivity to existing drainage system. Location of manhole off service road is limited by location of retaining wall.	• Harm to people and/or equipment • Struck by vehicle • Struck by object	7A (5P)	Design – 12/2/10 [redacted]	Construction	
	Proximity of manhole to northern IM retaining wall and traffic Options for the manhole location were investigated and the manhole was required to be installed directly behind the kerb and channel to achieve cover and maintenance requirements. The manhole C16500A and C16500B1 are located behind the kerbs of the ramp and out of the direct traffic path	• Harm to people and/or equipment • Struck by vehicle • Struck by object	5H (5R)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
1.4	Working in/adjacent gas pipe exclusion zone The design has been optimised to limit the number of gas main crossings. The gas mains have been highlighted on the design drawings (layout plans). The gas main has been shown on the longitudinal drainage sections. A protection slab has also been designed for the gas main (refer PUP package).	• Harm to people and/or equipment • Struck by plant • Damage to infrastructure • Explosion / ignition	5H (4U)	Design – 12/2/10 [redacted]	Construction	[redacted]
1.5	Proximity to traffic The alignment of the drainage system optimised to avoid crossing under the QR underpass. The design provides for a thrust bored crossing to the east of the underpass.	• Damage to QR infrastructure due to thrust boring activities • Harm to people and/or equipment • Working adjacent to and within live rail corridor leading to personnel harm	5H (5R)	Design – 12/2/10 [redacted]	Construction	
	Cranage and lifting underneath QR bridge Design has eliminated the interaction with the existing QR bridge by optimising the design to avoid crossing under the QR bridge.	• No residual risk due to removal of this specific hazard situation.	N/A	Design – 12/2/10 [redacted]	Construction	
	Excavation under QR bridge Design has eliminated the interaction with the existing QR bridge by optimising the design to avoid crossing under the QR bridge.	• No residual risk due to removal of this specific hazard situation.	N/A	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
1.6	Working adjacent traffic The longitudinal drainage has been designed in accordance with the appropriate guidelines. The longitudinal drainage design incorporates the requirements of the temporary traffic management plans.	• Harm to people and/or equipment • Public safety due to entering open excavations	7A (5P)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Working adjacent/within rail corridor The longitudinal drainage has been designed in accordance with the appropriate QR and Project standards	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • potential undermining of rail embankment, tracks and other infrastructure • Electrocution • Public access to rail corridor	7A (5P)	Design – 12/2/10 [redacted]	Construction	
2.0	ZONE 2					
2.1	Potential dam effect between Monash Rd and adjacent housing estate during significant rain event Monash road culverts have been designed to an acceptable level of immunity (PMF) for the road.	• Damage to property • Drowning • Harm to people and/or equipment	5H (5R)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
2.2	Localised flooding at upstream side of key culverts Options for over-sizing key culverts were considered. Where it did not adversely impact on residents downstream, hydraulic regime, or maintenance, over-sizing was adopted. Culverts have been designed with the appropriate level of immunity as specified in the Design Brief. Desktop study undertaken for all the Transverse culverts detailing the expected impact of a full blockage or significant rain event. Safety screens to culvert inlets/outlets have been designed in accordance with QUDM section 12.04 where required.	• Damage to property • Drowning • Harm to people and/or equipment	5H (5R)	Design – [redacted]	Construction	[redacted]
2.3	Working within power easement Existing electricity and overhead power lines have been identified and shown on the design drawings.	• Harm to people and/or equipment • Electrocution • Damage to power poles / power lines • Damage to plant	6H (5U)	Design – 12/2/10 [redacted]	Construction	
	Working in UXO clearance area UXO clearance areas have been shown on the exclusion zone drawings and the drainage design has avoided this exclusion zone	• Harm to people and/or equipment • Explosion if UXO uncovered inside or outside of exclusion zone	5H (4U)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
2.4	Working adjacent/within rail corridor The design has located the proposed gully infrastructure outside of the QR boundary to allow for ease of construction and to minimise the risk of damage to QR assets. Permanent and temporary fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in another package (refer Fencing Package DGRORF101) Utilising existing QR infrastructure where possible to minimise risk of undermining/affecting rail formation.	• Harm to people and/or equipment • Damage to QR infrastructure • Electrocution • Public access to rail corridor	4M (4R)	Design – 12/2/10 [redacted]	Construction	[redacted]
2.5	Introduction of constant water path to retaining structure Catch drains and toe drains have been provided where required to control stormwater runoff. Local drainage requirements have been incorporated in the design of the retaining walls. Wall drainage is shown on the structural retaining wall drawings	• Potential for retaining wall failure due to erosion • Potential for overtopping drainage system due to abnormally large rainfall event • Potential for erosion around wall following large rainfall event • Harm to people and/or equipment	4M (3U)	Design – [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
2.2	Localised flooding at upstream side of key culverts Options for over-sizing key culverts were considered. Where it did not adversely impact on residents downstream, hydraulic regime, or maintenance, over-sizing was adopted. Culverts have been designed with the appropriate level of immunity as specified in the Design Brief. Desktop study undertaken for all the Transverse culverts detailing the expected impact of a full blockage or significant rain event. Safety screens to culvert inlets/outlets have been designed in accordance with QUDM section 12.04 where required.	• Damage to property • Drowning • Harm to people and/or equipment	5H (5R)	Design – 12/2/10 [redacted]	Construction	[redacted]
2.3	Working within power easement Existing electricity and overhead power lines have been identified and shown on the design drawings.	• Harm to people and/or equipment • Electrocution • Damage to power poles / power lines • Damage to plant	6H (5U)	Design – 12/2/10 [redacted]	Construction	
	Working in UXO clearance area UXO clearance areas have been shown on the exclusion zone drawings and the drainage design has avoided this exclusion zone	• Harm to people and/or equipment • Explosion if UXO uncovered inside or outside of exclusion zone	5H (4U)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
2.4	Working adjacent/within rail corridor The design has located the proposed gully infrastructure outside of the QR boundary to allow for ease of construction and to minimise the risk of damage to QR assets. Permanent and temporary fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in another package (refer Fencing Package DGRORF101) Utilising existing QR infrastructure where possible to minimise risk of undermining/affecting rail formation.	• Harm to people and/or equipment • Damage to QR infrastructure • Electrocution • Public access to rail corridor	4M (4R)	Design – 12/2/10 [redacted]	Construction	[redacted]
2.5	Introduction of constant water path to retaining structure Catch drains and toe drains have been provided where required to control stormwater runoff. Local drainage requirements have been incorporated in the design of the retaining walls. Wall drainage is shown on the structural retaining wall drawings	• Potential for retaining wall failure due to erosion • Potential for overtopping drainage system due to abnormally large rainfall event • Potential for erosion around wall following large rainfall event • Harm to people and/or equipment	4M (3U)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
2.6	Working adjacent traffic The longitudinal drainage has been designed in accordance with the appropriate guidelines. The longitudinal drainage incorporates the requirements of the temporary traffic management plans.	• Public safety due to entering open excavations • Harm to people and/or equipment	7A (5P)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Working adjacent/within rail corridor: Permanent and temporary fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in another package (refer Fencing Package DGRORF101.)	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • potential undermining of rail embankment, tracks and other infrastructure • Electrocution • Public access to rail corridor • Personnel harm	4M (4R)	Design – 12/2/10 [redacted]	Construction	
3.0	**Zone 1**					
3.1	Damage to existing services Potholing of the existing services has been undertaken and included in the survey model. Existing services information also included in services model. Applicable existing services have been shown on the design drawings	• Damaging existing services requiring replacement • Personnel/equipment harm due to contact with live services	4M (4R)	Design – 12/2/10 [redacted]	Construction	

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

Date: 21 May 2009 / 09 July 2009 / 21 July 2009 **S.I.D. Report No:** SIDR#16

No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Working adjacent traffic The longitudinal drainage design incorporates the requirements of the temporary traffic management plans. Precast pits have been specified as part of the design.	• Damage to people and/or equipment • Public safety due to entering open excavations	7A (4P)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Working adjacent/within rail corridor The design has located the proposed culvert infrastructure outside of the QR boundary to and allow for ease of construction and to minimise the risk of damage to QR assets. Permanent and temporary fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in another package (refer Fencing Package DGRORF101.) The design has utilised as much of the existing upstream headwall as possible (subject to geometric positioning of the connecting culverts).	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • potential undermining of rail embankment, tracks and other infrastructure • Electrocution • Public access to rail corridor • Personnel harm	4M (4R)	Design – 12/2/10 [redacted]	Construction	[redacted]

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

Date: 21 May 2009 / 09 July 2009 / 21 July 2009 **S.I.D. Report No:** SIDR#16

No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Access to pipes after construction Fencing has been provided to limit falls from stormwater culverts and some fencing provided to limit access as per fencing package. Safety grates and screens have been located in accordance with QUDM section 12.04, risk assessment. Stakeholders (ICC) have been included in the selection of locating inlet screens	• Public safety around outlets (CPTED) • Public safety during storm events • Damage to public infrastructure • Harm to people and/or equipment	6H (4P)	Design – 12/2/10 [redacted]	Construction	[redacted]
3.2	Working adjacent traffic Permanent fencing and temporary fencing locations and details developed to restrict access. Fencing details are shown in another package (refer Fencing Package DGRORF101.) Precast pits have been specified as part of the design.	• Damage to people and/or equipment • Public safety due to entering open excavations	7A (5P)	Design – 12/2/10 [redacted]	Construction	

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Working adjacent/within rail corridor The design has located the proposed gully infrastructure outside of the QR boundary and allow for ease of construction and to minimise the risk of damage to QR assets. Permanent and temporary fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in another package (refer Fencing Package DGRORF101) The design has utilised as much of the existing upstream headwall as possible (subject to geometric positioning of the connecting culverts).	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • potential undermining of rail embankment, tracks and other infrastructure • Electrocution • Public access to rail corridor • Personnel harm	4M (4R)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Damage to culverts during installation of subsequent works Interdisciplinary reviews and checks have been undertaken as part of the design process. Clashes identified as part of the design process and services realigned or relocated as appropriate. Stormwater pipes are shown on structural drawings where the stormwater is integral with the structure. Pipe class and cover has been assessed for likely construction and permanent loads (refer to Design Report for details)	• Damage to culverts/pipes installed on site requiring replacement	4M (3U)	Design – 12/2/10 [redacted]	Construction	[redacted]

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Access to pipes after construction Fencing has been provided to limit falls from stormwater culverts and some fencing provided to limit access as per fencing package. Safety grates and screens have been located in accordance with QUDM section 12.04, risk assessment. Stakeholders (ICC) have been included in the selection of locating inlet screens	• Public safety around outlets (CPTED) • Public safety during storm events • Damage to public infrastructure • Harm to people and/or equipment	6H (4P)	Design – 12/2/10 [redacted]	Construction	[redacted]
3.3	Working adjacent traffic The longitudinal drainage has been designed in accordance with the appropriate guidelines. Permanent and temporary fencing locations and details developed to restrict access. Fencing details are shown in another package (refer Fencing Package DGRORF101.) Precast pits have been specified as part of the design.	• Damage to people and/or equipment • Public safety due to entering open excavations	7A (5P)	Design – 12/2/10 [redacted]	Construction	[redacted]

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

Date: 21 May 2009 / 09 July 2009 / 21 July 2009 **S.I.D. Report No:** SIDR#16

No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Working adjacent/within rail corridor The design has located the proposed gully infrastructure outside of the QR boundary and allow for ease of construction to minimise the risk of damage to QR assets. The design has utilised as much of the existing upstream headwall as possible (subject to geometric positioning of the connecting culverts). Permanent and temporary fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in another package (refer Fencing Package DGRORF101)	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • potential undermining of rail embankment, tracks and other infrastructure • Electrocution • Public access to rail corridor • Personnel harm	4M (4R)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Working adjacent Goodna State School Permanent and temporary fencing locations developed to restrict access. Fencing details are shown in another package (refer Fencing Package DGRORF101)	• Public entering open excavations resulting in injury • Public entering culverts resulting in injury • Property damage/vandalism	6H (4P)	Design – 12/2/10 [redacted]	Construction	

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

Date: 21 May 2009 / 09 July 2009 / 21 July 2009 **S.I.D. Report No:** SIDR#16

No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Damage to culverts during installation of subsequent works Interdisciplinary reviews and checks have been undertaken as part of the design process. Clashes identified as part of the design process and services realigned or relocated as appropriate. Stormwater pipes are shown on structural drawings where the stormwater is integral with the structure. Pipe class and cover has been assessed for likely construction and permanent loads (refer to Design Report for details)	• Damage to services installed on site • Damage to culverts/pipes installed on site requiring replacement	4M (3U)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Access to pipes after construction Fencing has been provided to limit falls from stormwater culverts and some fencing provided to limit access as per fencing package. Safety grates and screens have been located in accordance with QUDM section 12.04, risk assessment. Stakeholders (ICC) have been included in the selection of locating inlet screens	• Public safety around outlets (CPTED) • Public safety during storm events • Damage to public infrastructure	6H (4P)	Design – 12/2/10 [redacted]	Construction	

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
3.4	Working adjacent traffic The longitudinal drainage has been designed in accordance with the appropriate guidelines. The longitudinal drainage design incorporates the requirements of the temporary traffic management plans.	• Damage to people and/or equipment • Public safety due to entering open excavations	7A (5P)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Working adjacent/within rail corridor The longitudinal drainage has been designed in accordance with the appropriate guidelines. (QR) Minimal length of longitudinal drainage has been proposed within the QR corridor to minimise the risk.	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • potential undermining of rail embankment, tracks and other infrastructure • Electrocution • Open excavations within/adjacent the rail corridor • Public access to rail corridor	7A (5P)	Design – 12/2/10 [redacted]	Construction	
3.5	Introduction of constant water path to retaining structure Catch drains and toe drains have been provided where required to control stormwater runoff. Local drainage requirements have been incorporated in the design of the retaining walls. Wall drainage is shown on the structural retaining wall drawings	• Potential for retaining wall failure due to erosion • Potential for overtopping drainage system due to abnormally large rainfall event • Potential for erosion around wall following large rainfall event	4M (3U)	Design – 12/2/10	Construction	

Design Package: Zone 2 Transverse Drainage - Other Culverts **Project Name:** Ipswich Motorway Upgrade – Dinmore to Goodna

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
4.0	ZONE 4					
4.1	Working adjacent traffic Permanent fencing locations and details developed to restrict access to the Motorway. Fencing details are shown in another package (refer Fencing Package DGRORF101) Location of proposed drainage designed to limit the extent of excavation required to reduce the risk	• Damage to people and/or equipment • Public safety due to entering open excavations	7A (5P)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Working adjacent/within rail corridor The design has located the proposed gully infrastructure outside of the QR boundary to allow for ease of construction and to minimise the risk of damage to QR assets. Stakeholder approval has been sort to agree on the proposed crossing alignments. Crossings are significantly below track level and located away from all masts, signals and sidings, and are in accordance with the QR standards. Permanent fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in another package (refer Fencing Package DGRORF101)	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • potential undermining of rail embankment, tracks and other infrastructure • Electrocution • Open excavations within/adjacent the rail corridor • Public access to rail corridor	4M (4R)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Access to pipes after construction Fencing has been provided to limit falls from stormwater culverts and some fencing provided to limit access as per fencing package. Safety grates and screens have been located in accordance with QUDM section 12.04, risk assessment. Stakeholders (ICC) have been included in the selection of locating inlet screens All stormwater infrastructure has been design in accordance with relevant standard drawings.	• Public safety around outlets (CPTED) • Public safety during storm events • Damage to public infrastructure • Harm to people and/or equipment	6H (4P)	Design – 12/2/10 [redacted]	Construction	[redacted]
4.2	Working adjacent traffic Permanent fencing locations and details developed to restrict access to the Motorway. Fencing details are shown in another package (refer to DGPCAL101). The stormwater has been design in accordance with the relevant design documentation. The longitudinal drainage design incorporates the requirements of the temporary traffic management plans.	• Damage to people and/or equipment • Public safety due to entering open excavations	6H (5U)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Working adjacent/within rail corridor: No longitudinal drainage proposed within rail corridor. Permanent fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in relevant fencing package (refer DGRORF101)	• Damage to rail equipment or infrastructure • Damage to plant, equipment or work force • Electrocution • Public access to rail corridor	4M (4R)	Design – 12/2/10 [redacted]	Construction	[redacted]
4.3	Introduction of constant water path to retaining structure Catch drains and toe drains have been provided where required to control stormwater runoff. Local drainage requirements have been incorporated in the design of the retaining walls. Wall drainage is shown on the structural retaining wall drawings	• Potential for retaining wall failure due to erosion • Potential for overtopping drainage system due to abnormally large rainfall event • Potential for erosion around wall following large rainfall event	4M (3U)	Design – 12/2/10 [redacted]	Construction	
5.0	**ZONE 4 RETENTION BASIN**					
5.1	Space Constraints Design of basin completed to ensure that all earthworks are within Project Boundary and no works cross into QR corridor.	• Damage to people or plant	4M (3U)	Design – 12/2/10 [redacted]	Construction	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Residual Risk Transferred to Group	Recipient Group Acceptance Initial
	Flooding in QR access track Design of basins included emergency overflow provisions to contain runoff in large rainfall events within designated drainage corridors. Design checked to confirm Q100 flood levels are contained within the basin. Geotechnical team has been consulted over embankment stability issues	• Flooding into QR • Overtopping of rail formation • Harm to people and/or equipment	5H (4U)	Design – 12/2/10 [redacted]	Construction	[redacted]
	Working adjacent/within rail corridor Permanent fencing locations and details developed to restrict access to the rail corridor. Fencing details are shown in relevant fencing package. Design footprint reduced to be contained fully with DTMR land Included relevant stakeholders (QR) in design solutions and have received signoff	• Unintentional damage to infrastructure due to works in and around the QR rail corridor • Damage to plant, equipment or work force • Electrocution • Public access to rail corridor resulting in property damage or public harm	4M (4R)	Design – 12/2/10 [redacted]	Construction	
6.0	**FLOODING**					
6.1	Construction during flood events Advice on expected design event inundation areas Local flooding impacts of IMU designs have been assessed by flood models/drainage assessment	• Local flooding causing dangerous work site/traffic accidents • Harm to people and or equipment • Drowning	6H (4P)	Design – 22/2/10 [redacted]	Construction	

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No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
Operation and Maintenance – Risk Assessment (CHAIR 3)						
1	**Access to manholes**	• Proximity to traffic o Struck by vehicle	6H	• Traffic control required in advance of and around manhole where access is directly adjacent to or in roadway • Design manhole locations so that they are offset from highly trafficked areas • Develop and implement IWMS/JSA/HESP for maintenance activities, including Traffic Control Plan as required.	3L (3R)	Owner Design
2	**Capture and treatment of flammable spills around Church St**	• Drainage discharges to an open drain that runs adjacent houses and public space	5H	• Provide spill containment basin at the end of each longitudinal drainage wherever possible • Develop and implement an emergency response procedure in the case of spillage	3L (3R)	Owner, Design
3	**Maintenance of pits under kerb lines or within roadway**	• Proximity to traffic o Struck by vehicle o Closure of local roads or the motorway during maintenance	6H	• Traffic control required in advance of and around manhole where access is directly adjacent to or in roadway • Design drainage pit to provide easy access to the gully invert • Develop and implement IWMS/JSA/HESP for maintenance activities, including Traffic Control Plan as required.	3L (2U)	Owner, Design

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No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
4	**Maintenance of inlet/outlet safety structures required to prevent public access.**	• Objects/people caught in inlet/outlet structures with no means of escape • Access to structure for maintenance (potential confined space depending upon the structure	6H	• Maintenance to be completed in dry conditions • Design of inlet/outlet structure to consider removal of cage for maintenance purposes • Apply controls and safety systems for access as per Australian Standard where drainage pit is deemed to be a confined space • Review design and apply sloped face of grate to inlet/outlet • Develop and implement IWMS/JSA/HESP for maintenance activities, including Traffic Control Plan as required.	4M (4R)	Owner, Design
5	**> Q100 Rain Event**	• Overtopping of basin spillway o Refer to Item 1.2 o Flooding o Scour and erosion o High depths and velocities in pedestrian/road areas	5H	• Develop an emergency response procedure in the case of basin spillway overtopping • Design emergency overflow systems to allow drainage of extremely large rainfall events	4M (4R)	Owner, Design
		• Catastrophic failure of basin embankment o Refer to Item 1.2 o Flooding o Scour and erosion o High depths and velocities in pedestrian/road areas	5H	• Develop an emergency response procedure in the case of basin embankment failure • Design emergency overflow systems to allow drainage of extremely large rainfall events	4M (4R)	Owner, Design

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No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
6	**Significant Rain Event**	Rainfall greater than design storm o Flooding o Scour and erosion o High depths and velocities in pedestrian/road areas	5H	• regular inspection and maintenance regime to stormwater infrastructure • Review design to assess impacts due to large rainfall events	4M (4R)	Owner, Design
7	**Basin sediment removal activities**	• Significant build-up of silt / sediment raising level of basin o Reduction of basin's storage capacity o Contaminants/chemical	3L	• regular inspection and maintenance regime to check sediment levels in basin • provide depth gauge markers in basin as reference for water depth/sediment depth • Develop and implement IWMS/JSA/HESP for maintenance activities, including Traffic Control Plan as required	3L (3R)	Owner, Design
		• Access to basin o Slip / trip / fall	3L	• Design to allow for designated maintenance access ramp into basins • Dewater dam prior to maintenance (silt removal) activities • Work Method Statement to be developed for maintenance of basins to cover vehicle access, dewatering and personnel access and safety.	2L (2R)	Owner, Design

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No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
8	**Longitudinal Drainage pipes behind walls**	• Restricted access • Damage to wall • Working adjacent to traffic	6H (3L)	• Design to allow for future access to pipe for replacement/maintenance • Develop and implement IWMS/JSA/HESP for maintenance activities, including Traffic Control Plan as required	3L (3R)	Owner, Design
9	**Longitudinal drainage pipes in front of walls**	• Retaining wall failure • Working adjacent to traffic	6H (3L)	• Design to allow for pipe to be maintained in front of wall • Develop and implement IWMS/JSA/HESP for maintenance activities, including Traffic Control Plan as required	3L (3R)	Owner, Design
10	**Scour protection at stormwater outlets**	• Access to structure for maintenance • Loose debris / rubble	5H (2L)	• Work Method Statement to be developed for maintenance of outlets. • regular inspection and maintenance regime to check scour protection and possible blockages to culverts • review scour protection design to ensure installation requires minimal maintenance	3L (2U)	Owner, Design

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No	Job Step	What are the Hazards	Risk Score	Controls Required	Target Risk Score	Responsible Group
11	**Regional Flood management**	• Flooding of the traffic areas • Electrical hazards, public/environmental health hazards due to waste products/pollution • Emergency vehicle access restrictions, public access/escape prevented by floodwaters • Drowning • Increase depth and area of flood inundation	7A (5P)	• Flood modelling to be undertaken to assess flood extents • Bulk motorway to be designed to not worsen/change the pre-existing regional flood regime • Disaster/emergency management plans • Traffic control plans as required, Develop integrated work method statements for maintenance during floods • Liaise with flood emergency response personnel/emergency services	6H (4P)	Owner
RERODR206-1	**Inlet screens at transverse culverts**	• People being injured if washed into culvert structures • Drowning • Being pinned against an inlet screen	7A (5P)	• Sloped inlet screens to prevent unauthorised access • Sloped screens with horizontal bars to assist people to climb up and out to safety (as per QUDM recommendations)	5H (5R)	Owner, Designer

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Group Risk Transferred to	Recipient Group Acceptance Initial
Operation and Maintenance – Mitigation (CHAIR 3)						
1	Proximity to traffic: Manhole locations designed (where practical) to be offset from roadways to allow safe access, and in accordance with the applicable design standards. Step irons have also been provided inside manholes as per Australian Standards (where required)	• Working adjacent to live traffic and being struck by vehicle (where pits are adjacent to roadways) • Harm to people and/or equipment	6H (5U)	Design – 12/2/10 [redacted]	Owner	
2	Dangerous liquid discharges: Spill containment (40 000L) has been included in the water quality device within Zone 1 and 2	• Pollution due to drainage discharges to an open drain that runs adjacent houses and public space leading to environmental harm and/or harm to people. • Ignition of liquid leading to injury/fire • Public safety and health	4M (4R)	Design – 12/2/10 [redacted]	Owner	
3	Proximity to traffic: Design carried out in accordance with the applicable design standards.	• Working adjacent to live traffic and being struck by vehicle (where pits are adjacent to roadways) • Harm to people and/or equipment	6H (5U)	Design – 12/2/10 [redacted]	Owner	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Group Risk Transferred to	Recipient Group Acceptance Initial
4	Pit inlets and outlets: Inlet structures and outlet structures provided in locations in accordance with QUDM 12.04 and in consultation with ICC where applicable. Maintenance tracks or access points have been provided to assist in inspection where there are no spatial constraints.	• Objects/people caught in inlet/outlet structures with no means of escape • Access to structure for maintenance (potential confined space depending upon the structure • Harm to people and/or equipment	5H (4U)	Design – 12/2/10 [redacted]	Owner	
5	Overtopping basin spillway: Design provides an outlet for a controlled discharge up to the design storm event for the basin.	• Overtopping of basin spillway causing downstream harm to environment and /or people • Nuisance Flooding/erosion	5H (4U)	Design – 12/2/10 [redacted]	Owner	
	Basin failure: Design provides an outlet for a controlled discharge from the basin up to the design storm event for the basin.	• Overtopping of basin spillway causing downstream harm to equipment, environment and /or people • Nuisance Flooding/erosion	5H (4U)	Design – 12/2/10 [redacted]	Owner	
6	Rainfall greater than design storm: Design undertaken includes a desk top study of the events that may occur based on culverts becoming blocked or for events greater than a Q100.	• Flooding impacts due to rainfall greater than design storm • Overtopping of basin spillway causing downstream harm to equipment, environment and /or people • Nuisance Flooding/erosion	4M (3U)	Design – 12/2/10 [redacted]	Owner	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Group Risk Transferred to	Recipient Group Acceptance Initial
7	Sediment build-up: Depth gauge markers have been added to basins that are designed to retain water A rock lined invert to the basins has been proposed to indicate the base of the basins and to assist with maintenance.	• Improper access by personnel or plant resulting in comprising the basins functionality • Increased difficulty for maintenance people/equipment to service the basin causing harm to people and/or equipment.	3L (2U)	Design – 12/2/10 [redacted]	Owner	
	Access to basin: Designated maintenance access ramps have been provided in the design and highlighted on the construction plans. All water quality basin devices have been fenced and are generally located in between high volume traffic road with access tracks. Warning signage has been provided.	• Public safety due to forced access to basin • Damage to basin during maintenance activities • Personnel safety during maintenance activities (working over water)	3L (3R)	Design – 12/2/10 [redacted]	Owner	
8	Longitudinal drainage behind walls: Buried Longitudinal drainage pipes in close proximity behind walls have been avoided where possible throughout the design. Where longitudinal pipe are required behind a retaining wall, the design of the pipe has been integrated into the design of the wall (refer to individual retaining wall packages for details)	• Future access to pipes behind permanent walls • Damage to wall structural components causing harm to people or equipment	4M (3U)	Design – 12/2/10 [redacted]	Owner	

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No	Actions Taken by Responsible Group	Residual Risk	Achieved Risk Score	Responsible Group Sign Off	Group Risk Transferred to	Recipient Group Acceptance Initial
9	Longitudinal drainage in front of walls: Buried Longitudinal drainage pipes in close proximity to the front of the wall have been avoided where possible throughout the design. However where the longitudinal drainage line is located in front of the wall the retaining wall footing design has allowed for the possible future excavation.	• Retaining wall failure if trench is over-excavated in front of wall causing harm to people or equipment	4M (3U)	Design – 12/2/10 [redacted]	Owner	
10	Access to stormwater outlets: Access tracks have been designed to provide access to stormwater outlets where space allows, assisting in the visual inspection of stormwater outlet structures. Scour protection sized for the design flood velocities and detailed to minimise the need for maintenance	• Access via rock protection/unstable ground leading to personnel injury • Access during flood event causing personnel injury due to water pressures/flows.	4M (2P)	Design – 12/2/10 [redacted]	Owner	
11	Regional Flood Management Bulk motorway designed so to not worsen/change the pre-existing regional flood regime. Drainage infrastructure designed for recognised and appropriate design storm events.	• Flooding to traffic areas causing accidents and harm to people and or equipment • Drowning • Impacts on local business and economy	7A (5P)	Design 22/2/10 [redacted]	Owner	
RERODR206-1	Inlet screens at transverse culverts: Installation of inlet screens at culverts deemed to be "Class A" contact classification as per QUDM.	• People being pinned against screen • Drowning	6H (5U)	Design 25/2/10 [redacted]	Owner	

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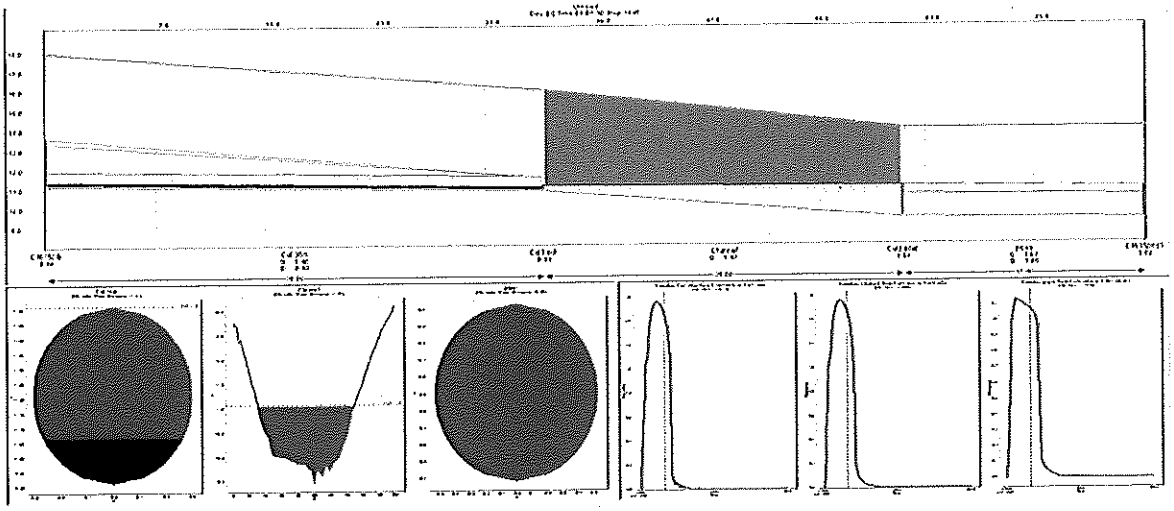
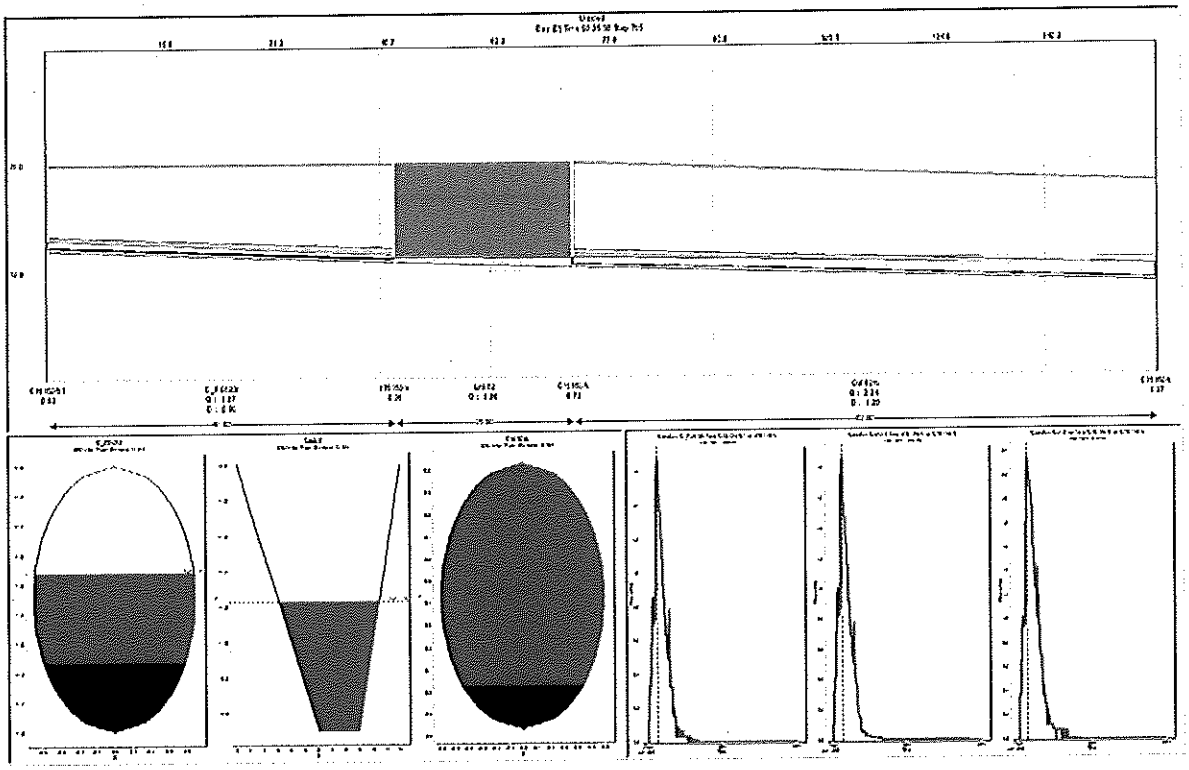
Design Lot	Design Lot Description
DGENKS103	Environmental Works Report
DGRODR100	Drainage Details
GORODR102	Longitudinal Drainage
GORODR103	Water Quality
GORODR105	Longitudinal Drainage - Church St EB Exit Ramp
GORODR106	Transverse Drainage - Culvert 1
GORODR107	Transverse Drainage - Culverts 2 & 3
RERODR104	Goodna Creek Rehabilitation
RERODR201	Longitudinal Drainage
RERODR202	Water Quality
RERODR205	Transverse Drainage (Early works culvert)
RERODR206	Transverse Drainage (Other Zone 2 culverts)
RIRODR300	Transverse Drainage
RIRODR301	Longitudinal Drainage
RIRODR302	Water Quality
RIRODR304	Longitudinal Drainage - Southern Service Roads
DIRODR400	Transverse Drainage
DIRODR401	Longitudinal Drainage
DIRODR402	Water Quality
DGFHKS100	Regional Flood Modelling Report

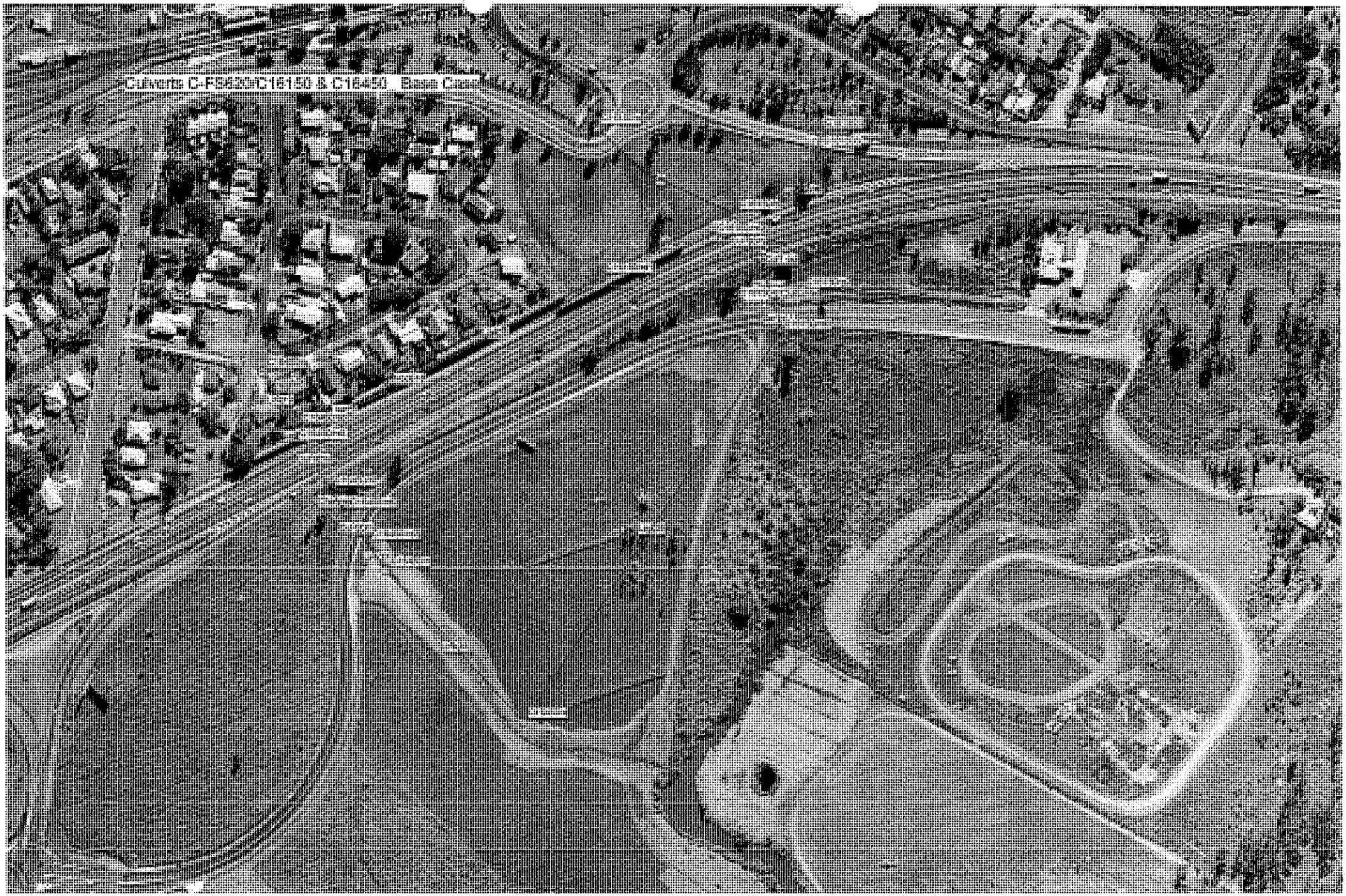
Appendix L – XP-SWMM Outputs

C-FS620_ Base



C-FS620_ Ultimate





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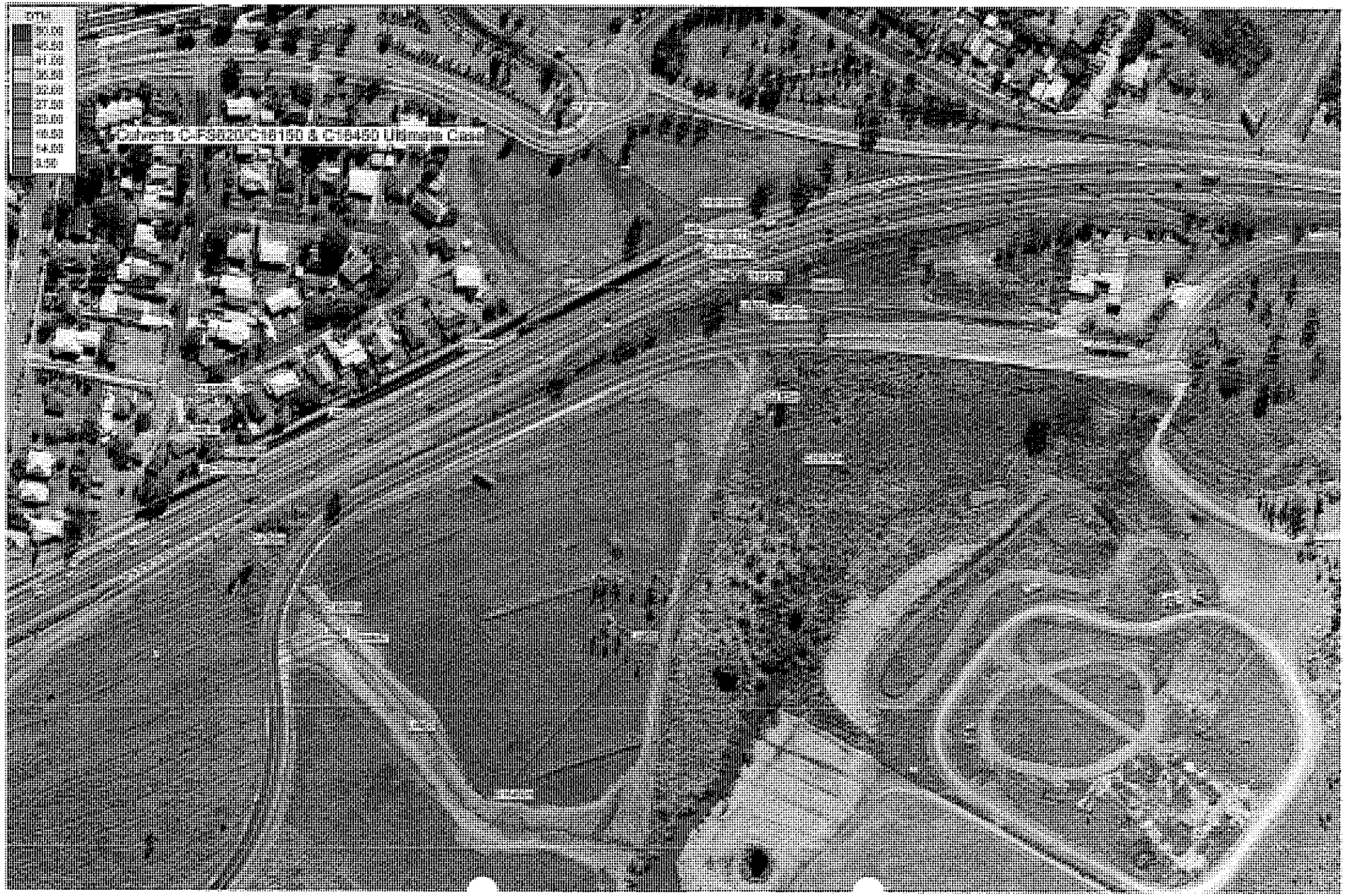

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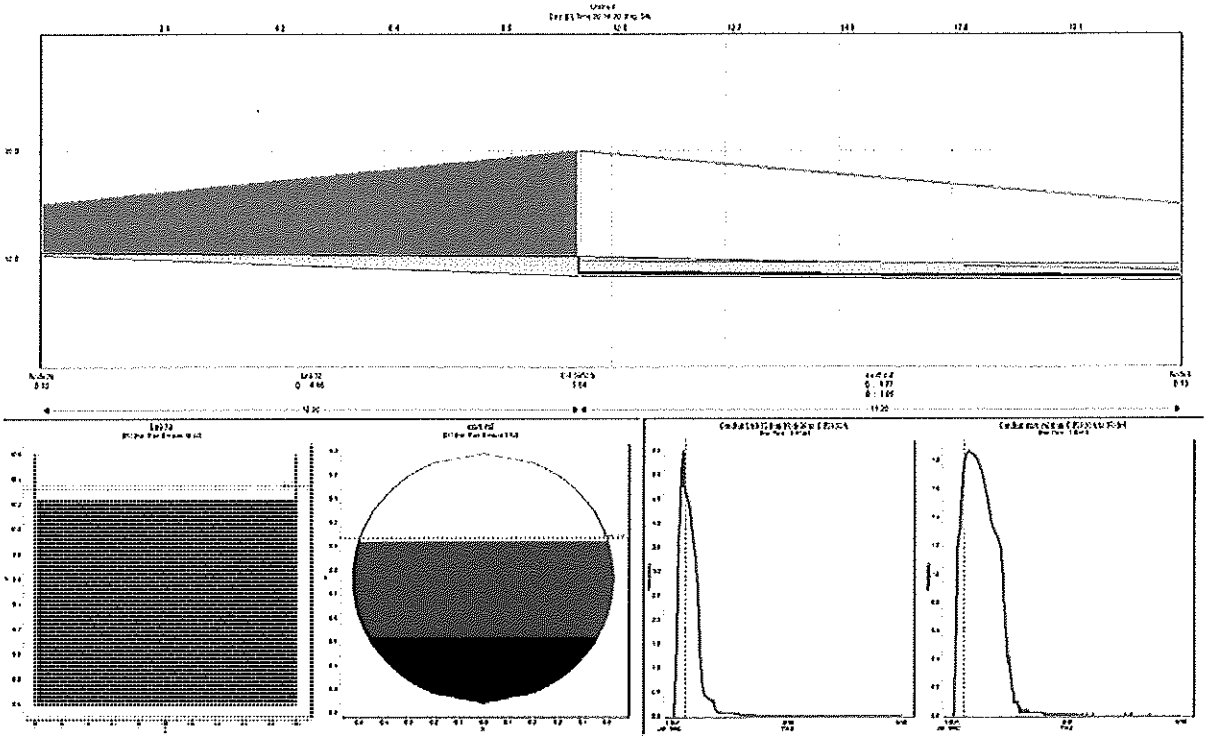
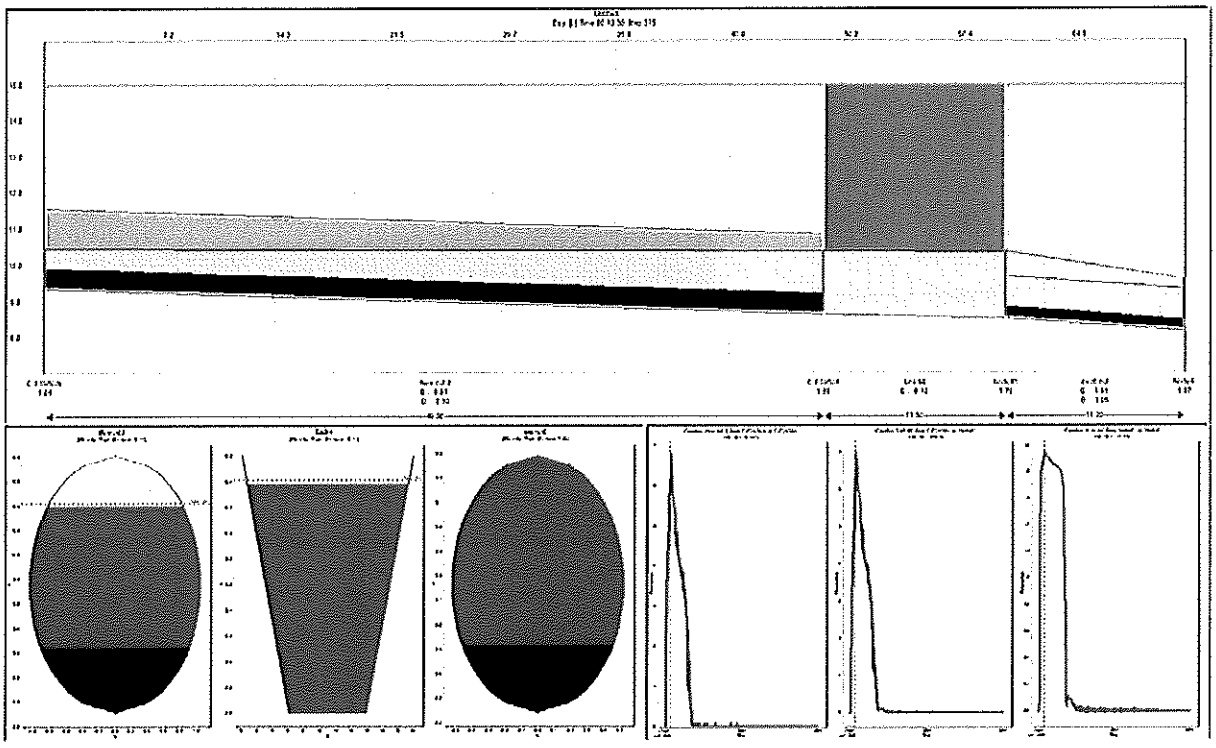
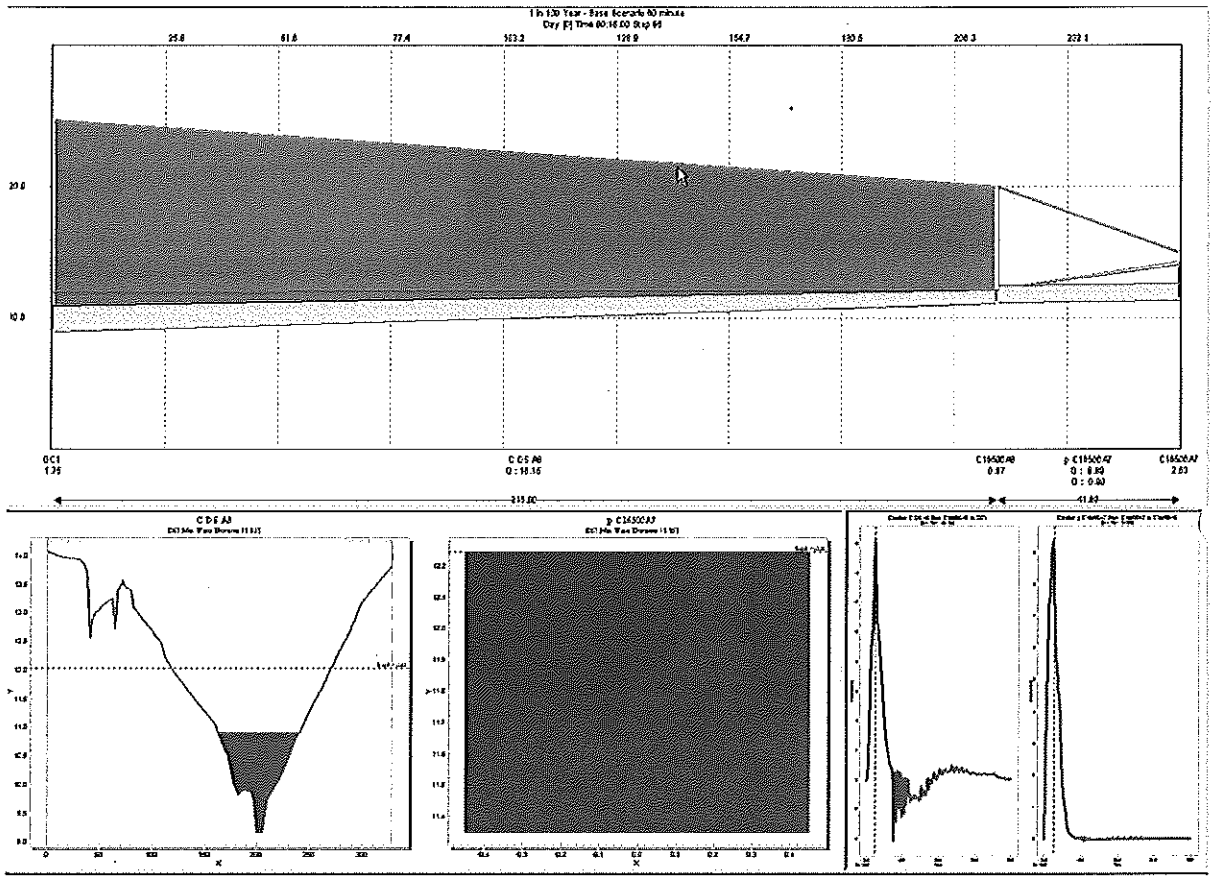
C-FS950_ Base



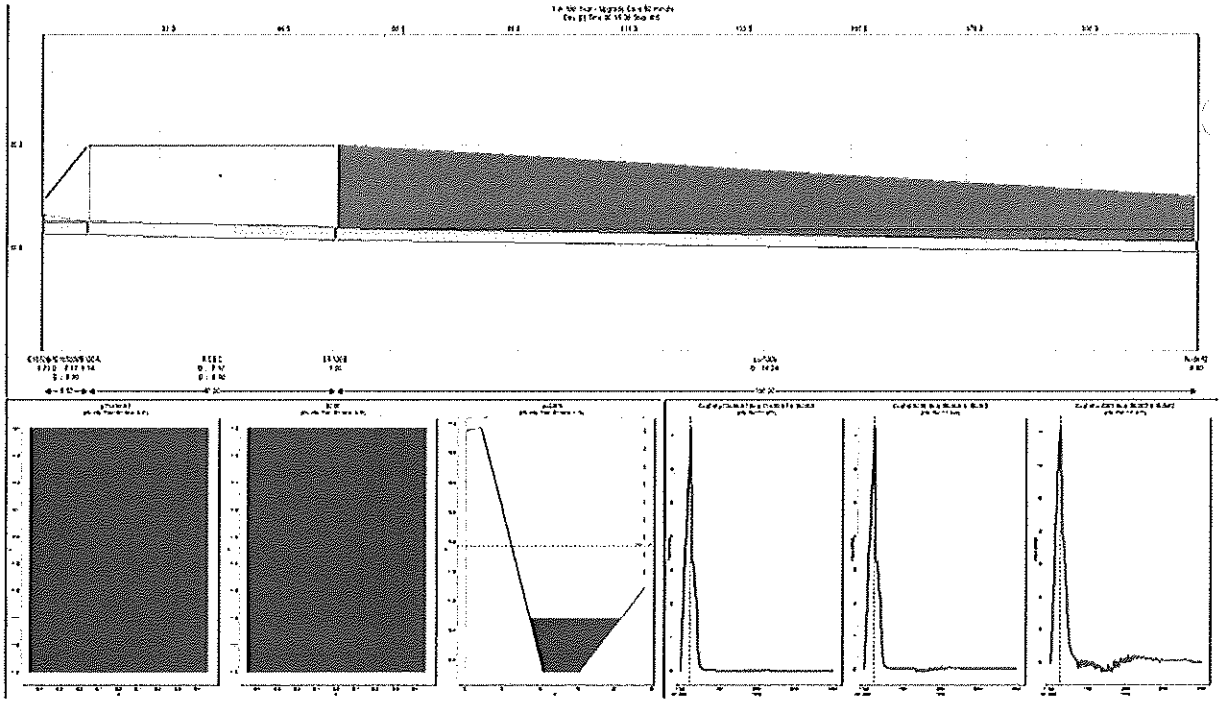
C-FS950_ Ultimate



C-SR100-Base Case



C-SR100- Ultimate Case



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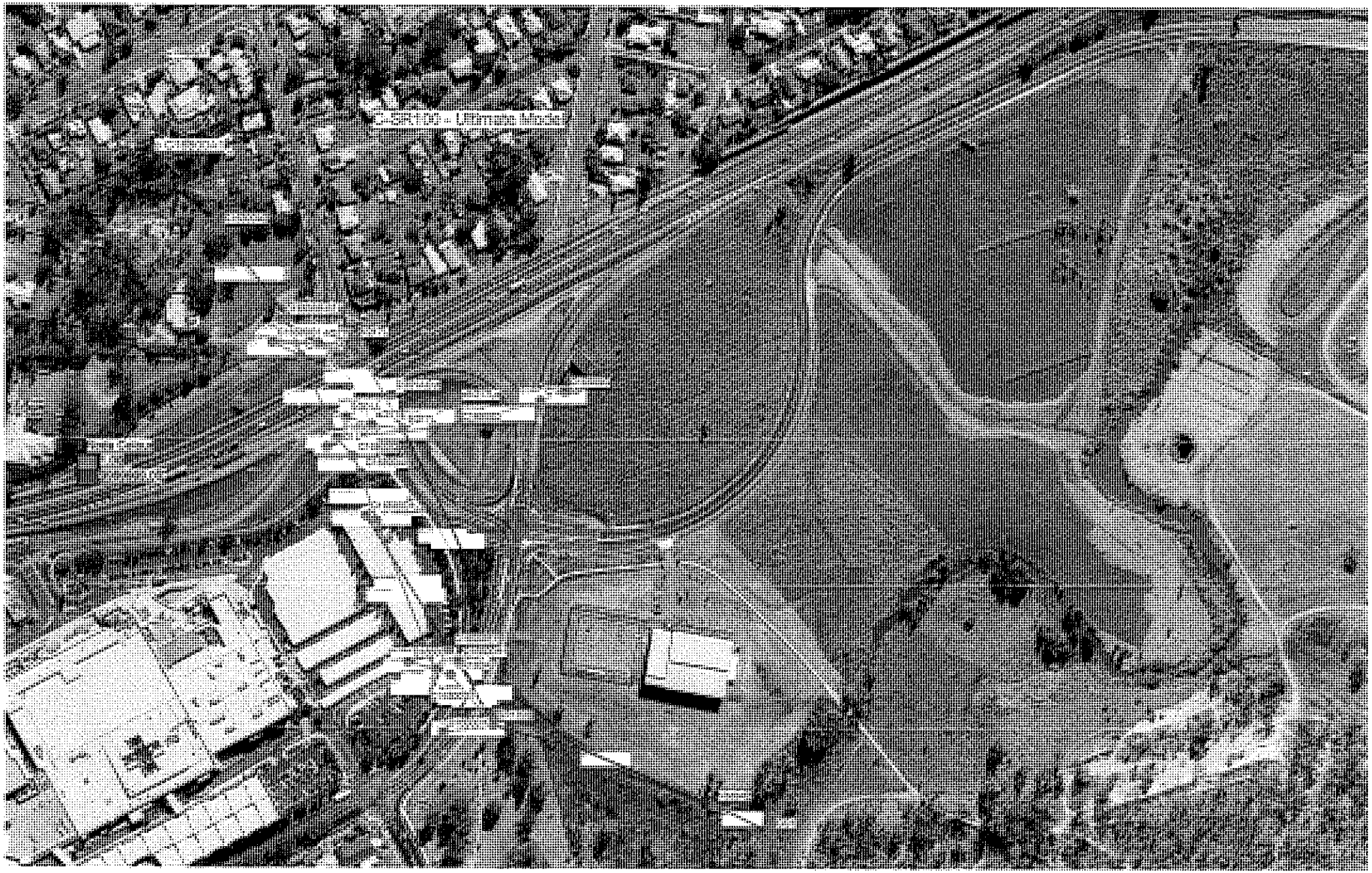


Scale 1 : 2323.02

Scale 1 : 1955.25

Scale 1 : 1732.93

OriginAlliance
Connecting Diamond to Goodna

Calculation Sheet

Design SR100A - Manhole

Checked

Date 27/11/09.

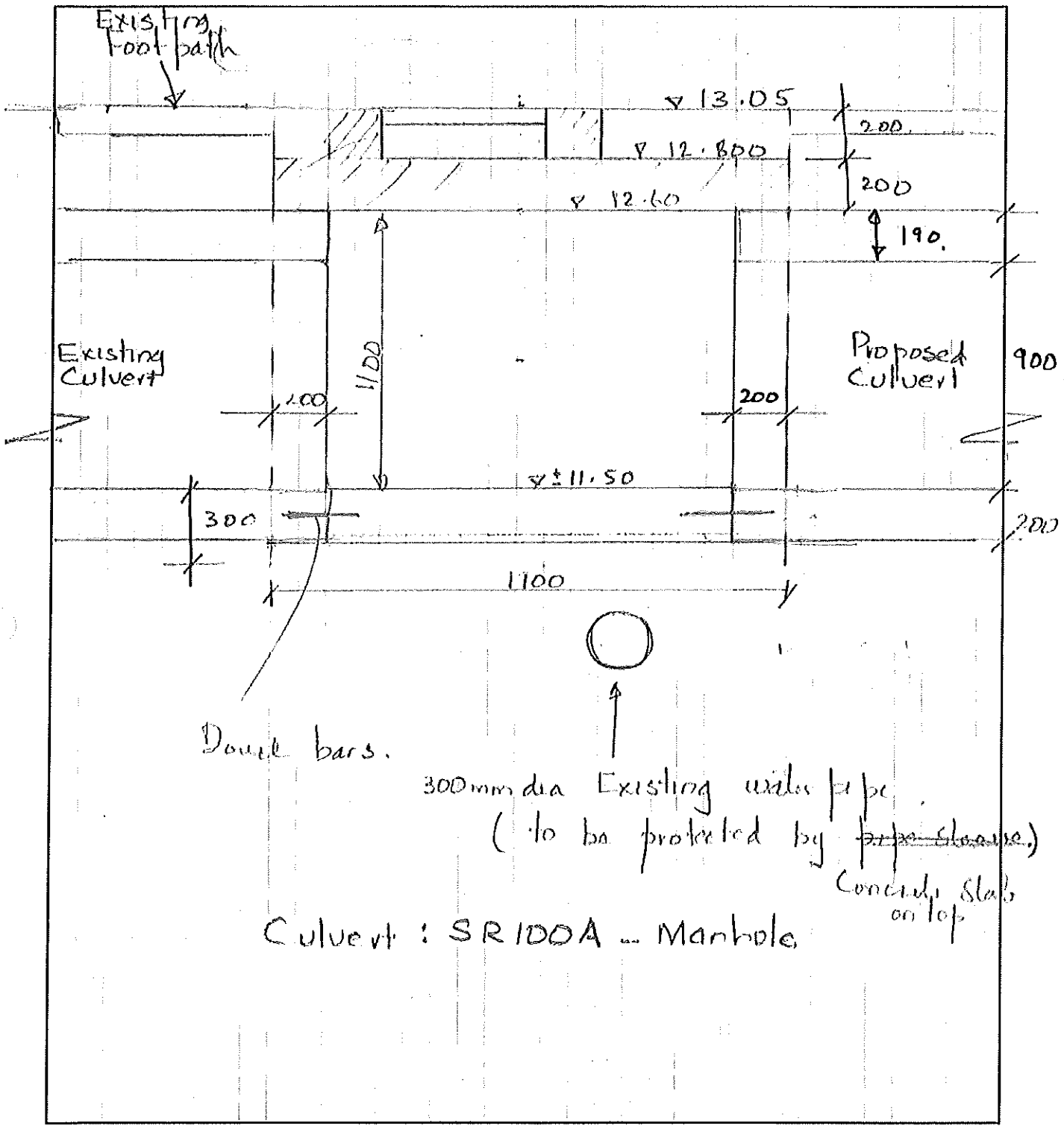
Date

Discipline

Zone 2 - Other Culverts.

Page

Description



Culvert : SR100A - Manhole

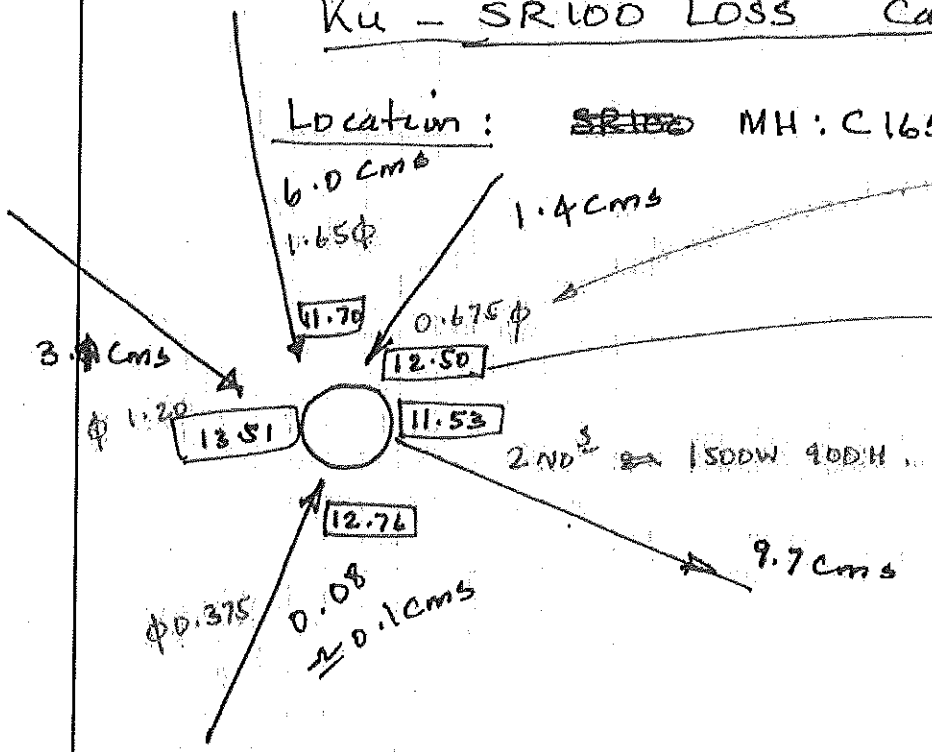
27/11/09

SUBJECT	BY	DATE	REF NO.
Zone 2 - Other Culverts		27/11/09	

Ku - SR100 Loss Calculations (Q20)

Existing case.

Location: ~~SR100~~ MH: C16500A7



$$V = \frac{4Q}{\pi D^2}$$

Inlet	Pipe (D) (m)	~~D~~	Q20 cms	V
1	0.675		1.4	
2	1.65		6.0	
3	1.20		3.1	
4	0.375		0.1	
~~5~~				

Average diameter.

$D_a = 2.15$ m

Outlet

1. 2 x 1500 W x 900 H

Average diameter

$D_o = 3.92$ m

$$\frac{D_v}{D_o} = \frac{2.15}{3.92} = 0.67 \quad \text{use } 0.7$$

~~1.82~~ ~~3.92~~ ~~2.15~~

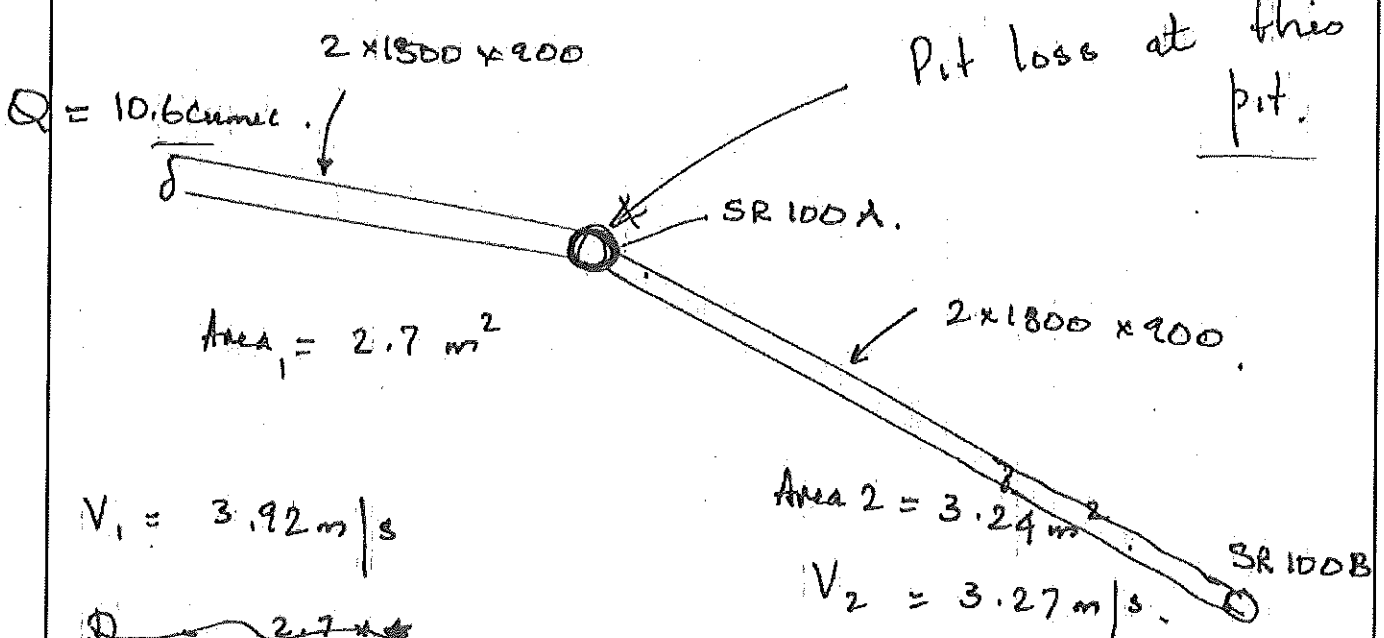
3.92

use $K_u = 1.5$

OriginAlliance
Connecting Dinmore to Goodna

SUBJECT	Zone 2 – Other Culverts	BY	DATE 27/4/09	REF NO.

New Pipes : Pit Losses



~~$D_e = \frac{2.7 \times 4}{\pi}$~~

$$2.7 = \frac{\pi}{4} D_u^2 \qquad 3.24 = \frac{\pi}{4} D_o^2$$

$$D_u = 1.85\,m. \qquad D_o = 2.03\,m.$$

$$\frac{D_u}{D_o} = 0.9$$

$$\theta = 25^\circ \text{ — } 30^\circ.$$

Loss (K) = 0.5

C-SR100 . 1in 20year ARI Base Scenario
SWMM Results

Links

Name	Max Vel. m/s	Max Flow cms
p C16500A1	4.17	1.14
p C16500A1	0.81	1.35
c C16500A2	0.47	2.96
P_C16500A2	3.21	1.16
p C16500B1	2.34	0.84
p C16500B1	0	0.00
biC16500A3	0.79	1.34
p C16500A3	3.54	1.01
p C16500A3	0.14	-0.43
biC16500F1	0	0.00
p C16500F1	3.06	3.10
p C16500A5	3.29	3.73
p C16500D1	5.49	2.45
bc16500d1	0.83	1.00
p C16500A6	2.95	6.02
p C16500G1	0.73	0.08
p C16500G1	0	0.00
bc16500g1	0.34	0.03
p C16500A7	3.44	9.38
p C16500I1	2.91	3.22
p C16500I1	0.73	1.81
C DS A8	0.84	16.15
pC16500E1	4.08	1.48
bc16500e1	1.12	0.29
p C16500H1	2.88	1.44
p C16500H1	0.63	1.37
p C16500C1	3.83	0.62
p C16500C1	0.84	0.85
p C16500A4	2.59	3.43
p C16500A4	2.6	3.44

Nodes

Name	Max Water Elevation (m)	Invert Elevation m
C16500A1	21.802	23.622
C16500A2	16.321	18.342
C16500B1	15.05	16.928
C16500A3	15.264	16.411
C16500F1	14.703	15.978
C16500A5	13.947	15.346
C16500D1	13.4	15.835
C16500A6	12.631	14.948
C16500G1	12.872	15.225
C16500A7	11.53	14.294
C16500I1	11.517	13.278
C16500A8	11.272	12.141
GC1	9.16	12.03
C16500E1	11.53	15.04
C16500H1	11.561	12.993
C16500C1	15.484	17.076
C16500A4	14.762	16.417

C-SR100 1in 20year ARI Ultimate Scenario
SWMM Results
Links

Name	Max Velocity m	Max Flow cms
p C16500A1	4.04	1.14
p C16500A1	0.64	0.67
cc16500a2	0.48	1.94
p C16500A2	3.59	1.30
p C16500A2	0	0.00
biC16500B1	0	0.00
obi	1.47	1.94
obi	1.47	1.94
obi	1.47	1.94
biC16500C1	0	0.00
p C16500C1	2.69	0.66
p C16500B1	1.81	3.25
p C16500B1	1.81	3.25
p C16500B1	1.81	3.25
p C16500A	2.64	3.75
p7/301a	3.66	1.97
b7/301a	0.41	0.13
p9/301a	3.07	1.37
by9/301A	0	0.00
bi8/217l	0.88	0.60
p8/217l	1.82	1.58
p8/217L	2.11	0.34
p8/217L	0.66	0.75
bi9/217L	0.94	2.33
p9/217L	1.14	0.21
bic16500i	0.64	0.07
p C16500I1	2.34	5.26
p C16500A4	2.21	3.02
p C16500A5	3.12	3.02
p C16500D1	1.24	0.05
bic16500D	0	0.00
biC16500F1	0	0.00
p C16500F1	2.92	3.09
p C16500G1	1.06	0.08
p C16500G1	0	0.00
bic16500g1	0.14	1.35
pC16500E1	5.33	1.94
bic16500e1	0	0.00
p C16500A6	2.94	3.14
p C16500A7	2.7	7.32
RCBC	2.26	7.32
csr100b	1.59	14.24
Link54	1.71	-17.15
bic16500h1	3.17	2.70
bic16500h1	0	0.00
pc16500b	2.26	3.02
pc16500d	1.82	2.42
C C16500E	0.96	2.33
PC16500F	1.98	2.23
bi4/217l	2.12	0.34
bi4/217l	0.67	0.63

Nodes

Name	Max Water Elevation m	Invert Elevation m
C16500A1	21.80	23.59
C16500A2	16.32	18.32
C16500B1	16.10	16.52
C16500C1	15.64	16.25
C16500B1p	14.65	15.96
C16500A	14.50	15.79
6/301L	14.05	15.95
9/301A	14.03	15.67
9/301AOut	24.04	24.04
8/217l	13.61	15.28
8/217L	13.97	15.64
9/217L	13.24	15.20
p9/217Lo	13.03	15.29
C16500I1	11.26	13.83
C16500C	14.12	14.99
C16500A5	13.95	14.60
C16500D1	13.40	13.62
C16500F1	14.70	15.89
C16500G1	12.87	15.34
C16500E1	11.63	14.94
C16500A6	12.63	13.61
C16500A7	11.53	13.28
SR100A	11.50	12.64
SR100B	11.00	12.00
Node42	9.80	11.92
GC1	9.16	11.92
C16500H1	11.17	13.01
C16500B	13.92	15.37
C16500D	13.17	14.29
C16500F	12.90	14.28
C16500G	12.83	13.48
4/217l	14.35	15.93

C-FS620 1in 20year ARI Base Scenario
SWMM Results
Links

Name	Max Velocity m/s	Max Flow cms
Channel1	0.70	2.38
Link39	0.58	3.25
Culvert	2.20	2.70
Ser Rd	0.00	0.00
Service Road	0.00	0.00
Link37	1.28	3.29
Link20	0.41	0.05
1200 pipe	2.67	2.40
Road1	1.34	3.33
Link18	0.79	0.19
Pipe	2.05	1.31
overland	0.25	2.29
Link35	0.44	0.04
Cul 36m	2.88	1.32
Weir	0.00	0.00
W1	0.00	0.00
Channel	0.57	1.32
pipes	1.82	1.60
ChalkST	0.00	0.00
Road	0.00	0.00
db	1.22	0.19
cb	1.17	0.65
Link11	0.94	0.34
Link9	1.05	0.43
Link12	0.64	0.07
ab	0.74	0.49
Link21	0.00	0.00
Link34	3.37	0.65
Link38	0.99	3.30

Nodes

Name	Invert Elevation m	Max Water Elevation m
C16450/K	14.86	15.84
C16450/x	10.00	10.17
C16450/rd2	14.65	15.84
C16450/rd3	14.32	14.88
C16450/ab	15.37	17.17
C16450/rd1	18.00	18.03
C16450/c	15.54	17.19
Node18	16.80	16.94
C16150/b	11.28	13.02
C16150/rd3	9.38	10.10
Cul1 out	10.91	11.13
Cul2 inlet	9.47	10.67
C16150/rd1	14.37	14.49
C16150/x	13.58	13.76
C16450/w	14.00	14.00
C16150/g1	13.00	13.06
C16150/g2	13.00	13.06
C16150/rd2	15.00	15.01
C16150/a	20.00	20.03
C16150/c	13.81	14.14
Node22	13.61	13.61
C16450/n	14.00	14.48

C-FS620 1in 20year ARI Ultimate Scenario

Name	Max Velocity m/s	Max Flow cms
Link20	0.00	0.00
Cul 94m	3.74	3.85
Link18	0.52	0.07
Pipe	2.89	1.83
overland	0.29	1.41
C_FS620t	2.29	1.07
road	0.00	0.00
Link52	4.04	1.23
Link12	0.84	0.14
ab	0.97	0.50
Link47	0.90	0.17
Link46	0.00	0.00
Link61	1.40	3.90
Cul 82m	2.87	1.47
Overflow	0.00	0.00
Link60	1.26	8.33
Link53	2.06	8.34

Name	Invert Elevation m	Max Water Elevation m
C16450/ab	15.20	16.19
C16450/r81	18.00	18.02
C16450/c	15.54	17.07
C16150/b1	12.25	13.02
c16150/x	11.00	11.26
C16150/r71	15.00	15.02
C16150/a	20.00	20.03
C16150/r72	15.00	15.02
Node44	16.00	16.00
C16450/z	12.80	13.25
C16150/h	10.50	10.93
C16150/z	8.83	9.81
C16450/x	10.00	10.21
Node57	12.20	12.89
Node59	13.00	13.00

Culverts C-FS 750 & C-FS 1250-Inlet Losses

Inlet Capcities (cumec)

Double Inlet Gully Pits

	1800mmx900mm	
depth(m)	0% blocked	50% blocked
0	0	0
0.05	0.055	0.055
0.1	0.156	0.156
0.14	0.26	0.26
0.2	0.444	0.444
0.25	0.621	0.621
0.3	0.73	0.73
0.35	0.789	0.789
0.4	0.843	0.843
0.45	0.895	0.895
0.5	0.943	0.943

Pit head Losses

Pipe Losses	Coefficients
Pit Loss	4
Exit Loss	1

Pipe Losses

Pipe Losses	Mannings n value
Concrete Pipes	0.014

Culverts C-SR 100-Pipe Losses

Pipe head Losses

Pipe Losses	Coefficients
Entrance Loss	0.7
Exit Loss	1

Pipe Losses

Pipe Losses	Mannings n value
RCBC Concrete bo	0.014

SWMM Results

C-FS950 1in 20year ARI Base Scenario

Links

Name	Max Flow cms	Max Velocity m/s
Link28	0.00	0.00
cul1	3.98	4.59
Overflow	12.60	3.01
Link10	4.16	0.68
exist cul	1.86	2.79
Mc Road	5.78	2.57
old rd	5.78	2.57
Mc Weir1	2.52	0.00
MCWeir	2.52	0.00
Link11	4.37	1.27
Cul 4	0.32	1.22
Rd Weir2	2.37	1.89
road 1	2.37	1.89
Link17	3.00	0.59
Link24	1.83	0.56
Pipe	4.53	5.16
Link27	0.81	0.93
Link29	0.64	1.22
Link23	1.36	0.51
Link21	1.01	1.03
Link30	0.92	1.65
Link32	5.51	1.13
Channel	2.51	0.77

Nodes

Name	Max Water Elevation m	Invert Elevation m
C-FS950/d	16.89	13.44
C-FS950/q1	13.78	12.90
C-FS950/a	10.33	8.60
Node4	8.80	8.24
Node12	8.80	7.50
C-FS950/f	18.96	17.73
C-FS950/e	17.56	17.50
C-FS950/h	20.22	18.84
C-FS950/g	21.05	17.54
C-FS1100/a	16.43	16.30
Node23	15.03	14.88
C-FS950/b	11.24	11.00
C-FS1100/b	16.16	16.00
C-FS950/q2	19.17	19.00
Node29	10.61	10.50
Node31	19.79	19.75
Node34	9.77	9.60

C-FS750 1in 20year ARI Base Scenario

Name	Max Flow cms	Max Velocity m/s
Link20	0.28	0.84
Link34	0.61	1.74
Link35	0.00	0

Name	Max Water Elevation m	Invert Elevation m
C-FS750/a	13.34	13
Node28	11.28	11
C-FS750/b	14.42	13.8
Node33	13.89	13.6

C-FS1250 1in 20year ARI Base Scenario

Name	Max Flow cms	Max Velocity m/s
Link33	0.52	1.21

Name	Max Water Elevation m	Invert Elevation m
C-FS1250/a	22.07	22

SWMM Results

C-FS950 1in 20year ARI Ultimate Scenario

Links

Name	Max Flow cms	Max Velocity m/s
Link28	0.00	0.00
cul1	3.98	4.73
Link10	4.09	2.48
Link11	5.88	1.43
Cul 4	0.63	2.36
Rd Weir2	1.61	1.62
road 1	1.61	1.62
Link17	2.57	3.67
Link24	1.82	0.57
Pipe	4.50	5.12
Link27	0.36	0.66
Link29	0.42	1.07
Link23	1.11	0.50
FS1100	0.30	1.56
Link30	0.85	1.60
New cul 2	5.74	2.06
Box Cul	5.49	1.77
old rd	5.49	1.77
Link44	5.98	0.43
Link21	0.68	0.88
exist cul	1.91	2.86
Mc Road	4.04	2.23
Weir	0.88	0.00
Channel2	6.38	0.61
Mc Weir	0.88	0.00
Mc Weir1	4.00	0.00
MCweir	4.00	0.00
Road.1	0.00	0.00
Road	0.00	0.00
Channel	3.97	0.94

Nodes

Name	Max Water Elevation m	Invert Elevation m
C-FS950/d	16.89	13.44
C-FS950/q1	13.50	12.90
Node4	8.83	8.24
Node12	8.83	7.50
C-FS950/f	18.95	17.73
C-FS950/e	17.71	17.50
C-FS950/h	20.22	18.84
C-FS950/g	21.03	17.54
C-FS1100/a	16.40	16.30
Node23	14.99	14.88
C-FS950/b	11.21	10.50
C-FS1100/b	16.75	16.25
C-FS950/q2	19.16	19.00
C-FS950/a	10.55	9.40
C-FS950/i	10.38	8.70
Node39	16.13	16.00
Node41	10.38	8.60
Node46	9.82	9.60

C-FS750 1in 20year ARI Ultimate Scenario

Name	Max Flow cms	Max Velocity m/s
Link33	0.34	0.274
Link35	0.84	0.884
Cul 35	1.80	0.899
Link51	0.39	0.744

Name	Max Water Elevation m	Invert Elevation m
C-FS750/rd	13.53	13.5
Node32	11.24	10.75
Node33	10.33	10
Node43	12.74	11
C-FS750/a	12.83	12.75

C-FS1250 1in 20year ARI Ultimate Scenario

Name	Max Flow cm	Max Velocity m/s
Link47	0.52	0.65
Link38	0.50	0.77
cul 6.1	0.52	1.51

Name	Max Water Elevation r	Invert Elevation m
C-FS1250/a	22.07	22
C-FS1250/b	20.98	20.4
C-FS1250/c	20.11	19.7
Node42	21.82	20.7

Appendix M – Pipe Class Outputs

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Load Summary Sheet

DESIGN OF 750 DIA. FJ DRAINAGE PIPE

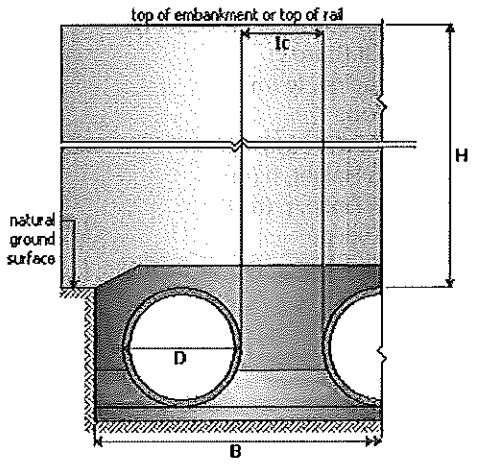
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS620
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	PipeClass_C7&C8.ppr

Design Parameters

Installation Condition:	embankment
Projection Type:	positive
Pipe Nominal Diameter (mm):	750
Pipe External Diameter, D (mm):	870
Number Of Barrels:	2
Barrel Spacing, Ic (m):	0.600
Soil Type:	other
Soil Density (kN/m³):	20
Soil Parameter K_μ:	0.1924
Width, B (m):	2.740
Height Of Fill, H (m):	1.900
Projection Height, h (m):	0.000
Projection Ratio, p (h/D):	0.000
Support Type:	H2
Bedding Factor:	2.0



Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/2.0	Wq/1.5	Tc	Pipe Class
earth	1.900	16.5		16.5	2
uniform surcharge load	1.900	21.8		21.8	2
W80	1.900	16.5	4.1	20.7	2
A160	1.900	16.5	5.7	22.2	2
M1600	1.900	16.5	7.4	23.9	2
S1600	1.900	16.5	6.1	22.7	2

All loads in kN/m. *Includes earth load at fill height shown.

Controlling Loads: earth + M1600 standard vehicle
Minimum Test Load: Tc = 16.5 + 7.4 = 23.9 kN/m

Short Term Load Cases/Combinations Considered (adjusted to pipe class 3)

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.400 - 5.364
CAT140H (Const)	0.000 - 5.441
CATD300E (Const)	0.400 - 5.288, 0.000 - 0.154
CAT621F (Const)	0.400 - 5.303
CAT815F (Const)	0.000 - 5.410

All loads in kN/m. *Includes earth load at fill ranges shown.

Adopt 750 dia. Class 3 FJ pipe (750/3 FJ) in accordance with AS/NZS 4058:2007.

Design Notes:
1. Short term live loads are considered as acting directly on the pipe (no distribution) in accordance with AS/NZS 3725:2007.
2. A nominal pipe wall thickness of 54 mm has been assumed.

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Installation and Quantities Sheet

INSTALLATION OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

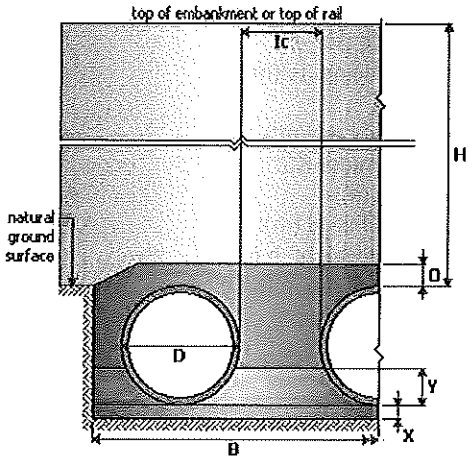
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS620
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	PipeClass_C7&C8.ppr

Design Parameters

Installation Condition:	embankment
Projection Type:	positive
Pipe Nominal Diameter (mm):	750
Pipe External Diameter, D (mm):	870
Number Of Barrels:	2
Barrel Spacing, Ic (m):	0.600
Width, B (m):	2.740
Height Of Fill, H (m):	1.900
Projection Height, h (m):	0.000
Projection Ratio, p (h/D):	0.000
Support Type:	H2
Excavation Volume (solid) (m^3/m):	2.7



Installation Quantities

Support Zone	Depth (mm)	Quantities(m^3/m)		Minimum Zone Compaction (%)	
		Solid	Loose	Density Index (for cohesionless soils)	Relative Density (standard compaction)
Bed zone	X = 100	0.274	0.329	60	-
Haunch zone	Y = 265	0.420	0.504	60	-
Overlay zone	O = 150	0.093	0.000	as per project specification	as per project specification

Material Grading Requirements

Sieve Size (mm)	75.0	19.0	9.5	2.36	0.60	0.30	0.15	0.075
Bed & Haunch Zones (% mass passing)	-	100	-	100-50	90-20	60-10	25-0	10-(

Construction Equipment Requirements

Name	Description	Allowable Fill Ranges* (m)
CPAAVR-10T	CPAA Construction Vehicle - Smooth Drum Vibratory Roller (...	0.400 - 5.364
CAT140H	Grader CAT 140H - Total weight 17.0 tonnes	0.000 - 5.441
CATD300E	Truck, Articulated CATD300E - Total weight (loaded) 49.2 t	0.400 - 5.288, 0.000 - 0.154
CAT621F	Scraper CAT621F - Total weight (loaded) 53.8t	0.400 - 5.303
CAT815F	Compacter, Soil CAT815F - Operating weight 20.9 t	0.000 - 5.410

*Equipment is not to be used outside of these fill ranges over top of pipe.

Design Notes:

1. All bed and haunch zone material passing the 0.075 mm sieve to have low plasticity (AS 1726).
2. Ordinary fill material to have no stones > 150 mm dia., and no more than 20% to be 75-150 mm.
3. For additional information refer to the project specification.
4. A nominal pipe wall thickness of 54 mm has been assumed.

DESIGN OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

Client And Project Details Date: 09-Feb-2009

Job number:	Design: C-FS620
Client:	Designer:
Project: New Project	Company:
Description:	File: PipeClass_C7&C8.ppr

Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/2.0	Wq/1.5	Tc	Pipe Class
earth	1.900	16.5		16.5	2
uniform surcharge load	1.900	21.8		21.8	2
W80	1.900	16.5	4.1	20.7	2
A160	1.900	16.5	5.7	22.2	2
M1600	1.900	16.5	7.4	23.9	2
S1600	1.900	16.5	6.1	22.7	2

All loads in kN/m. *Includes earth load at fill height shown

Short Term Load Cases/Combinations Considered (adjusted to pipe class 3)

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.400 - 5.364
CAT140H (Const)	0.000 - 5.441
CATD300E (Const)	0.400 - 5.288, 0.000 - 0.154
CAT621F (Const)	0.400 - 5.303
CAT815F (Const)	0.000 - 5.410

All loads in kN/m. *Includes earth load at fill ranges shown.

earth
Height of fill, H = 1.900 m

Embankment Condition, positive projection
Settlement ratio, rs = 1.000
Projection ratio, p = 0.000
Equal plane of settlement height, He = 0.000
Spangler coefficient, C'e = 1.000
Working load due to earth fill, Wg = 33.1 kN/m

W80
Footprint width at top of pipe, L1 = 3.256 m
Footprint length at top of pipe, L2 = 2.956 m
Footprint area, A = 9.625 m2
Load on footprint = 80.0 kN

Impact factor = 1.12
Live load pressure at top of pipe, q = 9.268 kPa

Minimum of L2 and D, S = 0.870 m
Effective supporting length of pipe, Le = 4.202 m

Working load due to live load, Wq = 6.2 kN/m

DESIGN OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

A160
Footprint width at top of pipe, L1 = 5.256 m
Footprint length at top of pipe, L2 = 2.956 m
Footprint area, A = 15.537 m2
Load on footprint = 160.0 kN

Impact factor = 1.12
Live load pressure at top of pipe, q = 11.482 kPa

Minimum of L2 and D, S = 0.870 m
Effective supporting length of pipe, Le = 6.202 m

Working load due to live load, Wq = 8.5 kN/m

S1600
Wheel footprint width at top of pipe, L1 = 5.256 m
Wheel footprint length at top of pipe, L2 = 5.454 m
Wheel footprint area, A = 28.666 m2
Load on wheel footprint = 240.0 kN

Impact factor = 1.00
Wheel pressure at top of pipe, q = 8.372 kPa

Minimum of L2 and D for wheel, S = 0.870 m
Effective supporting length of pipe for wheel, Le = 6.202 m

Working load due to live load, Wq (wheel) = 6.2 kN/m

UDL footprint width at top of pipe, L1 = 5.956 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 5.956 m2
Load on UDL footprint = 24.0 kN

Impact factor = 1.00
UDL pressure at top of pipe, q = 4.030 kPa

Minimum of L2 and D for UDL, S = 0.870 m
Effective supporting length of pipe for UDL, Le = 6.902 m

Working load due to live load, Wq (UDL) = 3.0 kN/m

Total working load due to live load, Wq = 9.2 kN/m

DESIGN OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

M1600
Wheel footprint width at top of pipe, L1 = 5.256 m
Wheel footprint length at top of pipe, L2 = 5.454 m
Wheel footprint area, A = 28.666 m2
Load on wheel footprint = 360.0 kN

Impact factor = 1.11
Wheel pressure at top of pipe, q = 13.940 kPa

Minimum of L2 and D for wheel, S = 0.870 m
Effective supporting length of pipe for wheel, Le = 6.202 m

Working load due to live load, Wq (wheel) = 10.3 kN/m

UDL footprint width at top of pipe, L1 = 5.956 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 5.956 m2
Load on UDL footprint = 6.0 kN

Impact factor = 1.11
UDL pressure at top of pipe, q = 1.118 kPa

Minimum of L2 and D for UDL, S = 0.870 m
Effective supporting length of pipe for UDL, Le = 6.902 m

Working load due to live load, Wq (UDL) = 0.8 kN/m

Total working load due to live load, Wq = 11.1 kN/m

uniform surcharge load
Working load due to uniform surcharge load, Wg = 10.4 kN/m

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Load Summary Sheet

DESIGN OF 900 DIA. FJ DRAINAGE PIPE

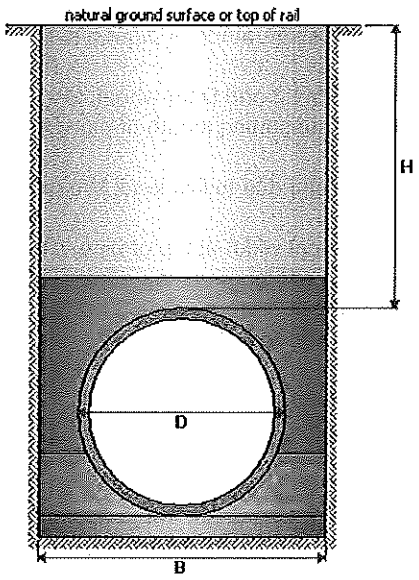
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS750
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Design Parameters

Installation Condition:	trench
Pipe Nominal Diameter (mm):	900
Pipe External Diameter, D (mm):	1029
Soil Type:	other
Soil Density (kN/m³):	20
Soil Parameter K_μ:	0.1924
Trench Width, B (m):	1.429
Height Of Fill, H (m):	1.400
Support Type:	H2
Bedding Factor:	2.0



Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/2.0	Wq/1.5	Tc	Pipe Class
earth	1.400	16.7		16.7	2
uniform surcharge load	1.400	22.8		22.8	2
W80	1.400	16.7	8.0	24.7	2
A160	1.400	16.7	10.4	27.1	2
M1600	1.400	16.7	11.5	28.2	2
S1600	1.400	16.7	8.7	25.4	2

All loads in kN/m. *Includes earth load at fill height shown.

Controlling Loads: earth + M1600 standard vehicle
Minimum Test Load: Tc = 16.7 + 11.5 = 28.2 kN/m

Short Term Load Cases/Combinations Considered (adjusted to pipe class 3)

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.000 - 50.000
CAT140H (Const)	0.000 - 50.000
CATD300E (Const)	0.000 - 50.000
CAT621F (Const)	0.400 - 50.000
CAT815F (Const)	0.000 - 50.000

All loads in kN/m. *Includes earth load at fill ranges shown.

Adopt 900 dia. Class 3 FJ pipe (900/3 FJ) in accordance with AS/NZS 4058:2007.

Design Notes:

1. Short term live loads are considered as acting directly on the pipe (no distribution) in accordance with AS/NZS 3725:2007.
2. A nominal pipe wall thickness of 57 mm has been assumed.

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Installation and Quantities Sheet

INSTALLATION OF 900 DIA. CLASS 3 FJ DRAINAGE PIPE

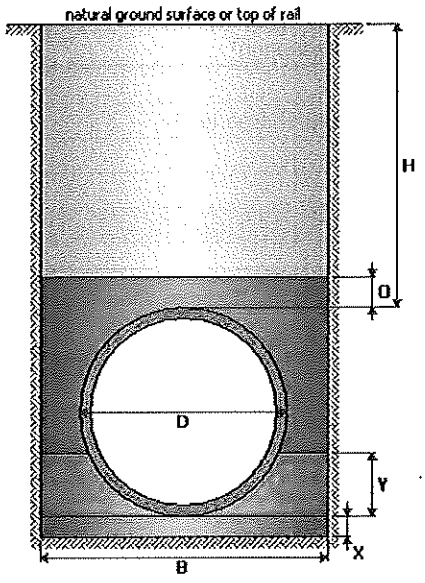
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS750
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Design Parameters

Installation Condition:	trench
Pipe Nominal Diameter (mm):	900
Pipe External Diameter, D (mm):	1029
Trench Width, B (m):	1.429
Height Of Fill, H (m):	1.400
Support Type:	H2
Excavation Volume (solid) (m³/m):	3.7



Installation Quantities

Support Zone	Depth (mm)	Quantities(m³/m)		Minimum Zone Compaction (%)	
		Solid	Loose	Density Index (for cohesionless soils)	Relative Density (standard compaction)
Bed zone	X = 100	0.143	0.172	60	-
Haunch zone	Y = 310	0.232	0.279	60	-
Overlay zone	O = 150	0.622	0.000	as per project specification	as per project specification
Backfill	1250	1.787	0.000	as per project specification	as per project specification

Material Grading Requirements

Sieve Size (mm)	75.0	19.0	9.5	2.36	0.60	0.30	0.15	0.075
Bed & Haunch Zones (% mass passing)	-	100	-	100-50	90-20	60-10	25-0	10-0

Construction Equipment Requirements

Name	Description	Allowable Fill Ranges* (m)
CPAAVR-10T	CPAA Construction Vehicle - Smooth Drum Vibratory Roller (...	0.000 - 50.000
CAT140H	Grader CAT 140H - Total weight 17.0 tonnes	0.000 - 50.000
CATD300E	Truck, Articulated CATD300E - Total weight (loaded) 49.2 t	0.000 - 50.000
CAT621F	Scraper CAT621F - Total weight (loaded) 53.8t	0.400 - 50.000
CAT815F	Compacter, Soil CAT815F - Operating weight 20.9 t	0.000 - 50.000

*Equipment is not to be used outside of these fill ranges over top of pipe.

Design Notes:

1. All bed and haunch zone material passing the 0.075 mm sieve to have low plasticity (AS 1726).
2. Ordinary fill material to have no stones > 150 mm dia., and no more than 20% to be 75-150 mm.
3. For additional information refer to the project specification.
4. The trench width shown above is not to be exceeded.
5. A nominal pipe wall thickness of 57 mm has been assumed.

DESIGN OF 900 DIA. CLASS 3 FJ DRAINAGE PIPE

Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS750
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/2.0	Wq/1.5	Tc	Pipe Class
earth	1.400	16.7		16.7	2
uniform surcharge load	1.400	22.8		22.8	2
W80	1.400	16.7	8.0	24.7	2
A160	1.400	16.7	10.4	27.1	2
M1600	1.400	16.7	11.5	28.2	2
S1600	1.400	16.7	8.7	25.4	2

All loads in kN/m. *Includes earth load at fill height shown

Short Term Load Cases/Combinations Considered (adjusted to pipe class 3)

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.000 - 50.000
CAT140H (Const)	0.000 - 50.000
CATD300E (Const)	0.000 - 50.000
CAT621F (Const)	0.400 - 50.000
CAT815F (Const)	0.000 - 50.000

All loads in kN/m. *Includes earth load at fill ranges shown.

earth
Height of fill, H = 1.400 m

Trench Condition, vertical walls
Spangler coefficient, Ct = 0.816
Working load due to earth fill, Wg = 33.3 kN/m

Positive Projection Check
Settlement ratio, rs = 1.000
Projection ratio, p = 0.389
Plane of equal settlement height, He = 1.400
Modified Spangler coefficient, C'e = 1.314
Working load due to earth fill, Wg = 37.9 kN/m

Trench controls, adopt Wg = 33.3 kN/m

W80
Footprint width at top of pipe, L1 = 2.530 m
Footprint length at top of pipe, L2 = 2.230 m
Footprint area, A = 5.642 m2
Load on footprint = 80.0 kN

Impact factor = 1.19
Live load pressure at top of pipe, q = 16.874 kPa

Minimum of L2 and D, S = 1.029 m
Effective supporting length of pipe, Le = 3.649 m

Working load due to live load, Wq = 12.0 kN/m

DESIGN OF 900 DIA. CLASS 3 FJ DRAINAGE PIPE

A160
Footprint width at top of pipe, L1 = 4.530 m
Footprint length at top of pipe, L2 = 2.230 m
Footprint area, A = 10.102 m2
Load on footprint = 160.0 kN

Impact factor = 1.19
Live load pressure at top of pipe, q = 18.848 kPa

Minimum of L2 and D, S = 1.029 m
Effective supporting length of pipe, Le = 5.649 m

Working load due to live load, Wq = 15.6 kN/m

S1600
Wheel footprint width at top of pipe, L1 = 4.730 m
Wheel footprint length at top of pipe, L2 = 4.530 m
Wheel footprint area, A = 21.427 m2
Load on wheel footprint = 240.0 kN

Impact factor = 1.00
Wheel pressure at top of pipe, q = 11.201 kPa

Minimum of L2 and D for wheel, S = 1.029 m
Effective supporting length of pipe for wheel, Le = 5.849 m

Working load due to live load, Wq (wheel) = 9.3 kN/m

UDL footprint width at top of pipe, L1 = 5.230 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 5.230 m2
Load on UDL footprint = 24.0 kN

Impact factor = 1.00
UDL pressure at top of pipe, q = 4.589 kPa

Minimum of L2 and D for UDL, S = 1.000 m
Effective supporting length of pipe for UDL, Le = 6.349 m

Working load due to live load, Wq (UDL) = 3.8 kN/m

Total working load due to live load, Wq = 13.1 kN/m

DESIGN OF 900 DIA. CLASS 3 FJ DRAINAGE PIPE

M1600
Wheel footprint width at top of pipe, L1 = 4.730 m
Wheel footprint length at top of pipe, L2 = 4.530 m
Wheel footprint area, A = 21.427 m2
Load on wheel footprint = 360.0 kN

Impact factor = 1.16
Wheel pressure at top of pipe, q = 19.490 kPa

Minimum of L2 and D for wheel, S = 1.029 m
Effective supporting length of pipe for wheel, Le = 5.849 m

Working load due to live load, Wq (wheel) = 16.2 kN/m

UDL footprint width at top of pipe, L1 = 5.230 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 5.230 m2
Load on UDL footprint = 6.0 kN

Impact factor = 1.16
UDL pressure at top of pipe, q = 1.331 kPa

Minimum of L2 and D for UDL, S = 1.000 m
Effective supporting length of pipe for UDL, Le = 6.349 m

Working load due to live load, Wq (UDL) = 1.1 kN/m

Total working load due to live load, Wq = 17.3 kN/m

uniform surcharge load
Working load due to uniform surcharge load, Wg = 12.3 kN/m

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Load Summary Sheet

DESIGN OF 2100 DIA. FJ DRAINAGE PIPE

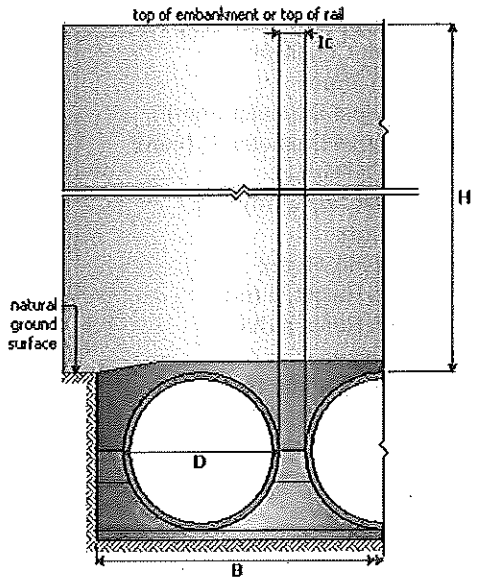
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS950
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Design Parameters

Installation Condition:	embankment
Projection Type:	positive
Pipe Nominal Diameter (mm):	2100
Pipe External Diameter, D (mm):	2388
Number Of Barrels:	3
Barrel Spacing, Ic (m):	0.398
Soil Type:	other
Soil Density (kN/m³):	20
Soil Parameter K_μ:	0.1924
Width, B (m):	8.756
Height Of Fill, H (m):	7.800
Projection Height, h (m):	0.000
Projection Ratio, p (h/D):	0.000
Support Type:	HS3
Bedding Factor:	4.0



Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/4.0	Wq/1.5	Ww/4.0	Tc	Pipe Class
earth + weight of internal water	7.800	93.1		7.0	100.2	3
uniform surcharge load	7.800	102.7		7.0	109.7	4
W80	7.800	93.1	0.9	7.0	101.0	3
A160	7.800	93.1	1.5	7.0	101.6	3
M1600	7.800	93.1	4.5	7.0	104.6	3
S1600	7.800	93.1	3.5	7.0	103.6	3

All loads in kN/m. *Includes earth load at fill height shown.

Controlling Loads: uniform surcharge load + weight of internal water
Minimum Test Load: Tc = 102.7 + 7.0 = 109.7 kN/m

Short Term Load Cases/Combinations Considered

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.000 - 11.653
CAT140H (Const)	0.000 - 11.676
CATD300E (Const)	0.000 - 11.586
CAT621F (Const)	0.000 - 11.586
CAT815F (Const)	0.000 - 11.659

All loads in kN/m. *Includes earth load at fill ranges shown.

Adopt 2100 dia. Class 4 FJ pipe (2100/4 FJ) in accordance with AS/NZS 4058:2007.

Design Notes:
1. Short term live loads are considered as acting directly on the pipe (no distribution) in accordance with AS/NZS 3725:2007.
2. A nominal pipe wall thickness of 102 mm has been assumed.

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Installation and Quantities Sheet

INSTALLATION OF 2100 DIA. CLASS 4 FJ DRAINAGE PIPE

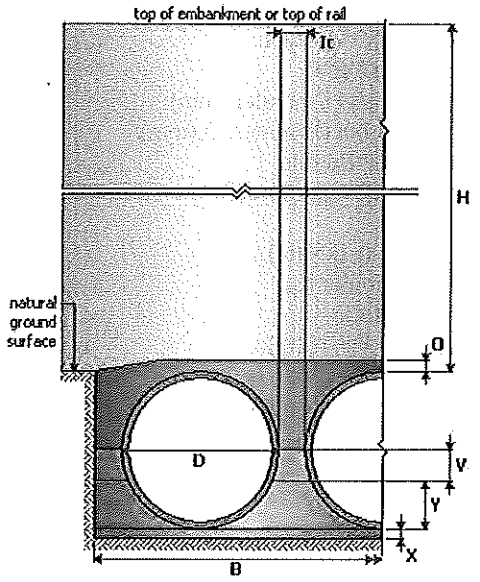
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS950
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Design Parameters

Installation Condition:	embankment
Projection Type:	positive
Pipe Nominal Diameter (mm):	2100
Pipe External Diameter, D (mm):	2388
Number Of Barrels:	3
Barrel Spacing, Ic (m):	0.398
Width, B (m):	8.756
Height Of Fill, H (m):	7.800
Projection Height, h (m):	0.000
Projection Ratio, p (h/D):	0.000
Support Type:	HS3
Excavation Volume (solid) (m^3/m):	22.3



Installation Quantities

Support Zone	Depth (mm)	Quantities(m^3/m)		Minimum Zone Compaction (%)	
		Solid	Loose	Density Index (for cohesionless soils)	Relative Density (standard compaction)
Bed zone	X = 150	1.314	1.577	70	-
Haunch zone	Y = 720	2.891	3.469	70	-
Side zone	V = 475	0.848	1.018	70	95
Overlay zone	O = 150	-4.651	0.000	as per project specification	as per project specification

Material Grading Requirements

Sieve Size (mm)	75.0	19.0	9.5	2.36	0.60	0.30	0.15	0.07
Bed & Haunch Zones (% mass passing)	-	100	-	100-50	90-20	60-10	25-0	10-0
Side Zone (% mass passing)	100	-	100-50	100-30	50-15	-	-	20-0

Construction Equipment Requirements

Name	Description	Allowable Fill Ranges* (m)
CPAAVR-10T	CPAA Construction Vehicle - Smooth Drum Vibratory Roller (...	0.000 - 11.653
CAT140H	Grader CAT 140H - Total weight 17.0 tonnes	0.000 - 11.676
CATD300E	Truck, Articulated CATD300E - Total weight (loaded) 49.2 t	0.000 - 11.586
CAT621F	Scraper CAT621F - Total weight (loaded) 53.8t	0.000 - 11.586
CAT815F	Compacter, Soil CAT815F - Operating weight 20.9 t	0.000 - 11.659

*Equipment is not to be used outside of these fill ranges over top of pipe.

Design Notes:

1. All bed, haunch and side zone material passing the 0.075 mm sieve to have low plasticity (AS 1726).
2. Ordinary fill material to have no stones > 150 mm dia., and no more than 20% to be 75-150 mm.
3. For additional information refer to the project specification.
4. A nominal pipe wall thickness of 102 mm has been assumed.

DESIGN OF 2100 DIA. CLASS 4 FJ DRAINAGE PIPE

Client And Project Details Date: 09-Feb-2009

Job number:		Design:	C-FS950
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/4.0	Wq/1.5	Ww/4.0	Tc	Pipe Class
earth + weight of internal water	7.800	93.1		7.0	100.2	3
uniform surcharge load	7.800	102.7		7.0	109.7	4
W80	7.800	93.1	0.9	7.0	101.0	3
A160	7.800	93.1	1.5	7.0	101.6	3
M1600	7.800	93.1	4.5	7.0	104.6	3
S1600	7.800	93.1	3.5	7.0	103.6	3

All loads in kN/m. *Includes earth load at fill height shown

Short Term Load Cases/Combinations Considered

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.000 - 11.653
CAT140H (Const)	0.000 - 11.676
CATD300E (Const)	0.000 - 11.586
CAT621F (Const)	0.000 - 11.586
CAT815F (Const)	0.000 - 11.659

All loads in kN/m. *Includes earth load at fill ranges shown.

weight of internal water
Working load due to water load, Ww = 28.1 kN/m

earth
Height of fill, H = 7.800 m

Embankment Condition, positive projection
Settlement ratio, rs = 1.000
Projection ratio, p = 0.000
Equal plane of settlement height, He = 0.000
Spangler coefficient, C'e = 1.000
Working load due to earth fill, Wg = 372.5 kN/m

W80
Footprint width at top of pipe, L1 = 11.810 m
Footprint length at top of pipe, L2 = 11.510 m
Footprint area, A = 135.933 m2
Load on footprint = 80.0 kN

Impact factor = 1.10
Live load pressure at top of pipe, q = 0.647 kPa

Minimum of L2 and D, S = 2.388 m
Effective supporting length of pipe, Le = 14.407 m

Working load due to live load, Wq = 1.3 kN/m

DESIGN OF 2100 DIA. CLASS 4 FJ DRAINAGE PIPE

A160
Footprint width at top of pipe, L1 = 13.810 m
Footprint length at top of pipe, L2 = 11.510 m
Footprint area, A = 158.953 m2
Load on footprint = 160.0 kN

Impact factor = 1.10
Live load pressure at top of pipe, q = 1.107 kPa

Minimum of L2 and D, S = 2.388 m
Effective supporting length of pipe, Le = 16.407 m

Working load due to live load, Wq = 2.2 kN/m

S1600
Wheel footprint width at top of pipe, L1 = 13.810 m
Wheel footprint length at top of pipe, L2 = 36.510 m
Wheel footprint area, A = 504.203 m2
Load on wheel footprint = 960.0 kN

Impact factor = 1.00
Wheel pressure at top of pipe, q = 1.904 kPa

Minimum of L2 and D for wheel, S = 2.388 m
Effective supporting length of pipe for wheel, Le = 16.407 m

Working load due to live load, Wq (wheel) = 3.8 kN/m

UDL footprint width at top of pipe, L1 = 14.510 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 14.510 m2
Load on UDL footprint = 24.0 kN

Impact factor = 1.00
UDL pressure at top of pipe, q = 1.654 kPa

Minimum of L2 and D for UDL, S = 1.000 m
Effective supporting length of pipe for UDL, Le = 17.107 m

Working load due to live load, Wq (UDL) = 1.4 kN/m

Total working load due to live load, Wq = 5.2 kN/m

DESIGN OF 2100 DIA. CLASS 4 FJ DRAINAGE PIPE

M1600
Wheel footprint width at top of pipe, L1 = 13.810 m
Wheel footprint length at top of pipe, L2 = 36.510 m
Wheel footprint area, A = 504.203 m2
Load on wheel footprint = 1440.0 kN

Impact factor = 1.10
Wheel pressure at top of pipe, q = 3.142 kPa

Minimum of L2 and D for wheel, S = 2.388 m
Effective supporting length of pipe for wheel, Le = 16.407 m

Working load due to live load, Wq (wheel) = 6.3 kN/m

UDL footprint width at top of pipe, L1 = 14.510 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 14.510 m2
Load on UDL footprint = 6.0 kN

Impact factor = 1.10
UDL pressure at top of pipe, q = 0.455 kPa

Minimum of L2 and D for UDL, S = 1.000 m
Effective supporting length of pipe for UDL, Le = 17.107 m

Working load due to live load, Wq (UDL) = 0.4 kN/m

Total working load due to live load, Wq = 6.7 kN/m

uniform surcharge load
Working load due to uniform surcharge load, Wg = 38.2 kN/m

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Load Summary Sheet

DESIGN OF 750 DIA. FJ DRAINAGE PIPE

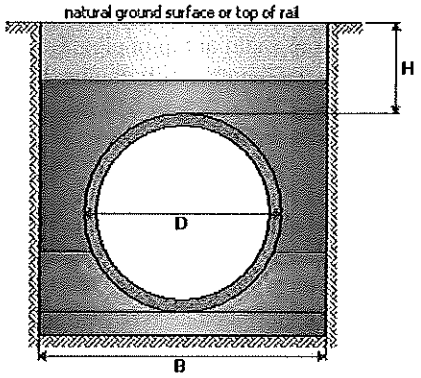
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS1250
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Design Parameters

Installation Condition:	trench
Pipe Nominal Diameter (mm):	750
Pipe External Diameter, D (mm):	870
Soil Type:	other
Soil Density (kN/m³):	20
Soil Parameter K_μ:	0.1924
Trench Width, B (m):	1.270
Height Of Fill, H (m):	0.400
Support Type:	H2
Bedding Factor:	2.0



Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/2.0	Wq/1.5	Tc	Pipe Class
earth	0.400	3.8		3.8	2
uniform surcharge load	0.400	9.0		9.0	2
W80	0.400	3.8	35.3	39.1	3
A160	0.400	3.8	35.3	39.1	3
M1600	0.400	3.8	25.8	29.6	2
S1600	0.400	3.8	16.1	19.9	2

All loads in kN/m. *Includes earth load at fill height shown.

Controlling Loads: earth + W80 standard vehicle
Minimum Test Load: Tc = 3.8 + 35.3 = 39.1 kN/m

Short Term Load Cases/Combinations Considered

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.400 - 50.000
CAT140H (Const)	0.000 - 50.000
CATD300E (Const)	0.400 - 50.000, 0.000 - 0.149
CAT621F (Const)	0.400 - 50.000
CAT815F (Const)	0.000 - 50.000

All loads in kN/m. *Includes earth load at fill ranges shown.

Adopt 750 dia. Class 3 FJ pipe (750/3 FJ) in accordance with AS/NZS 4058:2007.

Design Notes:

1. Long term live loads are considered as acting directly on the pipe (no distribution) in accordance with AS/NZS 3725:2007.
2. Short term live loads are considered as acting directly on the pipe (no distribution) in accordance with AS/NZS 3725:2007.
3. A nominal pipe wall thickness of 54 mm has been assumed.

Concrete Pipe Association of Australasia

CPAA
PipeClass
Pipe Installation and Quantities Sheet

INSTALLATION OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

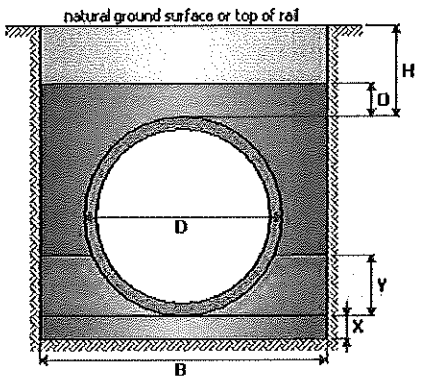
Client And Project Details

Date: 09-Feb-2009

Job number:		Design:	C-FS1250
Client:		Designer:	
Project:	New Project	Company:	
Description:		File:	Francis Street.ppr

Design Parameters

Installation Condition:	trench
Pipe Nominal Diameter (mm):	750
Pipe External Diameter, D (mm):	870
Trench Width, B (m):	1.270
Height Of Fill, H (m):	0.400
Support Type:	H2
Excavation Volume (solid) (m³/m):	1.8



Installation Quantities

Support Zone	Depth (mm)	Quantities(m³/m)		Minimum Zone Compaction (%)	
		Solid	Loose	Density Index (for cohesionless soils)	Relative Density (standard compaction)
Bed zone	X = 100	0.127	0.153	60	-
Haunch zone	Y = 265	0.184	0.221	60	-
Overlay zone	O = 150	0.518	0.000	as per project specification	as per project specification
Backfill	250	0.318	0.000	as per project specification	as per project specification

Material Grading Requirements

Sieve Size (mm)	75.0	19.0	9.5	2.36	0.60	0.30	0.15	0.075
Bed & Haunch Zones (% mass passing)	-	100	-	100-50	90-20	60-10	25-0	10-0

Construction Equipment Requirements

Name	Description	Allowable Fill Ranges* (m)
CPAAVR-10T	CPAA Construction Vehicle - Smooth Drum Vibratory Roller (...	0.400 - 50.000
CAT140H	Grader CAT 140H - Total weight 17.0 tonnes	0.000 - 50.000
CATD300E	Truck, Articulated CATD300E - Total weight (loaded) 49.2 t	0.400 - 50.000, 0.000 - 0.149
CAT621F	Scraper CAT621F - Total weight (loaded) 53.8t	0.400 - 50.000
CAT815F	Compacter, Soil CAT815F - Operating weight 20.9 t	0.000 - 50.000

*Equipment is not to be used outside of these fill ranges over top of pipe.

Design Notes:

1. All bed and haunch zone material passing the 0.075 mm sieve to have low plasticity (AS 1726).
2. Ordinary fill material to have no stones > 150 mm dia., and no more than 20% to be 75-150 mm.
3. For additional information refer to the project specification.
4. A nominal pipe wall thickness of 54 mm has been assumed.

DESIGN OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

Client And Project Details Date: 09-Feb-2009

Job number:		Design:	C-FS1250
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Project:	New Project	Company:	
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Long Term Load Cases/Combinations Considered (controlling load case/combination highlighted)

Load Description*	Fill Height (m)	Wg/2.0	Wq/1.5	Tc	Pipe Class
earth	0.400	3.8		3.8	2
uniform surcharge load	0.400	9.0		9.0	2
W80	0.400	3.8	35.3	39.1	3
A160	0.400	3.8	35.3	39.1	3
M1600	0.400	3.8	25.8	29.6	2
S1600	0.400	3.8	16.1	19.9	2

All loads in kN/m. *Includes earth load at fill height shown

Short Term Load Cases/Combinations Considered

Load Description*	Allowable Fill Ranges (m)
CPAAVR-10T (Const)	0.400 - 50.000
CAT140H (Const)	0.000 - 50.000
CATD300E (Const)	0.400 - 50.000, 0.000 - 0.149
CAT621F (Const)	0.400 - 50.000
CAT815F (Const)	0.000 - 50.000

All loads in kN/m. *Includes earth load at fill ranges shown.

earth
Height of fill, H = 0.400 m

Trench Condition, vertical walls
Spangler coefficient, Ct = 0.297
Working load due to earth fill, Wg = 9.6 kN/m

Positive Projection Check
Settlement ratio, rs = 1.000
Projection ratio, p = 0.389
Plane of equal settlement height, He = 0.400
Modified Spangler coefficient, C'e = 1.094
Working load due to earth fill, Wg = 7.6 kN/m

Positive projection controls, adopt Wg = 7.6 kN/m

W80
Footprint width at top of pipe, L1 = 1.080 m
Footprint length at top of pipe, L2 = 0.780 m
Footprint area, A = 0.842 m2
Load on footprint = 80.0 kN

Impact factor = 1.34
Live load pressure at top of pipe, q = 127.255 kPa

Minimum of L2 and D, S = 0.780 m
Effective supporting length of pipe, Le = 2.026 m

Working load due to live load, Wq = 52.9 kN/m

DESIGN OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

A160
Footprint width at top of pipe, L1 = 1.080 m
Footprint length at top of pipe, L2 = 0.780 m
Footprint area, A = 0.842 m2
Load on footprint = 80.0 kN

Impact factor = 1.34
Live load pressure at top of pipe, q = 127.255 kPa

Minimum of L2 and D, S = 0.780 m
Effective supporting length of pipe, Le = 2.026 m

Working load due to live load, Wq = 52.9 kN/m

S1600
Wheel footprint width at top of pipe, L1 = 1.080 m
Wheel footprint length at top of pipe, L2 = 0.780 m
Wheel footprint area, A = 0.842 m2
Load on wheel footprint = 40.0 kN

Impact factor = 1.00
Wheel pressure at top of pipe, q = 47.483 kPa

Minimum of L2 and D for wheel, S = 0.780 m
Effective supporting length of pipe for wheel, Le = 2.026 m

Working load due to live load, Wq (wheel) = 19.7 kN/m

UDL footprint width at top of pipe, L1 = 3.780 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 3.780 m2
Load on UDL footprint = 24.0 kN

Impact factor = 1.00
UDL pressure at top of pipe, q = 6.349 kPa

Minimum of L2 and D for UDL, S = 0.870 m
Effective supporting length of pipe for UDL, Le = 4.726 m

Working load due to live load, Wq (UDL) = 4.4 kN/m

Total working load due to live load, Wq = 24.1 kN/m

DESIGN OF 750 DIA. CLASS 3 FJ DRAINAGE PIPE

M1600

Wheel footprint width at top of pipe, L1 = 1.080 m
Wheel footprint length at top of pipe, L2 = 0.780 m
Wheel footprint area, A = 0.842 m2
Load on wheel footprint = 60.0 kN

Impact factor = 1.26
Wheel pressure at top of pipe, q = 89.744 kPa

Minimum of L2 and D for wheel, S = 0.780 m
Effective supporting length of pipe for wheel, Le = 2.026 m

Working load due to live load, Wq (wheel) = 37.3 kN/m

UDL footprint width at top of pipe, L1 = 3.780 m
UDL Footprint length at top of pipe, L2 = 1.000 m
UDL footprint area, A = 3.780 m2
Load on UDL footprint = 6.0 kN

Impact factor = 1.26
UDL pressure at top of pipe, q = 2.000 kPa

Minimum of L2 and D for UDL, S = 0.870 m
Effective supporting length of pipe for UDL, Le = 4.726 m

Working load due to live load, Wq (UDL) = 1.4 kN/m

Total working load due to live load, Wq = 38.7 kN/m

uniform surcharge load

Working load due to uniform surcharge load, Wg = 10.4 kN/m

Appendix N – Sub-catchment land use break-up

C-FS 620/C16150

Base scenario

Catchment	Total Area (ha)	LAND USE TYPE					Impervious Percentage
		Rural	Rural Residential	Road	Urban	Open Space	
C16150/a	0.78			100%			100%
C16150/b	2.44				28%	72%	17%
C16150/c	1.60			18%	32%	50%	37%
C16150/rd1	0.30			100%			100%
C16150/rd2	0.11			100%			100%
C16150/g1	0.76			44%		56%	44%
C16150/g2	1.17			34%		66%	34%
C16150/rd3	0.29			100%			100%

Upgrade scenario

Catchment	Total Area (ha)	LAND USE TYPE					Impervious Percentage
		Rural	Rural Residential	Road	Urban	Open Space	
C16150/a	0.78			100%			100%
C16150/b	2.07				28%	72%	17%
C16150/r71	0.22			100%			100%
C16150/r72	0.26			100%			100%
C16150/h	1.89					100%	0%
C16150/z	0.25			60%		40%	60%

FRANCIS STREET

Base scenario

Catchment	Total Area (ha)	LAND USE TYPE					Impervious Percentage
		Rural	Commericial	Road	Urban	Open Space	
C-FS750							
C-FS750/a	0.68			40%		60%	20%
C-FS750/b	1.50			18%	35%	47%	100%
C-FS950							
C-FS950/a	1.71				83%	17%	47%
C-FS950/b	2.68				100%		60%
C-FS950/qr1	0.46			100%			100%
C-FS950/qr2	1.32		20%	80%			98%
C-FS950/d	1.43		100%				90%
C-FS950/e	0.76			53%		47%	53%
C-FS950/f	0.75					100%	0%
C-FS950/g	11.86				100%		60%
C-FS950/h	4.09				100%		60%
C-FS1100/a	0.94		75%	25%			92%
C-FS1100/b	0.57		100%				50%
C-FS950							
C-FS1250/a	0.94				100%		60%
C-FS1250/r	0.11			100%			100%

Upgrade scenario

Catchment	Total Area (ha)	LAND USE TYPE					Impervious Percentage
		Rural	Commericial	Road	Urban	Open Space	
C-FS750							
C-FS750/a	2.55			9%	19%	72%	20%
C-FS750/rd	0.43			100%			100%
C-FS950							
C-FS950/a	1.34				78%	22%	47%
C-FS950/b	2.24				100%		60%
C-FS950/qr1	0.46			100%			100%
C-FS950/qr2	1.32		20%	80%			98%
C-FS950/d	1.43		100%				90%
C-FS950/e	0.76			53%		47%	53%
C-FS950/f	0.75					100%	0%
C-FS950/g	11.86				100%		60%
C-FS950/h	4.09				100%		60%
C-FS950/i	0.86					100%	0%
C-FS1100/a	0.66		75%	25%			92%
C-FS1100/b	0.57			50%		50%	50%
C-FS950							
C-FS1250/a	0.94				100%		60%
C-FS1250/r	0.11			100%			100%