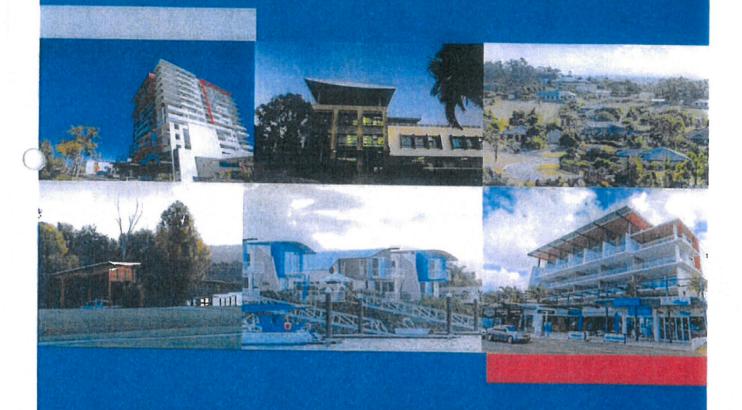


ROCKHAMPTON REGIONAL COUNCIL

These plans are approved subject to the current conditions of approval associated with Development Permit No. D. 1.2.791-2.213

Dated 1.0.03-2.014





Engineering Infrastructure Report

Crestwood Estate - Corner Rockhampton - Yeppoon Road & Norman Road, Norman Gardens

Residential Development - Stages 3B, 9, 10A, 10B and 11 (80 Lots)

Prepared for Citimark Properties



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2012

DOCUMENT CONTROL

Engineering Report - 2013

Issue	Date	Issue Details	Author	Checked	Approved
A	State of the second	Original Issue	MD	RS	
В	13 September 2013	Revised Issue	RS	JD	Jeff Davey RPEQ 8386



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1. INTRODUCTION

Brown Consulting (QLD) Pty Ltd has prepared the following report to address the civil engineering issues associated with the "Development Permit for Reconfiguration of a Lot" Application for stages 3B, 9, 10A, 10B and 11 of Crestwood Estate. Stages 3B, 9, 10A, 10B and 11 consist of 80 allotments and are a continuation of existing approvals or applications comprising of the fully constructed stage 1 from the formally known Chancellors Estate and stages 2, 3A, 4, 5, 6, 7 and 8 of Crestwood Estate.

This residential subdivision is proposed for development on existing Lot 300 on SP216105 and has previously received Reconfiguration of a Lot approval for stages 2, 3A and 4. An extension of time and permissible change to the approval for stages 5 and 6 has been submitted to Rockhampton Regional Council for assessment and approval. Further to this, an amendment to the Reconfiguration of a Lot approval for stages 7 and 8 is currently under assessment. Operational Works applications have been completed and submitted to the Rockhampton Regional Council for assessment of stages 2, 3A, and 4 in separate applications.

Stages 3B, 9, 10A, 10B and 11 are located to the north of Foulkes Street continuing on from previously constructed stages of Chancellors Estate and the Crestwood Development. The Crestwood Development is located adjacent to CQ University as well as other residential developments along the Norman Road growth corridor in the popular Norman Gardens suburb. The locality of the subject site can be seen in the following illustration.





2. STAGING

This proposal is for an 80 lot residential subdivision to be constructed over 5 stages (Stages 3B, 9, 10A, 10B and 11) (refer Appendix B). These proposed 80 allotments are a continuation of existing approvals or applications comprising of the fully constructed stage 1 of the former Chancellors Estate and stage 2, 3A, 4, 5, 6, 7 and 8 of Crestwood Estate. Stage 1 of the formally known Chancellors Estate consists of 65 residential allotments many of which are currently occupied with new homes. Stage 2 of Crestwood Estate comprises of 25 allotments, stage 3A consists of 14 allotments and stage 4 consists of 7 allotments all of which are for residential purposes. In addition, there are 20 allotments in stage 5, 28 allotments in stage 6, 20 allotments in stage 7 and 11 allotments as part of stage 8.

With the proposed 80 allotments included as part of this application for Reconfiguration of a Lot for stages 3B, 9 10A, 10B and 11, stage 3B comprises of 6 allotments, stage 9 includes 16 allotments, stage 10A consists of 14 allotments, stage 10B includes 7 allotments and stage 11 comprises of 37 allotments. In the entire Crestwood development, there are 205 residential allotments excluding the existing 65 allotments as part of the former Chancellors Estate.

A development plan prepared by Capricorn Survey Group is included in Appendix A and a staging plan prepared by Brown Consulting is enclosed in Appendix B.

3. GOOD PRACTICE URBAN DESIGN PRINCIPLES

The proposed development has been designed to incorporate best practices for urban developments, which are as follows:

- A mixture of gentle graded blocks, sloping allotments and elevated allotments will be incorporated into the proposed development. This ensures that the majority of the community is catered for from first home owners, to investors to luxury dwellings.
- Single access to Norman Road (Sub-Arterial Road) for the entire development with suitable approaches and sight distances. No allotments will gain access from either Norman Road or Foulkes Street (Major Collector Road). In particular, stage 3B of the development accesses from Geoff Wilson Drive and Stan Jones Street. Geoff Wilson Drive is classified as a Minor Urban Collector standard road and will be extended to provide access to all allotments in stages 9, 10A, 10B and 11 of the Crestwood development.
- Loop/ring and short cul-de-sac roads are used throughout the layout providing short, safe access and manoeuvrability around the development.



- Pedestrian links are strategically positioned throughout the development joining roadways, while
 providing good access to amenities within the development and also to external roadway
 networks.
- Stormwater drainage strategies will be incorporated and consist of natural vegetated swales and
 channels and bio-retention systems, providing low maintenance stormwater polishing and
 ensuring runoff is managed and discharged with minimal impact to the environment, whilst
 adding to the appearance of the development.

4. SITEWORKS/EROSION CONTROL/GROUND CONDITION

Siteworks for the development will consist of the following stages:

- Clearing and grubbing
- Bulk earthworks
- Underground services installation
- Roadworks and stormwater drainage works
- Final detailed works
- Vegetation establishment and landscaping

Preliminary earthworks plans for the development have been included in Appendix C1 of this report.

All stockpiles are to be segregated into topsoil, pavements, sands and protected with appropriate silt traps and fences. All stockpiles are to be accessed from the upstream side to reduce erosion and maintain consistency throughout the project construction phase. Erosion control measures are to be implemented during construction in accordance with the Capricorn Municipal Development Guidelines requirements (refer Appendix C2). All erosion control measures are to be closely monitored by the Principal Contractor and re-established after all rain events or due to any vandalism.



5. SEWERAGE RETICULATION

A sewerage reticulation strategy has been prepared for the proposed residential development (Refer Appendix D).

Existing gravity sewer reticulation is located within the vicinity of the proposed stages 3B, 9, 10A, 10B and 11 of the Crestwood development. A gravity sewer network is currently installed and operational to service existing allotments in stage 1 of the former Chancellors estate. This gravity sewer network flows into a sewage pump station completed as part of the stage 1 operational works. The sewage pump station has been commissioned by Rockhampton Regional Council and has the capacity to service the entire Crestwood development.

Stages 3B, 9, 10A, 10B and 11 will connect into existing gravity reticulation mains completed as part of the existing stage 1 flowing into the existing sewage pump station. New gravity sewer mains will be installed to service all proposed lots in these stages as shown in Appendix D of this report. No upgrades will be required to existing sewer infrastructure associated with providing sewer reticulation to these particular stages of the development.

With the existing sewage pump station in close proximity to stages 3B, 9, 10A, 10B and 11 of the development, and the pump station having the capacity to service the entire development, a Sewerage Network Analysis has not been requested from Rockhampton Regional Council. If council require a Sewerage Network Analysis, this can be completed as part of the future operational works application.

Appendix D includes concept plans of the proposed sewer reticulation strategy for stages 3B, 9, 10A, 10B and 11. The digital terrain model of the development site completed by Capricorn Survey Group indicates that the site generally has steep terrain, especially on the north eastern side of the development with a natural slope of 1 in 4 in various areas. Gentle grades are more prominent on the north western corner of the site with the entire site generally falling towards the road reserve of Norman Road. Therefore based on the data provided, there appears to be no engineering difficulties with obtaining sufficient grades and cover for the proposed reticulation network to service stages 3B, 9, 10A, 10B and 11 of the development.



6. WATER RETICULATION

A water reticulation strategy has been prepared for the subject land (refer Appendix E1).

All internal allotments will be serviced by new reticulation mains situated in all new road reserves and designed to provide good loop connections throughout the site. Internal fire hydrants will be installed on all new watermains at 80m centres and in accordance with the requirements of the Capricorn Municipal Development Guidelines.

The development will connect into the water reticulation mains in Geoff Wilson Drive and Stan Jones Street completed as part of the existing stage 1 of the former Chancellors Estate. New reticulation mains will be constructed from the existing water mains on Geoff Wilson Drive and Stan Jones Street to service stage 3B of the development. New water mains will be extended in the Geoff Wilson Drive road corridor to service stages 9, 10 and 11. Ultimately, the development is serviced by an existing reticulation main in the Foulkes Street road reserve which is serviced by the Norman Road water network.

A water supply network analysis has been requested from Rockhampton Regional Council to ensure that the proposed development does not adversely affect the pressure and flow rates to existing surrounding allotments and infrastructure. The letter requesting this analysis is included in Appendix E2.

7. STORMWATER MANAGEMENT

The aim of the stormwater strategy is to try to maintain the natural flowpaths that flow through the development site with minimal realignment. Water quantity and quality objectives are to be met in accordance with the QUDM, CMDG & Healthy Waterways ensuring the surrounding environment, allotments and infrastructure are not adversely affected due to this residential subdivision. Please refer to the Stormwater Management Report for details regarding water quantity and quality measures to be implemented in the development works.



8. ROADWORKS/PEDESTRIAN NETWORKS

8.1. Roadworks/Road Hierarchy

The proposed development will be accessed from Geoff Wilson Drive and Stan Jones Street (refer Appendix F).

The entire Crestwood development is accessed from Foulkes Street which is classified as a Major Urban Collector Road in accordance with the Capricorn Municipal Development Guidelines. Foulkes Street has an estimated traffic flow of between 3000 – 6000 AADT and has the capacity to adequately cater for the entire Crestwood development.

Stage 3B receives access from Geoff Wilson Drive and Stan Jones Street which services a number of existing allotments and is proposed to service stages 9, 10A, 10B and 11 as well as other stages of the Crestwood development. Geoff Wilson Drive is classified as a Minor Urban Collector road and will ultimately have a traffic flow catchment of approximately 120 - 130 allotments generating 1200 - 1300 AADT. Geoff Wilson Drive will be extended to service allotments in stage 3B and further extensions will be completed to adequately cater for stages 9, 10A, 10B and 11 of the development.

Geoff Wilson Drive will be constructed at 7.5m wide (invert to invert) in a minimum 18.0m wide road reserve. A 1.2m pathway will be constructed along the full length of the proposed section of Geoff Wilson Drive in accordance with the Capricorn Municipal Development Guidelines.

To monitor and control speed environments through the residential subdivision and in particular on large sweeping bends, the horizontal curve on Geoff Wilson Drive in stage 11 (crossing the stormwater culverts) has been assigned an advisory speed environment of 40km/h around the curve. Advisory signs for a 40km/h speed will be installed at suitable distances from the curve and in accordance with the requirements of the Manual of Uniform Traffic Control Devices (MUTCD). By implementing the advisory speed for the horizontal curve on Geoff Wilson Drive, safe intersection sight distance can be adequately achieved and the safety of residents and pedestrians taken into consideration.

Stan Jones Street will be extended as part of the roadworks for stage 3B of the development. The existing portion of Stan Jones Street in stage 1 is classified as a Minor Urban Collector as it will have an overall catchment of greater than 75 allotments. The proposed extension of Stan Jones Street will be constructed as an Urban Access Street standard and will service between 25 and 75 allotments and will therefore generate an AADT of between 250 and 750. This proposed road will be 7.5m wide (invert to invert) and be constructed in a minimum 16.0m wide road reserve. No pathway will be constructed along the proposed roadway.



It is proposed that Road H in stage 11 will be constructed as an Urban Access Street standard road in accordance with the Capricorn Municipal Development Guidelines. In this development, Road H will service around 25 allotments and generate 250 AADT. With an Urban Access Street capable of servicing 25 – 75 allotments, Road H will have the capacity for extension to service future allotments as part of neighbouring developments. Road H will be constructed at 7.5m wide (invert to invert) in a minimum 16.0m road reserve. No pathway is required for this roadway.

Roads B, C, E, F, G and I will be constructed as an Urban Access Place in accordance with the Capticorn Municipal Development Guidelines. These roadways will service under 25 allotments and have a traffic flow no greater than 250 AADT allowing an Urban Access Place standard road to be adequate. They will be constructed at 5.5m wide (invert to invert) in a minimum 16.0m wide road reserve. No pathway is required for these roads.

It is proposed that allotments 203 and 204 as part of stage 9 of the development will access from Bruce Hiskins Court which was constructed as part of the existing stage 1 of the former Chancellors Estate. Bruce Hiskins Court is currently an Urban Access Street standard road and services 20 allotments generating an AADT of 200. Therefore, Bruce Hiskins Court can adequately cater for the accesses of two additional allotments as part of stage 9 of the Crestwood development. Two separate accesses will be constructed to service lots 203 and 204 at the head of the cul-de-sac in Bruce Hiskins Court. Furthermore, allotments 202 and 205 will access from the Y head at the end of Road F in stage 9 of the development.



8.2. Intersection Sight Distance

The intersection of Geoff Wilson Drive and Road G in Stage 10 has been strategically designed and planned to comply with the sight distance requirements in accordance with the Department of Transport and Main Roads Queensland, Road Planning Design Manual (RPDM), Section 13 – Intersections at Grade. With Road G intersecting Geoff Wilson Drive in close proximity to a horizontal curve, the intersection and subsequent road corridors have been modelled and designed in order to meet the sight distance requirements of the RPDM. With Geoff Wilson Drive being a Minor Urban Collector road, a design speed of 50km/h is implemented for the road corridor as per the Capricorn Municipal Development Guidelines.

As per Table 13.5 of Section 13 – Intersections at Grade from the RPDM, the Safe Intersection Sight Distance (SISD) for a road with a design speed of 50km/h and a desirable 2.5 second reaction time is 96.0m. Geoff Wilson Drive has a longitudinal grade towards the intersection of Road G of approximately 0.5% - 3.0%. In accordance with Table 13.6 of Section 13 – Intersections at Grade from the RPDM, no correction has been applied to the Safe Intersection Sight Distance (SISD) due to the minimal longitudinal grade of the roadway within the vicinity of the intersection. Therefore, for the Geoff Wilson Drive and Road G intersection, the Safe Intersection Sight Distance (SISD) for the North Eastern leg on Geoff Wilson Drive is 96.0m.

As stated in section 8.1 – Roadworks/Road Hierarchy of this Engineering Infrastructure Report, it is proposed that an advisory speed environment of 40km/h be implemented for the large horizontal curve on Geoff Wilson Drive crossing the culverts in stage 11 of the development. Therefore, this will reduce the Safe Intersection Sight Distance (SISD) in the south western direction for vehicles performing a right hand turn from Road G onto Geoff Wilson Drive. This allows adequate sight distance to be achieved for the south western leg of Geoff Wilson Drive for the Road G intersection. As per the requirements of Section 13 – Intersections at Grade from the RPDM, the Safe Intersection Sight Distance (SISD) for a 40km/h design speed and a 2.5 second desirable reaction time is 72.0m.

This intersection has been designed to meet these requirements for sight distance in horizontal geometry with the minimum distance from the lip of kerb of Geoff Wilson Drive to the vehicle's driver set at 3.0m as per Section 13 – Intersections at Grade from the RPDM and this is illustrated in Appendix F of this report. With Geoff Wilson Drive having a longitudinal grade of around 0.5% – 3.0% on the approaches of the intersection, there is no difficulties with obtaining sight distance in relation to the vertical geometry of the intersecting Geoff Wilson Drive and Road G. This is detailed on the Geoff Wilson Drive longitudinal section included in Appendix F.



Furthermore, the other prominent intersection for sight distance issues within this stage of the development is that of the intersection of Geoff Wilson Drive and Road I in stage 11. This intersection has been checked to comply with the sight distance requirements as outlined in the Road Planning Design Manual (RPDM). With Geoff Wilson Drive classified as a Minor Urban Collector standard road and therefore having a speed environment of 50km/h, the Safe Intersection Sight Distance (SISD) required for this intersection is 96.0m in both directions. The vertical geometry of Geoff Wilson Drive is minimal within the vicinity of the intersection; therefore no correction of this distance is required as per the requirements outlined in the RPDM. Included in Appendix F of this Engineering Infrastructure Report is a plan detailing the sight distance available for this intersection. Road I has been strategically designed and planned to intersect with Geoff Wilson Drive at a suitable horizontal and vertical geometry and therefore meets the requirements for Safe Intersection Sight Distance (SISD) as indicated.



8.3. Summary

Preliminary longitudinal sections of all roads are illustrated in Appendix F. All proposed roads will be built in accordance with the Capricorn Municipal Development Guidelines with all public roads having a maximum slope of 1:6. Private driveways will have a maximum longitudinal grade of 1:5 in accordance with the Capricorn Municipal Development Guidelines. The cross sectional profiles of each road will be as per standard drawings in the Capricorn Municipal Development Guidelines. Detailed longitudinal and cross sections will be included in the future Operational Works Application.

The proposed road hierarchy plan, roadworks plan, sight distance detail plans, preliminary typical sections and longitudinal sections of all roads are included in Appendix F of this engineering report.

9. ELECTRICAL AND TELECOMMUNICATION

Existing underground electrical and underground telecommunication services were installed as part of stage 1 of the former Chancellors Estate. These existing services could be utilised to service stages 3B, 9, 10A, 10B and 11 of this development (refer Appendix G). Extensions of the electrical and telecommunication services can be completed to service stage 3B and further extensions can be completed in the road reserve of Geoff Wilson Drive to services stages 9, 10A, 10B and 11. Electrical reticulation design plans will be completed by Ergon Energy, which will be included with the future Operational Works Applications. NBN Co will be engaged to supply a telecommunications offer of supply for ensuring the most up to date services are available for this development.

10. CONCLUSION

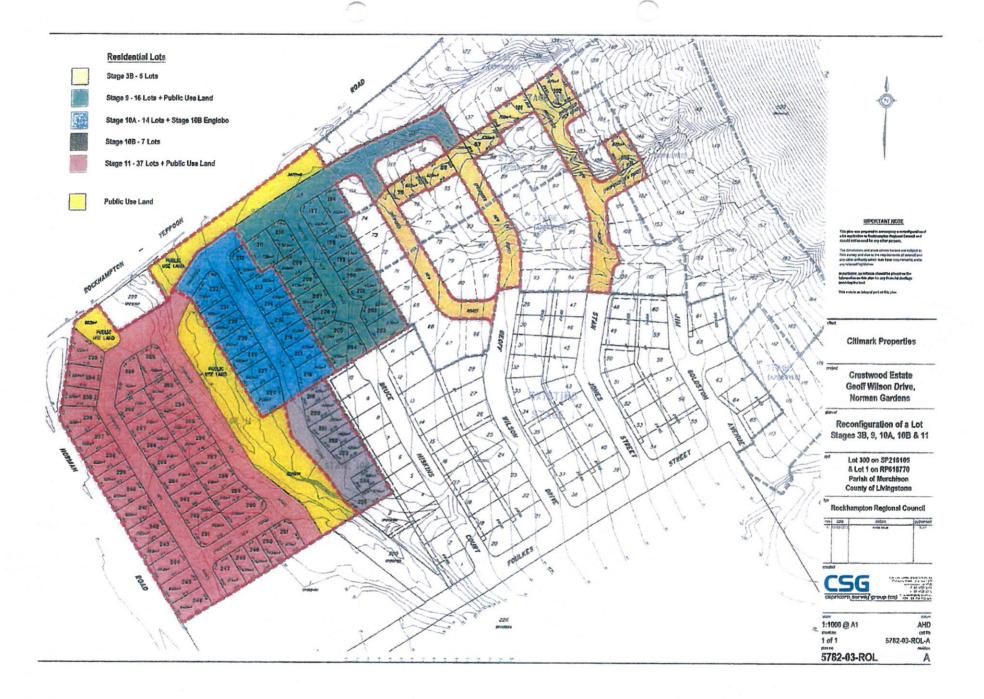
There appears to be no engineering infrastructure difficulties with the proposed stages 3B, 9, 10A, 10B and 11 of the residential subdivision 'Crestwood Estate' located on the corner of Rockhampton – Yeppoon Road and Norman Road, Norman Gardens. A review of the services proposed for this development and their impact on surrounding services, indicates that there is no impediment to development.

There is a workable design strategy for traffic and access, stormwater drainage, sewerage reticulation, water supply, electricity and telecommunications. Minor alterations in design may eventuate from future applications, however the fundamentals of the design strategy ensures that service provisions will not pose a serious constraint to development.

If you should have any questions regarding this report, please do not hesitate to contact the Brown Consulting Office in Rockhampton.

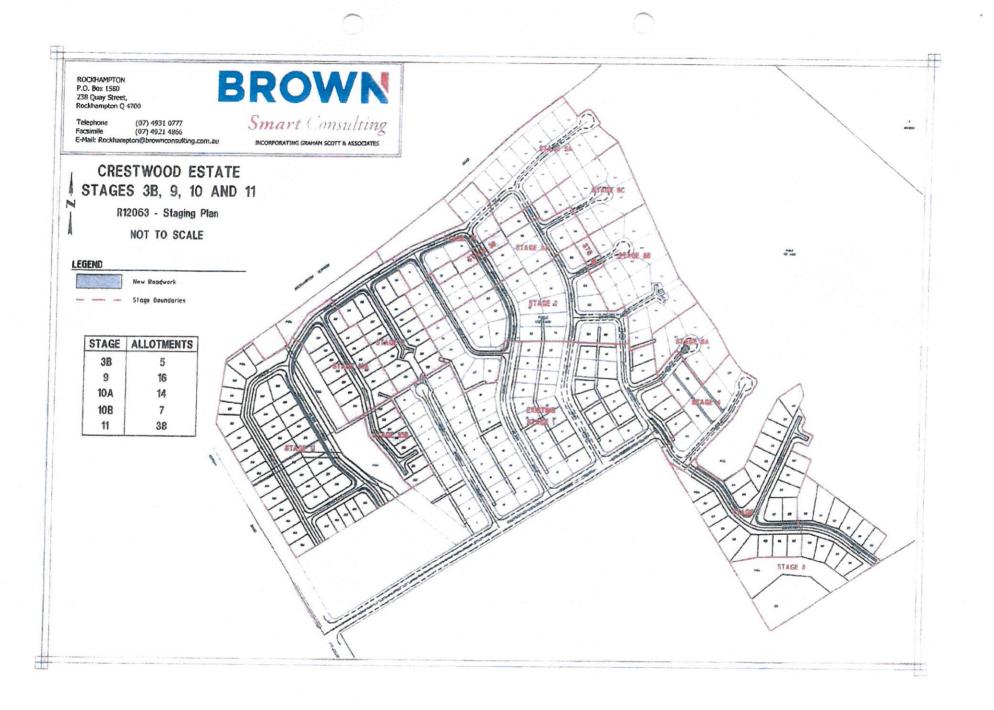


APPENDIX A – Development Plans



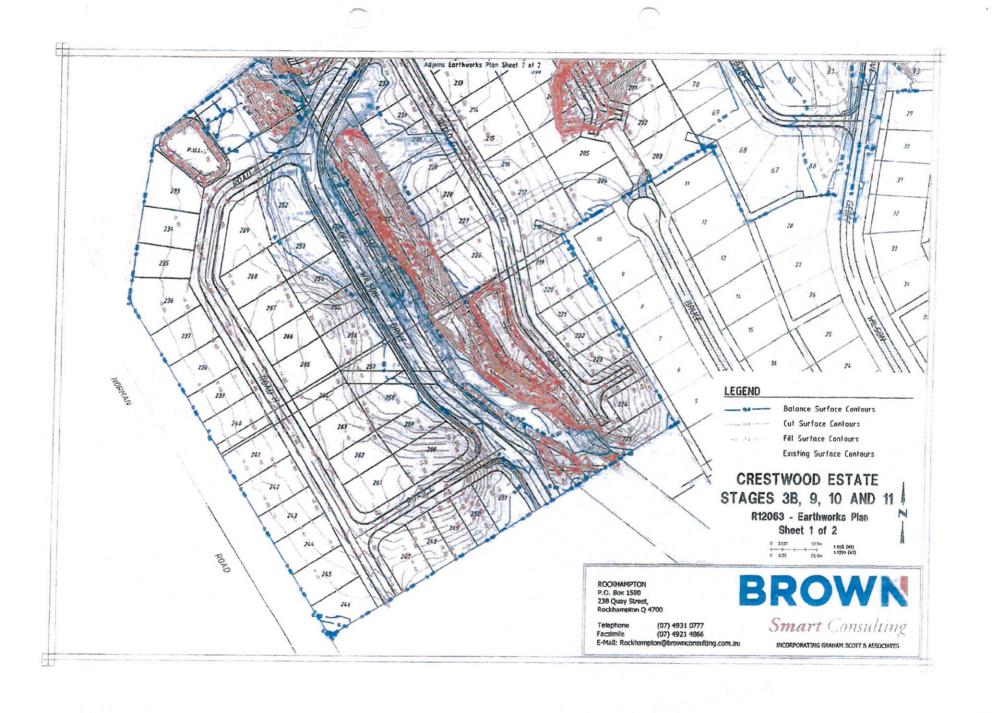


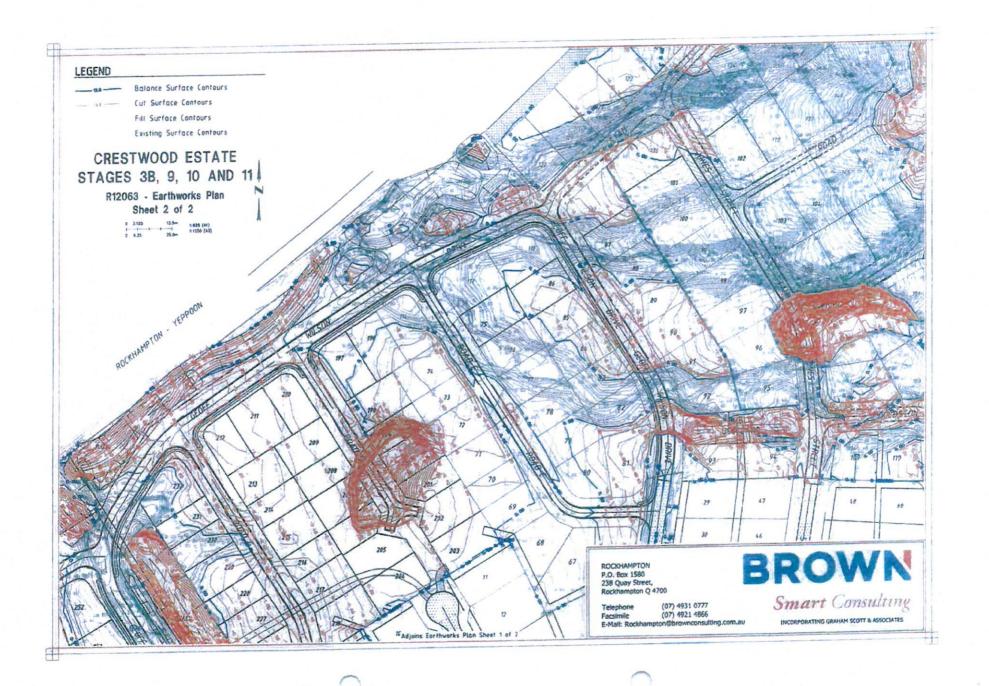
APPENDIX B – Staging Plan





APPENDIX C1 – Preliminary Earthworks Plans







APPENDIX C2 – CMDG Erosion Requirements

CAPRICORN MUNICIPAL DEVELOPMENT GUIDELINES

CONTROL OF EROSION AND SEDIMENTATION

C211

CONSTRUCTION SPECIFICATION

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Keeping the Capricorn Municipal Development Guidelines up-to-date

The Capricom Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricom Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.

GENERAL

C211.01 SCOPE

- The work to be executed under this Specification consists of the construction of structures and the implementation of measures to control erosion and sedimentation. These may be temporary or permanent.
- The Contractor shall plan and carry out the whole of the Works to avoid erosion and sedimentation of the site, surrounding country, watercourses, waterbodies and wetlands in compliance with the requirements of the Environmental Protection Act, 1994 and Amendments, Regulations and Policies, and Local Government's Adopted Policies where available.

C211.02 REFERENCE DOCUMENTS

Documents referenced in this Specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

Documents Standards Test Methods

(a) Council Specifications

C212

Clearing and Grubbing

C213 C273 Earthworks Landscaping

QLD State Legislation

The Environmental Protection Act, 1994 and Amendments, Regulations and **Policies**

(c)

Institution of Engineers Australia, Queensland Division (IEAQ)

Soil Erosion and Sediment Control - Engineering Guidelines

for Queensland Construction Sites, 1996.

Brisbane City Council (BCC)

Integrated Environmental Management System Manual, 1997.

C211.03 EROSION AND SEDIMENTATION CONTROL STRATEGY

For consideration of erosion and sedimentation control measures, the site shall be divided into sections based on the catchment area draining to each permanent drainage structure in the works. In addition to the area bounded by the road reserve, the sections shall include:

Site Sections

- (a) access and haulage tracks,
- (b) borrow pits and
- compound areas, such as Contractor's facilities and concrete batching (c) areas.

CONTROL OF EROSION AND SEDIMENTATION

2. Prior to pre-start meeting, the Contractor shall submit to Local Government an Erosion and Sedimentation Control Strategy for each of the nominated sections. This Strategy shall be superimposed on half-sized Erosion Control and Stormwater Management drawings of the works and shall be detailed for each catchment area of the works. The Strategy should incorporate the measures included on the plan to protect adjoining landowners, significant areas and receiving waters. The contractor shall incorporate into the Strategy those additional measures deemed necessary to accommodate the proposed construction methods and construction sequence to be employed for the construction of the works.

Section Plan

Plan

Inclusions

- The Strategy shall consist of scale diagrams indicating:
 - (a) features of the site including contours and drainage paths,
 - relevant construction details of all erosion and sedimentation control structures to be employed,
 - (c) all permanent and temporary erosion and sedimentation control measures, including the control measures to be implemented in advance of, or in conjunction with, clearing and grubbing operations as required under the Specification for CLEARING AND GRUBBING C212,
 - an order of works based upon construction and stabilisation of all culverts and surface drainage works at the earliest practical stage, and
 - (e) proposed time schedules for construction of structures and implementation of measures to control erosion and sedimentation.
 - Strategies for identification and protection of vegetation as required by Local Government.
- 4. The IEAO Guidelines and the Brisbane City Council Manual provides guidance on typical permanent and temporary erosion and sedimentation control measures which may be required and guidance in the preparation of an Erosion and Sedimentation Control Plan.

Guldance

- 5. No work shall commence until Local Government has approved the Erosion and Sedimentation Control Strategy. Such approval shall not relieve the Contractor of the full responsibility to provide whatever measures are required for effective erosion and sedimentation control at all times. The strategy shall be provided to Local Government prior to the pre-start meeting.
- Contractor's Responsibility
- The Contractor shall adhere to the approved Erosion and Sedimentation Control Strategy. The Contractor shall submit a revised Strategy for approval by Local Government in advance of intended variation from the approved Strategy.

Adherence to Plan

C211.04 EROSION AND SEDIMENTATION CONTROL MEASURES

 Erosion and sedimentation control measures shall include, but shall not be limited to, the following:

Scope

- (a) The minimisation of disturbance of the natural ground and retention of vegetation.
- (b) The installation of permanent drainage structures before the removal of topsoil and commencement of earthworks for formation within the catchment area of each structure.
- (c) The prompt completion of all permanent and temporary drainage works, once commenced, to minimise the period of exposure of disturbed areas.
- (d) The stabilisation of diversion and catch drains to divert uncontaminated runoff from outside the site, clear of the site. Catch drains shall be installed and lined before the adjacent ground is disturbed and the excavation is commenced.

- (e) The passage of uncontaminated water through the site without mixing with contaminated runoff from the site.
- (f) The provision of contour and diversion drains across exposed areas before, during and immediately after clearing and the re-establishment and maintenance of these drains during soil removal and earthworks operations.
- (g) The provision of sediment filtering or sediment traps, in advance of and in conjunction with earthworks operations, to prevent contaminated water leaving the site.
- (h) The restoration of the above drainage and sedimentation control works on a day to day basis to ensure that no disturbed area is left without adequate means of containment and treatment of contaminated water.
- The limitation of areas of erodible material exposed at any time to those areas being actively worked.
- (j) The minimisation of sediment loss during construction of embankments by means such as temporary or reverse superelevations during fill placement, constructing berms along the edge of the formation leading to temporary batter flumes and short term sediment traps.
- (k) The progressive vegetation of the site, in accordance with the Specification for LANDSCAPING, as work proceeds.

PERMANENT EROSION AND SEDIMENTATION CONTROL

C211.05 EARTHWORKS FOR PERMANENT EROSION AND SEDIMENTATION CONTROL BASINS

 Earthworks for permanent erosion and sedimentation control basins shall be constructed to the planned levels and dimensions shown on the Drawings or such levels and dimensions as determined by the Superintendent.

Pianned Levels

2. The entire storage and embankment foundation area of permanent erosion and sedimentation control basins shall be cleared in accordance with the Specification for CLEARING AND GRUBBING C212 and shall be stripped of topsoil and any unsuitable material under embankments removed in accordance with the Specification for EARTHWORKS C213.

Site Preparation

 The embankments shall be constructed in accordance with the Specification for EARTHWORKS C213. Compaction Requirements

C211.06 INLETS, SPILLWAYS AND LOW FLOW OUTLETS FOR SEDIMENTATION CONTROL BASINS AND SEDIMENT TRAPS

Inlets and spillways shall be constructed using rock filled woven galvanised steat
mattresses laid on a needle punched, mechanically bonded, non-woven geotextile filter
fabric, unless detailed otherwise shown on the Drawings. The rock filled mattresses shall
be laid in accordance with the manufacturer's instructions and Specification.

Rock Mattresses

2. A low flow outlet consisting of a 150 mm diameter plastic pipe shall be installed unless detailed otherwise as shown in the Drawings.

Plastic Pipe

C211.07 CLEANING SEDIMENTATION CONTROL STRUCTURES

The Contractor shall clean out permanent sedimentation control structures, cleaning out whenever the accumulated sediment has reduced the capacity of the structure by 50 per cent or more, or whenever the sediment has built up to a point where it is less than 300 mm below the spillway crest. All permanent sedimentation control structures shall be cleaned out by the Contractor prior to Practical Completion of the Works.

Contractor's Responsibility

2. Accumulated sediment shall be removed from permanent sedimentation control structures in such a manner as not to damage the structures. The sediment removed shall be disposed of in such locations that the sediment will not be conveyed back into the construction areas or into watercourses. The Contractor shall provide and maintain suitable access to permanent sedimentation control structures to allow cleaning out in all weather conditions.

Removal of Sediment

TEMPORARY EROSION AND SEDIMENTATION CONTROL

C211.08 GENERAL

 The Contractor shall ensure that effective erosion and sedimentation control is provided at all times.

Contractor's Responsibility

 Runoff from all areas where the natural surface is disturbed by construction, including access roads, depot and stockpile sites, shall be free of pollutants before it is either dispersed to stable areas or directed to natural watercourses. The Contractor shall be responsible for all temporary erosion and sedimentation control measures required for this purpose.

Pollutant Free

The Contractor shall provide and maintain slopes, crowns and drains on all
excavations and embankments to ensure satisfactory drainage at all times. Water shall
not be allowed to pond on the works unless such ponding is part of an approved Erosion
and Sedimentation Control Strategy.

Maintenance by Contractor

C211.09 TEMPORARY DRAINS

 Runoff from areas exposed during the work shall be controlled by construction of temporary contour drains and/or temporary diversion drains. Generally, a temporary contour drain or temporary diversion drain takes the form of a channel constructed across a slope with a ridge on its tower side. They may require progressive implementation and frequent alteration as the work progresses.

Control of Runoff

2. Gontour drains, which follow points on the natural surface of approximately the same elevation, shall be provided immediately after a construction site is cleared to intercept and divert runoff from the site to nearby stable areas at non-erosive velocities. Contour drains shall be formed with a grade of neither less than 1 per cent nor more than 1.5 per cent and shall be spaced at intervals of neither less than 20 m nor more than 50 m, depending on the erodibility of the exposed soil.

Contour Drains

3. Diversion drains shall be provided across haul roads and access tracks when such roads and access tracks are identified as constituting an erosion hazard due to their steepness, soll erodibility or potential for concentrating runoff flow. Diversion drains shall be formed to intercept and divert runoff from the road or track to stable outlets. Spacing of diversion drains shall not be greater than that required to maintain runoff at non-erosive velocities.

Diversion Drains

C211.10 TEMPORARY SEDIMENT TRAPS

 Temporary sediment-trapping devices shall be provided during construction to remove sediment from sediment-laden runoff flowing from areas of 0.5 hectares or more before the runoff enters natural watercourses or adjacent land.

Sediment Traps

C211.11 BATTER PROTECTION

The Contractor shall take all necessary action to protect batters from erosion.

Contractor's Responsibility

 Scour of newly-formed lill batters during and after embankment construction shall be minimised by diverting runoff from the formation away from the batter until vegetation is established.

Scour Control

C211.12 MAINTENANCE AND INSPECTION

1. The Contractor shall inspect all temporary erosion and sedimentation control works after each rain period and during periods of prolonged rainfall. Any defects revealed by such inspections shall be rectified immediately and these works shall be cleaned, repaired and augmented as required, to ensure effective erosion and sedimentation control thereafter.

Contractor's Responsibility

The Contractor shall provide and maintain access for cleaning out sedimentation control works.

Access

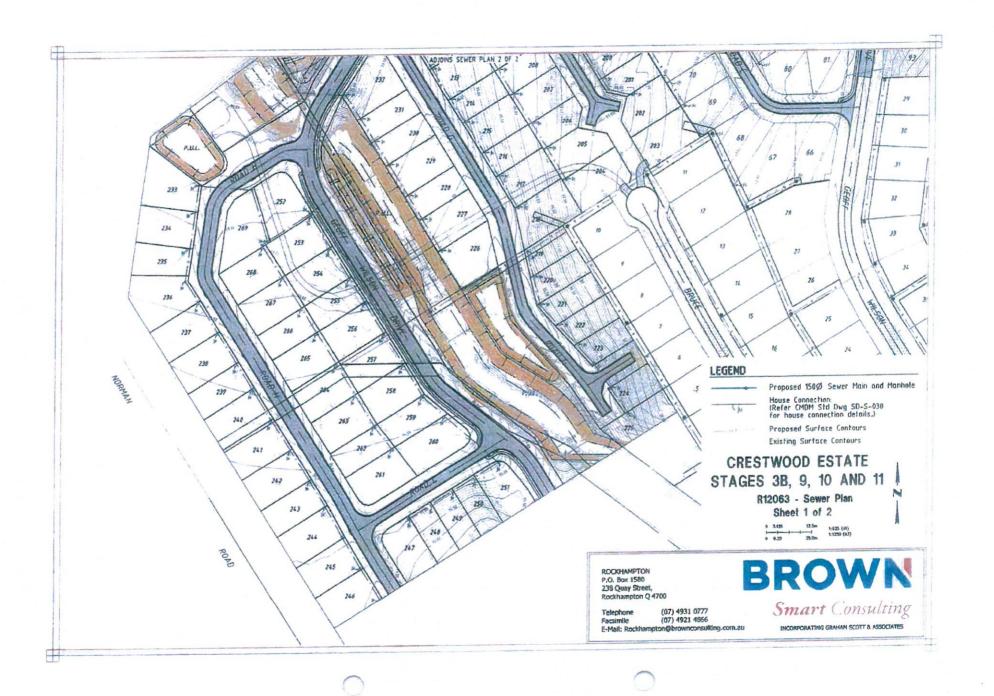
C211.13 REMOVAL

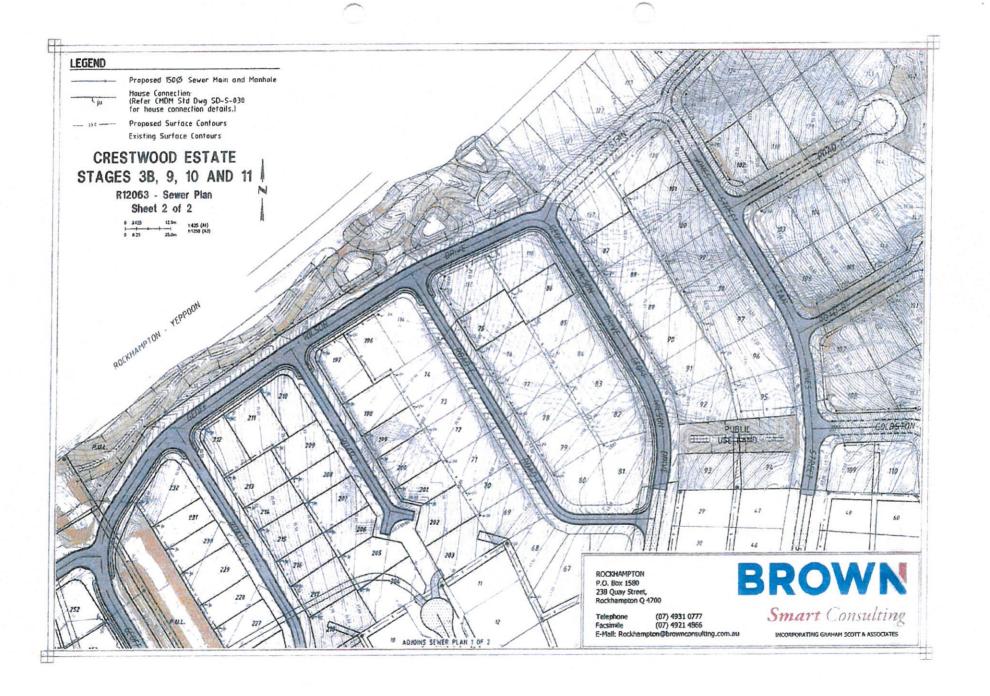
1. All temporary erosion and sedimentation control works shall be removed by the Contractor when revegetation is established on formerly exposed areas before the end of the Contract. All materials used for the temporary erosion and sedimentation control works shall be removed from the site or otherwise disposed by the Contractor.

Contractor's Responsibility



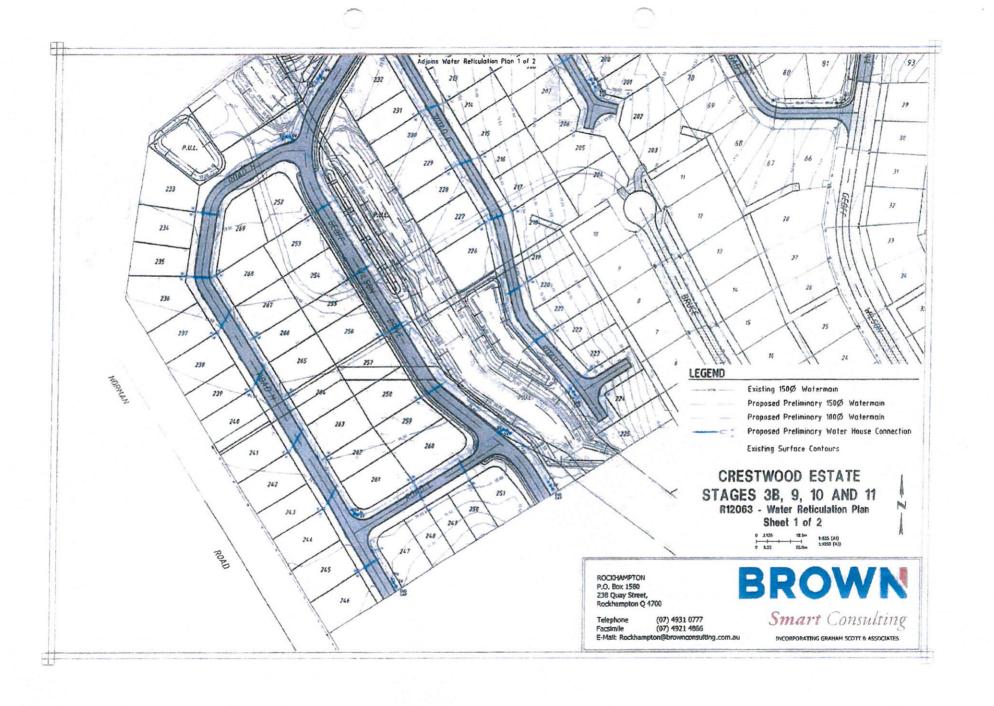
APPENDIX D – Preliminary Sewerage Layout
Plans

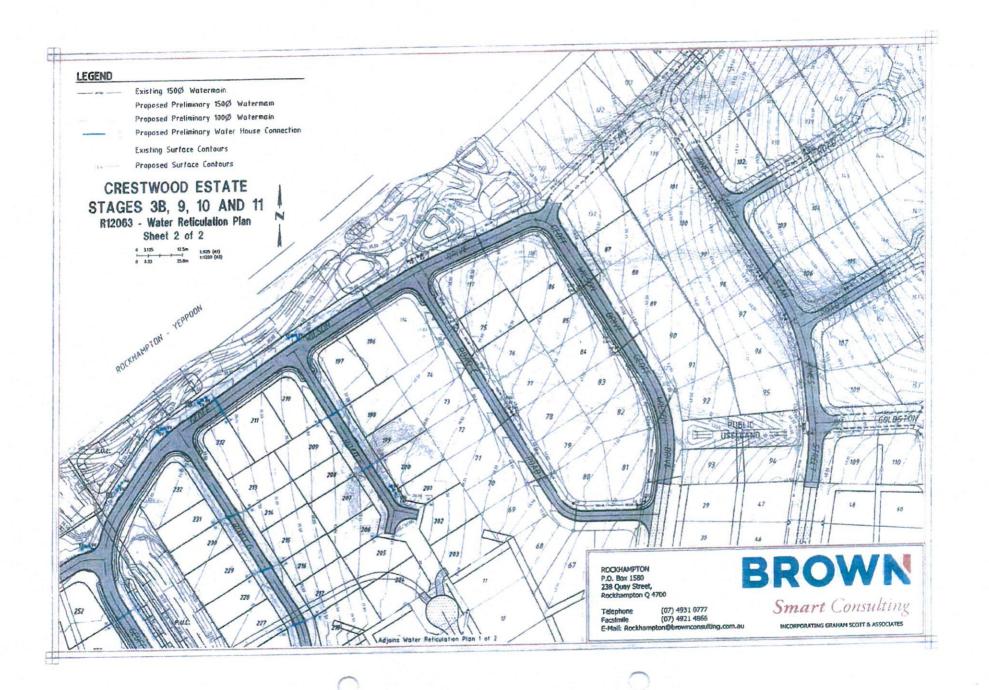






APPENDIX E1 – Preliminary Water Reticulation Plans







APPENDIX E2 – Letter Requesting Water Supply Network Analysis Our Ref: R12063/RS:aj/Ltr.FRW.Request.for.private.works.quotation.stages.5-11
Contact: Russell Schirmer

Fitzroy River Water PO Box 1860 ROCKHAMPTON QLD 4700

16 April 2013

Attention: Mr Peter Wheelhouse

Dear Peter,

Request for Private Works Quotation
Crestwood Estate - Corner Rockhampton/Yeppoon Road & Norman Road, North
Rockhampton
Residential Development - Stages 5, 6, 7, 8, 9, 10 and 11

On behalf of our client, Citimark Properties QLD Pty Ltd, we hereby request Rockhampton Regional Council/Fitzroy River Water to prepare a Private Works Quotation to carry out a water supply network analysis for the above-mentioned development.

This request for private works quotation is in relation to stages 5, 6, 7, 8, 9, 10 and 11 with all proposed lots included in these stages to be serviced with water reticulation.

To assist you with this application we have enclosed the following:

· A plan of the proposal showing the ultimate development

Please note your Quotation should be addressed to:-

Citimark Properties QLD Pty Ltd C/- Brown Consulting QLD Pty Ltd PO Box 1580 ROCKHAMPTON QLD 4700

Should you have any questions at all, please do not hesitate to contact out office and speak with Russell Schirmer.

Yours sincerely

Brown Consulting (Qld) Pty Ltd

Russell Schirmer

Civil Manager - Rockhampton

Encl. S

Sire Plan

Cc

Citimark Properties QLD Pty Ltd

Private Works Application for Water and Sewerage Services ABN 59 923 523 766

Email:

Phone: 4932 9000 or 1300 22 55 77 Fax: 4936 8862 or 1300 22 55 79 Address: PO Box 1860, Rockhampton QLD 4700

www.frw.com.au enquiries@rrc.qld.gov.au

PRIVACY NOTICE: Rockhampton Regional Council is collecting the personal information you supply on this form for the purpose of processing your application for water and sewerage services. Your personal details will not be disclosed to any other person or agency external to Council without your consent unless required or authorised by

Separate ap	plication forms to be co	ompleted for wat	er and sewerage requests	
Applicant's Name:	Russell Schirmer			
Company Name:	Citimark Properties QLD Pty Ltd			
Postal Address:	C:/ Brown Consulting 238 Quay St Rockhampton QLD 4700			
Telephone:	4931 0777 Mobile: 0418 743 523			
Fax:	4921 4866	Email:	Russell.Schirmer@brownconsulting com.au	
Property Owner's Name:	Citimark Properties QLD Pty Ltd			
Work Site Address:	300 Yeppoon Ro	ad, Norman	Gardens	
Site Description: (e.g. plan number)	Lot 300 SP216105			
Full description of w	ork request. Please att	ach applicable si	ite plans and drawings.	
Water Supply Network				
Applicant's Signatur	e: 2	Date	16/4/18	

Please return completed form to: Customer Service, Rockhampton Regional Council, PO Box 1860 Rockhampton QLD 4700

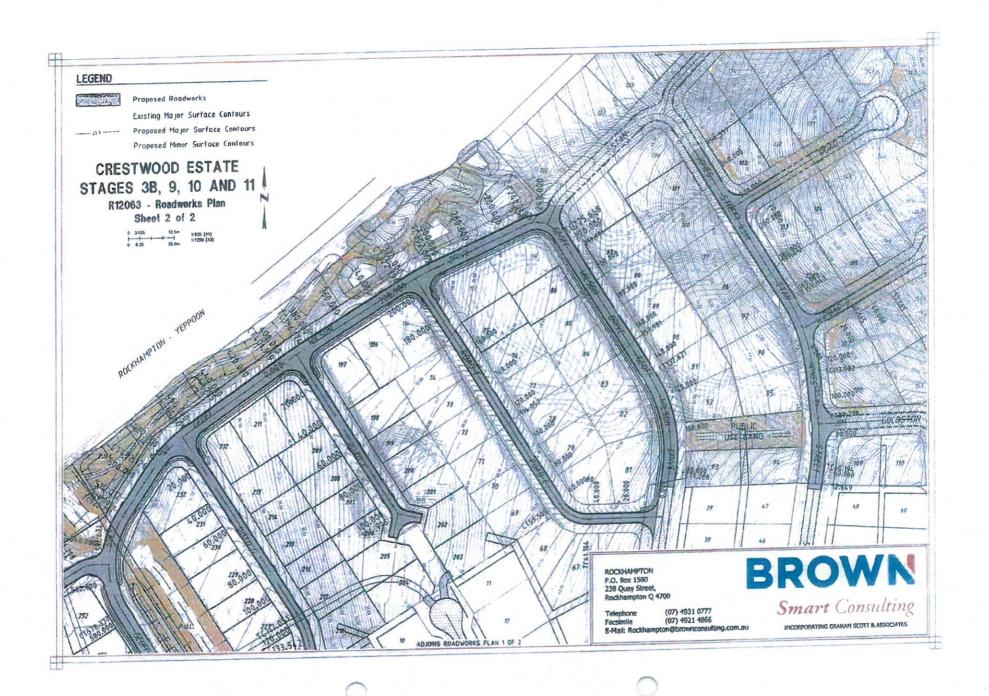
Fax: 4936 8862 or 1300 22 55 79 Email: enquiries@rrc.qld.qov.au

OFFICE USE ONLY	Date Rec'd	Pathways Application No.	CSO Initials
	Customer Service>Datay	Jarkes Maturart Candons Admini	stration Officer



APPENDIX F1 – Roadworks Plans

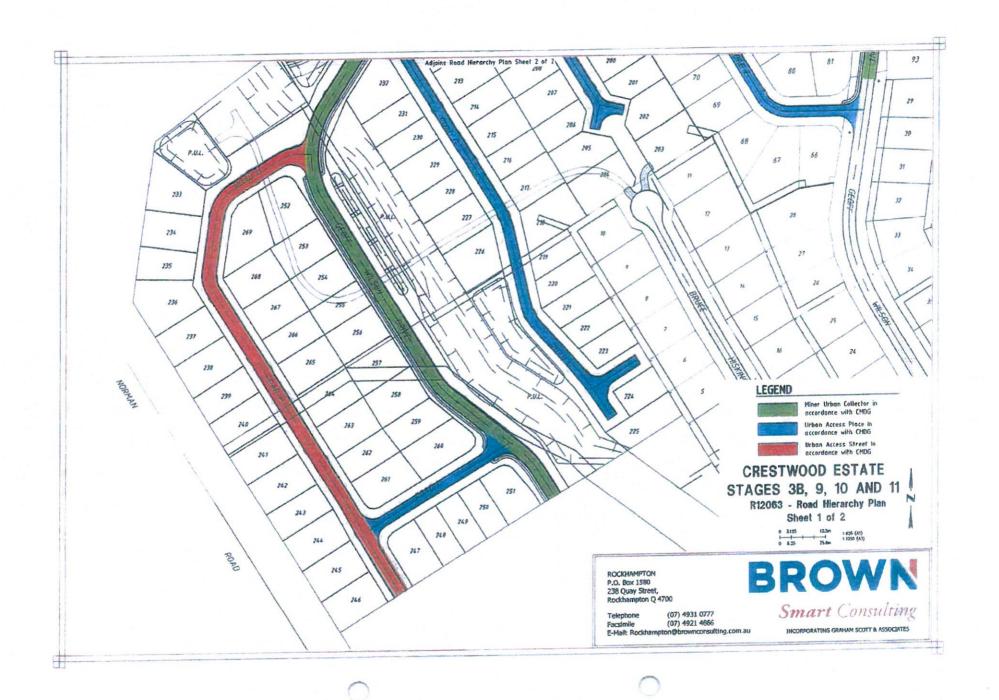


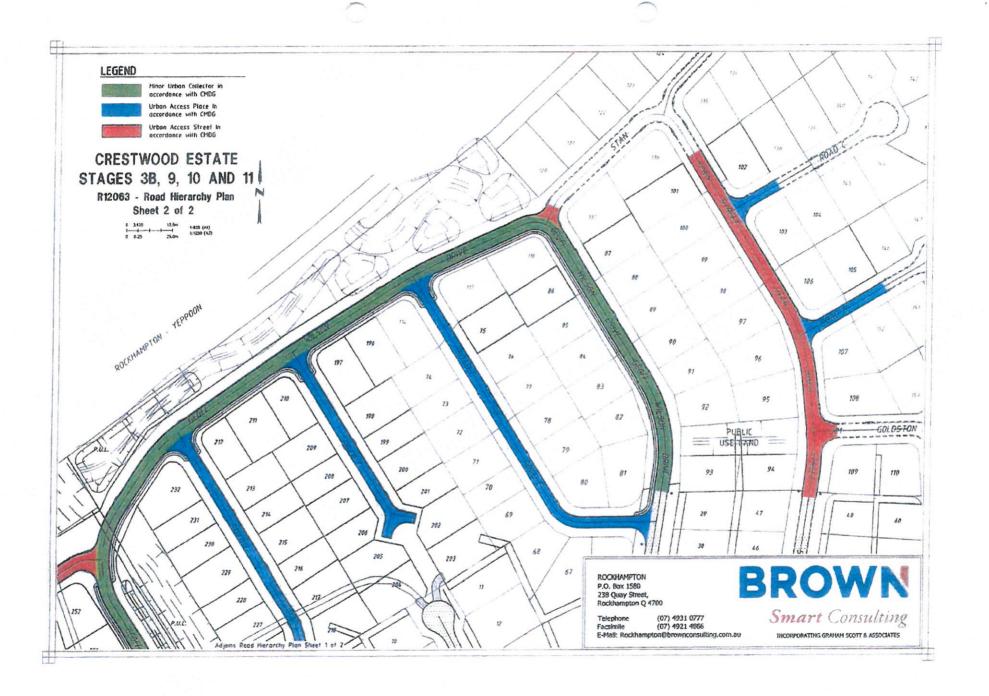




APPENDIX F2 - Road Hierarchy Plans

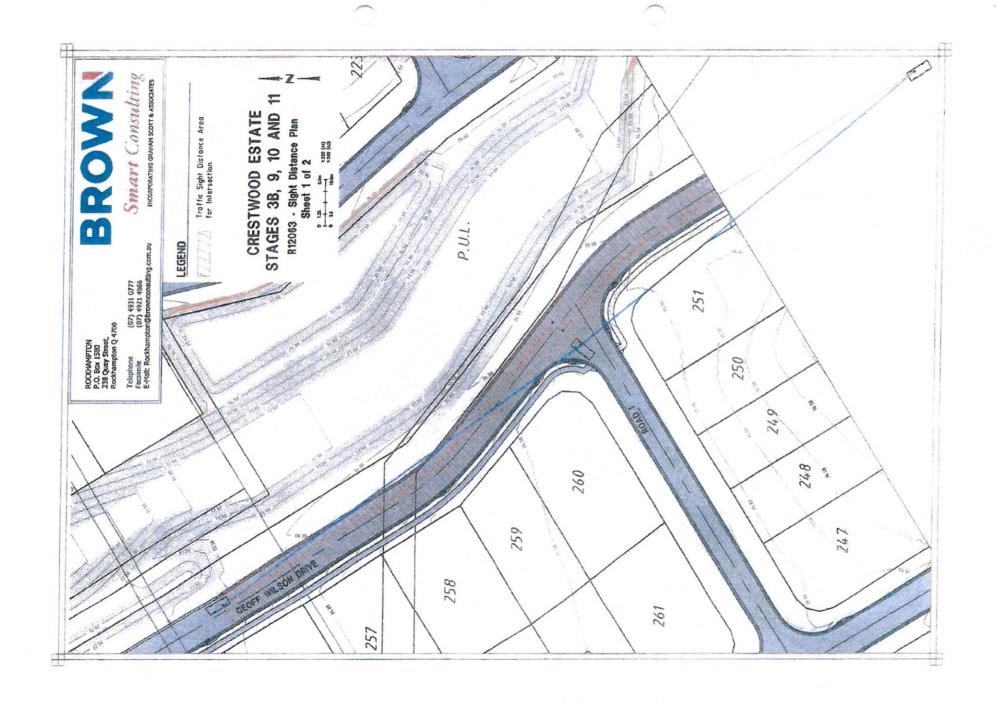
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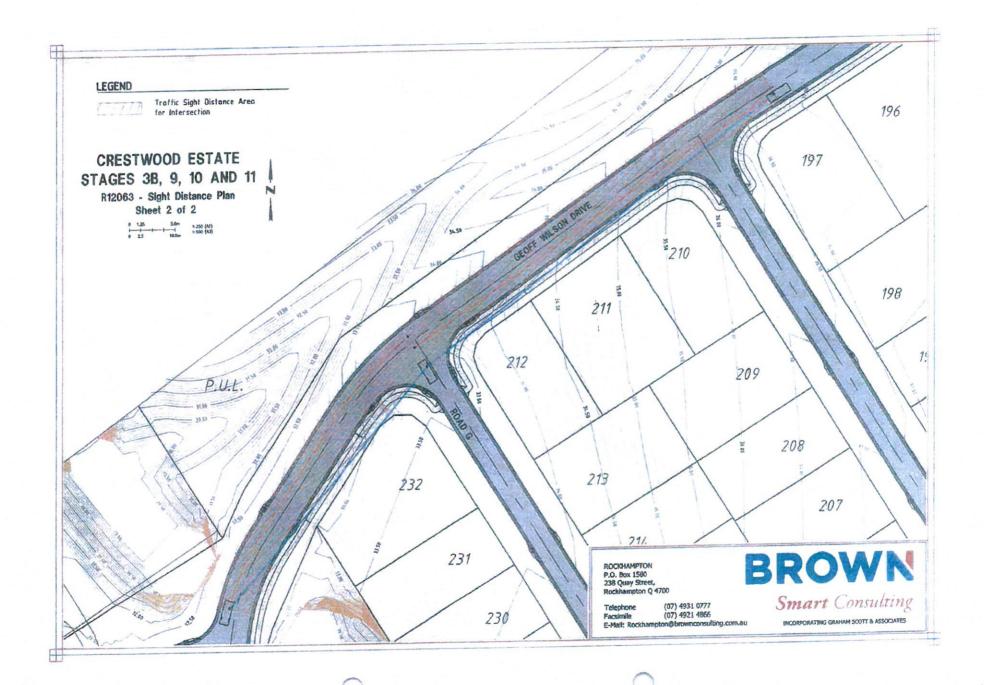






APPENDIX F3 – Intersection Sight Distance Plans







APPENDIX F4 – Roadworks Preliminary Longitudinal Sections

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CRESTWOOD ESTATE STAGES 3B, 9, 10 AND 11

R12063 - Road Longitudinal Sections Plan Sheet 1 of 4

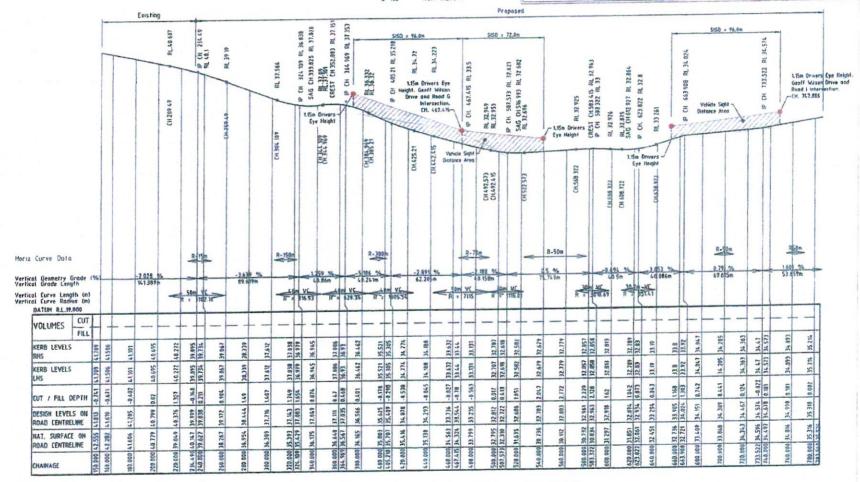
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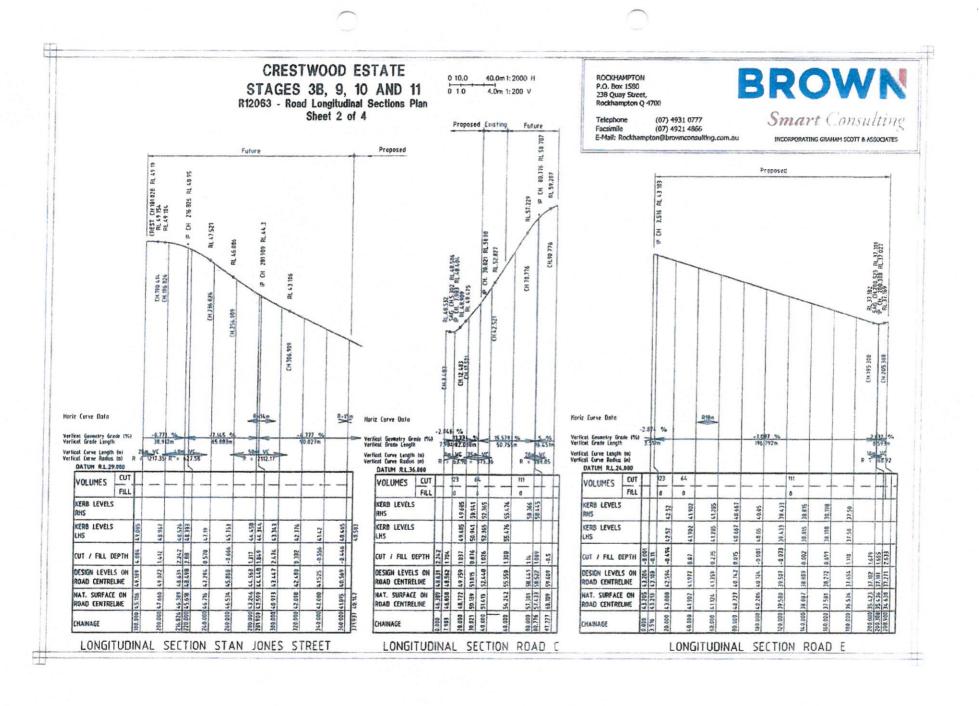
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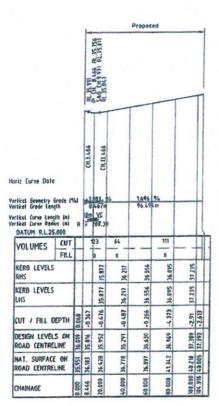
(07) 4931 0777 (07) 4921 4866 E-Mail: Rockhampton@brownconsulting.com.au Smart Consulting

INCORPORATING GRAHAM SCOTT & ASSOCIATES



LONGITUDINAL SECTION GEOFF WILSON DRIVE





Proposed RL34.91 CREST CHAN9.599 RL35.003 IP CH 169.795 RL35.098 R. 33.486 PP. CH. B.643 R. 33.336 SAG. CH.30.673 R. 33.371 R. 33.869 CH. 199.678 CH.164.795 CH.170.678 Horiz Curve Data Yertical Geometry Grade (%) Vertical Grade Length BATUM R.L.23.000 111 VOLUMES FILL KERB LEVELS 34.686 35.278 95.058 KERB LEVELS LHS CUT / FILL DEPTH DESIGN LEVELS ON ROAD CENTRELINE 33.469 33.469 33.720 13.971 35.648 NAT. SURFACE ON 34,359 34.851 ROAD CENTRELINE 20.000 CHAINAGE

LONGITUDINAL SECTION ROAD F

LONGITUDINAL SECTION Road G

CRESTWOOD ESTATE STAGES 3B, 9, 10 AND 11 R12063 - Road Longitudinal Sections Plan

Sheet 3 of 4

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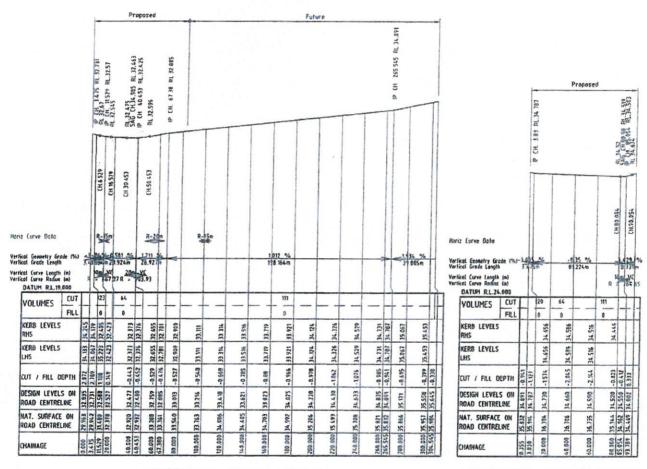
Telephone Facsimile (07) 4931 0777 (07) 4921 4866

E-Mail: Rockhampton@brownconsulting.com.au

BROWN

Smart Consulting

INCORPORATING GRAHAM SCOTT & ASSOCIATES



LONGITUDINAL SECTION ROAD H

CRESTWOOD ESTATE STAGES 3B, 9, 10 AND 11 R12063 - Road Longitudinal Sections Plan

Sheet 4 of 4

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LONGITUDINAL SECTION ROAD I

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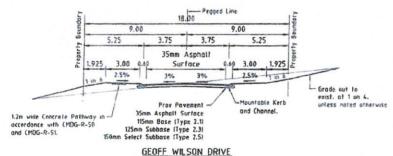
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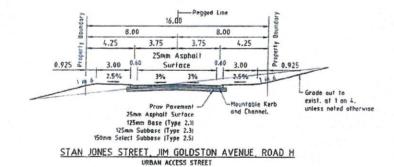
INCORPORATING GRAHAM SCOTT & ASSOCIATES



APPENDIX F5 – Roadworks Typical Sections



MINOR URBAN COLLECTOR



16.d0 Pegged Line 8.00 8.00 5.25 2.75 2.75 25mm Asphalt 3.00 9.60 Surface 9.60 3.00 1.925 & 2.5% 3% 3% 2.5% LGrade out to exist. at 1 on 4. -Mountable Kerb Prov Povement unless noted otherwise and Channel. 25mm Asphalt Surface 125mm Base (Type 2.1) 125mm Subbase (Type 2.3) 150mm Select Subbase (Type 2.5)

ROAD B, ROAD C, ROAD E, ROAD F, ROAD G & ROAD I URBAN ACCESS PLACE

CRESTWOOD ESTATE STAGES 3B, 9, 10 AND 11

R12063 - Typical Sections

NOT TO SCALE

ROCKHAMPTON P.O. Box 1580 238 Quay Street, Rockhampton Q 4700

(07) 4931 0777 Telephone

(07) 4921 4866 E-Mail; Rockhampton@brownconsulting.com.au

BROWN

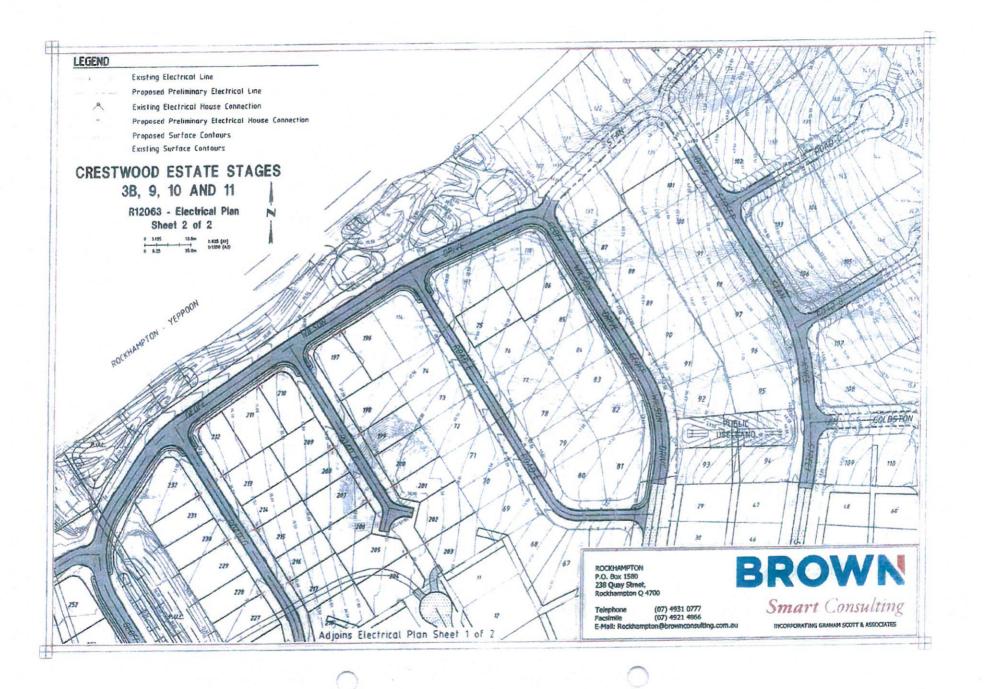
Smart Consulting

INCORPORATING GRAHAM SCOTT & ASSOCIATES



APPENDIX G – Preliminary Electrical Layout Plans



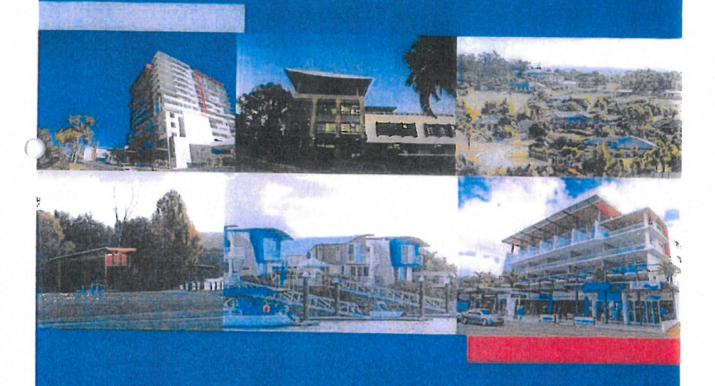


PROCIGHAMPTON REGIONAL GOUNGIL

Those plans are approved subject to the current conditions of approved associated with Dissencered Permit No. D 1279 - 2013

Dated 10 • 62 - 2014

BROWN Smart Consulting



Stormwater Management Report

Crestwood Estate, 205 Lot Residential Development

Stages 3B, 9, 10 & 11 (80 Lots)

Corner Rockhampton/Yeppoon Road & Norman Road, Rockhampton

Prepared for Citimark Properties



COMMERCIAL IN CONFIDENCE

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2013

DOCUMENT CONTROL

Document1

Issue	Date	Issue Details	Author	Checked	Approved
Α	19 June 2013	Report	RS	RS	G. Scott RPEQ 2412



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1. INTRODUCTION/BACKGROUND

This stommwater management report has been prepared on behalf of Citimark Properties in support of the Reconfigure of a Lot Application for Stages 3B, 9, 10 & 11 of Crestwood Estate. The proposed subdivision is located on the corner of Rockhampton/Yeppoon Road and Norman Road, North Rockhampton. The proposed development will include a mixture of residential allotments ranging in size of 450m² to approximately 900m², refer Appendix A for Development Plan of the proposed development.

The intent of the Stormwater Management Report is to provide guidelines and recommendations to incorporate into Operational Works procedures, to minimise the impact of the subdivision on the surrounding environment, infrastructure, and property owners.

The development site is currently cleared vacant residential land that is part the balance land to previously constructed Stage 1. The topography of the development side, based from Capricom Survey Groups DTM, demonstrates that the majority of the site is housed in 1 main catchment that discharges into a major centralised channel that traverses through the development site. This channel discharges into the road reserve of Rockhampton/Yeppoon Road, crosses the road via an existing major culvert structure and flows into Limestone Creek. Appendix B illustrates the existing contours over the development site.

As part of the original approvals associated with Stage 1 of the development (formally known as Chancellors Estate), is a Stormwater Flooding Report completed by Cardno Pty Ltd. This Stormwater Management Report for Stage 3B, 9, 10 & 11 of Crestwood Estate is an extension of this previously approved report and involves specific items associated with Stage 3B, 9, 10 & 11. These items include sizing of the reshaped centralised drainage channel, sizing of the internal culvert crossing over the drainage channel, checking of freeboard to allotments and addressing Water Quality Requirements in accordance with 'Healthy Waters'.

2. STORMWATER QUANTITY ASSESSMENT

This proposed Stormwater Management Report is an extension of the previously approved Flood Study completed by Cardno Pty Ltd and is to be read in conjunction with the mentioned Flood Study. Appendix C includes a copy of the previously approved Cardno Flood Study.

This previously approved Flood Study dated July 2008 includes a hydraulics assessment of the subject catchment the proposed development is situated within and models the existing case, partially developed



case and fully developed case. Peak flow for 1-100 year ARI events have been modelled for all cases. The Flood Study identifies design parameters to be used for sizing the drainage channel through the development and also the constructed major culvert structure that crosses Foulkes Street. The Flood Study also illustrates inundation areas along the centralised drainage channel for all 3 cases (existing, partially developed and fully developed). Figure 4 in Cardno Pty Ltd Flood Study demonstrates that the fully developed peak flow is contained within the centralised drainage channel area. The HEC-RAS modelling in the Flood Study illustrates the Q₁₀₀ water level of the existing major culvert structure under Rockhampton/Yeppoon Road. The water level reaches 32.500 AHD which as illustrated by the existing contours doesn't flow across Rockhampton/Yeppoon Road but actually weirs over Norman Road at approximately 40m back from the intersection with Rockhampton/Yeppoon Road. Based on the water level the depth of water over Norman Road in a Q₁₀₀ event is very minor and is approximately 70mm. Included in the Stormwater Management Report is culvert calculations of the existing major culvert structure under Rockhampton/Yeppoon Road which concur with the Cardno Flood Study findings. Appendix D illustrates the culvert calculation for the existing culvert under Rockhampton/Yeppoon Road.

3. PROPOSED MAJOR STORMWATER ELEMENTS

There are two (2) main stormwater drainage quantity elements to be incorporated into the proposed stage of Crestwood Estate. These are the centralised drainage channel and proposed major internal culvert structure where the drainage channel crosses Geoff Wilson Drive (near intersection with Road H). Flood immunity to allotments is also an important element, which is discussed later in this section.

Centralised Drainage Channel

The Centralised Drainage Channel has been constructed through the southern adjacent allotment in association with the previous completed works for Stage 1 of Chancellors Estate. The channel enters the proposed stages of Crestwood Estate and flows through Stage 11 in its natural state. This natural channel is being reshaped to provide a uniform shaped channel that carries and discharges the Q₁₀₀ peak flows as identified in Cardno Pty Ltd Flood Study. The proposed reshaping consists of 2 different Profiles with Profile 1 being along the common boundary of Stage 10B and Profile 2 being along the common boundary of Stage 10A. Appendix E illustrates the profiles for the reshaped drainage channel including preliminary design contours over Stages 3B, 9, 10 & 11.

Internal Culvert Crossing

The major proposed internal culvert structure to be incorporated into Stage 11 (under Geoff Wilson Drive) is to discharge the flow in the centralised drainage channel across the road and into the existing culvert



structure under Rockhampton/Yeppoon Road. This internal culvert structure has been sized to discharge the Q₁₀₀ peak flow in accordance with the QUDM. The proposed internal culvert structure under Geoff Wilson Drive is to be 3/2400 x 2100 RCBC with concrete headwalls and apron in accordance with the CMDG requirements. This culvert structure will cause a headwater level of 32.65m AHD approximately therefore, the minimum allotment level of a proposed block must be 300mm above this headwater level. Appendix F illustrates the culvert calculation for proposed major internal culvert structure to be built under Geoff Wilson Drive to discharge the Q₁₀₀ flow to the existing culvert structure under Rockhampton/Yeppoon Road in accordance with the QUDM.

Allotment Freeboard

As illustrated in the attached calculation the depth of water in the channel through Profile 1 will be fully contained within the channel area and will have a Q₁₀₀ water level of approximately 600mm below the top of the channel. This will provide adequate freeboard in accordance with the QUDM.

The depth of water in the channel through Profile 2 will also be fully contained within the channel area and will have a Q₁₀₀ water level of approximately 500mm below the top of the channel. This will also provide acceptable freeboard in accordance with the QUDM.

As mentioned above the proposed internal culvert structure will cause a headwater level of 32.65m AHD. This will be approximately 150mm above the crown of Geoff Wilson Drive. This is an acceptable depth of water over the roadway during a Q_{100} event and is in accordance with the requirements of the QUDM. To ensure that all allotment have acceptable freeboard above the Q_{100} level, all allotments are to have a minimum surface level of 32.95m AHD. This is achievable and will be implemented in the future Operational Works Application.

4. WATER QUALITY ASSESSMENT

4.1. Site Specific Objects

Due to the site's proximity to Limestone Creek, it is important that the site presents no worsening in terms of water quality following development. As the development is residential in character, the water quality parameters of relevance to the site are suspended solids, nutrients (nitrogen and phosphorus), litter and faecal coliforms.



Of these parameters, the detailed modelling of litter and faecal coliforms is not possible at present, using the industry standard analysis package (MUSIC – refer below) due to the lack of information regarding export rates.

The modelling of defined water quality objectives has therefore necessarily focused on suspended solids and nutrients (nitrogen and phosphorus).

In the absence of Rockhampton Regional Council water quality objectives, load reduction targets stated in the "Urban Stormwater Quality Planning Guidelines 2010" were adopted and are stated below:

85% Reduction of Total Suspended Solids70% Reduction in Total Phosphorus45% Reduction in Total Nitrogen90% Reduction in Gross Pollutants

These targets are measured against the pollutant load generated for the untreated developed scenario. Load reduction targets will be modelled as they more closely represent effects on Limestone Creek.

4.2. MUSIC Water Quality Analysis Methodology

In order to determine the effectiveness of different water quality treatment measures and meeting the water quality objectives, a stormwater quality analysis was performed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 5.1.

The models consist of three types of nodes:

- Source nodes representing different land uses and defining size of sub catchments
- Treatment Node representing different types of water quality treatment measures
- Receiving nodes represent the outlet point for the catchment under consideration. Each model
 only has one receiving node.

The model requires the user to specify meteorological data (rainfall and evaporation), soil properties and pollutant loads for each catchment. Suitable parameters for the MUSIC model were adopted in accordance with the recommendations of Mackay Regional City Council MUSIC Guidelines Version 1.1 2008 in the absence of Rockhampton Regional Council MUSIC Guidelines.



Climate data for the catchment was sourced from the Rockhampton rainfall data using the November 1989 to October 1998 rainfall events and the Rockhampton monthly Potential Evapo-transpiration (PET) with a 6-minute rainfall time step. The hydrologic routing option for the modelling was the "No Routing" option. This option generates more conservative results from the treatment measures as the runoff is modelled reaching the treatment measure all at the same time rather than allowing for travel and detention stages as the runoff progresses through the catchment.

A MUSIC model was created to determine the post development scenario with no WSUD and post development scenario with WSUD treatments. The source nodes for the post-development scenario were based upon the site master plan and have been shown in Tables 2.1 – 2.8. Ultimately; the receiving node for sites' catchments is Limestone Creek.

In accordance with Mackay Regional Council Water Quality Guidelines typical percentage impervious when splitting residential land uses recommends the following:

Table 2.1

Line Use Category	* Oyeral Caciment	" Impervious
Roof	35%	100%
Road Reserve	25%	70%
Remainder	40%	19%
Overall	100%	60%

Table 2.2: Post Development Sub-Catchment Land Uses Catchment WQA

NODE	ARTA (a)	Section 1991	So IMPURATIONS
Roof	1.096	35%	100%
Road Reserve	0.783	25%	70%
Remainder	1.253	40%	19%
Total	3.134	100%	60%



Table 2.3: Post Development Sub-Catchment Land Uses Catchment WQB

NODE	AREA (ba)	# CATCHMENT	FURTHER VIOLES
Roof	0.459	35%	100%
Road Reserve	0.328	25%	70%
Remainder	0.525	40%	19%
Total	1.313	100%	60%

Table 2.4: Post Development Sub-Catchment Land Uses Catchment WQC

NO II OF	VRD y (ha)	CAN VEGICINE N. I	4,400,000,000,000
Roof to Bio	0.072	17.5%	100%
Roof to Urban	0.072	17.5%	100%
Remainder	0.269	65%	19%
Total	0.414	100%	60%

Table 2.5: Post Development Sub-Catchment Land Uses Catchment WQD

	CALLY TAMEN C	Total Lie Control	
0.188	35%	100%	
0.134	25%	70%	
0.215	40%	19%	
0.538	100%	60%	
	0.188 0.134 0.215	0.188 35% 0.134 25% 0.215 40%	

Table 2.6: Post Development Sub-Catchment Land Uses Catchment WQE

NOEd	VR (25 %)	C. Viction N1	(ME) 89 JOE 8
Road Reserve	0.107	*50%	70%
Remainder	0.107	*50%	19%
Total	0.215	100%	44%

^{*}Note; The above table demonstrates a 50/50 split between the Road Reserve and Remainder land type Node, this indicates an assumed split that half the catchment will be captured by kerb and channel and discharged to Bio-Retention Basin (3). The remaining catchment will continue falling towards the treatment of the Main Channel swale drain, refer Appendix G.



Table 2.7: Post Development Sub-Catchment Land Uses Catchment WQF

NODE	ARUA (ha)	% CATCHMENT	% IMPURVIOUS
Road Reserve	0.025	*50%	70%
Remainder	0.025	*50%	19%
Total	0.050	100%	44%

^{*}Note; The above table demonstrates a 50/50 split between the Road Reserve and Remainder land type Node, this indicates an assumed split to clearly define the total impervious area for the subject catchment. Catchment WQF will directly discharge into the Main Channel swale drain.

Table 2.8: Post Development Sub-Catchment Land Uses Catchment WQG

NODE	AREA (ha)	CAPCHIMENT	A IMPLATIOUS
Roof	0.246	35%	100%
Road Reserve	0.176	25%	70%
Remainder	0.281	40%	19%
Total	0.704	100%	60%

Refer to the Water Sensitive Urban Design (WSUD) concept drawing in Appendix G for identification of subcatchment zones / areas for post development condition. The MUSIC model is based on a split catchment approach and will incorporate various treatment nodes. All the 7 sub-catchments ultimately discharge into Limestone Creek.

The Mackay Regional Councils' MUSIC Runoff Generation Parameters used for the modelling are detailed in Table 2.9.

Table 2.9: Runoff Generation Parameters

Parameter	Upland
Field Capacity (mm)	80
Infiltration Capacity Coefficient a	200
Infiltration Capacity Exponent b	1
Rainfall Threshold (mm)	1
Soil Capacity (mm)	200
Initial Storage (%)	30
Daily Recharge Rate (%)	0.5
Daily Baseflow Rate (%)	0.16
Initial Depth (mm)	10
Daily Deep Seepage (%)	2



Table 2.10: Pollutant Export Relationships

maj Payaray ME(SP), Samood Soods (Soods)	Pin impres	Tanal Sacracians of States to age to		(Capital) consistent (Lag to rig (L)		a ord Sheogen (Rosau movir	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Road	Mean	1.0	2.43	-0.97	-0.30	0.20	0.26
	Std Deviation	0.34	0.39	0.31	0.31	0.20	0.23
Roof	Mean		1.30		-0.89		0.26
	Std Deviation	0.34	0.39	0.31	0.31	0.20	0.23
Ground Level	Mean	1.0	2.18	-0.97	-0.47	0.20	0.26
	Std Deviation	0.34	0.39	0.31	0.31	0.20	0.23

^{**}Source: Mackay MUSIC Guidelines 1.1

4.3. Proposed Treatment Train

It is proposed to use a combination of open swales and Bio-Retention Basins to treat post development runoff from the site. The development can be separated into two main contributing catchments. For the purpose of this water quality analysis the site has been divided into 7 sub-catchments (refer Table 2.2 - 2.8) which ultimately all discharge to Limestone Creek.

The eastern catchments comprise of four sub-catchments being WQB, WQC, WQD & WQG. The combined area for these four catchments is approximately 2.969ha. The remaining sub-catchments WQA, WQE, WQF forming the western portion of the development (approximately 3.399ha), will be divided by the Main Channel. (See WSUD drawing Appendix G).

Ultimately as part of the post development scenario the combined eastern and western catchments will be captured by the stormwater roadway and roof water network. It will then discharge to the Bio-Retention Basins (1-4), which will outlet to the Main Channel and finally discharge to Limestone Creek.



In order to meet the water quality objectives, the filtration area within the Bio-Retention Basins has been sized to have minimum areas as represented in Table 2.11 below. The basin has been sized to have a minimum 400mm depth layer of filtration material with an additional 100mm transition layer to prevent filtration media blocking the subsoil drains over time and a further 200mm drainage layer in which the subsoil drain is to be laid.

The MUSIC model screen print showing drainage links and treatment devices is identified in the below image;

Figure

1.

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Figure. 1 - Treatment Train

Bio Retention Basin

Table 2.11: Bio-Retention Basin Properties

Dasin	Contributing Catchinents	Pricinced Determion (apprential)	Infiltration Paters Area (m) = 2 - 12	
Basin 1	WQA	1.000	420	0.400
Basin 2	WQB; WQC; WQG	0.500	500	0,400
Basin 3	WQE	0.500	70	0.400
Basin 4	WQD	0.500	400	0.400



Swale Drains

Refer Figures 2, 3 & 4 for all Swales and Main Channel parameters adopted for this analysis.



Figure 2 - Main Channel



Figure 3 - Bio-Retention Basin 1

^{*}Parameters for TN & Orthophosphate Content set by Water by Design Interim Bio-Retention Treatment Notle





Figure 4 - Bio-Retention Basin 2

*Parameters for TN & Orthopbosphate Content set by Water by Design Interim Bio-Retention Treatment Node



Figure 5 - Bio-Retention Basin 3

*Parameters for TN & Orthophosphate Content set by Water by Design Interim Bio-Relention Treatment Node





Figure 6 - Bio-Retention Basin 4

*Parameters for TN & Orthophosphate Content set by Water by Design Interim Bio-Retention Treatment Node

4.4. Quality Modelling Results

The properties of the treatment devices shown above are based on default values in MUSIC and some recommended values in the MUSIC guidelines.

Scenario 1- Fully Developed site with and without Water Sensitive Urban Design Techniques.

The detailed results produced by the model for the development are presented in Table 2.12.

The treatment train modelling results for the modelled scenario with all catchments shows that the development with utilisation of Water Sensitive Urban Design techniques effectively reduces the pollutant loads to levels compliant with the annual pollutant load reductions stated earlier in the Site Specific Objectives.

Total Suspended Solids target reduction achieved ~96.7%
Total Phosphorus target reduction achieved ~71.1%
Total Nitrogen target reduction achieved ~65.8%
Gross Pollutants target reduction achieved ~100%



Table 2.12: MUSIC Water Quality Results - Total Annual Loads

Poliutants	Total Susp Solids (TSS)	ended	Total P	nosphorus	Total (TN)	Nitrogen	Gross (GP)	Pollutants
Mitigation	Dev. No mitigation	WSU D	Dev. No	WSUD	Dev. No mitigatio n		Dev. I	WSUD
Pollutant Loading	9,750	326	20.3	5.87	115	39.2	1,200	0
Target Reduction	85% of Deve	loped	70% of D	eveloped	45% of 1	Developed	90% of	Developed
Achieved Reduction	96.7% of De	veloped	71.1% of	Developed	65.8% of	f Developed	>90% c	of Developed

4.5. Management Methodology

The following methodology will be followed through the construction and operational phase of the Bio-Retention Basins proposed as part of the development.

4.5.1. Construction Phase

Construction of the development and the following building works on site has the potential to mobilise large quantities of sediment in runoff. For Bio-Retention Basins to perform as designed there is a need to protect filter media and basin vegetation during this phase of the development. Therefore a Staged Construction and Establishment Method for construction of the Bio-Retention Basin will be followed. The stages for construction and establishment will be as follows:

- 1. Functional Installation Initially Bio-Retention Basins can be used as Sediment Basins. Once the majority of site construction works have been completed earthworks and shaping to create the layout and functional elements of the basin will be undertaken. This includes the installation of inlets, outlet structures, subsoil drainage, transition layers and filter media. The filter media is to be covered with a protective geofabric which is top-soiled and turfed or grass seeded. Silt fences are to be erected around the outside of the basins to exclude silt and restrict access to the basins.
- Building Construction Protective erosion and sediment control measures are to remain in
 place as the basins are to function as temporary Sediment Basins for the duration of the
 Building Construction Phase. Access to the basins is to be restricted throughout building
 construction phase.



3. Operational Establishment - Following completion of the Building Construction Phase turf, topsoil and protective geofabric is removed and each basin re-planted with vegetation and landscaping as proposed. For vegetation to establish properly regular watering and removal of weeds is required following planting.

4.5.2. Operational Phase

Following construction activities regular inspections of the Bio-Retention Basin are required in order to ensure vegetation establishes and the properties of the filter media remain effective. Procedures to be adopted for the carrying out inspections and maintenance of the basin are presented in Table 2.13 on the following page.



Table 2.13: Bio-Retention Basin Inspection & Maintenance Requirements

Property	Inspection	Inspection Programs	Maintenance
Bio-Retention Basin			
Litter & Weeds	Visually check for litter, weeds and debris within the Bio-Retention Basin.	Quarterly for first year then annually after establishment. Also after flood events.*	Remove litter, weeds and debris from basin and dispose of at approved waste disposal facility.
Inlet and Outlet	Visually check for blockages within the inlet and outlet pits and blocked weep holes within inlet pits.	Quarterly for first year then annually after establishment. Also after flood events.*	Remove any blockages or debris within inlet pits or blockages to weep holes.
Sedimentation	Visually check surface of Bio-Retention Basin for accumulation of sediment.	Quarterly for first year then annually after establishment. Also after flood events.*	Remove accumulated sediment where it is smothering vegetation.
Scour, Erosion and Vehicle Damage	Visually check Bio-Retention Basin surface for scouring and areas of erosion or vehicle damage.	Quarterly for first year then annually after establishment. Also after flood events.*	Repair damage to Bio-Retention Basin surface and filter media if exposed. Undertake replanting if necessary and maintain frequent watering of area until vegetation has established.
Vegetation	Visually check for any planted vegetation that has died.	Quarterly for first year then annually after establishment. Also after flood events.*	Remove dead vegetation and replace with stock of equivalent size and species as detailed in plant schedule. Maintain frequen watering until new vegetation has established.
	Photograph Bio-Retention Basin from same location for yearly review.	Annually during summer months.	N/A
	Map propagation of Bio-Retention Basin vegetation for yearly review.	Annually duting summer months.	N/A
Filter Media	Check surface of Bio-Retention Basin for any isolated "boggy" areas.	Annually.	Increase infiltration rate by tilling the surface of the filter media
	Visually check and determine time of ponding within basin after a storm event.	Annually during wetter periods.	If duration of ponding exceeds 48 hours trail tilling of the surface of the filter media. If no improvement occurs then dispose and replace the top 100 to 150mm layer of filter media.
Subsoil Drainage	Check subsoil drainage for blockages.	Every 5 years during dry periods.	If blockage discovered temove by flushing subsoil drainage pipe. Collecting and dispose flushed material appropriately.

^{**}Source: Water by design Maintaining Vegetated Stormwater Assets, February 2012.

^{*} Note that inspections are to take place monthly and following flood events for first six (6) months of operation. Flood Event defined as period of rainfall with intensity greater than 2 year Average Recurrence Interval (ARI).



5. CONCLUSION

This Stormwater Management Report identifies key infrastructure to be included in the Operational Works design documentation, ensuring minimal impact on upstream and downstream properties.

All storm events up to and including 100 year ARI events have been assessed. Bio-retention basins, vegetated channels and culvert crossings are to be incorporated into the development works, to control the rate of discharge entering downstream drainage systems and natural flowpaths.

Channels/swales and culvert crossings are required and will control and discharge the peak flow, ensuring the requirements of the QUDM are met, including 300mm minimum freeboard to all surrounding allotments.

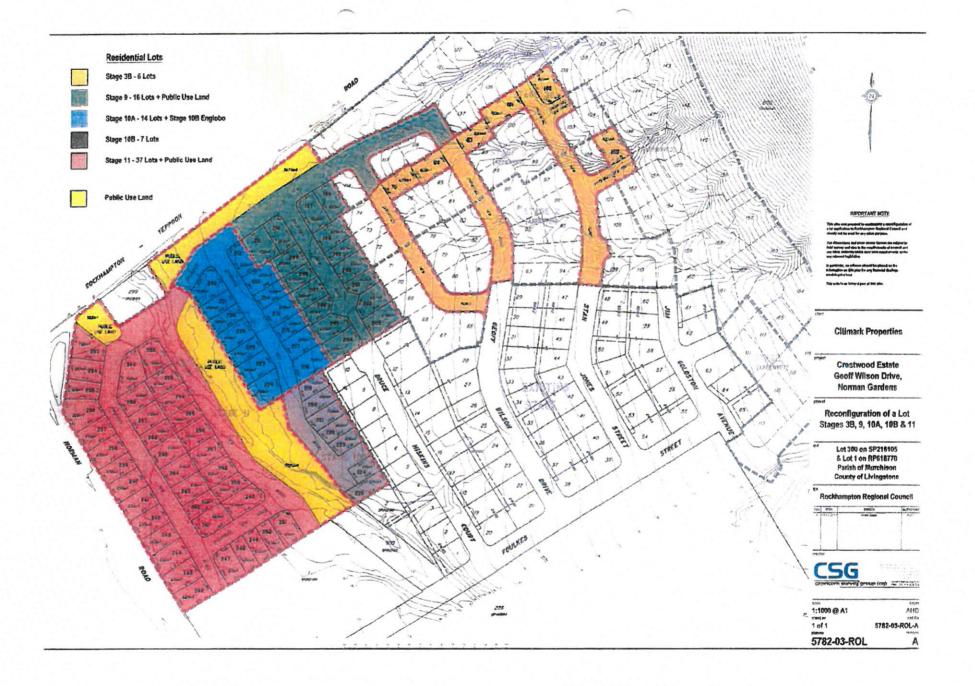
With the above mentioned elements included into the proposed development, no adverse effects on surrounding properties and existing infrastructure should occur during flood events, up to and including 100 year ARI.

In accordance with the Queensland Water Quality Guidelines, we believe that we have demonstrated that the proposed stormwater water quality strategy meets the annual load reduction percentages. The bio retention areas and swale systems may alter from what is mentioned within this Report during detailed design but the fundamentals will remain the same.

Should further information be required regarding the Stormwater Management Report, please don't hesitate to contact BROWN Consulting Rockhampton Office on 07 4931 0777.

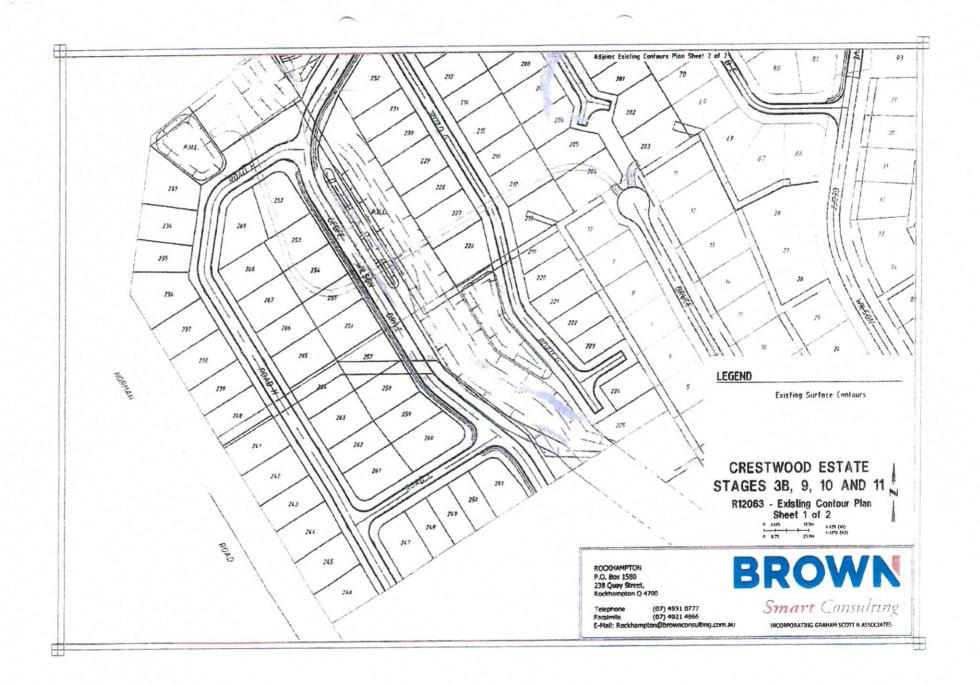


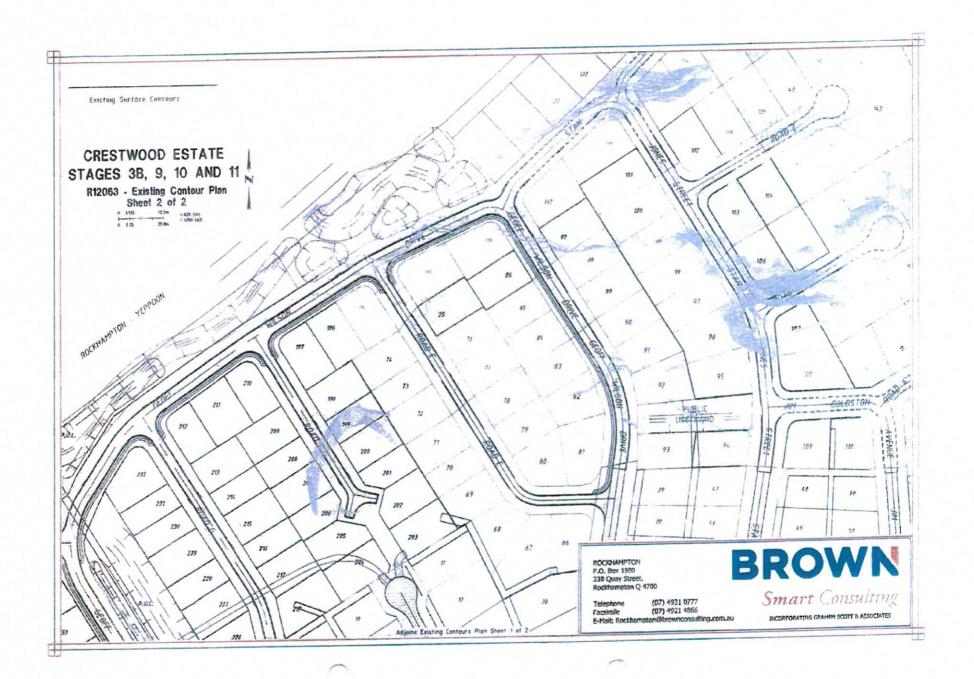
APPENDIX A - Overall Master Plan





APPENDIX B – Existing Contour Plan







APPENDIX C – Cardno Pty Ltd Approved Flood Study

(



PROPOSED RESIDENTIAL SUBDIVISION FOULKES STREET ROCKHAMPTON

OUR REFERENCE: 439101-153

DEVELOPMENT PERMIT FOR RECONFIGURATION OF A LOT (1 LOT INTO 2 LOTS WITH DRAINAGE RESERVE)

Response to Information Request D-1647/2007

Prepared for:

Jim & Kathryn Rundie

Prepared by:

Cardno (Qld) Pty Ltd

Compiler:

Chrls Shields

Date:

16th June 2008

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Gold Coast
Gosford
Beulkham Hills
Wollongong
Bussetton

Papus New Guinea Indonesia Vielnem China Kenya United Arab Emirates United Kingdom United States









INFORMATION REQUEST RESPONSE

Application No.:

D-1647/2007

Application Description:

Reconfiguring a Lot (3 Lots) and Operational Works

In accordance with section 3.3.6 of the Integrated Planning Act 1997, an Information Request has been issued to you in respect to your development application. As set out on the last page of your information request, under section 3.3.8 of the Integrated Planning Act 1997 there are three (3) ways that you can respond to the Information Request. To ensure that Council is clear in understanding your position in respect to the Information Request, you are required to complete this page and return it to Council with your response (if there is one) to the Information Request.

Therefore, please tick one of the following boxes, attach this page to your Information Request response (if you are making one), sign the bottom of the page and return this page to Council.

	I have <u>provided you with all</u> of the Information requested within the Information Request and ask you therefore to proceed with the assessment of the development application based on the information I have provided.
∇	I have <u>provided you with part</u> of the Information requested within the Information Request and ask you therefore to proceed with the assessment of the development application based on the information I have provided and that this response be taken to be a Notice under section 3.3.8(b) of the <i>Integrated Planning Act 1997</i> .
	l do not intend to provide you with any of the Information requested within the Information Request and ask you to proceed with the assessment of the development application based on the information I have provided and that this response be taken to be a Notice under section 3.3.8(c) of the Integrated Planning Act 1997.

Applicant's Signature

03/06/08

Important Note

Any response to Council that does not include this page properly completed or does not include specific references to section 3.3.8 of the *Integrated Planning Act 1997* in terms of the type of Information Request response being made, will be treated not as an Information Request response and will therefore not proceed the development application into the next stage of IDAS (Integrated Development Assessment System). Council may respond to any information submitted as a means of finalising or clarifying the information requested to be submitted, however there is no specific timeframe for Council to do so, and doing so does not reduce the Council's statutory decision making period.

Rockhampton City Council

Bolsover Stree Rockhampton Queensland PO Box 243 Rockhampton Old 4700

Telephone (07) 4936 8000 Email enquiries@roc.qld.gov.au Facsintie (07) 4922 1700



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Appendices

Appendix A - Amended Development Proposal Drawings (Rev B)

Appendix B - Landscaping Drawings

Appendix C - Approved Street Lighting Design for Chancellors Estate Stg1

Appendix D - Drainage Reserve Photo

Appendix E - Detailed Flood Study



Planning

Item 1

Please demonstrate how the proposed subdivision will comply with Acceptable Solution A1 and A6.1 of the Reconfiguring a Lot Code, Performance Criteria 3(d) and 4 of the Norman Road Residential Area Code and Performance Criteria 1 of the Parking and Access Code. NOTE: It is required that the proposal include pedestrian paths for the full length of Foulkes Street and Norman Road.

Response:

Concrete pedestrian footpaths have already been constructed for the full Foulkes St frontage as part of the Chancellors Estate Stage 1 civil works contract. No further response required.

Item 2

Please indicate the anticipated access to proposed Lot 1, in accordance with Acceptable Solution A3.1 of the **Reconfiguring a Lot Code**. The acceptable solution outlines that "Access is provided to an aliotment that previously had no access". NOTE: It is advised that both lots have access indicated on plan 439101-153-001 and 439101-153-007.

Response:

Access to proposed Lot 1 will remain unchanged and remain directly onto Foulkes St. This is the lowest order adjoining road in accordance with the CMDG hierarchy. The approximate location of this existing access is shown on Dwg 439101-153-007 Rev B attached in Appendix A.

Access to proposed Lot 2 is via a combined drainage / access easement on Lot 3 within Chancellors Estate Stage 1, from internal Road A. This is nominated as an Access Place and has been accepted within the Operational Works approval of Chancellors Estate Stage 1 as the appropriate access point for proposed Lot 2. This access, as well as all relevant service connections are shown on Dwg. 439101-153-007 Rev B attached in Appendix A.

Item 3

The application has applied for a 3 lot subdivision, however, in checking this, the third lot cannot be established. Please demonstrate the location of all three lots. NOTE: The proposed drainage easement is not included as a lot, and will be donated in favour of Council. If it is found that the application is only for 2 lots, a refund of \$240 will be issued upon request.

Response:

There are only 2 new allotments proposed, with the drainage reserve being incorrectly included as a "iot" in the application. It therefore seems that the \$240 refund to Jim and Kathryn Rundle is in order, and would be appreciated as soon as practical.

Item 4

Please submit to Council a Concept Landscaping Plan, prepared by a suitably qualified person, that is in accordance with the Landscape Code and Planning Policy No. 6 - Planting Species showing all proposed landscaped areas. The landscaping plan (A3 size and drawn to scale) shall show the following: -

outline of the proposed structures;



- existing vegetation and proposed vegetation to be removed;
- proposed furniture, art and/or public information boards;
- proposed planting within the site (including quantity, species, spacing between each, expected height at the time of planting and the expected mature height);
- paths and paving including pedestrians and cycle ways (location, materials used and showing entry points that are reinforced); and
- the method of planting and the proposed maintenance program.

The landscape plan shall demonstrate the following: -

- a) adequate shade for all car parking areas (in reference to the Landscape Code and Planning Policy No. 6 - recommended shade trees); and
- all proposed landscaping is be in accordance with Crime Prevention Though Environmental Design Code (CPTED) principals.

Due to Rockhampton's climate it is suggested that where possible existing mature trees on site are retained.

NOTE: As the proposal adjoins existing pedestrian infrastructure, it is required that the application include landscaping for the required pedestrian paths. It is advised that particular attention be paid to Acceptable Solution 8.1 of the Landscape Code, when landscaping beside the pedestrian paths.

Response:

As part of the landscaping design for Chancellors Estate Stage 1 (adjacent to the subject site), the Landscape Architect compiled details and planting schedules which incorporated the drainage reserve within Lot 2 on RP6187770, as well as details for the pedestrian footpath landscaping for the full Foulkes St frontage of the subject site. These details are attached in Appendix B.

Item 5

Please indicate compliance with Acceptable Solution A4.3 of the Reconfiguring a Lot Code. NOTE: Please indicate the proposed location of a building envelope so that does not traverse within 5 metres of the drainage easement.

Response:

Due to the large profile of the proposed drainage channel, and frequency at which the runoff from the catchment would achieve flows close to capacity (1 in 100 ARI), it is suggested that a standard 1.5m offset from the drainage reserve boundary is acceptable for the building envelope within proposed Lot 2. Similarly, the building envelope is proposed to be offset 1.5m from the roofwater drainage easement through proposed Lot 2. This is shown in Dwg. 439101-153-007 Rev B attached in Appendix A.

Item 6

Please demonstrate how the proposed development is in compliance with Acceptable Solution A14.6 of the Reconfiguring a Lot Code. NOTE: Please include the location of proposed street lighting facing Foulkes Street. Alternatively, if Chancellors Estate has already made provisions for such services, please locate these on amended site plans.

Response:

A full street lighting design was compiled and certified in accordance with AS1158 for Chancellors Estate Stage 1, which incorporated the proposed lights within the Foulkes St



median, and along the western side of Road A. A copy of these Council approved plans are attached in Appendix C. No further street lighting design is therefore required.

Item 7

Please indicate how proposed lot 2 is in accordance with Acceptable Solution 3 of the Crime Prevention Through Environmental Design Code. NOTE: It is required that either fencing or landscaping be used to distinguish between public and private land.

Response:

It is highly likely that the future owner of Lot 2 will provide a fence that provides protection from people entering the drainage reserve from within Lot 2, which will also act to prevent people from entering private land from the public drainage reserve. The applicant does not propose to fence the land at this stage.

Item 8

Please demonstrate compliance with Performance Criteria 13 of the Landscape Code. NOTE: this should be considered in conjunction with Information Request item (4). As there is an established streetscape created by Chancellors Estate, your streetscape should reflect this. 1. A .. Ph. 1 20

Response:

Please refer to Item 4 Response.

Item 9

Please demonstrate how the proposed development is in compliance with Performance Criteria 2 of the Water Quality and Quantity Code. NOTE: proposed plantings must maintain the integrity of the waterway, and include native plantings.

Response:

As detailed in the Item 4 response and the landscaping drawings attached in Appendix B. the proposed plantings within the drainage reserve are proposed to maintain the integrity of the banks (in conjunction with the proposed MaxJute® matting or similar), provide good visual amenity, and maintain a low profile in order to minimise maintenance and the likelihood of being 'pushed over' by higher flows. All plants have been selected for their low maintenance, durability and ability to be provide binding and stabilisation of the embankments. and a devot at landown ite.

Item 10

Please demonstrate how the proposed development complies with Performance Criteria 2 (and applicable Acceptable Solutions) of the Biodiversity and Nature Conservation Code. NOTE: This is an important aspect of the development, as it has been identified that the proposed drainage easement is a waterway corridor, and includes sensitive natural environments. Proposed revegetation should be sensitive to all requirements.

Response:

Please refer to Item 4 and Item 9 response.

Item 11

Please demonstrate compliance with Performance Criteria 5 of the Biodiversity and Nature Conservation Code. NOTE: Please pay particular attention to Acceptable Solution A5.1, whereby it requires a 30 metre buffer. This is particularly applicable to proposed lot 2.

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Response:

As there is currently no sensitive vegetation in the proposed drainage reserve, this particular item is not applicable, and the buffer therefore does not apply in this instance. Please refer to Appendix D for a recent photo of the drainage reserve area.

Item 12

Please demonstrate how the development is in compliance with Acceptable Solution 4 and Performance Criteria 11 & 12 of the Reconfiguring a Lot Code and Performance Criterion 5 of the Norman Road Residential Area Code. NOTE: it is required that open space be dedicated in favour of Council. The donation may not include drainage easements or any form of waterway corridor. For further guidance and requirements please refer to Planning Policy No. 5 - Open Space Infrastructure Contributions.

Response:

It is proposed that the Open Space contribution be waived in this case, due to the significant earthworks and landscaping proposed at no cost to Council, which ensures that the drainage reserve is easily maintainable and provides good visual amenity.

Development Engineering

Item 1

Please provide a Flood Study, prepared and certified by a suitably qualified and experienced Registered Professional Engineer of Queensland (RPEQ), for the major watercourse traversing the site (Lot 2 on RP618770). This Flood Study shall determine and clearly report all relevant engineering design details associated with flooding in the watercourse and the proposed open channel including, but not limited to, the following:

- the 100 year Average Recurrence Interval (Q100) flood levels, discharge volume and velocity for the existing watercourse configuration and the proposed open channel configuration (reported using Australian Height Datum, AHD, as the vertical datum);
- the 10 year Average Recurrence Interval (Q10) flood levels, discharge volume and velocity for the existing watercourse configuration and the proposed open channel configuration (reported using Australian Height Datum, AHD, as the vertical datum);
- (c) all input parameters used in the HEC-RAS modelling and demonstrate that they are representative of both the existing watercourse and the proposed drainage channel; and
- (d) a complete set of suitably scaled cross-sections and long-sections for both the existing watercourse and the proposed drainage channel as used in the HEC-RAS modelling.

All assumptions for the existing, post-development and ultimate development scenarios must be clearly stated.

Response:

A detailed flood study addressing all items above is attached in Appendix E.

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Item 2

Please demonstrate how the proposed open channel complies with the Capricom Municipal Development Guidelines, Section D5.12 "Open Channels" and the Queensland Urban Drainage Manual, Section 8.00 "Open Channel Hydraulics" including, but not limited to, the following:

(a) Please demonstrate how the proposed development complies with the requirements of the Capricorn Municipal Development Guidelines and Section 8.10(d) of the Queensland Urban Drainage Manual - Recommended Maximum Channel Side Slopes, which states, in part:

"The maximum channel sides slopes for gress lined sections should preferably be 1 on 6 (1V on 6H), with an absolute maximum of 1 on 4 (1V on 4H). If gress lined channels are designed with side slopes steeper than 1 on 4 (1V on 4H), regular maintenance may become impractical and the channel may eventually become overgrown. These conditions would reduce the capacity of the channel and could subsequently lead to flooding of low lying areas upstream. Channels lined with ground covers may be permitted to have maximum side slopes of 1 on 2 (1V on 2 H), however design of such channels must include considerations of potential future increases in channel roughness, and considerations of channel side slope stability."

- (b) Please demonstrate that the proposed development complies with the specified requirements in Section 8.08 of the Queensland Urban Drainage Manual Channel Freeboard. The recommended channel freeboard is the maximum of:
- (i) 0.3 metres, or
- (ii) 20% of the channel depth; or
- (iii) flow velocity head.
- (c) Please demonstrate how the proposed development complies with Section 8.13 of the Queensland Urban Drainage Manual Other Considerations, which states, in part, that:
- "(a) Access / Maintenance Berms

It is recommended that the overall easement / reserve width for an open channel provide for an access / maintenance berm of minimum width 4.5 metres on one side of the channel. This access / maintenance berm may be located within the channel itself at a lower elevation than the design flood level but should be located at a level corresponding to at least the 1 year ARI flow depth.

Where access and maintenance cannot be achieved for the whole channel from one side, it may be necessary to provide a similar access / maintenance berm on both sides of the channel. Notwithstanding the above provisions a 1.5 metre wide safety / access strip should be provided along at least one side of the channel above the design flood level in addition to the access / maintenance berm."

- (d) Please demonstrate how the proposed development complies with Section 8.10(c) of the Queensland Urban Drainage Manual Recommended Maximum Flow Velocities.
- (e) The Capricorn Municipal Development Guidelines, Clause D5.11 (2), requires that proposed "Overland flow paths shall be located on public land." Please demonstrate how the application complies with this requirement.



(f) Please demonstrate how the proposed open channel will provide for low-flow events consistent with the Capricorn Municipal Development Guidelines and the Queensland Urban Drainage Manual.

Response:

- (a) the proposed drainage channel has 1:2 batter slopes and is retained by the use of MaxJute or similar product anchored into the banks (in accordance with the manufacturer's specifications), in conjunction with landscaping that considers native plants, low maintenance, durability and good visual amenity (as detailed in Item 4). The roughness of this channel profile has adequately been incorporated into the HEC-RAS model, which is shown within the Flood Study attached in Appendix E.
- (b) this information is readily available in the Flood Study attached in Appendix E.
- (c) it is proposed that a 3.5m wide maintenance berm above the Q1 level, is to provided in the base of the drainage channel in order to allow service vehicles access to the base. This is shown in the typical detail on Dwg. 439101-153 Rev B attached in Appendix A. This has also been incorporated into the HEC-RAS model used for the Flood Study.
- (d) the flow velocities for the proposed channel are detailed within the Flood Study attached in Appendix E, and are within the limits prescribed in Section 8.10(c) of QUDM.
- (e) the overland flow path is detailed within the Flood Study attached in Appendix E, and demonstrates that the drainage reserve boundaries cater for this on the downstream side of the culvert structure in Foulkes St.
- (f) the proposed channel is to have a slight invert throughout it's length to ensure that low flows are conveyed through the drainage reserve. Also, the native vegetation and grasses in the base of the channel will provide a reasonable level of infiltration for the common storm events. No concrete spoon or similar arrangement is proposed within the channel as this is not in keeping with the natural visual amenity.

Item 3

The proposed drainage easement in favour of Council shown on Drawing 439101-153-007(A) needs to be a minimum of 3 metres wide in lieu of 2 metres shown in order to comply with the requirements of the Capricorn Municipal Development Guidelines. Please amend the proposal plans accordingly.

Response:

The drainage easement has been amended to provide the required 3m width. This is shown in amended Dwg. 439101-153-007 Rev B attached in Appendix A.

Item 4

Please relocate the stormwater outlet RW0/5 as close as practicable to the toe of the batter slope in the proposed drainage channel.

Response

As shown in Dwg. 439101-153-007 Rev B attached in Appendix A, the roofwater outlet 080616 RFI Response.doc



R0/5 is shown to discharge at the toe of the channel batter as required.

Item 5

Please demonstrate how the proposed development complies with the Norman Road Residential Area Code in the Rockhampton City Plan. In order to comply with A3.1 of this Code a dedication of 1.0 metre is required from the Foulkes Street frontage of Lot 2 on RP618770 to provide for the future Trunk Collector classification (22 metre wide road reserve) of Foulkes Street. Please revise and resubmit the proposal plans showing the 1.0 metre dedication from the frontage of Lot 2 on RP618770 as road reserve. In addition, please provide the three chord truncation to the corner of the subject site at the intersection or Foulkes Street and Norman Road in order to comply with A27.2 of the Reconfiguring a Lot Code.

Response:

It is considered unnecessary at this stage to provide the 1.0m strip for the Foulkes St road reserve widening, or the three chord truncation at Norman Rd, as the RoL application is predominantly to provide the drainage reserve for Council. These requirements would also require the removal and relocation of the existing horse paddock fencing.

The current use of the land will not change as a result of this application, and the opportunity exists at the future development application stage for Council to acquire this land.

Item 6

Please show a building envelope on proposed Lot 2 and detail the minimum floor level ensuring that a minimum freeboard of 500mm is provided above the Defined Flood Event (Q100) in accordance with the Flood Prone Land Code.

Response:

The proposed building envelope for Lot 2 is shown in Dwg. 439101-153 Rev B. It is important to note that the top of the drainage channel batter slope provides the required freeboard as detailed in the Item 2(b) response, and therefore provides flood immunity to any structure constructed on this lot.

item 7

In relation to the proposed filling and excavation activity on the site please provide information to demonstrate that the excavation or filling will not adversely affect the amenity of adjoining or nearby properties in accordance with Performance Criteria P2 of the Filling or Excavation Code. This assessment should address the following matters:

- (a) Proposed measures to manage dust emissions from excavation and filling;
- (b) Demonstrate that excavation or filling does not concentrate or divert stormwater runoff into an adjoining site;
- Demonstrate that the excavation and filling will not cause or allow the ponding of water on the site or any other adjoining land;
- (d) Identify proposed vegetation to be cleared as part of the excavation process.



Response:

- (a) dust emissions are proposed to be controlled through the use of water trucks working in conjunction with any cut / fill activities, as well as on any construction traffic routes.
- (b) as shown in Dwgs. 439101-153-002 Rev B and 439101-153-007 Rev B, the proposed earthworks will not concentrate or divert stormwater runoff into adjoining sites; rather, the flows will be controlled within a defined channel. Details of the stormwater runoff volumes can be obtained from the Flood Study attached in Appendix E.
- (c) the proposed channel longitudinal section shown in Dwg. 439101-153-003 attached in Appendix A, shows that there is to be no ponding within the site due to a constant grade to the north. This drawing also shows that the invert of the channel ties into the natural surface at the northern boundary of the subject site, therefore avoiding any ponding within the adjacent site to the north.
- (d) all existing vegetation within the earthworks areas shown on Dwg. 439101-153-002 Rev B attached in Appendix A, is proposed to be removed to allow topsoil to be stripped, and fill to be placed and compacted. Some larger trees towards the southwestern boundary of the earthworks may be able to be retained if minimal fill is required around their bases.

Item 8

Please address the requirements of the External Works and Servicing Code and demonstrate how the proposed development complies with the requirements of the same Code.

Response:

Both proposed Lots 1 and 2 are shown to be fully serviced, as Lot 1 currently has a dwelling present, and the services for Lot 2 are shown in Dwg. 439101-153-007 Rev B attached in Appendix A.

Item 9

The proposed access to the base of the drainage channel shown on Drawing 439101-153-007(A) appears to be located in an area where the batter slopes exceed those suitable for practical access to be achievable. Furthermore, the fencing associated with the culvert structure appears to conflict with the proposed location of the maintenance access. Therefore, the proposed maintenance access from Foulkes Street to the Drainage Reserve is not acceptable due to its proximity to the existing culvert structure and associated end structures, wingwalls, fencing and batter slopes. Please provide an alternative acceptable solution shown on a suitably scaled and adequately dimensioned plan. In addition, please identify all existing service infrastructure located on the road verge or in the vicinity of the proposed access. The proposed access to the Drainage Reserve needs to be suitable for heavy earthmoving equipment such as a 12 tonne excavator and, as a minimum, a Heavy Rigid Vehicle (HRV) as defined in AS2890.2-2002. Please demonstrate that the proposed access provides suitable access to the floor of the proposed channel and the culvert structure for the aforementioned maintenance machinery.



Response:

Since construction of the culvert under Foulkes St, the access proposed from Foulkes St is not practical. As discussed in recent meetings between Cardno and RRC representatives, access to the drainage reserve for maintenance is to be provided through the lot to the north of the subject site, via an easement from Norman Rd. The landowner is agreeable to providing an access easement through his land until such time as access is available via public land and roadways.

An "Amendment to Application" resulting from an RFI Response will be submitted to Council to include the downstream lot in the current application, with the downstream landowner's endorsement. This will allow Council to have legal access to the drainage reserve from the lot to the north, a general arrangement of which is shown on Dwg. 439-101-153-001 Rev B attached in Appendix A.

item 10

Please provide revised development proposal plans in response to the above information request items consistent with Planning Policy No. 15 in the Rockhampton City Plan.

Response:

A full set of revised development proposal plans is attached in Appendix A.

Fitzroy River Water (FRW)

item 1

The applicant is required to demonstrate how the proposed development intends to provide a sewer connection point to service proposed lot 1. The new connection point shall command the entire lot.

Response:

It is proposed that Lot 1 will continue to use the septic system as it currently does as-of-right. There is no change of use in relation to this lot.



Appendix A

Amended Development Proposal Drawings (Rev B)

Important Note:

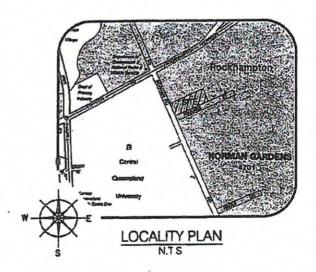
Please note that these drawings represent the proposals generally, however some details are to be modified as per the Flood Study attached in Appendix E. These amendments will be fully incorporated into the plans submitted for Operational Works Approval.

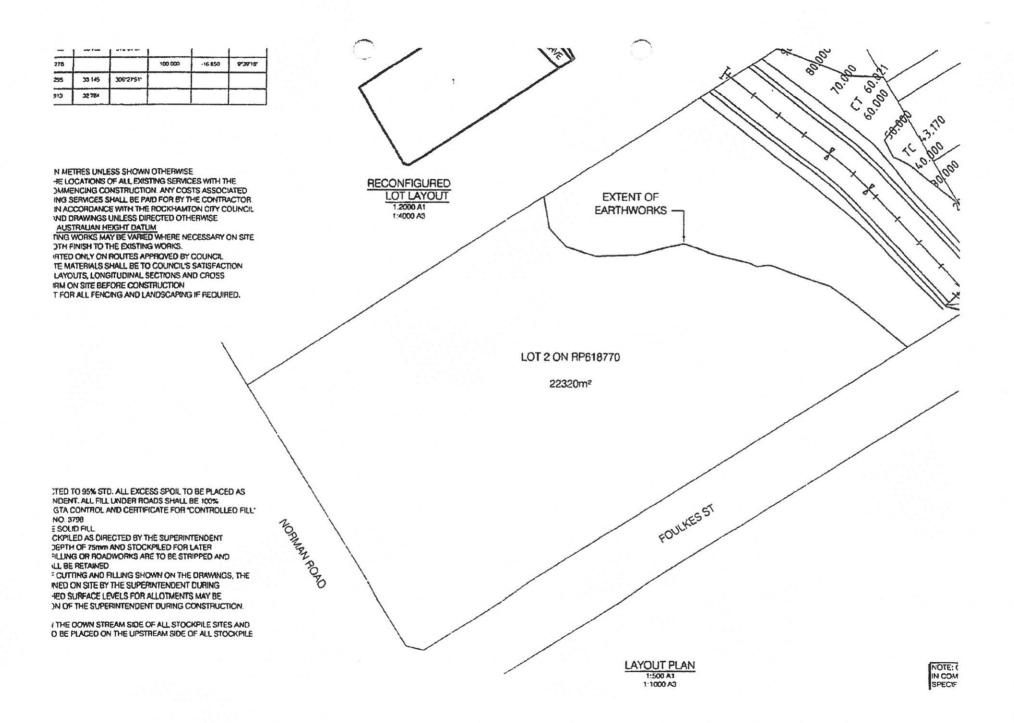
RESIDENTIAL SUBDIVISION 1 INTO 2 LOTS WITH DRAINAGE RESERVE

LOT 2 ON RP618770 FOULKES STREET, ROCKHAMPTON

	DRAWING LIST	
Drg No.	Description	
439101-153-000	TITLE SHEET	
439101-153-001	GENERAL LAYOUT PLAN	
439101-153-002	EARTHWORKS PLAN	
439101-153-003	CHANNEL LONGITUDINAL SECTION	
439101-153-004	CHANNEL CROSS SECTIONS - SHEET 1 OF 3	
439101-153-005	CHANNEL CROSS SECTIONS - SHEET 2 OF 3	
439101-153-006	CHANNEL CROSS SECTIONS - SHEET 3 OF 3	
439101-153-007	SERVICES AND RECONFIGURATION DETAILS	

	STANDARD DRAWINGS
Capricor	n Municipal Development Guidelines Standard Drawings
SD-D-010	EXCAVATION, BEDDING & BACKFILLING OF DRAINAGE PIPES





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WASTE MANAGEMENT

STANDARD

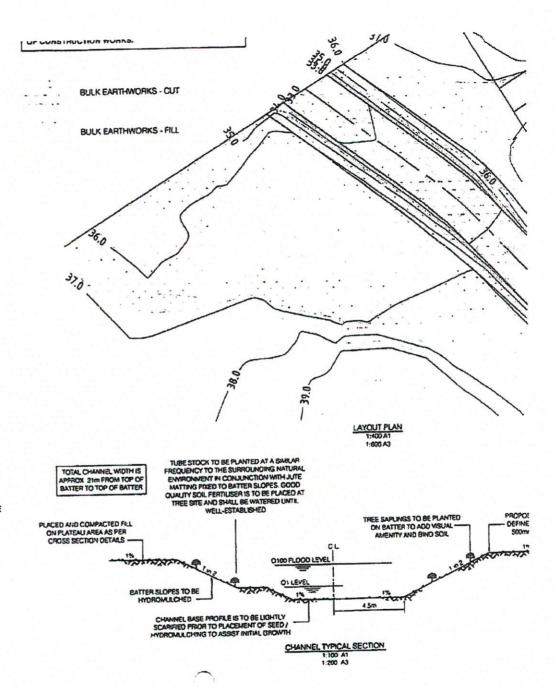
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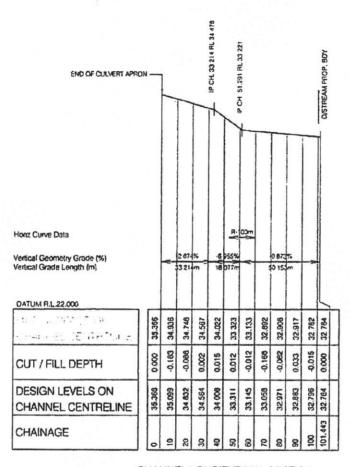
EARTHWORKS AND ROADWORKS NOTES

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- COHESIVE MATERIAL: ALLOTMENT FILL SHALL ACHIEVE A MENIMUM DRY DENSITY RATIO OF 98% OR HIGHER
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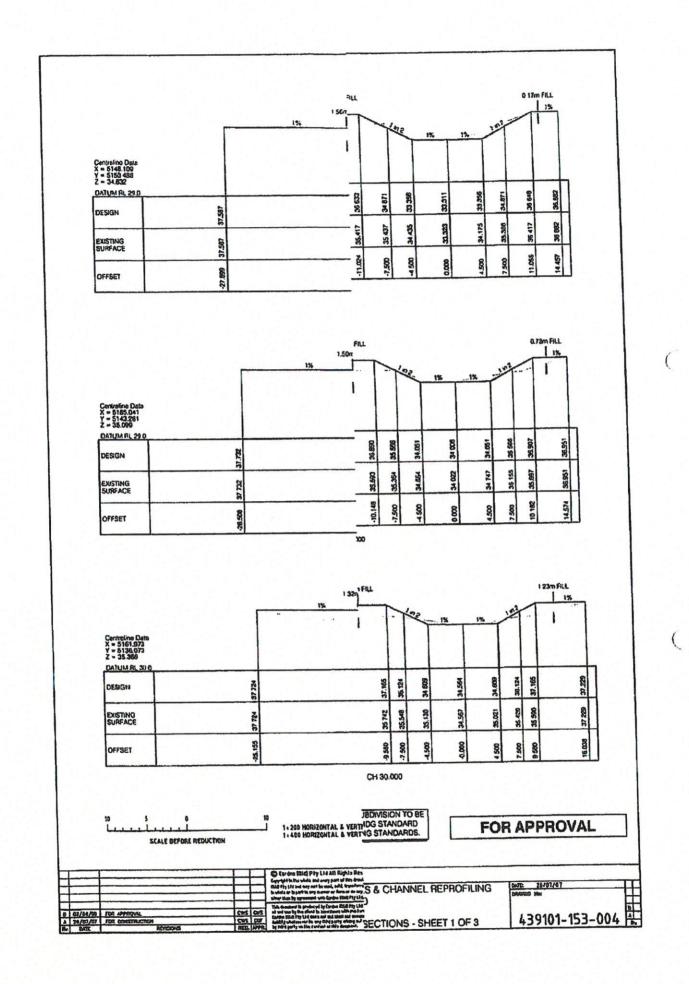
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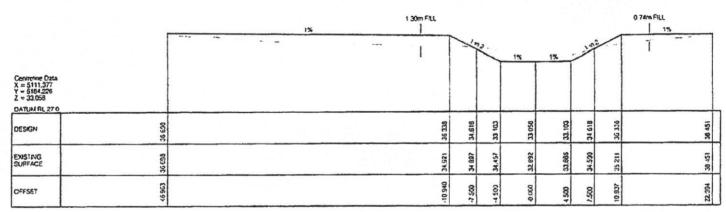
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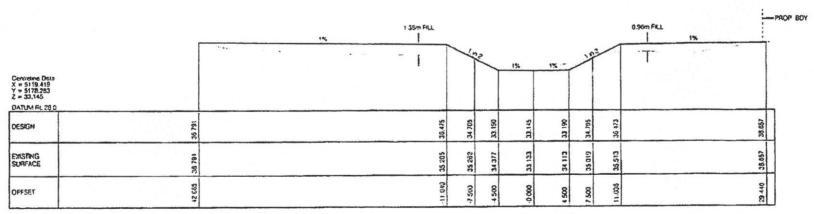


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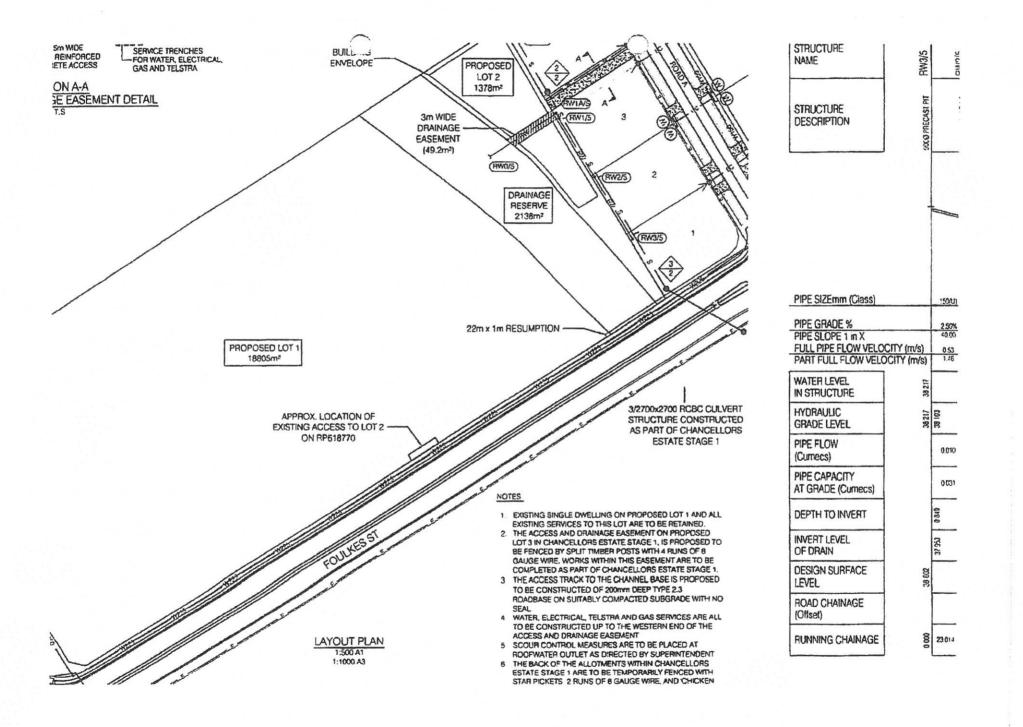
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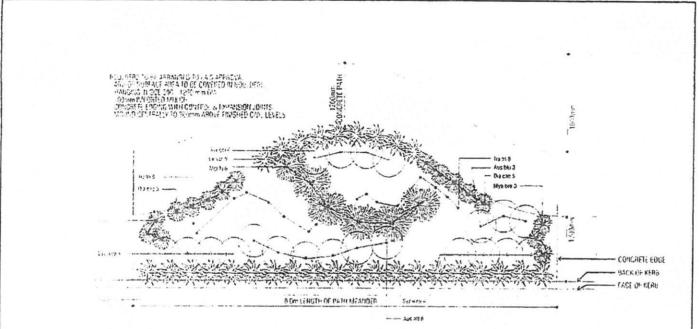
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Appendix B Landscaping Drawings



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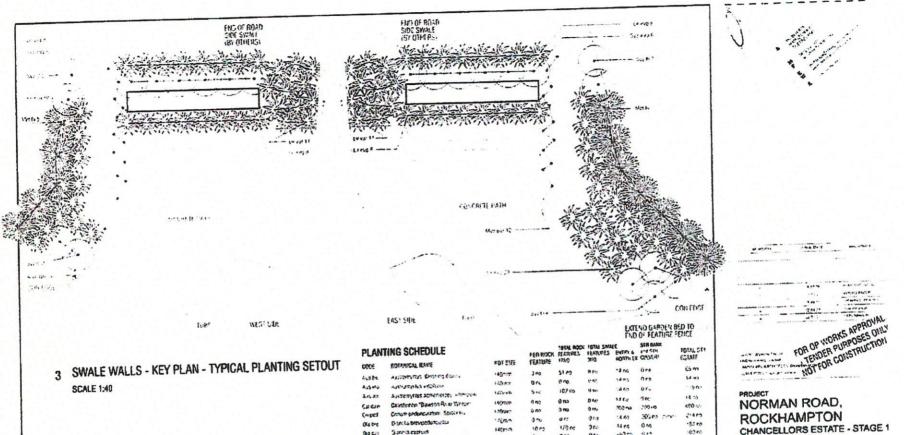
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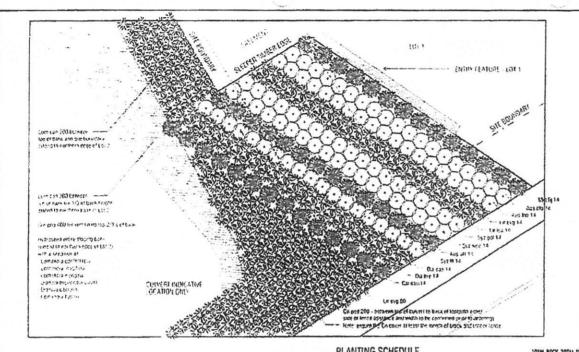
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PROJECT NORMAN ROAD, ROCKHAMPTON CHANCELLORS ESTATE - STAGE 1

DRAWING TITLE

PLANTING PLAN

PEBRUARY 2008 DRAWING HD: LDOC 635 1700





MaxJute thick

soil stabilisation & mulching mat

Benefits

HALTS EROSION

Exposed soils are protected with biodegradable Ma thick, providing erosion control for up to 18 mont

MaxJute" thick acts as a roll-on mulch, adding orga matter to the soil as it breaks down. Suppress mos weeds white planted vegetation is establishing

RETAINS WATER

MaxJute" thick greatly reduces moisture loss due t evaporation, and conforms to the contours of the

100% ORGANIC

MaxJute" thick contains no plastic meshes and will entangle wildlife or machinery.

OTHER FEATURES

Reduces heat absorption, helping to protect plants Flexible and strong when being laid.

Specifications

Name

MaxJute" thick

Material

100% organic biodegrada

jute fibres.

Needle-punched high den

matting. Brown colour.

Construction

Central hessian (30z) scrin and lower layers of jute fl

needle-punched onto the

Mass

750-800gsm (nominal)

Density

110-120kg/m1 (nominal)

Pinning rate

3 pins per m'

(see Installation Sheet)

Dimensions Standard

Width Length 25m 25m

Wide 25m

1.83m 3.66m 0.9m

Available in other widths on request. Also avail weed mat squares, under the brand name 'Max Contact Treemax sales staff for fire-retardant on Caution advised where fire is a risk

Jute fibres (400gsm)

Jule fibres (400gsm) needle punched to mesh

Hessian mesh (3 oz)

Preliminary weed control is essential before installation. Several weed species may have the ability to penetrate the matting. Example are Paspalum spp, Allium spp (Onion week Kikuyu grass, Couch grass, some Secale spp (Rye) and Cypenis rotundas (Nut grass).

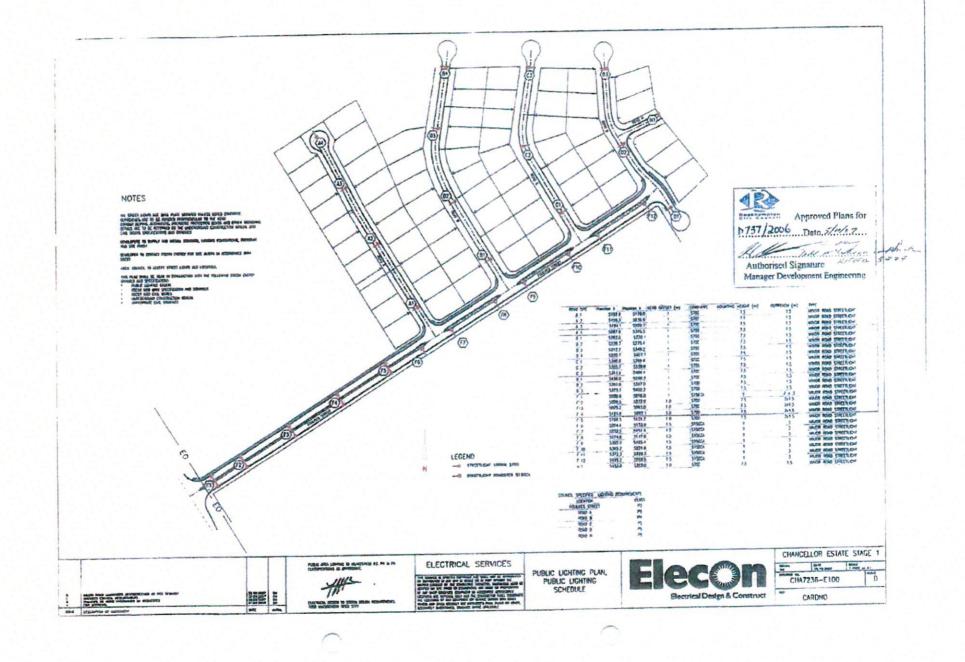
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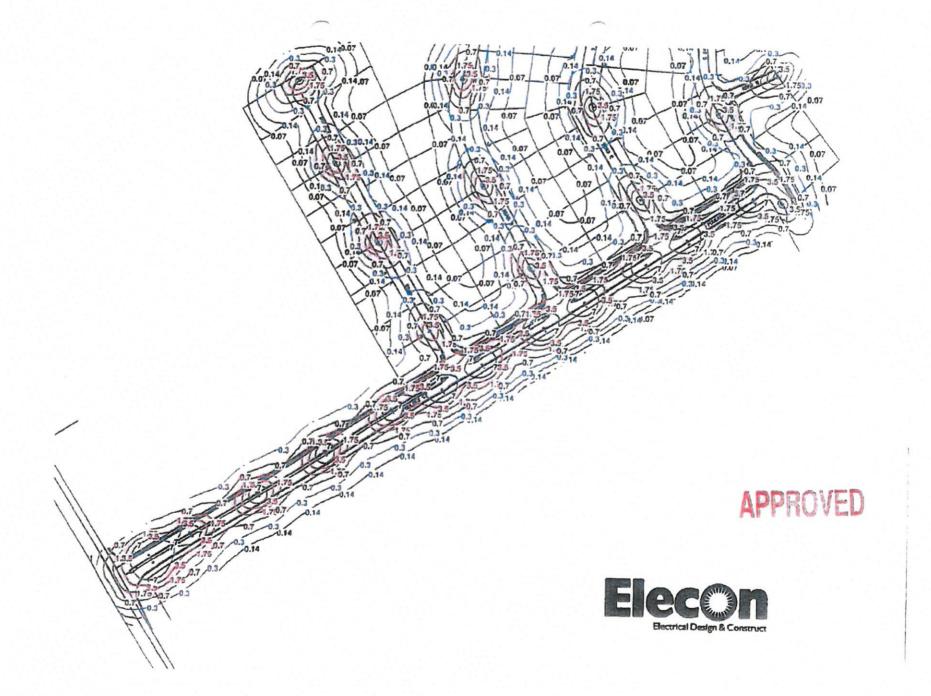
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Appendix C

Approved Street Lighting Design for Chancellors Estate Stage 1







Appendix D Drainage Reserve Photo





Appendix E Detailed Flood Study



ROCKHAMPTON REGIONAL COUNCIL

These plans are approved subject to the current conditions of approval associated with Development Permit No. 01279 - 2013.

Dated 10.03.2014



LOT 2 ON RP618770, ROCKHAMPTON

Flood Study



Cardno (Qid) Pty Ltd

ABN 57 051 074 992

5 Gardner Close Milton Q 4064

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Queensland 4066 Australia

Telephone: 07 3369 9822

Facsimile: 07 3369 9722

International: +61 7 3369 9822

cardno@cardno.com.au

www.cardno.com.au

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Ocument C	control				
		Author		Reviewer	
Version	Date	Name	Initials	Name	Initial
1	18 June 2008	Carlos Gonzalez	6.4	Martin Giles	M

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NORMAN ROAD SUBDIVISION, ROCKHAMPTON FLOOD STUDY ADDENDUM REPORT

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1. INTRODUCTION

It is proposed by Mintgrove Pty Ltd to reconfigure a lot located on Norman Road and Foulkes Street, City of Rockhampton. The property, which is shown on Figure 1, is described as Lot 2 on RP618770, Rockhampton Regional Council.

As part of the application to reconfigure Lot 2 on RP618770, a hydrologic investigation was undertaken to determine the peak flow rates and flood levels corresponding to the 100, 50, 20, 10, 2, 5 and 1 year Average Recurrence Interval (ARI) events within the tributary crossing the subject lot.

In September 2005, Cardno conducted a hydraulic study to determine the extent of inundation within an adjacent property (Lot 2 on RP849709) and to recommend the measures required to allow the proposed development layout to be achieved.

The hydraulic study (Cardno 2005) was submitted to Rockhampton City Council as part of the application for development approval for the site at 850 Norman Road, Norman Gardens, City of Rockhampton (application No. D-1970/2006). In July 2007, an addendum report was prepared to respond a request for further information issued by Council and to determine the extent of inundation within the property located immediately upstream of the subject site (Lot 1 on RP618770).

The present study comprises a detailed hydraulic study of the unnamed tributary of Limestone Creek running trough the subject site (and sites located downstream). This new study addresses the impact of the channel reprofiling and culverts proposed as part of the proposed lot reconfiguration to complement previous flood studies prepared by Cardno.

The present report also discusses the measures taken to eliminate the risk of bank erosion within the proposed channel reprofilling.

The layout proposed for the site is shown on Figure 2. To address the impact of the proposed lot reconfiguration on flooding conditions within the site, two development scenarios were analysed within the present study:

- · Existing conditions; and
- Developed conditions

The existing case reflects the current development level within the site. No modifications to the tributary crossing the site are considered for this scenario. However, it includes channel reprofilling previously recommended for the lots located downstream of the subject site (in Lot 2 on RP849709 and Lot 1 on RP618770).

For the developed case, the existing tributary will be reconfigured to a 23 metre wide channel to provide adequate flow conveyance within the tributary. Foulkes Street and the corresponding culverts located underneath (just upstream of the site) were also included in this case.

The present report was prepared to respond to engineering items 1 and 2 of the informal information request issued by Council on 31 January 2008.



DEVELOPMENT APPLICATION FOR RECONFIGURING A LOT (3 LOTS) AND OPERATIONAL WORKS - APPLICATION NO. D-1647/2007 - L2 RP618770 - 814 NORMAN ROAD, NORMAN GARDENS QLD 4701 FOR CARDNO (QLD) PTY LTD

After having completed a preliminary assessment of the abovementioned development application, it has been determined that additional information is required to be submitted in order that Council may make a proper assessment of the development proposal. It is requested that further information be submitted in response to the following matters:

Engineering

1. Please provide a Flood Study, prepared and certified by a suitably qualified and experienced Registered Professional Engineer of Queensland (RPEQ), for the major watercourse traversing the site (lot 2 on RP618770). This Flood Study shall determine and clearly report all relevant engineering design details associated with flooding in the watercourse and the proposed open channel including, but not limited to, the following:

The 100 year Average Recurrence Interval (Q100) flood levels, discharge volume and velocity for the existing watercourse configuration and the proposed open channel configuration (reported using Australian Height Datum, AHD, as the vertical datum); The 10 year Average Recurrence Interval (Q10) flood levels, discharge volume and velocity for the existing watercourse configuration and the proposed open channel configuration (reported using Australian Height Datum, AHD, as the vertical datum); All input parameters used in the HEC-RAS modelling and demonstrate that they are representative of both the existing watercourse and the proposed drainage channel; and

A complete set of suitably scaled cross-sections and long-sections for both the existing watercourse and the proposed drainage channel as used in the HEC-RAS modelling.

All assumptions for the existing, post-development and ultimate development scenarios must be clearly stated.

- Please demonstrate how the proposed open channel complies with the Capricorn Municipal Development Guidelines, Section D5.12 "Open Channels" and the Queensland Urban Drainage Manual, Section 8.00 "Open Channel Hydraulics" including, but not limited to, the following:
 - a) Please demonstrate how the proposed development complies with the requirements of the Capricorn Municipal Development Guidelines and Section 8.10(d) of the Queensland Urban Drainage Manual – Recommended Maximum Channel Side Slopes, which sates, in part:

"The maximum channel sides slopes for grass lined sections should preferably be 1 on 6 (1V on 6H), with an absolute maximum of 1 on 4 (1V on 4H). If grass lined channels are designed with side slopes steeper than 1 on 4 (1V on 4H), regular maintenance may become impractical and the channel may eventually become overgrown. These conditions would reduce the capacity of the channel and could subsequently lead to flooding of low lying areas upstream. Channels lined with ground covers may be permitted to have maximum side slopes of 1 on 2 (1V on 2H), however design of such channels must include considerations of potential future increases in channel roughness, and considerations of channel side slope stability."



- b) Please demonstrate that the proposed development complies with the specified requirements in Section 8.08 of the Queensland Urban Drainage Manual – Channel Freeboard. The recommended channel freeboard is the maximum of:
 - 1. 0.3 metres, or
 - II. 20% of the channel depth; or
 - III. Flow velocity head
- c) Please demonstrate how the proposed development complies with Section 8.13 of the Queensland Urban Drainage Manual – Other Considerations, which states, in part, that:
 - "(a) Access/Maintenance Berms

It is recommended that the overall easement/reserve width for an open channel provide for an access/maintenance berm of minimum width 4.5 metres on one side of the channel. This access/maintenance berm may be located within the channel itself at a lower elevation than the design flood level but should be located at a level corresponding to at least the 1 year ARI flow depth.

Where access and maintenance cannot be achieved for the whole channel from one site, it may be necessary to provide a similar access/maintenance berm on both sides of the channel. Notwithstanding the above provisions a 1.5 metre wide safety/access strip should be provided along at least one side of the channel above the design flood level in addition to the access/maintenance berm."

- d) Please demonstrate how the proposed development complies with Section 8.10(e) of the Queensland Urban Drainage Manual – Recommended Maximum Flow Velocities.
- e) The Capricorn Municipal Development Guidelines, Clause D5.11(2), requires that proposed "Overland flow paths shall be located on public land." Please demonstrate how the application complies with this requirement.
- f) Please demonstrate how the proposed open channel will provide for low-flow events consistent with the Capricorn Municipal Development Guidelines and the Queensland Urban Drainage Manual.



PEAK FLOW RATES

The peak flow rates occurring at various points within the catchment for the 100 year event were previously calculated (Cardno 2005) using the Rational Method in accordance with the *Queensland Urban Drainage Manual* (Neville Jones & Associates et al 1992)(QUDM). The catchment areas draining into the site and the subcatchments adopted for the analysis are shown on Figure 3.

Significant parts of the catchment draining to Norman Road will be left in an undeveloped state. A portion of the catchment will become low density residential development according to the Rockhampton City Plan (refer to Appendix A). Peak flow rates calculated in the present study are considered to be conservative as they are based on full development of the Norman Road residential precinct. Therefore, the peak flow rates reported in this study consider only the future development scenario within the catchment.

Appropriate fraction impervious and runoff coefficients were defined for these land uses based on Tables 5.04.1 and 5.04.2 of QUDM. The runoff coefficient derived for the 10 year event was multiplied by a frequency factor of 1.2 (Table 5.04.3 of QUDM) to derive the 100 year runoff coefficient.

The time of concentration for each subcatchment was calculated using a combination of Friend's Equation (Equation 5.05.1 of QUDM) for overland sheet flow, and the stream velocity method (Table 5.05.4 of QUDM) for stream flow. Due to the steepness of the catchment, the overland sheet flow length was limited to 50 metres, as runoff would quickly collect in rills.

The areas of bushland and development applicable to each subcatchment, the time of concentration for each subcatchment and the peak flow rates for the 100 year event calculated at various points of interest are listed in Table 1. The catchment plan is shown on Figure 3.

Peak flow rates corresponding to the design ARI events (1, 2, 5, 10, 20 and 50 years) were also calculated for the major watercourse flowing through the site to calculate the capacity of the culverts beneath Foulkes Street. The design ARI event flow rates (1 to 50 years) for the major tributary are presented in Table 2. Note that these flowrates represent the worst case scenario, as they correspond to the post-development conditions of the catchment.



Table 1 Peak Flow Rates- 100 Year Event

		Time o	of Concent	ation		Are	eas	
ocation	Contributing Sub- catchments	Overland Flow Time (min)	Stream Flow Time (min)	Time of Conc. (min)	Rainfall Intensity (mm/h)	Bushland (ha)	Developed (ha)	Peak Flow (m³/s)
Minor Creek Sy	ystem							
MN1	MN1	8.5	2.5	11.0	237	2.89	0.62	1.72
MN2	MN2	9.0	1.0	10.0	247	0.27	0.28	0.31
MN3	MN1, MN2, MN3	•	0.6	11.6	231.6	3.16	1.95	2.60
MN4	MN1, MN2, MN3, MN4	•	3.7	15.3	204.2	3.16	2.90	2,80
MN5	MN5	9.0	2.6	11.6	231.6	2.10	0.55	1.29
MN6	MN6	9.0	1.0	10.0	247	0.20	0.35	0.32
MN7	MN7	9.9	0.8	10.7	240	0.00	0.41	0.26
MN8	MN5, MN6, MNB	-	1.9	13.5	216.5	2.30	1.30	1.71
MN9	MN5, MN6, MN7, MN8, MN9	-	2.2	15.7	201.8	2.30	2.18	2.05
MN10	MN10	9.2	1.6	10.8	239	0.78	0.44	0.64
MN11	MN10, MN11		2.5	13.3	217.9	0.78	1.16	0.99
MN12	MN12	9.0	2.0	11.0	237	0.82	0.27	0.55
MN13	MN13	9.0	2.3	11.3	233.6	1.37	0.95	1.21
MN14	MN12, MN13, MN14	-	2.7	14.0	213	2.19	1.86	1.96
MN15	MN10, MN11, MN12, MN13, MN14, MN15		3.4	17.4	192.6	2.97	3.92	3.10
MN16	MN5, MN6, MN7, MN8, MN9, MN10, MN11, MN12, MN13, MN14, MN15, MN16	-	1.6	19.0	184	5.27	6.45	4.96
MN17	MN1, MN2, MN3, MN4, MN5, MN6, MN7, MN8, MN9, MN10, MN11, MN12, MN13, MN14, MN15, MN16, MN17	-	0.7	19.7	181.2	8.43	9.71	7.56
Major Creek	System							T
MJ1	MJ1	8.7	8.2	16.9	195.5	51.87	9.64	24.85
MJ2	MJ2	9.0	16.0	25.0	161	91.89	11.19	33.74
МЈЗ	MJ1, MJ2, MJ3	-	4.3	29.3	148.1	156.36	28.29	56.52
MJ6	MJ1, MJ2, MJ3, MJ6	-	17.5	46.8	114.8	156.36	48.01	49.27
MJ4	MJ4	8.7	2.1	10.8	239	12.62	0.00	5.93
MJ5	MJ4, MJ5	-	13.6	24.4	162.8	12.62	8.80	7.79
MJ9	MJ9	13	-	13.0	220	0.00	4.32	2.47
MJ6 (Foulkes St)			17.5	46.8	114.8	168.98	56.15	54.9
MJ7	MJ1, MJ2, MJ3, MJ4, MJ5, MJ6, MJ7, MJ9	•	10.9	57.7	102.3	168.98	66.69	51.4
MJ8	MJ1, MJ2, MJ3, MJ4, MJ5, MJ6, MJ7, MJ8, MJ9		7.4	65.1	95.7	168.98	71.37	49.8

Note: Refer to Figure 3 for location of subcatchments



Table 2 Peak Flow Rates- 1 to 50 Year Events

	Time of Cone	Rainfa	Il intensity	/ (mm/h)	Ar	eas	Pea	k Flow (r	n³/s)
Location	Time of Conc. (min)	50 yr	20 yr	10 yr	Bushland (ha)	Developed (ha)	50 yr	20 уг	10 yı
Major Creek Sys	tem								
MJ1	16.9	172.5	144.4	124.3	51.87	9.64	21.1	16.1	13.2
MJ2	25.0	143.0	120.0	103.0	91.89	11.19	28.8	22.0	18.0
MJ3	29.3	131.4	110.4	94.7	156.36	28.29	48.0	36.8	30.1
MJ6	46.8	101.8	86.2	73.6	156.36	48.01	42.2	32.6	26.5
MJ4	10.8	211.6	176.4	151.2	12.62	0.00	5.0	3.8	3.1
MJ5	24.4	144.8	121.2	104.2	12.62	8.80	6.6	5.1	4.1
MJ6 (Foulkes St)	46.8	101.8	86.2	73.6	168.98	56.15	46.7	36.1	29.3
PLM 9	13.0	195.0	163.0	140.0	0.00	4.32	2.1	1.6	1.3
MJ7	57.7	90.8	76.4	65.8	168.98	66.69	44.0	33.8	27.7
MJ8	65.1	85.3	71.6	61.3	168.98	71.37	42.3	32.4	26.4
	Time of Conc.	Rainfall intensity (mm/h)		Areas		Peak Flow (m³/s)			
Location	(min)	5 yr	2 yr	1 уг	Bushland (ha)	Developed (ha)	5 yr	2 ут	1 yı
Major Creek Sys	stem								
MJ1	16.9	109.3	84.2	65.2	51.87	9.64	11.0	7.6	5.5
MJ2	25.0	90.0	70.0	54.0	91.89	11.19	14.9	10.4	7.6
MJ3	29.3	83.4	64.7	50.0	156.36	28.29	25.2	17.5	12.
MJ6	46.8	64.9	50.9	39.2	156.36	48.01	22.2	15.6	11.3
MJ4	10.8	132.2	101.8	78.6	12.62	0.00	2.6	1.8	1.3
MJ5	24.4	91.2	70.6	54.6	12.62	8.80	3.4	2.4	1.7
MJ9	13.0	122	95	73	0.00	4.32	1.1	0.8	0.5
MJ6 (Foulkes Street)	46.8	64.9	50.9	39.2	168.98	56.15	24.6	17.2	12.
MJ7	57.7	58.4	45.3	35.0	168.98	66.69	23.4	16.2	11.
MJ8	65.1	54.4	42.3	32.8	168.98	71.37	22.3	15.5	11.

Note: Refer to Figure 3 for location of subcetchments



3. HYDRAULICS

Flood levels in the unnamed tributary of Limestone Creek were calculated using the HECRAS steady state backwater program developed by the US Army Corps of Engineers.

3.1 Existing Case

A HECRAS model of the tributary flowing through the site was previously set up using detailed surveyed cross-sections of the creek. The location of the cross sections is shown in Figure 4. Detailed tributary cross sections were obtained between Foulkes Street and Rockhampton-Yeppoon Road. However, no survey data was available upstream of Foulkes Street and upstream cross sections were sourced from 5 metres contour topographical data.

As previously stated in the flood study prepared by Cardno in July 2007, a stretch of approximately 300 metres of tributary downstream of the subject site has been or will be reconfigured in the near future, this channel works are not the subject of the present study (between cross sections A21 and A300).

The existing scenario considers the filling and channel reprofilling previously recommended for the lots located downstream of the subject site (Lot 2 on RP849709 and Lot 1 on RP618770). The two 2700X2400 mm reinforced concrete box culverts (RCBC) and the road profile of Rockhampton-Yeppoon Road were included in the model.

The HECRAS model for the existing case reflects the previously reported channel reconfiguration and also considers that the entire length of the tributary crossing the subject site (approximately 100 metres) remains in natural conditions (between cross sections A320 and A415). The cross sections used for the existing case model are shown in Appendix B. The pump station access road located in Lot 2 on RP849709 and associated culverts were also included in the model.

A Manning's n value of 0.10 was conservatively assumed for the channel and adjacent areas in each cross section. Normal depth was adopted as the tailwater level condition for the model. This depth was determined by calculating the slope between the most downstream cross sections, which was evaluated to be 0.1 percent.

The 100 and 10 year ARI events flood levels resulting from the analysis are presented in Table 3. The corresponding 100 year ARI extent of inundation for this scenario is plotted on Figure 4.

3.2 Developed Case

The model of the developed scenario involves reprofilling the section of the tributary crossing the subject site to Improve the conveyance of the tributary and to provide flood immunity within the property. The stretch of creek traversing the site will be reconfigured to a 23 metre wide channel (approximately 100 metres between cross sections A300 and A415). The modified cross section plots for the developed case are provided in Appendix C.



The new 23 metre wide channel will mostly have 1:2 batter slopes and will be 2.7 metres deep. A 1.8 maintenance berm will be located within the channel above the inundation level corresponding to the 1 year ARI event. A cross section of the proposed channel is shown in Figure 5. The invert slope of the proposed channel along the property will be approximately 1.25 %. A Manning's n value of 0.10 was conservatively assumed for the channel and bank areas in each cross section. The three 2700X2700 mm box culverts (RCBC) and the road profile of Foulkes Street were also included in the model for the developed scenario.

The 100 and 10 year ARI events flood levels for the post-development scenario are presented in Table 4. The corresponding 100year ARI extent of inundation for this scenario is also plotted on Figure 4. The water levels for the existing and developed scenarios are compared in Table 5.

Table 3 **Existing Case Peak Flood Levels**

		10	0 year ARI	10 year ARI Event		
Reach Name	Cross- section	Peak Flow (m³/s)	Water Level (m AHD)	Channel Velocity (m/s)	Peak Flow (m³/s)	Water Level (m AHD)
north	A829	5.93	50.42	1.02	3.13	50.30
north	A792	5.93	48.71	1.01	3.13	48.58
north	A740	5.93	46.40	1.05	3.13	46.27
north	A673	7.79	43.74	1.19	4.14	43.54
north	A590	7.79	38.51	1.98	4.14	38.35
southcomb	A972	49.27	44.99	1.75	26.45	44.50
southcomb	A896	49.27	43.20	1.16	26.45	42.97
southcomb	A796	49.27	41.20	1.24	26.45	40.77
southcomb	A590	49.27	38.52	1.03	26.45	38.35
combined	A510	55	38.05	0.73	29.32	37.55
combined	A430	55	37.32	1.47	29.32	36.90
combined	A415	55	37.06	1.40	29.32	36.69
combined	A400	55	36.79	1.40	29.32	36.45
combined	A386	55	36.49	1.45	29.32	36.14
combined	A362	55	36.08	1.22	29.32	35.67
combined	A340	55	35.81	1.04	29.32	35.3
outlet	A325	51.43	35.65	1.09	27.75	35.11
outlet	A320	51.43	35.59	1.06	27.75	35.06
outlet	A300	51.43	35.31	1.22	27.75	34.80
outlet	A252	51.43	34.33	1.79	27.75	33.81
outlet	A226	51.43	33.96	1.41	27.75	33.26
outlet	A200	51.43	33.83	0.92	27.75	33.09
outlet	A190	51.43	33.81	0.77	27.75	33.06
outlet	A150	51.43	33.53	1.69	27.75	32.82
outlet		Cul	vert (Pump	station acce	ss road)	
outlet	A135	51.43	33.02	2.06	27.75	32.14
outlet	A130	51.43	33.10	0.97	27.75	32.14
outlet	A109	49.84	33.02	0.78	26.50	31.95
outlet	A58	49.84	32.86	0.61	26.50	31.74
outlet	A36	49.84	32.85	0.57	26.50	31.73



		10	year ARI	10 year ARI Even		
Reach Name	Cross- section	Peak Flow (m³/s)	Water Level (m AHD)	Channel Velocity (m/s)	Peak Flow (m³/s)	Water Level (m AHD)
outlet	A21	49.84	32.84	0.73	26.50	31.72
outlet	A20	49.84	32.68	1.74	26.50	31.62
outlet			Culvert (Y	eppoon roa	d)	
outlet	A-15	49.84	31.64	2.16	26.50	31.33
outlet	A-85	49.84	31.64	0.35	26.50	31.26

Note: cross sections located within the site are shaded

Table 4 Developed Case Peak Flood Levels

		100	year ARI	Event	10 year	ARI Event		
Reach Name	Cross- section	Peak Flow (m³/s)	Water Level (m AHD)	Channel Velocity (m/s)	Peak Flow (m³/s)	Water Level (m AHD)		
north	A829	5.93	50.5	0.79	3.13	50.30		
north	A792	5.93	48.55	1.67	3.13	48.58		
north	A740	5.93	46.54	0.73	3.13	46.27		
north	A673	7.79	43.51	1.96	4.14	43.54		
north	A590	7.79	38.9	0.92	4.14	38.35		
southcomb	A972	49.27	44.82	2.12	26.45	44.50		
southcomb	A896	49.27	43.37	0.94	26.45	42.97		
southcomb	A796	49.27	40.9	1.94	26.45	40.77		
southcomb	A590	49.27	38.9	0.92	26.45	38.35		
combined	A510	55	38.83	0.38	29.32	37.91		
combined	A430	55	38.53	1.51	29.32	37.56		
combined		Culvert (Foulkes Street)						
combined	A415	55	37.34	2.67	29.32	36.75		
combined	A400	55	37.27	1.39	29.32	36.64		
combined	A386	55	37.09	1.58	29.32	36.47		
combined	A362	55	36.74	1.63	29.32	36.14		
combined	A340	55	36.37	1.73	29.32	35.78		
outlet	A325	51.43	36.15	1.64	27.75	35.56		
outlet	A320	51.43	36.06	1.67	27.75	35.48		
outlet	A300	51.43	35.53	2.06	27.75	35.04		
outlet	A252	51.43	34.37	1.74	27.75	33.81		
outlet	A226	51.43	34.05	1.33	27.75	33.36		
outlet	A200	51.43	33.87	0.90	27.75	33.14		
outlet	A190	51.43	33.81	0.77	27.75	33.06		
outlet	A150	51.43	33.53	1.69	27.75	32.82		
outlet		Cul	vert (Pump	station acco	ess road)			
outlet	A135	51.43	33.02	2.06	27.75	32.14		
outlet	A130	51.43	33.1	0.97	27.75	32.14		
outlet	A109	49.84	33.02	0.78	26.50	31.95		
outlet	A58	49.84	32.86	0.61	26.50	31.73		
outlet	A36	49.84	32.85	0.57	26.50	31.72		



		10	0 year ARI	10 year ARI Even		
Reach Name	Cross- section	Peak Flow (m³/s)	Water Level (m AHD)	Channel Velocity (m/s)	Peak Flow (m³/s)	Water Level (m AHD)
outlet	A21	49.84	32.83	0.73	26.50	31.71
outlet	A20	49.84	32.69	1.66	26.50	31.64
outlet			Culvert (Y	eppoon roa	d)	
outlet	A-15	49.84	31.65	2.12	26.50	31.33
outlet	A-85	49.84	31.64	0.35	26.50	31.26

Note: cross sections located within the site are shaded

Table 5 Increase in Flood Levels

Reach	Cross-	100 year ARI Event	10 year ARI Event			
Name	section	Afflux	(mm)			
north	A829	80	0			
north	A792	-160	0			
north	A740	140	0			
north	A673	-230	0			
north	A590	390	0			
southcomb	A972	-170	-60			
southcomb	A896	170	50			
southcomb	A796	-300	-80			
southcomb	A590	390	0			
combined	A510	780	360			
combined	A430	1210	660			
combined	Culv	Culvert (Foulkes Street)				
combined	A415	280	60			
combined	A400	480	190			
combined	A386	600	330			
combined	A362	660	470			
combined	A340	560	480			
outlet	A325	500	450			
outlet	A320	470	420			
outlet	A300	220	240			
outlet	A252	40	0			
outlet	A226	90	100			
outlet	A200	40	50			
outlet	A190	0	0			
outlet	A150	0	0			
outlet	Culvert (P	ump station acc	ess road)			
outlet	A135	0	0			
outlet	A130	0	0			
outlet	A109	0	0			
outlet	A58	0	-10			
outlet	A36	0	-10			
outlet	A21	-10	-10			



Reach	Gross-	100 year ARI Event	10 year ARI Event
Name	section	Afflux	(mm)
outlet	A20	10	20
outlet	Culv	vert (Yeppoon ro	oad)
outlet	A-15	10	0
outlet	A-85	0	0

Note: cross sections located within the site are shaded

According to results reported in Table 4, the maximum level obtained upstream of Foulkes Street is 38.53 mAHD, the top of the embankment on the upstream side of the Foulkes Street culvert has an elevation of 39.54 mAHD (refer to appendix D for details of culvert). Thus, the obtained results demonstrate that Foulkes Street is immune to flooding in occurrence of the 100 year ARI event.

Further, results presented in Table 5 show that Foulkes Street culvert causes a maximum increase in flood levels of 1210 mm within the property upstream of the site. This afflux will be dissipated within 350 metres from the upstream side of the culvert.

Channel velocities presented in Table 4 indicate that a maximum velocity of 2.06 m/s will occur within the proposed channel. The longitudinal slope of the channel is 1.25%, the banks of the channel are considered to comprise erosion resistant soil, as the invert of the channel will be grassed and the batters of the channel will be lined with a jute mat and landscaped plantings. Therefore the obtained velocities are within the range of permissible velocities recommended in Table 9.05.3 of QUDM 2007 for channels with gradients between 1 and 2 % (2.1 to 2.8 m/s).

The velocities within the Foulkes Street culvert for all the design ARI events (1 to 100 year) were extracted from the model and are presented in Table 6.

Table 6 Flow Velocities within Culvert A 140 - 1 to 100 year ARI Events

ARI Event (yr)	Q _{culvert} (m ³ /s)	Q _{well} (m³/s)	Velocity downstream end (m/s)	Velocity d/s end of apron (m/s) (Cross section A415)
100	55.00		5.11	2.67
50	46.68	-	4.90	2.53
20	36.08	-	4.60	2.33
10	29.32	_	4.36	2.18
5	24.58		4.17	2.11
2	17.24	-	3.82	1.88
1	12.50	-	3.52	1.64

Based on the velocities presented in Table 6, it can be observed that the outlet of the culvert should be protected to avoid local scour in occurrence of large flood events.

According to the guidelines for Stormwater Outlet Design in Perks and Waterways issued by Brisbane City Council in 2003, the 10 metres of creek located immediately downstream of the culvert apron should be protected to avoid scour. Loose rocks with a d₆₀ of at least 100 mm are recommended as scour protection devices.



Approximately 10 metres of the channel invert just downstream of the Foulkes Street culvert's concrete apron are already armoured with loose riprap. Photos of the existing protection are provided in Appendix D. The upstream width of the armoured channel invert is equal to the apron width (9 metres) and the downstream width of the invert is 15 metres. Therefore, the banks of the channel should also be armoured to a height of 2.5 metres to match the existing invert armouring. Further, it is recommended to place a 250 mm high masonry/concrete sill at the end of the concrete apron to control the occurrence of hydraulic jumps downstream of the culvert.



4. SPECIFIC RESPONSE

Outlined in the following section are the specific responses to each of the items requested in Council's Request for Further Information.

Item 1.

Please provide a Flood Study, prepared and certified by a suitably qualified and experienced Registered Professional Engineer of Queensland (RPEQ), for the major watercourse traversing the site (lot 2 on RP618770). This Flood Study shall determine and clearly report all relevant engineering design details associated with flooding in the watercourse and the proposed open channel including, but not limited to, the following:

- The 100 year Average Recurrence Interval (Q100) flood levels, discharge volume and velocity for the existing watercourse configuration and the proposed open channel configuration (reported using Australian Height Datum, AHD, as the vertical datum);
- The 10 year Average Recurrence Interval (Q10) flood levels, discharge volume and velocity for the existing watercourse configuration and the proposed open channel configuration (reported using Australian Height Datum, AHD, as the vertical datum);
- All input parameters used in the HEC-RAS modelling and demonstrate that they are representative of both the existing watercourse and the proposed drainage channel;
- A complete set of suitably scaled cross-sections and long-sections for both the existing watercourse and the proposed drainage channel as used in the HEC-RAS modelling.

All assumptions for the existing, post-development and ultimate development scenarios must be clearly stated.

Response:

A flood study titled "Lot 2 on RP618770, Rockhampton, Flood Study" has been completed by Cardno to address Council's request.

Flood levels, peak flow rates and velocities have been calculated for both the 100 and 10 year Average Recurrence Interval (ARI) events and are reported in Tables 3 and 4. Two development scenarios (existing and developed) were analysed within the present study.

The existing case reflects the current development level within the site. No modifications to the tributary crossing the site are considered for this scenario. However, it includes channel reprofilling previously recommended for the lots located downstream of the subject site (in Lot 2 on RP849709 and Lot 1 on RP618770).

For the developed case, the existing tributary will be reconfigured to a 23 metre wide channel to provide adequate flow conveyance within the tributary. Foulkes Street and the corresponding culverts located underneath (just upstream of the site) were also included in this case.

A complete set of cross sections used for the HECRAS models for both scenarios (existing and developed) are included in Appendices B and C of the report. All parameters used within the HECRAS models are explained in section 3 of the report



Item 2.

Please demonstrate how the proposed open channel complies with the Capricorn Municipal Development Guidelines, Section D5.12 "Open Channels" and the Queensland Urban Drainage Manual, Section 8.00 "Open Channel Hydraulics" including, but not limited to, the following:

a) Please demonstrate how the proposed development complies with the requirements of the Capricorn Municipal Development Guidelines and Section 8.10(d) of the Queensland Urban Drainage Manual – Recommended Maximum Channel Side Slopes, which states, in part:

"The maximum channel sides slopes for grass lined sections should preferably be 1 on 6 (1V on 6H), with an absolute maximum of 1 on 4 (1V on 4H). If grass lined channels are designed with side slopes steeper than 1 on 4 (1V on 4H), regular maintenance may become impractical and the channel may eventually become overgrown. These conditions would reduce the capacity of the channel and could subsequently lead to flooding of low lying areas upstream. Channels lined with ground covers may be permitted to have maximum side slopes of 1 on 2 (1V on 2H), however design of such channels must include considerations of potential future increases in channel roughness, and considerations of channel side slope stability."

Response:

The proposed channel comprises 1:2 batter slopes and will be lined with jute mats and landscape plantings. A conservative "Manning's n" coefficient of 0.1 has been used throughout the entire HECRAS models of both existing and developed cases to represent the existing vegetation of the gully crossing the site and the ultimate roughness of the proposed channel. The roughness coefficient used herein is equivalent to natural channels with dense plant growth and woody shrubs in banks.

- b) Please demonstrate that the proposed development complies with the specified requirements in Section 8.08 of the Queensland Urban Drainage Manual – Channel Freeboard. The recommended channel freeboard is the maximum of:
 - 0.3 metres, or
 - II. 20% of the channel depth; or
 - III. Flow velocity head

Response:

The freeboards obtained within the channel are listed in the Table below. It can be noted that the minimum freeboard within the proposed channel is 0.43 m at cross sections A400 and A386. The maximum free board within the channel is 0.93 m at cross section A300. These freeboards match and in most cases exceed the requirements listed in QUDM.



Chainage	Max Ch Elevation (m AHD)	100yr ARI W.L (m AHD)	0.2*dept h (m)	Freeboard (m)
A415	38.14	37.34	0.38	0.8
A410	38.07	37.36	0.40	0.71
A400	37.7	37.27	0.45	0.43
A386	37.52	37.09	0.45	0.43
A362	37.23	36.74	0.44	0.49
A340	36.95	36.37	0.42	0.58
A325	36.77	36.15	0.42	0.62
A320	36.71	36.06	0.41	0.65
A300	36.46	35.53	0.35	0.93

- c) Please demonstrate how the proposed development complies with Section 8.13 of the Queensland Urban Drainage Manual – Other Considerations, which states, in part, that:
 - "(a) Access/Maintenance Berms

It is recommended that the overall easement/reserve width for an open channel provide for an access/maintenance berm of minimum width 4.5 metres on one side of the channel. This access/maintenance berm may be located within the channel itself at a lower elevation than the design flood level but should be located at a level corresponding to at least the 1 year ARI flow depth.

Where access and maintenance cannot be achieved for the whole channel from one site, it may be necessary to provide a similar access/maintenance berm on both sides of the channel. Notwithstanding the above provisions a 1.5 metre wide safety/access strip should be provided along at least one side of the channel above the design flood level in addition to the access/maintenance berm."

Response:

A 1.8 m wide maintenance berm would be placed in one side of the channel. The table below reports the elevation of the berm and the 1 year ARI flow depths within the channel obtained with HECRAS. According to this table, it is clear that the maintenance berm will be above the 1 year ARI flow depth at all times.

Chainage	Berm Elevation (m AHD)	1yr ARI W.L (m AHD) 35.97 35.81 35.51 35.20 35.00	
A400	36.32		
A386	36.32		
A362	36.03		
A340	35.75		
A325	35.57		
A320	35.51	34.94	
A300	35.26	34.56	

 Please demonstrate how the proposed development complies with Section 8.10(e) of the Queensland Urban Drainage Manual – Recommended Maximum Flow Velocities.



Response:

Channel velocities presented in Table 4 indicate that a maximum velocity of 2.06 m/s will occur within the proposed channel. The longitudinal slope of the channel is 1.25%, the banks of the channel are considered to comprise erosion resistant soil, as the invert of the channel will be grassed and the batters of the channel will be lined with a jute mat and landscaped plantings. Therefore the obtained velocities are within the range of permissible velocities recommended in Table 9.05.3 of QUDM 2007 for channels with gradients between 1 and 2 % (2.1 to 2.8 m/s).

e) The Capricorn Municipal Development Guidelines, Clause D5.11(2), requires that proposed "Overland flow paths shall be located on public land." Please demonstrate how the application complies with this requirement.

According to results reported in Table 4, the maximum level obtained upstream of Foulkes Street is 38.53 mAHD, the top of the embankment on the upstream side of the Foulkes Street culvert has an elevation of 39.54 mAHD. Thus, the obtained results demonstrate that Foulkes Street is immune to flooding in occurrence of the 100 year ARI event. Consequently, the 100 year ARI peak flow rate will be contained within the drainage reserve at all times. The drainage reserve is public land and will be owned by Council.

Further, results presented in Table 5 show that Foulkes Street culvert causes a maximum increase in flood level of 1210 mm within the property upstream of the site. This afflux will be dissipated within 350 metres from the upstream side of the culvert.

f) Please demonstrate how the proposed open channel will provide for low-flow events consistent with the Capricorn Municipal Development Guidelines and the Queensland Urban Drainage Manual.

The proposed channel reconfiguration involves improving the condition of the tributary running through the site. The stretch of creek traversing the site will be reconfigured to a 23 metre wide channel (approximately 100 metres between cross sections A300 and A415). The new 23 metre wide channel will mostly have 1:2 batter slopes and will be 2.7 metres deep. A 1.8 metre wide maintenance berm will be located within the channel above the inundation level corresponding to the 1 year ARI event. The channel invert will be grassed while the banks will be lined with jute mats and landscaped. The invert slope of the proposed channel along the property will be approximately 1.25 %.

Due to large catchment area draining into the creek (225 hectares) and the consequent large flow rates, it is considered impractical to place pipes underneath the channel to carry the low flows. The capacity of the pipes would be negligible compared to the runoff that will occur and it is considered that a piped system would require frequent maintenance. Rather than providing a low flow pipe system, the channel invert will have a constant longitudinal gradient of 1.25 % that will allow the channel to be self draining. The invert width will be at least 11 metres, thus allowing access by machinery.



5. CONCLUSION

It is proposed by Mintgrove Pty Ltd to reconfigure a lot located at the corner of Norman Road and Foulkes Street, City of Rockhampton.

In September 2005, Cardno was commissioned to conduct a hydraulic study to determine the extent of inundation through the properties located downstream of the site. The report of the subject hydraulic study (Cardno 2005) was submitted to Rockhampton City Council as part of the application for development approval for the subject sites and Council issued a request for further information on 4 July 2007 in order to complete its assessment.

An addendum flood study of the unnamed tributary of Limestone Creek running trough the subject sites was conducted in response to the Request for Further Information and was issued to Council in July 2007.

As part of the application to reconfigure Lot 2 on RP618770, a new hydrologic investigation was undertaken to determine the peak flow rates and flood levels corresponding to the 100, 50, 20, 10, 2, 5 and 1 year Average Recurrence Interval (ARI) events within the tributary crossing the subject lot.

The present report describes the methodology of the study and details the impact on flood levels of channel reprofiling and culverts proposed as part of the development.

To address the impact of the proposed development on flooding conditions within the site, two development scenarios were analysed within the present study:

- · Existing conditions; and
- Developed conditions (channel reprofiling and Foulkes Street)

Based on the calculated flood levels for the developed scenario, it can be noted that the maximum increase in flood level within the site for this scenario is 660 mm. This afflux has a negligible impact on the site as it will be contained within the proposed channel at all times.

Present results also showed that Foulkes Street is immune to flooding in occurrence of the 100 year ARI event. However, Foulkes Street and its associated culvert cause a maximum increase in flood levels of 1210 mm upstream of the site in occurrence of the 100 year ARI storm event. This afflux will be dissipated within 350 metres from the upstream side of the culvert.

Obtained velocities indicate that a maximum velocity of 2.06 m/s will occur within the proposed channel. The longitudinal slope of the channel is 1.25%, the banks of the channel are considered to comprise erosion resistant soil, as the invert of the channel will be grassed and the batters of the channel will be lined with a jute mat and landscaped plantings. Therefore the obtained velocities are within the range of permissible velocities recommended in Table 9.05.3 of QUDM 2007 for channels with gradients between 1 and 2 % (2.1 to 2.8 m/s).

Velocities occurring at the downstream end of the Foulkes Street culvert's apron indicate that the 10 metres of creek located immediately downstream of the culvert apron should be protected to avoid scour (including the banks). Loose rocks with a d_{50} of at least 100 mm are recommended as scour protection devices. Further, it is recommended to place a 250 mm high masonry/concrete sill at the end of the concrete apron to control the occurrence of hydraulic jumps downstream of the culvert.



FIGURES

Figure	1	Locality	Plan

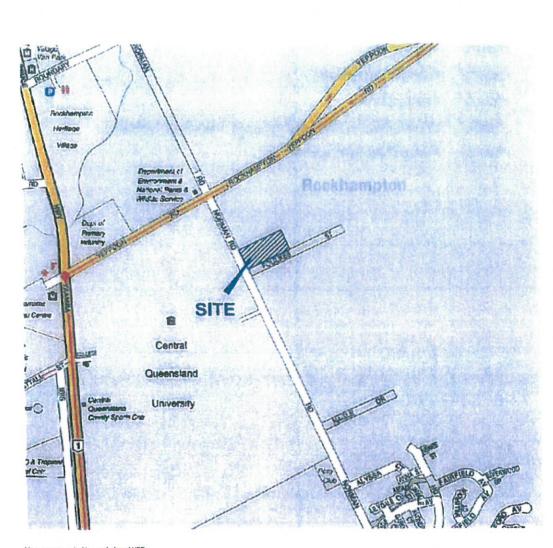
Figure 2 Proposed Development

Figure 3 Catchment Plan

Figure 4 100 year Flood inundation- Existing and Developed Conditions

Figure 5 Proposed Channel Cross Section





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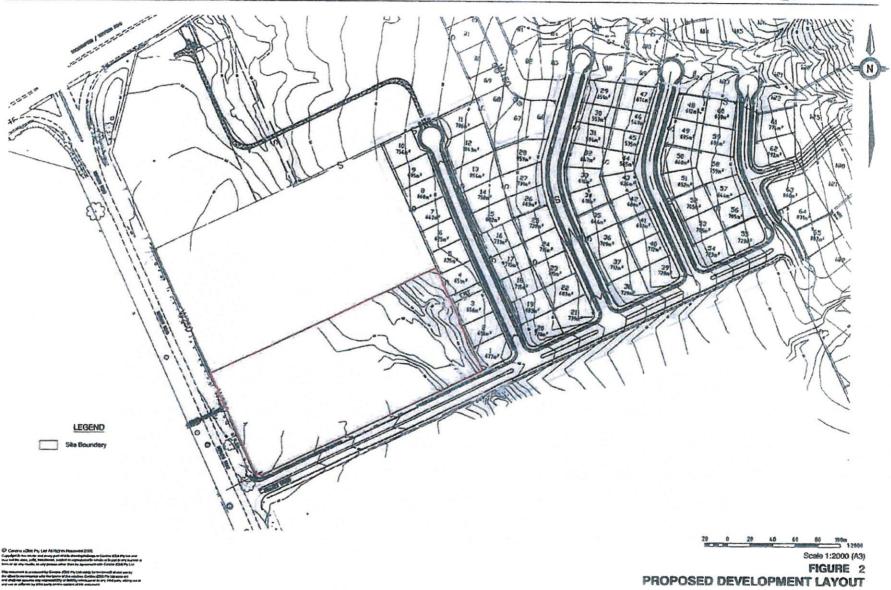
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FIGURE 1 **LOCALITY PLAN**

Project No.: R1031-01-3

Rev: Orig. Date: 17 June 2008 Mintgrove Pty Ltd

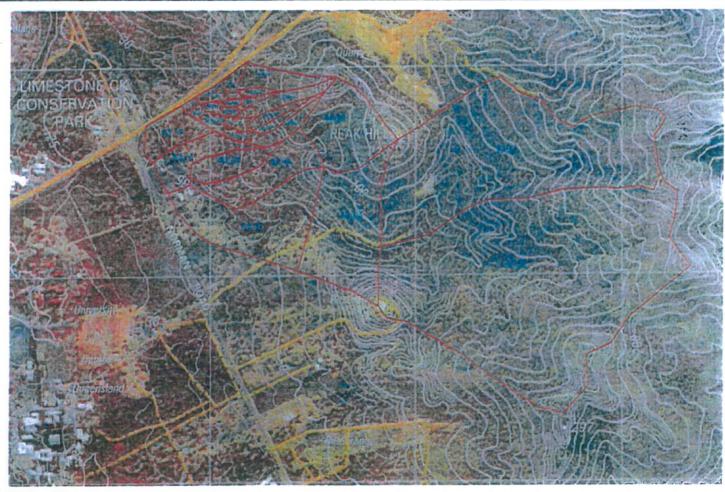




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N.T.S.

FIGURE 3 **CATCHMENT PLAN**

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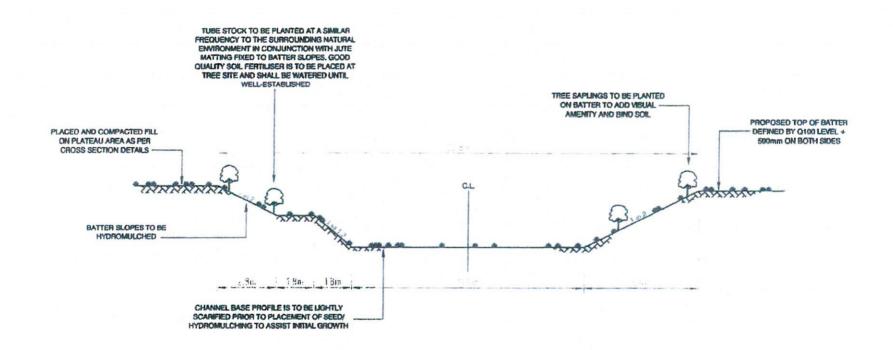
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Project No.: R1031-01-3

100YR EXTENT OF INUNDATION - EXISTING AND DEVELOPED CONDITIONS





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FIGURE 5

PROPOSED CHANNEL CROSS SECTION

Project No.: R1031-01-3

0 0.15 0.3 0.45 0.6 0.75m

Rev: Orig. Date: 17 June 2008

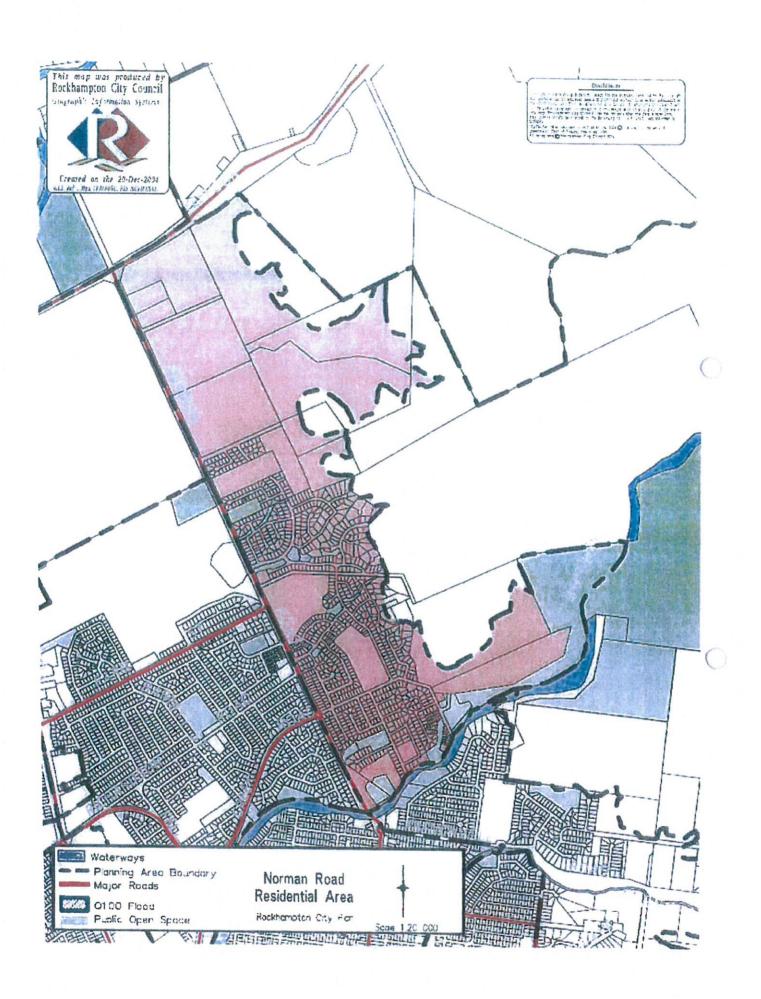
Mintgrove Pty Ltd CAD FILE: ANNOSI-BTIGGE BENEATH SENSigure 6 - Proposed Cleaned Crossocianaling INEE/ L

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APPENDIX A

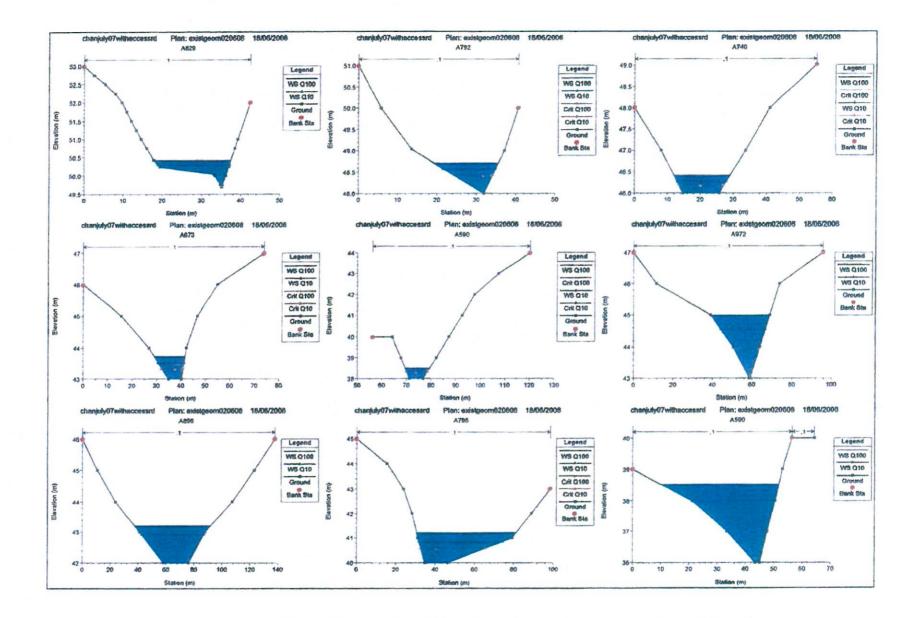
Norman Road Residential Area Plan

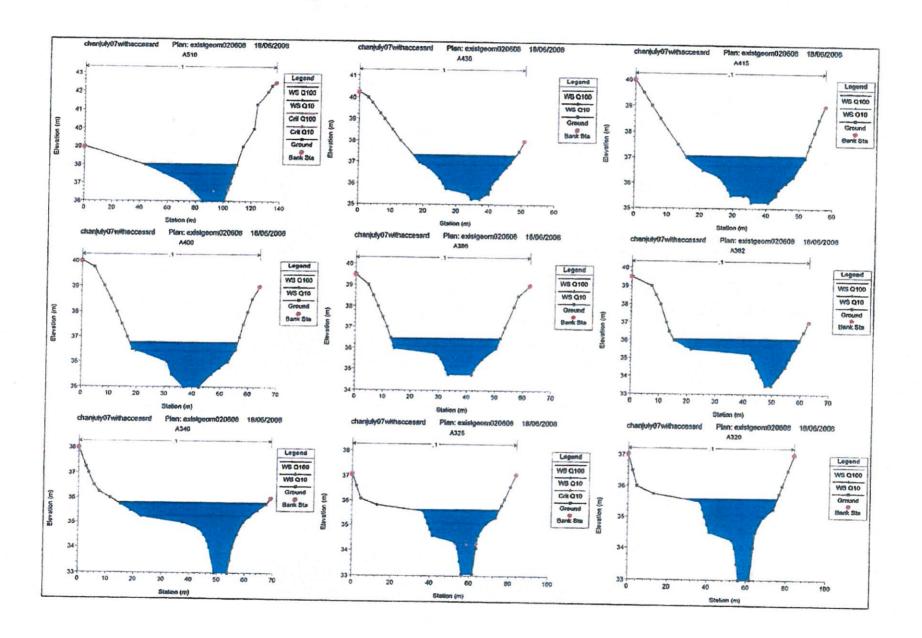


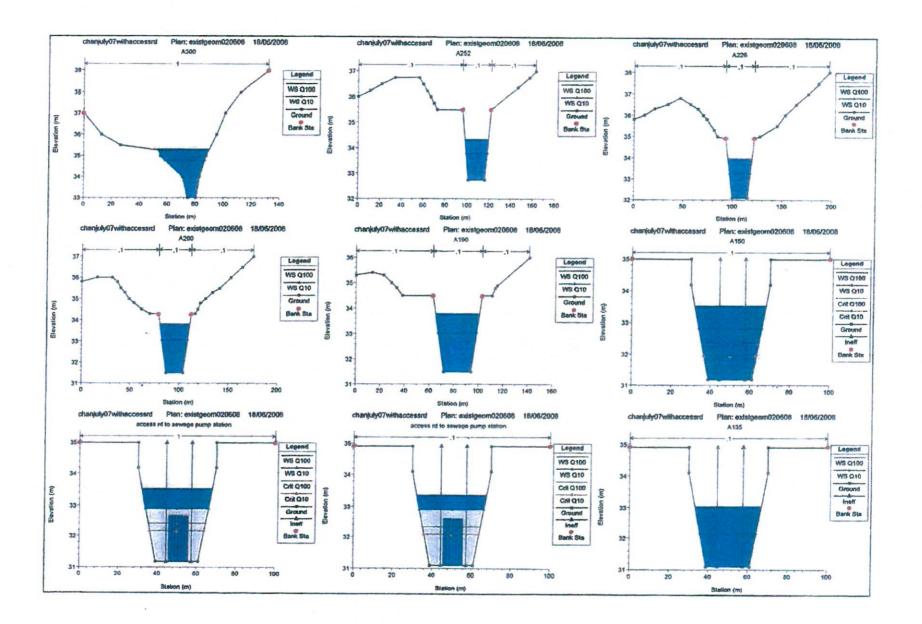


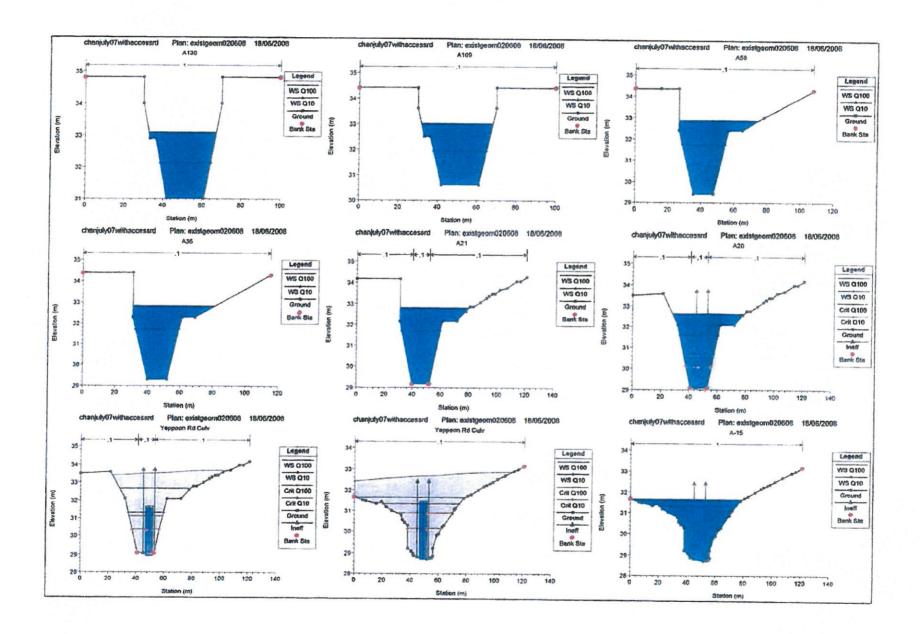
APPENDIX B

HECRAS Cross Sections (Existing Case)





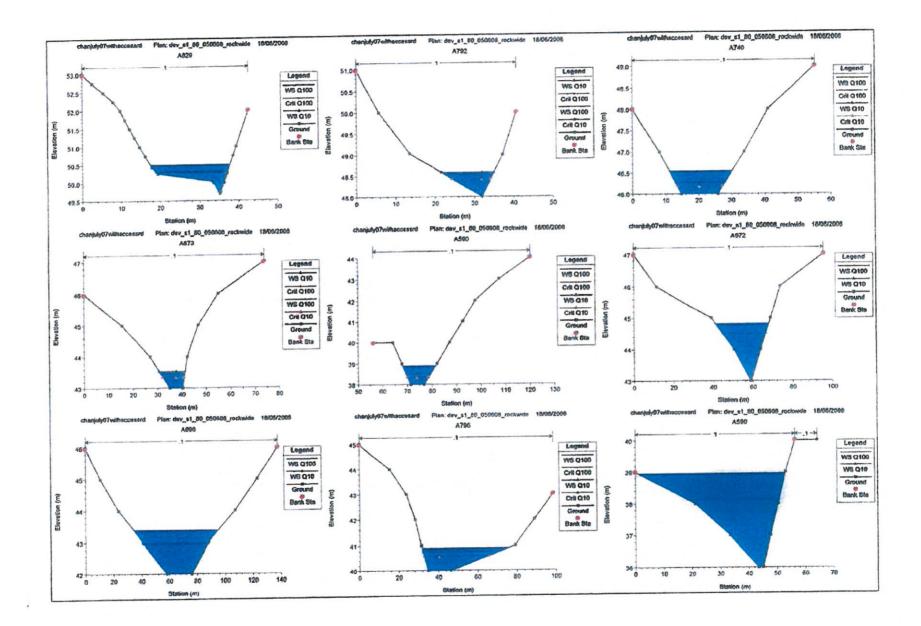


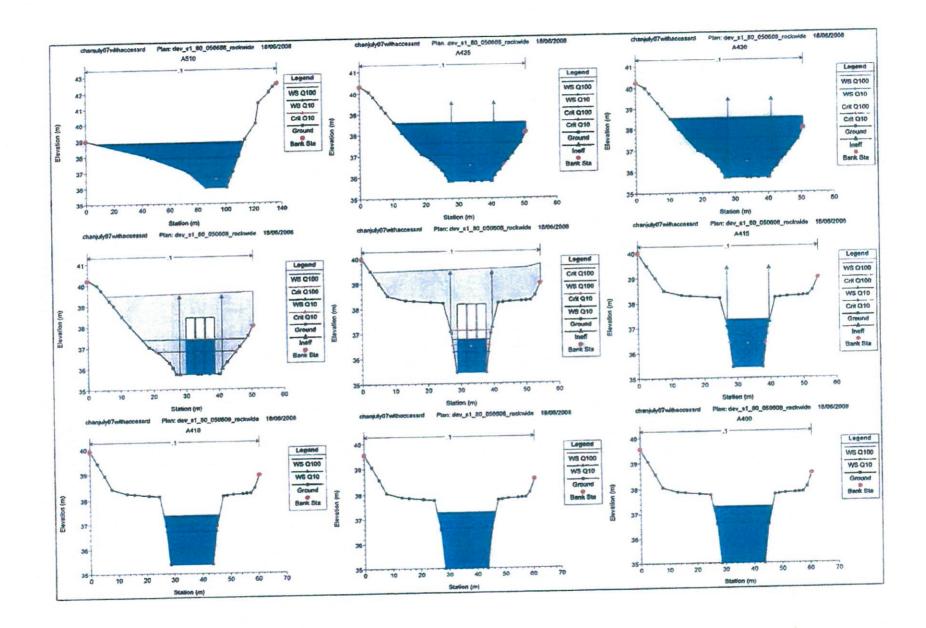


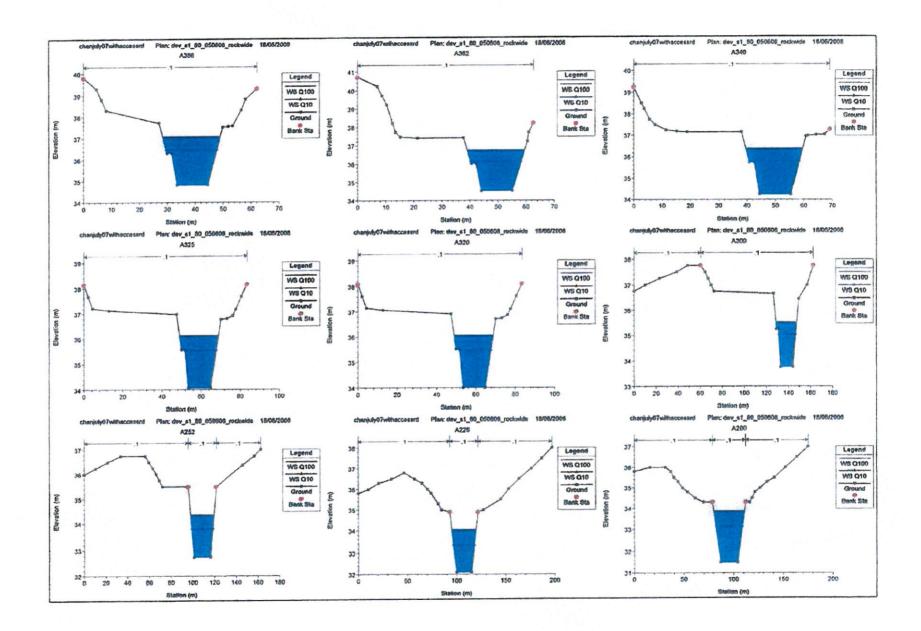


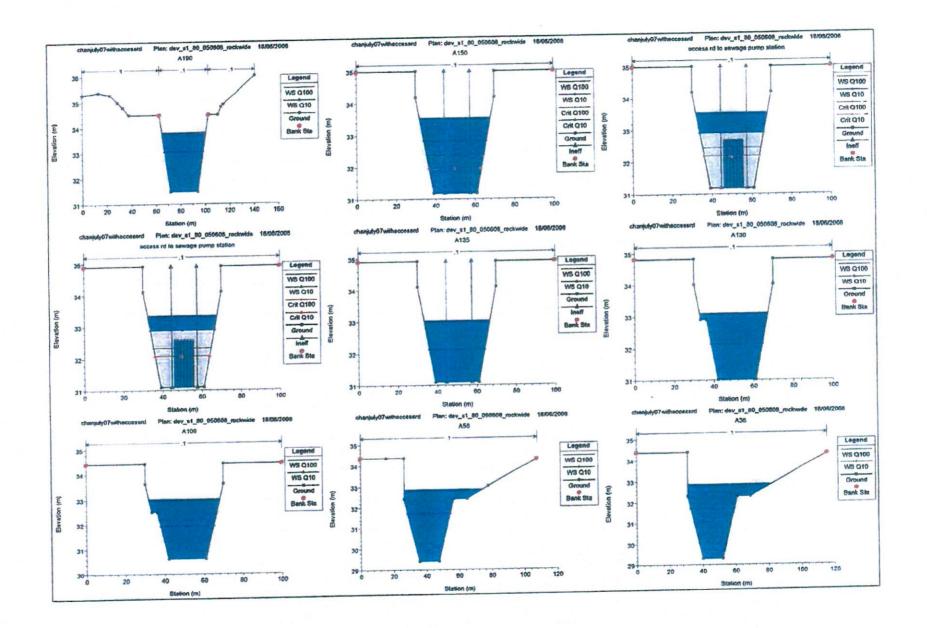
APPENDIX C

HECRAS Cross Sections (Developed Case)











APPENDIX D – Culvert Calculation (Existing Structure under Rockhampton/Yeppoon Road)

Existing Colvert under Rackbompton Yeppoon Road.

CulvertW - Design Case No 2

(File: R12063.CUL - Date: 19-6-2013)

34.500m

2 No 2700x2400 RCBC (2.743x2.438) at a slope= 0.58% Inlet RL 28.900m Outlet RL 28.700m

Culvert Data

Using Mannings 'n' = 0.013 Entrance Loss Coefficient 'l= 0.500 Entrance - Wingwall flare 90-15 deg

Weir Data

Weir Length = 15.000mWeir Coefficient = 0.577 Weir Crest Height = 3.800m (RL 32.500m)

No Channel Data specified to be used

Headwater

Approach Flow = 49.840m3/s Flow in each Culvert = 24.689m3/s

Flow over weir = 0.462m3/s (depth = 0.069m)

Tailwater depth = 2.400m (RL 31.100m)

Using fixed Tailwater depth

Critical depth at outlet = 2.020m (RL 30.720m) Effective tailwater depth = 2.400m (RL 31.100m)

Head Loss in Culvert = 1.183m

Depth at outlet adopted to

calculate outlet velocity = 1.811m (RL 30.511m)

Outlet Velocity = 4.968m/s

INLET control

Headwater is at RL 32.569m - 0.069m above Weir Crest Tailwater is at RL 31.100m - 2.400m above outlet invert

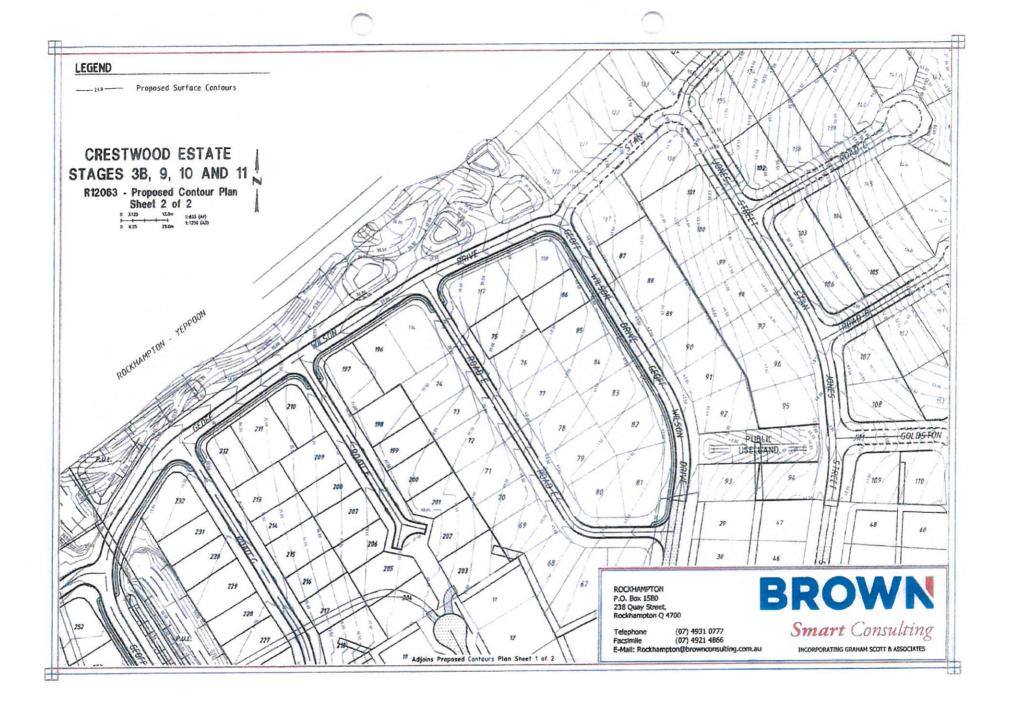
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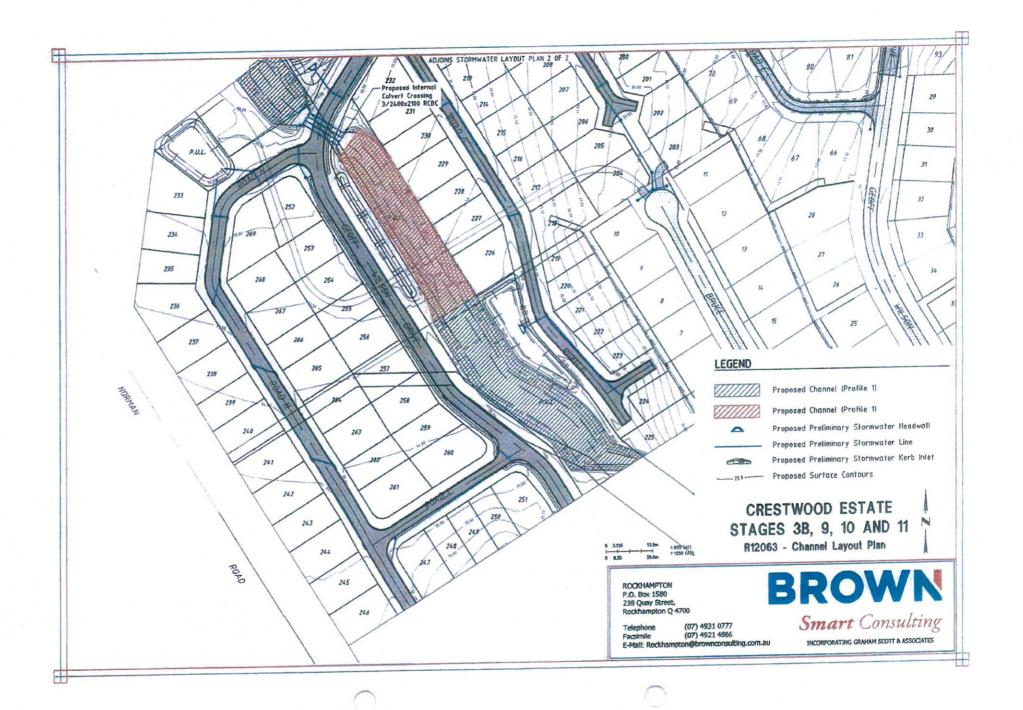


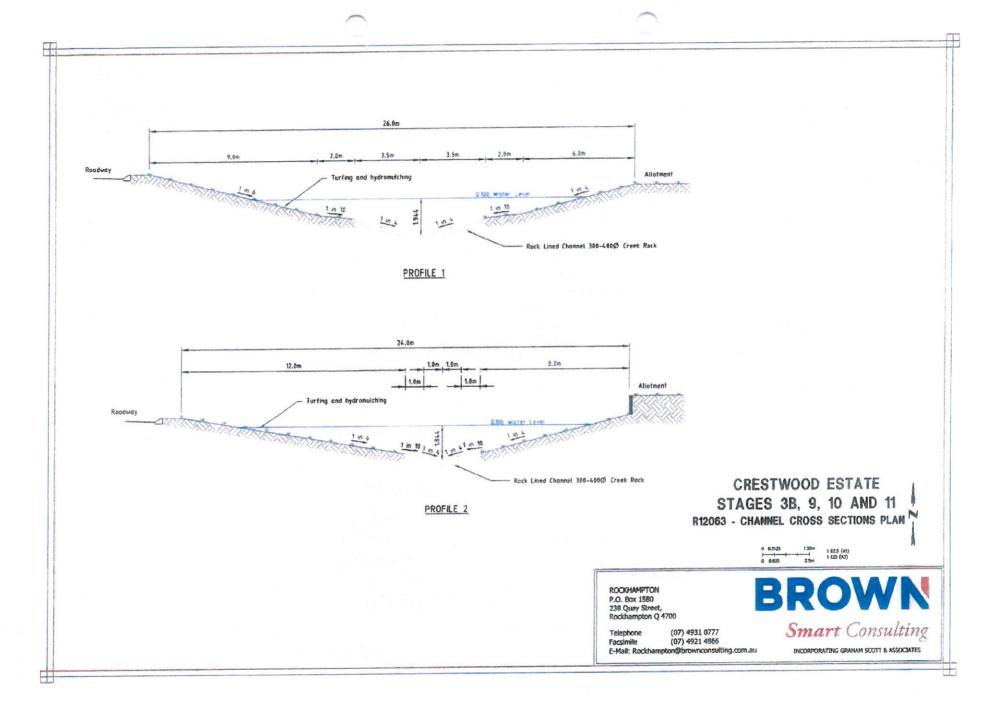
APPENDIX E – Channel Profile Sketches and Preliminary Design Contours

0











APPENDIX F – Culvert Calculation (Internal Major Structure)

19/06/2013				CRESTWOOD ESTATE ROCKHAMPTON STAGES 38, 9, 10 & 11 Q ₁₀₀ Drainage Calculations								Job No:	R12063
			- 1	Proposed Channels / Swales									
Seet No.	RLI (m)	RL2 (m)	W (m)	Water Level =		(A) 1(4) - (A) - (
				Bank Slope		Depth I (m)	Depth 2 (m)	Width (m)	Area (m²)	P (m)	q (m³/sec)	V (m/see)	Slope (%)
Channel - Profile 1	100,000	98.500	6,000	0.250	0.033	0.000	0.868	3,474	1.509	3.581	1.990	1.319	0.6
	98.500	98.300	2.000	0.100	0.033	0.868	1,069	2.000	1.937	2.010	4.436	2.290	0.6
	98,300	97.425	3.500	0.250	0.028	1.069	1.944	3.500	5.271	3.608	18.775	3.562	0.
	97.425	98.300	3.500	-0.250	0.028	1.944	1.069	3.500	5.271	3.608	18.775	3.562	0.
	98.300	98.500	2.000	-0.100	0.033	1.069	0.868	2.000	1.937	2.010	4.436	2.290	0.
	98.500	100.000	9.000	-0.167	0.033	0.868	0,000	5.211	2.263	5.283	3.018 51.43	1.334 m3/sec	0.
	N A			Water	Level =	64.680	pt (New York					
Sect No.	RLI	RL2	w	Bank		Depth I	Depth 2	Width	Area		9	V	Slop
	(B)	(m)	(m)	Slope		(u1)	(m)	(m)	(m²)	(m)	(m/see)	(im/sec)	(%)
Channel - Profile 2	100.000	98.000	8.000	0.250	0.033	0.000	1.494	5.974	4.462	6.158			0
	98.000	97.900	1.000	0.100	0.028	1.494		1.000	1.544	1.005	6.356		0
	97.900	97,650	1.000	0.250	0.028			1.000	1.719	1.031	7.474		0
	97.650	97.900	1.000	-0.250	0.028			1.000	1.719	1.031	1000	The state of the s	0
	97.900	98.000	1.000	-0.100	0.028			1.000	1.544	1.005	ALMAN SECTION		0
	98.000	100.000	12.000	-0.167	0.033	1.494	0.000	8.962 18.936	6,693	9.085	The second second	m3/sec	CONTRACT OF

Proposed Internal Colvert Structure

CulvertW - Design Case No 1

(File: R12063.CUL - Date: 19-6-2013)

22.000m

3 No 2400x2100 RCBC (2.438x2.134) at a slope= 0.91% Inlet RL 29.800m Outlet RL 29.600m

Culvert Data

Using Mannings 'n' = 0.013 Entrance Loss Coefficient 'l= 0.500 Entrance - Wingwall flare 90-15 deg

Weir Data

Weir Length = 20.000mWeir Coefficient = 0.577 Weir Crest Height = 2.900m (RL 32.500m)

No Channel Data specified to be used

Headwater

Approach Flow = 49.840m3/s Flow in each Culvert = 15.940m3/s

Flow over weir = 2.020m3/s (depth = 0.152m)

Tailwater depth = 1.900m (RL 31.500m)

Using fixed Tailwater depth

Critical depth at outlet = 1.629m (RL 31.229m) Effective tailwater depth = 1.900m (RL 31.500m)

Head Loss in Culvert = 0.786m

Depth at outlet adopted to

calculate outlet velocity = 1.230m (RL 30.830m)

Outlet Velocity = 5.294m/s

INLET control

Headwater is at RL 32.652m - 0.152m above Weir Crest Tailwater is at RL 31.500m - 1.900m above outlet invert

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APPENDIX G – Stormwater Management Quality
Plan

