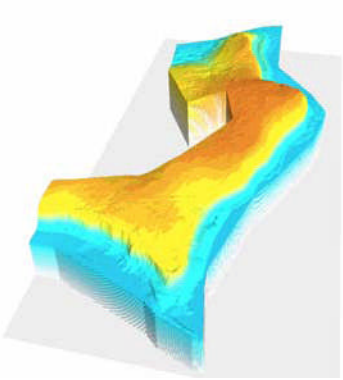
**HERVEY BAY CITY COUNCIL**
**FLOOD RISK REDUCTION STUDY**
**OVERALL STUDY CONSOLIDAQTION REPORT**

## Appendix N – Pialba / Point Vernon Coastal Strip Catchment Flood Risk Reduction Study

# HERVEY BAY CITY COUNCIL

## Pialba / Pt Vernon Coastal Strip Catchment Flood Risk Reduction Study



*Final Report*

**September 2006**

# Hervey Bay City Council

# Pialba / Pt Vernon Coastal Strip Catchment Flood Risk Reduction Study

## September 2006

John Wilson and Partners Pty Ltd
A.B.N. 85 011 022 503
Level 9 Centenary Square,
100 Wickham Street
Brisbane 4000
Telephone: (07) 3244 9600
Facsimile: (07) 3244 9699
Email: reception@jwp.com.au

| Document Control | | | | | |
|---|---|---|---|---|---|
| Revision | Author | Reviewer | Approved for Issue | | |
| | | | Name | Signature | Date |
| 0 | P. Crichton | A. Daly | G. Khouri | | May 2006 |
| 1 | P. Crichton | E.Reid | G. Khouri | | August 2006 |
| 2 | P. Crichton | E.Reid | G. Khouri | | September 2006 |

# CONTENTS

## Appendices

**Appendix A – Catchment Plan**
**Appendix B – Rainfall IFD Table**
**Appendix C – Catchment Land Use Summary**
**Appendix D – Existing Model Flood Results**
**Appendix E – Mitigated Model Flood Results**
**Appendix F – Sketch Plans of Proposed Upgrades**
**Appendix G – Hydraulic Results (Model 2)**
**Appendix H – Preliminary Cost Estimates**

# 1 Introduction

John Wilson & Partners (JWP) has been commissioned by Hervey Bay City Council to undertake a Flood Risk Reduction Study for the catchment represented as the Pialba / Pt Vernon Coastal Strip Catchment. The purpose of the analysis was to document existing flooding and drainage characteristics within the catchment along with assessing potential augmentation options for the purposes of reducing flood risk in the area. The study will be used for the purposes of managing both existing and future development within the catchment based upon the reduction of flood risk.

This study represents the first comprehensive study of the Pialba / Pt Vernon Coastal Strip catchment and includes a detailed hydrological and hydraulic analysis of selected regions within the catchment.

The major components of works undertaken for this study have included: -

- Definition of sub-catchment boundaries;
- The identification of existing drainage patterns including both piped systems (trunk drainage) and major overland flows;
- Construction of an extensive XP-STORM model for selected regions of the catchment;
- Hydrological and hydraulic model analysis to define flood levels, flow directions and drainage problems in selected regions of the catchment for the Q10, Q20, Q50 and Q100 design flood events;
- Investigation of flooding risks for each drainage network investigated;
- Analysis of augmentation options for the purposes of flood risk reduction;
- Preliminary construction cost estimates for the augmentation options; and
- Documentation of the study methodology and outcomes as part of a formal report on the investigation including a risk management report.

The following sections of this report aim to fully document the analysis works undertaken as part of this investigation.

# 2 Study Area

The Pialba / Pt Vernon Coastal Strip catchment itself consists mainly of the eastern and northern coastal fringes of the Pialba / Pt Vernon region, located in the northern limits of the city of Hervey Bay. Within the Pialba / Pt Vernon catchment, JWP have delineated a number of discrete and separate drainage systems which were deemed suitable for inclusion in a series of XP-STORM models. A plan illustrating broad scale sub-catchment areas for the Pialba / Pt Vernon Coastal Strip catchment as supplied by Hervey Bay City Council is included in Appendix A.

To the north in the Pt Vernon region of the catchment, low density residential land use is predominant, with flat to mild gradients evident on the higher side of The Esplanade. Steeper slopes exist on the lower side of The Esplanade, where the ground surface quickly falls away to meet the foreshore. In the Pialba region of the catchment, flat slopes are evident, again with predominately low density residential land use, with small sporadic areas of medium density residential and local business land use. Together, the total catchment area for the Pialba Pt Vernon catchment comprises of approximately 212 hectares.

# 3 Study Data

The works undertaken as part of this study and particularly the establishment of several discrete XP-STORM models for selected areas of the catchment have been prepared based upon a compilation of data sources as provided by Hervey Bay City Council. Specifically, the models have been developed using a range of data sources and information, each of which are outlined and discussed separately below.

## 3.1 Topography Data

Topographical data for the catchment was provided in the form of contour information at various intervals ranging from 200mm to some 5 metres. As the contour data represents the only available topographical information provided for the study, this information has been adopted. To facilitate the use of this information, JWP have prepared a Digital Terrain Model (DTM) using all of the contour data supplied for the purposes of facilitating data extraction for the various modelling tasks undertaken as part of this study. A copy of the DTM as prepared using the MapInfo Vertical Mapper software is included as Figure 1 which clearly illustrates the catchment location and topographical variations that exists throughout the catchment. The DTM prepared was used as a basis on which the drainage patterns throughout the area have been defined and various overland flow path information digitally extracted and incorporated into the flood models.

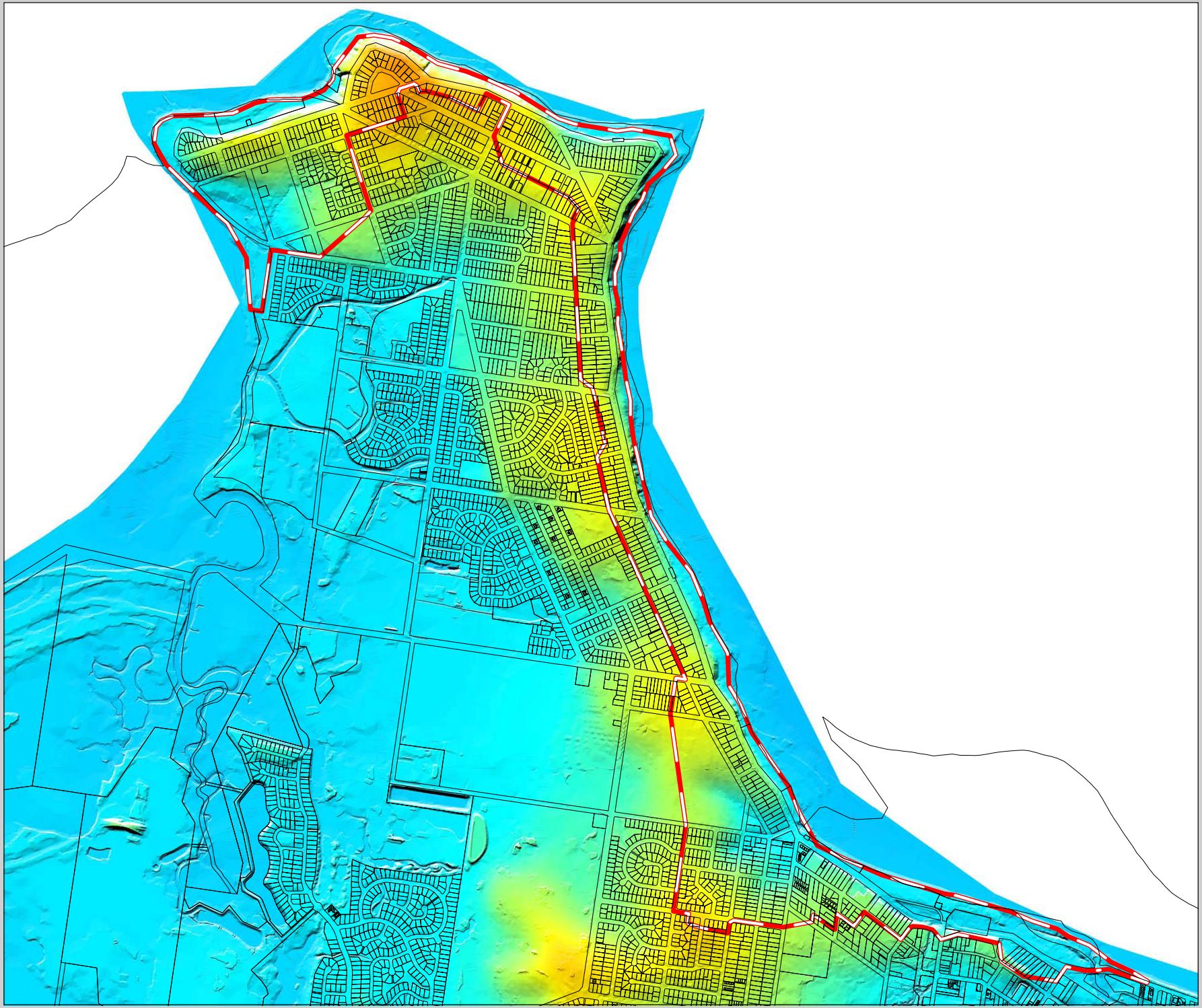
JWP note that the DTM prepared for the purposes of this study represents an interpolated topographic surface based upon contour information which itself represents an interpolated surface. As such, the DTM prepared for this study is unlikely to be sufficiently accurate to enable more detailed flood analysis works to be performed. The DTM is however suitable and appropriate for the purposes of a broad flood risk study as is the purpose of this study.

## 3.2 Survey Data

The collection of field survey data for the catchment was undertaken as part of the works for this project. The intent of the field survey collection was to infill missing information, obtain structure details and to provide more detailed topographical information at discrete and critical areas throughout the study. Areas where more detailed survey information was required were assessed by JWP following a detailed assessment and review of the information originally provided for the purposes of this study. A number of GIS maps highlighting the required areas of field survey were prepared by JWP and approval sought by Council. As part of the study, JWP were responsible for management of these works which included the preparation of detailed survey briefs, calling of survey tenders and managing the field collection data.

All detailed survey works collected for this project were provided by Surveyors@Work, a locally based and independent survey company in Hervey Bay. This information was collected using both traditional and GPS survey techniques and was provided in a digital AutoCAD format for the purposes of this project. JWP utilised this information to update the various drainage network details within the models to more accurately quantify the existing drainage networks.

Given that the survey data was only collected for the piped network at discrete locations throughout the catchment, it was not possible to update or compile a more accurate DTM for the catchment using this information.



HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Cadastre

Catchment Boundary

160 0 160 320 480

Metres

**Scale: 1:16,000**

# PIALBA / PT VERNON

## FIGURE 1

## CATCHMENT LOCATION

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

## 3.3 Pipe Data

Existing pipe and culvert crossing data throughout the catchment was provided by Council for the purposes of this study. Details of the existing pipe information were provided through Council supplied GIS data. This data was supplemented using detailed survey information collected at discrete areas as was discussed previously.

Using all the available information as supplied for the study, this information was consolidated for the purposes of preparing the existing pipe system details within the XP-STORM models. This combined dataset and the resulting XP-STORM piped systems were then used as a basis on which all modelling works for this project have been undertaken.

## 3.4 Site Inspection

As part of the works for this study, JWP have undertaken a detailed and comprehensive site inspection of the catchment. The site inspections were documented by way of site notes and photographs. Together, these assisted in the definition of the catchment and existing drainage patterns as well as benefiting in determining appropriate roughness parameters and verification of existing hydraulic structures.

# 4 Catchment Modelling

The analysis of the catchment response and the determination of design flood discharge estimates have been prepared primarily within the XP-STORM model. These estimates were also verified independently through the use of the Rational Method at critical areas within the catchments. The RAFTS model functionality has been applied within the XP-STORM models in the determination of catchment discharge. The following sections of this report provide a brief summary of the hydrological aspects associated with the preparation of the RAFTS models for the discrete sub catchment areas within the XP-STORM models.

We note that as many of the areas of piped network along the esplanade consisted of discrete culvert crossings, the preparation of an XP-STORM model for these areas was not necessary given these simple cross drainage systems. Rather, in these areas a rational method was used to estimate flows entering each discrete culvert crossing for each ARI event. These flows were then used as the basis for determining upgrade requirements in order to adequately reduce flood risk.

## 4.1 XP-STORM (RAFTS) Approach

As indicated above, catchment hydrology for this study has essentially been prepared using the nonlinear runoff routing methodology of RAFTS and this methodology is incorporated within the XP-STORM model. RAFTS utilises a network analysis with a series of sub-catchment and drainage links to model catchment performance. Hydrographs are produced for the design storm events by routing sub-catchment rainfall runoff through pre-defined drainage links within the catchment.

The RAFTS analysis involved: -

- the division of the selected modelling areas into a number of discrete sub-catchments;
- derivation of various physical properties for each of the sub-catchments, including:
  - impervious and pervious areas based upon ultimate land use development scenarios;
  - sub-catchment slopes; and
  - roughness value (Manning's 'n');
- the overall assembly of the sub-catchments and channels into a nodal network.

Storms with rainfall durations ranging from 15 minutes to 270 minutes were simulated as part of this study for the 1 in 10, 20, 50 and 100 year ARI design storm events. The assessment of numerous storm events for each design event allowed the determination of both critical durations and peak discharges at specific locations along each of the waterway systems.

## 4.2 Rational Method Approach

Where discrete culvert crossings were evident, such as along the Esplanade, rational method calculations were used to determine flows entering each culvert system for the 1 in 10, 20, 50 and 100yr ARI events.

Discrete sub catchments representing the watershed flowing to each culvert crossing were defined, and appropriate details such as slope, path length and roughness recorded. As many of the flowpaths in the urban areas consisted simply of the road network, an average velocity method was used based on the end area slope of the path length. Appropriate inlet add on times were also incorporated into the time of concentration calculations in accordance with the recommendations of the Queensland Urban Drainage Manual (QUDM). The resultant flows were used as the basis to determine the existing system capacity and upgrade requirements.

## 4.3 Rainfall Intensities

The design rainfall Intensity-Frequency Duration (IFD) data for various storm events of the study catchment were derived based upon the procedures outlined in Book 2 of the Australian Rainfall and Runoff (AR&R 2001 edition). Various rainfall parameters were taken directly from AR&R based upon a location representing roughly the centroid of the Pialba / Pt Vernon Coastal Strip catchment. Using these parameters, design IFD data for the catchment has been prepared and this is summarised in Appendix B of this report.

Design rainfall IFD data was applied across the catchment based upon rainfall temporal patterns determined in accordance with the procedures detailed in Australian Rainfall and Runoff (AR&R 2001). The full range of temporal patterns ranging from the 15 minute through to the 270 minute storms have been applied as part of this study.

It should be noted that no Areal Reduction Factors (ARF) have been applied on the rainfall intensities as part of this study. This approach is appropriate in this instance whereby catchment sizes are reasonably small and as such the magnitude of the reduction in rainfall intensities through the use of an ARF can be disregarded. This approach may result in a slightly conservative estimate of design flows from the catchment and this is appropriate especially in the context of a flood risk study.

## 4.4 Site and Catchment Characteristics

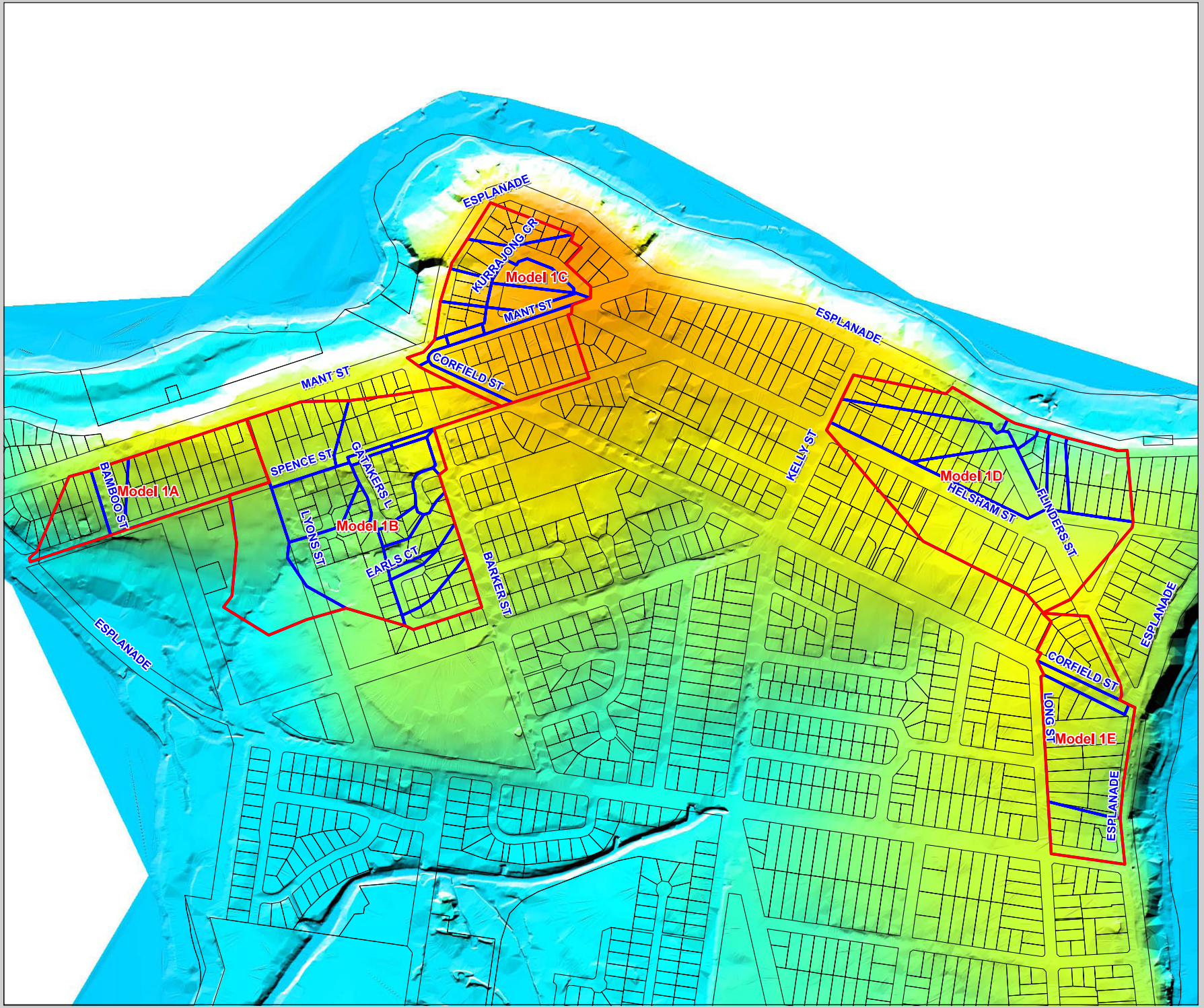
### 4.4.1 Catchment Definition

The overall catchment boundary for the analysis was delineated and supplied by Hervey Bay City Council for the purposes of this assessment. Using this overall catchment boundary and pipe network details, JWP subdivided the catchment into a number of individual sub-catchment boundaries on which individual XP STORM models were created. This was undertaken using the DTM prepared for the catchment. The XP STORM model based sub-catchment boundaries were then broken down into a number of discrete sub-catchments to ensure that the hydrological calculations for each model were representative and appropriately determined based on the specific locations throughout the sub-catchment. Generally, these boundaries were prepared using water shed lines ascertained from the DTM in addition with due consideration of the existing drainage patterns at the site including urbanised blocks.

A plan illustrating the entire catchment and sub-catchment boundaries delineated for the purposes of catchment hydrology is provided in Figure 2. In all, a total of some 87 separate and discrete sub-catchments have been delineated and applied in the various discrete XP-STORM models for this study. A total of some 14 separate catchments have been used for the rational method calculations.

### 4.4.2 Impervious Area and Roughness Values Determination

The quantity of pervious and impervious areas of each sub-catchment was determined based upon the land use data supplied by Hervey Bay City Council. As there was several different land uses represented in each particular sub-catchment, the amount of pervious and impervious areas were summed and averaged based on a land use balance. As such, determination of the area of impervious surfaces in each sub-catchment was based on, in order of preference, the runoff coefficients for the various land use types provided by Hervey Bay City Council, the Queensland Urban Drainage Manual (QUDM) (1992) and from previous experience with similar studies. The adopted runoff coefficients and appropriate roughness values applied for each land use type as detailed in Council's land use zone type are summarised in Table 4.1. Figure 3 illustrates the land use characteristics of the catchment as taken from Council's land use allocations attached to the cadastral database.




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Sub Catchment Boundary
- Cadastre
- Model Boundary

60 0 60 120 180

Metres

**Scale: 1:6,000**

# PIALBA / PT VERNON

## FIGURE 2A

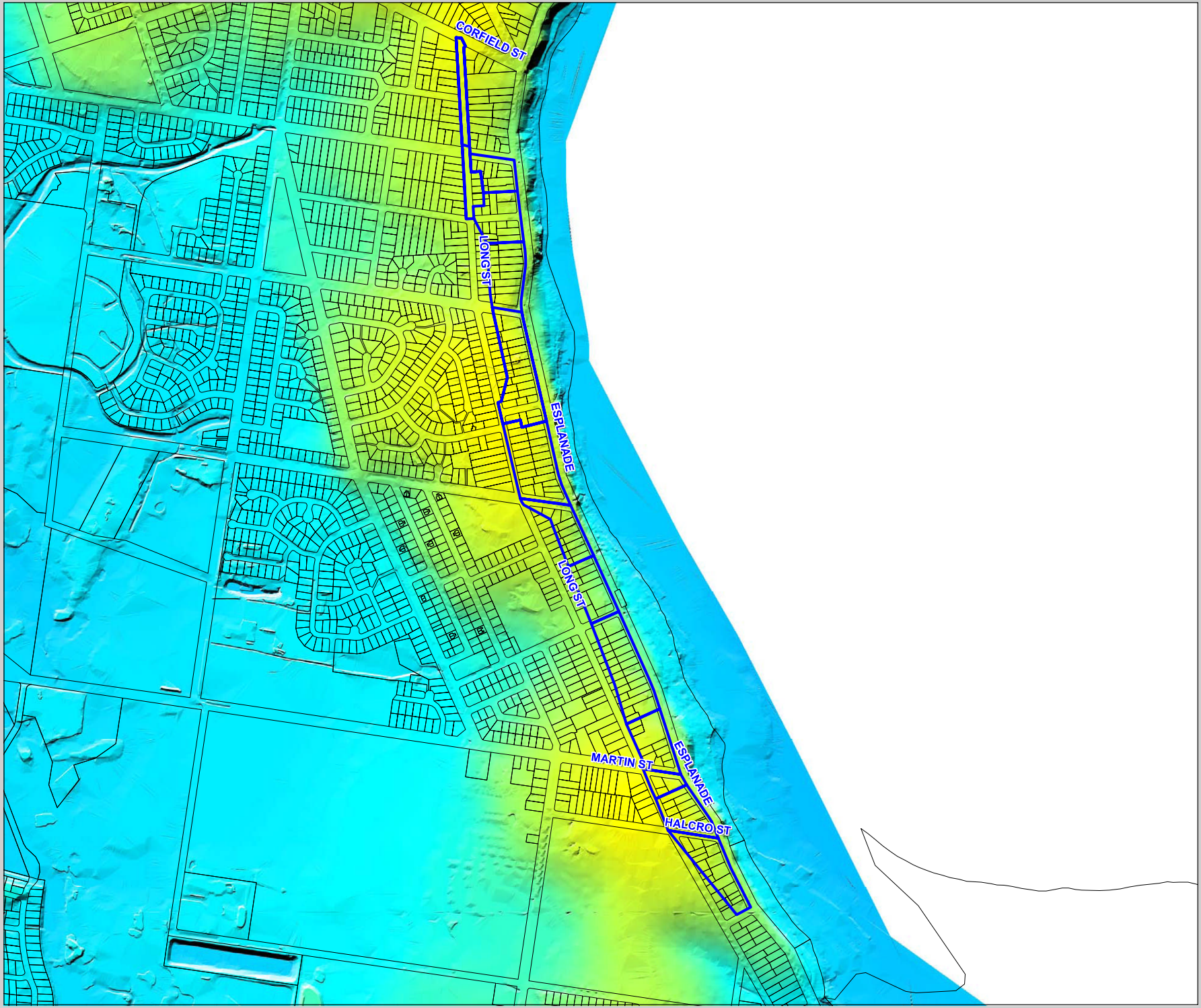
## SUB CATCHMENT BREAKDOWN MODELS 1A - 1E

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\42-Works\050301.001 Pt. Vernon Flood Risk\GIS\MapInfo\Figures

Projection Trans. Merc. MGA56(GDA 94)




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Sub Catchment Boundary

Cadastre

100 0 100 200 300

Metres

**Scale: 1:10,000**

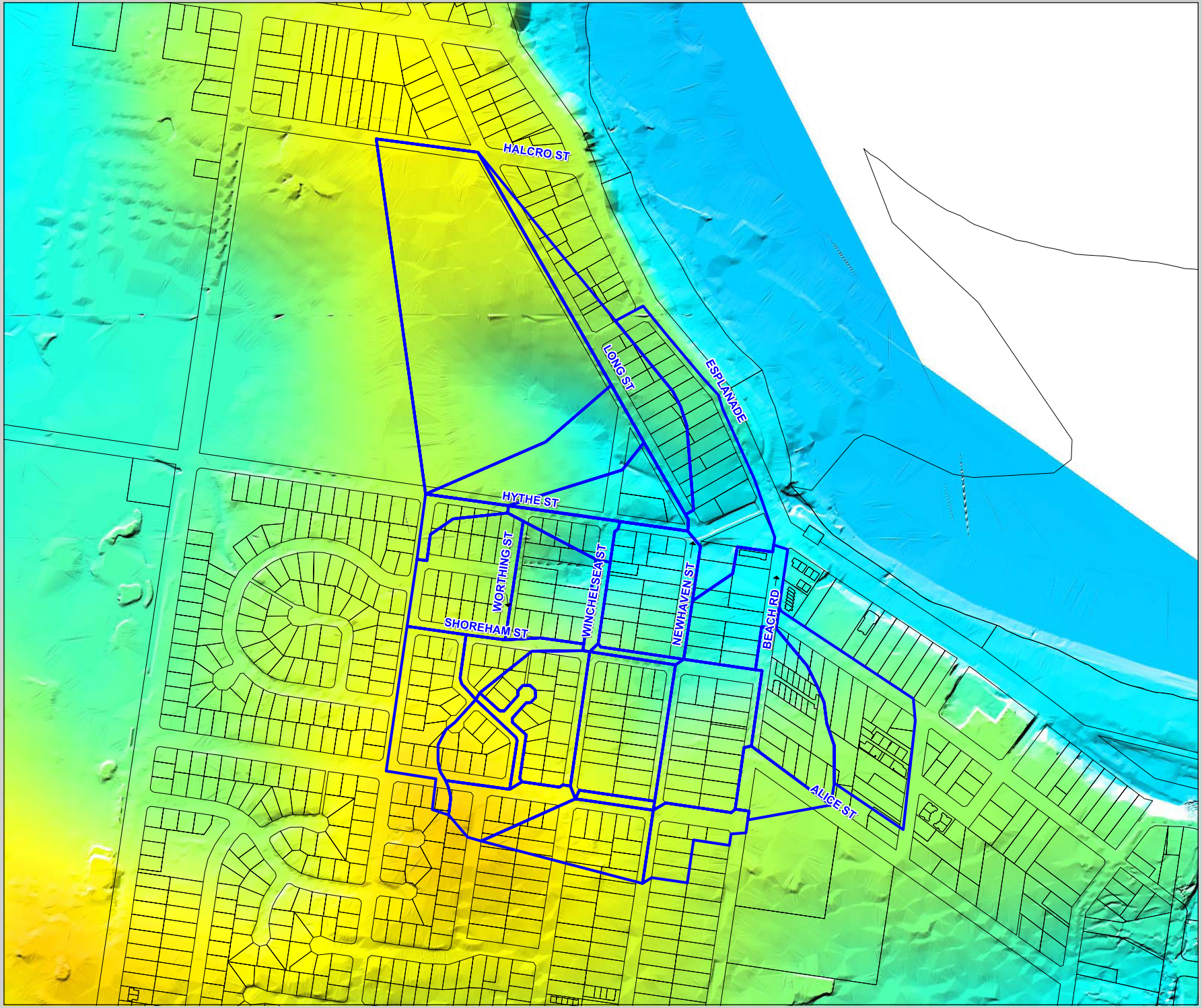
# PIALBA / PT VERNON

## FIGURE 2B

## SUB CATCHMENT BREAKDOWN MODEL 2

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Sub Catchment Boundary

Cadastre

50 0 50 100 150

Metres

**Scale: 1:5,000**

# PIALBA / PT VERNON

## FIGURE 2C

## SUB CATCHMENT BREAKDOWN MODEL 3

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

**Table 4.1: Fraction Impervious and Roughness Coefficients**

| Land Use Type | Fraction Impervious | Pervious Area Roughness | Impervious Area Roughness |
|---|---|---|---|
| Low Density Urban Residential | 60 | 0.025 | 0.015 |
| Medium Density Urban Residential | 80 | 0.025 | 0.015 |
| Open Space | 0 | 0.040 | 0.015 |
| Special Purposes | 50 | 0.025 | 0.015 |
| Road Reserve (including footpath) | 70 | 0.020 | 0.015 |

The GIS system was used for the purposes of interrogating and compiling land use information for the purposes of inclusion into the hydrology models and rational method calculations. This included the analysis of the various ultimate land use areas within each of the some 101 sub-catchments defined throughout the study area. A detailed summary of the ultimate land use areas for each of the sub-catchments delineated is attached in Appendix C of this report. This summary illustrates the various portions of the total sub-catchment area based upon land use based on Council's zoning information.

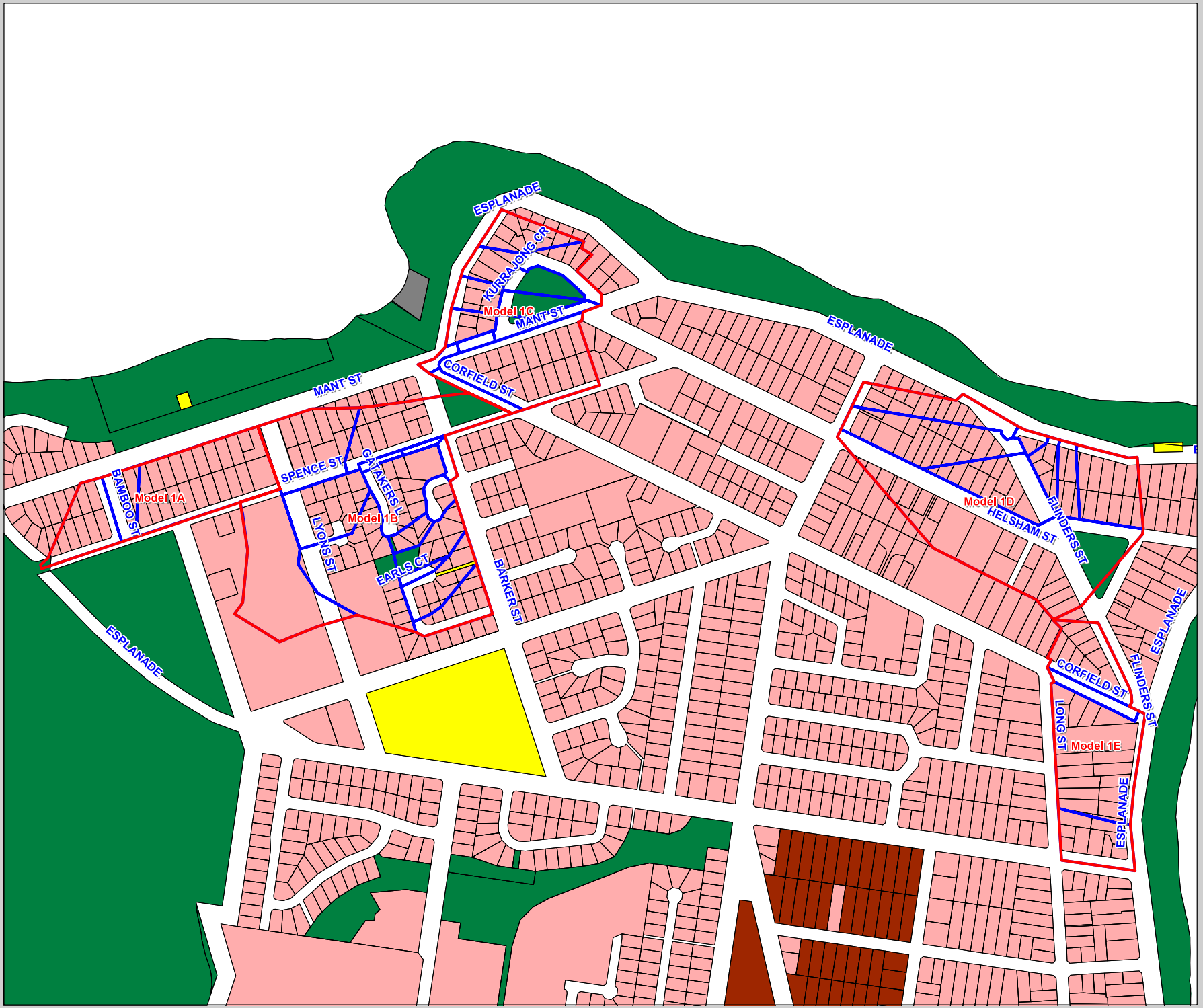
Variations from fraction impervious values supplied by Council are based on the separation of road reserves from surrounding land uses, as well as on site observation, review of aerial photography, and a conservative approach to catchment flows. This approach is deemed appropriate for the purposes of this flood risk reduction study.

The land use summary as presented in Appendix C forms the basis on which sub-catchment land use was included within the model. This included the determination of percentage pervious and impervious catchment data which was undertaken based upon a weighted average of catchment area and land use types. Each sub-catchment within the model has been modelled based upon a pervious and impervious fraction in accordance with the RAFTS methodology.

### 4.4.3 Rainfall Loss Parameters

Rainfall loss parameters adopted for this study included a 25 mm initial loss allowance along with a 2.5 mm/hour continuing loss. Initial and continuing losses were applied to pervious surfaces for all recurrence interval design storms. These loss rates are consistent with AR&R (2000) which recommends a continuing loss of 2.5 mm/hr and an initial loss of between 15-35 mm be applied in eastern Queensland.

Whilst Hervey Bay City Council have specified initial losses of 15mm for non-sand pervious surfaces and 35mm for sandy pervious surfaces, details of soil types throughout the catchment were not supplied and deemed to be highly variable, and thus an initial loss of 25mm was adopted. This approach is considered to be appropriate for the purposes of this study.




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Sub Catchment Boundary
- Open Space Landuse
- Residential Low Density
- Special Purposes Landuse
- Cadastre
- Model Boundary

60 0 60 120 180

Metres

**Scale: 1:6,000**

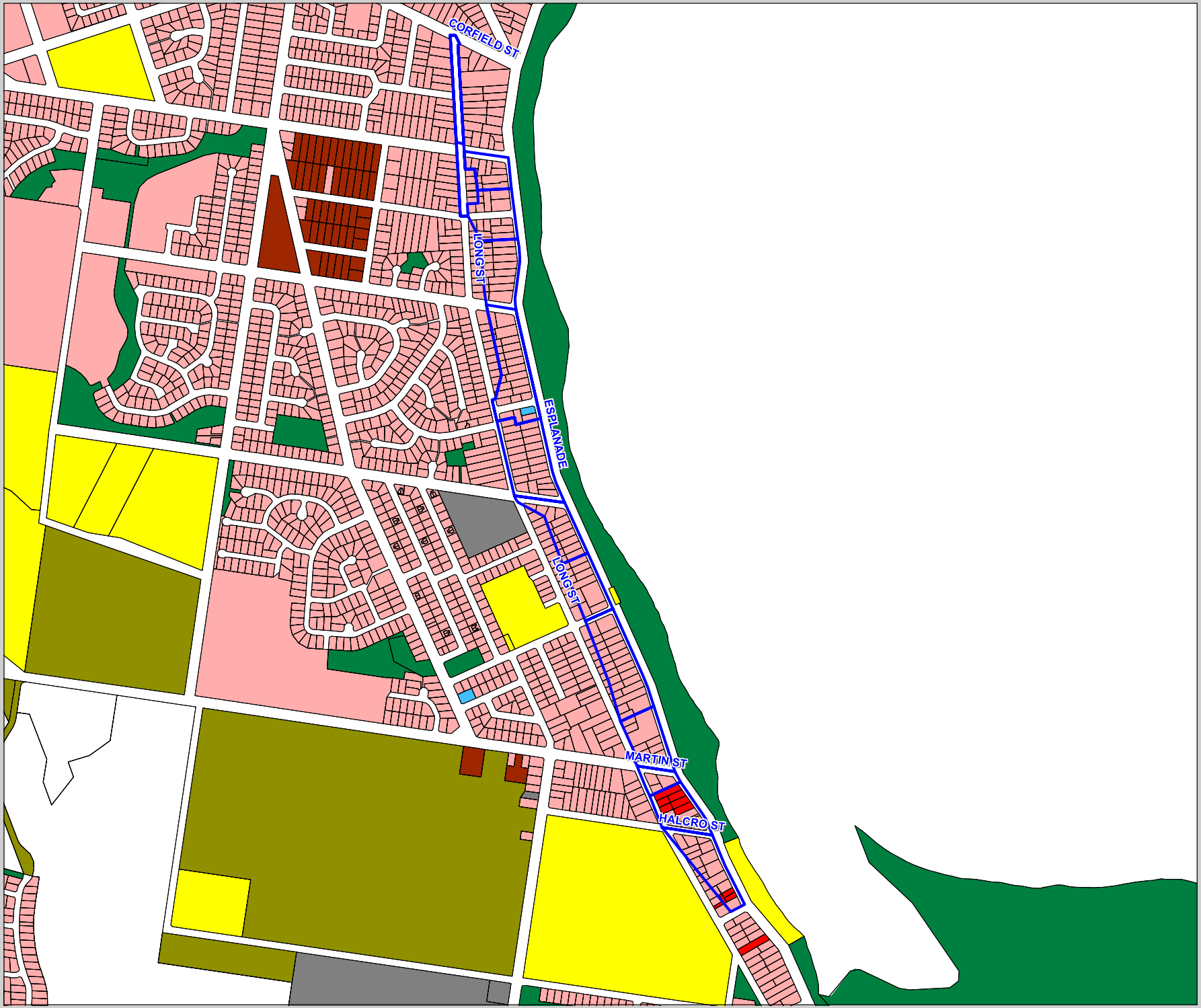
# PIALBA / PT VERNON

## FIGURE 3A

## SUB CATCHMENT LAND USE SUMMARY MODEL 1

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Sub Catchment Boundary
- Cadastre
- Local Shopping Landuse
- Residential Low Density Landuse
- Residential Medium Density Landuse

100 0 100 200 300

Metres

**Scale: 1:10,000**

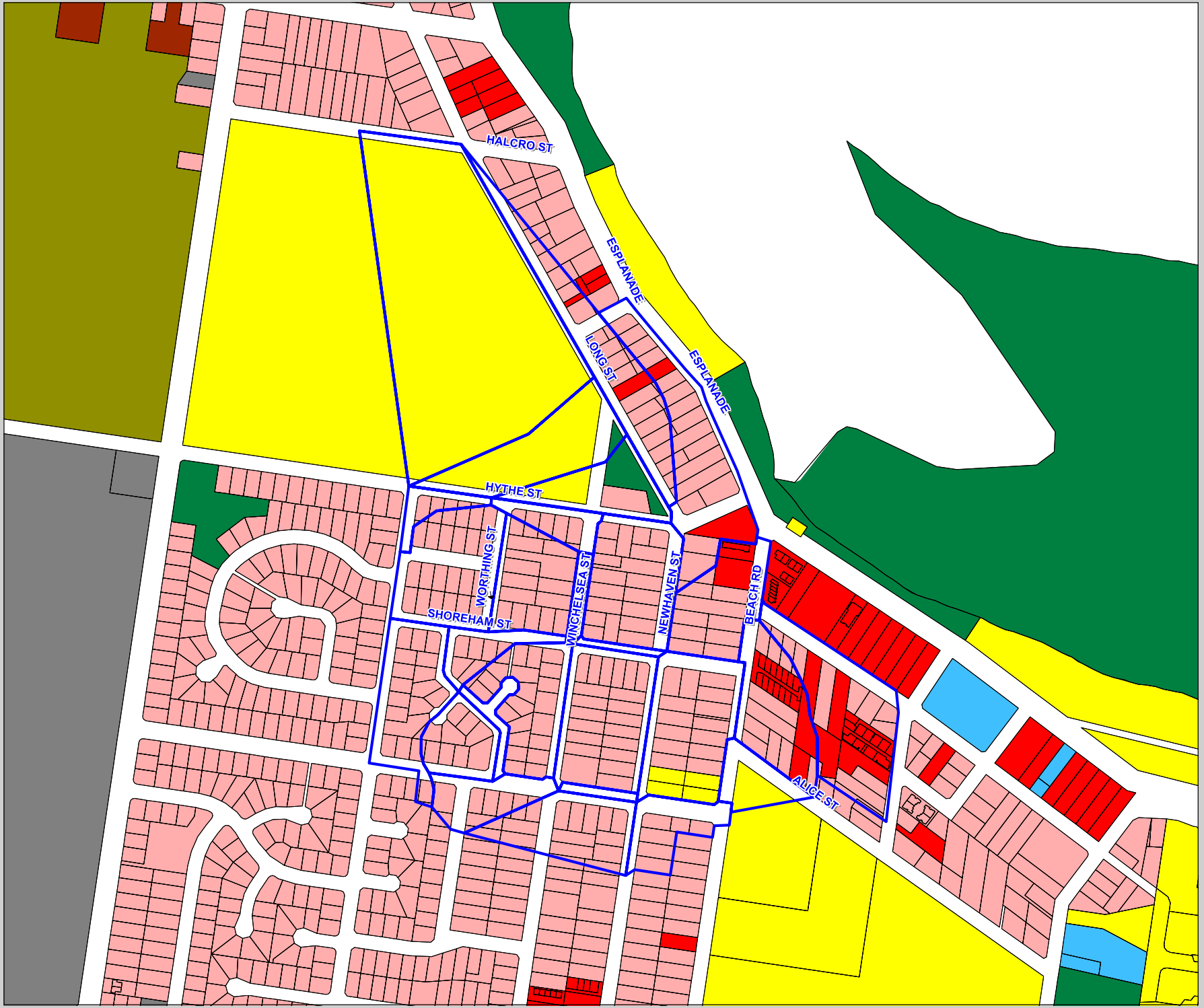
# PIALBA / PT VERNON

## FIGURE 3B

## SUB CATCHMENT LAND USE SUMMARY MODEL 2

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Sub Catchment Boundary
- Cadastre
- Open Space
- Residential Low Density Landuse
- Special Purposes Landuse
- Residential Medium Density Landuse

50 0 50 100 150

Metres

**Scale: 1:5,000**

# PIALBA / PT VERNON

## FIGURE 3C

## SUB CATCHMENT LAND USE SUMMARY MODEL 3

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

## 4.5 Hydrological Flow Verification (XP-Storm Models)

Since calibration of the hydrological model to recorded data was not possible owing to stream gauging records not being available for the catchment, rational method calculations were undertaken at various locations throughout the catchment for comparison and verification with the RAFTS results. The comparison of flows using this approach at key locations throughout the catchment are summarised in Table 4.2 below.

**Table 4.2: Comparison of Hydrologic Flow Results to Rational Method**

| Comparison Location | Q100 Rational Method ($m^3/s$) | Q100 XP-STORM Model ($m^3/s$) |
|---|---|---|
| **Spence St (Model 1a)** | 1.3 | 1.5 |
| **Spence St (Model 1b)** | 0.8 | 0.8 |
| **Mant St (Model 1c)** | 1.2 | 1.2 |
| **Flinders St (Model 1d)** | 2.4 | 2.2 |
| **Flinders St (Model 1e)** | 0.6 | 0.7 |
| **Hythe St (Model 3)** | 7.1 | 6.7 |

On the basis of the comparison performed using the rational method, the flows estimated using the current XP-STORM models as part of this study were found to agree quite well with the flows determined using the rational method. As such, the current XP-STORM models are considered to predict flows to an acceptable level of accuracy and have been adopted for the purposes of this assessment.

We note that it was difficult to select suitable flow comparison locations throughout the catchment owing to multiple flow paths as well as pipe diversions within the catchment. This was especially true at the most downstream locations in the catchments due to the variable flow directions in conjunction with regional flooding and backwater effects.

## 4.6 RAFTS Design Analysis Runs

The adopted XP-STORM models for the study have been analysed for the 1 in 10, 20, 50 and 100 year ARI events in the RAFTS hydrological mode in order to ascertain design flow estimates throughout the catchment. The analysis of each of the design events included model simulation for all rainfall events ranging from 15 to 270 minutes in order to ensure that critical design flows at each location throughout the catchment were fully identified. The results from the model are presented in further detail in the hydraulics section of this report.

# 5 Hydraulic Modelling

## 5.1 Modelling Philosophy (XP-STORM)

Given the nature of the catchment including discrete areas of drainage network, flat topography and some ill-defined overland flow paths, it was necessary to construct a number of detailed quasi 2 dimensional (2D) hydraulic models of the catchment. The XP-STORM modelling package has been selected for this purpose. The XP-STORM model is particularly suited for urbanised drainage areas as both sub-surface pipes combined with multi-link overland flow paths can be incorporated into a single model and the model run in a fully dynamic mode. In addition, the in-built RAFTS hydrology mode is also of benefit as local inflows can be allocated to discrete piped and overland systems thereby allowing a more representative model of the catchment to be prepared.

The various XP-STORM models created for the Pialba / Pt Vernon Coastal Strip catchment have included a significant number of overland flow paths to better define surface drainage flows and characteristics. Specifically, flow paths have been incorporated along each of the road systems within the urbanised area to facilitate flow distribution and to better determine drainage patterns. Further details of the model setup and methodology is summarised in further detail below.

## 5.2 Model Preparation

### 5.2.1 Overland Flow Paths and Pipe System

The establishment of a number of XP-STORM hydraulic models for the catchment was facilitated through the preparation of a DTM for the entire catchment. The DTM represents the ground surface and facilitates the identification of discrete flow paths and cross sectional information. As such, the DTM represents the base information on which the hydraulic models for the catchment and this study has been prepared.

JWP have utilised the GIS to prepare all model data for use in the XP-STORM models. This has included the definition of the model network including flow paths, nodes and cross section information. Model data was generated using the GIS and exported directly into the XP-STORM models to prepare a fully co-ordinated, correctly located and representative model of the selected modelling areas. Model data from the GIS has included: -

- Nodal information whereby the ground level was taken directly from the DTM;
- Model cross sectional data as digitally extracted using the DTM; and
- Flow paths including linkage lengths.

The above information was used to prepare the XP-STORM models for the catchments. The above procedure was used to generate all the overland drainage systems for each model. In addition to this, a separate pipe drainage system was also prepared within the models using the pipe data supplied by Council. The overland model was integrally linked to the sub-surface pipe model in the XP-STORM models to facilitate the flow interaction to occur between overland and sub-surface systems. This was done through the inclusion of manholes to allow surcharge to occur as well as flow entering the pipe system as appropriate. Figure 4 illustrates the overall layout of the XP-STORM models prepared as part of this study.

## 5.3 Modelling Philosophy (Manning's Equation)

As previously mentioned, multiple sets of discrete sub catchments existed along the esplanade. This required a different methodology to the other sections of drainage network, as an XP-STORM model for each individual culvert crossing was not necessary and was an over-complication of the simplistic systems.

In these cases, a pipe on grade (Manning's equation) analysis was used to determine the existing systems capacity as well as the size of the upgrade if so required (Details of the Manning's equation are discussed in Section 5.21.7 of QUDM).

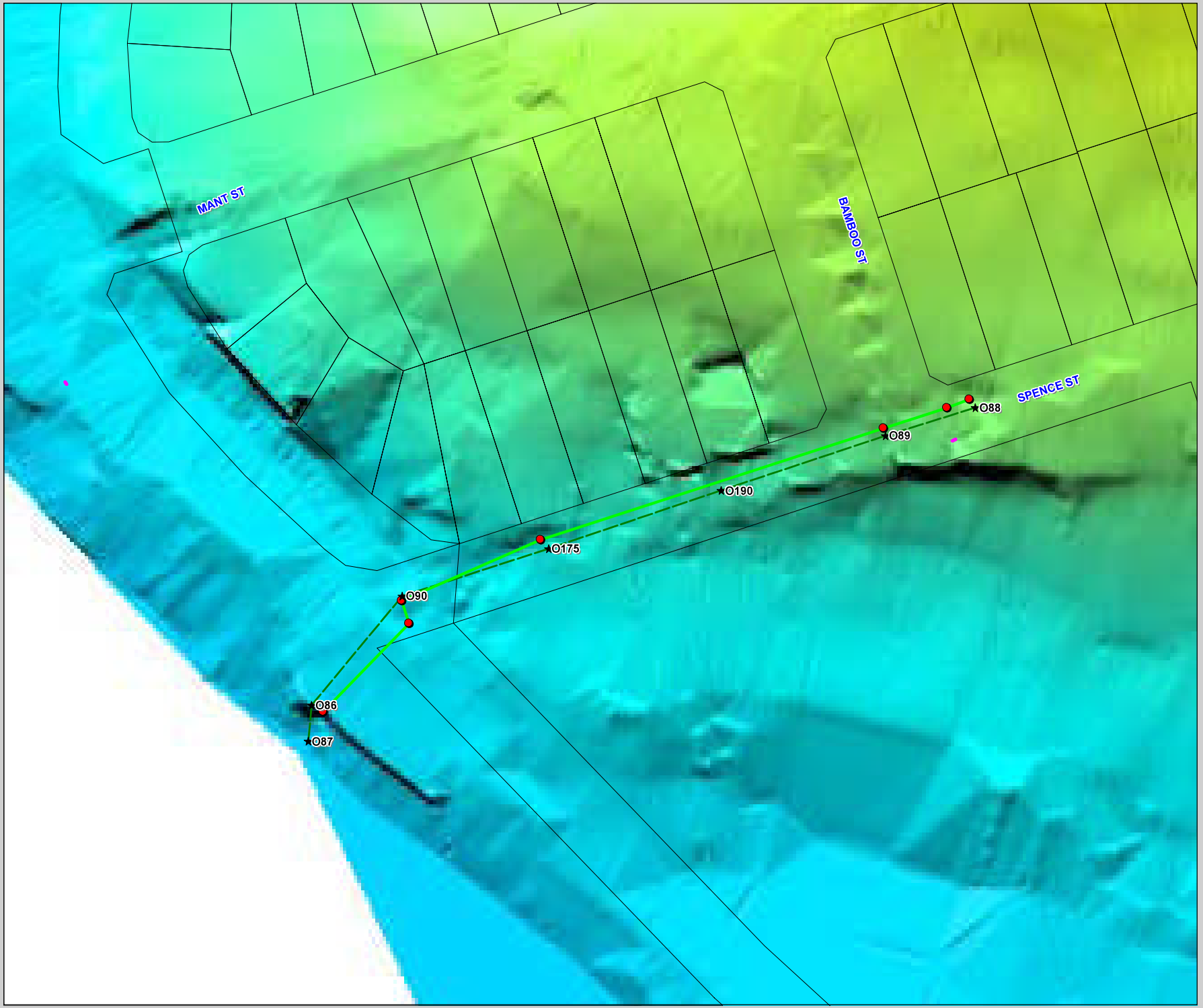
### 5.3.1 DTM and Cross Sections

As mentioned, the DTM forms the basis on which the XP-STORM models have been prepared. As such, the nature and accuracy of the DTM is critical in the establishment of a representative model.

In the urbanised area of the catchment, flow paths were placed along road systems representing the overland flow paths in these areas. As the DTM in these areas did not provide adequate representation of the road system in terms of kerb and crest levels, JWP have incorporated generic road templates into the model. The road templates extend across the full width of the road easement and include a generic road template with appropriate kerb and crest information to ensure a representative flow path is applied in the model.

### 5.3.2 Catchment Hydrology

As discussed previously in Section 4 of this report, catchment hydrology was prepared within the XP-STORM models, and through rational method calculations where appropriate. Specifically, the XP-STORM models allow the analysis of both catchment hydrology and hydraulic computations within a single fully consolidated model. Individual sub-catchments were applied at specific model nodal locations based on the local catchment characteristics while also ensuring that flows were apportioned appropriately within the model.




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Overland Flow Node
- Pipe Node (Manhole etc)
- Overland Link
- Pipe Link
- Cadastre

10 0 10 20 30

Metres

**Scale: 1:1,000**

# PIALBA / PT VERNON

## FIGURE 4A

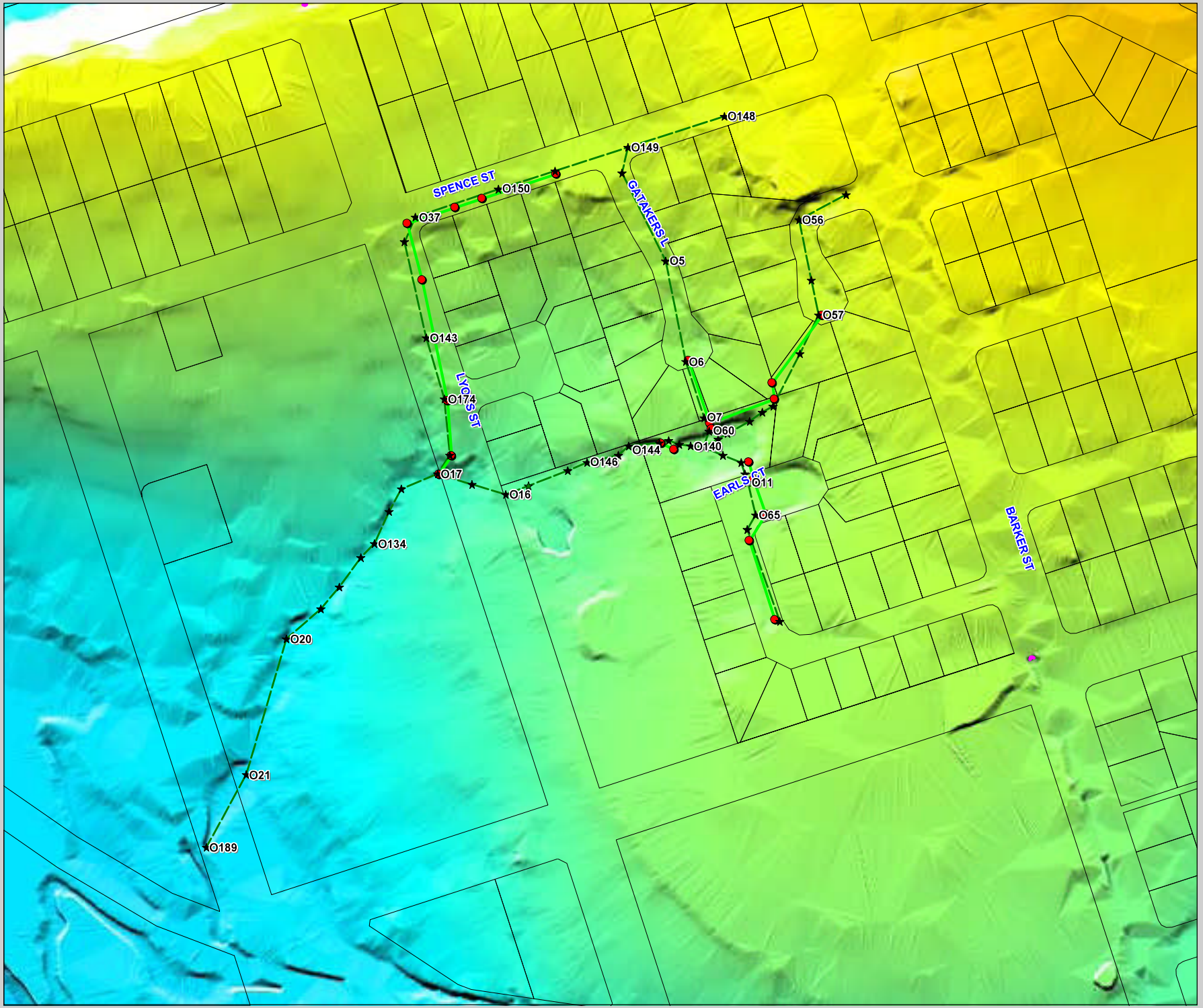
## MODEL LAYOUT MODEL 1A

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\42-Works\050301.001 Pt. Vernon Flood Risk\GIS\MapInfo\Figures

Projection Trans. Merc. MGA56(GDA 94)




HERVEY BAY CITY COUNCIL

N
W E
S

- Pipe Node (Manhole etc)
- Overland Link
- Pipe Link
- Cadastre

20 0 20 40 60

Metres

Scale: 1:2,000

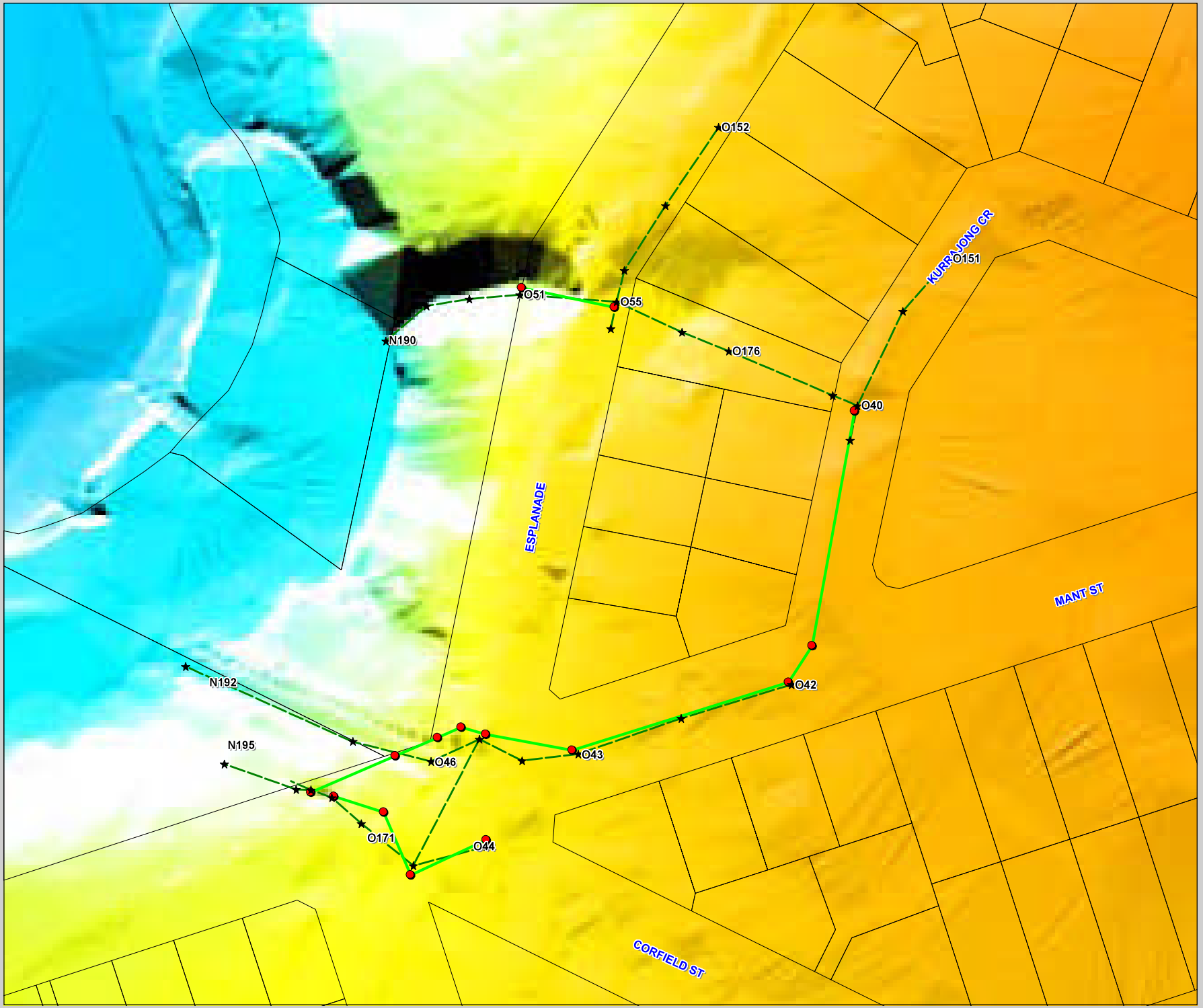
# PIALBA / PT VERNON

## FIGURE 4B

## MODEL LAYOUT MODEL 1B

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Overland Flow Node
- Pipe Node (Manhole etc)
- Pipe Link
- Cadastre
- Overland Link

10 0 10 20 30

Metres

**Scale: 1:1,000**

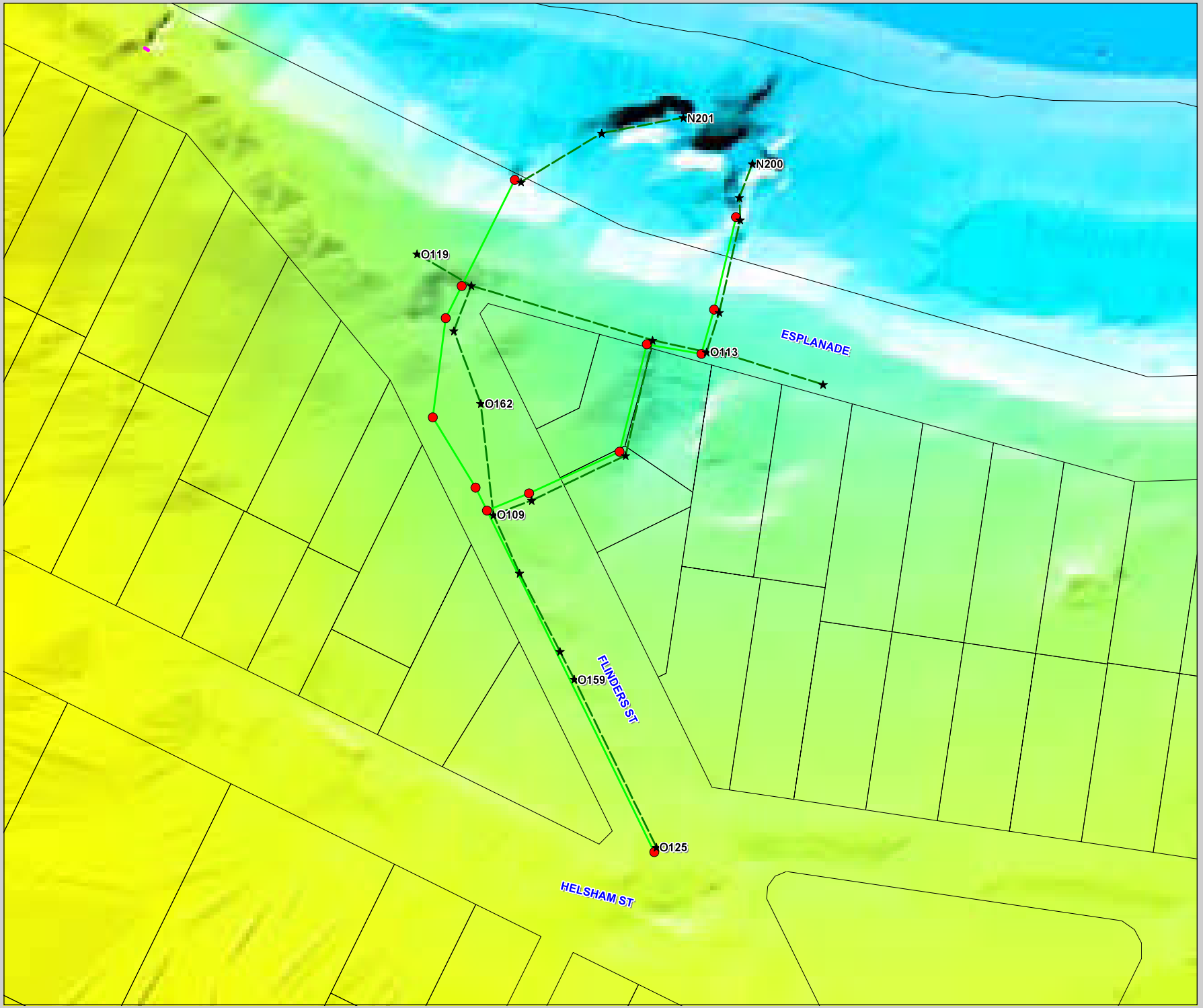
# PIALBA / PT VERNON

## FIGURE 4C

## MODEL LAYOUT MODEL 1C

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Overland Flow Node
- Pipe Node (Manhole etc)
- Overland Link
- Pipe Link
- Cadastre

10 0 10 20 30

Metres

**Scale: 1:1,000**

# PIALBA / PT VERNON

## FIGURE 4D

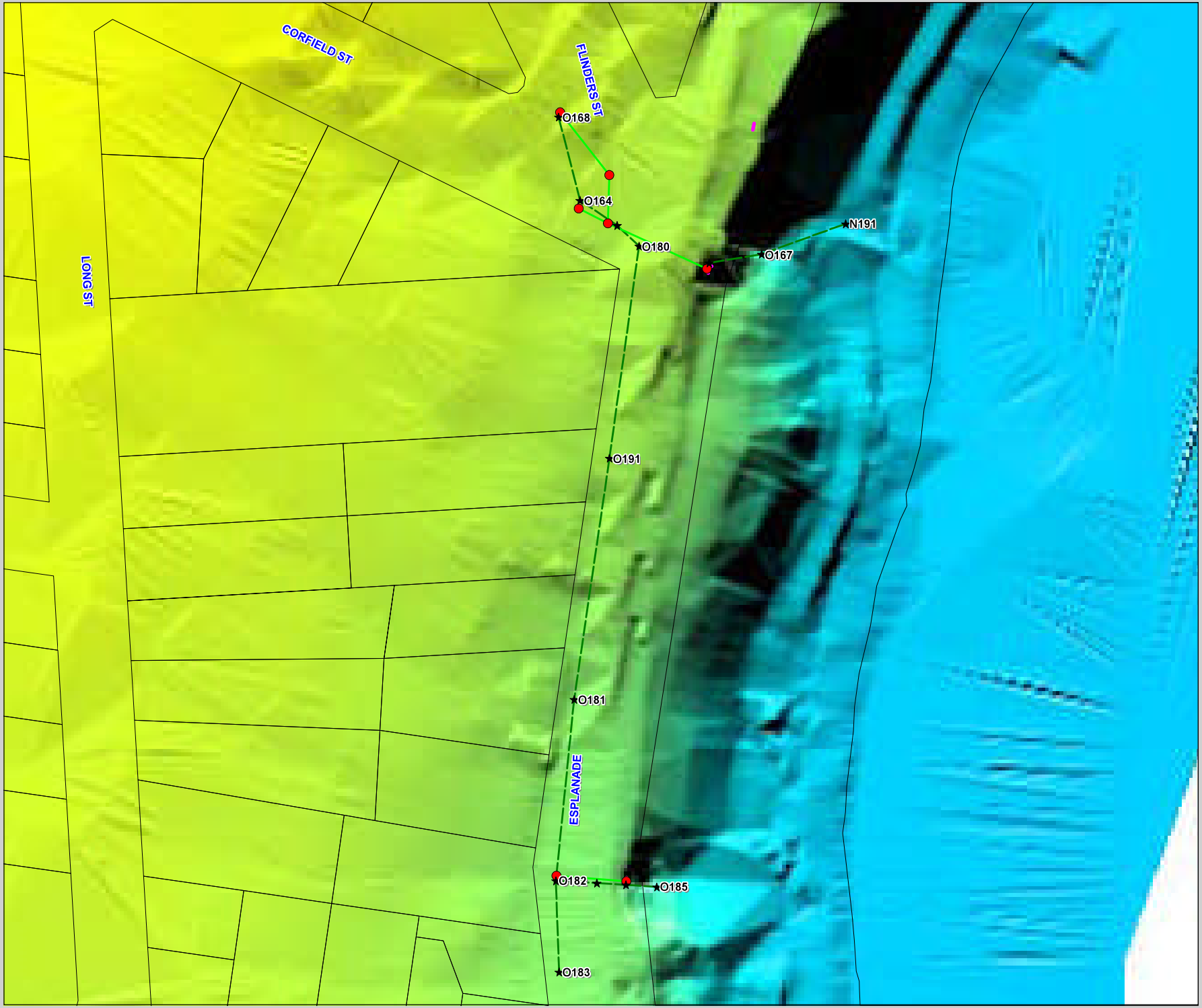
## MODEL LAYOUT MODEL 1D

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\42-Works\050301.001 Pt. Vernon Flood Risk\GIS\MapInfo\Figures

Projection Trans. Merc. MGA56(GDA 94)




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Overland Flow Node
- Pipe Node (Manhole etc)
- Overland Link
- Pipe Link
- Cadastre

10 0 10 20 30

Metres

**Scale: 1:1,000**

# PIALBA / PT VERNON

## FIGURE 4E

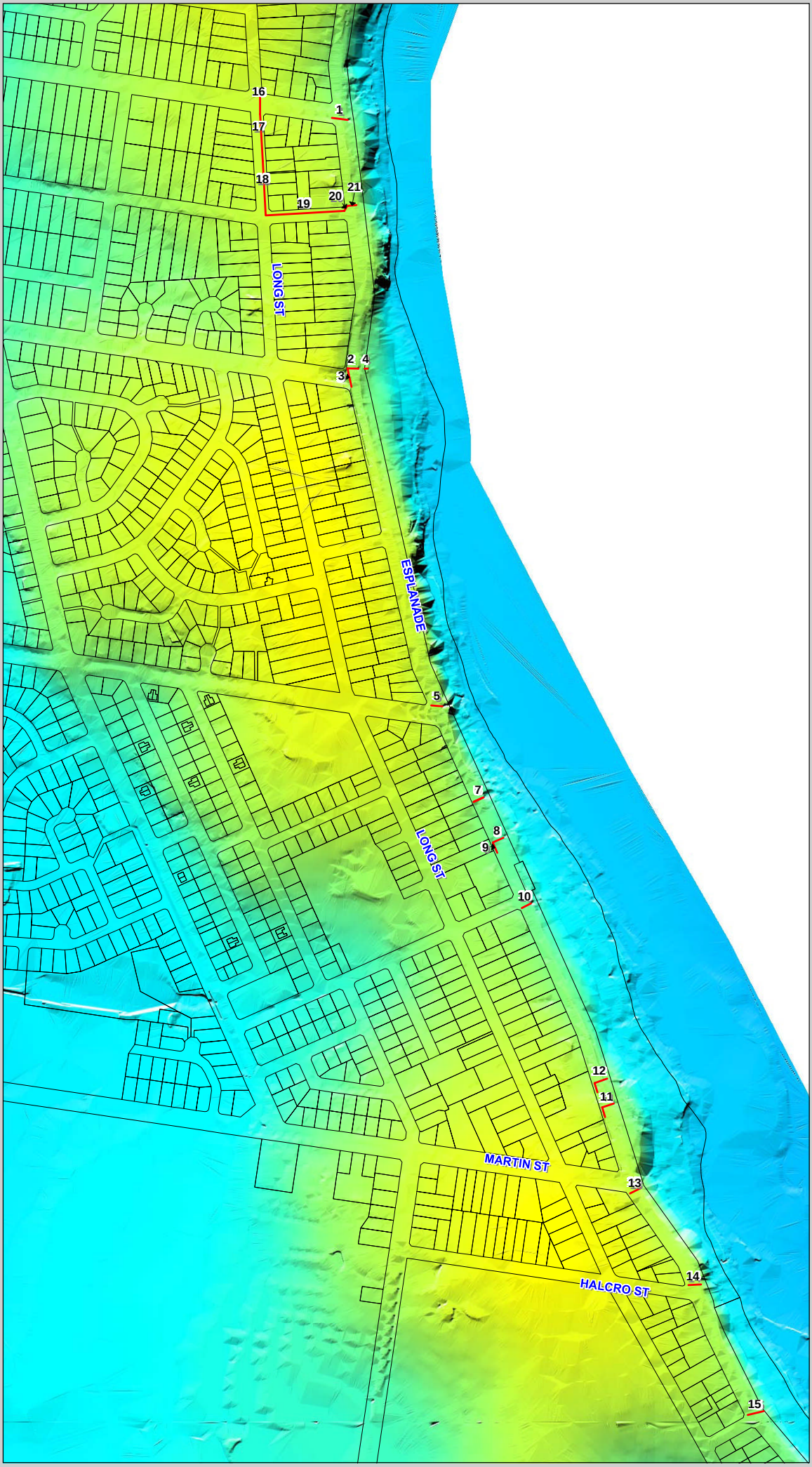
## MODEL LAYOUT MODEL 1E

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\42-Works\050301.001 Pt. Vernon Flood Risk\GIS\MapInfo\Figures

Projection Trans. Merc. MGA56(GDA 94)




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Cadastre

Existing Drainage Network

60 0 60 120 180

Metres

**Scale: 1:6,000**

# PIALBA / PT VERNON

## FIGURE 4F

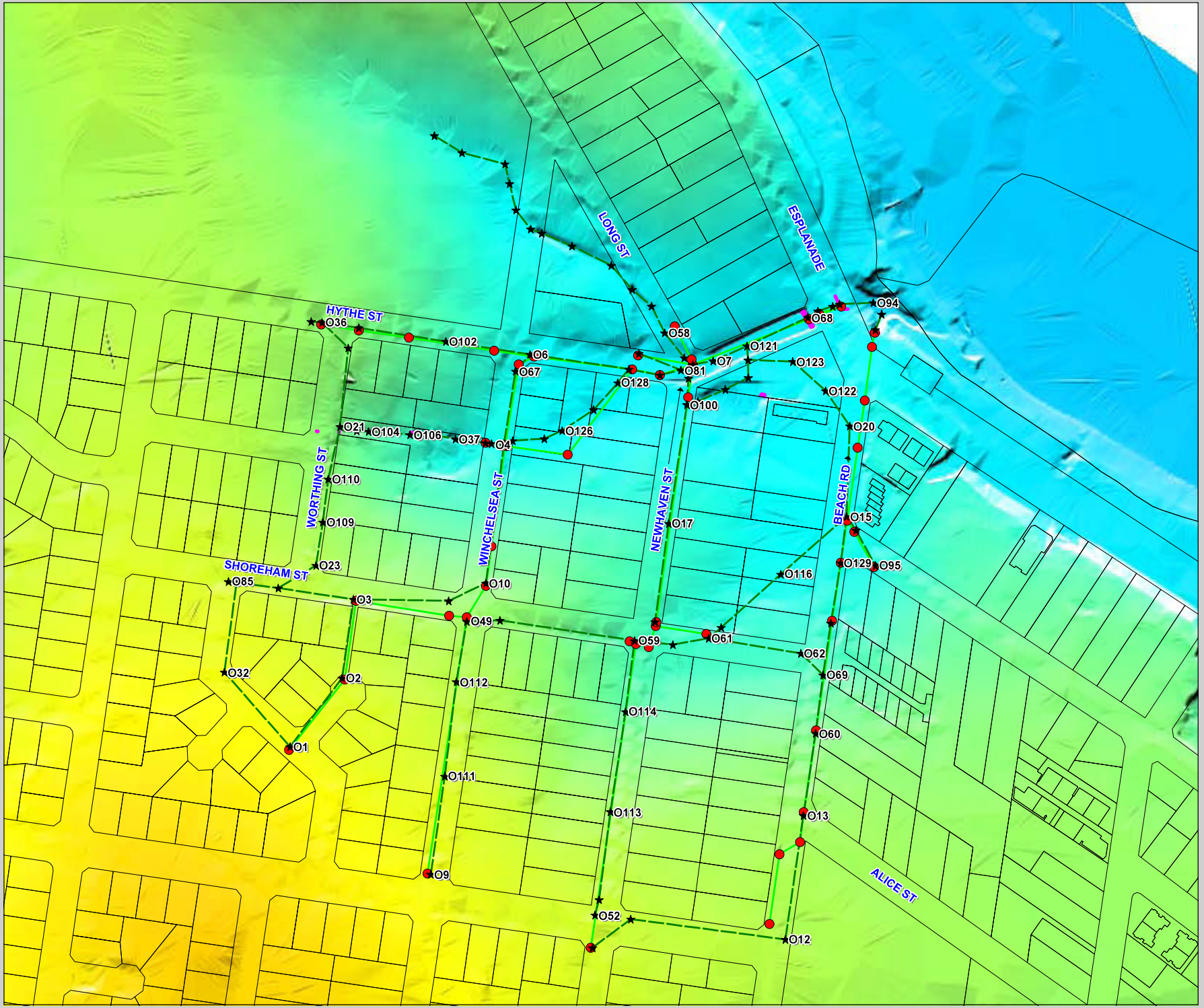
## CULVERT LOCATIONS MODEL 2

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\424\Ways\050301-001_Pt_Vernon_Flood_Risk\GIS\MapInfo\Figures

Projection Trans. Merc. MGA56(GDA 94)




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Overland Flow Node
- Pipe Node (Manhole etc)
- Overland Link
- Pipe Link
- Cadastre

25 0 25 50 75

Metres

**Scale: 1:2,500**

# PIALBA / PT VERNON

## FIGURE 4G

## MODEL LAYOUT MODEL 3

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

### 5.3.3 Channel Roughness

Channel roughness was specified in terms of the Manning's 'n' parameter. Manning 'n' values used in the hydraulic models were based on photographs in conjunction with a detailed site inspection undertaken as part of this study. In addition, channel roughness was also applied having regard to the project brief whereby various roughness parameters were pre-specified. Generally, Mannings 'n' parameters for the catchment have been applied throughout the catchment in accordance with those illustrated in Table 5.1 below.

**Table 5.1: XP-STORM model Roughness Coefficients**

| Condition | Mannings "n" |
|---|---|
| Natural grassed lined open channels | 0.035 |
| Roads | 0.02 |
| Road Verges | 0.035 |
| Concrete Pipes | 0.013 |
| Flow path though residential establishments | 0.75 |

The above set of Manning 'n' roughness coefficients has been adopted as baseline data only. Values used within the XP-STORM models were varied from the above in some circumstances based upon the observations made during the site inspections.

### 5.3.4 Hydraulic Structures

Hydraulic structures within the model included sub-surface piped systems along with discrete culvert crossings under the Esplanade. The inclusion of the pipe systems has been discussed in Section 5.2.1.

### 5.3.5 Boundary Condition

A Highest Astronomical Tide (HAT) tail water level condition has been applied at the downstream extent of each of the models. A HAT level of 2.15 m AHD has been applied and was determined from review of the supplied Hervey Bay Storm Tide Study. The Hervey Bay Storm Tide Study final report as prepared by Lawson & Treloar Pty Ltd, 2002, states *"few historical cyclones have caused significant storm tide levels in the Hervey Bay region during the period of record, since they have been generally less than the HAT."*

A sensitivity analysis of the model boundary condition was also required as part of this study and this has been undertaken and is discussed separately in Section 6.

### 5.3.6 Model Design Runs

The XP-STORM hydraulic models were analysed for the 1 in 10, 20, 50 and 100 year ARI design flood events for the full range of critical durations ranging from the 15 to 270 minute events. The results from the analysis runs for the existing case (current conditions) model are discussed separately in Section 6 of this report.

# 6 Existing Case Analysis Results

## 6.1 Results

All flood level and discharge results from the existing (ultimate development) scenario XP-STORM models are presented in Appendix D of this report. The results are presented based on flood level and discharge reporting locations which are summarised in detail in a spreadsheet format contained in Appendix D of this report. The flood extent plans for the existing (ultimate development) scenario model conditions also enclosed in Appendix D of this report, contain the model reporting locations and names to facilitate the determination of flood characteristics at specific locations throughout the catchments.

## 6.2 Boundary Condition Sensitivity Analysis

As requested in the project brief, a sensitivity analysis has been undertaken on the tidal levels adopted at the downstream boundary of the models. Model 3 and Model 1A are the only models included in the summary below, as the remaining models (Model 1B-1E) have drainage networks well above the TWL, and as such were found to be completely unaffected by sensitivity analysis changes to the adopted TWL.

The sensitivity analysis was undertaken on both the 10 and 100 year ARI events using the HAT tidal level and a ±0.3m variation (RL 2.15 m and RL 2.45 / 1.85m AHD respectively) based on the peak storm event for the associated model. Tables 6.1 and 6.2 below illustrate the difference in water levels predicated at various comparison points throughout the model.

**Table 6.1: 100 Yr ARI Tail Water Sensitivity Analysis Water Level Summary**

| XP-STORM Model Name | XP-STORM Node Name and Location | Water Level (m, AHD) TWL = RL 2.15m AHD (HAT) | Water Level (m, AHD) TWL = RL 2.45m AHD (HAT +0.3m) | Water Level (m, AHD) TWL = RL 1.85m AHD (HAT -0.3m) |
|---|---|---|---|---|
| Model 3 | O98 – Newhaven St | 4.29 | 4.34 | 4.28 |
| | O68 – Esplanade | 4.08 | 4.23 | 3.98 |
| | O28 – Hythe Street | 5.09 | 5.10 | 5.08 |
| | N18 – Esplanade | 3.99 | 4.11 | 3.99 |
| | N57 – Esplanade | 3.49 | 3.49 | 3.49 |
| Model 1A | N90 - Esplanade | 4.05 | 4.05 | 4.05 |

**Table 6.2: 10 Yr ARI Tail Water Sensitivity Analysis Water Level Summary**

| XP-STORM Model Name | XP-STORM Model & Node Name and Location | Water Level (m, AHD) TWL = RL 2.15m AHD (HAT) | Water Level (m, AHD) TWL = RL 2.45m AHD (HAT +0.3m) | Water Level (m, AHD) TWL = RL 1.85m AHD (HAT -0.3m) |
|---|---|---|---|---|
| Model 3 | O98 – Newhaven St | 4.10 | 4.12 | 4.08 |
| | O68 – Esplanade | 3.25 | 3.29 | 3.24 |
| | O28 – Hythe Street | 4.54 | 4.54 | 4.54 |
| | N18 – Esplanade | 2.86 | 3.15 | 2.56 |
| | N57 – Esplanade | 3.44 | 3.44 | 3.44 |
| Model 1A | N90 - Esplanade | 3.99 | 3.99 | 3.99 |

As can be seen from Tables 6.1 and 6.2 above, the difference in water levels which result from the risk assessment of tail water level does impact on the flood levels in the upstream catchment areas of Model 3 to some extent. The greatest difference in modelled flood levels was predicted around the main culvert crossing under The Esplanade. This would appear to be accurate, as this is the closest comparison point to the actual outlet, only some 50m upstream. Further up the catchment differences between modelled flood levels reduces to a few centimetres. Although the increase in flood levels around Newhaven St are limited to a maximum of 50mm, there is nonetheless an increase in water level which results and this illustrates the flat topographical conditions experienced in the lower reaches of the catchment. It can be concluded from this analysis that flood levels in the lower reaches of the catchment modelled in Model 3 are indeed sensitive to the adopted tail water level as applied in the model, but these impacts are for the most part minor.

Likewise, it can be seen in Tables 6.1 & 6.2 that changes to the TWL have no impact on water surface levels in Model 1A.

While tidal levels do influence water levels in the lower reaches of the catchment represented in Model 3, consideration needs to be given to the relative risk this imposes having regard to the selection of an appropriate tail water level. The above analysis results are shown for a combined probability event occurring which includes a HAT tidal level combined with a local catchment storm event. This combination represents a worst case scenario in terms of joint probability with both events coincidental in time. This conservative approach is considered appropriate for the purposes of this risk study.

## 6.3 Flood Extent Mapping

A total of twenty seven (27) flood extent plans have been prepared as part of this study. The plans are presented to illustrate the 10, 20, 50 and 100 year ARI anticipated extent of flooding over the study areas for the existing case, and the required design event for the mitigated case. The flood extent plans have been prepared based upon the DTM and using the outcomes from the hydraulic model in terms of flood levels. A 3-dimensional (3D) flood surface has been created using the model results within the GIS and this surface has been draped over the DTM in order to prepare a 3D flood depth surface. The 3D depth surface has been contoured such that only depths greater than or equal to zero are displayed which by default defines the extent of flood inundation for the event under question.

The flood extent plans prepared as part of this study include extent of mapping limits as have been identified on the plans. These limits have been included to illustrate the point of which mapping has been prepared and this is based on both the extent of the model prepared along with the extent of the DTM data for the catchment. Limit of mapping lines have also been included in other isolated areas whereby the extent of flooding was either undiscernible or inaccurately defined based

upon the information available. In all cases, water will discharge from the catchment in these areas.

The flood inundation mapping prepared as part of this study is subject to the following notations: -

1. The flood extent and associated flood data prepared as part of this study is based on available survey data as supplied by Hervey Bay City Council. This includes aerial photogrammetric survey, limited field validation survey and stormwater pipe and pit information. The flood extents and flood results will therefore be subject to the accuracy and detail of the background study information. Drainage conditions may also have changed since the collection of the survey information;
2. Flood extents shown in urbanised areas have generally been shown (where applicable) with the extent of flooding limited to the width of the road carriageway. This methodology was adopted where the depth of flooding within the road reserve was found to be less than 200mm (contained within the carriageway);
3. Local flooding within some property allotments was unable to be accurately defined as part of this study and is misleading if shown owing to the level of detail contained within the DTM and the interpolated procedures in estimating intermediate property ground level information. Properties in these areas may or may not be subject to inundation and a detailed floor and ground level survey would be necessary in these areas to accurately determine property inundation. These areas are clearly shown where applicable on the inundation maps;
4. All flood extents prepared as part of this study have been prepared based upon the DTM formed for the study area. Where critical information such as open channels have not been adequately represented in the DTM as a result of the original photogrammetric data captured, flood extents shown could be different to those which may occur on the ground. The accuracy of the flood extents prepared from this study is subject to the accuracy of the topographical representation contained within the DTM.

# 7 Existing Scenario Risk Identification & Prioritisation

### 7.1.1 Risk Identification Methodology

The method of evaluating flood risk prepared as part of this study is summarised in the following tables.

**Likelihood parameters**

| | |
|---|---|
| **Almost certain** | A 99.5% chance of a hazard being exceeded in a 50 year period – a 1 in 10 year event |
| **Likely** | Probability of exceedance is greater than 50% in a 50 year period, but less than 99.5% - a 1 in 50 year event |
| **Possible** | Probability of exceedance is greater than 20% in a 50 year period, but less than 50% - a 1 in 100 - 200year event |
| **Unlikely** | Probability of exceedance is greater than 5% in a 50 year period. but less than 20% - a 1 in 500 year event |
| **Rare** | Probability of exceedance is less than 5% in a 50 year period - a 1 in 500 year event |

**Consequence parameters** (based on 2000 AU$)

| | |
|---|---|
| **Insignificant** | Natural hazards are experienced and cause some stress on community lifelines. Community agencies cope with some effort and total community financial loss is less than $1.0m |
| **Minor** | No disaster is officially declared and effects lead to temporary failure of lifelines other than energy supply for up to 24 hours. Total community financial loss is less than $10m |
| **Moderate** | Disruption lasts for more than 5 days including energy disruption. Recovery takes 14 – 21 days. Vulnerable elements are severely affected and all major agencies are involved. Hospitalisation of victims occurs and total community financial loss is less than $50m. State of emergency is declared during the event. |
| **Major** | All lifelines affected. Energy is disrupted for up to 14 days. Recovery takes 4 – 6 weeks. At least one death is suffered and temporary evacuation of area is required. State of Disaster is declared and total community loss is up to $200m. |
| **Catastrophic** | Effects are severe and all lifelines are affected. No energy for up to 8 weeks and recovery takes 6 – 24 months. At least 10 deaths suffered and significant evacuation required. Total community financial loss in hundreds of millions. |

**Risk Ranking**

| **Return period** | **Consequence / Likelihood** | **Insignificant** | **Minor** | **Moderate** | **Major** | **Catastrophic** |
|---|---|---|---|---|---|---|
| 10 | Almost certain | H | H | E | E | E |
| 50 | Likely | M | H | H | E | E |
| 100/200 | Possible | L | M | H | E | E |
| 500 | Unlikely | L | L | M | H | E |
| 1000 | Rare | L | L | M | H | H |

Where: E = extreme risk H = high risk M = moderate risk L = low risk

In addition to infrastructure lifelines, risk parameters for people, buildings, economic loss and loss of the natural environment are proposed as follows:

| Risk element | Extreme (unacceptable) risk |
|---|---|
| People | Vulnerability to natural hazards is generally measured by the risk to life and property from known hazards. An area may be prone to a known hazard, but if there is no possible risk to life or property, the vulnerability is low. Where life and property are at risk, the magnitude and likelihood of the hazard combine to create a measure of vulnerability. **Unacceptable risks are death, serious injury and major health hazard.** |
| Buildings | The built environment is at risk from a number of known hazards in Hervey Bay. Various regulations have been developed locally (e.g. Local Laws) and at a wider scale (e.g. the Building Code of Australia) to minimise the risk of damage to the built environment. All of these regulations are based on an acceptable level of risk which has been determined either by Council or a wider community of interest (e.g. 1:100 flood immunity). Inevitably there will be extreme events which go beyond the acceptable level of immunity and the only possible way to immunise against these events is avoidance. **Unacceptable risks are collapse or damage to buildings requiring demolition.** |
| Economic loss | In all disaster events there is bound to be some form of economic loss. The Federal Government under the Natural Disaster Relief Arrangements provides funding to victims of disaster events. This funding is generally short term and designed to minimise immediate suffering and loss. Businesses need to make their own assessment of potential economic loss through a natural disaster event and make plans accordingly. These would range from building construction, to choice of location to insurance. **Unacceptable risks are loss of livelihood for more than 10% of the working community.** |
| Natural environment | The natural environment is at risk from a number of known hazards in Hervey Bay. **Unacceptable risks are loss of ecological systems, major habitats or conservation areas. Significant disruption to natural drainage systems.** |

**Risk escalation**

Risk escalation is likely to happen when initial risk minimisation programs or event response mechanisms do not achieve their intended purpose. The risks outlined in this document may have follow-on or secondary effects (e.g. an earthquake may lead to a dam break, which may lead to flooding, which may lead to injury or isolation). **Unacceptable risks arise from the failure of initial risk minimisation and response mechanisms.**

**Risk frequency**

Risks to physical infrastructure are usually incorporated in design parameters (e.g. bridges are designed to withstand certain loads; drains are designed to accommodate mathematically derived flood levels). These are generally based on industry standards of acceptable levels of risk. These standards have until recently had very little legislative basis. The recent adoption of *State Planning 1/03 - Mitigating the adverse impacts of Flood, Bushfire and Landslide* introduces risk frequency levels (e.g 1:100 years) which are required to be accommodated in planning and design documents (e.g. planning schemes and infrastructure codes). **Unacceptable risks are events which occur within the design capacity of infrastructure or industry accepted measures.**

| |
|---|
| **Legal and social justice implications**<br><br>Risk management is applied by Council across all parts of its jurisdiction in an equal manner and includes all persons. Council is required to make decisions on an annual basis about prioritising its expenditure on various competing items. Expenditure on risk minimisation is incorporated in most capital works projects by way of an in-built design standard. **Unacceptable risks are deliberate inequality of expenditure against any one group, or any one part of the city.** |
| **Political implications**<br><br>Council's decisions are subject to scrutiny and influence from various elements and sectors of the community. It is Council's role to make informed and un-biased decisions. **Unacceptable risks are decisions made which reflect unlawful political bias.** |

For each model prepared as part of the Pialba / Pt Vernon Catchment Flood Risk Identification Study, specific flood risks were identified through use of the above risk matrix and examination of modelling results as discussed in Chapter 6. Where modelling identified a hazard, an analysis of the various risk elements was undertaken using the risk matrix above. A risk ranking for the hazard was determined based on the likelihood and the consequences of the hazard occurring. For elements such as people, not only the potential to suffer injury or death as a result of property inundation was analysed, but also the ease of egress from the property through the determination of Velocity x Depth products. A risk ranking for each specific flooding risk was determined. This risk ranking can be used to prioritise mitigation options within the total catchment and is discussed in more detail in Chapter 8. A description of flooding and risk ranking for each model is provided in the following text. Based on the derived risk ranking and the flooding characteristics of each location the upgrade and immunity requirements are presented in Tables 7.1 - 7.3. These tables summarise the risk analysis for each specific model, namely models 1A-1E, 2 and 3, which represent the various discrete drainage networks within the Pialba / Pt Vernon Catchment.

### 7.1.2 Risk Identification

Modelling of the catchments identified the following results. Based on this preliminary assessment, it was determined whether further analysis of the areas was warranted.

#### 7.1.2.1 Model 1A

As is shown in the flood inundation extents (Appendix D), there are no areas of overtopping or inundation predicted within the confines of Model 1A. Limited flows entering the system are adequately catered for by the sub surface drainage system, and overland flows do not breach the road carriageway. Velocity x depth products are acceptable. Flow depths within the road reserve meet Council requirements, as per table 5.09.1 of QUDM.

#### 7.1.2.2 Model 1B

Problematic inundation areas in Model 1B are predicted to be limited to the end of the cul de sac at Gatakers Lane. The existing subsurface drainage system in this location is undersized, and as a result overtopping of the road carriageway occurs in all events with overland flows travelling down the provided overland flow path before discharging into the local detention basin. Flow depths within the road reserve therefore do not meet Council requirements (table 5.09.1 of QUDM), and further assessment of this area is warranted.

Other areas of concern include the area of Spence Street just before the intersection with Lyons Street. Again the very flat nature of the terrain is predicted to limit the flow conveyance capabilities of the sub surface and overland drainage systems. Flows for the 10 year ARI event are only just contained within the road carriageway, with a degree of overtopping for successive events greater than this design event. Velocity x depth products are acceptable. Again, flow depths within the road reserve do not meet Council requirements (table 5.09.1 of QUDM), and further assessment of this area is warranted.

All other areas represented within the model are adequately catered for by the existing drainage system.

#### 7.1.2.3 Model 1C

A trapped sag located in Kurrajong Crescent is predicted as one of two areas of concern for the catchment. Flat gradients in the drainage network at this point limit the ability of the sub surface system to adequately cater for the amount of overland flows generated from the catchment. As such, ponding is predicted to occur and flows may overtop the road carriageway and travel down through lots 29 & 30 The Esplanade adjacent to the sag point, towards The Esplanade. This occurs in all ARI events and results in property inundation. This current flow regime fails to meet Council requirements (table 5.09.1 of QUDM), and further assessment of this area is warranted.

Similarly, the model indicates that the sag point in The Esplanade in front of the aforementioned lot accumulates flows to a point where significant ponding occurs in all ARI events. Overtopping of the road carriageway occurs in the 100yr ARI event. Whilst this is acceptable as the design event for The Esplanade is the 50yr ARI, upgrades to the drainage network in Kurrajong Crescent will increase flows entering the culvert under The Esplanade, and as such, upgrades will be required to the culvert system crossing The Esplanade to enable all flows draining to the culvert to be adequately catered for. Currently the ponding in this area does not meet Council requirements (table 5.09.1 of QUDM), and further assessment of this area is warranted. Velocity x depth products are acceptable.

#### 7.1.2.4 Model 1D

The main flooding issue relating to model 1D is associated with the sag point in front of number 74 The Esplanade. Modelling suggests the sub surface drainage system has inadequate capacity to handle all ARI flows, and ponding occurs with overtopped flows travelling down the embankment discharging to the foreshore, thus failing to meet Council requirements (table 5.09.1 of QUDM). Further assessment of this area is warranted. There are no other areas of concern within this model, as flows are contained within the sub-surface system and road carriageway. Velocity x depth products are acceptable.

#### 7.1.2.5 Model 1E

Once again the main issue with respect to the area represented by Model 1E is a sag point and culvert crossing under The Esplanade (adjacent to number 117 The Esplanade). Modelling indicates the limited capacity of the system again results in ponding and overtopping of the road carriageway in all ARI events, with overland flows travelling down the embankment / foreshore before discharging into the bay. This fails to meet Council requirements (table 5.09.1 of QUDM) and further assessment of this area is warranted. Velocity x depth products are acceptable.

### 7.1.2.6 Discrete Culvert Crossings – The Esplanade

As discussed earlier, a portion of the catchment was investigated using a rational method and Manning's equation (pipe on grade) approach. As such inundation extents for the areas investigated using this method are not available.

However, these areas are limited to discrete culvert crossings of The Esplanade, and as such inundation of property is unlikely due to the ease in which ponded flows can overtop the road crown and drain down the steep foreshore.

Many of the discrete culvert crossings investigated were undersized for the 50 year ARI design event and as such it could be assumed that some ponding would occur in these locations, possibly similar to that shown in modelling of other culverts along The Esplanade. As such, it could be assumed that many culverts would fail to meet Council requirements (table 5.09.1 of QUDM), and further assessment of these culvert systems is warranted. As mentioned above, it is unlikely however that the ponding would result in inundation of property. Hydraulic analysis results for the various discrete culvert crossings can be seen in Appendix G.

### 7.1.2.7 Model 3

The modelling suggests flooding at the intersection of Newhaven and Hythe Streets is an area of concern. This is due to not only the flat nature of the terrain in these areas, but also due to the large amount of overland flow entering the vicinity from the large parcel of currently vacant (ultimately developed) land located to the north west of the intersection. Some 6.7 $m^3/s$ enters the area in the 100 year ARI event, which is only currently serviced by a field inlet pit and a single 1200mm RCP. As such, significant overland flows occur in the area, which then travel across the Hythe Street / Newhaven Street intersection to the large open channel which drains to The Esplanade and associated culvert system. The subsurface drainage system running under this open channel is also undersized, resulting in significant surcharging into the open channel at the Newhaven Street end. This is deemed acceptable, as all flows are contained within the open channel system. All of these factors result in a raised water surface level in the area, and inundation of the previously mentioned intersection. As a result a detailed assessment of this area needs to be undertaken to reduce potential risks.

Modelling results suggest ponding of flows at the bottom of the open channel travelling from Worthing Street to Winchelsea Street is also of concern. Due to the extremely flat nature of the subsurface drainage system in Winchelsea Street, flows already within the piped system flowing from higher in the catchment appear to initially surcharge out the field inlet at the bottom of the open channel, until a sufficient hydraulic head is built up in the open channel through ponding at the Winchelsea Street end to reverse the flow direction. As the subsurface system is already at capacity, the additional flows provided by the open channel are unable to be adequately accommodated, and as such, significant ponding occurs until flows overtop into Winchelsea Street, even in the 10yr ARI event. As a result, Winchelsea Street warrants a detailed assessment.

The final area of concern relates to the trapped sag located on Shoreham Street between Beach Road and Newhaven Street. Again the limited hydraulic grade available to the local subsurface drainage system limits flow conveyance, and modelling suggests significant ponding occurs at this location with overtopping of the road carriageway, resulting in property inundation in all ARI events. These overland flows travel through properties until reaching Beach Road. As a result, Shoreham Street warrants further analysis. Upgrades to both the local drainage in Shoreham Street and the downstream trunk drainage of Newhaven Street will need to be considered.

Flows ponding at the end of the Corbet Court cul de sac result in overtopping of the road carriageway in the 20yr ARI event and above. Whilst flows are minor, this overtopping warrants further investigation at a later date to enable compliance with Council design guidelines. Velocity x depth products for all streets within model 3 are acceptable.

**Table 7.1: Flood Risk Analysis for Model 1.**

| Location | Risk Element | Acceptable standard | Currently meets desired risk standard | Likelihood | Consequence | Risk Ranking | Upgrade recommended |
|---|---|---|---|---|---|---|---|
| **Model 1 A** | | | | | | | |
| Spence St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| **Model 1B** | | | | | | | |
| Spence St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Gatakers La | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jacklin Cl | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Earls Ct | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Lyons St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| **Model 1C** | | | | | | | |
| Mant St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| The Esplanade | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Kurrajong Cr | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Possible | Minor | **Moderate** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| **Model 1D** | | | | | | | |
| Flinders St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| The Esplanade | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |

| Model 1E | | | | | | | |
|---|---|---|---|---|---|---|---|
| Flinders St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Corfield St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| The Esplanade | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |

**Table 7.2: Design Capacity Analysis - Model 2.**

| Map Reference ID | Asset ID | Required Design Capacity | Achieve Design Capacity? | Resultant Property Inundation? | Upgrade Required? (To meet Council design standards) |
|---|---|---|---|---|---|
| 1 | SWD11209 | Q50 | × | Park Only | Yes |
| 2 | SWD10067 | Q50 | × | Park Only | Yes |
| 3 | SWD10068 | Q50 | × | Park Only | Yes |
| 4 | SWD10066 | Q50 | × | Park Only | Yes |
| 5 | SWD10065 | Q50 | × | Park Only | Yes |
| 6 & 7 | SWD10063 & SWD10064 | Q50 | ✓ | No | No |
| 8 | SWD10061 | Q50 | × | Park Only | Yes |
| 9 | SWD10062 | Q50 | × | Park Only | Yes |
| 10 | SWD10060 | Q50 | × | Park Only | Yes |
| 11 & 12 | SWD10056 & SWD10058 | Q50 | ✓ | No | No |
| 13 | SWD10171 | Q50 | × | Park Only | Yes |
| 14 | SWD10170 | Q50 | × | Park Only | Yes |
| 15 | SWD10169 | Q50 | × | Park Only | Yes |
| 16 | SWD10073 | Q10 | × | Unlikely | Yes |
| 17 | SWD10072 | Q10 | ✓ | No | No |
| 18 | SWD10071 | Q10 | ✓ | No | No |
| 19 | SWD11208 | Q10 | ✓ | No | No |
| 20 | SWD11204 | Q10 | × | Park Only | Yes |
| 21 | SWD11203 | Q50 | × | Park Only | Yes |

**Table 7.3: Flood Risk Analysis for Model 3.**

| Location | Risk Element | Acceptable standard | Currently meets desired risk standard | Likelihood | Consequence | Risk Ranking | Upgrade recommended |
|---|---|---|---|---|---|---|---|
| **Model 3** | | | | | | | |
| Bayview Tce | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Corbet Ct | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Shoreham St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Moderate | **Moderate** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | × | Possible | Moderate | **High** | ✓ |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Winchelsea St | People - drowning | No resultant deaths, injuries or major health hazards | × | Possible | Moderate | **High** | ✓ |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Moderate | **Moderate** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Worthing St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Newhaven St | People - drowning | No resultant deaths, injuries or major health hazards | × | Possible | Moderate | **High** | ✓ |
| | People - ease of egress | DV Product <0.6 | × | Possible | Moderate | **High** | ✓ |
| | Buildings | Q100 immunity | ✓ | Unlikely | Moderate | **Moderate** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Hythe St | People - drowning | No resultant deaths, injuries or major health hazards | × | Possible | Moderate | **High** | ✓ |
| | People - ease of egress | DV Product <0.6 | × | Possible | Moderate | **High** | ✓ |
| | Buildings | Q100 immunity | ✓ | Unlikely | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Beach Rd | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Moderate | **Moderate** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Unlikely | Moderate | **Moderate** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Watson St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Possible | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| The Esplanade | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Possible | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |
| Long St | People - drowning | No resultant deaths, injuries or major health hazards | ✓ | Unlikely | Insignificant | **Low** | × |
| | People - ease of egress | DV Product <0.6 | ✓ | Unlikely | Insignificant | **Low** | × |
| | Buildings | Q100 immunity | ✓ | Possible | Insignificant | **Low** | × |
| | Economic loss | Loss of livelihood for less than 10% of working community | ✓ | Unlikely | Insignificant | **Low** | × |
| | Natural environment | N/A | ✓ | Unlikely | Insignificant | **Low** | × |

# 8 Risk Treatment & Flooding Mitigation

Treatment of flooding risks in each model as identified in Chapter 7 of this report has been investigated and is summarised below. Specifically, flooding areas that were identified as high risk were mitigated by means of drainage augmentation or other forms of mitigation works with the aim of an overall reduction of the flooding risk. Where flow depths were identified as failing to meet Council design guidelines, mitigation options have been suggested to alleviate flooding depths and ensure compliance to Council design requirements.

## 8.1 Model 1A

Risk rankings for all areas of model 1A were low, and Council design standards were met. Therefore, no drainage network mitigation works were investigated.

## 8.2 Model 1B

Risk analysis undertaken in Chapter 7 has shown that there are no areas of significant risk identified within Model 1B. There was however inundation problems identified at the end of Gatakers Lane, where the flow depths meant Council design requirements (refer table 5.09.1 of QUDM) were not met. It was found that a simple duplication of the drainage network from Gatakers Lane to the outlet headwall (450mm dia. RCP's) was found to be adequate in handling the required flows and reducing ponding depths. This simple duplication allows flows to be retained within the road carriageway at this location for all events, even up to the 100yr ARI event. Preliminary cost analysis undertaken for this upgrade estimate the total cost of this upgrade to be $45,000.

As discussed in Chapter 7, whilst ponding occurs in Spence Street, actual overtopping only occurs for events greater than the 10 year ARI event and is minimal. This results in a risk ranking of moderate. Upgrades to the drainage network may be investigated further at a later date.

## 8.3 Model 1C

Risk analysis undertaken for model 1C as discussed in Chapter 7 failed to find any high flooding risks, however ponding of overland flows and overtopping of Kurrajong Court resulted in failure of the system to meet Council design requirements.

Whilst upgrading/augmenting the existing system would appear to be the best option for Kurrajong Court, the extent of upgrades required to the downstream network would render this option economically unviable. Attaining a drainage easement through the vacant lot of 29 The Esplanade would provide a more cost effective and hydraulically effective solution. A simple addition of inlet(s) at this location, as well as a 450mm dia. RCP running through the property removes inundation / road reserve overtopping issues at this point as described in Section 6.4.3. This augmented system can then be joined back into the existing culvert crossing at The Esplanade, for discharge to the foreshore area.

The existing culvert crossing in front of number 29 The Esplanade needs augmenting to be able to accommodate the increase in flows entering the culvert from the upgraded Kurrajong Court system. This system already fails to meet Council design requirements, and the increase in flows in the system from the upgrades proposed in Kurrajong Crt would worsen the problem. A duplication of the existing 600mm dia. RCP is recommended. This augmentation provides the associated area of The Esplanade around the sag point with a design immunity equivalent to the 50 year ARI. Preliminary cost estimates for the augmented network to enable design storm immunity place the total cost in the vicinity of $105,000.

## 8.4 Model 1D & 1E

Flood risk within models 1D and 1E has been shown to be low, as discussed in chapter 7. However, inundation around the culvert crossings in front of numbers 74 and 117 The Esplanade results in Council design guidelines not being achieved.

Insufficient inlet capacities and flow conveyance capacities of the existing system at the sag points results in ponding of flows in these locations in the 50 year ARI event. As such, not only are upgrades required to improve flow conveyance of the existing systems, overland flow capture rates will need upgrading through the installation of more inlet pits. Duplication of the existing drainage networks provides sufficient capacity, with a slight lowering of some invert levels in model 1D to improve flow regimes.

As discussed in Chapter 7, actual property inundation resulting from the undersized culverts would, for all intensive purposes, be non existent as overtopping of the road crown would occur after a certain degree of ponding, with flows then allowed to travel down the steep embankment to the foreshore of the bay. Preliminary cost analysis undertaken for the upgrades to the drainage networks in models 1D & 1E estimate the total cost of the upgrades to be $48,000 & $38,000 respectively.

## 8.5 Discrete Culvert Crossings – Esplanade

As limited information regarding the discrete culvert crossings of the esplanade was available due to the style of investigation undertaken, it could be concluded from investigations carried out on similar culvert systems within models 1D & 1E that ponding in some of these locations would occur. As discussed in Sections 8.3 & 8.4 above, whilst ponding may occur, inundation of property is unlikely to result due to the ease in which flows can break out of the road reserve and escape down the steep foreshore. Again, these upgrades are aimed at reducing nuisance flooding, road maintenance costs and to enable an adequate design storm immunity of The Esplanade.

The latter of these is a critical element for enabling the many discrete culvert system's to meet Council design requirements. Total costs associated with the upgrading of undersized culverts for The Esplanade is estimated as $411,000 and includes a total of some 12 individual culvert crossings. This cost includes all pipe upgrades and estimates of inlet pit and manhole upgrades.

## 8.6 Model 3

The drainage network represented in Model 3 represents the highest degree of flood risk in the Pialba / Pt Vernon Coastal Strip catchment.

Firstly, the sag point in Shoreham Street represents a high flood risk for houses located downstream. The existing system has inadequate capacity to handle the design flows, and significant overland flows travel through residential properties until reaching Beach Road during all the ARI events modelled. Risk reduction strategies have been implemented by way of drainage upgrades from the sag point to the open channel at the intersection of Hythe and Newhaven Streets. These upgrades have been estimated to cost in the order of $356,000.

The grated inlet and downstream drainage network which services the open channel running from Worthing to Winchelsea Streets is the second area of flooding risk in Model 3. Significant ponding occurs at this location due to the inadequate capacity of the drainage network to handle the flows at this location. Whilst the accuracy of the DTM limits the degree of certainty on actual inundation extents, it is shown in the model that flows pond to a point where overtopping into Winchelsea Street occurs. This in turn causes inundation of properties from Winchelsea Street to Hythe Streets in the 20yr ARI events and above. The ponding of flows at Winchelsea Street has a high flood risk in terms of inundation of properties, and the elimination of ponding and overtopping of flows at this location and the resultant upgrading of the downstream drainage network, directly impacts on the

elimination of inundation of properties between Winchelsea and Hythe Streets. An estimated total cost for this section of the upgrade is $349,000.

The final region of flood risk within Model 3 relates to the intersection of Hythe and Newhaven Streets. The inundation in this area, whilst not directly resulting in any flood risk to property, provides risk to the local community, with a flood depth of some 395 mm and 950 mm at the intersection during the 10 and 100 year ARI events respectively. As previously discussed, much of this flooding is a result of overland flows entering the intersection from lot 10-30 Halcro Street. Incorporation of the detention basin acts to help reduce the flows entering the intersection, and thus inundation and flood risk. It is envisaged that the cost of this detention basin would be largely funded by development of the 10-30 Halcro Street site and has therefore been excluded from the costs as part of these works.

## 8.7 Risk Treatment Summary

Whilst the Pialba / Pt Vernon Coastal Strip catchment has definitive areas of flood risk, a vast majority of the flooding / inundation experienced throughout the catchment is largely nuisance flooding in various locations. As such, many of the augmentation upgrades are aimed at eliminating this localised flooding for the purposes of achieving Council design guideline requirements, and in some cases, minimising flood risk. For the discrete culvert crossings of The Esplanade, this road represents a significant egress route for all northern suburb areas and as such catering for an adequate road immunity along The Esplanade is of critical importance for flood risk and egress. The flat nature of the region and generally low flow depths mean depth x velocity products for all streets investigated were below the 0.6 $m^2/s$ threshold as recommended in section 5.09.1 of the Queensland Urban Drainage Manual (QUDM).

**Table 8.1: Flood Risk Treatment Summary (Does not include upgrades suggested in order to meet HBCC design requirements)**

| Location | Risk | Acceptable standard | Current Risk Ranking | Mitigation works proposed | Mitigated Risk Ranking | Estimated cost |
|---|---|---|---|---|---|---|
| **Model 3** | | | | | | |
| Shoreham St | Buildings | Q100 immunity | **High** | Drainage augmentation works around the sag point in Shoreham St and downstream drainage network. | **Low** | $356,000 |
| Winchelsea St | People - drowning | No resultant deaths, injuries or major health hazards | **High** | Upgrade to field inlet pit and downstream drainage network. | **Low** | $349,000 |
| Newhaven St | People - drowning | No resultant deaths, injuries or major health hazards | **High** | Condition the installation of regional detention basin on development of 10-30 Halcro St. | **Low** | Not costed – funded by developer of 10-30 Halcro St |
| | People - ease of egress | DV Product <0.6 | **High** | | **Low** | |
| Hythe St | People - drowning | No resultant deaths, injuries or major health hazards | **High** | | **Low** | |
| | People - ease of egress | DV Product <0.6 | **High** | | **Low** | |

# 9 Conclusions

This study has been successful in identifying and quantifying flooding risk and providing drainage augmentation options for the Pialba / Pt Vernon Coastal Strip Catchment study area for the primary purposes of reducing existing flood risks in the area. Specifically, the works completed have included: -

- The identification and assessment of existing drainage capacities, flow paths and flood information for the 10, 20, 50 and 100 year ARI design flood events;
- Preparation of detailed flood data outputs to fully document the outcomes from the analysis works including flood summary data, catchment flows and flood extent plans;
- A sensitivity analysis on the starting tail water level from the catchment including the analysis of a HAT ± 0.3m as requested in the project brief.
- Assessment of flood risk and the preparation of flood risk summaries;
- Identification of potential mitigation options for the catchment;
- Formal hydrological and hydraulic assessment of the agreed drainage augmentation options for the catchment including the preparation of detailed outputs to fully document the outcomes from the mitigation works;
- Identification of a preferred augmentation options for the catchment which has be shown to provide a beneficial outcome for the study in terms of lowering flood levels, reducing flood inundation and consequently flood risk;
- Preparation of preliminary establishment cost estimates for the preferred work options;
- Preparation of summary tables, models, flood extents, GIS mapping and reporting outputs to formally document the outcomes of the study.
- Preparation of a report congruous with Hervey Bay City Council Disaster Mitigation Plan

JWP recommends that Council utilises the outcomes from this Flood Risk Assessment Study for the Pialba / Pt Vernon Coastal Strip catchment in the management of existing and future stakeholders within the catchment in terms of reducing flood risk to an acceptable and manageable standard. In addition, it is also recommended that further works be instigated to proceed with the detailed design of the preferred mitigation works such that flood risks throughout the catchments can be significantly reduced. This would also include programming these works and securing future allocations under Council's Capital Works Program or alternatively through other funding arrangements.

# 10 References


1. The Queensland Urban Drainage Manual (QUDM);
2. Australian Rainfall and Runoff (AR&R - 2001 edition);
3. Lawson & Treloar Pty Ltd, "*The Hervey Bay Storm Tide Study - Final Report*", 2002.

# 11 Qualification

1. In preparing the report and estimate of costs JWP has exercised the degree of skill and care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering design principles.

2. JWP has used all reasonable endeavours to inform itself of the parameters and requirements of the project and has taken all reasonable steps to ensure that the report and costs estimate is as accurate and comprehensive as possible given the information upon which it is based.

3. It is not intended that this report and costs estimate represent a final assessment of the feasibility of the project.

4. JWP reserves the right to review and amend all calculations, cost estimates and/or opinions included or referred to in the report if:

   (a) additional sources of information not presently available (for whatever reason) are provided or become known to JWP; or

   (b) JWP considers it prudent to revise the estimate in light of any information which becomes known to it after the date of submission.

5. JWP does not give any warranty nor accept any liability in relation to the completeness or accuracy of the report and cost estimate.

6. If any warranty would be implied whether by law, custom or otherwise, that warranty is to the full extent permitted by law excluded.

7. All limitations of liability shall apply for the benefit of the employees, agents and representatives of JWP to the same extent that they apply for the benefit of JWP.

8. This report and cost estimate is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this report and cost estimate.

9. If any claim or demand is made by any person against JWP on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the report and cost estimate or information therein, JWP will rely upon this provision as a defence to any such claim or demand.

# APPENDIX A

## Catchment Plan

HERVEY BAY CITY COUNCIL

N
W E
S

**Layout**

Catchment Boundary

Sub Catchment Boundary

160 0 160 320 480

Metres

**Scale: 1:16,000**

# PIALBA / PT VERNON

## APPENDIX A

## COUNCIL SUPPLIED CATCHMENT & SUB CATCHMENT BOUNDARIES

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

# APPENDIX B

## Rainfall IFD Table

| LOCATION - HERVEY BAY, QLD | | | | | | | |
|---|---|---|---|---|---|---|---|
| Duration (mins) | 1 Year ARI (mm/hour) | 2 Year ARI (mm/hour) | 5 Year ARI (mm/hour) | 10 Year ARI (mm/hour) | 20 Year ARI (mm/hour) | 50 Year ARI (mm/hour) | 100 Year ARI (mm/hour) |
| Minutes | 1 | 2 | 5 | 10 | 20 | 50 | 100 |
| 5 | 115 | 148 | 186 | 209 | 239 | 280 | 311 |
| 5.5 | 112 | 143 | 180 | 202 | 232 | 270 | 300 |
| 6 | 108 | 139 | 175 | 196 | 224 | 262 | 291 |
| 6.5 | 105 | 135 | 170 | 190 | 218 | 254 | 282 |
| 7 | 102 | 131 | 165 | 185 | 212 | 247 | 275 |
| 7.5 | 100 | 128 | 161 | 180 | 206 | 241 | 267 |
| 8 | 97 | 125 | 157 | 176 | 201 | 235 | 261 |
| 8.5 | 95 | 122 | 153 | 171 | 196 | 229 | 254 |
| 9 | 93 | 119 | 150 | 168 | 192 | 224 | 248 |
| 9.5 | 91 | 116 | 146 | 164 | 188 | 219 | 243 |
| 10 | 89 | 114 | 143 | 160 | 184 | 214 | 238 |
| 11 | 85 | 109 | 138 | 154 | 176 | 206 | 228 |
| 12 | 82 | 105 | 132 | 148 | 170 | 198 | 220 |
| 13 | 80 | 102 | 128 | 143 | 164 | 191 | 212 |
| 14 | 77 | 98 | 124 | 138 | 158 | 185 | 205 |
| 15 | 75 | 95 | 120 | 134 | 153 | 179 | 198 |
| 16 | 72 | 93 | 116 | 130 | 149 | 174 | 193 |
| 17 | 70 | 90 | 113 | 126 | 145 | 169 | 187 |
| 18 | 69 | 88 | 110 | 123 | 141 | 164 | 182 |
| 19 | 67 | 85 | 107 | 120 | 137 | 160 | 177 |
| 20 | 65 | 83 | 105 | 117 | 134 | 156 | 173 |
| 21 | 64 | 81 | 102 | 114 | 131 | 152 | 169 |
| 22 | 62 | 80 | 100 | 112 | 128 | 149 | 165 |
| 23 | 61 | 78 | 98 | 109 | 125 | 145 | 161 |
| 24 | 60 | 76 | 95 | 107 | 122 | 142 | 158 |
| 25 | 58 | 75 | 94 | 105 | 120 | 139 | 154 |
| 26 | 57 | 73 | 92 | 102 | 117 | 136 | 151 |
| 27 | 56 | 72 | 90 | 100 | 115 | 134 | 148 |
| 28 | 55 | 70 | 88 | 99 | 113 | 131 | 145 |
| 29 | 54 | 69 | 87 | 97 | 111 | 129 | 143 |
| 30 | 53 | 68 | 85 | 95 | 109 | 127 | 140 |
| 32 | 51 | 66 | 82 | 92 | 105 | 122 | 135 |
| 34 | 49.8 | 64 | 80 | 89 | 102 | 118 | 131 |
| 36 | 48.3 | 62 | 77 | 86 | 99 | 115 | 127 |
| 38 | 46.9 | 60 | 75 | 84 | 96 | 111 | 123 |
| 40 | 45.6 | 58 | 73 | 81 | 93 | 108 | 120 |
| 45 | 42.8 | 55 | 68 | 76 | 87 | 101 | 112 |
| 50 | 40.4 | 52 | 64 | 72 | 82 | 96 | 106 |
| 55 | 38.3 | 48.9 | 61 | 68 | 78 | 90 | 100 |
| 60 | 36.5 | 46.5 | 58 | 65 | 74 | 86 | 95 |
| 75 | 31.7 | 40.5 | 51 | 57 | 65 | 75 | 83 |
| 90 | 28.2 | 36 | 45.2 | 51 | 58 | 67 | 75 |
| 105 | 25.5 | 32.6 | 41 | 45.9 | 53 | 61 | 68 |
| 120 | 23.4 | 29.9 | 37.7 | 42.2 | 48.3 | 56 | 63 |
| 135 | 21.6 | 27.7 | 34.9 | 39.1 | 44.9 | 52 | 58 |
| 150 | 20.2 | 25.9 | 32.7 | 36.6 | 42 | 49 | 54 |
| 165 | 19 | 24.3 | 30.7 | 34.5 | 39.5 | 46.2 | 51 |
| 180 | 17.9 | 23 | 29 | 32.6 | 37.4 | 43.8 | 48.6 |
| 195 | 17 | 21.8 | 27.6 | 31 | 35.6 | 41.6 | 46.3 |
| 210 | 16.2 | 20.8 | 26.3 | 29.5 | 33.9 | 39.7 | 44.2 |
| 225 | 15.5 | 19.9 | 25.2 | 28.3 | 32.5 | 38 | 42.3 |
| 240 | 14.8 | 19 | 24.1 | 27.1 | 31.2 | 36.5 | 40.6 |
| 270 | 13.7 | 17.6 | 22.4 | 25.2 | 28.9 | 33.9 | 37.8 |
| 300 | 12.8 | 16.4 | 20.9 | 23.5 | 27.1 | 31.7 | 35.4 |
| 360 | 11.4 | 14.6 | 18.6 | 21 | 24.1 | 28.3 | 31.6 |
| 420 | 10.3 | 13.2 | 16.8 | 19 | 21.9 | 25.7 | 28.7 |
| 480 | 9.4 | 12.1 | 15.5 | 17.4 | 20.1 | 23.7 | 26.4 |
| 540 | 8.7 | 11.2 | 14.3 | 16.2 | 18.7 | 22 | 24.5 |
| 600 | 8.12 | 10.5 | 13.4 | 15.1 | 17.5 | 20.6 | 23 |
| 660 | 7.63 | 9.83 | 12.6 | 14.3 | 16.5 | 19.4 | 21.7 |
| 720 | 7.21 | 9.29 | 11.9 | 13.5 | 15.6 | 18.4 | 20.5 |
| 840 | 6.52 | 8.43 | 10.9 | 12.4 | 14.4 | 17 | 19.1 |
| 960 | 5.97 | 7.75 | 10.1 | 11.5 | 13.4 | 15.9 | 17.9 |
| 1080 | 5.53 | 7.19 | 9.44 | 10.8 | 12.6 | 15 | 16.9 |
| 1200 | 5.15 | 6.72 | 8.88 | 10.2 | 11.9 | 14.3 | 16.1 |
| 1320 | 4.84 | 6.32 | 8.4 | 9.68 | 11.4 | 13.6 | 15.4 |
| 1440 | 4.57 | 5.98 | 7.98 | 9.22 | 10.8 | 13 | 14.8 |
| 1800 | 3.93 | 5.17 | 6.99 | 8.13 | 9.62 | 11.6 | 13.2 |
| 2160 | 3.46 | 4.57 | 6.25 | 7.32 | 8.7 | 10.6 | 12.1 |
| 2520 | 3.11 | 4.12 | 5.68 | 6.69 | 7.98 | 9.76 | 11.2 |
| 2880 | 2.82 | 3.75 | 5.22 | 6.17 | 7.39 | 9.08 | 10.4 |
| 3240 | 2.58 | 3.45 | 4.83 | 5.74 | 6.89 | 8.5 | 9.79 |
| 3600 | 2.39 | 3.19 | 4.5 | 5.37 | 6.47 | 8.01 | 9.24 |
| 3960 | 2.22 | 2.97 | 4.22 | 5.04 | 6.1 | 7.57 | 8.76 |
| 4320 | 2.07 | 2.78 | 3.97 | 4.76 | 5.77 | 7.19 | 8.34 |

# APPENDIX C

## Catchment Land Use Summary

## Model 1

Client: HBCC
Job: Pt Vernon
User: PC
Printed On: 22/05/2006

| Sub Catchment ID | OPEN SPACE | RESIDENTIAL LOW DENSITY | SPECIAL PURPOSES | ROAD RESERVE |
|---|---|---|---|---|
| 1 | 0.110 | 0.511 | | 0.380 |
| 2 | | 0.902 | | 0.098 |
| 3 | | 0.704 | | 0.296 |
| 4 | | 0.889 | | 0.111 |
| 5 | | 0.708 | | 0.292 |
| 6 | | 0.528 | | 0.472 |
| 11 | | 0.877 | | 0.123 |
| 12 | | 0.796 | | 0.204 |
| 13 | 0.001 | 0.399 | | 0.600 |
| 14 | | 0.721 | | 0.279 |
| 15 | 0.002 | 0.001 | | 0.998 |
| 16 | | 0.720 | | 0.280 |
| 17 | | 0.937 | | 0.063 |
| 18 | 0.782 | 0.004 | | 0.214 |
| 20 | | 0.014 | | 0.986 |
| 21 | 0.189 | 0.525 | | 0.286 |
| 22 | | 0.411 | | 0.589 |
| 23 | 0.000 | 0.831 | | 0.169 |
| 24 | | 0.678 | | 0.322 |
| 25 | | 0.699 | | 0.301 |
| 26 | | 0.673 | 0.000 | 0.327 |
| 27 | | 0.753 | 0.046 | 0.200 |
| 28 | 0.231 | 0.761 | | 0.008 |
| 29 | 0.073 | 0.927 | | 0.000 |
| 30 | | 0.221 | | 0.779 |
| 31 | 0.056 | 0.793 | | 0.151 |
| 32 | | 0.533 | | 0.467 |
| 33 | | 0.895 | | 0.105 |
| 34 | 0.018 | 0.698 | | 0.283 |
| 36 | | 0.917 | | 0.083 |
| 37 | | 0.005 | | 0.995 |
| 38 | | 0.024 | | 0.976 |
| 39 | | 0.852 | | 0.148 |
| 40 | | 0.924 | | 0.076 |
| 41 | | 0.667 | | 0.333 |
| 42 | | 0.000 | | 1.000 |
| 43 | 0.813 | 0.000 | | 0.187 |
| 44 | 0.000 | | | 1.000 |
| 46 | | 0.936 | | 0.064 |
| 47 | | 0.731 | | 0.269 |

## Model 2

Client: HBCC
Job: Pt Vernon
User: PC
Printed On: 22/05/2006

| Sub Catchment ID | LOCAL SHOPPING | RESIDENTIAL LOW DENSITY | RESIDENTIAL MEDIUM DENSITY | ROAD RESERVE |
|---|---|---|---|---|
| 1 | | 0.732 | | 0.268 |
| 2 | 0.017 | 0.786 | | 0.197 |
| 3 | | 0.791 | | 0.209 |
| 4 | | 0.757 | | 0.243 |
| 5 | | 0.849 | | 0.151 |
| 6 | | 0.883 | | 0.117 |
| 7 | | 0.799 | | 0.201 |
| 8 | | 0.552 | 0.001 | 0.447 |
| 9 | | 0.331 | 0.409 | 0.260 |
| 10 | | 0.736 | 0.064 | 0.200 |
| 11 | | | | 1.000 |
| 12 | | 0.121 | | 0.879 |
| 13 | | 0.223 | | 0.777 |
| 14 | | 0.776 | | 0.224 |

## Model 3

Client: HBCC
Job: Pt Vernon
User: PC
Printed On: 22/05/2006

| Sub Catchment ID | OPEN SPACE | RESIDENTIAL LOW DENSITY | RESIDENTIAL MEDIUM DENSITY | SPECIAL PURPOSES | ROAD RESERVE |
|---|---|---|---|---|---|
| AD_Node11 | | | 0.960 | 0.960 | 0.041 |
| AD_Node2 | 0.264 | 0.157 | 0.237 | 0.657 | 0.343 |
| AD_Node8 | 0.027 | | | 0.027 | 0.973 |
| 2 | | 0.404 | | | 0.596 |
| 3 | | 0.691 | | | 0.309 |
| 4 | | 0.677 | | | 0.323 |
| 5 | | 0.519 | | | 0.481 |
| 6 | | 0.760 | | | 0.240 |
| 7 | | 0.537 | | 0.000 | 0.463 |
| 8 | | 0.906 | | | 0.094 |
| 9 | | 0.679 | | | 0.321 |
| 10 | | 0.849 | | | 0.151 |
| 11 | | 0.000 | | | 1.000 |
| 12 | | 0.789 | | | 0.211 |
| 13 | | 0.008 | | | 0.992 |
| 14 | | 0.504 | | | 0.496 |
| 16 | | 0.787 | | | 0.213 |
| 17 | | 0.000 | | | 1.000 |
| 18 | | 0.571 | 0.060 | | 0.369 |
| 19 | | 0.005 | | 0.441 | 0.554 |
| 20 | | 0.504 | 0.357 | | 0.139 |
| 21 | | 0.396 | 0.404 | | 0.200 |
| 22 | | 0.603 | | 0.215 | 0.182 |
| 23 | | 0.651 | 0.130 | | 0.219 |
| 24 | | 0.651 | 0.205 | | 0.143 |
| 29 | | 0.000 | | | 1.000 |
| 30 | | 0.525 | | | 0.475 |

# APPENDIX D

## Existing Scenario Model Results

## Model 1A Existing

Client: HBCC
User: PC
Date: 22/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O190 | 7.41 | 7.55 | 0.14 | 7.54 | 0.13 | 7.52 | 0.11 | 7.41 | 0.00 |
| O88 | 9.98 | 10.10 | 0.13 | 10.10 | 0.12 | 10.09 | 0.11 | 9.98 | 0.00 |
| O90 | 3.88 | 4.04 | 0.16 | 4.03 | 0.14 | 4.01 | 0.13 | 3.99 | 0.11 |

## Model 1B Existing

Client: HBCC
User: PC
Date: 22/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O148 | 14.99 | 15.03 | 0.04 | 15.03 | 0.04 | 15.03 | 0.04 | 15.03 | 0.04 |
| O149 | 13.68 | 13.72 | 0.04 | 13.71 | 0.04 | 13.71 | 0.04 | 13.71 | 0.04 |
| O150 | 12.74 | 12.97 | 0.23 | 12.95 | 0.22 | 12.95 | 0.21 | 12.93 | 0.19 |
| O37 | 12.60 | 12.75 | 0.15 | 12.74 | 0.14 | 12.74 | 0.13 | 12.73 | 0.12 |
| O143 | 10.43 | 10.59 | 0.16 | 10.58 | 0.15 | 10.58 | 0.15 | 10.57 | 0.14 |
| O174 | 9.59 | 9.76 | 0.17 | 9.75 | 0.16 | 9.75 | 0.16 | 9.74 | 0.15 |
| O134 | 6.51 | 6.78 | 0.27 | 6.76 | 0.25 | 6.75 | 0.24 | 6.73 | 0.22 |
| O20 | 4.48 | 4.80 | 0.32 | 4.77 | 0.29 | 4.76 | 0.28 | 4.74 | 0.26 |
| O21 | 2.50 | 3.22 | 0.71 | 3.18 | 0.67 | 3.14 | 0.64 | 3.09 | 0.58 |
| O189 | 2.49 | 3.15 | 0.66 | 3.11 | 0.62 | 3.08 | 0.58 | 3.02 | 0.53 |
| O65 | 11.00 | 11.12 | 0.12 | 11.10 | 0.10 | 11.08 | 0.08 | 11.07 | 0.07 |
| O11 | 11.02 | 11.12 | 0.09 | 11.09 | 0.06 | 11.08 | 0.05 | 11.06 | 0.04 |
| O60 | 9.76 | 10.55 | 0.79 | 10.46 | 0.70 | 10.39 | 0.63 | 10.32 | 0.56 |
| O140 | 9.76 | 10.55 | 0.79 | 10.46 | 0.70 | 10.39 | 0.63 | 10.32 | 0.56 |
| O144 | 9.67 | 9.94 | 0.27 | 9.94 | 0.27 | 9.93 | 0.26 | 9.92 | 0.24 |
| O146 | 9.46 | 9.59 | 0.12 | 9.58 | 0.12 | 9.58 | 0.12 | 9.57 | 0.11 |
| O16 | 8.49 | 8.57 | 0.08 | 8.57 | 0.08 | 8.56 | 0.08 | 8.56 | 0.07 |
| O7 | 10.86 | 10.88 | 0.02 | 10.88 | 0.02 | 10.87 | 0.01 | 10.87 | 0.00 |
| O6 | 11.00 | 11.50 | 0.50 | 11.43 | 0.43 | 11.38 | 0.38 | 11.32 | 0.32 |
| O5 | 11.98 | 12.03 | 0.05 | 12.03 | 0.04 | 12.03 | 0.04 | 12.03 | 0.04 |
| O57 | 13.48 | 13.52 | 0.04 | 13.51 | 0.03 | 13.51 | 0.03 | 13.51 | 0.03 |
| O56 | 14.05 | 14.10 | 0.05 | 14.10 | 0.05 | 14.10 | 0.05 | 14.10 | 0.04 |

## Model 1C Existing

Client: HBCC
User: PC
Date: 22/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O40 | 20.15 | 20.46 | 0.31 | 20.45 | 0.30 | 20.45 | 0.30 | 20.43 | 0.28 |
| O42 | 19.99 | 20.09 | 0.10 | 20.08 | 0.09 | 20.07 | 0.08 | 20.06 | 0.07 |
| O43 | 17.93 | 18.06 | 0.13 | 18.05 | 0.12 | 18.04 | 0.11 | 18.01 | 0.08 |
| O44 | 16.98 | 17.10 | 0.11 | 17.09 | 0.11 | 17.08 | 0.10 | 17.06 | 0.08 |
| O46 | 15.67 | 15.73 | 0.06 | 15.72 | 0.05 | 15.72 | 0.05 | 15.71 | 0.04 |
| O171 | 15.59 | 15.69 | 0.10 | 15.67 | 0.08 | 15.65 | 0.06 | 15.62 | 0.03 |
| N195 | 10.60 | 10.71 | 0.11 | 10.70 | 0.10 | 10.69 | 0.09 | 10.68 | 0.08 |
| N192 | 4.80 | 4.86 | 0.06 | 4.85 | 0.05 | 4.84 | 0.04 | 4.84 | 0.04 |
| O176 | 18.82 | 19.02 | 0.20 | 19.01 | 0.19 | 19.00 | 0.18 | 18.97 | 0.15 |
| O55 | 17.24 | 17.47 | 0.23 | 17.38 | 0.14 | 17.34 | 0.10 | 17.33 | 0.09 |
| O51 | 12.93 | 13.03 | 0.10 | 13.03 | 0.10 | 13.02 | 0.09 | 13.02 | 0.09 |
| N190 | 5.25 | 5.36 | 0.11 | 5.35 | 0.10 | 5.35 | 0.10 | 5.34 | 0.09 |

## Model 1D Existing

Client: HBCC
User: PC
Date: 22/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O125 | 13.31 | 13.50 | 0.19 | 13.49 | 0.17 | 13.47 | 0.16 | 13.44 | 0.13 |
| O159 | 11.88 | 12.04 | 0.16 | 12.02 | 0.14 | 12.01 | 0.13 | 11.98 | 0.10 |
| O109 | 10.90 | 11.10 | 0.20 | 11.08 | 0.18 | 11.06 | 0.16 | 11.00 | 0.10 |
| O162 | 10.48 | 10.69 | 0.21 | 10.65 | 0.17 | 10.61 | 0.13 | 10.55 | 0.07 |
| O119 | 9.61 | 9.79 | 0.18 | 9.76 | 0.15 | 9.72 | 0.11 | 9.65 | 0.04 |
| O113 | 7.73 | 8.06 | 0.33 | 8.03 | 0.30 | 8.00 | 0.27 | 7.96 | 0.23 |
| N200 | 1.44 | 2.12 | 0.68 | 2.12 | 0.68 | 2.12 | 0.68 | 2.12 | 0.68 |
| N201 | 1.50 | 2.12 | 0.62 | 2.12 | 0.62 | 2.12 | 0.62 | 2.12 | 0.62 |

## Model 1E Existing

Client: HBCC
User: PC
Date: 22/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O168 | 13.50 | 13.63 | 0.13 | 13.63 | 0.13 | 13.62 | 0.12 | 13.61 | 0.11 |
| O164 | 12.93 | 13.06 | 0.13 | 13.05 | 0.12 | 13.05 | 0.12 | 13.00 | 0.07 |
| O180 | 12.50 | 12.67 | 0.17 | 12.65 | 0.15 | 12.64 | 0.14 | 12.59 | 0.09 |
| O167 | 7.10 | 7.21 | 0.11 | 7.21 | 0.11 | 7.20 | 0.10 | 7.20 | 0.10 |
| N191 | 3.40 | 3.51 | 0.11 | 3.50 | 0.10 | 3.50 | 0.10 | 3.50 | 0.10 |
| O191 | 11.85 | 11.97 | 0.12 | 11.96 | 0.11 | 11.94 | 0.09 | 11.90 | 0.05 |
| O181 | 10.46 | 10.79 | 0.33 | 10.76 | 0.30 | 10.73 | 0.27 | 10.70 | 0.24 |
| O182 | 10.34 | 10.70 | 0.36 | 10.67 | 0.33 | 10.65 | 0.31 | 10.60 | 0.26 |
| O183 | 10.31 | 10.71 | 0.40 | 10.68 | 0.37 | 10.65 | 0.34 | 10.61 | 0.30 |
| O185 | 7.01 | 7.41 | 0.40 | 7.39 | 0.38 | 7.37 | 0.36 | 7.33 | 0.32 |

## Model 3 Existing

Client: HBCC
User: PC
Date: 7/06/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| AD_Node11 | 6.50 | 6.70 | 0.20 | 6.66 | 0.16 | 6.65 | 0.15 | 6.63 | 0.13 |
| AD_Node2 | 4.54 | 5.24 | 0.70 | 5.15 | 0.61 | 5.10 | 0.56 | 5.06 | 0.52 |
| AD_Node7 | 5.46 | 6.09 | 0.63 | 5.98 | 0.52 | 5.93 | 0.47 | 5.88 | 0.42 |
| O1 | 15.70 | 15.80 | 0.10 | 15.78 | 0.08 | 15.77 | 0.07 | 15.76 | 0.06 |
| O10 | 10.10 | 10.24 | 0.14 | 10.21 | 0.11 | 10.20 | 0.10 | 10.18 | 0.08 |
| O100 | 4.50 | 4.88 | 0.38 | 4.71 | 0.21 | 4.61 | 0.11 | 4.58 | 0.08 |
| O102 | 7.59 | 7.59 | 0.00 | 7.59 | 0.00 | 7.59 | 0.00 | 7.59 | 0.00 |
| O104 | 8.26 | 8.46 | 0.20 | 8.42 | 0.16 | 8.40 | 0.14 | 8.38 | 0.12 |
| O106 | 7.07 | 7.20 | 0.13 | 7.18 | 0.11 | 7.17 | 0.10 | 7.16 | 0.09 |
| O109 | 11.10 | 11.37 | 0.27 | 11.31 | 0.21 | 11.29 | 0.19 | 11.28 | 0.18 |
| O110 | 10.10 | 10.51 | 0.41 | 10.36 | 0.26 | 10.33 | 0.23 | 10.31 | 0.21 |
| O111 | 14.14 | 14.24 | 0.10 | 14.21 | 0.07 | 14.18 | 0.04 | 14.14 | 0.00 |
| O112 | 12.50 | 12.59 | 0.09 | 12.56 | 0.06 | 12.53 | 0.03 | 12.50 | 0.00 |
| O113 | 11.54 | 11.63 | 0.09 | 11.62 | 0.08 | 11.61 | 0.07 | 11.60 | 0.06 |
| O114 | 8.71 | 8.82 | 0.11 | 8.79 | 0.08 | 8.78 | 0.07 | 8.77 | 0.06 |
| O116 | 5.75 | 6.04 | 0.29 | 5.97 | 0.22 | 5.94 | 0.19 | 5.90 | 0.15 |
| O12 | 12.24 | 12.38 | 0.14 | 12.35 | 0.11 | 12.32 | 0.08 | 12.29 | 0.05 |
| O121 | 3.47 | 4.17 | 0.70 | 3.93 | 0.46 | 3.83 | 0.36 | 3.73 | 0.26 |
| O122 | 4.86 | 5.02 | 0.16 | 5.00 | 0.14 | 4.98 | 0.12 | 4.97 | 0.11 |
| O123 | 4.23 | 4.61 | 0.38 | 4.42 | 0.19 | 4.40 | 0.17 | 4.38 | 0.15 |
| O126 | 5.25 | 5.39 | 0.14 | 5.35 | 0.10 | 5.30 | 0.05 | 5.26 | 0.00 |
| O128 | 4.50 | 5.10 | 0.60 | 4.87 | 0.37 | 4.67 | 0.17 | 4.54 | 0.04 |
| O129 | 6.00 | 6.17 | 0.17 | 6.14 | 0.14 | 6.14 | 0.14 | 6.12 | 0.12 |
| O13 | 11.22 | 11.35 | 0.13 | 11.32 | 0.10 | 11.30 | 0.08 | 11.28 | 0.06 |
| O15 | 5.57 | 5.93 | 0.36 | 5.86 | 0.29 | 5.81 | 0.24 | 5.78 | 0.21 |
| O17 | 7.00 | 7.18 | 0.18 | 7.14 | 0.14 | 7.12 | 0.12 | 7.08 | 0.08 |
| O2 | 14.28 | 14.48 | 0.20 | 14.43 | 0.15 | 14.41 | 0.13 | 14.38 | 0.10 |
| O20 | 5.19 | 5.48 | 0.29 | 5.44 | 0.25 | 5.42 | 0.23 | 5.39 | 0.20 |
| O21 | 9.10 | 9.23 | 0.13 | 9.21 | 0.11 | 9.20 | 0.10 | 9.19 | 0.09 |
| O4 | 6.00 | 6.29 | 0.29 | 6.26 | 0.26 | 6.22 | 0.22 | 6.19 | 0.19 |
| O23 | 12.10 | 12.37 | 0.27 | 12.32 | 0.22 | 12.30 | 0.20 | 12.28 | 0.18 |
| O3 | 12.35 | 12.51 | 0.16 | 12.48 | 0.13 | 12.47 | 0.12 | 12.45 | 0.10 |
| O32 | 15.53 | 15.59 | 0.06 | 15.57 | 0.04 | 15.56 | 0.03 | 15.56 | 0.03 |
| O36 | 10.50 | 10.50 | 0.00 | 10.50 | 0.00 | 10.50 | 0.00 | 10.50 | 0.00 |
| O37 | 5.60 | 6.31 | 0.71 | 6.28 | 0.68 | 6.27 | 0.67 | 6.26 | 0.66 |
| O49 | 11.39 | 11.54 | 0.15 | 11.51 | 0.12 | 11.49 | 0.10 | 11.46 | 0.07 |
| O52 | 13.72 | 13.83 | 0.11 | 13.81 | 0.09 | 13.80 | 0.08 | 13.79 | 0.07 |
| O58 | 4.50 | 4.63 | 0.13 | 4.58 | 0.08 | 4.55 | 0.05 | 4.50 | 0.00 |
| O59 | 7.91 | 8.10 | 0.19 | 8.07 | 0.16 | 8.06 | 0.15 | 8.04 | 0.13 |
| O60 | 9.49 | 9.63 | 0.14 | 9.59 | 0.10 | 9.57 | 0.08 | 9.54 | 0.05 |
| O61 | 7.08 | 7.53 | 0.45 | 7.48 | 0.40 | 7.45 | 0.37 | 7.42 | 0.34 |
| O62 | 7.40 | 7.60 | 0.20 | 7.52 | 0.12 | 7.48 | 0.08 | 7.44 | 0.04 |
| O67 | 5.81 | 6.09 | 0.28 | 6.08 | 0.27 | 6.08 | 0.27 | 6.00 | 0.19 |
| O68 | 3.20 | 4.07 | 0.87 | 3.45 | 0.25 | 3.32 | 0.12 | 3.24 | 0.04 |
| O69 | 8.00 | 8.10 | 0.10 | 8.07 | 0.07 | 8.06 | 0.06 | 8.03 | 0.03 |
| O7 | 3.69 | 4.22 | 0.53 | 4.04 | 0.35 | 3.94 | 0.25 | 3.84 | 0.15 |
| O81 | 4.10 | 5.07 | 0.97 | 4.85 | 0.75 | 4.66 | 0.56 | 4.53 | 0.43 |
| O85 | 13.98 | 14.20 | 0.22 | 14.17 | 0.19 | 14.15 | 0.17 | 14.14 | 0.16 |
| O9 | 15.50 | 15.60 | 0.10 | 15.57 | 0.07 | 15.56 | 0.06 | 15.50 | 0.00 |
| O94 | 0.52 | 2.97 | 2.45 | 2.82 | 2.30 | 2.58 | 2.06 | 2.42 | 1.90 |
| O95 | 6.31 | 6.47 | 0.16 | 6.44 | 0.13 | 6.43 | 0.12 | 6.42 | 0.11 |

# APPENDIX E

## Mitigated Scenario Model Results

## Model 1B Mitigated

Client: HBCC
User: PC
Date: 17/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O148 | 14.99 | 15.03 | 0.04 | 15.03 | 0.04 | 15.03 | 0.04 | 15.03 | 0.04 |
| O149 | 13.68 | 13.72 | 0.04 | 13.71 | 0.04 | 13.71 | 0.04 | 13.71 | 0.04 |
| O150 | 12.74 | 12.96 | 0.23 | 12.95 | 0.21 | 12.94 | 0.21 | 12.93 | 0.19 |
| O37 | 12.60 | 12.74 | 0.14 | 12.73 | 0.13 | 12.72 | 0.12 | 12.71 | 0.11 |
| O143 | 10.43 | 10.59 | 0.15 | 10.58 | 0.14 | 10.57 | 0.14 | 10.56 | 0.12 |
| O174 | 9.59 | 9.76 | 0.17 | 9.75 | 0.17 | 9.75 | 0.16 | 9.73 | 0.15 |
| O134 | 6.51 | 6.78 | 0.27 | 6.76 | 0.25 | 6.75 | 0.24 | 6.73 | 0.22 |
| O20 | 4.48 | 4.80 | 0.32 | 4.78 | 0.30 | 4.76 | 0.28 | 4.74 | 0.26 |
| O21 | 2.50 | 3.22 | 0.72 | 3.18 | 0.68 | 3.14 | 0.64 | 3.09 | 0.59 |
| O189 | 2.49 | 3.16 | 0.66 | 3.12 | 0.62 | 3.08 | 0.58 | 3.03 | 0.53 |
| O65 | 11.00 | 11.11 | 0.11 | 11.09 | 0.08 | 11.07 | 0.07 | 11.05 | 0.05 |
| O11 | 11.02 | 11.10 | 0.08 | 11.08 | 0.05 | 11.06 | 0.04 | 11.04 | 0.02 |
| O60 | 9.76 | 10.56 | 0.80 | 10.47 | 0.71 | 10.39 | 0.63 | 10.31 | 0.55 |
| O140 | 9.76 | 10.56 | 0.80 | 10.47 | 0.71 | 10.39 | 0.63 | 10.31 | 0.55 |
| O144 | 9.67 | 9.94 | 0.27 | 9.94 | 0.27 | 9.93 | 0.26 | 9.91 | 0.24 |
| O146 | 9.46 | 9.59 | 0.12 | 9.58 | 0.12 | 9.58 | 0.12 | 9.57 | 0.11 |
| O16 | 8.49 | 8.57 | 0.08 | 8.57 | 0.08 | 8.56 | 0.08 | 8.56 | 0.07 |
| O7 | 10.86 | 10.86 | 0.00 | 10.86 | 0.00 | 10.86 | 0.00 | 10.86 | 0.00 |
| O6 | 11.00 | 11.19 | 0.19 | 11.10 | 0.10 | 11.07 | 0.07 | 11.04 | 0.04 |
| O5 | 11.98 | 12.03 | 0.05 | 12.03 | 0.05 | 12.03 | 0.05 | 12.03 | 0.05 |
| O57 | 13.48 | 13.52 | 0.04 | 13.51 | 0.03 | 13.51 | 0.03 | 13.51 | 0.03 |
| O56 | 14.05 | 14.10 | 0.05 | 14.10 | 0.05 | 14.10 | 0.05 | 14.10 | 0.04 |

## Model 1C Mitigated

Client: HBCC
User: PC
Date: 17/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O40 | 20.15 | 20.42 | 0.27 | 20.35 | 0.20 | 20.33 | 0.18 | 20.31 | 0.16 |
| O42 | 19.99 | 20.08 | 0.09 | 20.07 | 0.08 | 20.07 | 0.08 | 20.05 | 0.06 |
| O43 | 17.93 | 18.05 | 0.12 | 18.04 | 0.11 | 18.03 | 0.10 | 18.01 | 0.08 |
| O44 | 16.98 | 17.09 | 0.11 | 17.09 | 0.11 | 17.08 | 0.10 | 17.06 | 0.08 |
| O46 | 15.67 | 15.73 | 0.06 | 15.72 | 0.05 | 15.72 | 0.05 | 15.71 | 0.04 |
| O171 | 15.59 | 15.69 | 0.10 | 15.67 | 0.08 | 15.64 | 0.05 | 15.62 | 0.03 |
| N195 | 10.60 | 10.71 | 0.11 | 10.70 | 0.10 | 10.69 | 0.09 | 10.68 | 0.08 |
| N192 | 4.80 | 4.85 | 0.05 | 4.85 | 0.05 | 4.84 | 0.04 | 4.84 | 0.04 |
| O176 | 18.82 | 18.89 | 0.07 | 18.82 | 0.00 | 18.82 | 0.00 | 18.82 | 0.00 |
| O55 | 17.24 | 17.33 | 0.09 | 17.33 | 0.09 | 17.32 | 0.08 | 17.31 | 0.07 |
| O51 | 12.93 | 13.05 | 0.12 | 13.05 | 0.12 | 13.04 | 0.11 | 13.03 | 0.10 |
| N190 | 5.25 | 5.38 | 0.13 | 5.37 | 0.12 | 5.37 | 0.12 | 5.35 | 0.10 |

## Model 1D Mitigated

Client: HBCC
User: PC
Date: 17/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O125 | 13.31 | 13.50 | 0.19 | 13.49 | 0.17 | 13.47 | 0.16 | 13.44 | 0.13 |
| O159 | 11.88 | 12.04 | 0.16 | 12.02 | 0.14 | 12.01 | 0.13 | 11.98 | 0.10 |
| O109 | 10.90 | 11.10 | 0.20 | 11.08 | 0.18 | 11.06 | 0.16 | 11.01 | 0.11 |
| O162 | 10.48 | 10.69 | 0.21 | 10.65 | 0.17 | 10.61 | 0.13 | 10.56 | 0.08 |
| O119 | 9.61 | 9.79 | 0.18 | 9.76 | 0.15 | 9.73 | 0.12 | 9.65 | 0.04 |
| O113 | 7.73 | 8.01 | 0.28 | 7.93 | 0.20 | 7.85 | 0.12 | 7.83 | 0.09 |
| N200 | 1.44 | 2.12 | 0.68 | 2.12 | 0.68 | 2.12 | 0.68 | 2.12 | 0.68 |
| N201 | 1.50 | 2.12 | 0.62 | 2.12 | 0.62 | 2.12 | 0.62 | 2.12 | 0.62 |

## Model 1E Mitigated

Client: HBCC
User: PC
Date: 17/05/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| O168 | 13.50 | 13.63 | 0.13 | 13.63 | 0.13 | 13.62 | 0.12 | 13.61 | 0.11 |
| O164 | 12.93 | 13.06 | 0.13 | 13.06 | 0.13 | 13.05 | 0.12 | 13.00 | 0.07 |
| O180 | 12.50 | 12.67 | 0.17 | 12.65 | 0.15 | 12.64 | 0.14 | 12.59 | 0.09 |
| O167 | 7.10 | 7.21 | 0.11 | 7.21 | 0.11 | 7.20 | 0.10 | 7.20 | 0.10 |
| N191 | 3.40 | 3.51 | 0.11 | 3.50 | 0.10 | 3.50 | 0.10 | 3.50 | 0.10 |
| O191 | 11.85 | 11.97 | 0.12 | 11.96 | 0.11 | 11.94 | 0.09 | 11.90 | 0.05 |
| O181 | 10.46 | 10.77 | 0.31 | 10.73 | 0.27 | 10.72 | 0.26 | 10.69 | 0.23 |
| O182 | 10.34 | 10.57 | 0.23 | 10.50 | 0.16 | 10.45 | 0.11 | 10.42 | 0.08 |
| O183 | 10.31 | 10.61 | 0.30 | 10.59 | 0.28 | 10.58 | 0.27 | 10.56 | 0.25 |
| O185 | 7.01 | 7.42 | 0.41 | 7.41 | 0.40 | 7.39 | 0.38 | 7.36 | 0.35 |

## Model 3 Mitigated

Client: HBCC
User: PC
Date: 7/06/2006

| | | 100 yr ARI | | 50yr ARI | | 20yr ARI | | 10yr ARI | |
|---|---|---|---|---|---|---|---|---|---|
| Node ID | Node Level (m, AHD) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) | WSL (m,AHD) | Depth (m) |
| AD_Node11 | 6.50 | 6.70 | 0.20 | 6.66 | 0.16 | 6.65 | 0.15 | 6.63 | 0.13 |
| AD_Node2 | 4.54 | 5.26 | 0.72 | 5.21 | 0.67 | 5.17 | 0.63 | 5.11 | 0.57 |
| AD_Node7 | 5.46 | 6.08 | 0.62 | 5.98 | 0.52 | 5.93 | 0.47 | 5.88 | 0.42 |
| O1 | 15.70 | 15.80 | 0.10 | 15.76 | 0.06 | 15.75 | 0.05 | 15.74 | 0.04 |
| O10 | 10.10 | 10.24 | 0.14 | 10.22 | 0.12 | 10.20 | 0.10 | 10.18 | 0.08 |
| O100 | 4.50 | 4.60 | 0.10 | 4.58 | 0.08 | 4.57 | 0.07 | 4.56 | 0.06 |
| O102 | 7.59 | 7.59 | 0.00 | 7.59 | 0.00 | 7.59 | 0.00 | 7.59 | 0.00 |
| O104 | 8.26 | 8.46 | 0.20 | 8.41 | 0.15 | 8.40 | 0.14 | 8.38 | 0.12 |
| O106 | 7.07 | 7.20 | 0.13 | 7.17 | 0.10 | 7.17 | 0.10 | 7.16 | 0.09 |
| O109 | 11.10 | 11.37 | 0.27 | 11.28 | 0.18 | 11.27 | 0.17 | 11.25 | 0.15 |
| O110 | 10.10 | 10.50 | 0.40 | 10.32 | 0.22 | 10.30 | 0.20 | 10.28 | 0.18 |
| O111 | 14.14 | 14.24 | 0.10 | 14.20 | 0.06 | 14.18 | 0.04 | 14.14 | 0.00 |
| O112 | 12.50 | 12.59 | 0.09 | 12.56 | 0.06 | 12.53 | 0.03 | 12.50 | 0.00 |
| O113 | 11.54 | 11.63 | 0.09 | 11.60 | 0.06 | 11.60 | 0.06 | 11.59 | 0.05 |
| O114 | 8.71 | 8.82 | 0.11 | 8.78 | 0.07 | 8.77 | 0.06 | 8.76 | 0.05 |
| O116 | 5.75 | 5.91 | 0.16 | 5.75 | 0.00 | 5.75 | 0.00 | 5.75 | 0.00 |
| O12 | 12.24 | 12.38 | 0.14 | 12.32 | 0.08 | 12.31 | 0.07 | 12.28 | 0.04 |
| O121 | 3.47 | 4.37 | 0.90 | 3.97 | 0.50 | 3.88 | 0.41 | 3.78 | 0.31 |
| O122 | 4.86 | 5.00 | 0.14 | 4.98 | 0.12 | 4.97 | 0.11 | 4.96 | 0.10 |
| O123 | 4.23 | 4.45 | 0.22 | 4.39 | 0.16 | 4.37 | 0.14 | 4.36 | 0.13 |
| O126 | 5.25 | 5.25 | 0.00 | 5.25 | 0.00 | 5.25 | 0.00 | 5.25 | 0.00 |
| O128 | 4.50 | 4.50 | 0.00 | 4.50 | 0.00 | 4.50 | 0.00 | 4.50 | 0.00 |
| O129 | 6.00 | 6.17 | 0.17 | 6.14 | 0.14 | 6.13 | 0.13 | 6.12 | 0.12 |
| O13 | 11.22 | 11.35 | 0.13 | 11.30 | 0.08 | 11.28 | 0.06 | 11.26 | 0.04 |
| O15 | 5.57 | 5.84 | 0.27 | 5.73 | 0.16 | 5.72 | 0.15 | 5.70 | 0.13 |
| O17 | 7.00 | 7.10 | 0.10 | 7.06 | 0.06 | 7.05 | 0.05 | 7.05 | 0.05 |
| O2 | 14.28 | 14.48 | 0.20 | 14.39 | 0.11 | 14.38 | 0.10 | 14.35 | 0.07 |
| O20 | 5.19 | 5.45 | 0.26 | 5.40 | 0.21 | 5.38 | 0.19 | 5.36 | 0.17 |
| O21 | 9.10 | 9.23 | 0.13 | 9.21 | 0.11 | 9.20 | 0.10 | 9.19 | 0.09 |
| O4 | 6.00 | 6.18 | 0.18 | 6.14 | 0.14 | 6.12 | 0.12 | 6.10 | 0.10 |
| O23 | 12.10 | 12.37 | 0.27 | 12.28 | 0.18 | 12.27 | 0.17 | 12.25 | 0.15 |
| O3 | 12.35 | 12.51 | 0.16 | 12.46 | 0.11 | 12.45 | 0.10 | 12.43 | 0.08 |
| O32 | 15.53 | 15.59 | 0.06 | 15.56 | 0.03 | 15.56 | 0.03 | 15.55 | 0.02 |
| O36 | 10.50 | 10.50 | 0.00 | 10.50 | 0.00 | 10.50 | 0.00 | 10.50 | 0.00 |
| O37 | 5.60 | 5.92 | 0.32 | 5.68 | 0.08 | 5.67 | 0.07 | 5.66 | 0.06 |
| O49 | 11.39 | 11.54 | 0.15 | 11.47 | 0.08 | 11.46 | 0.07 | 11.44 | 0.05 |
| O52 | 13.72 | 13.83 | 0.11 | 13.78 | 0.06 | 13.77 | 0.05 | 13.77 | 0.05 |
| O58 | 4.50 | 4.63 | 0.13 | 4.57 | 0.07 | 4.54 | 0.04 | 4.50 | 0.00 |
| O59 | 7.91 | 8.10 | 0.19 | 8.05 | 0.14 | 8.03 | 0.12 | 8.01 | 0.10 |
| O60 | 9.49 | 9.62 | 0.13 | 9.57 | 0.08 | 9.55 | 0.06 | 9.53 | 0.04 |
| O61 | 7.08 | 7.62 | 0.54 | 7.47 | 0.39 | 7.26 | 0.18 | 7.19 | 0.11 |
| O62 | 7.40 | 7.66 | 0.26 | 7.50 | 0.10 | 7.46 | 0.06 | 7.43 | 0.03 |
| O67 | 5.81 | 5.96 | 0.15 | 5.89 | 0.08 | 5.87 | 0.06 | 5.86 | 0.05 |
| O68 | 3.20 | 4.32 | 1.12 | 3.49 | 0.29 | 3.38 | 0.18 | 3.26 | 0.06 |
| O69 | 8.00 | 8.10 | 0.10 | 8.06 | 0.06 | 8.04 | 0.04 | 8.03 | 0.03 |
| O7 | 3.69 | 4.40 | 0.71 | 4.04 | 0.35 | 3.96 | 0.27 | 3.87 | 0.18 |
| O81 | 4.10 | 4.46 | 0.36 | 4.22 | 0.12 | 4.17 | 0.07 | 4.12 | 0.02 |
| O85 | 13.98 | 14.20 | 0.22 | 14.13 | 0.15 | 14.12 | 0.14 | 14.11 | 0.13 |
| O9 | 15.50 | 15.60 | 0.10 | 15.55 | 0.05 | 15.54 | 0.04 | 15.50 | 0.00 |
| O94 | 0.52 | 3.05 | 2.53 | 2.89 | 2.37 | 2.66 | 2.14 | 2.50 | 1.98 |
| O95 | 6.31 | 6.47 | 0.16 | 6.45 | 0.14 | 6.44 | 0.13 | 6.43 | 0.12 |

# APPENDIX F

## Proposed Upgrade Sketch Plans


HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Proposed Network Upgrade

Cadstre

15 0 15 30 45

Metres

**Scale: 1:1,500**

# PIALBA / PT VERNON

## APPENDIX F

## PROPOSED DRAINAGE NETWORK UPGRADES MODEL 1E

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699


HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Proposed Network Upgrade

Cadastre

15 0 15 30 45

Metres

**Scale: 1:1,500**

# PIALBA / PT VERNON

## APPENDIX F

## PROPOSED DRAINAGE NETWORK UPGRADES MODEL 1B

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699


HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Proposed Network Upgrade

Cadastre

10 0 10 20 30

Metres

**Scale: 1:1,000**

# PIALBA / PT VERNON

## APPENDIX F

## PROPOSED DRAINAGE NETWORK UPGRADE MODEL 1D

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699


HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

Proposed Network Upgrade

Cadastre

10 0 10 20 30

Metres

**Scale: 1:1,000**

# PIALBA / PT VERNON

## APPENDIX F

## PROPOSED DRAINAGE NETWORK UPGRADE MODEL 1C

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\42-Wwrks\050301.001 Pt. Vernon Flood Risk\GIS\MapInfo\Figures

Projection Trans. Merc. MGA56(GDA 94)


HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Proposed Network Upgrades
- Proposed Detention Basin
- Cadastre

20 0 20 40 60

Metres

**Scale: 1:2,000**

# PIALBA / PT VERNON

## APPENDIX F

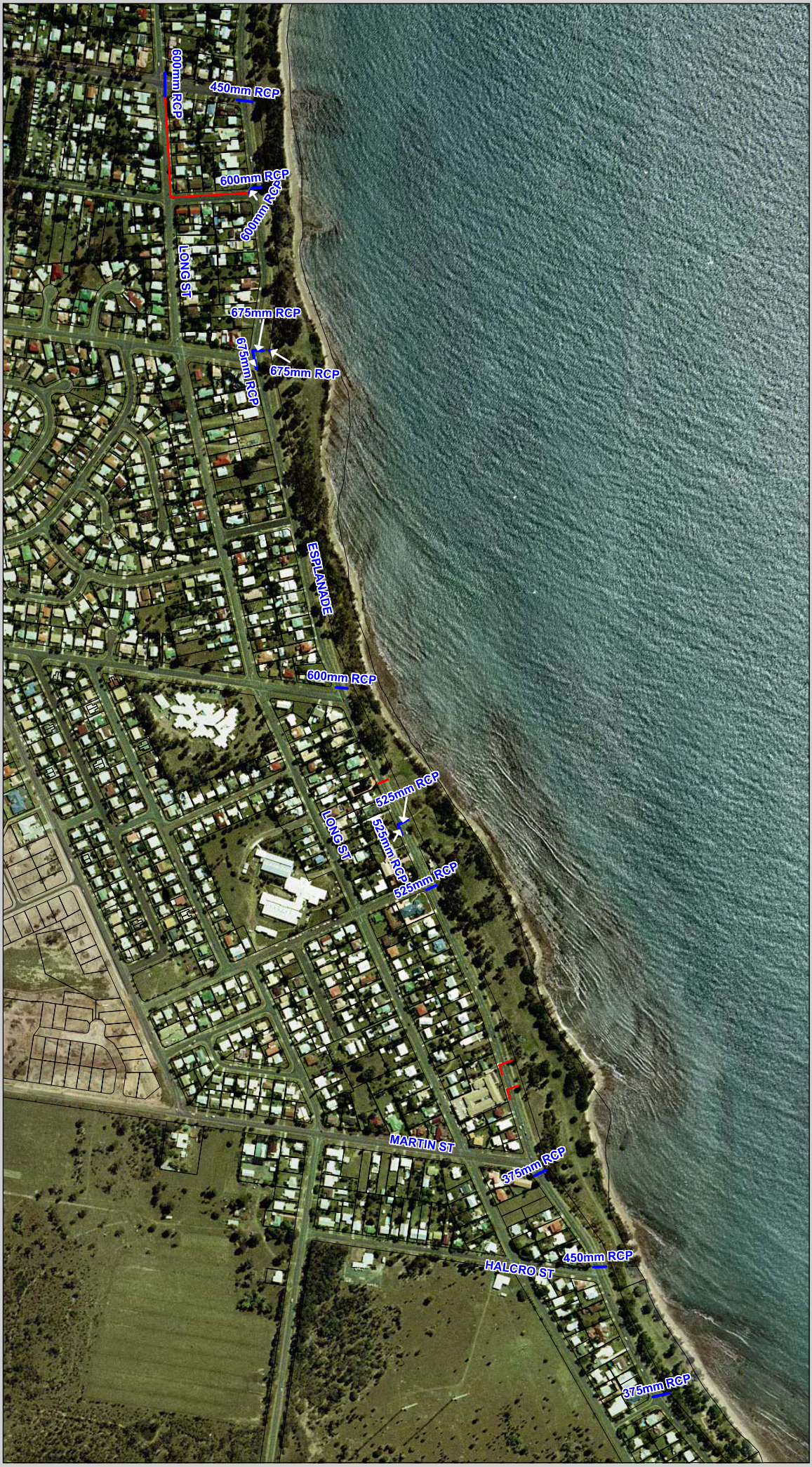
## PROPOSED DRAINAGE NETWORK UPGRADES MODEL 3

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\42-Works\050301.001 Pt. Vernon Flood Risk\GIS\Mapinfo\Figures

Projection Trans. Merc. MGA56(GDA 94)




HERVEY BAY CITY COUNCIL

N
W E
S

**Legend**

- Cadastre
- Culvert or Pipe Network Investigated in Model 2
- Proposed Upgrade

60 0 60 120 180

Metres

**Scale: 1:6,000**

# PIALBA / PT VERNON

## APPENDIX F

## PROPOSED DRAINAGE NETWORK UPGRADES MODEL 2

JWP

John Wilson and Partners Pty. Ltd.
ABN 85 011 022 503
PO Box 585, Fortitude Valley QLD 4006
Ph. 32449600 Fax. 32449699

File Path: Z:\424\Ways\050301-001_Pt_Vernon_Flood_Risk\GIS\MapInfo\Figures

Projection Trans. Merc. MGA56(GDA 94)

# APPENDIX G

## Hydraulic Results (Model 2)

**Client:** HBCC
**Job:** Point Vernon (Model 2)
**User:** PC
**Date:** 22/05/2006

Denotes Interpolated IL

## EXISTING PIPE CONFIGURATIONS

| Catchment | Old Pipe ID | Old Diameter (mm) | No. Barrells | Area (sq. m) | R (m) | USIL (m RL) | DSIL (m RL) | Length (m) | Slope (m/m) | Capacity (m3/s) | Required Capacity (m3/s) | At Q50 Standard? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SWD11209 | 375 | 1 | 0.1104 | 0.0938 | 10.324 | 9.659 | 24.91 | 0.026696106 | 0.29 | 0.46 | NO |
| 2 | SWD10067 | 450 | 1 | 0.159 | 0.1125 | 10.288 | 9.843 | 16.97 | 0.026222746 | 0.46 | 1.88 | NO |
| 15 | SWD10068 | 300 | 1 | 0.0707 | 0.075 | 10.575 | 10.288 | 29.49 | 0.009732113 | 0.10 | 1.16 | NO |
| 2 | SWD10066 | 450 | 1 | 0.159 | 0.1125 | 9.715 | 9.543 | 4.76 | 0.036134454 | 0.54 | 1.88 | NO |
| 3 | SWD10065 | 375 | 1 | 0.1104 | 0.0938 | 10.966 | 10.691 | 17.72 | 0.015519187 | 0.22 | 1.11 | NO |
| 4 | SWD10063 & SWD10064 | 450 | 2 | 0.159 | 0.1125 | 8.868 | 8.258 | 15.98 | 0.038172716 | 1.11 | 0.60 | YES |
| 5 | SWD10061 | 450 | 1 | 0.159 | 0.1125 | 7.774 | 7.614 | 18.66 | 0.008574491 | 0.26 | 0.61 | NO |
| 5 | SWD10062 | 450 | 1 | 0.159 | 0.1125 | 7.924 | 7.774 | 17.52 | 0.008561644 | 0.26 | 0.61 | NO |
| 6 | SWD10060 | 450 | 1 | 0.159 | 0.1125 | 8.45 | 7.68 | 16.33 | 0.04715248 | 0.62 | 1.09 | NO |
| 7 | SWD10056 | 450 | 1 | 0.159 | 0.1125 | 10.372 | 10.071 | 19.14 | 0.015726228 | 0.36 | 0.67 | YES |
| 7 | SWD10058 | 450 | 1 | 0.159 | 0.1125 | 10.164 | 9.309 | 20.73 | 0.041244573 | 0.58 | | |
| 8 | SWD10171 | 300 | 1 | 0.0707 | 0.075 | 12.34 | 12.109 | 18.94 | 0.01219641 | 0.11 | 0.26 | NO |
| 9 | SWD10170 | 375 | 1 | 0.1104 | 0.0938 | 11.492 | 11.016 | 19.19 | 0.024804586 | 0.28 | 0.64 | NO |
| 10 | SWD10169 | 300 | 1 | 0.0707 | 0.075 | 10.032 | 8.096 | 26.02 | 0.074404304 | 0.26 | 0.76 | NO |
| 11 | SWD10073 | 525 | 1 | 0.2165 | 0.1313 | 12.311 | 12.287 | 36.15 | 0.0006639 | 0.11 | 0.25 | NO |
| 11 | SWD10072 | 525 | 1 | 0.2165 | 0.1313 | 12.287 | 12.009 | 74.55 | 0.003729041 | 0.26 | 0.25 | YES |
| 11 | SWD10071 | 525 | 1 | 0.2165 | 0.1313 | 12.009 | 11.838 | 86.23 | 0.001983069 | 0.19 | 0.25 | NO |
| 13 | SWD11208 | 525 | 1 | 0.2165 | 0.1313 | 11.838 | 10.819 | 124.62 | 0.008176858 | 0.39 | 0.50 | NO |
| 14 | SWD11204 | 525 | 1 | 0.2165 | 0.1313 | 10.819 | 10.651 | 8.21 | 0.02046285 | 0.62 | 1.06 | NO |
| 14 | SWD11203 | 525 | 1 | 0.2165 | 0.1313 | 10.651 | 10.595 | 14.33 | 0.003907886 | 0.27 | 1.06 | NO |

## UPGRADED PIPE CONFIGURATIONS

| Catchment | Old Pipe ID | New Diameter (mm) | No. Barrells | Area (sq. m) | R (m) | USIL (m RL) | DSIL (m RL) | Length (m) | Slope (m/m) | Capacity (m3/s) | Required Capacity (m3/s) | At Q50 Standard? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SWD11209 | 375 | 2 | 0.1104 | 0.0938 | 10.324 | 9.659 | 24.91 | 0.026696106 | 0.57 | 0.46 | YES |
| 2 | SWD10067 | 600 | 2 | 0.2827 | 0.15 | 10.288 | 9.843 | 16.97 | 0.026222746 | 1.99 | 1.88 | YES |
| 15 | SWD10068 | 600 | 2 | 0.2827 | 0.15 | 10.575 | 10.288 | 29.49 | 0.009732113 | 1.21 | 1.16 | YES |
| 2 | SWD10066 | 600 | 2 | 0.2827 | 0.15 | 9.715 | 9.543 | 4.76 | 0.036134454 | 2.33 | 1.88 | YES |
| 3 | SWD10065 | 600 | 2 | 0.2827 | 0.15 | 10.966 | 10.691 | 17.72 | 0.015519187 | 1.53 | 1.11 | YES |
| 4 | SWD10063 & SWD10064 | 450 | 2 | 0.159 | 0.1125 | 8.868 | 8.258 | 15.98 | 0.038172716 | 1.11 | 0.60 | YES |
| 5 | SWD10061 | 600 | 2 | 0.2827 | 0.15 | 7.774 | 7.614 | 18.66 | 0.008574491 | 1.14 | 0.61 | YES |
| 5 | SWD10062 | 600 | 2 | 0.2827 | 0.15 | 7.924 | 7.774 | 17.52 | 0.008561644 | 1.14 | 0.61 | YES |
| 6 | SWD10060 | 450 | 2 | 0.159 | 0.1125 | 8.45 | 7.68 | 16.33 | 0.04715248 | 1.24 | 1.09 | YES |
| 7 | SWD10056 | 450 | 1 | 0.159 | 0.1125 | 10.372 | 10.071 | 19.14 | 0.015726228 | 0.36 | 0.67 | YES |
| 7 | SWD10058 | 450 | 1 | 0.159 | 0.1125 | 10.164 | 9.309 | 20.73 | 0.041244573 | 0.58 | | |
| 8 | SWD10171 | 450 | 1 | 0.159 | 0.1125 | 12.34 | 12.109 | 18.94 | 0.01219641 | 0.31 | 0.26 | YES |
| 9 | SWD10170 | 450 | 2 | 0.159 | 0.1125 | 11.492 | 11.016 | 19.19 | 0.024804586 | 0.90 | 0.64 | YES |
| 10 | SWD10169 | 450 | 1 | 0.159 | 0.1125 | 10.032 | 8.096 | 26.02 | 0.074404304 | 0.78 | 0.76 | YES |
| 11 | SWD10073 | 600 | 2 | 0.2827 | 0.15 | 12.311 | 12.287 | 36.15 | 0.0006639 | 0.32 | 0.25 | YES |
| 11 | SWD10072 | 525 | 1 | 0.2165 | 0.1313 | 12.287 | 12.009 | 74.55 | 0.003729041 | 0.26 | 0.25 | YES |
| 11 | SWD10071 | 525 | 2 | 0.2165 | 0.1313 | 12.009 | 11.838 | 86.23 | 0.001983069 | 0.38 | 0.25 | YES |
| 13 | SWD11208 | 525 | 2 | 0.2165 | 0.1313 | 11.838 | 10.819 | 124.62 | 0.008176858 | 0.78 | 0.50 | YES |
| 14 | SWD11204 | 525 | 2 | 0.2165 | 0.1313 | 10.819 | 10.651 | 8.21 | 0.02046285 | 1.23 | 1.06 | YES |
| 14 | SWD11203 | 750 | 2 | 0.4418 | 0.1875 | 10.651 | 10.595 | 14.33 | 0.003907886 | 1.39 | 1.06 | YES |

# APPENDIX H

## Preliminary Cost Estimates

Date Printed : 22/05/2006

# MASTER DRAINAGE AREA "Model 1B"
## PRELIMINARY DRAINAGE ESTIMATE

| No. | Description | Comment | | Unit | | Unit Cost | | Number | | Amount | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | GENERAL | | | | | | | | | | |
| 0001 | Traffic Control | As per Appendix "K" | | ITEM | | | | | $ | 1,000.00 | |
| 0002 | Site Establishment | Min. $10,000 | | ITEM | | $ 1.00 | | 10000 | $ | 10,000.00 | |
| 0004 | Box out & remove existing driveways | | | ITEM | | $ 150.00 | | | $ | - | |
| 0005 | Remove existing K & C structures | | | ITEM | | $ 10.00 | | 5 | $ | 50.00 | |
| | ROADWORKS | | | | | | | | | | |
| 0039 | Gravel base course (solid) | | | m3 | Scale | $ 35.00 | | 11 | $ | 394.00 | |
| 0045 | Footpath reshaping | | | m2 | | $ 5.40 | | | $ | - | |
| 0047 | Footpath loaming | | | m2 | | $ 4.32 | | | $ | - | |
| | DRAINAGE | | | | | | | | | | |
| 0051 | Takeup & stack existing RC pipes | | | m | | $ 50.00 | | 0 | $ | - | |
| 0067 | Excavation of open drain | | | m3 | Scale | $ - | | | $ | - | |
| 0068 | Subsoil drains in place (STANDARD) | | | m | | $ 19.35 | | 5 | $ | 97.00 | |
| 0075 | Excavate/lay/backfill 300mm RC pipe | **Type A** | | m | | $ 100.00 | | | $ | - | |
| 1075 | Excavate/lay/backfill 300mm RC pipe | **Type B** | | m | | $ 125.00 | | | $ | - | |
| 2075 | Excavate/lay/backfill 300mm RC pipe | **Type C** | | m | | $ 207.00 | | | $ | - | |
| 3075 | Excavate/lay/backfill 300mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0076 | Excavate/lay/backfill 375mm RC pipe | **Type A** | | m | | $ 110.00 | | | $ | - | |
| 1076 | Excavate/lay/backfill 375mm RC pipe | **Type B** | | m | | $ 161.00 | | | $ | - | |
| 2076 | Excavate/lay/backfill 375mm RC pipe | **Type C** | | m | | $ 230.00 | | | $ | - | |
| 3076 | Excavate/lay/backfill 375mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0077 | Excavate/lay/backfill 450mm RC pipe | **Type A** | | m | | $ 120.00 | | | $ | - | |
| 1077 | Excavate/lay/backfill 450mm RC pipe | **Type B** | | m | | $ 190.00 | | 50 | $ | 9,500.00 | |
| 2077 | Excavate/lay/backfill 450mm RC pipe | **Type C** | | m | | $ 250.00 | | | $ | - | |
| 3077 | Excavate/lay/backfill 450mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0078 | Excavate/lay/backfill 525mm RC pipe | **Type A** | | m | | $ 135.00 | | | $ | - | |
| 1078 | Excavate/lay/backfill 525mm RC pipe | **Type B** | | m | | $ 195.00 | | | $ | - | |
| 2078 | Excavate/lay/backfill 525mm RC pipe | **Type C** | | m | | $ 250.00 | | | $ | - | |
| 3078 | Excavate/lay/backfill 525mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0079 | Excavate/lay/backfill 600mm RC pipe | **Type A** | | m | | $ 145.00 | | | $ | - | |
| 1079 | Excavate/lay/backfill 600mm RC pipe | **Type B** | | m | | $ 207.00 | | | $ | - | |
| 2079 | Excavate/lay/backfill 600mm RC pipe | **Type C** | | m | | $ 276.00 | | | $ | - | |
| 3079 | Excavate/lay/backfill 600mm RC pipe | **Type D** | | m | | $ 391.00 | | | $ | - | |
| 0080 | Excavate/lay/backfill 675mm RC pipe | **Type A** | | m | | $ 160.00 | | | $ | - | |
| 1080 | Excavate/lay/backfill 675mm RC pipe | **Type B** | | m | | $ 210.00 | | | $ | - | |
| 2080 | Excavate/lay/backfill 675mm RC pipe | **Type C** | | m | | $ 300.00 | | | $ | - | |
| 3080 | Excavate/lay/backfill 675mm RC pipe | **Type D** | | m | | $ 414.00 | | | $ | - | |
| 0081 | Excavate/lay/backfill 750mm RC pipe | **Type A** | | m | | $ 177.00 | | | $ | - | |
| 1081 | Excavate/lay/backfill 750mm RC pipe | **Type B** | | m | | $ 240.00 | | | $ | - | |
| 2081 | Excavate/lay/backfill 750mm RC pipe | **Type C** | | m | | $ 300.00 | | | $ | - | |
| 3081 | Excavate/lay/backfill 750mm RC pipe | **Type D** | | m | | $ 460.00 | | | $ | - | |
| 0082 | Excavate/lay/backfill 825mm RC pipe | **Type A** | | m | | $ 177.00 | | | $ | - | |
| 1082 | Excavate/lay/backfill 825mm RC pipe | **Type B** | | m | | $ 276.00 | | | $ | - | |
| 2082 | Excavate/lay/backfill 825mm RC pipe | **Type C** | | m | | $ 350.00 | | | $ | - | |
| 3082 | Excavate/lay/backfill 825mm RC pipe | **Type D** | | m | | $ 460.00 | | | $ | - | |
| 0083 | Excavate/lay/backfill 900mm RC pipe | **Type A** | | m | | $ 207.00 | | | $ | - | |
| 1083 | Excavate/lay/backfill 900mm RC pipe | **Type B** | | m | | $ 276.00 | | | $ | - | |
| 2083 | Excavate/lay/backfill 900mm RC pipe | **Type C** | | m | | $ 360.00 | | | $ | - | |
| 3083 | Excavate/lay/backfill 900mm RC pipe | **Type D** | | m | | $ 480.00 | | | $ | - | |
| 0084 | Excavate/lay/backfill 1050mm RC pipe | **Type A** | | m | | $ 215.00 | | | $ | - | |
| 1084 | Excavate/lay/backfill 1050mm RC pipe | **Type B** | | m | | $ 300.00 | | | $ | - | |
| 2084 | Excavate/lay/backfill 1050mm RC pipe | **Type C** | | m | | $ 380.00 | | | $ | - | |
| 3084 | Excavate/lay/backfill 1050mm RC pipe | **Type D** | | m | | $ 520.00 | | | $ | - | |
| 0085 | Excavate/lay/backfill 1200mm RC pipe | **Type A** | | m | | $ 290.00 | | | $ | - | |
| 1085 | Excavate/lay/backfill 1200mm RC pipe | **Type B** | | m | | $ 350.00 | | | $ | - | |
| 2085 | Excavate/lay/backfill 1200mm RC pipe | **Type C** | | m | | $ 517.50 | | | $ | - | |
| 3085 | Excavate/lay/backfill 1200mm RC pipe | **Type D** | | m | | $ 620.00 | | | $ | - | |
| 0086 | Excavate/lay/backfill 1350mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1086 | Excavate/lay/backfill 1350mm RC pipe | **Type B** | | m | | $ 380.00 | | | $ | - | |
| 2086 | Excavate/lay/backfill 1350mm RC pipe | **Type C** | | m | | $ 580.00 | | | $ | - | |
| 3086 | Excavate/lay/backfill 1350mm RC pipe | **Type D** | | m | | $ 650.00 | | | $ | - | |
| 0087 | Excavate/lay/backfill 1500mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1087 | Excavate/lay/backfill 1500mm RC pipe | **Type B** | | m | | $ 437.00 | | | $ | - | |
| 2087 | Excavate/lay/backfill 1500mm RC pipe | **Type C** | | m | | $ 598.00 | | | $ | - | |
| 3087 | Excavate/lay/backfill 1500mm RC pipe | **Type D** | | m | | $ 680.00 | | | $ | - | |
| 0088 | Excavate/lay/backfill 1650mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1088 | Excavate/lay/backfill 1650mm RC pipe | **Type B** | | m | | $ 540.00 | | | $ | - | |
| 2088 | Excavate/lay/backfill 1650mm RC pipe | **Type C** | | m | | $ 644.00 | | | $ | - | |
| 3088 | Excavate/lay/backfill 1650mm RC pipe | **Type D** | | m | | $ 700.00 | | | $ | - | |
| 0089 | Excavate/lay/backfill 1800mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1089 | Excavate/lay/backfill 1800mm RC pipe | **Type B** | | m | | $ 550.00 | | | $ | - | |
| 2089 | Excavate/lay/backfill 1800mm RC pipe | **Type C** | | m | | $ 725.00 | | | $ | - | |
| 3089 | Excavate/lay/backfill 1800mm RC pipe | **Type D** | | m | | $ 750.00 | | | $ | - | |
| 0090 | Excavate/lay/backfill 1950mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1090 | Excavate/lay/backfill 1950mm RC pipe | **Type B** | | m | | $ - | | | $ | - | |
| 2090 | Excavate/lay/backfill 1950mm RC pipe | **Type C** | | m | | $ 750.00 | | | $ | - | |
| 3090 | Excavate/lay/backfill 1950mm RC pipe | **Type D** | | m | | $ 800.00 | | | $ | - | |
| 0091 | Excavate/lay/backfill 2100mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1091 | Excavate/lay/backfill 2100mm RC pipe | **Type B** | | m | | $ - | | | $ | - | |
| 2091 | Excavate/lay/backfill 2100mm RC pipe | **Type C** | | m | | $ 800.00 | | | $ | - | |
| 3091 | Excavate/lay/backfill 2100mm RC pipe | **Type D** | | m | | $ 950.00 | | | $ | - | |
| 0145 | Side entry pit 2-4 metres extra | | | No. | | $ 1,090.00 | | | $ | - | |
| 0146 | Manholes 1050mm 0-2 metre deep | | | No. | | $ 1,600.00 | | | $ | - | |
| 0148 | Manholes 1500mm 0-3 metre deep | | | No. | | $ 2,179.00 | | 2 | $ | 4,358.00 | |
| 0149 | Manholes 2100mm 0-3 metre deep | | | No. | | $ 3,683.00 | | | $ | - | |
| 0151 | Manholes 1050mm 2-4 metre deep | | | No. | | $ 2,500.00 | | | $ | - | |
| 0153 | Manholes 1500mm 3-5 metre deep | | | No. | | $ 4,250.00 | | | $ | - | |
| 0154 | Manholes 2100mm 3-5 metre deep | | | No. | | $ 5,910.00 | | | $ | - | |
| 0155 | Manholes Special in place | | | ITEM | | $ 1.00 | | | $ | - | |
| | CONCRETE | | | | | | | | | | |
| 0161 | Concrete K & C type **M1** (incl. supply of conc.) | | | m | Scale | $ 60.00 | | 5 | $ | 400.00 | |
| 0162 | Concrete K & C type **B1** (incl. supply of conc.) | | | m | Scale | $ - | | | $ | - | |
| 0163 | Concrete K & C type **M3** (incl. supply of conc.) | | | m | Scale | $ - | | | $ | - | |
| | PIPES & DRAINWAYS | | | | | | | | | | |
| 0294 | Supply 300mm RC pipe RRJ class 2 | | | m | | $ 27.50 | | 0 | $ | - | |
| 0295 | Supply 375mm RC pipe RRJ class 2 | | | m | | $ 41.09 | | 0 | $ | - | |
| 0296 | Supply 450mm RC pipe RRJ class 2 | | | m | | $ 58.68 | | 50 | $ | 2,934.00 | |
| 0297 | Supply 525mm RC pipe RRJ class 2 | | | m | | $ 74.77 | | 0 | $ | - | |
| 0298 | Supply 600mm RC pipe RRJ class 2 | | | m | | $ 91.94 | | 0 | $ | - | |
| 0299 | Supply 675mm RC pipe IJ class 2 | | | m | | $ 96.71 | | 0 | $ | - | |
| 0300 | Supply 750mm RC pipe IJ class 2 | | | m | | $ 113.97 | | 0 | $ | - | |
| 0301 | Supply 825mm RC pipe IJ class 2 | | | m | | $ 131.48 | | 0 | $ | - | |
| 0302 | Supply 900mm RC pipe IJ class 2 | | | m | | $ 159.31 | | 0 | $ | - | |
| 0303 | Supply 1050mm RC pipe IJ class 2 | | | m | | $ 208.75 | | 0 | $ | - | |
| 0304 | Supply 1200mm RC pipe IJ class 2 | | | m | | $ 261.55 | | 0 | $ | - | |
| 0305 | Supply 1350mm RC pipe IJ class 2 | | | m | | $ 319.98 | | 0 | $ | - | |
| 0306 | Supply 1500mm RC pipe IJ class 2 | | | m | | $ 389.19 | | 0 | $ | - | |
| 0307 | Supply 1650mm RC pipe IJ class 2 | | | m | | $ 459.92 | | 0 | $ | - | |
| 0308 | Supply 1800mm RC pipe IJ class 2 | | | m | | $ 537.25 | | 0 | $ | - | |
| 0309 | Supply 1950mm RC pipe IJ class 2 | | | m | | $ 650.68 | | 0 | $ | - | |
| 0310 | Supply 2100mm RC pipe IJ class 2 | | | m | | $ 796.09 | | 0 | $ | - | |
| | BOX CULVERTS | | | | | | | | | | |
| 0350 | Supply X mm RCBC | | | m | P.O.A. | | | | $ | - | |
| 0351 | Supply X mm RCBC | | | m | P.O.A. | | | | $ | - | |
| 0352 | Supply X mm RCBC | | | m | P.O.A. | | | | $ | - | |
| | PROVISIONAL | | | | | | | | | | |
| 0484 | Construction safety fee | $ | 32,000.00 | ITEM | | $ 1.00 | $ - | | $ | 1,000.00 | 0.2% of Subtotal |
| 0486 | Supervision | $ | 32,000.00 | ITEM | | $ 1.00 | | | $ | 2,000.00 | 3.6% of Subtotal |
| 0489 | Transport of plant | | | ITEM | | $ 1.00 | | | $ | - | |
| | SERVICES | | | | | | | | | | |
| 0496 | Alteration to services - General | | | ITEM | | $ 1.00 | | | $ | - | |
| 0497 | Acquisition of land | | | ITEM | | $ 1.00 | | | $ | - | |
| 0498 | Acquisition of easements | | | ITEM | | $ 1.00 | | | $ | - | |
| | Subtotal | | | | | | | | $ | 31,733.00 | |
| | Contingencies | | | | | | | | | | |
| 0490 | Contingencies (Provisional) | | | ITEM | | 30% | | | $ | 9,520.00 | 30% of Subtotal |
| | DESIGN CHARGES | | | | | | | | | | |
| 0450 | Project Design & Survey | | | ITEM | | $ 1.00 | | 3174 | $ | 3,174.00 | 10% of Subtotal |
| 0451 | | | | | | | | | | | |
| 0452 | Total | | | | | | | | $ | 45,000.00 | N.B: Rounded up to nerarest $1000 |
| 0453 | | | | | | | | | | | |
| 0454 | | | | | | | | | | | |
| 0456 | | | | | | | | | | | |
| 0480 | | | | | | | | | | | |
| | N.B: Price has been rounded up to nerarest $1000 | | | | | | | | | | |

Date Printed : 22/05/2006

# MASTER DRAINAGE AREA "Model 1C"
## PRELIMINARY DRAINAGE ESTIMATE

| No. | Description | Comment | | Unit | | Unit Cost | | Number | | Amount | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | GENERAL | | | | | | | | | | |
| 0001 | Traffic Control | As per Appendix "K" | | ITEM | | | | | $ | 1,000.00 | |
| 0002 | Site Establishment | Min. $10,000 | | ITEM | | $ 1.00 | | | $ | - | |
| 0004 | Box out & remove existing driveways | | | ITEM | | $ 150.00 | | | $ | - | |
| 0005 | Remove existing K & C structures | | | ITEM | | $ 10.00 | | 5 | $ | 50.00 | |
| | DRAINAGE | | | | | | | | | | |
| 0051 | Takeup & stack existing RC pipes | | | m | | $ 50.00 | | 0 | $ | - | |
| 0067 | Excavation of open drain | | | m3 | Scale | $ - | | | $ | - | |
| 0068 | Subsoil drains in place (STANDARD) | | | m | | $ 19.35 | | 5 | $ | 97.00 | |
| 0075 | Excavate/lay/backfill 300mm RC pipe | **Type A** | | m | | $ 100.00 | | | $ | - | |
| 1075 | Excavate/lay/backfill 300mm RC pipe | **Type B** | | m | | $ 125.00 | | | $ | - | |
| 2075 | Excavate/lay/backfill 300mm RC pipe | **Type C** | | m | | $ 207.00 | | | $ | - | |
| 3075 | Excavate/lay/backfill 300mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0076 | Excavate/lay/backfill 375mm RC pipe | **Type A** | | m | | $ 110.00 | | | $ | - | |
| 1076 | Excavate/lay/backfill 375mm RC pipe | **Type B** | | m | | $ 161.00 | | | $ | - | |
| 2076 | Excavate/lay/backfill 375mm RC pipe | **Type C** | | m | | $ 230.00 | | | $ | - | |
| 3076 | Excavate/lay/backfill 375mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0077 | Excavate/lay/backfill 450mm RC pipe | **Type A** | | m | | $ 120.00 | | | $ | - | |
| 1077 | Excavate/lay/backfill 450mm RC pipe | **Type B** | | m | | $ 190.00 | | | $ | - | |
| 2077 | Excavate/lay/backfill 450mm RC pipe | **Type C** | | m | | $ 250.00 | | | $ | - | |
| 3077 | Excavate/lay/backfill 450mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0078 | Excavate/lay/backfill 525mm RC pipe | **Type A** | | m | | $ 135.00 | | | $ | - | |
| 1078 | Excavate/lay/backfill 525mm RC pipe | **Type B** | | m | | $ 195.00 | | | $ | - | |
| 2078 | Excavate/lay/backfill 525mm RC pipe | **Type C** | | m | | $ 250.00 | | | $ | - | |
| 3078 | Excavate/lay/backfill 525mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0079 | Excavate/lay/backfill 600mm RC pipe | **Type A** | | m | | $ 145.00 | | | $ | - | |
| 1079 | Excavate/lay/backfill 600mm RC pipe | **Type B** | | m | | $ 207.00 | | 27 | $ | 5,589.00 | |
| 2079 | Excavate/lay/backfill 600mm RC pipe | **Type C** | | m | | $ 276.00 | | | $ | - | |
| 3079 | Excavate/lay/backfill 600mm RC pipe | **Type D** | | m | | $ 391.00 | | | $ | - | |
| 0080 | Excavate/lay/backfill 675mm RC pipe | **Type A** | | m | | $ 160.00 | | | $ | - | |
| 1080 | Excavate/lay/backfill 675mm RC pipe | **Type B** | | m | | $ 210.00 | | | $ | - | |
| 2080 | Excavate/lay/backfill 675mm RC pipe | **Type C** | | m | | $ 300.00 | | | $ | - | |
| 3080 | Excavate/lay/backfill 675mm RC pipe | **Type D** | | m | | $ 414.00 | | | $ | - | |
| 0081 | Excavate/lay/backfill 750mm RC pipe | **Type A** | | m | | $ 177.00 | | | $ | - | |
| 1081 | Excavate/lay/backfill 750mm RC pipe | **Type B** | | m | | $ 240.00 | | | $ | - | |
| 2081 | Excavate/lay/backfill 750mm RC pipe | **Type C** | | m | | $ 300.00 | | | $ | - | |
| 3081 | Excavate/lay/backfill 750mm RC pipe | **Type D** | | m | | $ 460.00 | | | $ | - | |
| 0082 | Excavate/lay/backfill 825mm RC pipe | **Type A** | | m | | $ 177.00 | | | $ | - | |
| 1082 | Excavate/lay/backfill 825mm RC pipe | **Type B** | | m | | $ 276.00 | | | $ | - | |
| 2082 | Excavate/lay/backfill 825mm RC pipe | **Type C** | | m | | $ 350.00 | | | $ | - | |
| 3082 | Excavate/lay/backfill 825mm RC pipe | **Type D** | | m | | $ 460.00 | | | $ | - | |
| 0083 | Excavate/lay/backfill 900mm RC pipe | **Type A** | | m | | $ 207.00 | | | $ | - | |
| 1083 | Excavate/lay/backfill 900mm RC pipe | **Type B** | | m | | $ 276.00 | | | $ | - | |
| 2083 | Excavate/lay/backfill 900mm RC pipe | **Type C** | | m | | $ 360.00 | | | $ | - | |
| 3083 | Excavate/lay/backfill 900mm RC pipe | **Type D** | | m | | $ 480.00 | | | $ | - | |
| 0084 | Excavate/lay/backfill 1050mm RC pipe | **Type A** | | m | | $ 215.00 | | | $ | - | |
| 1084 | Excavate/lay/backfill 1050mm RC pipe | **Type B** | | m | | $ 300.00 | | | $ | - | |
| 2084 | Excavate/lay/backfill 1050mm RC pipe | **Type C** | | m | | $ 380.00 | | | $ | - | |
| 3084 | Excavate/lay/backfill 1050mm RC pipe | **Type D** | | m | | $ 520.00 | | | $ | - | |
| 0085 | Excavate/lay/backfill 1200mm RC pipe | **Type A** | | m | | $ 290.00 | | | $ | - | |
| 1085 | Excavate/lay/backfill 1200mm RC pipe | **Type B** | | m | | $ 350.00 | | | $ | - | |
| 2085 | Excavate/lay/backfill 1200mm RC pipe | **Type C** | | m | | $ 517.50 | | | $ | - | |
| 3085 | Excavate/lay/backfill 1200mm RC pipe | **Type D** | | m | | $ 620.00 | | | $ | - | |
| 0086 | Excavate/lay/backfill 1350mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1086 | Excavate/lay/backfill 1350mm RC pipe | **Type B** | | m | | $ 380.00 | | | $ | - | |
| 2086 | Excavate/lay/backfill 1350mm RC pipe | **Type C** | | m | | $ 580.00 | | | $ | - | |
| 3086 | Excavate/lay/backfill 1350mm RC pipe | **Type D** | | m | | $ 650.00 | | | $ | - | |
| 0087 | Excavate/lay/backfill 1500mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1087 | Excavate/lay/backfill 1500mm RC pipe | **Type B** | | m | | $ 437.00 | | | $ | - | |
| 2087 | Excavate/lay/backfill 1500mm RC pipe | **Type C** | | m | | $ 598.00 | | | $ | - | |
| 3087 | Excavate/lay/backfill 1500mm RC pipe | **Type D** | | m | | $ 680.00 | | | $ | - | |
| 0088 | Excavate/lay/backfill 1650mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1088 | Excavate/lay/backfill 1650mm RC pipe | **Type B** | | m | | $ 540.00 | | | $ | - | |
| 2088 | Excavate/lay/backfill 1650mm RC pipe | **Type C** | | m | | $ 644.00 | | | $ | - | |
| 3088 | Excavate/lay/backfill 1650mm RC pipe | **Type D** | | m | | $ 700.00 | | | $ | - | |
| 0089 | Excavate/lay/backfill 1800mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1089 | Excavate/lay/backfill 1800mm RC pipe | **Type B** | | m | | $ 550.00 | | | $ | - | |
| 2089 | Excavate/lay/backfill 1800mm RC pipe | **Type C** | | m | | $ 725.00 | | | $ | - | |
| 3089 | Excavate/lay/backfill 1800mm RC pipe | **Type D** | | m | | $ 750.00 | | | $ | - | |
| 0090 | Excavate/lay/backfill 1950mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1090 | Excavate/lay/backfill 1950mm RC pipe | **Type B** | | m | | $ - | | | $ | - | |
| 2090 | Excavate/lay/backfill 1950mm RC pipe | **Type C** | | m | | $ 750.00 | | | $ | - | |
| 3090 | Excavate/lay/backfill 1950mm RC pipe | **Type D** | | m | | $ 800.00 | | | $ | - | |
| 0091 | Excavate/lay/backfill 2100mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1091 | Excavate/lay/backfill 2100mm RC pipe | **Type B** | | m | | $ - | | | $ | - | |
| 2091 | Excavate/lay/backfill 2100mm RC pipe | **Type C** | | m | | $ 800.00 | | | $ | - | |
| 3091 | Excavate/lay/backfill 2100mm RC pipe | **Type D** | | m | | $ 950.00 | | | $ | - | |
| 0145 | Side entry pit 2-4 metres extra | | | No. | | $ 1,090.00 | | 2 | $ | 2,180.00 | |
| 0146 | Manholes 1050mm 0-2 metre deep | | | No. | | $ 1,600.00 | | | $ | - | |
| 0148 | Manholes 1500mm 0-3 metre deep | | | No. | | $ 2,179.00 | | | $ | - | |
| 0149 | Manholes 2100mm 0-3 metre deep | | | No. | | $ 3,683.00 | | | $ | - | |
| 0151 | Manholes 1050mm 2-4 metre deep | | | No. | | $ 2,500.00 | | | $ | - | |
| 0153 | Manholes 1500mm 3-5 metre deep | | | No. | | $ 4,250.00 | | | $ | - | |
| 0154 | Manholes 2100mm 3-5 metre deep | | | No. | | $ 5,910.00 | | | $ | - | |
| 0155 | Manholes Special in place | | | ITEM | | $ 1.00 | | | $ | - | |
| | CONCRETE | | | | | | | | | | |
| 0161 | Concrete K & C type **M1** (incl. supply of conc.) | | | m | Scale | $ 60.00 | | 5 | $ | 400.00 | |
| 0162 | Concrete K & C type **B1** (incl. supply of conc.) | | | m | Scale | $ - | | | $ | - | |
| 0163 | Concrete K & C type **M3** (incl. supply of conc.) | | | m | Scale | $ - | | | $ | - | |
| | BITUMEN SURFACING | | | | | | | | | | |
| 0200 | Prime Coat | | | m2 | Scale | $ 10.00 | | | $ | - | |
| 0206 | Asphaltic Concrete type 2 (10mm) S & L | (light traffic) 25-40mm Thick | | Tonne | Scale | $ - | | | $ | - | |
| 0207 | Asphaltic Concrete type 4 (14mm) S & L | (light traffic) 35-55mm Thick | | Tonne | Scale | $ - | | | $ | - | |
| | PIPES & DRAINWAYS | | | | | | | | | | |
| 0294 | Supply 300mm RC pipe RRJ class 2 | | | m | | $ 27.50 | | 0 | $ | - | |
| 0295 | Supply 375mm RC pipe RRJ class 2 | | | m | | $ 41.09 | | 0 | $ | - | |
| 0296 | Supply 450mm RC pipe RRJ class 2 | | | m | | $ 58.68 | | 0 | $ | - | |
| 0297 | Supply 525mm RC pipe RRJ class 2 | | | m | | $ 74.77 | | 0 | $ | - | |
| 0298 | Supply 600mm RC pipe RRJ class 2 | | | m | | $ 91.94 | | 27 | $ | 2,483.00 | |
| 0299 | Supply 675mm RC pipe IJ class 2 | | | m | | $ 96.71 | | 0 | $ | - | |
| 0300 | Supply 750mm RC pipe IJ class 2 | | | m | | $ 113.97 | | 0 | $ | - | |
| 0301 | Supply 825mm RC pipe IJ class 2 | | | m | | $ 131.48 | | 0 | $ | - | |
| 0302 | Supply 900mm RC pipe IJ class 2 | | | m | | $ 159.31 | | 0 | $ | - | |
| 0303 | Supply 1050mm RC pipe IJ class 2 | | | m | | $ 208.75 | | 0 | $ | - | |
| 0304 | Supply 1200mm RC pipe IJ class 2 | | | m | | $ 261.55 | | 0 | $ | - | |
| 0305 | Supply 1350mm RC pipe IJ class 2 | | | m | | $ 319.98 | | 0 | $ | - | |
| 0306 | Supply 1500mm RC pipe IJ class 2 | | | m | | $ 389.19 | | 0 | $ | - | |
| 0307 | Supply 1650mm RC pipe IJ class 2 | | | m | | $ 459.92 | | 0 | $ | - | |
| 0308 | Supply 1800mm RC pipe IJ class 2 | | | m | | $ 537.25 | | 0 | $ | - | |
| 0309 | Supply 1950mm RC pipe IJ class 2 | | | m | | $ 650.68 | | 0 | $ | - | |
| 0310 | Supply 2100mm RC pipe IJ class 2 | | | m | | $ 796.09 | | 0 | $ | - | |
| | BOX CULVERTS | | | | | | | | | | |
| 0350 | Supply X mm RCBC | | | m | | P.O.A. | | | $ | - | |
| 0351 | Supply X mm RCBC | | | m | | P.O.A. | | | $ | - | |
| 0352 | Supply X mm RCBC | | | m | | P.O.A. | | | $ | - | |
| | PROVISIONAL | | | | | | | | | | |
| 0484 | Construction safety fee | $ | 14,000.00 | ITEM | | $ 1.00 | $ - | | $ | 1,000.00 | 0.2% of Subtotal |
| 0486 | Supervision | $ | 14,000.00 | ITEM | | $ 1.00 | | | $ | 1,000.00 | 3.6% of Subtotal |
| 0489 | Transport of plant | | | ITEM | | $ 1.00 | | | $ | - | |
| | SERVICES | | | | | | | | | | |
| 0496 | Alteration to services - General | | | ITEM | | $ 1.00 | | | $ | - | |
| 0497 | Acquisition of land | | | ITEM | | $ 1.00 | | | $ | - | |
| 0498 | Acquisition of easements | | | ITEM | | $ 1.00 | | | $ | - | |
| | Subtotal | | | | | | | | $ | 13,799.00 | |
| | Contingencies | | | | | | | | | | |
| 0490 | Contingencies (Provisional) | | | ITEM | | 30% | | | $ | 4,140.00 | 30% of Subtotal |
| | DESIGN CHARGES | | | | | | | | | | |
| 0450 | Project Design & Survey | | | ITEM | | $ 1.00 | | 1380 | $ | 1,380.00 | 10% of Subtotal |
| 0451 | | | | | | | | | | | |
| 0452 | Total | | | | | | | | $ | 20,000.00 | N.B: Rounded up to nerarest $1000 |
| 0453 | | | | | | | | | | | |
| 0454 | | | | | | | | | | | |
| 0456 | | | | | | | | | | | |
| 0480 | | | | | | | | | | | |
| | N.B: Price has been rounded up to nerarest $1000 | | | | | | | | | | |

Date Printed : 22/05/2006

# MASTER DRAINAGE AREA "Model 1D"
## PRELIMINARY DRAINAGE ESTIMATE

| No. | Description | Comment | | Unit | | Unit Cost | | Number | | Amount | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | GENERAL | | | | | | | | | | |
| 0001 | Traffic Control | As per Appendix "K" | | ITEM | | | | | $ | 1,000.00 | |
| 0002 | Site Establishment | Min. $10,000 | | ITEM | | $ 1.00 | | 10000 | $ | 10,000.00 | |
| 0004 | Box out & remove existing driveways | | | ITEM | | $ 150.00 | | | $ | - | |
| 0005 | Remove existing K & C structures | | | ITEM | | $ 10.00 | | 15 | $ | 150.00 | |
| | DRAINAGE | | | | | | | | | | |
| 0051 | Takeup & stack existing RC pipes | | | m | | $ 50.00 | | 0 | $ | - | |
| 0067 | Excavation of open drain | | | m3 | Scale | $ - | | | $ | - | |
| 0068 | Subsoil drains in place (STANDARD) | | | m | | $ 19.35 | | 15 | $ | 291.00 | |
| 0075 | Excavate/lay/backfill 300mm RC pipe | **Type A** | | m | | $ 100.00 | | | $ | - | |
| 1075 | Excavate/lay/backfill 300mm RC pipe | **Type B** | | m | | $ 125.00 | | | $ | - | |
| 2075 | Excavate/lay/backfill 300mm RC pipe | **Type C** | | m | | $ 207.00 | | | $ | - | |
| 3075 | Excavate/lay/backfill 300mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0076 | Excavate/lay/backfill 375mm RC pipe | **Type A** | | m | | $ 110.00 | | | $ | - | |
| 1076 | Excavate/lay/backfill 375mm RC pipe | **Type B** | | m | | $ 161.00 | | | $ | - | |
| 2076 | Excavate/lay/backfill 375mm RC pipe | **Type C** | | m | | $ 230.00 | | | $ | - | |
| 3076 | Excavate/lay/backfill 375mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0077 | Excavate/lay/backfill 450mm RC pipe | **Type A** | | m | | $ 120.00 | | | $ | - | |
| 1077 | Excavate/lay/backfill 450mm RC pipe | **Type B** | | m | | $ 190.00 | | | $ | - | |
| 2077 | Excavate/lay/backfill 450mm RC pipe | **Type C** | | m | | $ 250.00 | | | $ | - | |
| 3077 | Excavate/lay/backfill 450mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0078 | Excavate/lay/backfill 525mm RC pipe | **Type A** | | m | | $ 135.00 | | | $ | - | |
| 1078 | Excavate/lay/backfill 525mm RC pipe | **Type B** | | m | | $ 195.00 | | | $ | - | |
| 2078 | Excavate/lay/backfill 525mm RC pipe | **Type C** | | m | | $ 250.00 | | | $ | - | |
| 3078 | Excavate/lay/backfill 525mm RC pipe | **Type D** | | m | | $ - | | | $ | - | |
| 0079 | Excavate/lay/backfill 600mm RC pipe | **Type A** | | m | | $ 145.00 | | | $ | - | |
| 1079 | Excavate/lay/backfill 600mm RC pipe | **Type B** | | m | | $ 207.00 | | 40 | $ | 8,280.00 | |
| 2079 | Excavate/lay/backfill 600mm RC pipe | **Type C** | | m | | $ 276.00 | | | $ | - | |
| 3079 | Excavate/lay/backfill 600mm RC pipe | **Type D** | | m | | $ 391.00 | | | $ | - | |
| 0080 | Excavate/lay/backfill 675mm RC pipe | **Type A** | | m | | $ 160.00 | | | $ | - | |
| 1080 | Excavate/lay/backfill 675mm RC pipe | **Type B** | | m | | $ 210.00 | | | $ | - | |
| 2080 | Excavate/lay/backfill 675mm RC pipe | **Type C** | | m | | $ 300.00 | | | $ | - | |
| 3080 | Excavate/lay/backfill 675mm RC pipe | **Type D** | | m | | $ 414.00 | | | $ | - | |
| 0081 | Excavate/lay/backfill 750mm RC pipe | **Type A** | | m | | $ 177.00 | | | $ | - | |
| 1081 | Excavate/lay/backfill 750mm RC pipe | **Type B** | | m | | $ 240.00 | | | $ | - | |
| 2081 | Excavate/lay/backfill 750mm RC pipe | **Type C** | | m | | $ 300.00 | | | $ | - | |
| 3081 | Excavate/lay/backfill 750mm RC pipe | **Type D** | | m | | $ 460.00 | | | $ | - | |
| 0082 | Excavate/lay/backfill 825mm RC pipe | **Type A** | | m | | $ 177.00 | | | $ | - | |
| 1082 | Excavate/lay/backfill 825mm RC pipe | **Type B** | | m | | $ 276.00 | | | $ | - | |
| 2082 | Excavate/lay/backfill 825mm RC pipe | **Type C** | | m | | $ 350.00 | | | $ | - | |
| 3082 | Excavate/lay/backfill 825mm RC pipe | **Type D** | | m | | $ 460.00 | | | $ | - | |
| 0083 | Excavate/lay/backfill 900mm RC pipe | **Type A** | | m | | $ 207.00 | | | $ | - | |
| 1083 | Excavate/lay/backfill 900mm RC pipe | **Type B** | | m | | $ 276.00 | | | $ | - | |
| 2083 | Excavate/lay/backfill 900mm RC pipe | **Type C** | | m | | $ 360.00 | | | $ | - | |
| 3083 | Excavate/lay/backfill 900mm RC pipe | **Type D** | | m | | $ 480.00 | | | $ | - | |
| 0084 | Excavate/lay/backfill 1050mm RC pipe | **Type A** | | m | | $ 215.00 | | | $ | - | |
| 1084 | Excavate/lay/backfill 1050mm RC pipe | **Type B** | | m | | $ 300.00 | | | $ | - | |
| 2084 | Excavate/lay/backfill 1050mm RC pipe | **Type C** | | m | | $ 380.00 | | | $ | - | |
| 3084 | Excavate/lay/backfill 1050mm RC pipe | **Type D** | | m | | $ 520.00 | | | $ | - | |
| 0085 | Excavate/lay/backfill 1200mm RC pipe | **Type A** | | m | | $ 290.00 | | | $ | - | |
| 1085 | Excavate/lay/backfill 1200mm RC pipe | **Type B** | | m | | $ 350.00 | | | $ | - | |
| 2085 | Excavate/lay/backfill 1200mm RC pipe | **Type C** | | m | | $ 517.50 | | | $ | - | |
| 3085 | Excavate/lay/backfill 1200mm RC pipe | **Type D** | | m | | $ 620.00 | | | $ | - | |
| 0086 | Excavate/lay/backfill 1350mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1086 | Excavate/lay/backfill 1350mm RC pipe | **Type B** | | m | | $ 380.00 | | | $ | - | |
| 2086 | Excavate/lay/backfill 1350mm RC pipe | **Type C** | | m | | $ 580.00 | | | $ | - | |
| 3086 | Excavate/lay/backfill 1350mm RC pipe | **Type D** | | m | | $ 650.00 | | | $ | - | |
| 0087 | Excavate/lay/backfill 1500mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1087 | Excavate/lay/backfill 1500mm RC pipe | **Type B** | | m | | $ 437.00 | | | $ | - | |
| 2087 | Excavate/lay/backfill 1500mm RC pipe | **Type C** | | m | | $ 598.00 | | | $ | - | |
| 3087 | Excavate/lay/backfill 1500mm RC pipe | **Type D** | | m | | $ 680.00 | | | $ | - | |
| 0088 | Excavate/lay/backfill 1650mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1088 | Excavate/lay/backfill 1650mm RC pipe | **Type B** | | m | | $ 540.00 | | | $ | - | |
| 2088 | Excavate/lay/backfill 1650mm RC pipe | **Type C** | | m | | $ 644.00 | | | $ | - | |
| 3088 | Excavate/lay/backfill 1650mm RC pipe | **Type D** | | m | | $ 700.00 | | | $ | - | |
| 0089 | Excavate/lay/backfill 1800mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1089 | Excavate/lay/backfill 1800mm RC pipe | **Type B** | | m | | $ 550.00 | | | $ | - | |
| 2089 | Excavate/lay/backfill 1800mm RC pipe | **Type C** | | m | | $ 725.00 | | | $ | - | |
| 3089 | Excavate/lay/backfill 1800mm RC pipe | **Type D** | | m | | $ 750.00 | | | $ | - | |
| 0090 | Excavate/lay/backfill 1950mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1090 | Excavate/lay/backfill 1950mm RC pipe | **Type B** | | m | | $ - | | | $ | - | |
| 2090 | Excavate/lay/backfill 1950mm RC pipe | **Type C** | | m | | $ 750.00 | | | $ | - | |
| 3090 | Excavate/lay/backfill 1950mm RC pipe | **Type D** | | m | | $ 800.00 | | | $ | - | |
| 0091 | Excavate/lay/backfill 2100mm RC pipe | **Type A** | | m | | $ - | | | $ | - | |
| 1091 | Excavate/lay/backfill 2100mm RC pipe | **Type B** | | m | | $ - | | | $ | - | |
| 2091 | Excavate/lay/backfill 2100mm RC pipe | **Type C** | | m | | $ 800.00 | | | $ | - | |
| 3091 | Excavate/lay/backfill 2100mm RC pipe | **Type D** | | m | | $ 950.00 | | | $ | - | |
| 0145 | Side entry pit 2-4 metres extra | | | No. | | $ 1,090.00 | | 4 | $ | 4,360.00 | |
| 0146 | Manholes 1050mm 0-2 metre deep | | | No. | | $ 1,600.00 | | | $ | - | |
| 0148 | Manholes 1500mm 0-3 metre deep | | | No. | | $ 2,179.00 | | 1 | $ | 2,179.00 | |
| 0149 | Manholes 2100mm 0-3 metre deep | | | No. | | $ 3,683.00 | | | $ | - | |
| 0151 | Manholes 1050mm 2-4 metre deep | | | No. | | $ 2,500.00 | | | $ | - | |
| 0153 | Manholes 1500mm 3-5 metre deep | | | No. | | $ 4,250.00 | | | $ | - | |
| 0154 | Manholes 2100mm 3-5 metre deep | | | No. | | $ 5,910.00 | | | $ | - | |
| 0155 | Manholes Special in place | | | ITEM | | $ 1.00 | | | $ | - | |
| | CONCRETE | | | | | | | | | | |
| 0161 | Concrete K & C type **M1** (incl. supply of conc.) | | | m | Scale | $ 60.00 | | 15 | $ | 900.00 | |
| 0162 | Concrete K & C type **B1** (incl. supply of conc.) | | | m | Scale | $ - | | | $ | - | |
| 0163 | Concrete K & C type **M3** (incl. supply of conc.) | | | m | Scale | $ - | | | $ | - | |
| | BITUMEN SURFACING | | | | | | | | | | |
| 0200 | Prime Coat | | | m2 | Scale | $ 10.00 | | | $ | - | |
| 0206 | Asphaltic Concrete type 2 (10mm) S & L | (light traffic) 25-40mm Thick | | Tonne | Scale | $ - | | | $ | - | |
| 0207 | Asphaltic Concrete type 4 (14mm) S & L | (light traffic) 35-55mm Thick | | Tonne | Scale | $ - | | | $ | - | |
| | PIPES & DRAINWAYS | | | | | | | | | | |
| 0294 | Supply 300mm RC pipe RRJ class 2 | | | m | | $ 27.50 | | 0 | $ | - | |
| 0295 | Supply 375mm RC pipe RRJ class 2 | | | m | | $ 41.09 | | 0 | $ | - | |
| 0296 | Supply 450mm RC pipe RRJ class 2 | | | m | | $ 58.68 | | 0 | $ | - | |
| 0297 | Supply 525mm RC pipe RRJ class 2 | | | m | | $ 74.77 | | 0 | $ | - | |
| 0298 | Supply 600mm RC pipe RRJ class 2 | | | m | | $ 91.94 | | 40 | $ | 3,678.00 | |
| 0299 | Supply 675mm RC pipe IJ class 2 | | | m | | $ 96.71 | | 0 | $ | - | |
| 0300 | Supply 750mm RC pipe IJ class 2 | | | m | | $ 113.97 | | 0 | $ | - | |
| 0301 | Supply 825mm RC pipe IJ class 2 | | | m | | $ 131.48 | | 0 | $ | - | |
| 0302 | Supply 900mm RC pipe IJ class 2 | | | m | | $ 159.31 | | 0 | $ | - | |
| 0303 | Supply 1050mm RC pipe IJ class 2 | | | m | | $ 208.75 | | 0 | $ | - | |
| 0304 | Supply 1200mm RC pipe IJ class 2 | | | m | | $ 261.55 | | 0 | $ | - | |
| 0305 | Supply 1350mm RC pipe IJ class 2 | | | m | | $ 319.98 | | 0 | $ | - | |
| 0306 | Supply 1500mm RC pipe IJ class 2 | | | m | | $ 389.19 | | 0 | $ | - | |
| 0307 | Supply 1650mm RC pipe IJ class 2 | | | m | | $ 459.92 | | 0 | $ | - | |
| 0308 | Supply 1800mm RC pipe IJ class 2 | | | m | | $ 537.25 | | 0 | $ | - | |
| 0309 | Supply 1950mm RC pipe IJ class 2 | | | m | | $ 650.68 | | 0 | $ | - | |
| 0310 | Supply 2100mm RC pipe IJ class 2 | | | m | | $ 796.09 | | 0 | $ | - | |
| | BOX CULVERTS | | | | | | | | | | |
| 0350 | Supply X mm RCBC | | | m | | P.O.A. | | | $ | - | |
| 0351 | Supply X mm RCBC | | | m | | P.O.A. | | | $ | - | |
| 0352 | Supply X mm RCBC | | | m | | P.O.A. | | | $ | - | |
| | PROVISIONAL | | | | | | | | | | |
| 0484 | Construction safety fee | $ | 34,000.00 | ITEM | | $ 1.00 | $ - | | $ | 1,000.00 | 0.2% of Subtotal |
| 0486 | Supervision | $ | 34,000.00 | ITEM | | $ 1.00 | | | $ | 2,000.00 | 3.6% of Subtotal |
| 0489 | Transport of plant | | | ITEM | | $ 1.00 | | | $ | - | |
| | SERVICES | | | | | | | | | | |
| 0496 | Alteration to services - General | | | ITEM | | $ 1.00 | | | $ | - | |
| 0497 | Acquisition of land | | | ITEM | | $ 1.00 | | | $ | - | |
| 0498 | Acquisition of easements | | | ITEM | | $ 1.00 | | | $ | - | |
| | Subtotal | | | | | | | | $ | 33,838.00 | |
| | Contingencies | | | | | | | | | | |
| 0490 | Contingencies (Provisional) | | | ITEM | | 30% | | | $ | 10,152.00 | 30% of Subtotal |
| | DESIGN CHARGES | | | | | | | | | | |
| 0450 | Project Design & Survey | | | ITEM | | $ 1.00 | | 3384 | $ | 3,384.00 | 10% of Subtotal |
| 0451 | | | | | | | | | | | |
| 0452 | Total | | | | | | | | $ | 48,000.00 | N.B: Rounded up to nerarest $1000 |
| 0453 | | | | | | | | | | | |
| 0454 | | | | | | | | | | | |
| 0456 | | | | | | | | | | | |
| 0480 | | | | | | | | | | | |
| | N.B: Price has been rounded up to nerarest $1000 | | | | | | | | | | |

Date Printed : 22/05/2006

# MASTER DRAINAGE AREA "Model 1E"
## PRELIMINARY DRAINAGE ESTIMATE

| No. | Description | Comment | | Unit | | Unit Cost | Number | | Amount | |
|---|---|---|---|---|---|---|---|---|---|---|
| | GENERAL | | | | | | | | | |
| 0001 | Traffic Control | As per Appendix "K" | | ITEM | | | | $ | 1,000.00 | |
| 0002 | Site Establishment | Min. $10,000 | | ITEM | | $ 1.00 | 10000 | $ | 10,000.00 | |
| 0004 | Box out & remove existing driveways | | | ITEM | | $ 150.00 | | $ | - | |
| 0005 | Remove existing K & C structures | | | ITEM | | $ 10.00 | 15 | $ | 150.00 | |
| | DRAINAGE | | | | | | | | | |
| 0051 | Takeup & stack existing RC pipes | | | m | | $ 50.00 | 0 | $ | - | |
| 0067 | Excavation of open drain | | | m3 | Scale | $ - | | $ | - | |
| 0068 | Subsoil drains in place (STANDARD) | | | m | | $ 19.35 | 15 | $ | 291.00 | |
| 0075 | Excavate/lay/backfill 300mm RC pipe | **Type A** | | m | | $ 100.00 | | $ | - | |
| 1075 | Excavate/lay/backfill 300mm RC pipe | **Type B** | | m | | $ 125.00 | | $ | - | |
| 2075 | Excavate/lay/backfill 300mm RC pipe | **Type C** | | m | | $ 207.00 | | $ | - | |
| 3075 | Excavate/lay/backfill 300mm RC pipe | **Type D** | | m | | $ - | | $ | - | |
| 0076 | Excavate/lay/backfill 375mm RC pipe | **Type A** | | m | | $ 110.00 | | $ | - | |
| 1076 | Excavate/lay/backfill 375mm RC pipe | **Type B** | | m | | $ 161.00 | | $ | - | |
| 2076 | Excavate/lay/backfill 375mm RC pipe | **Type C** | | m | | $ 230.00 | | $ | - | |
| 3076 | Excavate/lay/backfill 375mm RC pipe | **Type D** | | m | | $ - | | $ | - | |
| 0077 | Excavate/lay/backfill 450mm RC pipe | **Type A** | | m | | $ 120.00 | | $ | - | |
| 1077 | Excavate/lay/backfill 450mm RC pipe | **Type B** | | m | | $ 190.00 | | $ | - | |
| 2077 | Excavate/lay/backfill 450mm RC pipe | **Type C** | | m | | $ 250.00 | | $ | - | |
| 3077 | Excavate/lay/backfill 450mm RC pipe | **Type D** | | m | | $ - | | $ | - | |
| 0078 | Excavate/lay/backfill 525mm RC pipe | **Type A** | | m | | $ 135.00 | | $ | - | |
| 1078 | Excavate/lay/backfill 525mm RC pipe | **Type B** | | m | | $ 195.00 | | $ | - | |
| 2078 | Excavate/lay/backfill 525mm RC pipe | **Type C** | | m | | $ 250.00 | | $ | - | |
| 3078 | Excavate/lay/backfill 525mm RC pipe | **Type D** | | m | | $ - | | $ | - | |
| 0079 | Excavate/lay/backfill 600mm RC pipe | **Type A** | | m | | $ 145.00 | | $ | - | |
| 1079 | Excavate/lay/backfill 600mm RC pipe | **Type B** | | m | | $ 207.00 | 20 | $ | 4,140.00 | |
| 2079 | Excavate/lay/backfill 600mm RC pipe | **Type C** | | m | | $ 276.00 | | $ | - | |
| 3079 | Excavate/lay/backfill 600mm RC pipe | **Type D** | | m | | $ 391.00 | | $ | - | |
| 0080 | Excavate/lay/backfill 675mm RC pipe | **Type A** | | m | | $ 160.00 | | $ | - | |
| 1080 | Excavate/lay/backfill 675mm RC pipe | **Type B** | | m | | $ 210.00 | | $ | - | |
| 2080 | Excavate/lay/backfill 675mm RC pipe | **Type C** | | m | | $ 300.00 | | $ | - | |
| 3080 | Excavate/lay/backfill 675mm RC pipe | **Type D** | | m | | $ 414.00 | | $ | - | |
| 0081 | Excavate/lay/backfill 750mm RC pipe | **Type A** | | m | | $ 177.00 | | $ | - | |
| 1081 | Excavate/lay/backfill 750mm RC pipe | **Type B** | | m | | $ 240.00 | | $ | - | |
| 2081 | Excavate/lay/backfill 750mm RC pipe | **Type C** | | m | | $ 300.00 | | $ | - | |
| 3081 | Excavate/lay/backfill 750mm RC pipe | **Type D** | | m | | $ 460.00 | | $ | - | |
| 0082 | Excavate/lay/backfill 825mm RC pipe | **Type A** | | m | | $ 177.00 | | $ | - | |
| 1082 | Excavate/lay/backfill 825mm RC pipe | **Type B** | | m | | $ 276.00 | | $ | - | |
| 2082 | Excavate/lay/backfill 825mm RC pipe | **Type C** | | m | | $ 350.00 | | $ | - | |
| 3082 | Excavate/lay/backfill 825mm RC pipe | **Type D** | | m | | $ 460.00 | | $ | - | |
| 0083 | Excavate/lay/backfill 900mm RC pipe | **Type A** | | m | | $ 207.00 | | $ | - | |
| 1083 | Excavate/lay/backfill 900mm RC pipe | **Type B** | | m | | $ 276.00 | | $ | - | |
| 2083 | Excavate/lay/backfill 900mm RC pipe | **Type C** | | m | | $ 360.00 | | $ | - | |
| 3083 | Excavate/lay/backfill 900mm RC pipe | **Type D** | | m | | $ 480.00 | | $ | - | |
| 0084 | Excavate/lay/backfill 1050mm RC pipe | **Type A** | | m | | $ 215.00 | | $ | - | |
| 1084 | Excavate/lay/backfill 1050mm RC pipe | **Type B** | | m | | $ 300.00 | | $ | - | |
| 2084 | Excavate/lay/backfill 1050mm RC pipe | **Type C** | | m | | $ 380.00 | | $ | - | |
| 3084 | Excavate/lay/backfill 1050mm RC pipe | **Type D** | | m | | $ 520.00 | | $ | - | |
| 0085 | Excavate/lay/backfill 1200mm RC pipe | **Type A** | | m | | $ 290.00 | | $ | - | |
| 1085 | Excavate/lay/backfill 1200mm RC pipe | **Type B** | | m | | $ 350.00 | | $ | - | |
| 2085 | Excavate/lay/backfill 1200mm RC pipe | **Type C** | | m | | $ 517.50 | | $ | - | |
| 3085 | Excavate/lay/backfill 1200mm RC pipe | **Type D** | | m | | $ 620.00 | | $ | - | |
| 0086 | Excavate/lay/backfill 1350mm RC pipe | **Type A** | | m | | $ - | | $ | - | |
| 1086 | Excavate/lay/backfill 1350mm RC pipe | **Type B** | | m | | $ 380.00 | | $ | - | |
| 2086 | Excavate/lay/backfill 1350mm RC pipe | **Type C** | | m | | $ 580.00 | | $ | - | |
| 3086 | Excavate/lay/backfill 1350mm RC pipe | **Type D** | | m | | $ 650.00 | | $ | - | |
| 0087 | Excavate/lay/backfill 1500mm RC pipe | **Type A** | | m | | $ - | | $ | - | |
| 1087 | Excavate/lay/backfill 1500mm RC pipe | **Type B** | | m | | $ 437.00 | | $ | - | |
| 2087 | Excavate/lay/backfill 1500mm RC pipe | **Type C** | | m | | $ 598.00 | | $ | - | |
| 3087 | Excavate/lay/backfill 1500mm RC pipe | **Type D** | | m | | $ 680.00 | | $ | - | |
| 0088 | Excavate/lay/backfill 1650mm RC pipe | **Type A** | | m | | $ - | | $ | - | |
| 1088 | Excavate/lay/backfill 1650mm RC pipe | **Type B** | | m | | $ 540.00 | | $ | - | |
| 2088 | Excavate/lay/backfill 1650mm RC pipe | **Type C** | | m | | $ 644.00 | | $ | - | |
| 3088 | Excavate/lay/backfill 1650mm RC pipe | **Type D** | | m | | $ 700.00 | | $ | - | |
| 0089 | Excavate/lay/backfill 1800mm RC pipe | **Type A** | | m | | $ - | | $ | - | |
| 1089 | Excavate/lay/backfill 1800mm RC pipe | **Type B** | | m | | $ 550.00 | | $ | - | |
| 2089 | Excavate/lay/backfill 1800mm RC pipe | **Type C** | | m | | $ 725.00 | | $ | - | |
| 3089 | Excavate/lay/backfill 1800mm RC pipe | **Type D** | | m | | $ 750.00 | | $ | - | |
| 0090 | Excavate/lay/backfill 1950mm RC pipe | **Type A** | | m | | $ - | | $ | - | |
| 1090 | Excavate/lay/backfill 1950mm RC pipe | **Type B** | | m | | $ - | | $ | - | |
| 2090 | Excavate/lay/backfill 1950mm RC pipe | **Type C** | | m | | $ 750.00 | | $ | - | |
| 3090 | Excavate/lay/backfill 1950mm RC pipe | **Type D** | | m | | $ 800.00 | | $ | - | |
| 0091 | Excavate/lay/backfill 2100mm RC pipe | **Type A** | | m | | $ - | | $ | - | |
| 1091 | Excavate/lay/backfill 2100mm RC pipe | **Type B** | | m | | $ - | | $ | - | |
| 2091 | Excavate/lay/backfill 2100mm RC pipe | **Type C** | | m | | $ 800.00 | | $ | - | |
| 3091 | Excavate/lay/backfill 2100mm RC pipe | **Type D** | | m | | $ 950.00 | | $ | - | |
| 0145 | Side entry pit 2-4 metres extra | | | No. | | $ 1,090.00 | 4 | $ | 4,360.00 | |
| 0146 | Manholes 1050mm 0-2 metre deep | | | No. | | $ 1,600.00 | | $ | - | |
| 0148 | Manholes 1500mm 0-3 metre deep | | | No. | | $ 2,179.00 | 1 | $ | 2,179.00 | |
| 0149 | Manholes 2100mm 0-3 metre deep | | | No. | | $ 3,683.00 | | $ | - | |
| 0151 | Manholes 1050mm 2-4 metre deep | | | No. | | $ 2,500.00 | | $ | - | |
| 0153 | Manholes 1500mm 3-5 metre deep | | | No. | | $ 4,250.00 | | $ | - | |
| 0154 | Manholes 2100mm 3-5 metre deep | | | No. | | $ 5,910.00 | | $ | - | |
| 0155 | Manholes Special in place | | | ITEM | | $ 1.00 | | $ | - | |
| | CONCRETE | | | | | | | | | |
| 0161 | Concrete K & C type **M1** (incl. supply of conc.) | | | m | Scale | $ 60.00 | 15 | $ | 900.00 | |
| 0162 | Concrete K & C type **B1** (incl. supply of conc.) | | | m | Scale | $ - | | $ | - | |
| 0163 | Concrete K & C type **M3** (incl. supply of conc.) | | | m | Scale | $ - | | $ | - | |
| | BITUMEN SURFACING | | | | | | | | | |
| 0200 | Prime Coat | | | m2 | Scale | $ 10.00 | | $ | - | |
| 0206 | Asphaltic Concrete type 2 (10mm) S & L | (light traffic) 25-40mm Thick | | Tonne | Scale | $ - | | $ | - | |
| 0207 | Asphaltic Concrete type 4 (14mm) S & L | (light traffic) 35-55mm Thick | | Tonne | Scale | $ - | | $ | - | |
| | PIPES & DRAINWAYS | | | | | | | | | |
| 0294 | Supply 300mm RC pipe RRJ class 2 | | | m | | $ 27.50 | 0 | $ | - | |
| 0295 | Supply 375mm RC pipe RRJ class 2 | | | m | | $ 41.09 | 0 | $ | - | |
| 0296 | Supply 450mm RC pipe RRJ class 2 | | | m | | $ 58.68 | 0 | $ | - | |
| 0297 | Supply 525mm RC pipe RRJ class 2 | | | m | | $ 74.77 | 0 | $ | - | |
| 0298 | Supply 600mm RC pipe RRJ class 2 | | | m | | $ 91.94 | 20 | $ | 1,839.00 | |
| 0299 | Supply 675mm RC pipe IJ class 2 | | | m | | $ 96.71 | 0 | $ | - | |
| 0300 | Supply 750mm RC pipe IJ class 2 | | | m | | $ 113.97 | 0 | $ | - | |
| 0301 | Supply 825mm RC pipe IJ class 2 | | | m | | $ 131.48 | 0 | $ | - | |
| 0302 | Supply 900mm RC pipe IJ class 2 | | | m | | $ 159.31 | 0 | $ | - | |
| 0303 | Supply 1050mm RC pipe IJ class 2 | | | m | | $ 208.75 | 0 | $ | - | |
| 0304 | Supply 1200mm RC pipe IJ class 2 | | | m | | $ 261.55 | 0 | $ | - | |
| 0305 | Supply 1350mm RC pipe IJ class 2 | | | m | | $ 319.98 | 0 | $ | - | |
| 0306 | Supply 1500mm RC pipe IJ class 2 | | | m | | $ 389.19 | 0 | $ | - | |
| 0307 | Supply 1650mm RC pipe IJ class 2 | | | m | | $ 459.92 | 0 | $ | - | |
| 0308 | Supply 1800mm RC pipe IJ class 2 | | | m | | $ 537.25 | 0 | $ | - | |
| 0309 | Supply 1950mm RC pipe IJ class 2 | | | m | | $ 650.68 | 0 | $ | - | |
| 0310 | Supply 2100mm RC pipe IJ class 2 | | | m | | $ 796.09 | 0 | $ | - | |
| | BOX CULVERTS | | | | | | | | | |
| 0350 | Supply X mm RCBC | | | m | | P.O.A. | | $ | - | |
| 0351 | Supply X mm RCBC | | | m | | P.O.A. | | $ | - | |
| 0352 | Supply X mm RCBC | | | m | | P.O.A. | | $ | - | |
| | PROVISIONAL | | | | | | | | | |
| 0484 | Construction safety fee | $ | 27,000.00 | ITEM | | $ 1.00 | $ - | $ | 1,000.00 | 0.2% of Subtotal |
| 0486 | Supervision | $ | 27,000.00 | ITEM | | $ 1.00 | | $ | 1,000.00 | 3.6% of Subtotal |
| 0489 | Transport of plant | | | ITEM | | $ 1.00 | | $ | - | |
| | SERVICES | | | | | | | | | |
| 0496 | Alteration to services - General | | | ITEM | | $ 1.00 | | $ | - | |
| 0497 | Acquisition of land | | | ITEM | | $ 1.00 | | $ | - | |
| 0498 | Acquisition of easements | | | ITEM | | $ 1.00 | | $ | - | |
| | Subtotal | | | | | | | $ | 26,859.00 | |
| | Contingencies | | | | | | | | | |
| 0490 | Contingencies (Provisional) | | | ITEM | | 30% | | $ | 8,058.00 | 30% of Subtotal |
| | DESIGN CHARGES | | | | | | | | | |
| 0450 | Project Design & Survey | | | ITEM | | $ 1.00 | 2686 | $ | 2,686.00 | 10% of Subtotal |
| 0451 | | | | | | | | | | |
| 0452 | Total | | | | | | | $ | 38,000.00 | N.B: Rounded up to nerarest $1000 |
| 0453 | | | | | | | | | | |
| 0454 | | | | | | | | | | |
| 0456 | | | | | | | | | | |
| 0480 | | | | | | | | | | |
| | N.B: Price has been rounded up to nerarest $1000 | | | | | | | | | |

Date Printed : 22/05/2006

# MASTER DRAINAGE AREA "Shoreham St - Model 3"
## PRELIMINARY DRAINAGE ESTIMATE

| No. | Description | Comment | | Unit | | Unit Cost | Number | Amount | |
|---|---|---|---|---|---|---|---|---|---|
| | GENERAL | | | | | | | | |
| 0001 | Traffic Control | | | ITEM | | | | $ 5,000.00 | |
| 0002 | Site Establishment | Min. $10,000 | | ITEM | | $ 1.00 | 10000 | $ 10,000.00 | |
| 0004 | Box out & remove existing driveways | | | ITEM | | $ 150.00 | 6 | $ 900.00 | |
| 0005 | Remove existing K & C structures | | | ITEM | | $ 10.00 | 210 | $ 2,100.00 | |
| | DRAINAGE | | | | | | | | |
| 0051 | Takeup & stack existing RC pipes | | | m | | $ 50.00 | 185 | $ 9,250.00 | |
| 0067 | Excavation of open drain | | | m3 | Scale | $ - | | $ - | |
| 0068 | Subsoil drains in place (STANDARD) | | | m | | $ 19.35 | 210 | $ 4,064.00 | |
| 0075 | Excavate/lay/backfill 300mm RC pipe | **Type A** | | m | | $ 100.00 | | $ - | |
| 1075 | Excavate/lay/backfill 300mm RC pipe | **Type B** | | m | | $ 125.00 | | $ - | |
| 2075 | Excavate/lay/backfill 300mm RC pipe | **Type C** | | m | | $ 207.00 | | $ - | |
| 3075 | Excavate/lay/backfill 300mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0076 | Excavate/lay/backfill 375mm RC pipe | **Type A** | | m | | $ 110.00 | | $ - | |
| 1076 | Excavate/lay/backfill 375mm RC pipe | **Type B** | | m | | $ 161.00 | | $ - | |
| 2076 | Excavate/lay/backfill 375mm RC pipe | **Type C** | | m | | $ 230.00 | | $ - | |
| 3076 | Excavate/lay/backfill 375mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0077 | Excavate/lay/backfill 450mm RC pipe | **Type A** | | m | | $ 120.00 | | $ - | |
| 1077 | Excavate/lay/backfill 450mm RC pipe | **Type B** | | m | | $ 190.00 | | $ - | |
| 2077 | Excavate/lay/backfill 450mm RC pipe | **Type C** | | m | | $ 250.00 | | $ - | |
| 3077 | Excavate/lay/backfill 450mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0078 | Excavate/lay/backfill 525mm RC pipe | **Type A** | | m | | $ 135.00 | | $ - | |
| 1078 | Excavate/lay/backfill 525mm RC pipe | **Type B** | | m | | $ 195.00 | 115 | $ 22,425.00 | |
| 2078 | Excavate/lay/backfill 525mm RC pipe | **Type C** | | m | | $ 250.00 | | $ - | |
| 3078 | Excavate/lay/backfill 525mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0079 | Excavate/lay/backfill 600mm RC pipe | **Type A** | | m | | $ 145.00 | | $ - | |
| 1079 | Excavate/lay/backfill 600mm RC pipe | **Type B** | | m | | $ 207.00 | | $ - | |
| 2079 | Excavate/lay/backfill 600mm RC pipe | **Type C** | | m | | $ 276.00 | | $ - | |
| 3079 | Excavate/lay/backfill 600mm RC pipe | **Type D** | | m | | $ 391.00 | | $ - | |
| 0080 | Excavate/lay/backfill 675mm RC pipe | **Type A** | | m | | $ 160.00 | | $ - | |
| 1080 | Excavate/lay/backfill 675mm RC pipe | **Type B** | | m | | $ 210.00 | | $ - | |
| 2080 | Excavate/lay/backfill 675mm RC pipe | **Type C** | | m | | $ 300.00 | | $ - | |
| 3080 | Excavate/lay/backfill 675mm RC pipe | **Type D** | | m | | $ 414.00 | | $ - | |
| 0081 | Excavate/lay/backfill 750mm RC pipe | **Type A** | | m | | $ 177.00 | | $ - | |
| 1081 | Excavate/lay/backfill 750mm RC pipe | **Type B** | | m | | $ 240.00 | | $ - | |
| 2081 | Excavate/lay/backfill 750mm RC pipe | **Type C** | | m | | $ 300.00 | | $ - | |
| 3081 | Excavate/lay/backfill 750mm RC pipe | **Type D** | | m | | $ 460.00 | | $ - | |
| 0082 | Excavate/lay/backfill 825mm RC pipe | **Type A** | | m | | $ 177.00 | | $ - | |
| 1082 | Excavate/lay/backfill 825mm RC pipe | **Type B** | | m | | $ 276.00 | | $ - | |
| 2082 | Excavate/lay/backfill 825mm RC pipe | **Type C** | | m | | $ 350.00 | | $ - | |
| 3082 | Excavate/lay/backfill 825mm RC pipe | **Type D** | | m | | $ 460.00 | | $ - | |
| 0083 | Excavate/lay/backfill 900mm RC pipe | **Type A** | | m | | $ 207.00 | | $ - | |
| 1083 | Excavate/lay/backfill 900mm RC pipe | **Type B** | | m | | $ 276.00 | 370 | $ 102,120.00 | |
| 2083 | Excavate/lay/backfill 900mm RC pipe | **Type C** | | m | | $ 360.00 | | $ - | |
| 3083 | Excavate/lay/backfill 900mm RC pipe | **Type D** | | m | | $ 480.00 | | $ - | |
| 0084 | Excavate/lay/backfill 1050mm RC pipe | **Type A** | | m | | $ 215.00 | | $ - | |
| 1084 | Excavate/lay/backfill 1050mm RC pipe | **Type B** | | m | | $ 300.00 | | $ - | |
| 2084 | Excavate/lay/backfill 1050mm RC pipe | **Type C** | | m | | $ 380.00 | | $ - | |
| 3084 | Excavate/lay/backfill 1050mm RC pipe | **Type D** | | m | | $ 520.00 | | $ - | |
| 0085 | Excavate/lay/backfill 1200mm RC pipe | **Type A** | | m | | $ 290.00 | | $ - | |
| 1085 | Excavate/lay/backfill 1200mm RC pipe | **Type B** | | m | | $ 350.00 | | $ - | |
| 2085 | Excavate/lay/backfill 1200mm RC pipe | **Type C** | | m | | $ 517.50 | | $ - | |
| 3085 | Excavate/lay/backfill 1200mm RC pipe | **Type D** | | m | | $ 620.00 | | $ - | |
| 0086 | Excavate/lay/backfill 1350mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1086 | Excavate/lay/backfill 1350mm RC pipe | **Type B** | | m | | $ 380.00 | | $ - | |
| 2086 | Excavate/lay/backfill 1350mm RC pipe | **Type C** | | m | | $ 580.00 | | $ - | |
| 3086 | Excavate/lay/backfill 1350mm RC pipe | **Type D** | | m | | $ 650.00 | | $ - | |
| 0087 | Excavate/lay/backfill 1500mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1087 | Excavate/lay/backfill 1500mm RC pipe | **Type B** | | m | | $ 437.00 | | $ - | |
| 2087 | Excavate/lay/backfill 1500mm RC pipe | **Type C** | | m | | $ 598.00 | | $ - | |
| 3087 | Excavate/lay/backfill 1500mm RC pipe | **Type D** | | m | | $ 680.00 | | $ - | |
| 0088 | Excavate/lay/backfill 1650mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1088 | Excavate/lay/backfill 1650mm RC pipe | **Type B** | | m | | $ 540.00 | | $ - | |
| 2088 | Excavate/lay/backfill 1650mm RC pipe | **Type C** | | m | | $ 644.00 | | $ - | |
| 3088 | Excavate/lay/backfill 1650mm RC pipe | **Type D** | | m | | $ 700.00 | | $ - | |
| 0089 | Excavate/lay/backfill 1800mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1089 | Excavate/lay/backfill 1800mm RC pipe | **Type B** | | m | | $ 550.00 | | $ - | |
| 2089 | Excavate/lay/backfill 1800mm RC pipe | **Type C** | | m | | $ 725.00 | | $ - | |
| 3089 | Excavate/lay/backfill 1800mm RC pipe | **Type D** | | m | | $ 750.00 | | $ - | |
| 0090 | Excavate/lay/backfill 1950mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1090 | Excavate/lay/backfill 1950mm RC pipe | **Type B** | | m | | $ - | | $ - | |
| 2090 | Excavate/lay/backfill 1950mm RC pipe | **Type C** | | m | | $ 750.00 | | $ - | |
| 3090 | Excavate/lay/backfill 1950mm RC pipe | **Type D** | | m | | $ 800.00 | | $ - | |
| 0091 | Excavate/lay/backfill 2100mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1091 | Excavate/lay/backfill 2100mm RC pipe | **Type B** | | m | | $ - | | $ - | |
| 2091 | Excavate/lay/backfill 2100mm RC pipe | **Type C** | | m | | $ 800.00 | | $ - | |
| 3091 | Excavate/lay/backfill 2100mm RC pipe | **Type D** | | m | | $ 950.00 | | $ - | |
| 0145 | Side entry pit 2-4 metres extra | | | No. | | $ 1,090.00 | 7 | $ 7,630.00 | |
| 0146 | Manholes 1050mm 0-2 metre deep | | | No. | | $ 1,600.00 | | $ - | |
| 0148 | Manholes 1500mm 0-3 metre deep | | | No. | | $ 2,179.00 | 3 | $ 6,537.00 | |
| 0149 | Manholes 2100mm 0-3 metre deep | | | No. | | $ 3,683.00 | | $ - | |
| 0151 | Manholes 1050mm 2-4 metre deep | | | No. | | $ 2,500.00 | | $ - | |
| 0153 | Manholes 1500mm 3-5 metre deep | | | No. | | $ 4,250.00 | | $ - | |
| 0154 | Manholes 2100mm 3-5 metre deep | | | No. | | $ 5,910.00 | | $ - | |
| 0155 | Manholes Special in place | | | ITEM | | $ 1.00 | | $ - | |
| | CONCRETE | | | | | | | | |
| 0161 | Concrete K & C type **M1** (incl. supply of conc.) | | | m | Scale | $ 60.00 | 210 | $ 12,600.00 | |
| 0162 | Concrete K & C type **B1** (incl. supply of conc.) | | | m | Scale | $ - | | $ - | |
| 0163 | Concrete K & C type **M3** (incl. supply of conc.) | | | m | Scale | $ - | | $ - | |
| | PIPES & DRAINWAYS | | | | | | | | |
| 0294 | Supply 300mm RC pipe RRJ class 2 | | | m | | $ 27.50 | 0 | $ - | |
| 0295 | Supply 375mm RC pipe RRJ class 2 | | | m | | $ 41.09 | 0 | $ - | |
| 0296 | Supply 450mm RC pipe RRJ class 2 | | | m | | $ 58.68 | 0 | $ - | |
| 0297 | Supply 525mm RC pipe RRJ class 2 | | | m | | $ 74.77 | 115 | $ 8,599.00 | |
| 0298 | Supply 600mm RC pipe RRJ class 2 | | | m | | $ 91.94 | 0 | $ - | |
| 0299 | Supply 675mm RC pipe IJ class 2 | | | m | | $ 96.71 | 0 | $ - | |
| 0300 | Supply 750mm RC pipe IJ class 2 | | | m | | $ 113.97 | 0 | $ - | |
| 0301 | Supply 825mm RC pipe IJ class 2 | | | m | | $ 131.48 | 0 | $ - | |
| 0302 | Supply 900mm RC pipe IJ class 2 | | | m | | $ 159.31 | 370 | $ 58,945.00 | |
| 0303 | Supply 1050mm RC pipe IJ class 2 | | | m | | $ 208.75 | 0 | $ - | |
| 0304 | Supply 1200mm RC pipe IJ class 2 | | | m | | $ 261.55 | 0 | $ - | |
| 0305 | Supply 1350mm RC pipe IJ class 2 | | | m | | $ 319.98 | 0 | $ - | |
| 0306 | Supply 1500mm RC pipe IJ class 2 | | | m | | $ 389.19 | 0 | $ - | |
| 0307 | Supply 1650mm RC pipe IJ class 2 | | | m | | $ 459.92 | 0 | $ - | |
| 0308 | Supply 1800mm RC pipe IJ class 2 | | | m | | $ 537.25 | 0 | $ - | |
| 0309 | Supply 1950mm RC pipe IJ class 2 | | | m | | $ 650.68 | 0 | $ - | |
| 0310 | Supply 2100mm RC pipe IJ class 2 | | | m | | $ 796.09 | 0 | $ - | |
| | BOX CULVERTS | | | | | | | | |
| 0350 | Supply 600 X 1800 mm RCBC | | | m | P.O.A. | | | $ - | |
| 0351 | Supply X mm RCBC | | | m | P.O.A. | | | $ - | |
| 0352 | Supply X mm RCBC | | | m | P.O.A. | | | $ - | |
| | PROVISIONAL | | | | | | | | |
| 0484 | Construction safety fee | $ | 260,000.00 | ITEM | | $ 1.00 | $ - | $ 1,000.00 | 0.2% of Subtotal |
| 0486 | Supervision | $ | 260,000.00 | ITEM | | $ 1.00 | | $ 10,000.00 | 3.6% of Subtotal |
| 0489 | Transport of plant | | | ITEM | | $ 1.00 | | $ - | |
| | SERVICES | | | | | | | | |
| 0496 | Alteration to services - General | | | ITEM | | $ 1.00 | | $ - | |
| 0497 | Acquisition of land | | | ITEM | | $ 1.00 | | $ - | |
| 0498 | Acquisition of easements | | | ITEM | | $ 1.00 | | $ - | |
| | Subtotal | | | | | | | $ 261,170.00 | |
| | Contingencies | | | | | | | | |
| 0490 | Contingencies (Provisional) | | | ITEM | | 30% | | $ 78,351.00 | 30% of Subtotal |
| | DESIGN CHARGES | | | | | | | | |
| 0450 | Project Design & Survey | | | ITEM | | $ 1.00 | 26117 | $ 26,117.00 | 10% of Subtotal |
| 0451 | | | | | | | | | |
| 0452 | Total | | | | | | | $ 366,000.00 | N.B: Rounded up to nerarest $1000 |
| 0453 | | | | | | | | | |
| 0454 | | | | | | | | | |
| 0456 | | | | | | | | | |
| 0480 | | | | | | | | | |
| | N.B: Price has been rounded up to nerarest $1000 | | | | | | | | |

Date Printed : 22/05/2006

# MASTER DRAINAGE AREA "Winchelsea St - Model 3"
## PRELIMINARY DRAINAGE ESTIMATE

| No. | Description | Comment | | Unit | | Unit Cost | Number | Amount | |
|---|---|---|---|---|---|---|---|---|---|
| | GENERAL | | | | | | | | |
| 0001 | Traffic Control | | | ITEM | | | | $ 5,000.00 | |
| 0002 | Site Establishment | Min. $10,000 | | ITEM | | $ 1.00 | 10000 | $ 10,000.00 | |
| 0004 | Box out & remove existing driveways | | | ITEM | | $ 150.00 | | $ - | |
| 0005 | Remove existing K & C structures | | | ITEM | | $ 10.00 | 130 | $ 1,300.00 | |
| | DRAINAGE | | | | | | | | |
| 0051 | Takeup & stack existing RC pipes | | | m | | $ 50.00 | 80 | $ 4,000.00 | |
| 0067 | Excavation of open drain | | | m3 | Scale | $ - | | $ - | |
| 0068 | Subsoil drains in place (STANDARD) | | | m | | $ 19.35 | 130 | $ 2,516.00 | |
| 0075 | Excavate/lay/backfill 300mm RC pipe | **Type A** | | m | | $ 100.00 | | $ - | |
| 1075 | Excavate/lay/backfill 300mm RC pipe | **Type B** | | m | | $ 125.00 | | $ - | |
| 2075 | Excavate/lay/backfill 300mm RC pipe | **Type C** | | m | | $ 207.00 | | $ - | |
| 3075 | Excavate/lay/backfill 300mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0076 | Excavate/lay/backfill 375mm RC pipe | **Type A** | | m | | $ 110.00 | | $ - | |
| 1076 | Excavate/lay/backfill 375mm RC pipe | **Type B** | | m | | $ 161.00 | | $ - | |
| 2076 | Excavate/lay/backfill 375mm RC pipe | **Type C** | | m | | $ 230.00 | | $ - | |
| 3076 | Excavate/lay/backfill 375mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0077 | Excavate/lay/backfill 450mm RC pipe | **Type A** | | m | | $ 120.00 | | $ - | |
| 1077 | Excavate/lay/backfill 450mm RC pipe | **Type B** | | m | | $ 190.00 | | $ - | |
| 2077 | Excavate/lay/backfill 450mm RC pipe | **Type C** | | m | | $ 250.00 | | $ - | |
| 3077 | Excavate/lay/backfill 450mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0078 | Excavate/lay/backfill 525mm RC pipe | **Type A** | | m | | $ 135.00 | | $ - | |
| 1078 | Excavate/lay/backfill 525mm RC pipe | **Type B** | | m | | $ 195.00 | | $ - | |
| 2078 | Excavate/lay/backfill 525mm RC pipe | **Type C** | | m | | $ 250.00 | | $ - | |
| 3078 | Excavate/lay/backfill 525mm RC pipe | **Type D** | | m | | $ - | | $ - | |
| 0079 | Excavate/lay/backfill 600mm RC pipe | **Type A** | | m | | $ 145.00 | | $ - | |
| 1079 | Excavate/lay/backfill 600mm RC pipe | **Type B** | | m | | $ 207.00 | | $ - | |
| 2079 | Excavate/lay/backfill 600mm RC pipe | **Type C** | | m | | $ 276.00 | | $ - | |
| 3079 | Excavate/lay/backfill 600mm RC pipe | **Type D** | | m | | $ 391.00 | | $ - | |
| 0080 | Excavate/lay/backfill 675mm RC pipe | **Type A** | | m | | $ 160.00 | | $ - | |
| 1080 | Excavate/lay/backfill 675mm RC pipe | **Type B** | | m | | $ 210.00 | | $ - | |
| 2080 | Excavate/lay/backfill 675mm RC pipe | **Type C** | | m | | $ 300.00 | | $ - | |
| 3080 | Excavate/lay/backfill 675mm RC pipe | **Type D** | | m | | $ 414.00 | | $ - | |
| 0081 | Excavate/lay/backfill 750mm RC pipe | **Type A** | | m | | $ 177.00 | | $ - | |
| 1081 | Excavate/lay/backfill 750mm RC pipe | **Type B** | | m | | $ 240.00 | | $ - | |
| 2081 | Excavate/lay/backfill 750mm RC pipe | **Type C** | | m | | $ 300.00 | | $ - | |
| 3081 | Excavate/lay/backfill 750mm RC pipe | **Type D** | | m | | $ 460.00 | | $ - | |
| 0082 | Excavate/lay/backfill 825mm RC pipe | **Type A** | | m | | $ 177.00 | | $ - | |
| 1082 | Excavate/lay/backfill 825mm RC pipe | **Type B** | | m | | $ 276.00 | | $ - | |
| 2082 | Excavate/lay/backfill 825mm RC pipe | **Type C** | | m | | $ 350.00 | | $ - | |
| 3082 | Excavate/lay/backfill 825mm RC pipe | **Type D** | | m | | $ 460.00 | | $ - | |
| 0083 | Excavate/lay/backfill 900mm RC pipe | **Type A** | | m | | $ 207.00 | | $ - | |
| 1083 | Excavate/lay/backfill 900mm RC pipe | **Type B** | | m | | $ 276.00 | 12 | $ 3,312.00 | |
| 2083 | Excavate/lay/backfill 900mm RC pipe | **Type C** | | m | | $ 360.00 | | $ - | |
| 3083 | Excavate/lay/backfill 900mm RC pipe | **Type D** | | m | | $ 480.00 | | $ - | |
| 0084 | Excavate/lay/backfill 1050mm RC pipe | **Type A** | | m | | $ 215.00 | | $ - | |
| 1084 | Excavate/lay/backfill 1050mm RC pipe | **Type B** | | m | | $ 300.00 | 113 | $ 33,900.00 | |
| 2084 | Excavate/lay/backfill 1050mm RC pipe | **Type C** | | m | | $ 380.00 | | $ - | |
| 3084 | Excavate/lay/backfill 1050mm RC pipe | **Type D** | | m | | $ 520.00 | | $ - | |
| 0085 | Excavate/lay/backfill 1200mm RC pipe | **Type A** | | m | | $ 290.00 | | $ - | |
| 1085 | Excavate/lay/backfill 1200mm RC pipe | **Type B** | | m | | $ 350.00 | | $ - | |
| 2085 | Excavate/lay/backfill 1200mm RC pipe | **Type C** | | m | | $ 517.50 | | $ - | |
| 3085 | Excavate/lay/backfill 1200mm RC pipe | **Type D** | | m | | $ 620.00 | | $ - | |
| 0086 | Excavate/lay/backfill 1350mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1086 | Excavate/lay/backfill 1350mm RC pipe | **Type B** | | m | | $ 380.00 | | $ - | |
| 2086 | Excavate/lay/backfill 1350mm RC pipe | **Type C** | | m | | $ 580.00 | | $ - | |
| 3086 | Excavate/lay/backfill 1350mm RC pipe | **Type D** | | m | | $ 650.00 | | $ - | |
| 0087 | Excavate/lay/backfill 1500mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1087 | Excavate/lay/backfill 1500mm RC pipe | **Type B** | | m | | $ 437.00 | | $ - | |
| 2087 | Excavate/lay/backfill 1500mm RC pipe | **Type C** | | m | | $ 598.00 | | $ - | |
| 3087 | Excavate/lay/backfill 1500mm RC pipe | **Type D** | | m | | $ 680.00 | | $ - | |
| 0088 | Excavate/lay/backfill 1650mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1088 | Excavate/lay/backfill 1650mm RC pipe | **Type B** | | m | | $ 540.00 | | $ - | |
| 2088 | Excavate/lay/backfill 1650mm RC pipe | **Type C** | | m | | $ 644.00 | | $ - | |
| 3088 | Excavate/lay/backfill 1650mm RC pipe | **Type D** | | m | | $ 700.00 | | $ - | |
| 0089 | Excavate/lay/backfill 1800mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1089 | Excavate/lay/backfill 1800mm RC pipe | **Type B** | | m | | $ 550.00 | | $ - | |
| 2089 | Excavate/lay/backfill 1800mm RC pipe | **Type C** | | m | | $ 725.00 | | $ - | |
| 3089 | Excavate/lay/backfill 1800mm RC pipe | **Type D** | | m | | $ 750.00 | | $ - | |
| 0090 | Excavate/lay/backfill 1950mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1090 | Excavate/lay/backfill 1950mm RC pipe | **Type B** | | m | | $ - | | $ - | |
| 2090 | Excavate/lay/backfill 1950mm RC pipe | **Type C** | | m | | $ 750.00 | | $ - | |
| 3090 | Excavate/lay/backfill 1950mm RC pipe | **Type D** | | m | | $ 800.00 | | $ - | |
| 0091 | Excavate/lay/backfill 2100mm RC pipe | **Type A** | | m | | $ - | | $ - | |
| 1091 | Excavate/lay/backfill 2100mm RC pipe | **Type B** | | m | | $ - | | $ - | |
| 2091 | Excavate/lay/backfill 2100mm RC pipe | **Type C** | | m | | $ 800.00 | | $ - | |
| 3091 | Excavate/lay/backfill 2100mm RC pipe | **Type D** | | m | | $ 950.00 | | $ - | |
| 0145 | Side entry pit 2-4 metres extra | | | No. | | $ 1,090.00 | 3 | $ 3,270.00 | |
| 0146 | Manholes 1050mm 0-2 metre deep | | | No. | | $ 1,600.00 | | $ - | |
| 0148 | Manholes 1500mm 0-3 metre deep | | | No. | | $ 2,179.00 | 4 | $ 8,716.00 | |
| 0149 | Manholes 2100mm 0-3 metre deep | | | No. | | $ 3,683.00 | 1 | $ 3,683.00 | |
| 0151 | Manholes 1050mm 2-4 metre deep | | | No. | | $ 2,500.00 | | $ - | |
| 0153 | Manholes 1500mm 3-5 metre deep | | | No. | | $ 4,250.00 | | $ - | |
| 0154 | Manholes 2100mm 3-5 metre deep | | | No. | | $ 5,910.00 | | $ - | |
| 0155 | Manholes Special in place | | | ITEM | | $ 1.00 | | $ - | |
| | CONCRETE | | | | | | | | |
| 0161 | Concrete K & C type **M1** (incl. supply of conc.) | | | m | Scale | $ 60.00 | 130 | $ 7,800.00 | |
| 0162 | Concrete K & C type **B1** (incl. supply of conc.) | | | m | Scale | $ - | | $ - | |
| 0163 | Concrete K & C type **M3** (incl. supply of conc.) | | | m | Scale | $ - | | $ - | |
| | PIPES & DRAINWAYS | | | | | | | | |
| 0294 | Supply 300mm RC pipe RRJ class 2 | | | m | | $ 27.50 | 0 | $ - | |
| 0295 | Supply 375mm RC pipe RRJ class 2 | | | m | | $ 41.09 | 0 | $ - | |
| 0296 | Supply 450mm RC pipe RRJ class 2 | | | m | | $ 58.68 | 0 | $ - | |
| 0297 | Supply 525mm RC pipe RRJ class 2 | | | m | | $ 74.77 | 0 | $ - | |
| 0298 | Supply 600mm RC pipe RRJ class 2 | | | m | | $ 91.94 | 0 | $ - | |
| 0299 | Supply 675mm RC pipe IJ class 2 | | | m | | $ 96.71 | 0 | $ - | |
| 0300 | Supply 750mm RC pipe IJ class 2 | | | m | | $ 113.97 | 0 | $ - | |
| 0301 | Supply 825mm RC pipe IJ class 2 | | | m | | $ 131.48 | 0 | $ - | |
| 0302 | Supply 900mm RC pipe IJ class 2 | | | m | | $ 159.31 | 12 | $ 1,912.00 | |
| 0303 | Supply 1050mm RC pipe IJ class 2 | | | m | | $ 208.75 | 113 | $ 23,589.00 | |
| 0304 | Supply 1200mm RC pipe IJ class 2 | | | m | | $ 261.55 | 0 | $ - | |
| 0305 | Supply 1350mm RC pipe IJ class 2 | | | m | | $ 319.98 | 0 | $ - | |
| 0306 | Supply 1500mm RC pipe IJ class 2 | | | m | | $ 389.19 | 0 | $ - | |
| 0307 | Supply 1650mm RC pipe IJ class 2 | | | m | | $ 459.92 | 0 | $ - | |
| 0308 | Supply 1800mm RC pipe IJ class 2 | | | m | | $ 537.25 | 0 | $ - | |
| 0309 | Supply 1950mm RC pipe IJ class 2 | | | m | | $ 650.68 | 0 | $ - | |
| 0310 | Supply 2100mm RC pipe IJ class 2 | | | m | | $ 796.09 | 0 | $ - | |
| | BOX CULVERTS | | | | | | | | |
| 0350 | Supply & Install 600 X 1800 mm RCBC | | | m | P.O.A. | | | $ 130,000.00 | |
| 0351 | Supply X mm RCBC | | | m | P.O.A. | | | $ - | |
| 0352 | Supply X mm RCBC | | | m | P.O.A. | | | $ - | |
| | PROVISIONAL | | | | | | | | |
| 0484 | Construction safety fee | $ | 250,000.00 | ITEM | | $ 1.00 | $ - | $ 1,000.00 | 0.2% of Subtotal |
| 0486 | Supervision | $ | 250,000.00 | ITEM | | $ 1.00 | | $ 9,000.00 | 3.6% of Subtotal |
| 0489 | Transport of plant | | | ITEM | | $ 1.00 | | $ - | |
| | SERVICES | | | | | | | | |
| 0496 | Alteration to services - General | | | ITEM | | $ 1.00 | | $ - | |
| 0497 | Acquisition of land | | | ITEM | | $ 1.00 | | $ - | |
| 0498 | Acquisition of easements | | | ITEM | | $ 1.00 | | $ - | |
| | Subtotal | | | | | | | $ 248,998.00 | |
| | Contingencies | | | | | | | | |
| 0490 | Contingencies (Provisional) | | | ITEM | | 30% | | $ 74,700.00 | 30% of Subtotal |
| | DESIGN CHARGES | | | | | | | | |
| 0450 | Project Design & Survey | | | ITEM | | $ 1.00 | 24900 | $ 24,900.00 | 10% of Subtotal |
| 0451 | | | | | | | | | |
| 0452 | Total | | | | | | | $ 349,000.00 | N.B: Rounded up to nerarest $1000 |
| 0453 | | | | | | | | | |
| 0454 | | | | | | | | | |
| 0456 | | | | | | | | | |
| 0480 | | | | | | | | | |
| | N.B: Price has been rounded up to nerarest $1000 | | | | | | | | |