NORTH EAST GROWTH CORRIDOR SHEPPARTON

DRAINAGE STRATEGY PEER REVIEW
13 JULY 2018

PREPARED FOR VICTORIAN PLANNING AUTHORITY

This report has been prepared by the office of Spiire
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Acknowledgements and Recognition

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1. INTRODUCTION

Spiire has been engaged by the Victorian Planning Authority (VPA) to complete a peer review on the drainage strategy prepared for the North East Growth Corridor (NEGC) in Shepparton by Reeds Consulting (Reeds).

The drainage strategy review has been undertaken to determine if there is a more economical drainage solution for the NEGC. The drainage costs for the corridor have been calculated at approximately $20 million and has raised multiple submissions through the recent exhibition process from landowner and developers for a review to be undertaken.

From these submissions the peer review focuses on the proposed drainage catchments, basin locations, basin numbers, basin depths and basin cost estimates prepared by Reeds. In addition to this report Spiire has undertaken its own assessment of the existing drainage catchments and has provided an alternative drainage solution for the NEGC.

To finalise the peer review report the VPA has requested a functional design and opinion of probable costs for the catchment 1 basin to be undertaken and apportioned across the corridor to determine the overall drainage costs. This information will then assist in determining the development contribution rates to be implemented once development occurs.

The information contained in this report is based on Spiire's local knowledge of work in Shepparton's flat terrain and long working relationship with Greater Shepparton City Council (GSCC), Goulburn-Murray Water (G-MW) and Goulburn Broken Catchment Management Authority (GBCMA) to provide drainage solutions that best fit the local drainage challenges and constraints.

Prior to the issue of this report Spiire has previously prepared a desktop assessment on the drainage corridor, this document supersedes the previous issued report dated March 2016.

1.1 SCOPE OF WORKS

The scope of the works includes the following:

- Collection and review of Reeds drainage strategy completed in July 2014.
- Catchment review, analysis and modelling in order to determine number of basins required to drain the corridor.
- Analysis and modelling of proposed development pollutant loadings and treatment elements required to achieve best practice objectives.
- Preparation of peer review report including functional drawings and opinion of probable costs.
- Apportionment of drainage costs across NEGC.
- Address drainage related submissions raised through the exhibition process.

1.2 METHODOLOGY

The following methodology was utilised to develop an appropriate drainage strategy for the NEGC:

- Rational method calculations to determine stormwater runoff from catchments.
- Basin storage calculations using Swinburne Institute of Technology 1987 method with G-MW and Infrastructure Design Manual (IDM) requirements.
- Water Quality Modelling (MUSIC modelling to determine a water sensitive urban design strategy and sizing of treatment elements to ensure adequate space was allowed within the development).

2. REVIEW OF EXISTING DRAINAGE STRATEGY

The current drainage strategy for the NEGC has been completed by Reeds who have been involved over a 5 year period with their final drainage strategy being adopted in July 2014. Over this period Reeds have undertaken extensive consultation with GSCC and service authorities to develop the strategy which proposed to split the NEGC into five drainage catchments each with a corresponding basin as shown below in Figure 1.

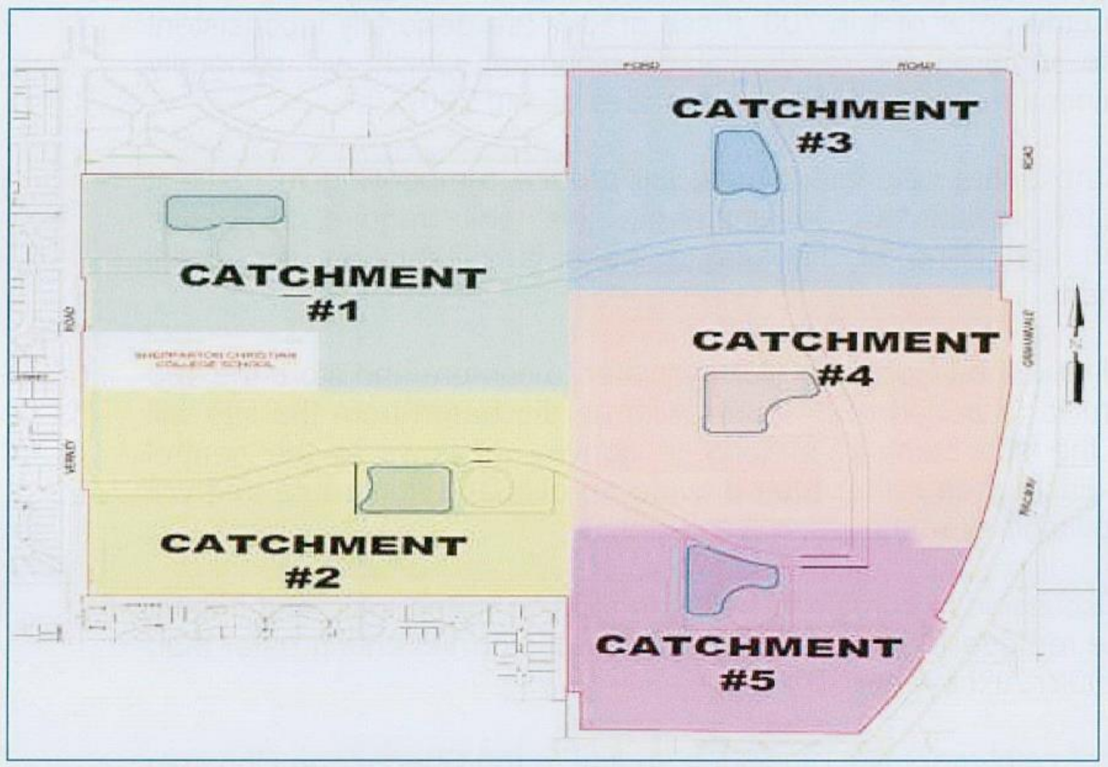


Figure 1: Reeds NEGC Drainage Catchment Plan.

Based on the 5 drainage catchments in Figure 1, Reeds have undertaken a functional design for the basin in catchment 1 as shown in Figure 2. Based on this design Reeds have completed an opinion of probable cost for the construction works to determine a cost that can be apportioned over the remaining catchments.

The civil works estimate completed by Reeds in July 2015 estimates the basin 1 civil costs to be $1,802,568.80. This estimate excludes any construction contingencies, authority fees and charges and any professional fees.

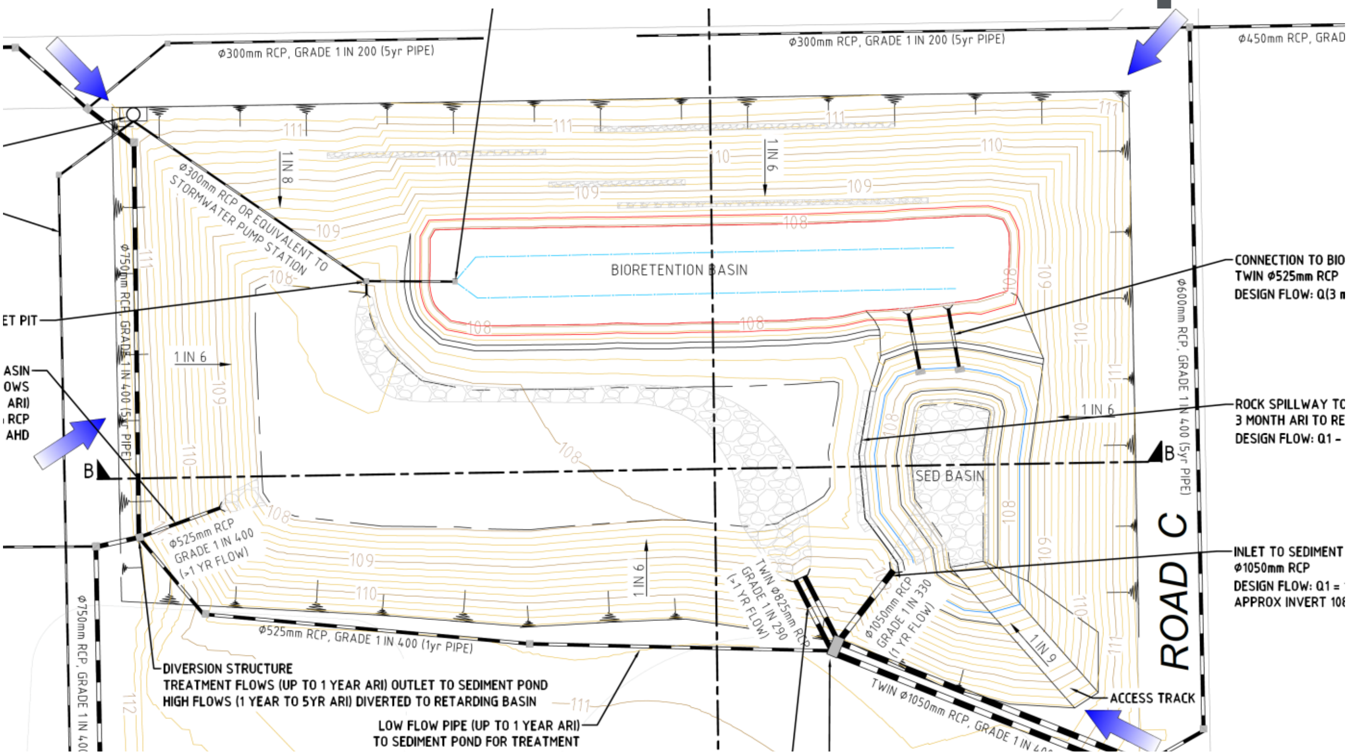


Figure 2: Reeds Consulting Catchment 1 Functional Design Plan.

In order to determine an overall drainage cost for the NEGC the VPA have adopted Reeds estimate for the catchment 1 basin. In addition to Reeds estimate the VPA have added the following costs:

- Construction contingencies
- Authority fees and charges
- Professional fees
- Land acquisition costs
- Basin landscape works
- Consumer price index (CPI) adjustment

The addition of the costs above has resulted in a total drainage cost for the NEGC of $19,536,726.64 or $134,897.53 per hectare of net developable area.

Drainage is the largest component of costs for the NEGC and in order to determine a more economical drainage solution Spiire's review on Reeds drainage strategy will focus on the following:

- Investigation on the possibility of reducing basin numbers
- Address recent submission concerns over the catchment 1 basin location
- Review storage capacity calculations
- Review water sensitive urban design (WSUD)
- Review outfall infrastructure strategy
- And, review construction costings and adopt local contractor rates.

Refer to Appendix A for Reeds drainage strategy report and Appendix B for Reeds functional plans and estimates.

2.1 BASIN NUMBERS REVIEW

As discussed, Reeds have proposed to split the NEGC into 5 drainage catchments. On review of the basin locations within these catchments it has been identified that catchment 4 basin is located on an existing G-MW irrigation supply channel. Traditionally G-MW channels are located on high ground in order to supply water to the adjacent land. A review of the existing surface levels within this area confirm this and a basin located in this area would result in large earthworks to be undertaken to grade the catchment towards the basin.

Based on this finding Spiire propose to split the NEGC into 4 drainage catchments as shown in Figure 3.

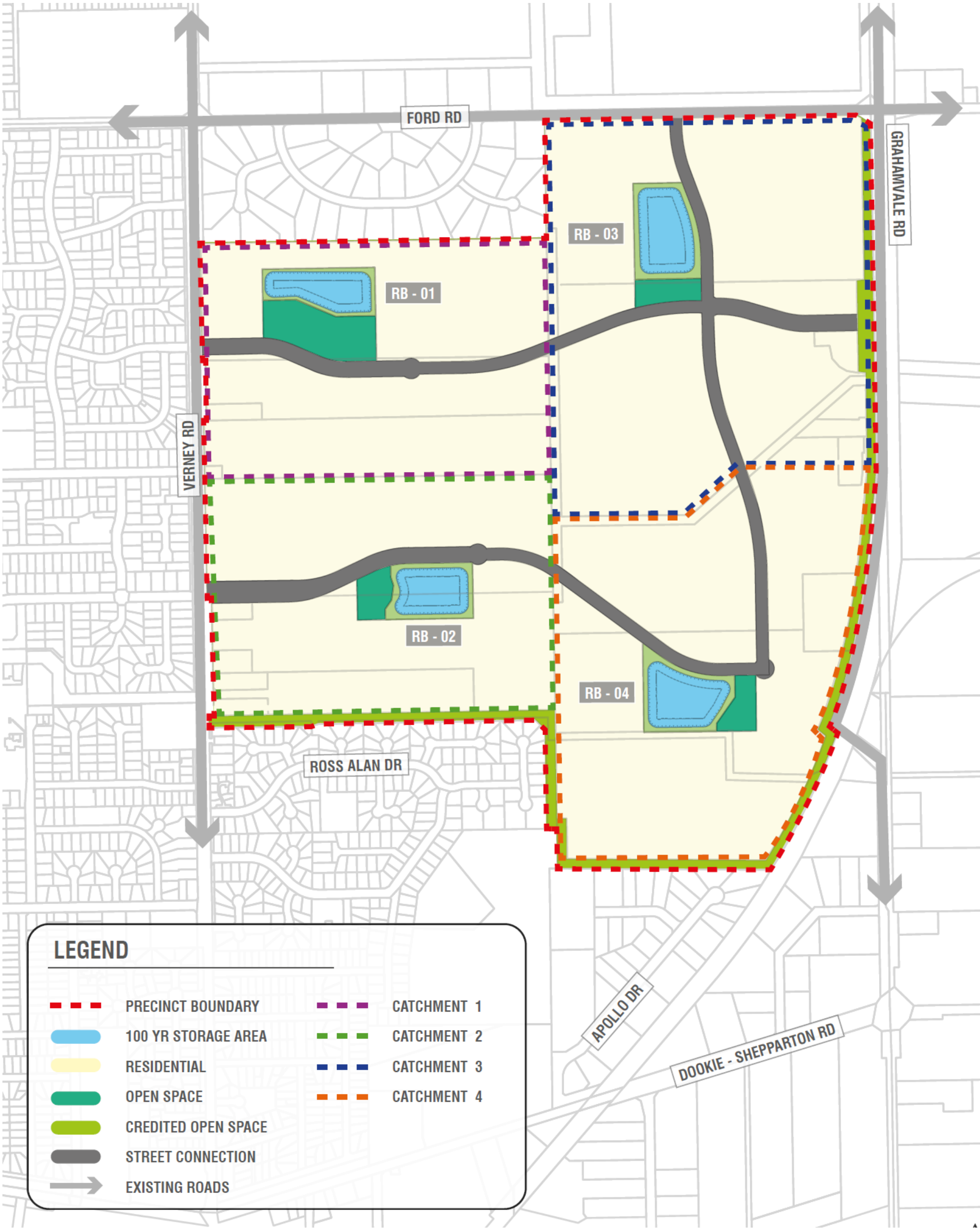


Figure 3: Spiire's NEGC Drainage Catchment Plan.

Refer to Section 3 of this report for the detailed catchment analysis and basin location determination.

Refer to Appendix C for Spiire's revised drainage catchment plan.

2.2 CATCHMENT 1 BASIN LOCATION REVIEW

Reeds have located the catchment 1 basin in the North West corner of the catchment to utilise the natural fall of the land. During the exhibition process a submission has been raised in regards to the proximity of the basin in relation to the existing low density residential development north of the basin. The submission relates to concerns over the existing septic systems servicing the existing development and the basin location.

To address this concern Spiire has reviewed the offset and shifted the basin further south as show in Figure 3 below to provide a minimum of 60m setback between the proposed basin and existing septic systems following the guidelines set out in Table 5 from the Environmental Protection Authority (EPA) Code of Practice for Onsite Wastewater Management.

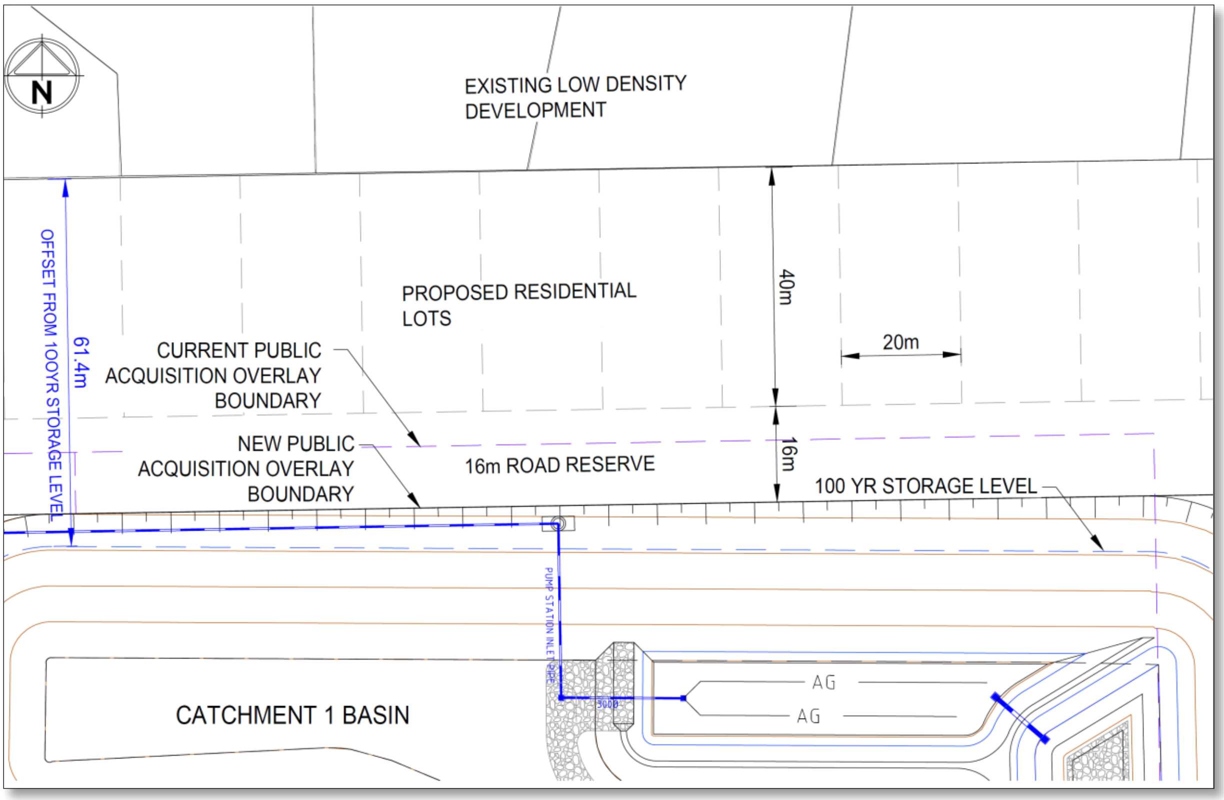


Figure 4: Proposed Basin offset Plan.

2.3 STORAGE CALCULATIONS REVIEW

Review of the storage calculations undertaken by Reeds has uncovered a variance between their 100 year storage calculations. From Reeds drainage strategy report (Report) completed in July 2014 there are two (2) different values for their 100 year storage volumes. The 2 values stated for the 100 year storage volume are 31,000 cubic metres for catchment 1 as shown in Figure 5. And a storage volume of 28,800 cubic metres from their RORB outputs in Annexure E of their report as shown in Figure 6.

SHEPPARTON NEGC SUBCATCHMENT STORAGE REQUIREMENTS			
Sub-Catchment ID	Sub-catchment Approximate Area (Ha)	Storage Volume 100Yr ARI storm 24 Hour (cubic metres)	Basin Area 100Yr level (sq.m)
1	32.2	31,000	14,720
2	35.5	38,000	16,850
3	34.5	33,800	16,200
4	37	42,800	19,400
5	25.8	27,500	14,350
TOTAL	**165**	**173,100**	**81,520**

Figure 5: Reeds Basin Storage Volumes.

```
Routing results:
****************
XXXX
XXXX: 24 hour 100 year Design Storm
DESIGN run no.  1

Parameters:  kc =      1.25     m = 0.80

Loss parameters      Initial loss (mm)      Runoff coeff.
                           10.00                 0.60

Results of routing through special storage STORAGE A
 Peak elevation=  110.65 m
 Peak outflow =     0.00 m³/s
 Peak storage =     2.88E+04 m³


*** Special storage :    STORAGE A

                             Hydrograph
                          Outflow   Inflow
Peak discharge,m³/s         0.003    1.585
Time to peak,h               26.0      3.0
Volume,m³               6.58E+02 2.90E+04
Time to centroid,h           38.3      6.8
Lag (c.m. to c.m.),h         32.3      0.9
Lag to peak,h                20.0     -3.0
```

Figure 6: Reeds RORB output for Catchment 1.

From Reeds RORB output on catchment 1 it was identified a coefficient of runoff (C of R) of 0.6 was used for the storage volume calculations and this is the mostly likely the cause between the differences in storage volumes.

The C of R adopted by Reeds does not match the IDM coefficients of runoff for residential areas lot areas greater than 600 m^2 to 1,000 m^2 and 0.75 for residential road reserves as shown in Figure 7.

Catchment Type	**Runoff Coefficient** (applies to all **AEP** for most Councils)	**Runoff Coefficient** (applies to 20% **AEP** for those Councils listed in Selection Table 16.7)
LDRZ – lot areas > 2 ha	0.30 See notes 1, 2 and 3	0.30
LDRZ - >1 ha to 2 ha	0.35 See notes 1, 2 and 3	0.30
LDRZ – lot areas >4000 m^2 to 1 ha	0.40 See notes 1, 2 and 3	0.35
LDRZ – lot areas >2000 m^2 to 4000 m^2	0.45 See notes 1, 2 and 3	0.35
Residential areas – lot areas >1000 m^2 to 2000 m^2	0.50 See notes 1, 2 and 3	0.40
Residential areas – lot areas >600 m^2 to 1,000 m^2	0.70 See notes 1, 2 and 3	0.55
Residential areas – lot areas >450 m^2 to 600 m^2	0.75	0.60
Residential areas – lot areas >300 m^2 to 450m^2	0.80	0.65
Residential areas – lot areas <300 m^2	0.80	0.80
Residential areas (medium density, i.e. Units, including potential unit development sites)	0.90	
Commercial zones	0.90	
Industrial zones	0.90	
Residential road reserves	0.75	
Landscaped areas	0.25	
Public Open Space	0.35	
Paved areas	0.95	

Figure 7: Table 10 IDM Runoff Coefficients.

Adopting the IDM values for runoff coefficients will result in an increased storage volume required for the catchment 1 basin and subsequently the other 4 basins. Refer to Section 4 of this report for Spiire's revised basin storage calculations.

Spiire has also reviewed the IDM requirement to store the peak 5 year storage volume below the invert of the incoming drainage pipes and deem this an unnecessary requirement given the current depths of the basin which will reduce overall construction costs.

2.4 WATER SENSITIVE URBAN DESIGN REVIEW

Review of the water sensitive urban design (WSUD) calculations within the report undertaken Reeds includes a sedimentation pond size of 1100m² and bio retention treatment area of 2000m² as shown in Figures 8 and 9.

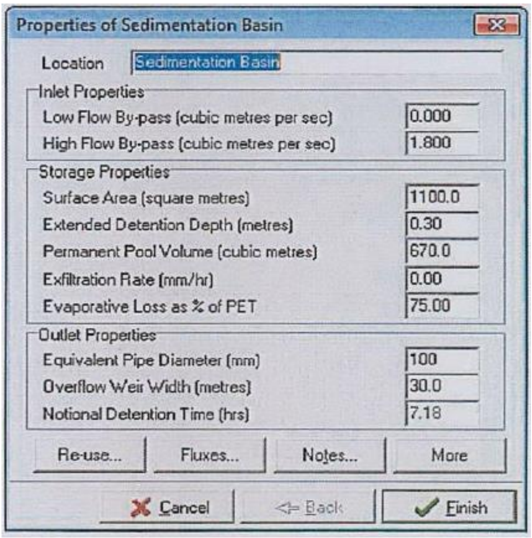


Figure 8: Reeds Sedimentation Pond Sizing.

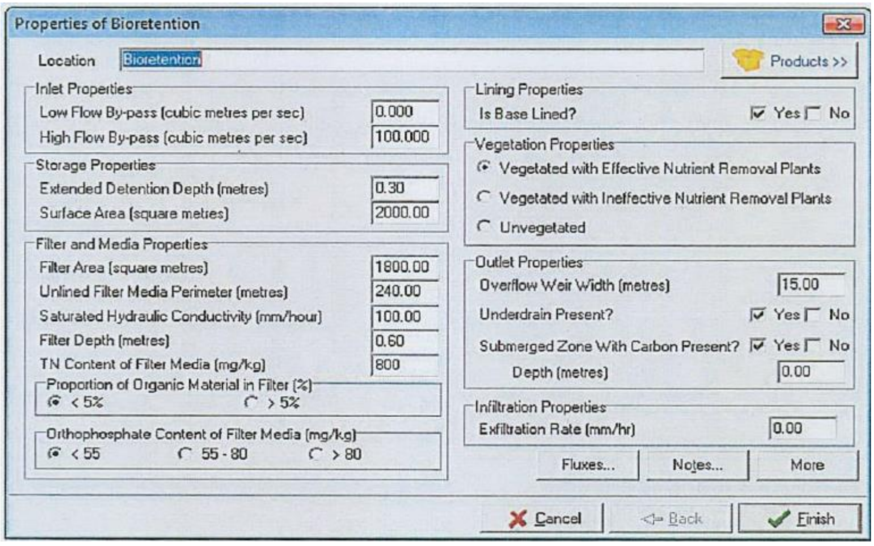


Figure 9: Reeds Bio Retention Basin Sizing.

Undertaking new calculations for these treatment nodes has reduced these areas significantly back to 870m² for sedimentation pond and 600m² for bio retention area.

Potential reasons behind the differences in calculations could be the increased detention depth for the sediment pond of 0.5m from 0.3m that Spiire has adopted and the low hydraulic conductivity rate of 100mm/hr compared to the 150mm/hr adopted by Spiire for the bio retention area and we are uncertain of the rainfall data used. However, neither of these are reasons for it to be so different and without the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) design file it is hard to determine the exact causes. Another potential reason to explain the differences could be the increased accuracy of the software package since the earlier calculations were carried out Reeds.

Refer to Section 5 of this report for Spiire's MUSIC modelling results.

2.5 OUTFALL INFRASTRUCTURE REVIEW

Spiire agrees with Reeds approach to drain all basins rising main back into G-MW's Drain 3 in lieu of draining the northern catchments in G-MW's Drain 4 as shown below in Figure 8.

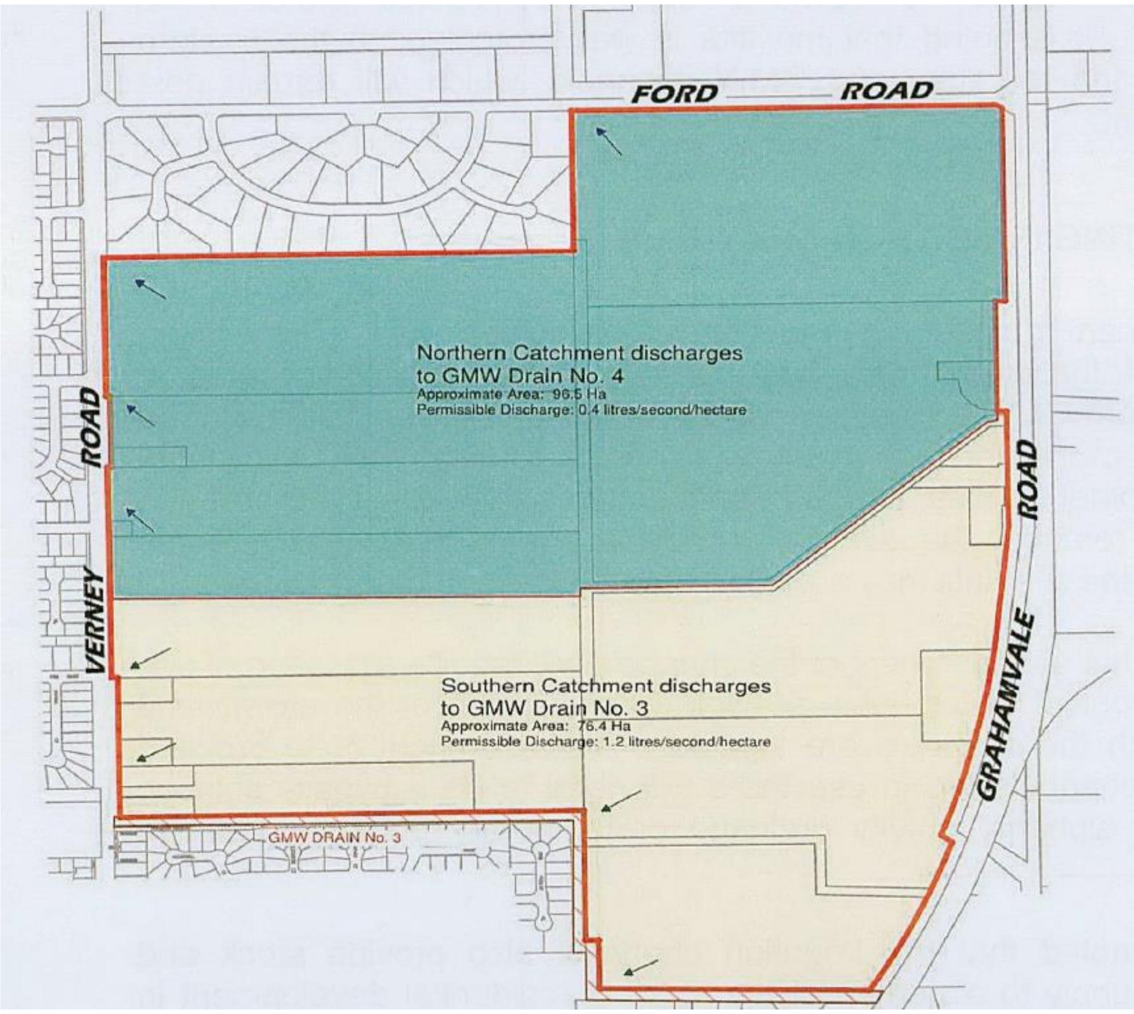


Figure 10: G-MW Existing Drainage Catchments.

2.6 CIVIL COST REVIEW

As discussed, civil cost estimates for catchment 1 basin were undertaken by Reeds in July 2015. The estimate for these works was $1,802,569.80 with no construction contingency allowance provided or any authority fees and charges and professional fees.

A review of the costings identified an excavation cost of $12.50 per cubic metre. Spiire believes this rate is excessive when compared to local contractor rates, and also given the fact the excavated soil will be retained on site to assist in earthworks for overland flows. Based on similar projects completed within Shepparton region Spiire believes the excavation rate can be reduced to $5 per cubic metre of soil.

Examples of where similar works have been undertaken include the basin construction for the Lifestyle Village in Shepparton where the average tendered excavation rate was $3.22 per cubic metre in 2011 for approximately 10,000 cubic metres of soil and the average tendered excavation rate for the basin works at Providence Estate in Shepparton was $4.50 per cubic metre in 2018 for approximately 22,000 cubic metres of soil.

Other items from the costing undertaken by Reeds that can be reduced or removed from the catchment 1 basin include:

- Quantity of pipes and pits included in functional design costings, total costs for pits and pipes amount to approximately $277,000. Spiire has reduced these works to only include the basin outfall pipes and pits into the costing for the basin works which is approximately $75,000.
- Geofabric waterproof liner, of approximately $20 per metre squared. Spiire have removed this item and replaced with a permeable geotextile which is approximately $7 per metre squared.
- Concrete footpaths, total cost $78,750. Spiire have excluded this cost and recommend this cost should either be borne by the developer if they front onto the basin with a road reserve or included in the landscape costings if deemed a part of the open space elements.
- Overdesign of WSUD treatment areas. New calculations have determine these areas to significantly reduce in size as discussed.

Reducing or removing the items above provides a significant saving in civil costs with excavation cost forming the largest component of works which results in a $465,000 saving when applied on Reeds estimates.

Refer to section 7 of this report for Spiire's revised cost estimates for the NEGC drainage.

2.7 DRAINAGE STRATEGY CONCLUSION

Overall the methodology adopted by Reeds is in line with Spiire's approach, only differences will be the slight tweaks to the designs and construction cost rates discussed and the change to the strategy to remove catchment 4 basin and bring the total number of basins to 4.

3. EXISTING CONDITIONS

3.1 CATCHMENT REVIEW

The NEGC catchment is approximately 177 Hectares (ha) in size and bounded north by Ford Road, east by Grahamvale Road, west by Verney Road and south by G-MW's Drain 3. Reeds Consulting has proposed to spilt the NEGC into five (5) catchments as explained in Section 2 of the report.

A review of the existing survey information supplied by GSCC shows the natural fall of the land is grading east to west across the site. After analysing the catchments Spiire note the catchment 4 basin is located on an existing G-MW channel where traditionally these assets are located on the high ground to provide irrigation to the adjacent land. A review of the levels confirm this and to reduce earthwork costs to convey 100 year drainage flows to the retention basin, Spiire proposes to split the NEGC into 4 catchments as shown below in Figure 11 and Appendix D.

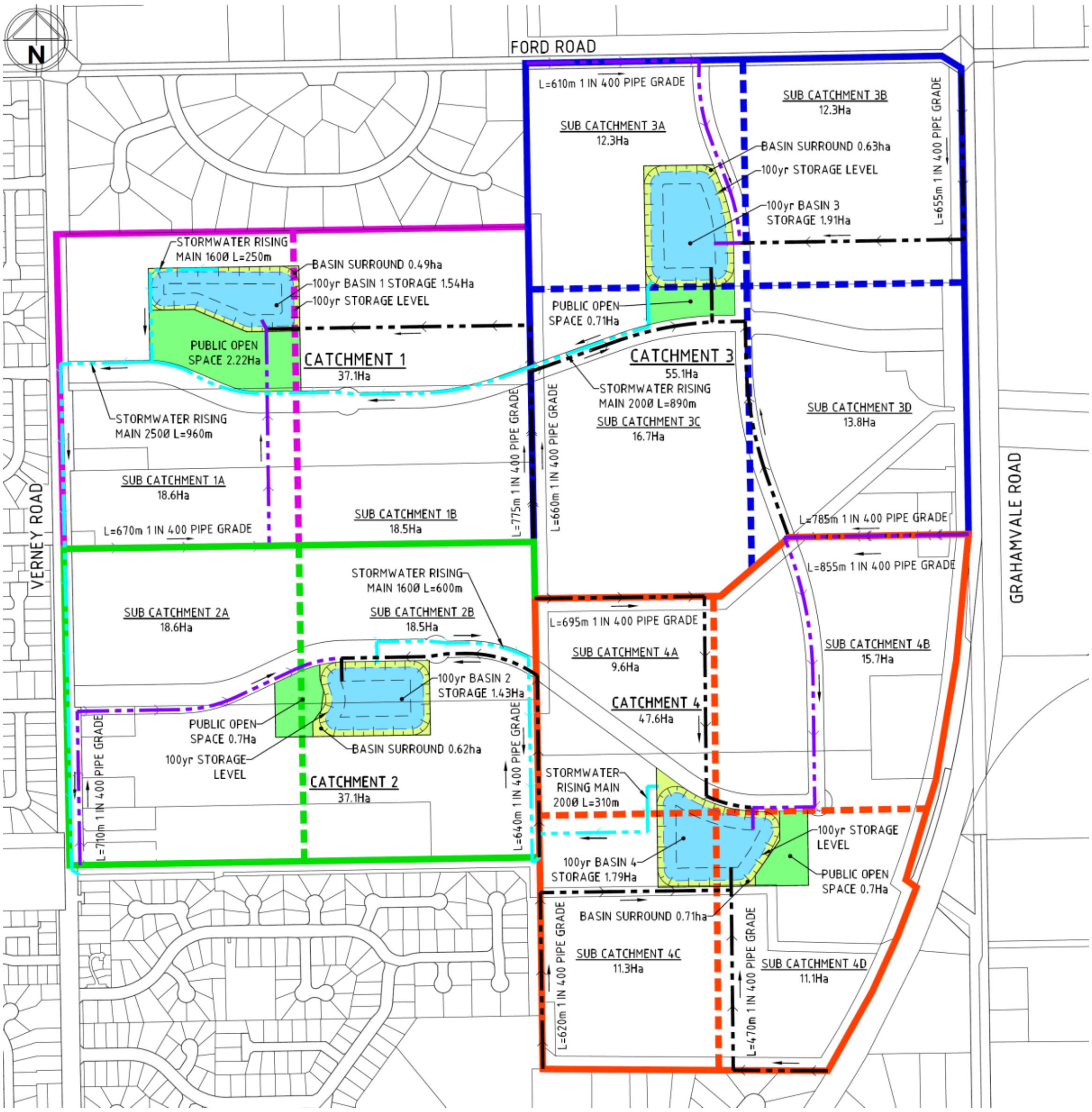


Figure 11: Spiire's NEGC Drainage Catchment Plan.

As shown in Figure 11 catchments 1 and 2 are located on the west side of the corridor and catchments 3 and 4 are located on the eastern side to utilise the available grades.

The natural grade on catchments 1 is approximately 1 in 620 towards Verney Road from the eastern catchment boundary. Due to the grade over the land the basin location is critical in reducing the earthwork volumes across the development. Therefore catchment 1 basin has been located in the North West corners of the catchment to maximise the grade of the land and to allow the 100 year overland flows to enter the basin. By locating the basin in the lowest area of the catchment it also reduces the final depth of the basin as the underground drainage and the land are grading in the same direction.

The existing survey information supplied by GSCC did not include any levels through catchment 2. Therefore, the basin location for this catchment has been kept as centrally as possible to reduced pipe lengths and the overall basin depth.

Catchments 3 and 4 continue to grade west; however, it is not as significant as catchment 1. The grade across the catchments is approximately 1 in 2400 from the eastern and southern catchment boundaries. Due to these catchment being quite flat the basin location is not as critical as discussed with catchments 1 and 2. Therefore as in catchment 2 the basins have been located in the centre of each catchment to reduce the pipe lengths and overall depth of basins.

By reducing the catchments from 5 to 4 it has increased the overall size of catchments 3 and 4 by consolidating catchments 3, 4 and 5 from Figure 1. These catchments were merged because of the relatively flat ground when compared to catchments 1 and 2.

The catchment boundaries discussed above have been based off feature survey information supplied by GSCC and may be subject to change during detail design of drainage basins.

3.2 GEOTECHNICAL INVESTIGATION

In order to determine the existing ground water conditions of the NEGC, GSCC have engaged the services of Geotechnical Testing Services (GTS) to undertake a groundwater investigation at the nominated basin locations. (Refer to Appendix E)

GTS undertook 10 boreholes to a depth of 6m and found no ground water present. GTS noted moist to wet material present at 5.2m on borehole 1 which is located at the catchment 1 basin location.

The catchment 1 basin is approximately 4.5m deep with only the sedimentation pond being excavated deeper than the 5.2m where wet to moist layer exists. An allowance to clay line the sedimentation pond has been included in the civil estimates to control any ground water present.

4. CATCHMENT 1 BASIN MODELLING

4.1 STORAGE REQUIREMENTS

Storage requirements for Catchment 1 were calculated using Swinburne Institute of Technology 1987 which is a conservative method for on-site storage calculations. The following parameters were adopted from G-MW's and IDM standards for basins:

- Basin sized for the 24hr 1 in 100 year storm event with a blocked outfall.
- 1% ARI volume to be stored.
- No requirement to store the peak 5 year volume below the incoming drainage pipes.
- Shepparton Intensity Frequency Data sourced from Bureau of Meteorology.
- Coefficients of runoff have been adopted from Table 9 in the IDM.

Table 1: Basin 100 Year Storage Volumes

Catchment No.	Approximate Area (ha)	C of R*	100YR Storage Volume (m^3)
1	37.1	0.73	31,276
2	37.1	0.73	31,276
3	55.1	0.73	46,450
4	47.6	0.73	40,128
Total	**177**		**149,130**

*Average coefficient values adopted.

Refer to Appendix F for storage volume calculations.

4.2 BASIN COMMAND ANALYSIS

To determine the minimum depth required for each basin a pipe control investigation was undertaken. The pipe control exercise was based on the following parameters:

- 1 in 400 pipe grades
- 1m/s pipe flow for time of concentration in pipe
- 6 minute initial time of concentration
- 1.1m initial pipe cover
- Rational flow calculations.
- Manning's calculations to determine outfall pipe sizes.

Pipe reaches were determined as shown in Figure 12 with the purple dashed lines representing the controlling line in each sub-catchment. Pipe sizes were determined for the 5 year flows generated from the development.

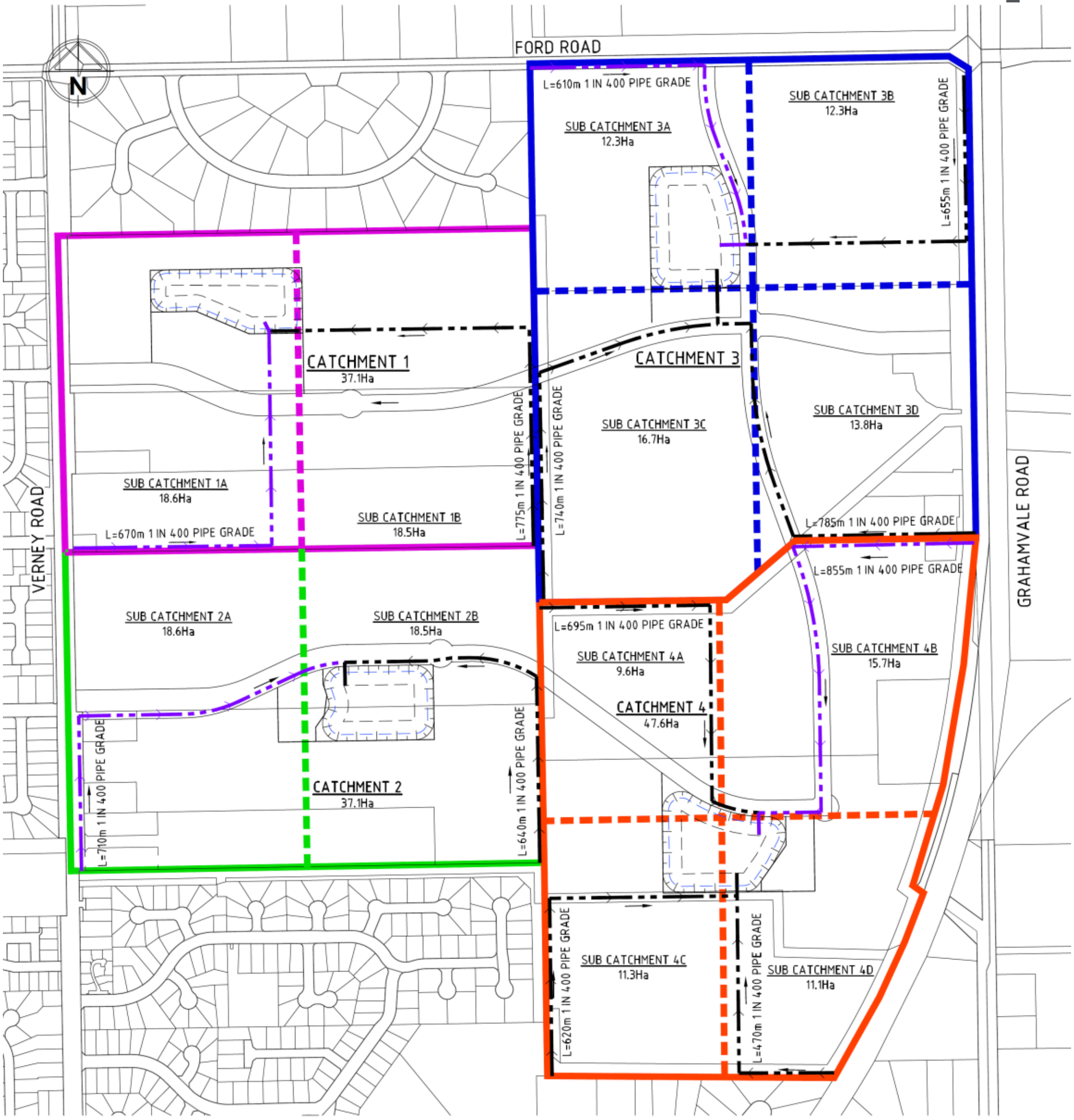


Figure 12: Pipe Reach Plan.

From this information the following minimum depths can be determined as shown in Table 2.

Table 2: Basin Pipe Controls.

Catchment No.	Control Length (m)	Approx. Outfall Pipe Diameter (mm)	Approx. Basin Depth (m)
1B	775	1350	4.5
2A	710	1350	4.4
3D	785	1200	4.4
4B	855	1200	4.3

Outfall pipe size calculations for each sub-catchment can be found in Appendix G.

5. WATER SENSITIVE URBAN DESIGN

The proposed water quality treatment elements for the proposed development were modelled using MUSIC Version 6.2. Rainfall data was selected in line with Melbourne Water's 'Guidelines for the use of MUSIC'. Proposed development catchment areas and fractions impervious were also entered based on Melbourne Water MUSIC Guidelines. Water quality treatment elements were entered and analysed by trial and error to determine an effective treatment train that met the required water quality objectives. All sediment basins were sized using a calculation based on the methods within chapter 5 of the WSUD Engineering Procedures 2005.

5.1 RAINFALL AND EVAPOTRASPIRATION DATA

Tatura rainfall data (Years 1980-1990) was selected as the reference rainfall and evapotranspiration location as per Melbourne Water MUSIC guidelines.

5.2 RUNOFF PARAMETERS

0.75 Fraction impervious value was adopted allow for any increase in density the development that may occur in the future

5.3 WATER QUALITY OBJECTIVES

The objectives required by the Infrastructure Design Manual relate to the Urban Stormwater - Best Practice Environmental Guidelines (2009). The performance objectives of this document are summarised below in Table 3.

Table 3: Summary of treatment objectives for stormwater quality.

Pollutant	Performance Objective
Suspended Solids (SS)	80% reduction of the typical urban load
Total Phosphorous (TP)	45% reduction of the typical urban load
Total Nitrogen (TN)	45% reduction of the typical urban load
Litter/Gross Pollutants (GP)	70% reduction of the typical urban load

5.4 PROPOSED WATER SENSITIVE URBAN DESIGN TREATMENT

The proposed WSUD treatment for catchment 1 basin includes a sedimentation pond and bio retention system. Calculations to determine the size of each treatment areas has been undertaken using MUSIC.

Figure 13 below shows the treatment train considered for the WSUD system on the catchment 1 basin.

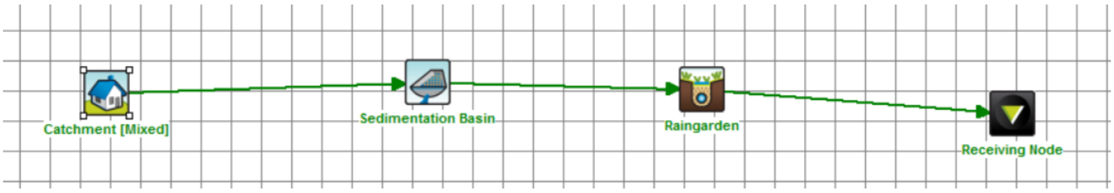


Figure 13: Catchment 1 MUSIC treatment train.

Figures 14, 15, 16 and 17 show the MUSIC model inputs and results to achieve best practice reduction on pollutant loads before being pumped to G-MW Drain 3.

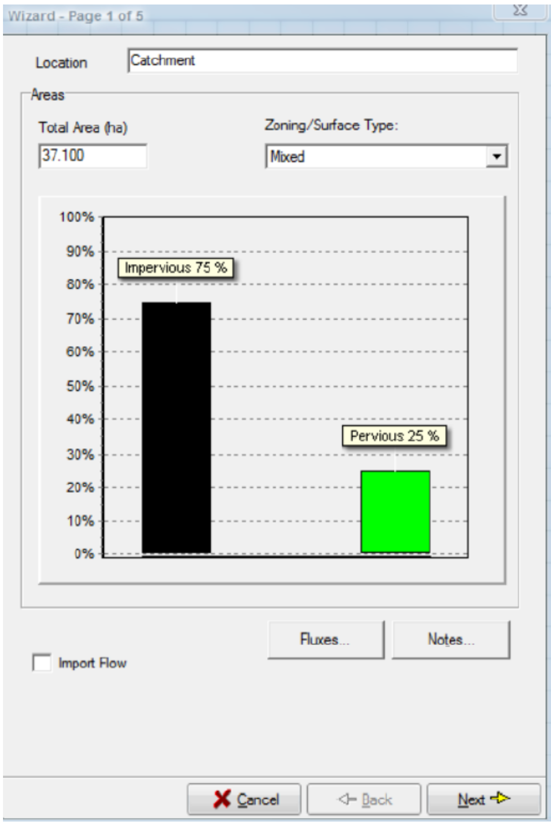


Figure 14: Catchment 1 MUSIC Details

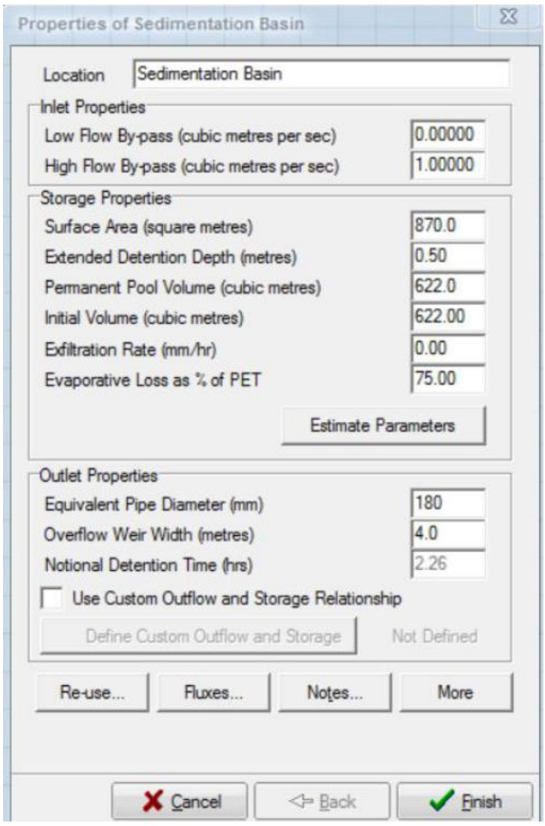


Figure 15: Catchment 1 Sedimentation Pond Details

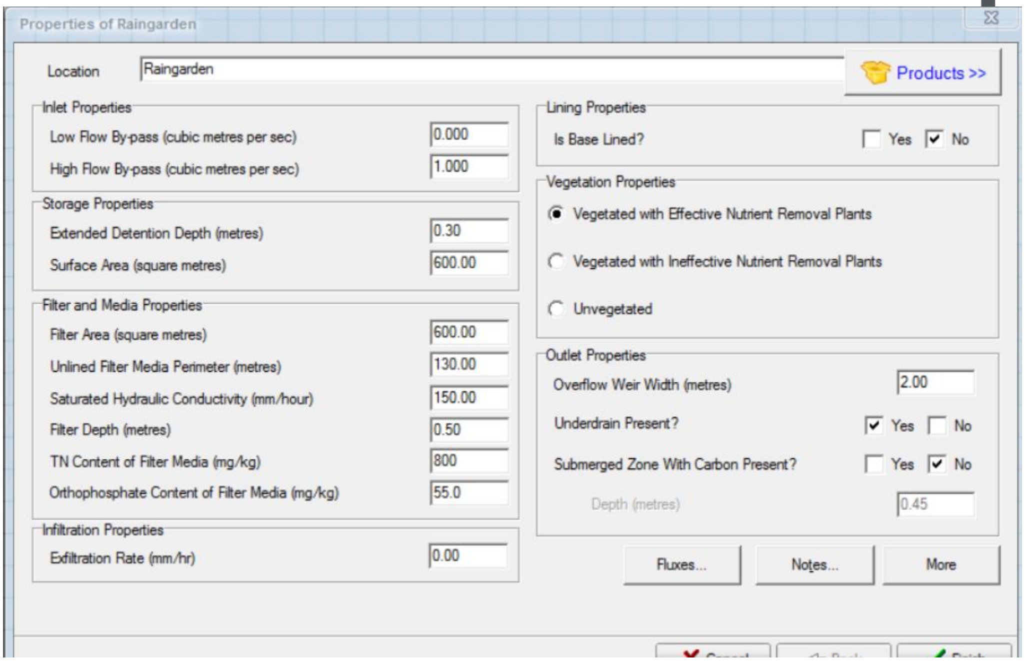
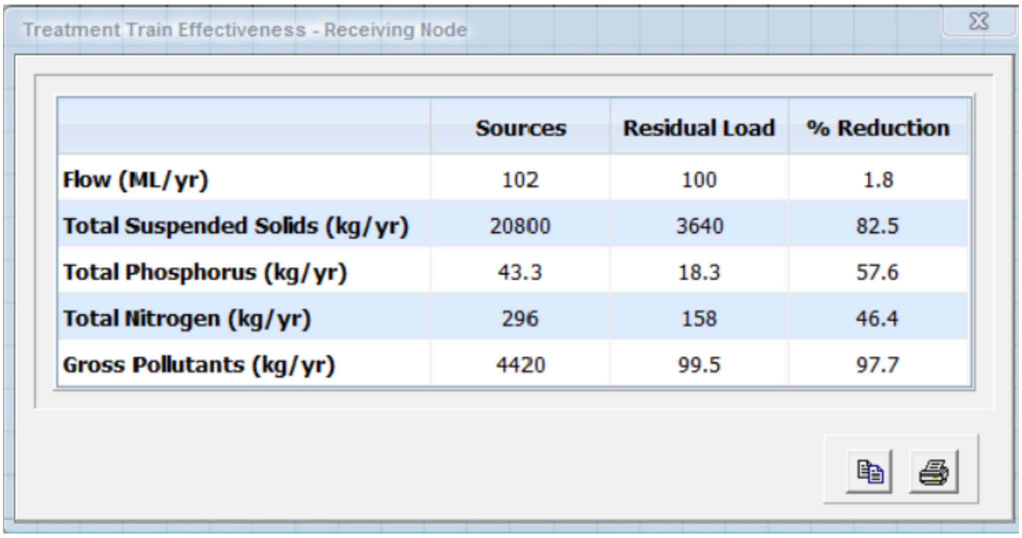


Figure 16: Catchment 1 Bio Retention Details



	Sources	Residual Load	% Reduction
Flow (ML/yr)	102	100	1.8
Total Suspended Solids (kg/yr)	20800	3640	82.5
Total Phosphorus (kg/yr)	43.3	18.3	57.6
Total Nitrogen (kg/yr)	296	158	46.4
Gross Pollutants (kg/yr)	4420	99.5	97.7

Figure 17: MUSIC Results Catchment 1.

Refer to Appendix H for MUSIC treatment train and Appendix I for sedimentation basin calculations.

6. FUNCTIONAL BASIN DESIGN CATCHMENT 1

Functional designs plans were prepared for the catchment 1 basin to determine the extent of works required to meet G-MW and IDM standards. The functional design also includes an opinion of probable cost for the basin civil construction.

The functional basin designs were based on the following G-MW and IDM requirements:

- Basin sized for the 24hr 1 in 100 year storm event with a blocked outfall.
- Sedimentation ponds have been provided to cater for the 1 year flows into the basin.
- Flows greater than 1 year have been diverted around the WSUD.
- Bio retention rain gardens have been provided to meet water quality requirements.
- High flows to bypass the sedimentation pond and bio retention basin.
- 1 in 6 batters have been provided in design to allow access to basin floor for mowing/maintenance.
- 1 in 400 minimum grade for along basin floor/bed.
- Concrete access track has been provided to provide maintenance to the sedimentation pond.
- Stormwater pump stations and rising mains to discharge into G-MW's Drain 3.
- 1m freeboard to allow overland flow to enter basin from surrounding basin area.
- Freeboard area ranging from 6m to 10m wide depending on if the area is to be consider for open space requirements as per Section 18.2 of the IDM.
- Maximum discharge rate of 1.2L/s/Ha.

Based on these requirements the function design for catchment 1 basin is shown in Figure 18 below.

Spiire acknowledge that our current proposed functional design provides limited flood immunity to the bio retention system. Flood storage in the base of the retarding basin can only accommodate a volume approximate to the 1 year flood volume, calculated as approximately 3,800 cubic metres. Therefore the WSUD system will be drowned out and may require reactive maintenance in storm events greater than the 1 year ARI which is typical of a Shepparton drainage solution given the flat terrain and outfall constraints.

Furthermore, in a 100 year storm event the system will take up to 9 days to empty, which is not ideal for any proposed water quality treatment system. The plant species selected in the design should consider this and a maintenance program should be developed and adhered to in order to replant plants that may die due to drowning and reset the filter media that may be clogged with resuspended sediment.

6.1 OPENSPACE WITHIN DRAINAGE BASINS

To reduce the open space area requirements on each park within the NEGC, the VPA and GSCC have reduced the 1 hectare parks back to 0.7ha with the remaining open space area to be provide within the drainage reserve.

Section 18.2 of the IDM states that any area to be contributed to open space requirements must meet the following criteria:

- Be at least 10m wide; and
- Incorporate the construction of shared walkways; and
- Have a cross-fall within a 10m wide corridor around any path; and
- Be linked to other public open space being provided in the area; and
- Not be inundated during any event up to and including a 20% AEP event; and

- Unless otherwise agreed by Council, not be inundated during a 1% AEP event.

Spiire have applied these conditions to catchments 2, 3, and 4 within the NEGC and have achieved a minimum of 0.3ha of unencumbered land to offset the reduction in open space park areas.

By applying this principal it will reduce the overall costs for open space areas where the landscape treatments around basins will not be as intensive as they are with an open space park areas. Refer to Figure 11 and Appendix J of this report for these areas.

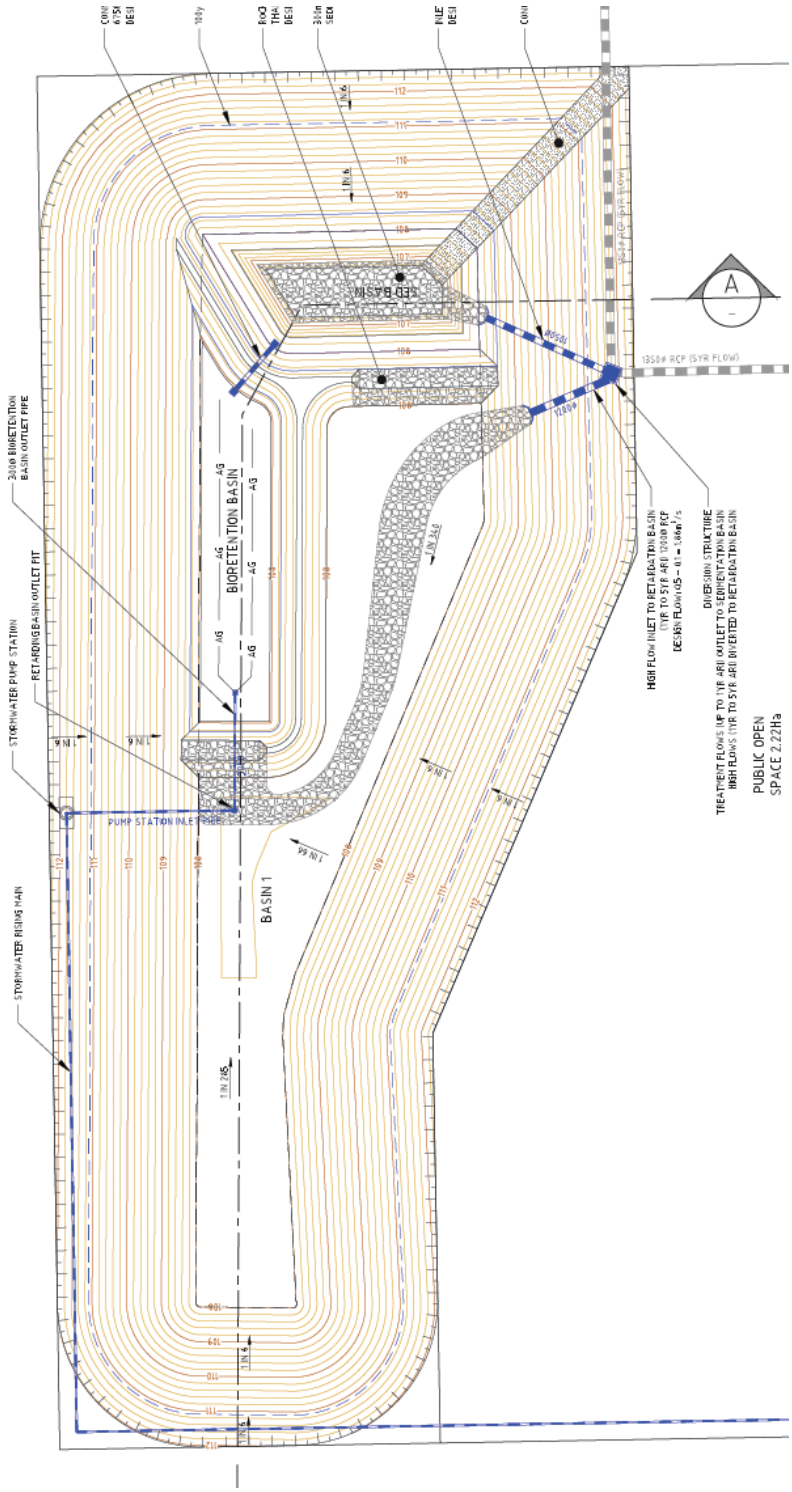


Figure 18: Catchment 1 Functional Basin Design.

Please refer to Appendix J for the catchment 1 functional basin design.

7. OPINION OF PROBABLE COSTS

From the functional design prepared for the catchment 1 basin an OPC for civil works has been undertaken. This OPC's has been used as a basis for the cost apportionment over the remaining 3 catchment basins as shown in Figure 11.

The following assumptions have been adopted for the costings:

- No allowance for landscaping works included in estimates.
- Council Fees of 3.25% included in estimate.
- 5% Traffic Management included in estimate.
- 0.5% Environmental Management included in estimate.
- Survey and Design Fees of 10% included in estimate.
- 5% Supervision and Project Management included in estimate.
- 2.5% Site Establishment Fee included in estimate.
- 15% Construction Contingency included in estimate.
- Basin excavation material assumed to be retained on site to be utilised in subdivision earthworks.
- Pump station and rising main works calculated separate to basin costing due to the variance in scope of works between basins.
- Civil elements of WSUD treatment systems included in estimate.

Based on the assumptions above the total civil construction cost for the catchment 1 basin works is **$1,182,371.00.**

This estimate is a significant reduction on the $1,802,569.80 prepared by Reeds. The main factors contributing to the reduction in cost is:

- Local contractor rates have been applied which has greatly reduced key items like excavation costs from $12.50 per cubic metre to $5.
- Slight reduction in earthwork quantities, approximately 6,000 cubic metres.
- Significant reduction in the amount of pipes and pits included in estimate.
- No footpath allowances in estimates.
- Significant reduction in WSUD areas and lining material.
- Removal of hydro seeding from civil estimates and to be included in landscape estimates.

The largest saving from the estimates is the basin excavation cost which has reduced from $775,000 in Reeds estimates to $280,000 in Spiire's estimates and this is achieved through applying local contractor rates.

Refer to Appendix K of this report for cost break down of catchment 1 basin estimates and individual estimates for the outfall infrastructure costs for each catchment.

7.1 COST APPORTIONMENT

The cost apportionments have been based on the storage volume required for each catchment. This was deemed the most appropriate method for apportionment given the excavation costs represent the largest components of the basin construction. Below is the apportionment calculations for each basin based off the OPC for catchment 1.

Table 4: Civil Apportionment Calculations.

Catchment No.	Approximate Area (ha)	100YR Storage Volume (m^3)	Apportionment	Basin Cost	Pump Station Rising Main Cost	Total Cost
1	37.1	31,276	100%	$765,667*	$416,704**	**$1,182,371**
2	37.1	31,276	100%	$765,667	$390,204**	**$1,155,871**
3	55.1	46,450	149%	$1,140,844	$570,213**	**$1,711,057**
4	47.6	40,128	128%	$980,054	$358,002**	**$1,338,056**
Total				**$3,652,232**	**$1,735,123****	**$5,387,355**

* Base civil cost to be apportioned over remaining catchment basins.
** Separate cost estimates complete for each catchment.

As discussed the outfall infrastructure works have been calculated separately and any common infrastructure items apportioned accordingly. Catchments 1 and 3 share a common outfall infrastructure and therefore an apportionment of costs has been applied to these items in particular the rising main works as shown in Table 5 below.

Table 5: Civil Apportionment Calculations - Catchments 1 and 3.

Catchment No.	Approximate Area (ha)	100YR Storage Volume (m^3)	Common Rising Main Apportionment^
1	37.1	31,276	40%
3	55.1	46,450	60%
Total	**92.2**	**77,726**	**100%**

^ Apportionment based on 100 year storage volume.

The total basin civil costs for the NEGC is **$5,387,355** including construction contingencies, professional fees and authority fees and charges.

Land acquisition costs and landscape works are to be applied to this figure to determine the resultant drainage costs for the NEGC.

Refer to Appendix K of this report for cost break down of catchment 1 basin estimates and individual estimates for the outfall infrastructure costs for each catchment.

8. DRAINAGE SUBMISSIONS FROM INITIAL EXHIBITION

Please find below submissions in relation to drainage items from the initial exhibition of documentation for the NEGC. Spiire has provided a response in **bold** on the following submissions where appropriate:

- Provide a revised recommendation on applying the functional layout plan for retarding basin 1 to the other basins.

  To determine the most accurate drainage costs for the NEGC functional designs and costings for each basin would be recommended.

- Suggestion to compare construction rates with local contractor rates, as the given rates appear to be high and more consistent with metropolitan standards.

  New cost estimates have adopted local contractor rates for construction costs.

- The requirement of 5 drainage basins is excessive for the land area within the corridor

  The new drainage strategy proposes to adopt 4 drainage basins.

- There is a discrepancy between the Spiire and Reeds Consulting drainage report, Spiire indicate the site has a significant grade where Reeds indicate the site is generally flat

  Significant grade mentioned by Spiire relates to Catchment 1 analysis where a grade of 1 in 620 for the catchment is quoted. Reeds report Page 14 references a grade of 1 in 700 across Catchment 1 which is a similar observation. Given Shepparton's flat terrain and approximately 2m of fall from the south to the north of the township these grades represent a significant fall across the site to be utilised.

- There scope to merge the two northern catchments, as typically with larger diameter pipes could be laid at flatter grades of 1 in 600, almost fully negating the increased distances from the basin.

  More information required before providing a response.

- The northern catchments are proposed to be discharges via pumped systems to the south as the northern channel has limited capacity to cater for flows. Has the southern catchments discharge rate been compromised to accommodate the northern flows and hence the southern basins needing to be larger? It is acknowledged that the 1.2L/s/ha may be a maximum discharge limit set by the drainage authority, however this requires clarification.

  No, the 1.2 L/s/ha is a standard condition from G-MW and basins are sized based on a blocked outfall for a 24 hour period.

- Due to the large size of the basin footprints, the requirement for cross-fall of the base of the basin appears to not be considered, further increasing the depth required for the basin, which a permanent water body in the base would eliminate.

  New functional designs include a minimum of 1 in 400 grade along the basin footprint as per IDM requirements.

- Is it expected that the site is free from inundation in the 500 year event, which is the basis for their calculations.

  No response.

- A bio retention basin would require frequent resetting. A wetland may provide more tolerant of the inundation, with no clogging of surfaces available.

  Refer to section 6 of the report, Spiire agrees the bio retention basins will require frequent resetting, however to reduce any impacts on groundwater through deeper excavation over a larger areas for a wetland and the increased construction costs Spiire have kept the bio retention systems proposed by Reeds.

- A review of the MUSIC water quality treatment analysis indicates there may be a large omission of the bio retention design. Any flows entering the sedimentation basin/bio retention basin exceeding this flowrate will quickly overwhelm the system leading to bypass.

Flow routing through the system will occur during the detailed design phase. In general however, the sediment pond is used to retain flows slightly, which protects the bio retention from high velocities. The sediment pond will overflow during events larger than 3 month flows.

- There may be an issue with the WSUD treatment calculations, which as part of detailed design may force a larger area to be required for drainage purposes.

  Refer to section 5 of the report, WSUD calculations were calculated by Spiire and resulted in smaller treatment areas than calculated by Reeds.

- The estate on Matilda Drive is on septic tanks, the number of houses in this estate will cause damaging run off as drainage in these types of housing states is never sufficient. The housing estate across Verney Road floods constantly.

  Basin positioning has been reviewed and shifted further south to provide a minimum setback from the existing septic systems to meet EPA standards. Refer to section 2.2 of the report.

  The IDM requirement to store the 5 year peak storage below the invert of the incoming drainage line further deepens the basin leading to increased costs.

  New designs have excluded this requirement given basin depths are 4m+ and hydraulic grade analysis is based on the top of pipe which is lower than the 5 year peak volume.

9. CONCLUSION

In conclusion to the drainage strategy review, functional basin designs, and OPC's completed please find below a list of findings and recommendations:

- Review of Reeds drainage strategy identified catchment 4 basin was located over an existing G-MW irrigation supply channel and would result an inefficient design and add significant earthwork costs during development.
- New drainage strategy proposes 4 basins in lieu of the 5 proposed by Reeds.
- Review of Reed storage calculations showed 2 values for the 100 year storage volumes.
- Review of the catchment 1 basin location identified the basin was too close to the existing low density development north of the basin and was shifted south to provide minimum setback requirements to meet EPA guidelines for Onsite Wastewater Management.
- Review of OPC undertaken by Reeds identified construction rates more consistent with metropolitan areas.
- Geotechnical investigation was undertaken with no water present to 6m deep.
- Basin cost estimates have been undertaken for catchment 1 basin and apportioned over the remaining 3 catchments.
- Apportionment of civil costs based on 100 year storage volume requirements for each catchment given excavation works represent the largest component of the basin costings.
- WSUD analysis identified the proposed WSUD treatment areas were oversized to cater for the catchment.
- Land acquisition costs to be applied to civil work estimates.
- Landscape costs to be applied to civil work estimates.
- Total cost for basin civil works is **$5,387,355.00.**

APPENDIX A – REEDS CONSULTING DRAINAGE STRATEGY REPORT JULY 2014

REEDS
CONSULTING

21656E
RB

11th July 2014

Attention: Mr Michael MacDonagh
Principal Strategic Planner
Greater Shepparton City Council
Locked Bag 1000
Shepparton VIC 3632

Dear Michael,

RE: **NORTH EAST GROWTH CORRIDOR**
DRAINAGE STRATEGY REPORTS

Please find attached two hard copies of the Drainage Strategy Report as per my email of 11th July 2014, in relation to the Shepparton North East Growth Corridor Precinct Structure Plan.

Should you have any queries regarding the above please do not hesitate to contact the undersigned to discuss.

Yours Faithfully,
For Reeds Consulting Pty Ltd

RICHARD BREWSTER
Engineering Director

Enc.

Land Surveyors
Civil Engineers
Planners
Development Consultants
Project Coordinators

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Pty Ltd

Land Surveyors
Civil Engineers
Planners
Development Consultants
Project Managers
Multimedia Cartographers

DRAINAGE STRATEGY REPORT FOR SHEPPARTON NORTH EAST GROWTH CORRIDOR PRECINCT STRUCTURE PLAN

Prepared for: City of Greater Shepparton
Project Ref: 21656E
Date: July 2014

Prepared By:
Reeds Consulting Pty Ltd
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Melbourne VIC 3000
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Fax: 03 8660 3060
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REEDS CONSULTING

CONTENTS

1 INTRODUCTION

This report has been prepared to inform and assist the City of Greater Shepparton in relation to the stormwater drainage servicing issues and requirements associated with the development of the proposed Shepparton North East Growth Corridor Precinct Structure Plan.

The information contained in this report is based on investigations by Reeds Consulting Pty Ltd that have been facilitated by our inquiries with City of Greater Shepparton (CGS), Goulburn Murray Water (GMW) and the Goulburn and Broken Catchment Management Authority (GBCMA) and the information provided by these parties.

In addition to the above authority consultations, additional advice has been provided in relation to site levels and limited geotechnical investigation to assess current groundwater conditions.

Reeds Consulting have undertaken several inspections of the site and surrounding drainage infrastructure to better assess the constraints of the current conditions and the limitations that will be placed on the development of the land in its intended use of residential subdivision.

The report is based on both written and verbal advice from the abovementioned parties and our own calculations and assessments. The information has been prepared with due diligence and care however Reeds Consulting retains the right to alter this report should we become aware of a change in policy or advice that is contrary to the assumptions upon which this report has been prepared.

Prior to issue of this report Reeds Consulting has prepared interim documents in relation to the drainage strategy for the Shepparton North East Growth Corridor (NEGC), this document supersedes the previously issued reports dated September 2012 and January 2014.

2 EXISTING CONDITIONS

2.1 SITE DESCRIPTION

The subject area is approximately four kilometres north east of the Shepparton town centre.

The area is bounded by Ford Road to the north, Grahamvale Road and Goulburn Murray Waters irrigation channel to the east, Verney Road to the west and Goulburn Murray Waters Drain number 3 along the southern abuttal. A plan of the subject land is shown in Figure 1 below.

The subject land has a total area of approximately 172 Ha and consists of 8 major parcels of land, several smaller landholdings and contains two existing school sites. A number of existing irrigation channels bisect the site. The retirement of these channels will be a constraint on the full development of the PSP area as the channels will need to remain until all irrigation activity ceases in the precinct.

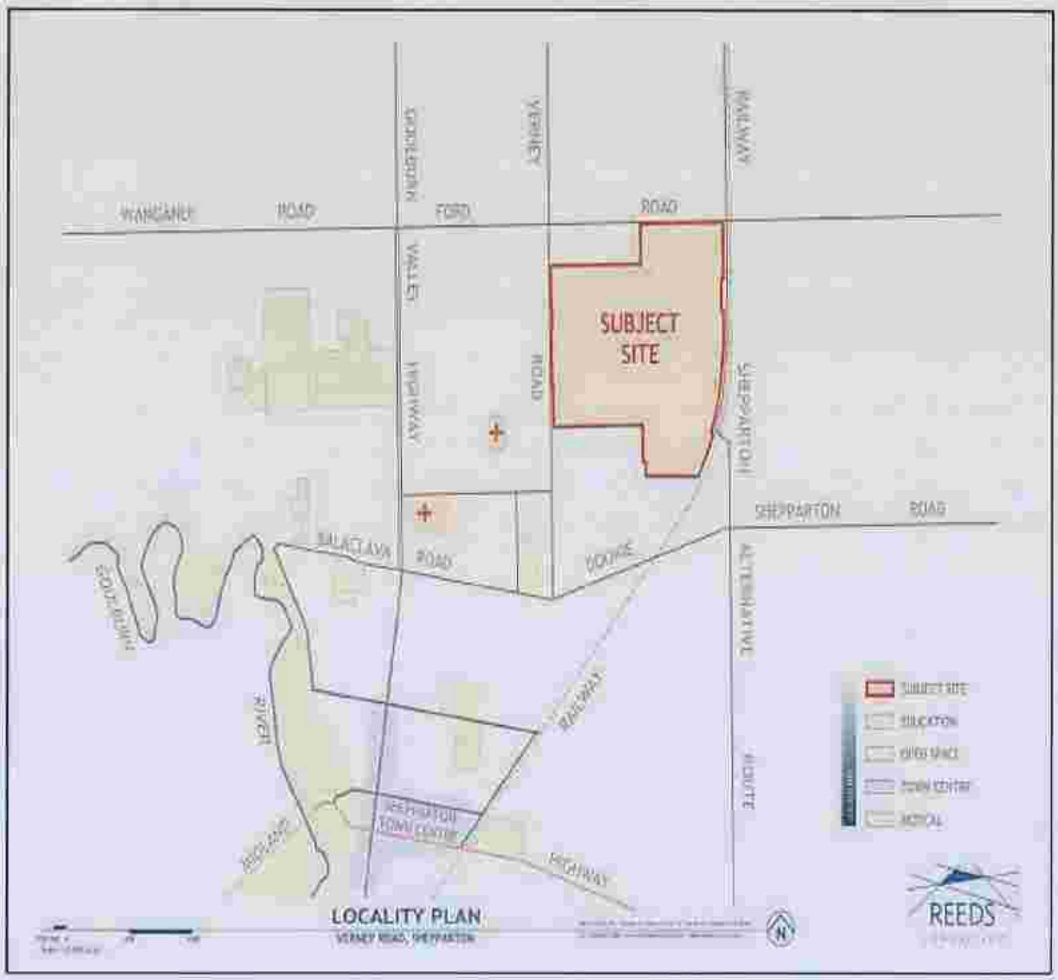


FIGURE 1: SITE LOCALITY PLAN.

2.2 EXISTING DRAINAGE CONDITIONS

The area has historically been used for fruit production and generally exhibits flat grades that have been artificially modified to facilitate gravity irrigation and drainage of land.

The land sheds runoff into two existing drainage catchments; these are demonstrated in figure 2 below. The southern portion of the site drains to Goulburn Murray Waters Drainage Channel No.3. The northern portion of the site drains to Goulburn Murray Waters Drainage Channel No. 4.

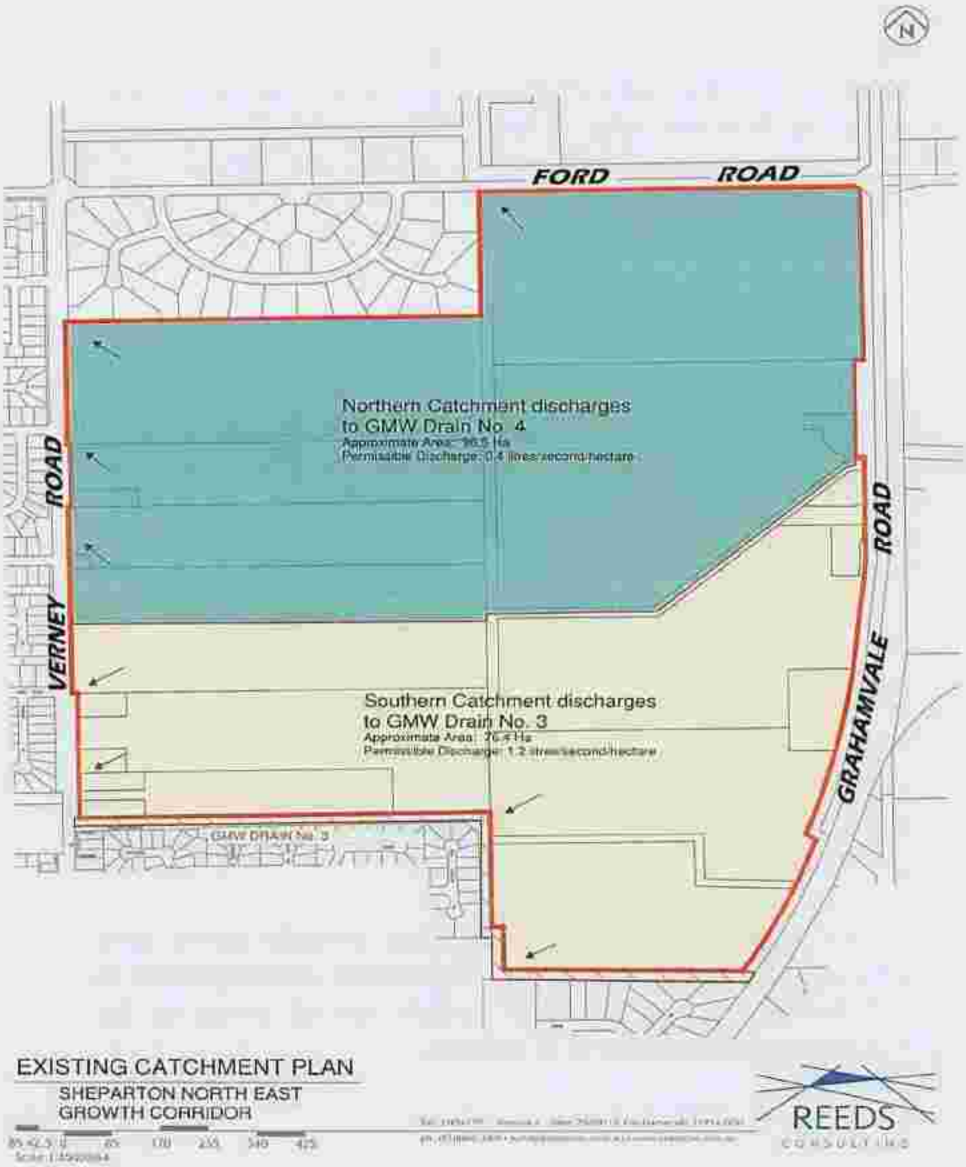


FIGURE 2: EXISTING DRAINAGE CATCHMENTS

Advice from Goulburn Murray Water indicates that the site currently has no formal drainage strategy and the current drainage outlets are limited to rural capacity and are not sufficient to provide any formal level of drainage or flood protection to the area.

The subject area is not identified as land subject to inundation in a 100Yr event on GBCMA's flood mapping of the Shepparton Area (refer Annexure A). In its current state the site is subject to localised flooding following more substantial rain events. In particular GMW has provided advice that Drain No 4 has an extremely limited capacity to receive water from the site or to accept stormwater when the drain is running partially full. This is discussed in more detail below.

Investigations with GMW and council in relation to external catchments that may discharge flows into the site has not revealed any external flow paths exist. As such these have not been considered further in this discussion. It is noted that the site is well protected on the Eastern abuttal by the rail lines and GMW channels, which will remain post development.

2.3 EXISTING IRRIGATION CHANNELS

Two significant irrigation channels bisect the subject land. The primary purpose of these channels has been to convey water for orchard irrigation from GMW's supply network. Whilst these channels are not a component of the drainage strategy they are a constraint that will control the development timing, as their continued use will impact the ability to effectively remodel the site to provide adequate drainage to some portions of the site until they are retired from service and abandoned.

It is noted that abandonment of the channels will require cessation of use and surrender of water rights as well as acquisition of the crown land within which the channels are located. If development is to proceed whilst the channels are in use there will need to be a bypass solution comprising siphons, gravity drainage or temporary pumped drainage lines.

It is also noted that the irrigation channels also provide stock and domestic supply to a portion of the existing residential development in the north-west of the subject area. This supply would need to be replaced as part of the channel retirement process.

3 PROPOSED DRAINAGE STRATEGY

The following section outlines the design constraints and methodology behind the development of the drainage strategy for the site.

The site has a number of design constraints, which include physical, aesthetic and social, these have all been considered during the development of the drainage strategy.

It became apparent during the process that the drainage solution for this site would have a controlling effect on the overall road and public open space network and to this end the drainage strategy has been developed in conjunction with the overall PSP layout to ensure that an integrated design solution is achieved that will permit the efficient and economic development of the site.

The constraints on the site are derived from three primary sources; these are natural topographic constraints, Goulburn Murray Water constraints in relation to outlet capacity and water quality treatment and City of Greater Shepparton constraints in relation to internal drainage requirements and a stated desire to integrate any storage / retarding basins in areas of open space. Each of these design controls is discussed below:

3.1 TOPOGRAPHIC CONSTRAINTS

The site is generally flat with minimal surface grades due to the historic agricultural use artificially shaping the land surface to provide efficient gravity flood irrigation of the orchards.

To develop the site for residential development it will be necessary to undertake significant site remodelling and bulk earthworks to meet required minimum grades for roads and allotments and to convey and control overland stormwater flow.

Filling of the site will be constrained by abuttal to existing development in the north west of the area and to a lesser degree by the interface with existing roads and channels that surround the site.

In order to provide an economic design solution and limit the extent of earthworks it is necessary to remodel the site into a series of sub-catchments. Based on the geometry of the overall parcel the drainage strategy has proposed a series of five approximately equally sized sub-catchments.

These sub-catchments are defined on the drainage strategy plan in Annexure B.

3.2 GOULBURN MURRAY WATER ADVICE

Goulburn Murray Water is the responsible drainage authority that manages the drainage and irrigation network in the Greater Shepparton area.

GMW defines both the treatment requirements for stormwater and the permissible discharge flows into their drainage network. Advice from GMW in relation to drainage of the subject area has confirmed that Drainage Channel No. 4 to the north of the site has significant discharge constraints and a maximum permissible discharge rate of 0.4 litres /second /hectare.

Drainage Channel No. 3 to the south of the subject land has a permissible discharge rate of 1.2 litres /second /hectare which is still a restrictive figure when considering the size of the catchment.

In discussions with GMW there has been confirmation that alteration of the existing drainage catchment boundaries would be supported to enable the majority of the site to be conveyed to Drain No. 3 provided that the maximum discharge rate is not exceeded. GVW have also advised that level monitoring of Drain No. 3 will be necessary and no outfall / discharge permitted when a pre-determined top water level is reached or exceeded. Given the extremely restrictive discharge rate permitted to Drain No 4, the drainage strategy for this precinct will be to discharge all flows, other than localised road flows in the Ford Road abuttal to Drainage Channel No 3.

During or following times of heavy rainfall GMW has advised that the drainage channel network does not have sufficient capacity to cater for any additional contributing flows. GMW has confirmed that a pump controller will be necessary to regulate discharges into Drain No. 3. As a result of this limitation it is a requirement that the drainage system within the PSP area be designed to store all discharge from a 1% AEP (100 Yr. ARI) storm for a 24 hour period. This is a significant factor in the development of the drainage strategy and requires the inclusion of significant storage basins within the site area.

In addition to the controls placed on the quantity of discharge from the site GMW have also stipulated that the quality of the discharged stormwater must meet industry benchmark practice with regard to the removal of suspended solids (80%), nitrogen (45%) and phosphorous (45%). To achieve the water quality targets for stormwater the drainage strategy will incorporate Water Sensitive Urban Design (WSUD) elements where possible into the road and storage basin design.

3.3 CITY OF GREATER SHEPPARTON ADVICE

In developing the drainage strategy Council has placed a number of design constraints on the site. These are a combination of technical constraints and desired outcomes with respect of landscape interface and integration of public amenity between proposed storage basins and public open space areas.

Councils technical design criteria is based on the requirements in the Infrastructure Design Manual (IDM) and includes the provision of a major / minor drainage system with a 5Yr ARI underground system and an overland flow path with capacity to convey and control 100Yr ARI runoff.

Council have indicated a desire to move away from past municipal practices of providing isolated water storage basins. Traditionally these have been located in fenced off reserves and have been excavated depressions with steep batters to maximise storage capacity. Council have stipulated that any stormwater storage basins be integrated with public open space. Such integration offers a range of community benefits including additional opportunity for landscape embellishment of open space, increased overall size of community reserve areas, improved visual amenity and sightlines within the reserve and opportunity to integrate shared pathways with the basin to enhance passive recreation opportunities.

The inclusion of the storage basins within public reserve areas increases design constraints due to the safety and maintenance requirements of flatter batter slopes and curvilinear geometry to give a more 'natural' footprint to the basins. Both of these factors reduce the efficiency of the storage area. The design compromise is to minimise the footprint of the storage area whilst providing a natural basin shape and gentle batters that are amenable to all reserve users.

3.4 SUB-CATCHMENTS

The drainage strategy for this site has been dictated by the various constraints discussed above. The site has been divided into 5 sub-catchments that will each have an independent storage basin capable of storing a 1% AEP storm for a 24 hour period with no discharge to the receiving waters external to the site. The location of the storage basins is generally central within each catchment to ensure that the drainage lengths are not excessive which avoids unnecessarily deep basins.

Each storage basin will have a controlled pumped discharge as a gravity discharge will not be possible due to the site topography and relative water levels in the drainage channels.

Generally each sub-catchment will have a 5 Yr. ARI piped drainage network to convey flows to the storage basin area. Flows in excess of the 5Yr ARI event will be conveyed overland via the road network to the storage basin. Once piped flows reach the storage basin area they will need to discharge into a sediment pond to remove bulk sediment load.

The sediment pond will require a low flow (3 month capacity) outlet into a bio-swale treatment zone to remove nitrogen and phosphorous loads contained in the stormwater. Flows in excess of the 3 month ARI storm will be diverted from the sediment pond directly to the storage basin, so as to limit damage to the bio-swale area.

Preliminary drainage analysis of each sub-catchment has been undertaken and from this an estimated storage requirement has been determined for each basin based on the 100Yr storm. A summary of these results and preliminary basin storage volumes is presented in Fig 3 below sub-catchment identification is per Annexure B:

SHEPPARTON NEGC SUBCATCHMENT STORAGE REQUIREMENTS			
Sub-Catchment ID	Sub-catchment Approximate Area (Ha)	Storage Volume 100Yr ARI storm 24 Hour (cubic metres)	Basin Area 100Yr level (sq.m)
1	32.2	31,000	14,720
2	35.5	38,000	16,850
3	34.5	33,800	16,200
4	37	42,800	19,400
5	25.8	27,500	14,350
TOTAL	**165**	**173,100**	**81,520**

FIGURE 3: BASIN STORAGE CAPACITY & INDICATIVE SIZING

Based on the required storage volumes and batter slopes of 1 in 8 an approximate footprint area for each storage basin has been calculated. These have been located approximately central to each sub-catchment area; the areas shown have been used for estate planning. The road network and public open space elements have been integrated in this strategy to provide the most efficient layout for the site. It should be noted that the above calculations are based on a 'regular' basin shape and the inclusion of a 'natural' shaping will be less efficient and increase the basin footprint. The treatment of the storage basins is discussed below. It is noted that the two school sites within the parcel have existing drainage connections. It is not proposed to alter the existing connections for the developed portion of the school sites. Where the school land may be sold off and its use altered to residential development then these areas of altered land use would be incorporated into the estate storage design.

3.5 STORAGE BASINS

The storage basins vary slightly in size due to variance in the sub-catchment areas. In general these basins will be located within or directly adjacent to public open space reserves, such that the spaces become integrated community areas.

Each basin is expected to be in the order of four (4) to five (5) metres deep to provide the required storage volume. In higher order rain events these basins will be sized to fill to the level of the surrounding reserve; however the public open space areas will be above the 100 Yr. storage level and will maintain functionality. In times of low rainfall the basins will generally be 'dry' grassed areas with the exception of the sediment ponds which will always contain water due to them receiving all minor flows within the catchment. Appropriate signage will be required around the storage areas to alert users to the potential for inundation following rain events.

Council has stipulated that the five year storage level in the basin must be lower than the invert level of the local drainage network to ensure that a free draining network in the 5Yr ARI event. A preliminary design has been prepared in relation to Catchment No 1 to demonstrate the operation of the storage basins and provide a functional assessment of the catchment remodelling. This detailed assessment is provided in Section 4.0 of this report and additional data is provided in annexures.

The Shepparton area has high incidence of groundwater and this was a primary consideration in assessing the viability of such significant storage bodies. To address the concerns relating to groundwater and to confirm the feasibility of the storage basins, a geotechnical consultant was engaged to undertake field bores and assess ground water conditions.

Once preliminary assessment of likely basin location was determined the geotechnical engineer was provided co-ordinates of the proposed basin locations and drilling was undertaken at the proposed location of each basin. The testing revealed that there was no groundwater present at depths up to five (5) metres and as such the basin footprints as proposed in the Drainage Strategy plan are considered feasible in terms of the proposed depths. A full copy of the geotechnical report prepared by BM Consulting Engineers is included in Annexure C. The basin footprints proposed have been based on a batter slope of 1 in 8. This is a reasonably conservative figure but one that provides unimpeded pedestrian access to the basins. The ultimate landscape treatment of the basins will provide opportunities to increase this batter slope through intense localised landscape treatment or the incorporation of formal retaining walls, boardwalks and fences in other areas.

The successful integration of the basins into the public open space will rely upon the variability of the landscape treatments and the details of this concept will be fully developed during detailed design. The inclusion of areas of steeper batters has the beneficial impact of reducing the overall basin footprint, decreasing the area of land subject to regular inundation and creating or enhancing visual interest and overall aesthetics. Section 4 of this report has included a preliminary basin modelling exercise and contains cross sections of a design for catchment - Catchment No 1.

It is anticipated that the landscape treatments for the basins will be predominantly open grassed areas in the lower areas subjected to frequent inundation. The inclusion of open swales / dry creek beds and appropriate ephemeral plantings will be appropriate in the lower reaches of the swales.

The upper reaches of the basins can be planted with trees and species that will tolerate occasional inundation. The use of mulched garden areas should be restricted to the periphery of the basin areas to avoid transportation of the mulch and blockage of the drainage outlet systems and pumps.

Each storage basin will have a localised sump and pump station to enable discharge of collected runoff. The sump areas could be either underground chambers or incorporate small pondages.

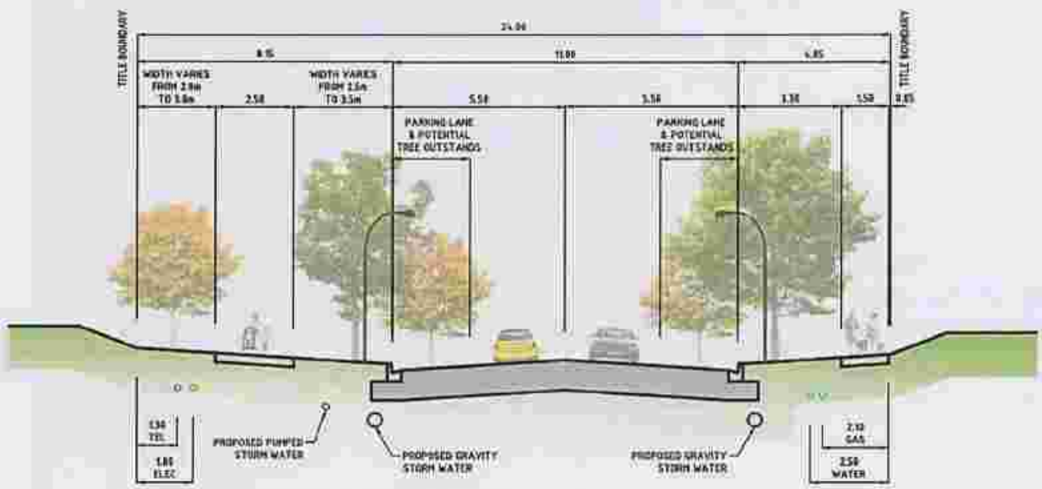
Due to the already significant depth of the basins it is not anticipated that there will be significant opportunity for large water bodies to be incorporated into the storage basins. These would be required to be excavated below the required storage level (i.e. the top water level of any permanent water body would need to be below the 5 metre basin depth).

3.6 STORMWATER OUTLETS

As discussed in the above report ultimate discharge of stormwater runoff is to GMW's Drain No.3. This discharge will be via a pressurised discharge from each storage basin. After assessment of the likely development staging, landholdings, site topography and road network the most economic and flexible solution is to provide two linked pressurised systems, with two independent connection points to Drain No 3. GMW has offered in-principle support of two discharge points.

The proposed discharge system is shown in the Drainage Strategy plan provided in Annexure B. A combined discharge system will be constructed that links the basins in Catchments 1, 3 and 4 and discharges via Verney Road to Drain 3. Basins 2 and 5 could also combine to a localised discharge point part way along the Southern boundary of the site.

Such an arrangement will enable infrastructure costs to be rationalised and alleviate the need to install multiple pipelines within road reservations to cater for drainage discharge. A proposed street cross section is shown below which incorporates the pumped drainage outlet and demonstrates that the inclusion of this asset within a typical street is achievable.



CROSS SECTION 3 - 24m WIDE RESERVE LINK ROAD

3.7 WATER SENSITIVE URBAN DESIGN

Prior to discharge into GMW's drainage channel, stormwater flows will need to be treated to meet best practice targets for the removal of contaminants particularly suspended solids, dissolved nitrogen and phosphorous.

There are a number of treatment options available to reduce the pollutant load on receiving waters, these include:

- Household rainwater tanks connected to toilets or laundry;
- Localised rain gardens adjacent to carparks, community buildings or commercial precincts;
- Inclusion of gross pollutant traps (GPT's) on local drainage networks;
- Linear treatments such as grassed swales or bio-swales;
- End of line treatments such as wetlands.

Usually a combination of several treatments provides the optimal solution for a larger site. Within the Shepparton NEGC there is opportunity to implement a number of these solutions. Given the depth of the storage basins required to retard stormwater flows a wetland is not considered feasible as this option would require additional excavation below the level of the basin floor and would be subject to frequent inundation due to the lack of ability to bypass 'higher flow' events.

It is considered that the primary treatment feature of the drainage network will be the inclusion of grassed swales and / or bio-swales within edges of the storage basins, these would be linked to the piped drainage network via a sedimentation pond and would provide opportunity to create a natural appearance 'creek bed' style treatment.

The size of the basins will mean that swale lengths can be in excess of several hundred meters per basin by incorporating multiple or curvilinear alignments which will offer the opportunity to incorporate an appropriate landscape theme throughout the basin floor and still retain significant areas of grass that can be utilised by park users in times of low rainfall.

The basin swales could potentially be supplemented by swales located within road medians or as discussed by incorporating elements into site design for commercial and community precincts. Detailed design and modelling of the WSUD elements will be undertaken during the detailed design phase of the project and will need to consider not only the physical constraints of the site but also the financial impact of both initial construction and ongoing maintenance of the various treatment train elements.

4 CATCHMENT No.1 ANALYSIS AND BASIN DESIGN

During the process of developing the drainage strategy Council Officers requested that a further level of detail design be undertaken to provide surety to council that the servicing strategy proposed could be successfully integrated within the public open space reserves as described.

In particular council sought investigation on the following aspects of the strategy:

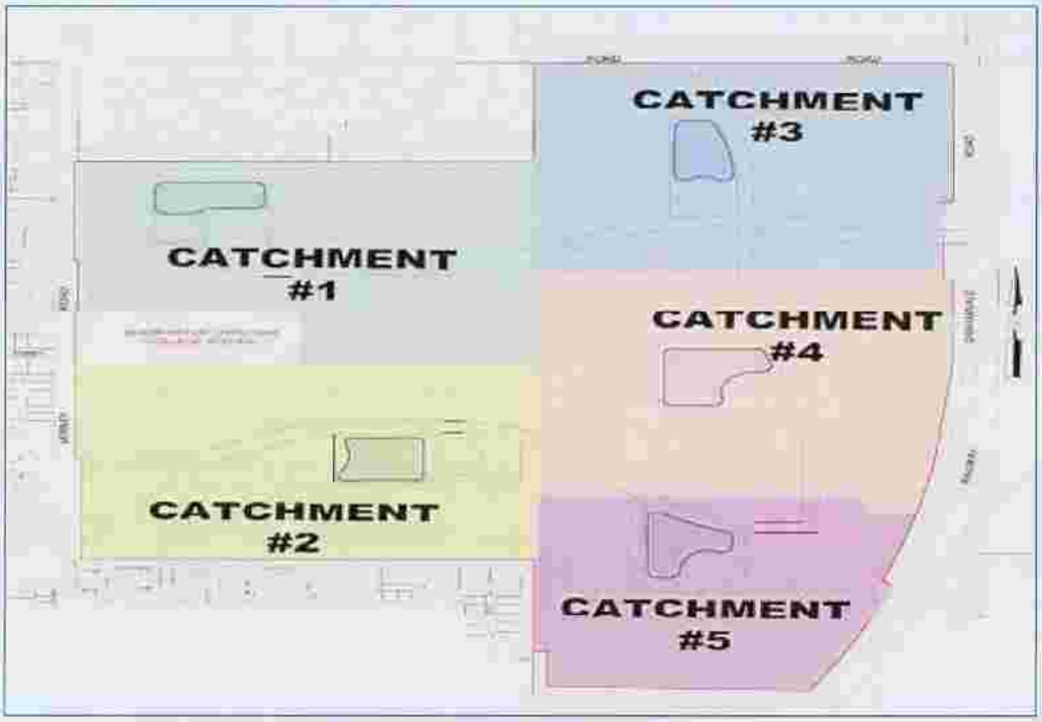
1. Detailed analysis of storage basin sizing and shape;
2. Water Sensitive Urban design elements including sizing and treatment level;
3. Integration of the WSUD elements in the basin / reserve area;
4. Integration of basins within the public open reserve area and details of the operation of the system.

The design presented below is not intended as a final detailed design of the subdivision and is a high level functional design assessment of potential operation of all elements of the drainage system. Final detailed design will be undertaken following issue of planning permits and may have other constraints that need to be considered that do not form part of the assumptions of this report. It is anticipated that the design of all storage basins within the Shepparton NEGC will generally be of the form detailed in this report. Base assumptions have been listed in this report in order that assessment of applicability can be made.

4.1 SITE DESCRIPTION

Shown is a copy of the overall site with the five (5) drainage catchments highlighted. The proposed storage basin location is also shown within each sub-catchment, the locations have been selected generally to be central to each catchment to minimise the length of drainage pipelines to each basin and hence limit the depth of incoming lines to the basin and ultimately control basin depth.

FIGURE 1: SHEPPARTON NEGC DRAINAGE CATCHMENT PLAN



In some cases the basin location has also been dictated by other planning constraints, such as collector road location, community facilities and existing schools. In these cases the basins have sometimes been shown to be 'off centre' to the catchment. It is noted that in the case of Catchment 1 the basin is noticeably 'off centre'.

For the purposes of undertaking this analysis catchment No.1 has been selected on the basis that its 'off centre' basin location will aggravate basin depth due to the longer controlling drainage reaches required to reach the outlet location.

This catchment also has a number of existing constraints such as abuttal to existing development, an existing school and an intersection with Verney Road. The above elements all add constraints that are at least equivalent to those of the other catchments and for the purposes of this type of assessment provide suitably conservative assessment criteria to ensure that the operation of the other basins is functional.

4.2 CATCHMENT 1 DESCRIPTION

Catchment No 1 is located in the North West portion of the site and is approximately 32.1 hectares in area. It is bounded to the North by the existing Matilda Drive residential development, to the south by the existing Shepparton Christian College school site and to the West by Verney Road.

Due to its historic use for fruit production the existing surface levels have been artificially graded to uniformly fall from East to West. Examination of existing contour plans show that the average existing grades on the land are in the order of 1 in 700; these grades are generally inconsistent with those required for residential development which will generally require minimum road and allotment grades of 1 in 200.

As such the entire catchment area will require remodelling to make it suitable for residential development, this will require extensive excavation and filling of the site to make is suitable for residential development.

The requirement by Goulburn Murray Water to capture and store the 100 year storm for a period of 24 hours with no discharge from the site will result in the site being re-shaped to convey all flows to the central reserve / basin area rather than provide an overland flow route that will convey flows off-site.

Further discussion is contained below in relation to the logic and impact on the site remodelling, and also the impact of storm events greater than the 1 in 100Yr ARI event.

The area of catchment No 1 includes abuttal to the Shepparton Christian College site; a portion of the school site is already developed and has existing drainage to Verney Road. This area has been excluded from the catchment analysis and its existing drainage arrangements are proposed to remain in place.

For the purpose of this catchment analysis the undeveloped portion of the school land has been included as there is future possibility that this could ultimately form part of the residential development.

A preliminary layout of the elements of the storage and treatment system is shown in Annexure D; this includes various cross sections of the ponds to give an indication of levels.

The assumptions behind the development of this plan are discussed below.

4.3 ASSUMPTIONS

The preliminary storage basin sizing listed in Section 3.3 above were determined based on with regard to catchment No.1 this is now further refined.

The following data and assumptions have been used to undertake this more detailed analysis:

Catchment Area:	32.1 Ha
Initial Time of Concentration:	6 minutes
Maximum length of reach to basin:	700m
Assumed grading of pipelines:	1 in 400
Assumed surface grading:	1 in 200 (herringbone)
Basin discharge limit in 5 Yr event:	1.2 litres/sec/Ha
Basin discharge limit in 100Yr event:	Nil
100Yr Storage period with no discharge:	24 Hours

The storage analysis was undertaken using RORB flood modelling software. Annexure E shows a copy of the raw data results of this analysis, a summary is provided below.

4.4 RESULTS

Based on the above assumptions and input data the flood storage required for Basin 1 in a 100Yr event with no discharge for a 24 Hour period is 28,500 cubic metres.

This volume is the required storage in a 1 in 100Year event and such a rainfall event will see the entire basin area fill to a depth of approximately three metres. In such an event the public reserve area will not be subject to inundation for storage purposes , however, overland flows will be conveyed to the basin via the reserve are during such a storm event.

4.5 BASIN DESIGN - CONTROLS AND ASSUMPTIONS

The storage analysis and discussion in Section 3.5 determined a basin size based on constraints of limiting the depth to five meters and assuming a batter slope of an average of 1 in 8. This then allowed a determination of the basin 'footprint' such that an area could be defined for estate planning purposes.

In order to provide greater surety about the basin / reserve outcome council has required additional analysis and modelling to be undertaken to model a preliminary basin solution taking into account the likely road pavement and allotment levels, the invert of incoming drainage pipelines and the impact and Water Sensitive Urban Design (WSUD) treatments.

All of these elements will impact the potential shape and depth of the storage basins and the successful integration with the adjacent reserve area.

Per above discussion, catchment 1 has existing constraints on three abuttals. These elements limit the extent of earthworks possible on the abuttal boundaries. In general where the land abuts existing development future ground levels will need to match existing conditions or be managed via integrated fencing and low retaining walls. The abuttal to Verney Road allows for some level difference that can be remediated via landscaping however the intersection with Verney Road is a 'fixed' control that provides initial control for internal road grading.

A model was generated using the existing Verney Road levels as a control point. A high point was located within the site entry to ensure that Verney Road flows remain within the existing reservation and do not enter Catchment No 1. The road grading then generally grades to a low point located adjacent to the reserve and rises to the abuttal boundary with Catchment No's 3 and 4.

The collector road grading was then used as the basis for minor road gradings and setting of allotment control levels around the abuttal of the catchment zone. Road grading controls used were all based on the minimum grading of 1 in 200 defined in the Infrastructure Design Manual (IDM) road design guidelines, this was considered a conservative approach and flatter grades could be achieved by incorporating a herringbone grading design in the ultimate detailed design process. The approach outlined here provides a surface model framework for further assessment of drainage pipelines. From the above surface model a number of drainage pipeline alignments were assessed to determine the controlling reach. Generally the longer the reach the deeper the pipeline will be at the basin outlet, hence this will have a direct impact on the ultimate basin depth.

Following determination of a pipeline invert level at the storage basin a further constraint was considered, this was the council requirement to that a 1 in 5 Year storm event must be stored at a level below the invert of the incoming drainage line. This constraint needs to be considered as it may be a controlling factor in the basin footprint if the incoming drainage lines are excessively deep. Modelling outputs for the 5Yr storage level have been included in Annexure F and in the 1 in 5 Year event assumes that the system is still discharging at a rate of 1.2 litres / sec / Ha. A number of iterations were required to produce a representative surface model and pipeline network. Following the initial work on this element other factors were considered, primarily these were constructability issues and flood events greater than a 100Yr event; discussion of these elements is expanded below.

4.6 EARTHWORKS BALANCE

The design methodology described above is based on a physical constraints only, such as existing surface, minimum grades of pipes road and allotment, it is a necessary first step in determining the physical constraints of the ultimate basin, however other factors need to be given consideration in shaping the end result.

A review of this preliminary framework was undertaken from a constructability perspective and it was revealed that the remodeling of Catchment No 1 would require in excess of 320,000 cubic meters of fill material. This presented both potential supply issues in the local area and had significant cost and timing implications for the efficient development of this site. A revised model was prepared which lowered the finished surface level of the public reserve to approximately 1.0-1.2 metres below the existing surface level. An appropriate adjustment was made to the local street network and associated drainage pipelines and a resultant earthworks balance of less than 40,000 cubic meters of fill was achieved. Given the area of the catchment this is considered an approximate balance and will result in the bulk of the site remodeling being completed as a cut to fill exercise within the site. This will result in a more efficient development process from both cost and timing perspectives.

Despite the public reserve area being lowered below the current surface level the limiting factor for the base of the storage basin was still capped at generally 4.5 metres below the original ground surface level, this will result in a general maximum level differential between the public reserve and base of the storage basin of around 2.8 metres, which will provide greater opportunity for successful integration between the two areas. The level difference between the basin areas and the road reserve will be in the order of 3.5 – 4.0m. The detailed modelling of the storage basin has adopted a general batter slope of a maximum of 1 in 6. This can varied during detailed design when more formal elements can be considered.

4.7 FLOOD CONTROL AND MITIGATION

A potential negative impact of shaping the catchment to direct flows towards a central basin is the remove the ability for catchment 'overflow' to occur in greater than the 100Yr ARI events.

As discussed in the preceding section the central reserve in this catchment will be generally 1.2m metres below the current surface level, this is approximately 800mm below the existing road levels in Verney Road. A high point within the site entry will prevent excess flows from Verney Road entering the site however this will also prevent excess flows within the site from 'overflowing' to Verney Road.

The catchment layout which has the storage basins adjacent to public reserve areas provides significant opportunity for 'extreme event' storage such that once the 1 in 100Yr design storage within the basins is exceeded there will be a significant level of storage available within the reserve area and surrounding road reservation to provide protection to surrounding allotments. All abutting allotments will then be elevated above the road reserve for additional protection from 'extreme rainfall events'.

An extreme event scenario of a 1 in 500 Year event was modelled based on the above, the additional volume of storage required was approximately 10,500 cubic metres this would in effect result in an increased depth of flooding of 450mm. This would cause a portion of the public reserve area to become inundated. Allotment levels are proposed to be generally a minimum of 600 mm above the 100 Year storage level and would be above even a 500 Year event.

Annexure G has a plan showing the flooding level in a 1 in 100 Year storm event. Annexure H shows the extent of flooding in a 1 in 500 year storm event on the modelled basin; all allotments are protected from inundation in this scenario as the overflow flooding will be captured in the reserve area. The calculations made assume there are no external or downstream controls on the inundation of the land and consider only runoff from within this catchment. Previous advice has indicated that the PSP area is not currently subject to inundation in a 1 in 100Yr event.

4.8 WSUD - BACKGROUND AND ASSUMPTIONS

The above discussion considers the hydraulic and topographic constraints of the basin, catchment and future allotments, the final element in determining the operation of the drainage system is the treatment of storm water flows to remove pollutants prior to discharge into receiving waters.
In line with industry best practice, storm-water flows are to be treated prior to discharge from the site to remove the following pollutants in all events up to a 3 month ARI storm:

- Suspended solids 80% reduction
- Nitrogen 45% reduction
- Phosphorous 45% reduction

There are several methods of achieving these targets: these are generically discussed section 3.7 above. In the preparation of the detailed analysis preliminary WSUD design has been undertaken using MUSIC modelling software. A copy of the results and inputs is provided in Annexure I and a summary is provided below.

When considering the suitability of WSUD treatment options, there are several constraints that control the suitability of one treatment over another. Given the storage function of the basins and the likelihood of regular inundation, in-line treatments were not considered suitable as frequent flooding and or high velocity flows will scour treatment zones and re-suspend sediment material within the treatment area.

The treatment considered most suitable is an offline bio-retention zone and sediment pond, with a bypass weir for storm events greater than the 3 month ARI design event.

4.9 ALTERNTIVE OPTIONS

The treatment proposed is still considered to be an 'end of line' style treatment and could be supplemented by upstream measures such as swales in road reserves or water tanks within properties connected to dwellings for toilet flushing or laundry supply.

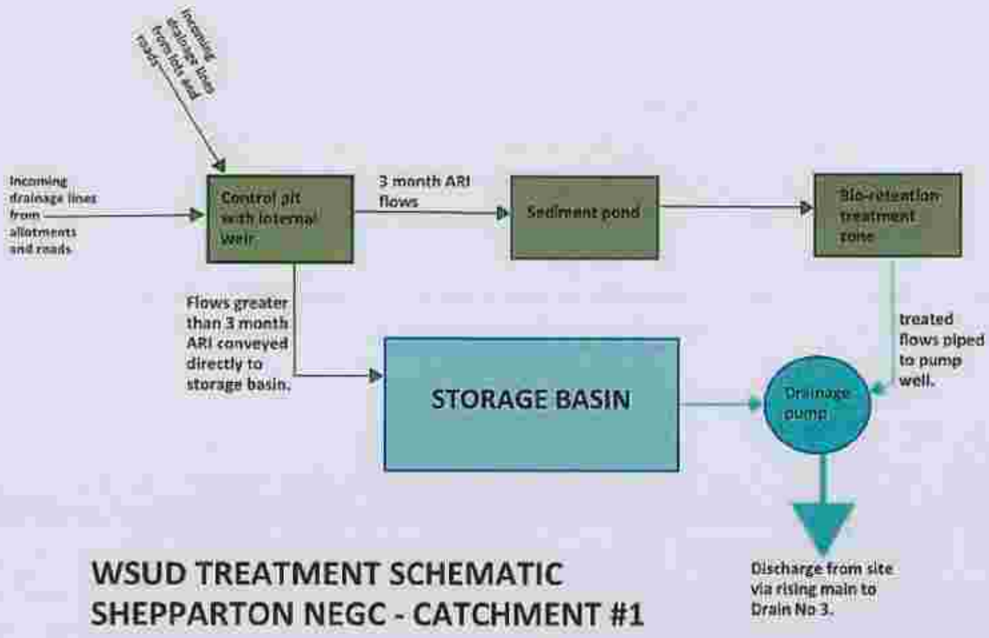
The option of swales in road reserves has not been modelled in this exercise as it requires a significant area of land and can only practically treat flows from road reserve areas. Hence in a residential setting provides limited benefit for the additional land required for implementation. There are also potential issues created for property access and traffic movement.

The inclusion of rainwater tanks connected to dwellings has also not been modelled in this assessment as it would require regulatory controls to be imposed on all allotments within the Growth Corridor and can potentially push a significant additional cost back to homeowners, particularly on smaller allotments where tanks may need to be constructed underground due to limited space within the allotment.

The exclusion of both of these upstream measures means that the assessment of treatment area within the reserve and storage basin is conservative as the calculated treatment zones will be larger that otherwise required if supplementary treatments such as those listed were included.

4.10 WSUD TREATMENT TRAIN

The treatment train adopted in this design assessment is that of an 'off line' bio-retention zone, located within the basin but with protective measures in place to divert high flow events and avoid damage to the treatment zone. A schematic of the treatment train adopted is shown below to describe the various elements of the treatment process.



WSUD TREATMENT SCHEMATIC
SHEPPARTON NEGC - CATCHMENT #1

All flows are conveyed via the underground pipe network to a control pit located within the reserve area. This pit has an internal weir arrangement that will divert all flows up to a 3 month ARI storm towards the bio-retention zone; flows in excess of this event will then bypass and be conveyed directly into the storage basin, with no treatment. After consideration of several options a single discharge point and consolidated treatment zone design was adopted as this minimised future maintenance for council and only had a minor impact on depth of incoming drainage lines.

4.10.1 Sediment basin

Low flows that are diverted from the control pit will be directed to a sediment pond that will allow primary settling of suspended sands and sediment within the stormwater.

The sediment pond has been sized based on Melbourne Water guidelines. The volume of storage required in the sediment pond is 670 cubic metres. This equates to a normal water level (NWL) area of approximately 1000 sqm. The sediment pond will generally be a permanently wet area as all low flow events will be directed through the sediment pond, as such it will received regular 'top –up' flows and will provide opportunity for landscape embellishment.

The basin water level will generally be 2.5 metres below the adjacent road reserve however with planting and appropriate alignment of shared path networks within the reserve, views of the pond could be incorporated into the final reserve design.

Sediment ponds require periodic maintenance, the sediment pond modelled in this design will require de-silting every five (5) years based on typical sediment removal and flows. To facilitate the maintenance requirements an access ramp has been modelled into the design to ensure that this will be a practical consideration during the detailed design process. This access is currently shown on the south eastern side of the sediment pond accessed from the adjacent minor street.

There would be opportunity in detailed design to include formal landscape treatments such as retaining walls or platforms close to the edge of these sediment ponds. Such treatments would allow for vertical banks and reduce the required footprint. Such treatments would require consideration of public safety fencing as these are best dealt with during detailed design. In order to maintain the conservative approach during the town planning phase the model has allowed for 1 in 6 batters between the road reserve / sediment pond and storage basin.

4.10.2 Bio-retention treatment zone

Following primary treatment in the sediment pond to reduce suspended solids, flows will then be conveyed to the bio- retention treatment zone. This zone is again protected from high velocity flows which will damage the treatment medium. The treatment zone will be located lower than the adjacent sediment pond but above the general base of the storage basin. Annexure J contains a plan of the basin area as modelled and shows cross sections to better demonstrate the relativity of the various elements and their connectivity.

The bio-retention zone will receive flows from the sediment pond via a low flow pipe line, with higher flows being diverted via a weir or spillway arrangement that will deliver a sheet flow over a wide area rather than a concentrated flow at one point. This ensures that treatment area is maximised and assists in protecting against localised scour of the filter medium as flows become more intense during a storm event.

The bio-retention zone is a relatively flat area, filled with a filter medium and planted with appropriate plants to aid the removal of nitrogen and phosphorous from stormwater flows. Generally these are 'reed' type plantings that will tolerate high variance in moisture conditions at their roots. Flows will be retained in this area for a period of time and will percolate through the filter medium and root systems and be collected via a perforated drain network under the treatment zone that will convey flows to the ultimate outlet at the discharge pump. In the event that storage within the basin area is exceeded, flows would be diverted directly to the basin via controlled weir flow. The MUSIC modelling undertaken in relation to Catchment No 1 indicates that a treatment area of 1800 square metres will be required to achieve best practice reduction figures.

5 SITE MODELING AND LANDSCAPE OPTIONS

A digital terrain model has been prepared based on the detailed design undertaken during the preparation of this report; this model includes the road network, reserve area, storage basins, sediment ponds and bio-retention zone. This model has been prepared to assist in visualizing the potential outcomes for the Catchment No 1 reserve and basin.

This report has been prepared to determine the constraints, dimensions and levels of the various elements required to successfully provide drainage to this site. The successful integration will rely on appropriate landscape treatments to ensure that the outcomes of both the reserve and storage basins can be met.

As discussed earlier in this report, the use of mulches within the area impacted by a 1 in 100Yr storm event should be avoided and tree plantings should be appropriate for the level of inundation that a particular area may receive.

Tree plantings in the base of the storage areas should be avoided and species that are able to withstand some inundation can be planted within batter areas between the 1 in 5 Yr and 1 in 100Yr inundation extents.

Dense 'grassy' plantings adjacent to the sediment ponds will discourage access to the permanent water area but still provide opportunity for sightlines to the water areas as well as encourage wildlife to inhabit these areas of relatively permanent water.

The additional areas required for the sediment pond and bio-retention zone have been added to the basic basin footprint originally calculated.

The 100Yr ARI storm has been re-calculated based on the detailed basin incorporating the additional elements and a top water level determined. The depth of flooding in a 100Yr event will be approximately 2.65 metres.

In this event both the sediment pond and bio-retention zone will be inundated however the inundation will occur via indirect means and after several hours duration of storm event, as such high velocity linear flows through either of these elements will be avoided and as such scour and damage to the elements minimized.

To further aid the visualization of the impact of flood events and the level of inundation anticipated a series of inundation plans have been prepared for a 5 year, 100Yr and 500 Year event, these are included in Annexures G & H.

REEDS CONSULTING

6 CONCLUSION

This report has sought to outline the physical and statutory constraints that impact provision of drainage facilities to the Shepparton NEGC as well as consider the desired outcomes from a public amenity perspective. The site requires significant remodelling and the inclusion of storage basins that will be a major visual feature of the redevelopment of the site.

A number of opportunities exist to incorporate Water Sensitive Urban Design elements into drainage infrastructure to ensure that stormwater runoff from the development of the land meets current best practice requirements for the removal of pollutants.

The design presented in Section 4 of the report is based on reasonable assumptions to determine the potential for the functional operation of the drainage strategy. The design presented is not intended to be a final detailed design and will be subject to variation during the subsequent planning permit and staged subdivision design phases of the project. Options exist to relocate the storage basin and other public reserve elements such that efficiencies in the drainage system may be achieved. This functional design has sought to provide a conservative assessment of the likely built form of the basins and reserves in order to confirm the viability of the proposal.

This assessment has demonstrated that the integration of various elements of the drainage strategy can be successfully incorporated into a public reserve area and the need for isolated and visually unappealing storage basins can be eliminated and a higher order land use afforded these areas which can complement the adjacent public reserve areas and improve public amenity in these areas.

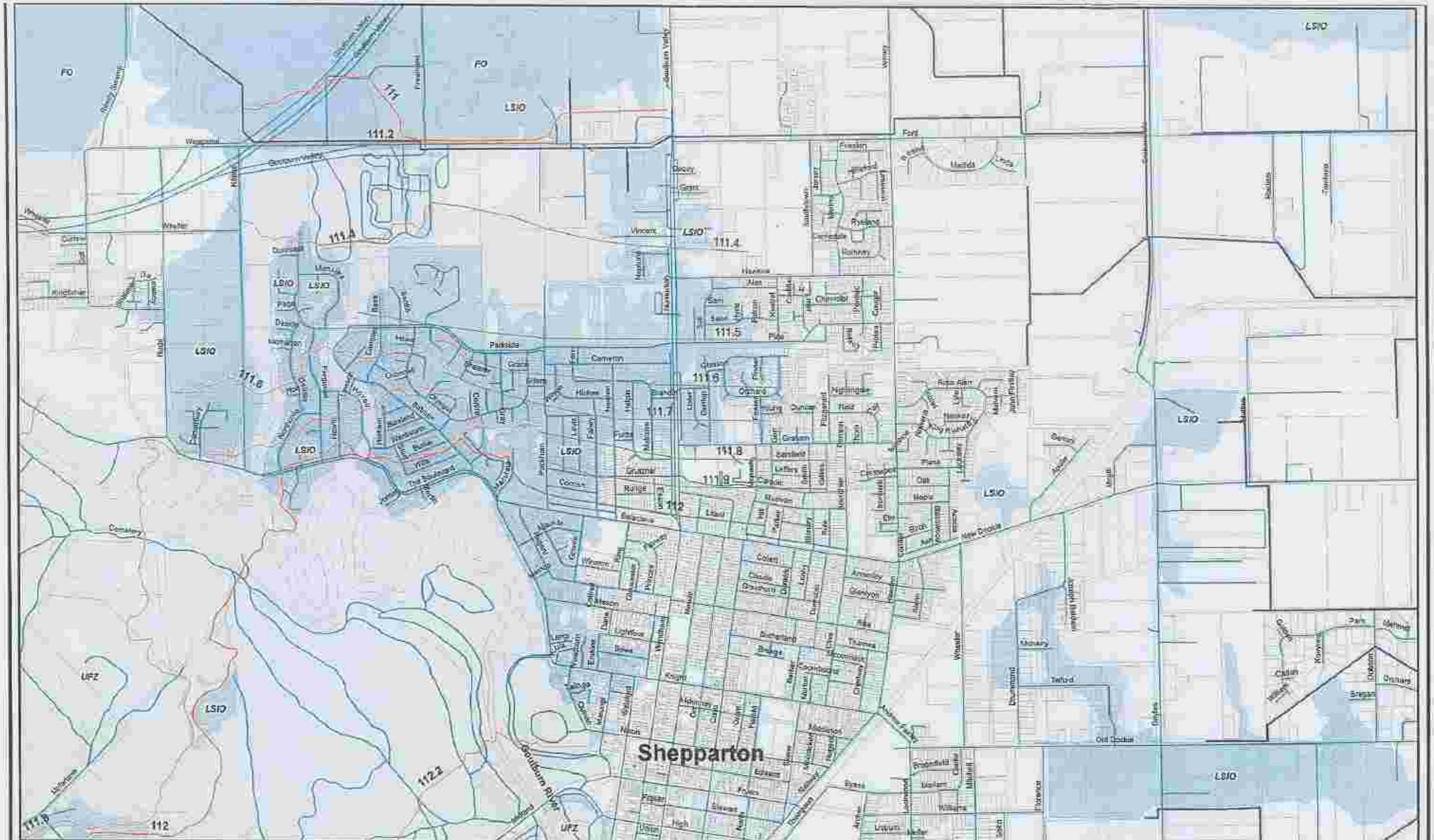
Prepared by:
REEDS CONSULTING PTY LTD

RICHARD BREWSTER
Engineering Director

Disclaimer
The information contained within this report has been obtained from various servicing Authorities either verbally or in writing however, until such time as formal applications made, conditions and the appropriate approvals obtained, it should only be used as a guide. Any party wishing to use the material contained within this report should make their own inquiries to satisfy themselves to the accuracy of the information.

ANNEXURE A

Goulburn and Broken Catchment Management Authority (GBCMA) 1% AEP Flood Inundation plan



MAP KEY

GENERAL NOTES

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The Goulburn Broken Catchment Management Authority does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

Cadastral information is supplied by Department of Sustainability and Environment.

This map has been prepared using the best available data and mapping techniques. The accuracy of this map however is not absolute and reflects only the accuracy of the data and techniques used. This information is subject to change whenever new information is found or determined from future studies.

NOTES ON DECLARATION AND BEST ESTIMATED FLOOD LEVELS

The flood level lines shown on this plan define the surface level of the "1% probability flood". Where flood level declarations have occurred, this is the flood prescribed by Section 204 of the Water Act 1989 for floodplain management purposes and has a 1 in 100 chance of being equalled or exceeded in any one year. Other flood level contours represent the best estimate of the 1% probability flood.

The derivation of these 1% flood level lines has been based on available historical flood level and flow information, hydrologic and hydraulic modelling. Areas outside the 1% probability flood limit may be inundated by rarer flood events.

For the purpose of determining flood levels for locations between flood level lines, it can be assumed that the flood surface levels change at a uniform rate between flood level lines.

The flood level lines shown on this plan can be used to assist in the determination of designated levels in accordance with Clause 6.2 of the *Building Regulations 1994*. Although there may be buildings within the area covered by the flood level lines, it should not be assumed that the floor of any individual building is below flood level. Buildings should be surveyed to determine whether their floors are above or below the 1% flood level.

FLOOD OVERLAY INFORMATION

This map showing Urban Floodway Zone (UFZ), Floodway Overlay (FO or RFO) and Land Subject to Inundation Overlay (LSIO) are indicative only and not to be used as a substitute over the planning scheme maps.

0 0.1 0.2 0.4 0.6 0.8 Kilometres

Scale 1:20 000 at A3

Legend

- Declared/Designated Flood Contours (metres AHD)
- Best Estimated Flood Contours (metres AHD)
- Land Subject to Inundation Overlay
- Floodway or Rural Floodway Overlay
- Urban Floodway Zone
- Known Levees
- Irrigation Channels
- Waterways
- Roads
- GBCMA Waterway Boundary

AUSTRALIA
DEPARTMENT OF FINANCE AND ADMINISTRATION

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

1% FLOOD LEVEL CONTOUR ATLAS

540335

Date: 20 June 2008

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ANNEXURE B

Shepparton North East Growth Corridor Drainage Strategy Plan

- Traffic Lights
- Local Town Centre
- Roundabout
- Precinct Structure Plan Area
- Conventional Residential
- Community Facilities
- Existing School
- Reserve Area
- Retarding Basin & 20 year Event
- 34m Connector Street
- 26m Connector Street - Option 1
- 26m Connector Street - Option 2
- 24m Connector Street
- 16m Residential Street
- Bus Route
- Shared Path
- Temporary Common Access
- Shared Path Within Reserve
- 400m Walkable Catchment
- 100m Shed Buffers
- Interface Zone
- Pumped Drainage Lines

Total Site Area	170 ha (approx)
Existing Schools	10.67 ha
Mixed Use	2.50 ha
Encumbered Reserves	6.675 ha
Unencumbered Reserves	8.340 ha
Area of Connector Streets	10.97 ha
Net Developable Area	130.85 ha

PROPOSED FUTURE PRECINCT STRUCTURE PLAN

NORTH EASTERN GROWTH CORRIDOR, SHEPPARTON

Refer to sheet 2 for Cross Sections and Catchment details

SHEET 1 OF 2

LEVEL 6
440 ELIZABETH STREET
MELBOURNE VIC 3000

REEDS CONSULTING

ANNEXURE C

Groundwater Investigation
BM Consulting Engineers

B·M
CIVIL ENGINEERS

B.M CONSULTING ENGINEERS PTY.LTD.
A.B.N 36 473 826 551

6 Clarke Street, Shepparton, 3630
P.O. Box 6577, Shepparton, 3632

David Melrose C.E. Eng (Civil), M.I.E. (Aus.) EC1917
David Earl B. Eng (Civil), M.I.E. (Aus.)
Peter Willmott B. Eng (Civil), M.I.E. (Aus.)

Ph: (03) 5821 7393
Fax: (03) 5831 3042

20-Apr-11

CLIENT : Reeds Consulting

JOB DESCRIPTION: Provide Site Investigation for proposed Stormwater Retardation Basins.

PROJECT ADDRESS: Shepparton North East Growth Area.

OUR JOB NO: 30170

REPORT BACKGROUND:

Rezoning of farmland to residential land is proposed as part of the North East growth area of Shepparton. As part of this process up to five stormwater retardation basins may be required. John McKernan of Reeds Consulting has requested this investigation in order to determine the suitability of the nominated sites for the proposed use and also to provide the soil parameters necessary for the basin designs.

REPORT OBJECTIVES:

Two boreholes are to be drilled at each of the proposed retention sites. Soil profiles are to be logged and an assessment of soil type and porosity undertaken. Permeable soils or unsuitable water retaining soils such as filling, dispersive or granular soils are to be identified. The presence of groundwater or other factors that may impact on the design of basins and on the construction techniques are to be identified.

1.0 SITE DESCRIPTION:

1.1 There are five (5) proposed construction sites. All sites are currently within orchards. Their locations are illustrated on figure 1 and pictured in the photos.

1.2 Geologically the soils of the area are fine grained soils of Quaternary Pleistocene alluvium of the Shepparton Formation. These are sediments of sands, silts and clays laid down in lens like deposits. There can be variations in soil types over short distances with the discontinuity of the lenses.

2.0 SITE INVESTIGATION:

2.1 Boreholes of general depth 5000mm and down to 6000mm were drilled using 100mm diameter continuous flight mechanical augering — two at each site. The locations and logs as well as GPS co-ordinates for each test hole are shown on the attached borehole log sheets.

Photo1: Site 1 boreholes 1&2.

Photo 2: Site 2 Boreholes 3&4

Photo 3: Site 3 Boreholes 5 & 6.

Photo 4: Site 4 Boreholes 7&8.

Photo 5: Site 5 Boreholes 9&10.

Logged soils were hand and visually classified. Soil shear strength was assessed in the field using shear vane measurements. Soils were sampled and returned to the laboratory for comparison and confirmation of the classification and to indicate other soil properties typical of those in the classified group. Particle size distribution and Plasticity testing was undertaken as part of the testing process. Maximum dry densities of the pre-dominant soil type were assessed. All tests were undertaken to our NATA accredited procedures. (Laboratory Registration Number 5023)

2.2 **Borehole Descriptions**: Soils recovered were of similar texture from all test holes with minor variations in sand and clay content and colour.

Site 1

Borehole 1: There is light brown clay of sand traces to 3400mm with moist brown clay with sand traces extending to the end of the bore.

Borehole 2: Beneath shallow clayey fine sand, there is light brown silty clay with sand traces to 1500mm with light brown clay extending to the end of the bore at 5000mm.

Site 2

Borehole 3: There is light brown silty clay with sand extending to the end of the bore at 5000mm..

Borehole 4: There is light brown silty clay with sand extending to the end of the bore at 5000mm..

Site 3

Borehole 5: Beneath shallow clayey sand there is stiff brown clay to 500mm and overlying light brown silty clay with sand. The light brown silty clay of sand traces extends to the end of the bore.

Borehole 6: Beneath shallow clayey sand there is stiff brown clay to 500mm and overlying light brown silty clay with sand. There is a seam of clayey sand between 1800mm and 2400mm before the light brown silty clay of sand traces extends to the end of the bore.

Site 4

Borehole 7: Beneath shallow clayey sand there is stiff red brown clay to 800mm and overlying clayey sand of medium density to 2000mm. Beyond this, light brown silty clay with sand traces extends to the end of the bore.

Borehole 8: Beneath 200mm of shallow clayey sand there is stiff red/ brown clay which becomes increasingly sandy with depth to become red/brown sandy clay from 800mm to 2000mm. Beyond this, there is light brown silty clay of sand traces which extends to the end of the bore.

Site 5

Borehole 9: There is light brown silty clay with sand to 1500mm. Beyond this, there is very stiff light brown clay to the end of the bore at 5000mm.

Borehole 10: : There is light brown silty clay with sand to 1500mm. Beyond this, there is very stiff light brown clay to the end of the bore at 5000mm.

2.3 **Laboratory Testing and Classification:** The soils encountered are within the range of medium plasticity with minor variations in liquid limits yielded across the entire site. The results of site 2 (BH3 & BH4) reflect the sandier soils encountered in this area and are of lower plasticity or CL soils. There is a significant sand content in all soils analysed. The soils of the site 1 (BH1 & BH2) are of a heavier clay and this was also reflected in the higher plasticity test results for this site.

In summary, all samples analysed are classified as clays with the lesser components of silt and sand. The sand and silt will enhance the soils' workability while the clay will contribute to the impermeability properties.

These results are typical of soils gathered and tested by this company in the alluvial soils of the Shepparton area. The Plasticity testing on samples from each test hole are summarised in table 1. Particle size distribution analyses results are summarised in Table 2.

2.4 Based on the correlation of soil properties, the estimated seasonal soil surface movement is moderate. It is estimated to be between between 20mm and 40mm.

For construction of residential parameters, the site classification for the site is **M-D Moderately Reactive** in accordance with AS2870-12011.

Borehole No.	Depth (mm) %	LL	PL	PI	LS	Class
1	1000-1500	49	17	32	16	CI-CH
2	500-1600	44	16	28	14.5	CI
4	200-2000	31	13	18	10	CL-CI
5	500-2000	44	16	28	14	CI
8	2000-3000	41	15	26	13.5	CI
10	800-1500	47	17	30	15	CI-CH

Table 1: Plasticity Test Results

		Australian Standard Sieve Sizes(mm)				
Borehole No.	Depth (mm)	2.36	0.6	0.3 %	0.075	
1	1000-1500	100	98	97	92	CI-CH
2	500-1600	100	99	98	92	CI
4	200-2000	99	96	92	74	CL-CI
5	500-2000	100	99	97	89	CI
8	2000-3000	99	98	96	87	CI
10	800-1500	97	95	92	87	CI-CH

Table 2: Particle Size Distribution Test Results

2.5 **Ground Water:** Bore holes were monitored over a 4 hour period . No infiltration of ground water occurred within this time in any of the test holes. It is reasonable to assume that groundwater will not be encountered in any excavations down to at least 5000mm and up to 6000mm across the site. There were no gravelly seams carrying perched water encountered in any of the bores. There were no dry gravelly seams of potential to carry water during different climatic conditions encountered in any of the bores across the site.

2.6 **Soil Moisture Content:** Soils were observed in the field to be moist (but not wet) over all of the soil profiles. Measured moistures were of the range 12.2% -18.4% . At these values the soils are pre- moistened and are within 4% of respective optimum moisture contents. Addition of moisture during construction would be nominal in magnitude and easily applied at these levels where some curing is already inherent in the soils.

2.7 **Bulk Densities:** Samples from most sites and representative of the major soil types were laboratory tested to determine the moisture density relationship. The results are tabulated in table 3.

Report No.	Borehole No.	Depth (mm)	Moisture-Density		
			Bulk Density	Max.Dry Density	OMC
			ρ_s	ρ_d	
11721	1	1000-1500	1976 kg/m^3	1717 kg/m^3	18.7
11723	4	200-2000	2076 kg/m^3	1849 kg/m^3	14.5
11724	5	500-2000	1969 kg/m^3	1712 kg/m^3	19.4
11725	8	2000-3000	2012 kg/m^3	1760 kg/m^3	16.5
11726	10	800-1500	1994 kg/m^3	1684 kg/m^3	20.3

Table 3: Dispersion test results summary

2.8 **Bearing Capacity:** Shear vane testing was carried out at intervals within the natural soils to establish soil shear strengths. For shallow pad and strip footings bearing on natural soils below any surface silt, the estimated maximum allowable bearing capacities are as follows:

Depth (natural soils) Below the surface. (mm)	Allowable Bearing Capacity (kPa.)
400mm	80
600mm	100
900mm	150
1200mm	200

Table 4: Allowable Bearing capacities All Sites.

2.9 **Deep structures and Soil retention (manholes and pumpwells):** As a guide, typical values for cohesion and angle of shearing resistance are estimated based on the correlation of soil properties for the sandy clay soil as classified.

$c = 12\text{kPa}$

$\phi = 29°$

$\phi_g = 0.45$ max. (capacity reduction factor based on the level of investigation)

2.9 **Adhesion:** The silty clay and clay soils have estimated adhesion of at least 10kPa.

2.30 **Dispersion:** Samples were laboratory tested using the Emerson Dispersion Classification number method. The solutes of distilled water and tap water were used. Tap water is representative of the stormwater that may be retarded in the basins while distilled water is representative of the soils' behaviour under direct rainfall runoff . Dispersive behaviour of the soil during storage conditions may result in slumping and a loss of storage geometry and therefore operating capacity. It may also allow seepage of stored from the basin. Dispersive behaviour of the soil surface slopes under the action of rainfall travelling down it will result in rutting and erosion of the banks. The eroded soils will be washed into the storage with subsequent reductions in design capacities.

Table 4 is a summary of the emerson number test results. The values indicate that the soils are non dispersive in the water storage mode. Soils form sites 1 and 4 may erode easily with rainfall possibly rutting exposed slopes.

Report No.	Borehole No.	Depth (mm)	Emerson Class Number	
			0 ppm	120ppm
11721	1	1000-1500	4	4
11722	2	500-1600	2	5
11723	4	200-2000	5	6
11724	5	500-2000	5	5
11725	8	2000-3000	2	4
11726	10	800-1500	6	6

Table 5: Dispersion test results summary

2.31 Permeability:

Silty clay soils and clay soils of sand traces and plasticity properties of those recovered from all the sites are practically impermeable when constructed at the prescribed density and moisture content. By correlation of soil properties , the permeability of all samples tested at 95% of standard density is anticipated to be less than $1x10^{-9}$ m/s.

In their natural state , the soils are affected by the root zone and deep seasonal cracks and fissures would be prevalent. Reworking the lining of basin soils would create an homogeneous mass of compacted soil as required for impermeable conditions.

3.0 CONCLUSIONS, DESIGN and CONSTRUCTION:

3.1 General: The test bores and laboratory testing yielded similar results across the entire site. Soil profiles as encountered are typical of those of the Shepparton area on Shepparton Formation alluvial soils. Soils are generally silty clays with sand traces and of medium plasticity. These soils will be impermeable as a reworked and compacted liner in the retardation basins.

The sandy clay and clayey sand soils are of good workability properties. They are readily excavated and easy to place by conventional earth moving equipment. The soils exist at moisture contents close to optimum and nominal moisture addition will be required for compacted placement. The soils in this state are pre-cured and additional moisture will be efficiently absorbed as required. The soils' sand content facilitates the addition of moisture and the ability to be readily compacted.

There was an absence of groundwater at all of the sites tested. An awareness that water may be encountered in deeper than 6.0m excavations is important as ground water levels are subject to seasonal and climatic variations. Excavations beyond 6.0m may strike groundwater under a nominal pressure head which may lead to water rising closer to the surface. There is no evidence to suggest that this will be the case from this investigation.

There was no rock encountered in any of the test sites as would be expected in this site of deep alluvium. There are areas of surface soil which will require removal and nominal stripping to avoid vegetable matter. There is a clayey sand seam which was encountered in borehole 6 of site 4. This seam does not represent a prior stream or serious point of escape or influx of water. Such clayey sand seams if encountered during construction will need to be chase excavated, blended with the clayey soils and replaced under compaction. No other factors which may limit the selection of a particular site for the proposed new construction were encountered.

The frequency of borehole sites and the intensity of the testing program is considered reasonable and comprehensive for the requirements of this project and in the context of a subsurface investigation. It remains possible that there may be variations in the geotechnical conditions from those described in this report as no geotechnical investigation can be considered exhaustive. The results and recommendations are therefore a reasonable platform upon which to base subsequent site selection and preliminary design decisions with a flexibility to change course should there be variations in the conditions beyond a more intensive investigation within the actual construction envelope.

3.2 Design Recommendations:

Beds of the Storages: Losses and seepage form retention basins are usually through the base under the storage water pressure head. It is important that the base be impervious and constructed of appropriate materials. In the current format the natural soils are suitable at the proposed base depth. A liner of minimum layer depth 600mm is recommended . This can be constructed by reworking and compaction of the natural soils of the site with the aforementioned properties taken into account.

Reworking requires that the liner soils be conditioned to an appropriate texture and moisture content and then placed under compaction. Compaction cannot be achieved using earthmoving traffic alone — an articulated pad foot roller would be the minimum requirement for these soil types.

The design levels of the basins: The proposed design levels being no greater than 4.0m below existing surfaces will be satisfactory as no groundwater has been encountered within this range.

Batter slopes: are recommended to be 2.5 : 1 on the upstream faces of basins. These values are appropriate for the soil types. Compaction equipment should be able to negotiate slopes of this magnitude. Compaction of the batters and reinstatement of protective grasses will minimise potential erosion due to rainfall. Flatter slopes may be adopted if there is a plan to use the basins recreationally or regular grass mower traffic is planned.

3.3 Construction and Maintenance Recommendations:

Stripping: Strip the area beneath the bed and embankment construction of any topsoil and vegetable matter. Stockpile this material for spreading across the finished embankments as required. Material containing vegetable matter or humus must be avoided as structural filling.

Compaction: All of the recommendations given are based on the materials being compacted to engineering density standards for earthworks. This is important to counteract the potential for some site soils to be dispersive on batter slopes and it will also develop the impermeability of the soils. Re-work the bases in shallow layers of no greater than 200mm and compact using a vibrating pad foot roller.

Moisture Content : The filling should be placed within -2% to + 1% of its optimum moisture content. Within these limits the soils will be able to be compacted to maximum densities with impermeability and using the least compactive effort.

Compaction Control: In order to maintain control over density and moisture content it is recommended that a compaction testing program be undertaken during construction to establish an effective placement procedure. The earthworks code AS3798 can be used as a guide for the frequency of testing. Compaction should be such that no test is less than 95% of the maximum dry density as determined in the laboratory. With a proven test success record and therefore proven construction process, the frequency of testing may be relaxed. Obviously the most critical areas for control are within the lower embankments and the storage beds.

Maintenance: Desirably plant binding type grasses on the finished topsoiled surfaces in order to minimise erosion and the seasonal drying of storage base soils. This will assist in preventing propagation of surface cracking in the liners.

Carry out maintenance checking over the duration of the storage's operational lifetime using the techniques offered in the publication "Your Dam - an asset or a liability" (DSE-Victoria website)

Please contact the undersigned for any further enquires.

David Melrose.

TEST BORE LOCATIONS

BORE COORDINATES

1	E 358019.530	N 5975793.560
2	E 358157.168	N 5973923.281
3	E 358927.925	N 5975998.253
4	E 358930.510	N 5975995.253
5	E 358063.708	N 5975437.610
6	E 358038.830	N 5975486.287
7	E 358283.960	N 5975339.541
8	E 358413.915	N 5975332.483
9	E 358903.418	N 5976032.446
0	E 359011.525	N 5976031.267

B.M CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 28565 **Date:** 1.4.2011

Location: NE Shepparton Growth Corridor

Client: Reeds Consulting **Borehole No.:** 1

Easting: E 358019
Northing: N5975799

Depth	Description	Plasticity	Cohesion Density	Moistu
100				
200				
300				
400				
500				
600	Lt. Br. Clay (sand traces)	M-HP	VST	M
700				
800				
900				
1000				
1100				
1200				
1300	LL=49%			
1400	PL=17%			
1500	PI=32%			
1600	LS=16%			
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
3100				
3200				
3300				
3400				
3500				
3600				
3700				
3800	Brown Clay with sand traces	MP	ST	M
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				
4800				
4900				
5000				
5200				
5300				
5400				
5500				
5600				
5700				
5800				
5900				
6000	EOB			

PLASTICITY		**LP**- LOW **MP**- MEDIUM **HP**- HIGH
CONSISTENCY	COHESIVE SOILS	**VS**- very soft **S**-soft **F**-firm **ST** - stiff **VST** - very stiff **H**-hard
	NON COHESIVE SOILS	**VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense
MOISTURE CONDITION		**D**-dry **M**- moist **W**-wet **SA**-saturated
DRILLING METHOD	continuous flight auger [X]	hand auger [ ]

B.M CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting **Borehole No.:** 2

Easting: 358167E
Northing: 5975923N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200	Clayey Fine Sand			
300				
400				
500				
600	Lt. Br. Silty Clay with sand	MP	ST	M
700				
800				
900	LL=44%			
1000	PL=16%			
1100	PI=28%			
1200	LS=14.5%			
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
3100				
3200				
3300	Lt. Br Clay	MP	VST	M
3400				
3500				
3600				
3700				
3800				
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				
4800				
4900				
5000	EOB			
5100				

PLASTICITY		LP- LOW MP- MEDIUM HP- HIGH
CONSISTENCY	COHESIVE SOILS	VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard
	NON COHESIVE SOILS	VL very loose L- loose MD-medium dense DS-dense VD-very dense
MOISTURE CONDITION		D-dry M- moist W-wet SA-saturated
DRILLING METHOD	continuous flight auger [X]	hand auger [ ]

B.M CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 3

Easting: 358827E
Northing: 5975995N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200				
300				
400				
500				
600	Lt. Br. Silty Clay with sand	LP-MP	ST	M
700				
800				
900	LL=31%			
1000	PL=13%			
1100	PI=18%			
1200	LS=10%			
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
3100				
3200				
3300				
3400				
3500				
3600				
3700				
3800				
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				
4800				
4900				
5000	EOB			
5100				

PLASTICITY		LP- LOW MP- MEDIUM HP- HIGH
CONSISTENCY	COHESIVE SOILS	VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard
	NON COHESIVE SOILS	VL very loose L- loose MD-medium dense DS-dense VD-very dense
MOISTURE CONDITION		D-dry M- moist W-wet SA-saturated
DRILLING METHOD	continuous flight auger X	hand auger

B.M
CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 4

Easting: 358950E
Northing: 5975995N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200				
300				
400				
500				
600	Lt. Br. Silty Clay with sand	LP-MP	ST	M
700				
800				
900	LL=31%			
1000	PL=13%			
1100	PI=18%			
1200	LS=10%			
1300				
1400				
1500				
1600				
1700				
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800				
2900				
3000				
3100				
3200				
3300				
3400				
3500				
3600				
3700				
3800				
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				
4800				
4900				
5000	EOB			
5100				

PLASTICITY		**LP**- LOW **MP**- MEDIUM **HP**- HIGH	
CONSISTENCY	COHESIVE SOILS	**VS**- very soft **S**-soft F-firm **ST** - stiff **VST** - very stiff **H**-hard	
	NON COHESIVE SOILS	**VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense	
MOISTURE CONDITION		**D**-dry **M**- moist **W**-wet **SA**-saturated	
DRILLING METHOD	continuous flight auger	X	hand auger

B.M CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 5

Easting: 358865E
Northing: 5975487N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200	Clayey Sand			
300				
400	Br.. CLAY	HP	VST	M
500				
600	Lt. Br. Silty Clay with sand	MP	ST	M
700				
800				
900	LL=44%			
1000	PL=16%			
1100	PI=28%			
1200	LS=14%			
1300				
1400				
1500				
1600				
1700				
1800				
1900		LP	D	M
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800	Lt. Br. Silty Clay with sand	MP	VST	M
2900				
3000				
3100				
3200				
3300				
3400				
3500				
3600				
3700				
3800				M
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				
4800				
4900				
5000	EOB			
5100				

PLASTICITY		**LP**- LOW **MP**- MEDIUM **HP**- HIGH
CONSISTENCY	COHESIVE SOILS	**VS**- very soft **S**-soft **F**-firm **ST** - stiff **VST** - very stiff **H**-hard
	NON COHESIVE SOILS	**VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense
MOISTURE CONDITION		**D**-dry **M**- moist **W**-wet **SA**-saturated
DRILLING METHOD	continuous flight auger: X	hand auger:

B.M CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 6

Easting: 359039E
Northing: 5975486N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200	Clayey Sand			
300				
400	Br., CLAY	HP	VST	M
500				
600	Lt. Br. Silty Clay with sand	MP	ST	M
700				
800				
900	LL=44%			
1000	PL=16%			
1100	PI=28%			
1200	LS=14%			
1300				
1400				
1500				
1600				
1700				
1800				
1900	Br. Clayey Sand	LP	D	M
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800	Lt. Br. Silty Clay with sand	MP	VST	M
2900				
3000				
3100				
3200				
3300				
3400				
3500				
3600				
3700				
3800				M
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				M
4800				
4900				
5000	EOB			
5100				

PLASTICITY		**LP**- LOW **MP**- MEDIUM **HP**- HIGH
CONSISTENCY	COHESIVE SOILS	**VS**- very soft **S**-soft **F**-firm **ST** - stiff **VST** - very stiff **H**-hard
	NON COHESIVE SOILS	**VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense
MOISTURE CONDITION		**D**-dry **M**- moist **W**-wet **SA**-saturated
DRILLING METHOD	continuous flight auger [X]	hand auger [ ]

B.M CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 7

Easting: 359039E
Northing: 5975486N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200	Clayey Sand			
300				
400	Red/Br.. CLAY			
500				
600	Red/Brown Sandy Clay	MP	ST	M
700				
800				
900				
1000				
1100				
1200	Clayey Sand	LP	ST	M
1300				
1400				
1500				
1600				
1700				
1800				
1900				M
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700		MP	ST	
2800	Lt. Br. Silty Clay with sand			
2900				M
3000				
3100				
3200				
3300				
3400				
3500				
3600				
3700				
3800				
3900				M
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				
4800				
4900				M
5000	EOB			
5100				

PLASTICITY		**LP**- LOW **MP**- MEDIUM **HP**- HIGH
CONSISTENCY	COHESIVE SOILS	**VS**- very soft **S**-soft **F**-firm **ST** - stiff **VST** - very stiff **H**-hard
	NON COHESIVE SOILS	**VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense
MOISTURE CONDITION		**D**-dry **M**- moist **W**-wet **SA**-saturated
DRILLING METHOD	continuous flight auger [X]	hand auger [ ]

B.M
CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 8

Easting: 358414E
Northing: 5975339N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200	Clayey Sand			
300				
400	Red/Br.. CLAY			
500				
600	Red/Brown Sandy Clay	MP	ST	M
700				
800				
900				
1000				
1100				
1200	Clayey Sand	LP	ST	M
1300				
1400				
1500				
1600				
1700				
1800				
1900				M
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				
2800	Lt. Br. Silty Clay with sand	MP	VST	M
2900				
3000	LL=41%			
3100	PL=15%			
3200	PI=26			
3300	LS=13.5%			
3400				
3500				
3600				
3700				
3800				
3900				M
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				
4800				
4900				M
5000	EOB			
5100				

PLASTICITY		**LP**- LOW **MP**- MEDIUM **HP**- HIGH	
CONSISTENCY	COHESIVE SOILS	**VS**- very soft **S**-soft **F**-firm **ST** - stiff **VST** - very stiff **H**-hard	
	NON COHESIVE SOILS	**VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense	
MOISTURE CONDITION		**D**-dry **M**- moist **W**-wet **SA**-saturated	
DRILLING METHOD	continuous flight auger	X	hand auger

B.M
CIVIL ENGINEERS

SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting **Borehole No.:** 9

Easting: 358905E
Northing: 5975038N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200				
300				
400				
500				
600	Lt. Br. Silty Clay with sand	MP	ST	M
700				
800				
900				
1000				
1100				
1200				
1300				
1400				
1500				
1600				
1700				M
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				M
2800				
2900				
3000				
3100				
3200				
3300	Lt. Br Clay	MP	VST	M
3400				
3500				
3600				
3700				
3800				
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				M
4800				
4900				
5000	EOB			
5100				

PLASTICITY		LP- LOW MP- MEDIUM HP- HIGH
CONSISTENCY	COHESIVE SOILS	VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard
	NON COHESIVE SOILS	VL very loose L- loose MD-medium dense DS-dense VD-very dense
MOISTURE CONDITION		D-dry M- moist W-wet SA-saturated
DRILLING METHOD	continuous flight auger	X hand auger

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SITE INVESTIGATION LOG

Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 10

Easting: 359011E
Northing: 5975021N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200				
300				
400				
500				
600	Lt. Br. Silty Clay with sand	MP	ST	M
700				
800				
900	LL=47%			
1000	PL=17%			
1100	PI=30			
1200	LS=15			
1300				
1400				
1500				
1600				
1700				M
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				M
2800				
2900				
3000				
3100				
3200				
3300	Lt. Br Clay	MP	VST	M
3400				
3500				
3600				
3700				
3800				
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				M
4800				
4900				
5000	EOB			
5100				

PLASTICITY		LP- LOW MP- MEDIUM HP- HIGH
CONSISTENCY	COHESIVE SOILS	VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard
	NON COHESIVE SOILS	VL very loose L- loose MD-medium dense DS-dense VD-very dense
MOISTURE CONDITION		D-dry M- moist W-wet SA-saturated
DRILLING METHOD	continuous flight auger	X hand auger

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Quality of Materials Report

Client:	**Reeds Consulting**	Report Number:	**30170 - 1**
Client Address:	**Level 6, 440 Elizabeth Street Melbourne VIC 3000**		
Job Number:	**30170**	Report Date:	**18/04/2011**
Project:	**Geotechnical Investigation**	Order Number:	-
Location	**NE Shep Growth Area , Shepparton**	**Page 1 of 6**	
Lab No:	**11721**	Sample Location	
Date Sampled:	**1/04/2011**	Bore Hole : 1	
Date Tested:	**14/04/2011**	Start Depth (mm) : 1000	
Sampled By:	**David Melrose**	End Depth (mm) : 1500	
Sample Method:	**AS1289.1.2.1**	Clay with trace Sand (CI-CH)	
Material Source:	**Site**	Spec Description:	-
For Use As:	**Investigation**	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**

A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm		**100**	
53.00 mm		**100**	
37.50 mm		**100**	
26.50 mm		**100**	
19.00 mm		**100**	
13.2 mm		**100**	
9.50 mm		**100**	
6.7 mm		**100**	
4.75 mm		**100**	
2.36 mm		**100**	
1.18 mm		**99**	
0.600 mm		**98**	
0.425 mm		**98**	
0.300 mm		**97**	
0.150 mm		**95**	
0.075 mm		**92**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**49**	
Plastic Limit (%)	**AS1289.3.2.1**		**17**	
Plasticity Index	**AS1289.3.3.1**		**32**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**16.0**	

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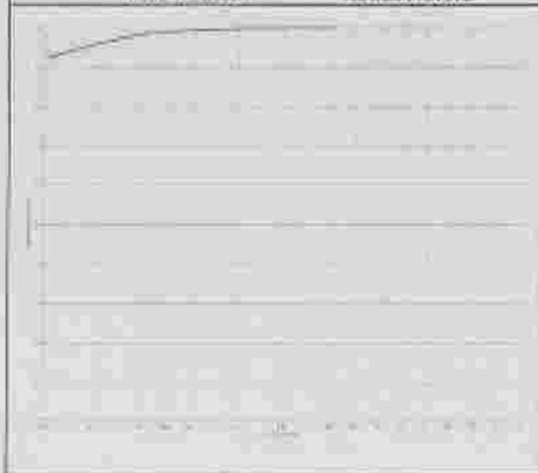
Quality of Materials Report

Client:	Reeds Consulting	Report Number:	30170 - 1
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000		
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	-
Location	NE Shep Growth Area , Shepparton	Page 2 of 6	
Lab No:	11722	Sample Location	
Date Sampled:	1/04/2011	Bore Hole : 2	
Date Tested:	14/04/2011	Start Depth (mm) : 500	
Sampled By:	David Melrose	End Depth (mm) : 1600	
Sample Method:	AS1289.1.2.1	Silty Clay with trace Sand (CI)	
Material Source:	Site	Spec Description:	-
For Use As:	Investigation	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: AS1289.3.6.1



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm		100	
53.00 mm		100	
37.50 mm		100	
26.50 mm		100	
19.00 mm		100	
13.2 mm		100	
9.50 mm		100	
6.7 mm		100	
4.75 mm		100	
2.36 mm		100	
1.18 mm		100	
0.600 mm		99	
0.425 mm		99	
0.300 mm		98	
0.150 mm		96	
0.075 mm		92	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	AS1289.3.1.2		44	
Plastic Limit (%)	AS1289.3.2.1		16	
Plasticity Index	AS1289.3.3.1		28	
Linear Shrinkage (%)	AS1289.3.4.1		14.5	

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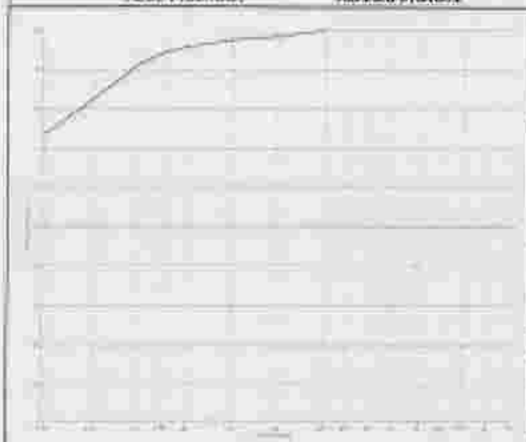
Quality of Materials Report

Client:	Reeds Consulting	Report Number:	30170 - 1
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000		
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	-
Location	NE Shep Growth Area , Shepparton	Page 3 of 6	
Lab No:	11723	Sample Location	
Date Sampled:	1/04/2011	Bore Hole : 4	
Date Tested:	14/04/2011	Start Depth (mm) : 200	
Sampled By:	David Melrose	End Depth (mm) : 2000	
Sample Method:	AS1289.1.2.1	Silty Clay with Sand (CL-CI)	
Material Source:	Site	Spec Description:	-
For Use As:	Investigation	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: AS1289.3.6.1



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm		100	
53.00 mm		100	
37.50 mm		100	
26.50 mm		100	
19.00 mm		100	
13.2 mm		100	
9.50 mm		100	
6.7 mm		100	
4.75 mm		100	
2.36 mm		99	
1.18 mm		98	
0.600 mm		96	
0.425 mm		94	
0.300 mm		92	
0.150 mm		83	
0.075 mm		74	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	AS1289.3.1.2		31	
Plastic Limit (%)	AS1289.3.2.1		13	
Plasticity Index	AS1289.3.3.1		18	
Linear Shrinkage (%)	AS1289.3.4.1		10.0	

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Quality of Materials Report

Client:	**Reeds Consulting**	Report Number:	**30170 - 1**
Client Address:	**Level 6, 440 Elizabeth Street Melbourne VIC 3000**		
Job Number:	**30170**	Report Date:	**18/04/2011**
Project:	**Geotechnical Investigation**	Order Number:	-
Location:	**NE Shep Growth Area , Shepparton**	**Page 4 of 6**	
Lab No:	**11724**	Sample Location	
Date Sampled:	**1/04/2011**	Bore Hole : 5	
Date Tested:	**14/04/2011**	Start Depth (mm) : 500	
Sampled By:	**David Melrose**	End Depth (mm) : 2000	
Sample Method:	**AS1289.1.2.1**	Silty Clay with trace Sand (CI)	
Material Source:	**Site**	Spec Description:	-
For Use As:	**Investigation**	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**

A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm		**100**	
53.00 mm		**100**	
37.50 mm		**100**	
26.50 mm		**100**	
19.00 mm		**100**	
13.2 mm		**100**	
9.50 mm		**100**	
6.7 mm		**100**	
4.75 mm		**100**	
2.36 mm		**100**	
1.18 mm		**100**	
0.600 mm		**99**	
0.425 mm		**98**	
0.300 mm		**97**	
0.150 mm		**93**	
0.075 mm		**89**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**44**	
Plastic Limit (%)	**AS1289.3.2.1**		**16**	
Plasticity Index	**AS1289.3.3.1**		**28**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**14.0**	

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David Hart [illegible]
Peter Wallmeit [illegible]

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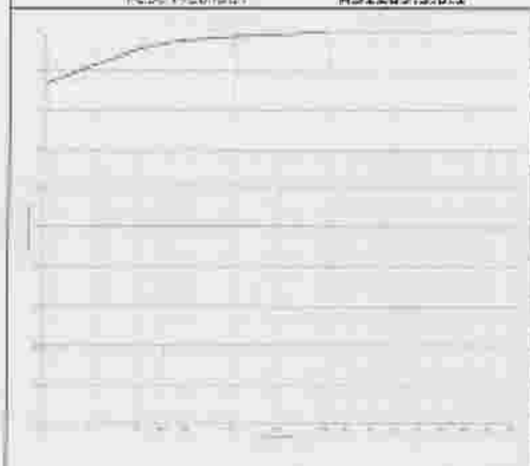
Fax: (03) 5821 [illegible]

Quality of Materials Report

Client:	Reeds Consulting	Report Number:	30170 - 1
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000		
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	-
Location	NE Shep Growth Area , Shepparton	Page 5 of 6	
Lab No:	11725	Sample Location	
Date Sampled:	1/04/2011	Bore Hole : 8	
Date Tested:	14/04/2011	Start Depth (mm) : 2000	
Sampled By:	David Melrose	End Depth (mm) : 3000	
Sample Method:	AS1289.1.2.1	Silty Clay with trace Sand (CI)	
Material Source:	Site	Spec Description:	-
For Use As:	Investigation	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: AS1289.3.6.1



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm		100	
53.00 mm		100	
37.50 mm		100	
26.50 mm		100	
19.00 mm		100	
13.2 mm		100	
9.50 mm		100	
6.7 mm		100	
4.75 mm		100	
2.36 mm		99	
1.18 mm		99	
0.600 mm		98	
0.425 mm		97	
0.300 mm		96	
0.150 mm		91	
0.075 mm		87	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	AS1289.3.1.2		41	
Plastic Limit (%)	AS1289.3.2.1		15	
Plasticity Index	AS1289.3.3.1		26	
Linear Shrinkage (%)	AS1289.3.4.1		13.5	

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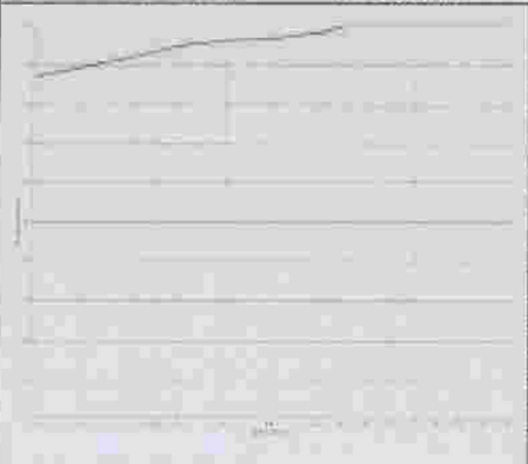
Quality of Materials Report

Client:	Reeds Consulting	Report Number:	30170 - 1
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000		
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	-
Location	NE Shep Growth Area , Shepparton	Page 6 of 6	
Lab No:	11726	Sample Location	
Date Sampled:	1/04/2011	Bore Hole : 10	
Date Tested:	14/04/2011	Start Depth (mm) : 800	
Sampled By:	David Melrose	End Depth (mm) : 1500	
Sample Method:	AS1289.1.2.1	Clay with trace Sand & Gravel (CI-CH)	
Material Source:	Site	Spec Description:	-
For Use As:	Investigation	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: AS1289.3.6.1



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm		100	
53.00 mm		100	
37.50 mm		100	
26.50 mm		100	
19.00 mm		100	
13.2 mm		100	
9.50 mm		100	
6.7 mm		100	
4.75 mm		98	
2.36 mm		97	
1.18 mm		96	
0.600 mm		95	
0.425 mm		94	
0.300 mm		92	
0.150 mm		90	
0.075 mm		87	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	AS1289.3.1.2		47	
Plastic Limit (%)	AS1289.3.2.1		17	
Plasticity Index	AS1289.3.3.1		30	
Linear Shrinkage (%)	AS1289.3.4.1		15.0	

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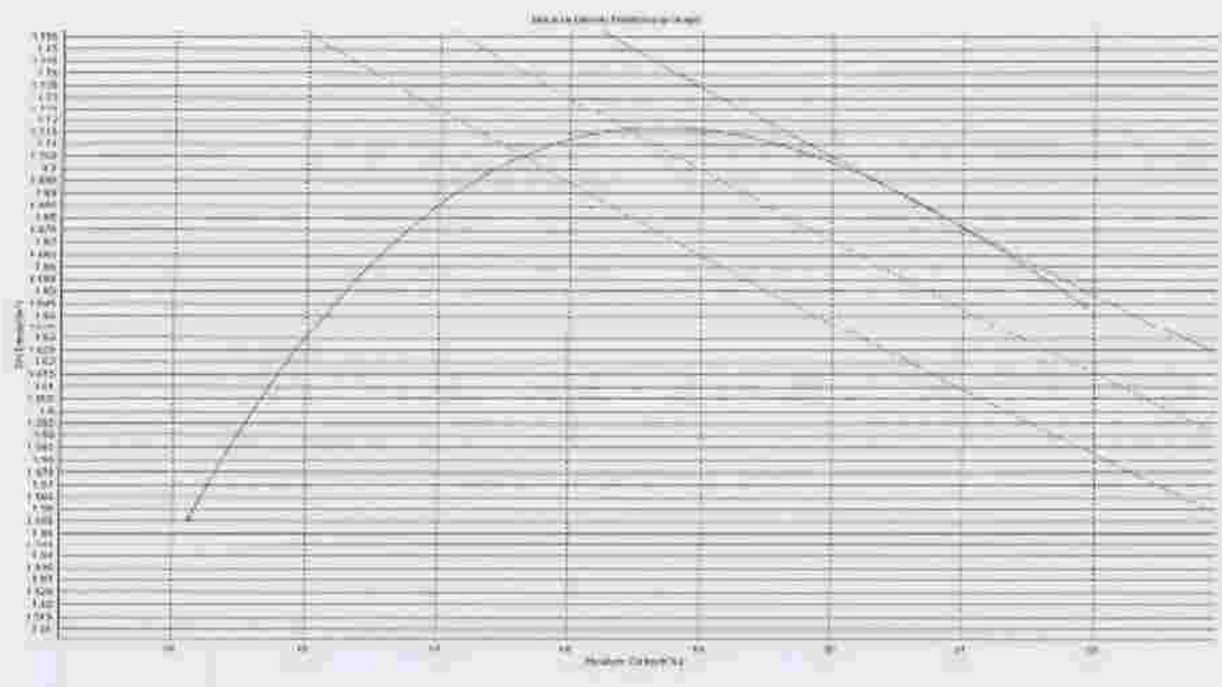
Moisture Density Relationship Report

Client:	**Reeds Consulting**	Report Number:	**30170 - 3**
Client Address:	**Level 6, 440 Elizabeth Street Melbourne VIC 3000**		
Job Number:	**30170**	Report Date:	**18/04/2011**
Project:	**Geotechnical Investigation**	Order Number:	
Location	**NE Shep Growth Area , Shepparton**	Test Method :	**AS1289.5.1.1**
Lab No:	**11721**	Sample Location	
Date Sampled:	**1/04/2011**	Bore Hole : 1	
Date Tested:	**8/04/2011**	Start Depth (mm) : 1000	
Sampled By:	**David Melrose**	End Depth (mm) : 1500	
Sample Method:	**AS1289.1.2.1**	Clay with trace Sand (CI-CH)	
Material Source:	**Site**		
For Use As:	**Investigation**	Lot Number:	-
Remarks:	-	Item Number :	-

Page 1 of 5

Maximum Size (mm) :	**19.0**	Moisture Content Test Method :	**AS1289.2.1.1**
Oversize (%) :	-	Oversize Test Method :	-
MDD (t/m^3) :	**1.717**	Oversize Density (t/m^3) :	
OMC(%) :	**18.7**		



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Approved Signatory	Form Number
David Sleep	**REP MDR-1-17**
NATA Accred No:5023	

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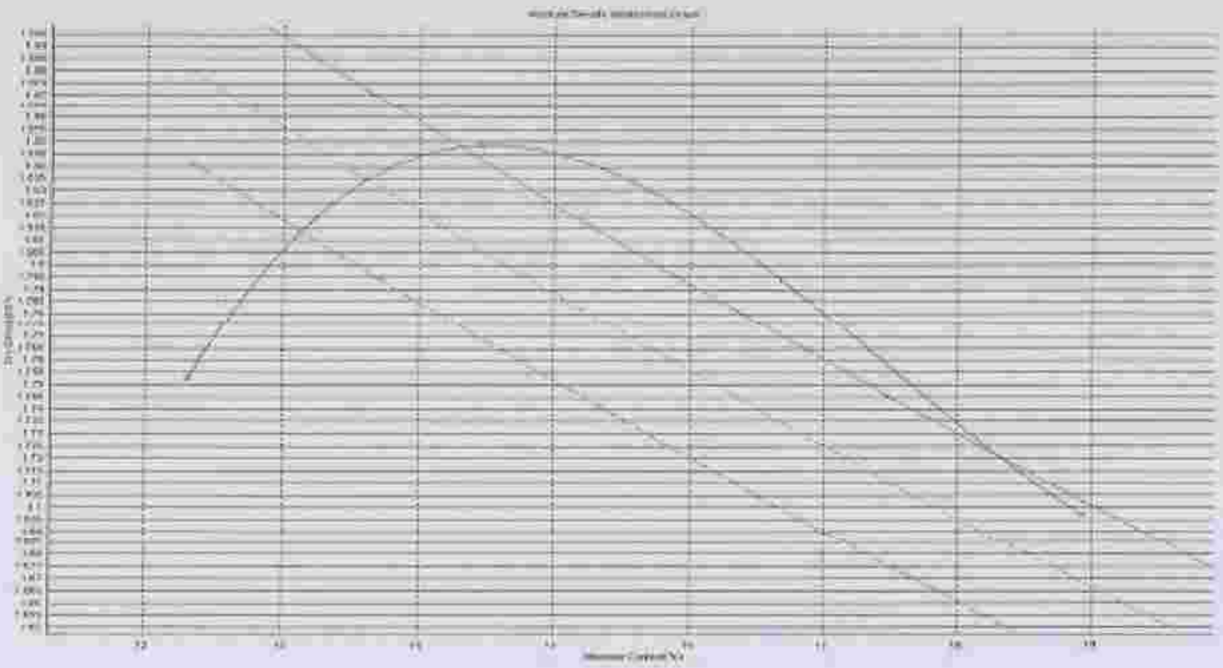
Moisture Density Relationship Report

Client:	**Reeds Consulting**	Report Number:	**30170 - 3**
Client Address:	**Level 6, 440 Elizabeth Street Melbourne VIC 3000**		
Job Number:	**30170**	Report Date:	**18/04/2011**
Project:	**Geotechnical Investigation**	Order Number:	
Location	**NE Shep Growth Area , Shepparton**	Test Method :	**AS1289.5.1.1**
Lab No:	**11723**	Sample Location	
Date Sampled:	**1/04/2011**	Bore Hole : 4	
Date Tested:	**8/04/2011**	Start Depth (mm) : 200	
Sampled By:	**David Melrose**	End Depth (mm) : 2000	
Sample Method:	**AS1289.1.2.1**	Silty Clay with Sand (CL-CI)	
Material Source:	**Site**		
For Use As:	**Investigation**	Lot Number:	-
Remarks:	-	Item Number :	-

Maximum Size (mm) :	19.0	Moisture Content Test Method :	**AS1289.2.1.1**
Oversize (%) :	-	Oversize Test Method :	-
MDD (t/m³) :	**1.849**	Oversize Density (t/m³) :	
OMC(%) :	**14.5**		



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Approved Signatory: David Sleep
NATA Accred No: 5023

Form Number: **REP MDR-1-17**

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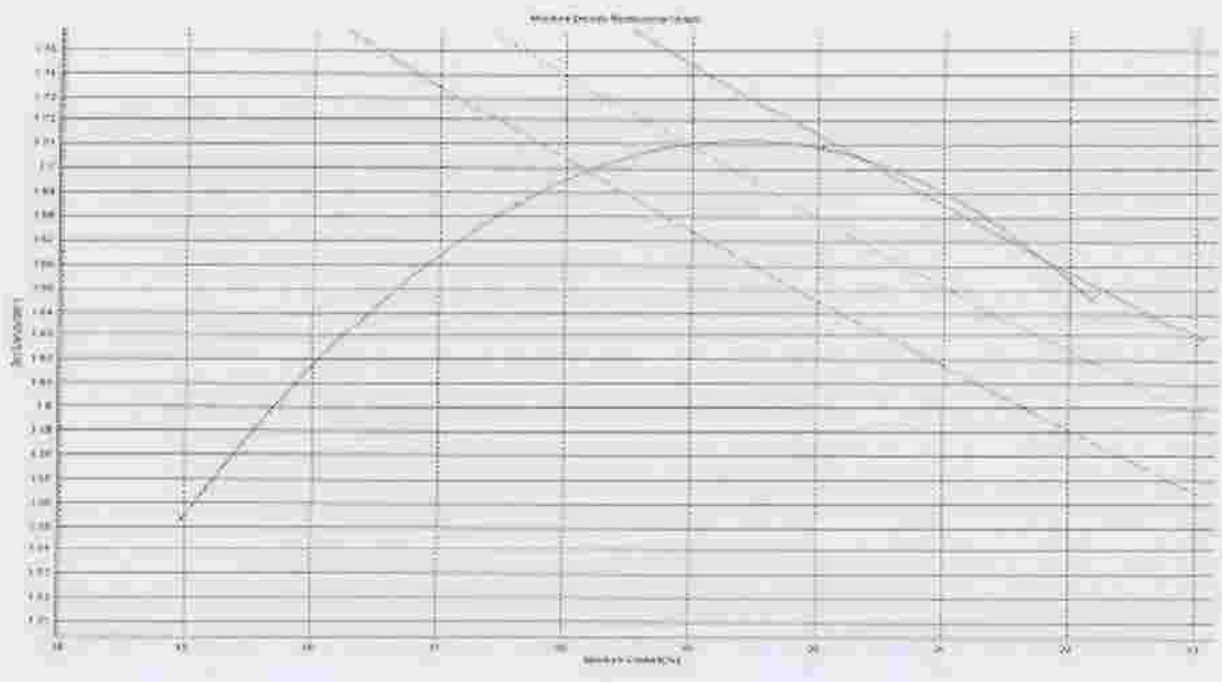
Moisture Density Relationship Report

Client:	Reeds Consulting	Report Number:	30170 - 3
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000		
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	
Location	NE Shep Growth Area , Shepparton	Test Method :	AS1289.5.1.1
Lab No:	11724	Sample Location	
Date Sampled:	1/04/2011	Bore Hole : 5	
Date Tested:	8/04/2011	Start Depth (mm) : 500	
Sampled By:	David Melrose	End Depth (mm) : 2000	
Sample Method:	AS1289.1.2.1	Silty Clay with trace Sand (CI)	
Material Source:	Site		
For Use As:	Investigation	Lot Number:	-
Remarks:	-	Item Number :	-

Maximum Size (mm) :	19.0	Moisture Content Test Method :	AS1289.2.1.1
Oversize (%) :	-	Oversize Test Method :	-
MDD (t/m³) :	**1.712**	Oversize Density (t/m³) :	
OMC(%) :	**19.4**		



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Approved Signatory	Form Number
David Sleep	REP MDR-1-17
NATA Accred No:5023	

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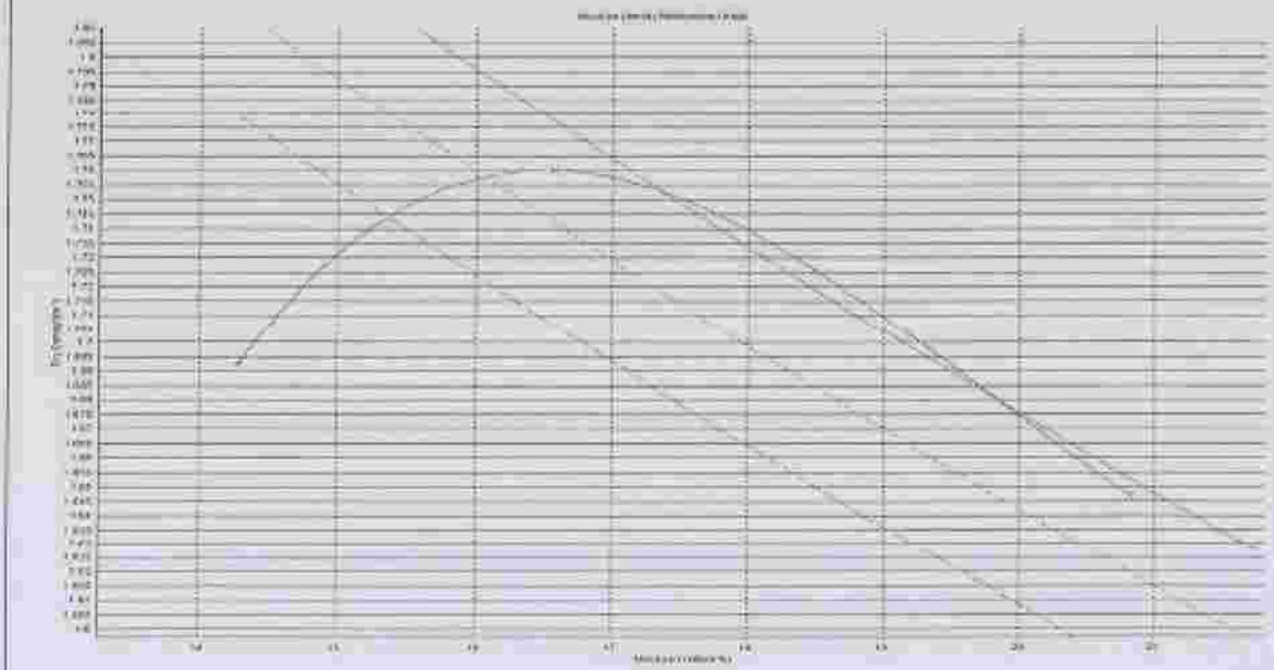
Moisture Density Relationship Report

Client:	**Reeds Consulting**	Report Number:	**30170 - 3**
Client Address:	**Level 6, 440 Elizabeth Street Melbourne VIC 3000**		
Job Number:	**30170**	Report Date:	**18/04/2011**
Project:	**Geotechnical Investigation**	Order Number:	
Location	**NE Shep Growth Area , Shepparton**	Test Method :	**AS1289.5.1.1**
Lab No:	**11725**	Sample Location	
Date Sampled:	**1/04/2011**	Bore Hole : 8	
Date Tested:	**8/04/2011**	Start Depth (mm) : 2000	
Sampled By:	**David Melrose**	End Depth (mm) : 3000	
Sample Method:	**AS1289.1.2.1**	Silty Clay with trace Sand (CI)	
Material Source:	**Site**		
For Use As:	**Investigation**	Lot Number:	-
Remarks:	-	Item Number :	-

Maximum Size (mm) :	**19.0**	Moisture Content Test Method :	**AS1289.2.1.1**
Oversize (%) :	-	Oversize Test Method :	-
MDD (t/m³) :	**1.760**	Oversize Density (t/m³) :	
OMC(%) :	**16.5**		



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Approved Signatory	Form Number
David Sleep	**REP MDR-1-17**
NATA Accred No: 5023	

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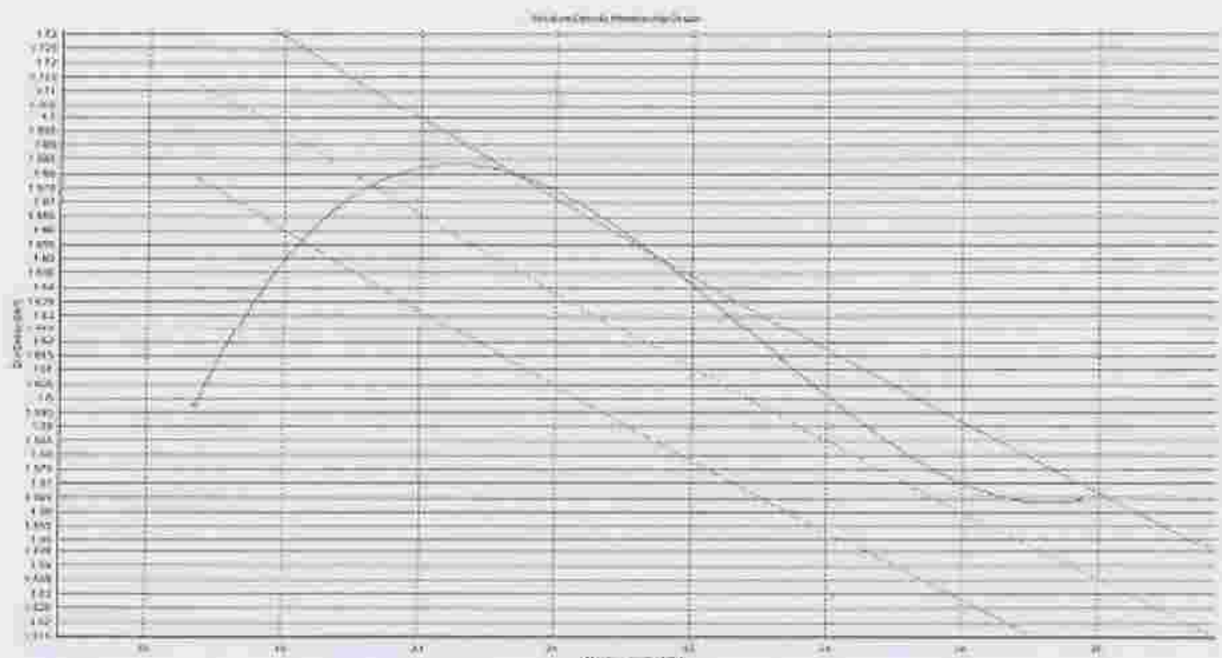
Moisture Density Relationship Report

Client:	Reeds Consulting	Report Number:	30170 - 3
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000		
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	
Location	NE Shep Growth Area , Shepparton	Test Method :	AS1289.5.1.1
Lab No:	11726	Sample Location	
Date Sampled:	1/04/2011	Bore Hole : 10	
Date Tested:	8/04/2011	Start Depth (mm) : 800	
Sampled By:	David Melrose	End Depth (mm) : 1500	
Sample Method:	AS1289.1.2.1	Clay with trace Sand & Gravel (CI-CH)	
Material Source:	Site		
For Use As:	Investigation	Lot Number:	-
Remarks:	-	Item Number :	-

Maximum Size (mm) :	19.0	Moisture Content Test Method :	AS1289.2.1.1
Oversize (%) :	-	Oversize Test Method :	-
MDD (t/m³) :	**1.684**	Oversize Density (t/m³) :	
OMC(%) :	**20.3**		



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Approved Signatory	Form Number
David Sleep	REP MDR-1-17
NATA Accred No: 5023	

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B.M CONSULTING ENGINEERS PTY.LTD.
[illegible]
[illegible], Shepparton
P.O. Box [illegible], Shepparton, [illegible]
David Mahoney [illegible]
David East [illegible]
Peter Williams [illegible]
Ph: [illegible]
Fax: [illegible]

Emerson Class Number Report

Client :	Reeds Consulting	Report Number:	30170 - 2
Client Address :	Level 6, 440 Elizabeth Street Melbourne VIC 3000	Report Date:	18/04/2011
Job Number :	30170	Order Number:	
Project :	Geotechnical Investigation	Test Method:	AS 1289.3.8.1
Location :	NE Shep Growth Area , Shepparton		

Lab No :	11721	11722	11723	11724
ID No :	-	-	-	-
Lot No :	-	-	-	-
Item No :	-	-	-	-
Sampling Method :	AS1289.1.2.1	AS1289.1.2.1	AS1289.1.2.1	AS1289.1.2.1
Date Sampled :	1/4/2011	1/4/2011	1/4/2011	1/4/2011
Date Tested :	13/4/2011	13/4/2011	13/4/2011	13/4/2011
Material Source :	Site	Site	Site	Site
For Use As :	Investigation	Investigation	Investigation	Investigation
Sample Location :	Bore Hole : 1 Start Depth (mm) : 1000 End Depth (mm) : 1500 Clay with trace Sand (CI-CH)	Bore Hole : 2 Start Depth (mm) : 500 End Depth (mm) : 1600 Silty Clay with trace Sand (CI)	Bore Hole : 4 Start Depth (mm) : 700 End Depth (mm) : 2000 Silty Clay with Sand (CL-CI)	Bore Hole : 5 Start Depth (mm) : 500 End Depth (mm) : 2000 Silty Clay with trace Sand (CI)
TEST 1				
Soil Description :	**Clay with trace Sand (CI-CH)**	**Silty Clay with trace Sand (CI)**	**Silty Clay with Sand (CL-CI)**	**Silty Clay with trace Sand (CI)**
Type of Water Used :	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**
Temperature of Water (°C) :	**20.0**	**20.0**	**20.0**	**20.0**
Emerson Class Number :	**Class 4**	**Class 2**	**Class 5**	**Class 5**
TEST 2				
Soil Description :	**Clay with trace Sand (CI-CH)**	**Silty Clay with trace Sand (CI)**	**Silty Clay with Sand (CL-CI)**	**Silty Clay with trace Sand (CI)**
Type of Water Used :	**Tap Water**	**Tap Water**	**Tap water**	**Tap Water**
Temperature of Water (°C) :	**20**	**20**	**20**	**20**
Emerson Class Number :	**Class 4**	**Class 5**	**Class 6**	**Class 5**
Remarks :				

NATA	**This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.**	APPROVED SIGNATORY David Sleep NATA Accred No: 5023	FORM NUMBER **RPO52-7**

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CIVIL ENGINEERS

B.M CONSULTING
ENGINEERS PTY.LTD.
P.O. Box 6577, Shepparton. 3632

Emerson Class Number Report

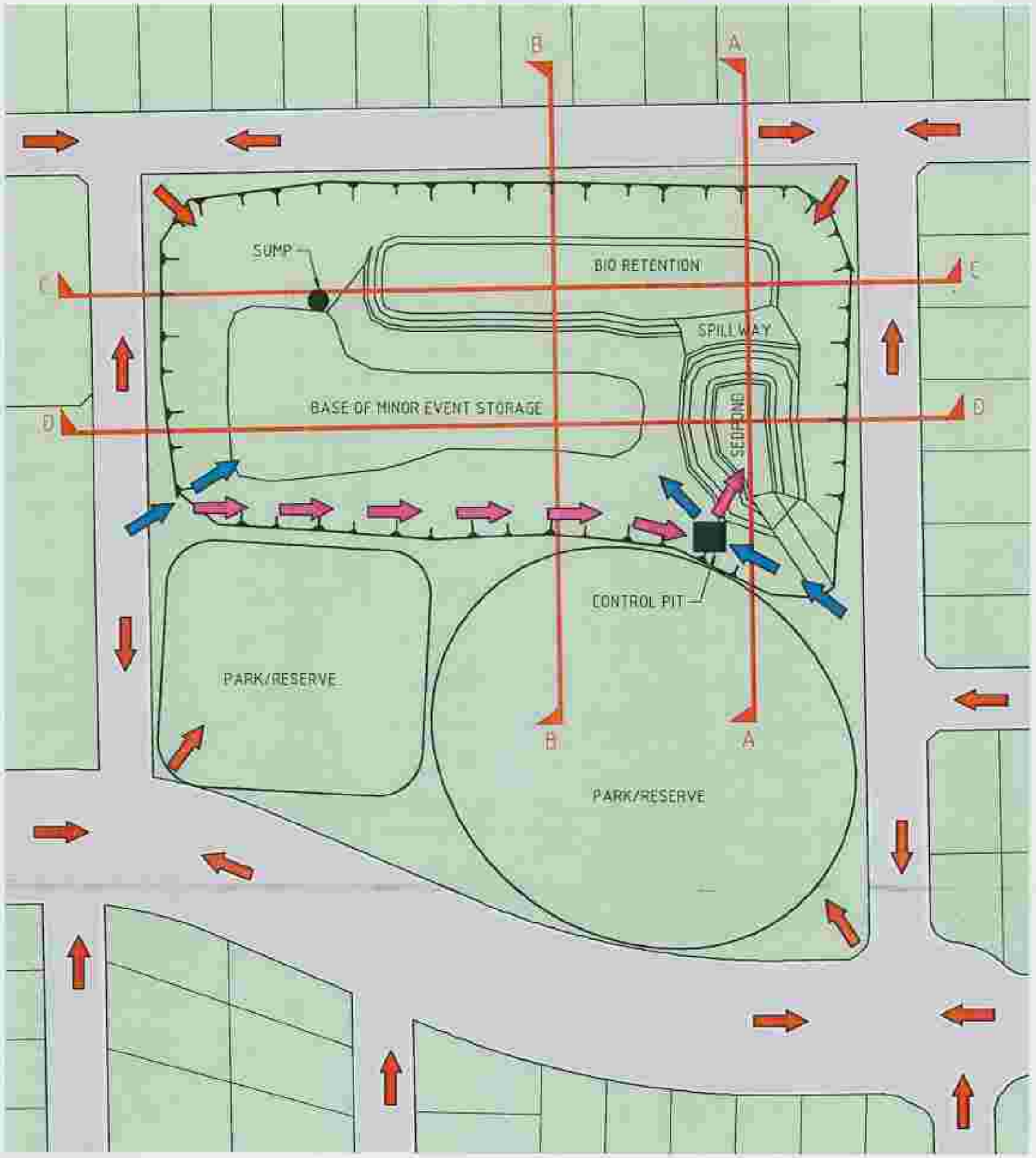
Client :	Reeds Consulting	Report Number:	30170 - 2
Client Address :	Level 6, 440 Elizabeth Street Melbourne VIC 3000	Report Date:	18/04/2011
Job Number :	30170	Order Number:	
Project :	Geotechnical Investigation	Test Method:	AS 1289.3.8.1
Location :	NE Shep Growth Area , Shepparton		

Lab No :	11725	11726		
ID No :	-	-		
Lot No :	-	-		
Item No :	-	-		
Sampling Method :	AS1289.1.2.1	AS1289.1.2.1		
Date Sampled :	1/4/2011	1/4/2011		
Date Tested :	13/4/2011	13/4/2011		
Material Source :	Site	Site		
For Use As :	Investigation	Investigation		
Sample Location :	Bore Hole : 8 Start Depth (mm) : 2000 End Depth (mm) : 3500 Silty Clay with trace Sand (CI)	Bore Hole : 10 Start Depth (mm) : 800 End Depth (mm) : 1500 Clay with trace Sand & Gravel (CI-CH)		
TEST 1				
Soil Description :	**Silty Clay with trace Sand (CI)**	**Clay with trace Sand & gravel (CI-CH)**		
Type of Water Used :	**Distilled Water**	**Distilled Water**		
Temperature of Water (°C) :	**20.0**	**20.0**		
Emerson Class Number :	**Class 2**	**Class 6**		
TEST 2				
Soil Description :	**Silty Clay with trace Sand (CI)**	**Clay with trace Sand & gravel (CI-CH)**		
Type of Water Used :	**Tap Water**	**Tap Water**		
Temperature of Water (°C) :	**20**	**20**		
Emerson Class Number :	**Class 4**	**Class 6**		
Remarks :				

NATA	**This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.**	APPROVED SIGNATORY David Sleep NATA Accred No 5023	FORM NUMBER **RPO52-7**

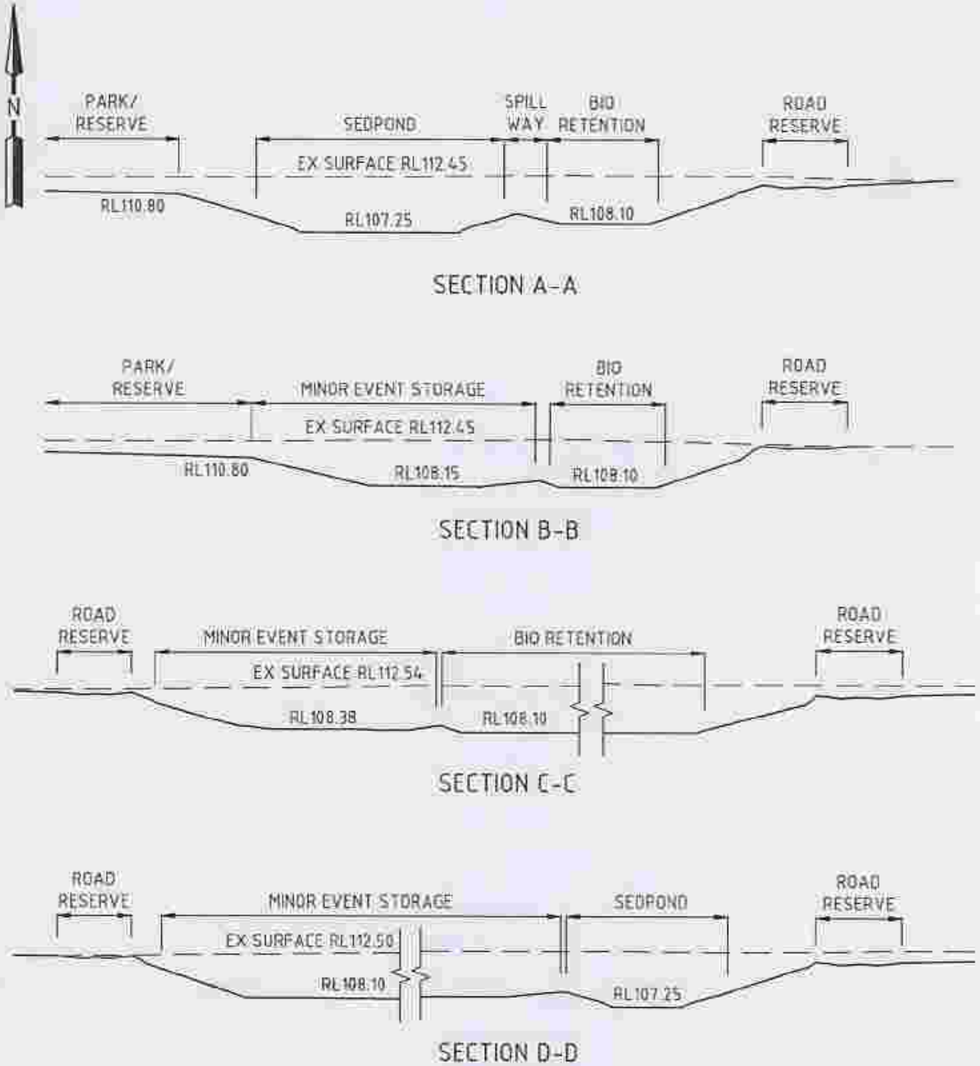
ANNEXURE D

Preliminary Retarding Basin and Water Treatment Plan



PLAN VIEW

0 12.5 25 50
Scale 1:1250 @ A3



SECTIONS

0 10 20 40
0 5 10 20
Scale H 1:1000 V 1:500 @ A3

LEGEND

- TREATMENT FLOWS/DRAINAGE (PIPED)
- MINOR EVENT FLOWS/DRAINAGE (PIPED)
- MAJOR EVENT FLOWS

H:\21656\STAGE '1' - PRELIM GRADING & DRAINAGE\CAD\DWG SET\FUNCTIONAL\PRELIM RB & ROADS & SECTIONS.DWG

A	PRELIMINARY ISSUE	03.02.14	PC

PRELIMINARY RETARDING BASIN AND WATER TREATMENT

REEDS CONSULTING
Reeds Consulting Pty Ltd
Level 6, 440 Elizabeth Street Melbourne 3000
phone (03) 8660 3000 fax (03) 8660 3030
e-mail engineering@reedscon.com.au

CIVIL ENGINEERS • LAND SURVEYORS • DEVELOPMENT CONSULTANTS

ANNEXURE E

Retarding Basin & Reserve Volumes Computation Results

RETARDING BASIN & RESERVE VOLUMES		
RL (m)	FILL / VOLUME (m^3)	VOLUME MINUS SEDPOND VOLUMES (m^3)
107.9 (BASE)	281.544	0.000
108.0	361.797	18.752
108.2	1124.632	634.007
108.4	2452.996	1779.895
108.6	4021.537	3348.436
108.8	5838.501	5165.400
109.0	7838.016	7164.915
109.2	9982.968	9309.867
109.4	12255.330	11582.229
109.6	14656.888	13983.787
109.8	17189.432	16516.331
110.0	19854.750	19181.649
110.2	22654.631	21981.530
110.4	25590.863	24917.762
110.6	28665.235	27992.134
110.8	31879.535	31206.434
111.0	35494.873	34821.772
111.2	39734.185	39061.084
111.4	44610.017	43936.916
111.6	50189.130	49516.029

SEDPOND VOLUMES	
RL (m)	FILL / VOLUME (m^3)
107.25 (BASE)	0.000
107.4	51.747
107.6	130.816
107.8	226.471
107.9	281.544
108.0	343.045
108.2	490.625
108.4 (NWL)	673.101

NOTE Sediment storage to 0.5 below NWL (ie RL 107.9)is 281m^3
Requirement for 5 Yr frequency cleanout (at 1.6 m^3/Ha/Yr loading) is 256 m^3.
The proposal is adequate for 5yr maintenance with max sediment level 0.5m below NWL

Routing results:
****

XXXX
XXXX: 15 min 5 year Design Storm
DESIGN run no. 1

Parameters: kc = 1.25 m = 0.80

Loss parameters	Initial loss (mm)	Runoff coeff.
	10.00	0.60

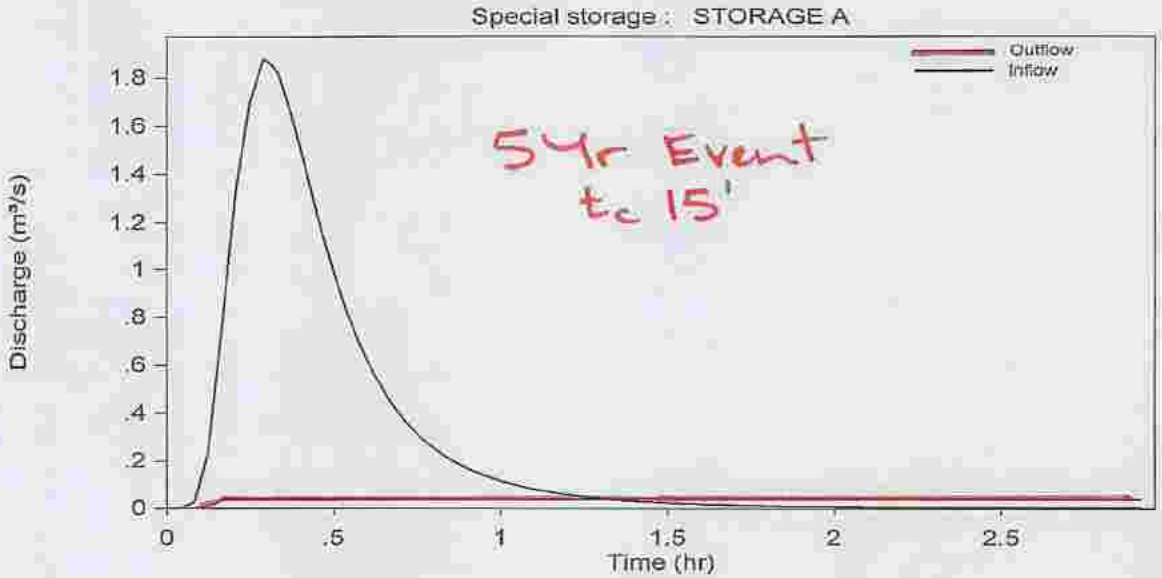
Results of routing through special storage STORAGE A
Peak elevation= 108.49 m
Peak outflow = 0.04 m^3/s
Peak storage = 2.51E+03 m^3

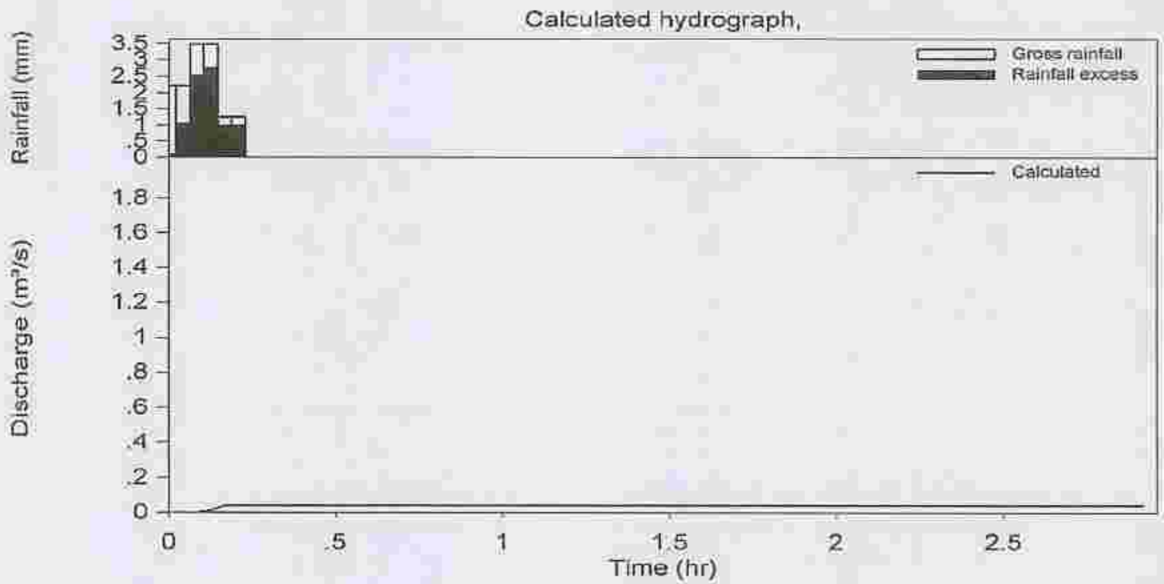
*** Special storage : STORAGE A

	Hydrograph Outflow	Hydrograph Inflow
Peak discharge, m^3/s	0.040	1.880
Time to peak,h	1.29	0.29
Volume, m^3	4.03E+02	2.73E+03
Time to centroid,h	1.54	0.46
Lag (c.m. to c.m.),h	1.40	0.33
Lag to peak,h	1.16	0.16

*** Calculated hydrograph,

	Hydrograph Calc.
Peak discharge, m^3/s	0.04000
Time to peak,h	1.29
Volume, m^3	4.03E+02
Time to centroid,h	1.54
Lag (c.m. to c.m.),h	1.40
Lag to peak,h	1.16


Special storage : STORAGE A
Outflow
Inflow
5Yr Event
tc 15'
Discharge (m³/s)
1.8
1.6
1.4
1.2
1
.8
.6
.4
.2
0
0
.5
1
1.5
2
2.5
Time (hr)


Calculated hydrograph,
Gross rainfall
Rainfall excess
Rainfall (mm)
Calculated
Discharge (m³/s)
1.8
1.6
1.4
1.2
1
.8
.6
.4
.2
0
0
.5
1
1.5
2
2.5
Time (hr)

Routing results:
****

XXXX
XXXX: 24 hour 100 year Design Storm
DESIGN run no. 1

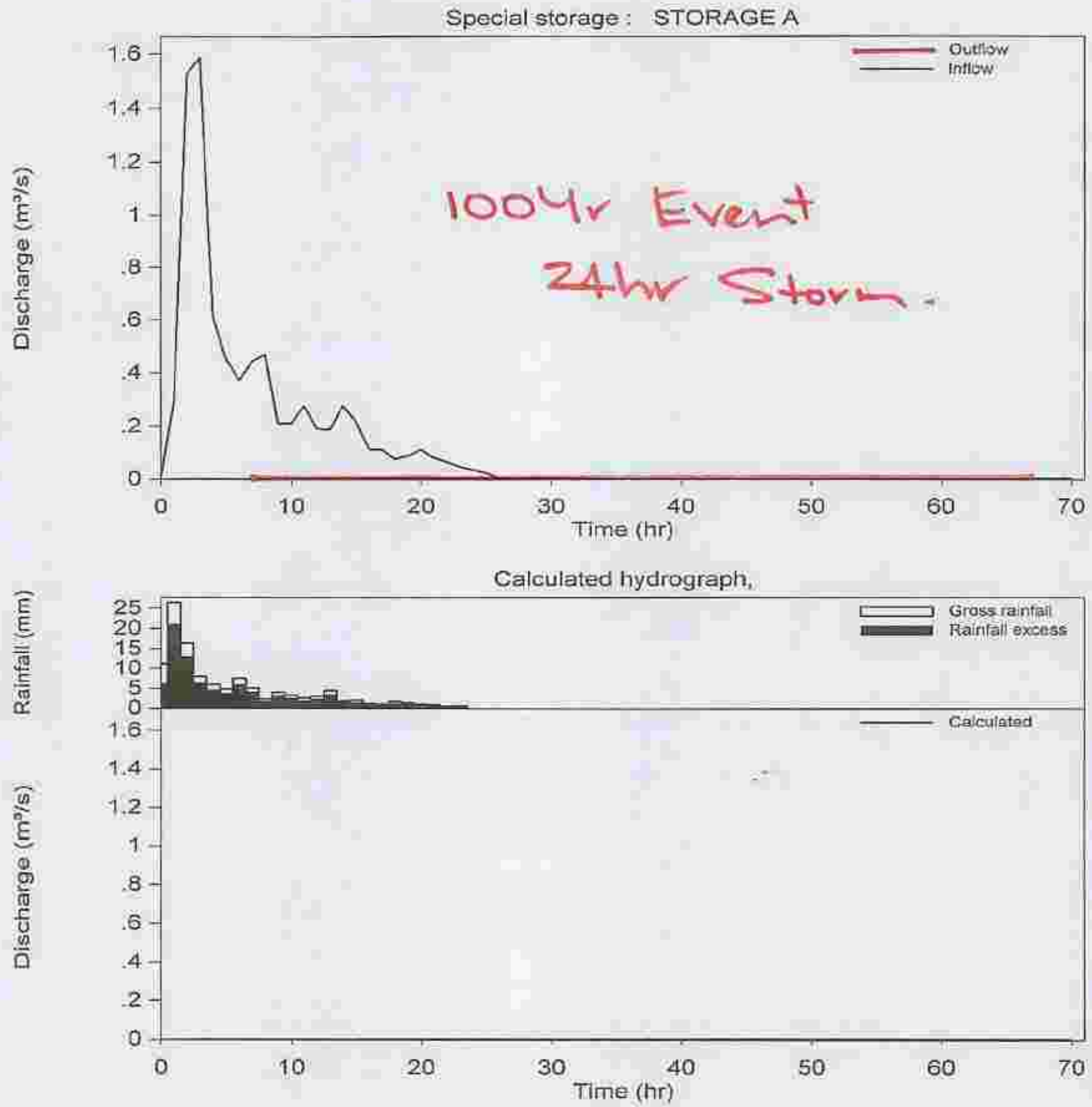
Parameters: kc = 1.25 m = 0.80

Loss parameters	Initial loss (mm)	Runoff coeff.
	10.00	0.60

Results of routing through special storage STORAGE A
Peak elevation= 110.65 m
Peak outflow = 0.00 m³/s
Peak storage = 2.88E+04 m³

*** Special storage : STORAGE A

	Hydrograph Outflow	Inflow
Peak discharge,m³/s	0.003	1.585
Time to peak,h	26.0	3.0
Volume,m³	6.58E+02	2.90E+04
Time to centroid,h	38.3	6.8
Lag (c.m. to c.m.),h	32.3	0.9
Lag to peak,h	20.0	-3.0



Special storage : STORAGE A
Outflow
Inflow
Discharge (m³/s)
Time (hr)
100Yr Event
24hr Storm.
Calculated hydrograph,
Gross rainfall
Rainfall excess
Rainfall (mm)
Calculated
Discharge (m³/s)
Time (hr)

Routing results:
****

XXXX
XXXX: 24 hour 500 year Design Storm
DESIGN run no. 1

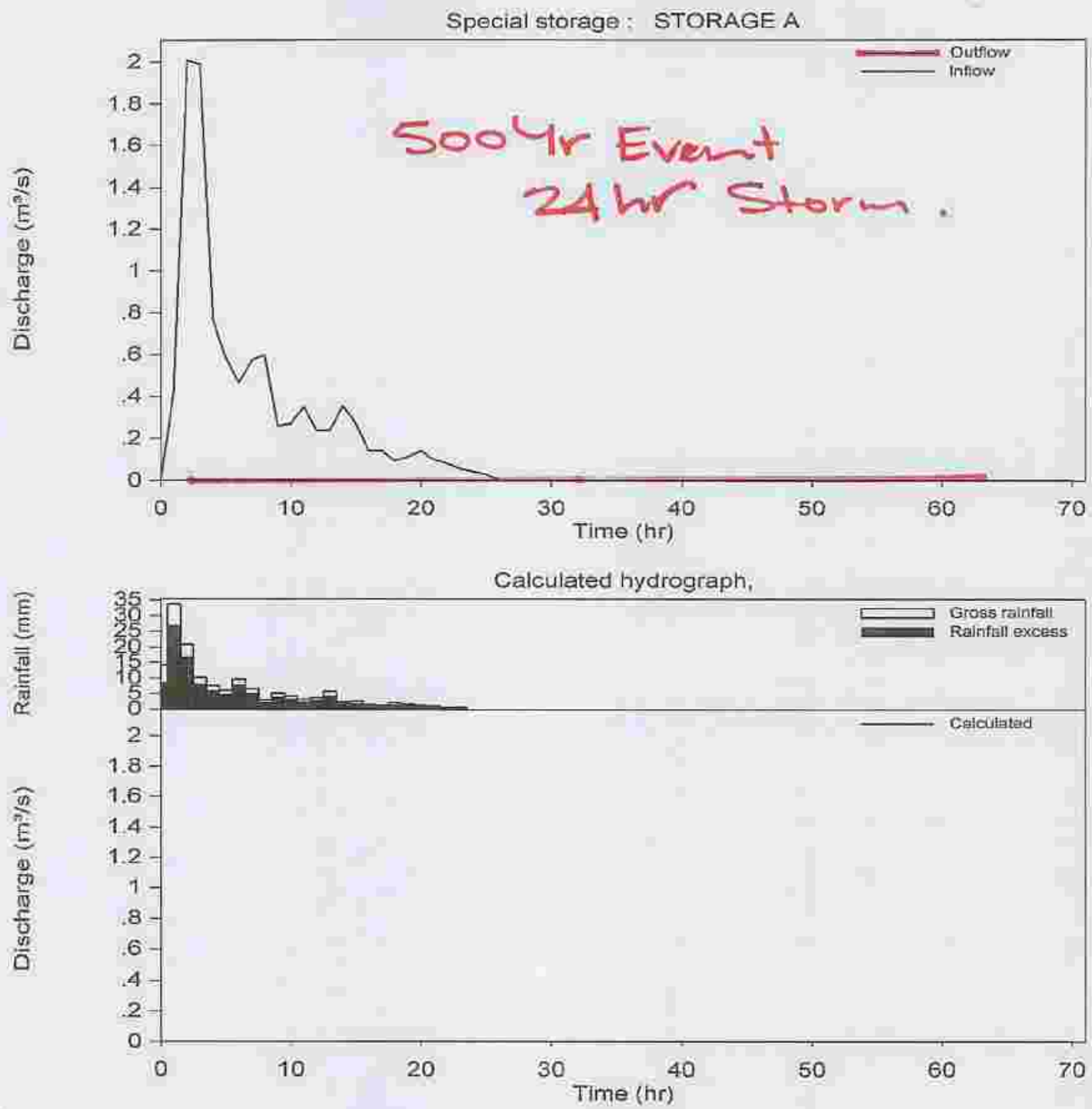
Parameters: kc = 1.25 m = 0.80

Loss parameters	Initial loss (mm)	Runoff coeff.
	10.00	0.60

Results of routing through special storage STORAGE A
Peak elevation= 111.10 m
Peak outflow = 0.00 m³/s
Peak storage = 3.70E+04 m³

*** Special storage : STORAGE A

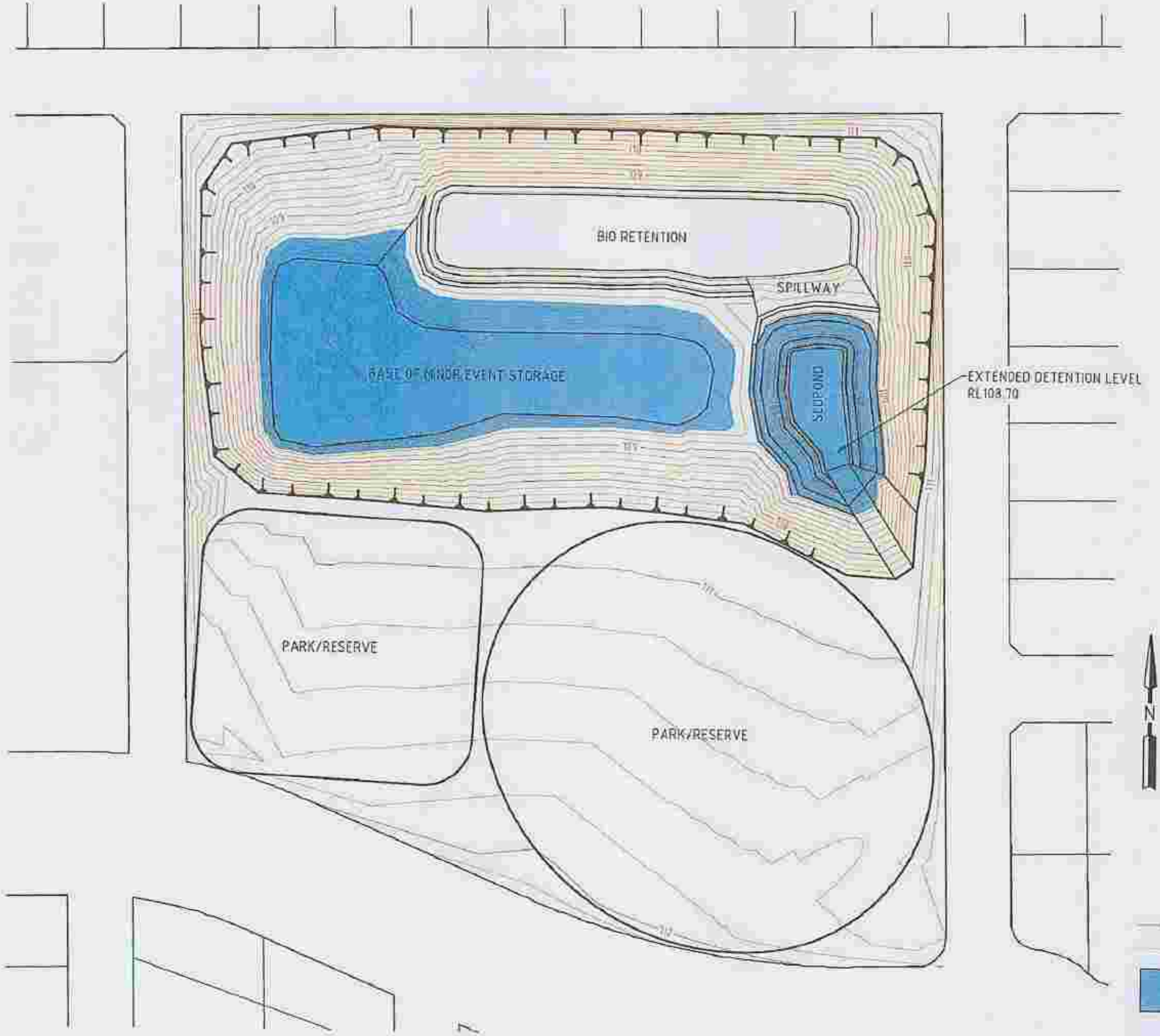
	Hydrograph Outflow	Inflow
Peak discharge,m³/s	0.004	2.007
Time to peak,h	26.0	2.0
Volume,m³	8.44E+02	3.72E+04
Time to centroid,h	38.3	6.8
Lag (c.m. to c.m.),h	32.3	0.8
Lag to peak,h	20.0	-4.0



Special storage : STORAGE A
Outflow
Inflow
500Yr Event
24hr Storm.
Discharge (m³/s)
Time (hr)
Calculated hydrograph,
Gross rainfall
Rainfall excess
Rainfall (mm)
Calculated
Discharge (m³/s)
Time (hr)

ANNEXURE F

Preliminary Retarding Basin Storage Extents – 5yr



LEGEND

108	MAJOR CONTOUR - 1m INTERVAL
	MINOR CONTOUR - 0.2m INTERVAL
	STORAGE EXTENT - 5yr STORM EVENT (RL108.49)

0 10 20 40
Scale 1:1000 @ A3

PRELIMINARY RETARDING BASIN STORAGE EXTENTS - 5yr

H:\21656\STAGE '1' - PRELIM GRADING & DRAINAGE\CAD\DWG SET\FUNCTIONAL\PRELIM RB & ROADS & SECTIONS.DWG

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REEDS CONSULTING
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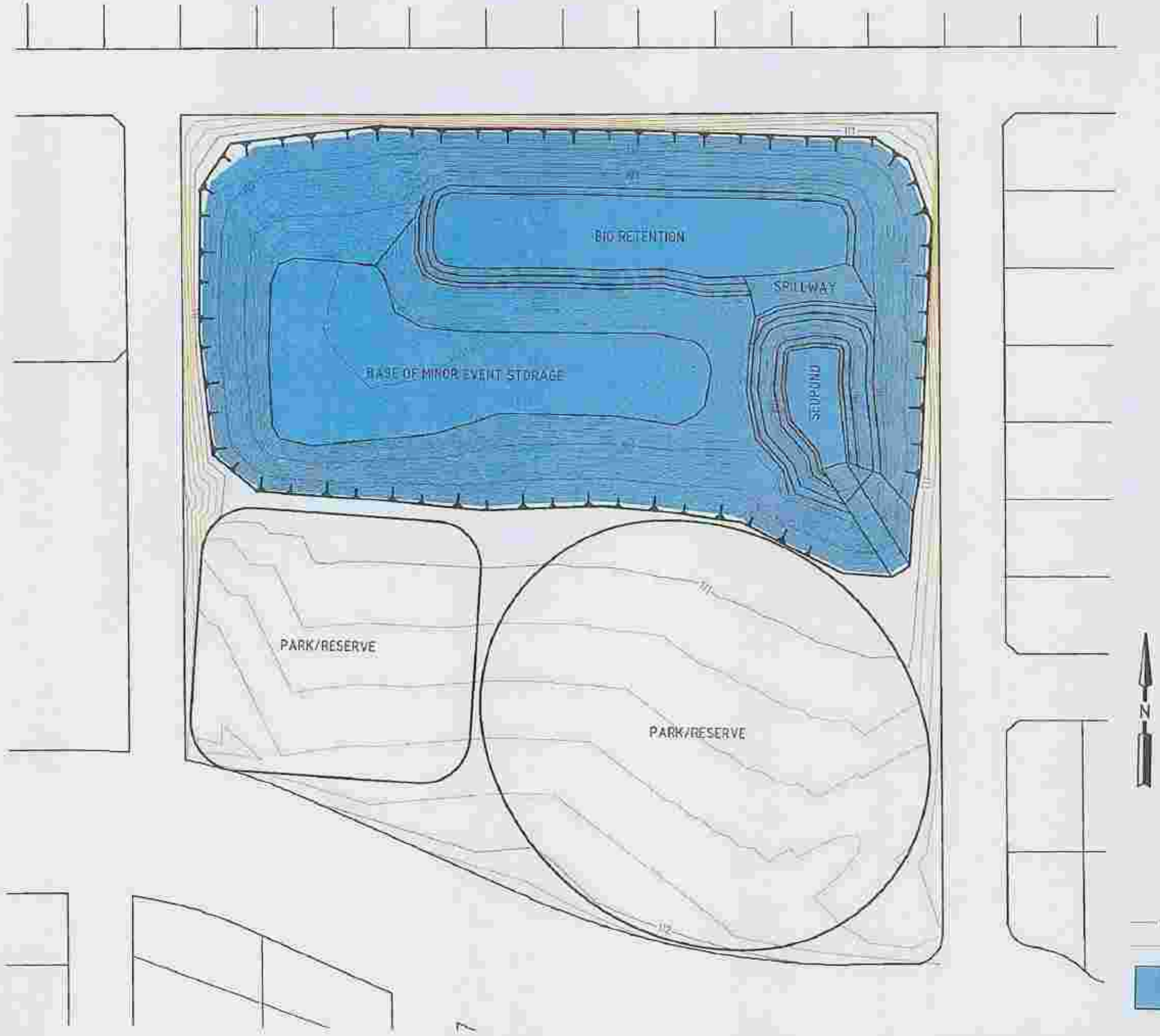
ANNEXURE G

Preliminary Retarding Basin Storage Extents – 100yr



LEGEND

- MAJOR CONTOUR - 1m INTERVAL
- MINOR CONTOUR - 0.2m INTERVAL
- STORAGE EXTENT - 100yr STORM EVENT (RL110.65)

0 10 20 40
Scale 1:1000 @ A1

PRELIMINARY RETARDING BASIN STORAGE EXTENTS - 100yr

Reeds Consulting Pty Ltd
Level 6, 440 Elizabeth Street Melbourne 3000
phone (03) 8660 3000 fax (03) 8660 3030
e-mail engineering@reedscon.com.au

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ANNEXURE H

Preliminary Retarding Basin Storage Extents – 500yr

LEGEND

- MAJOR CONTOUR - 1m INTERVAL
- MINOR CONTOUR - 0.2m INTERVAL
- STORAGE EXTENT - 500yr STORM EVENT (RL 111.10)

0 10 20 40
Scale 1:1000 @ A1

PRELIMINARY RETARDING BASIN STORAGE EXTENTS - 500yr

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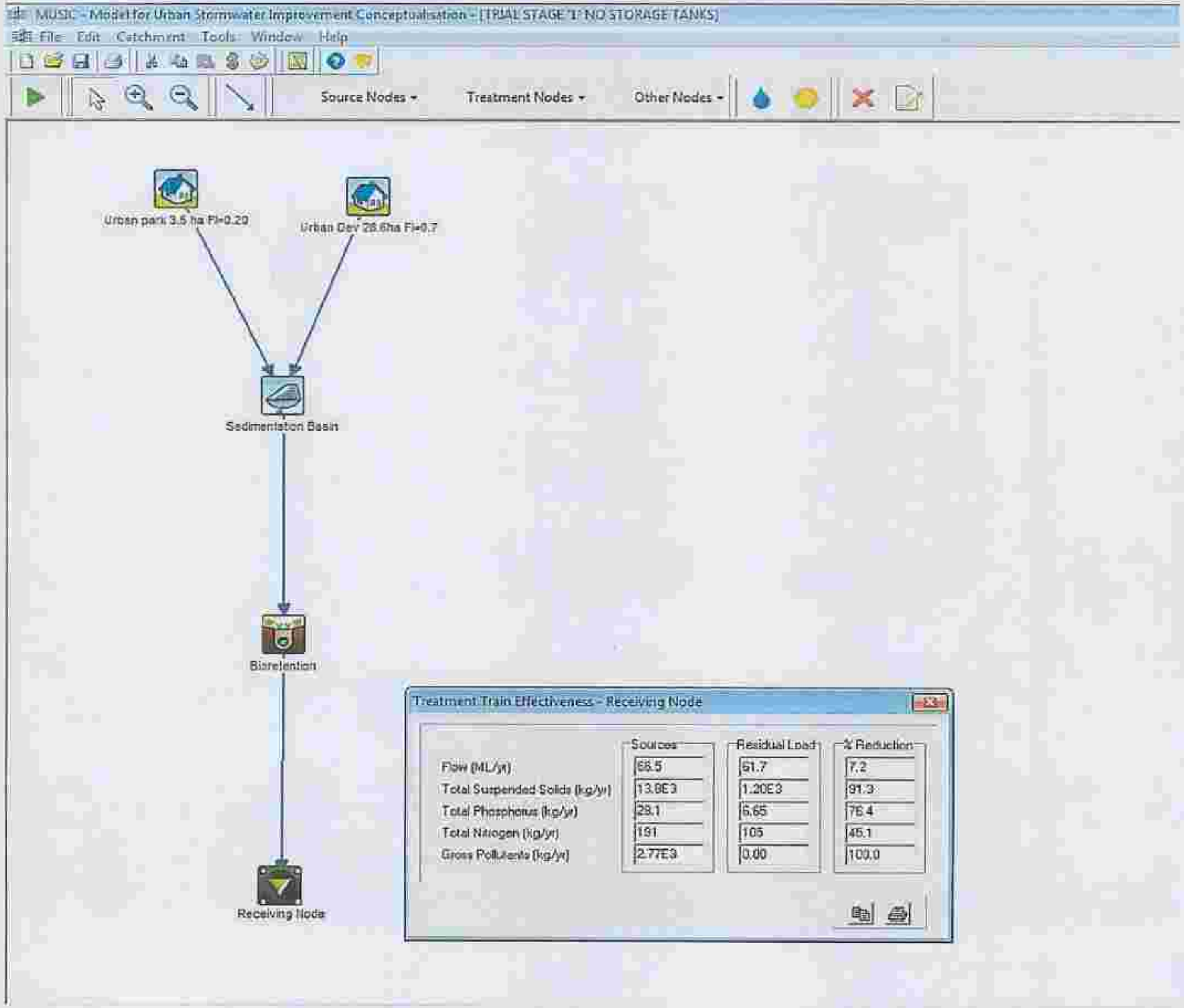
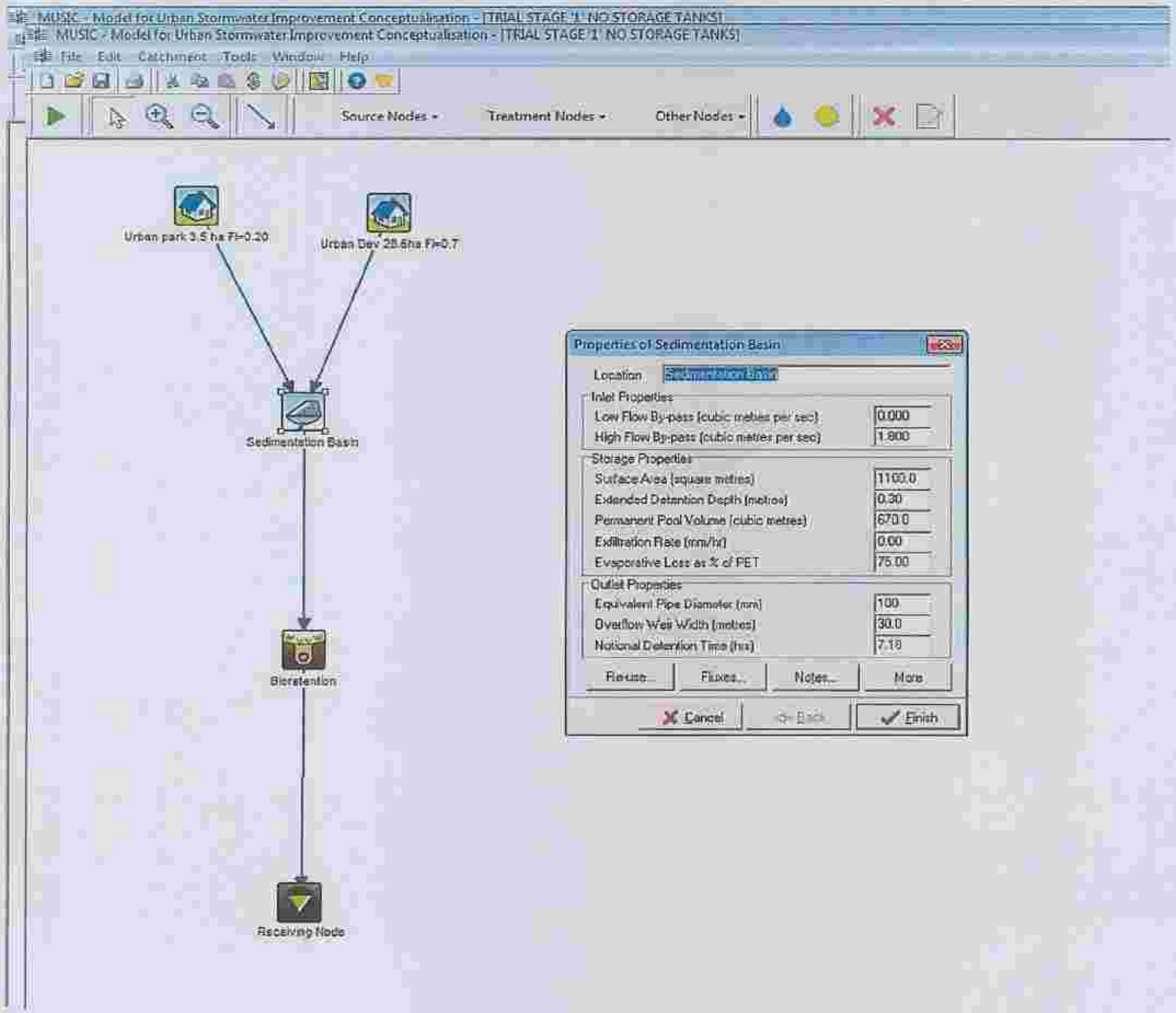
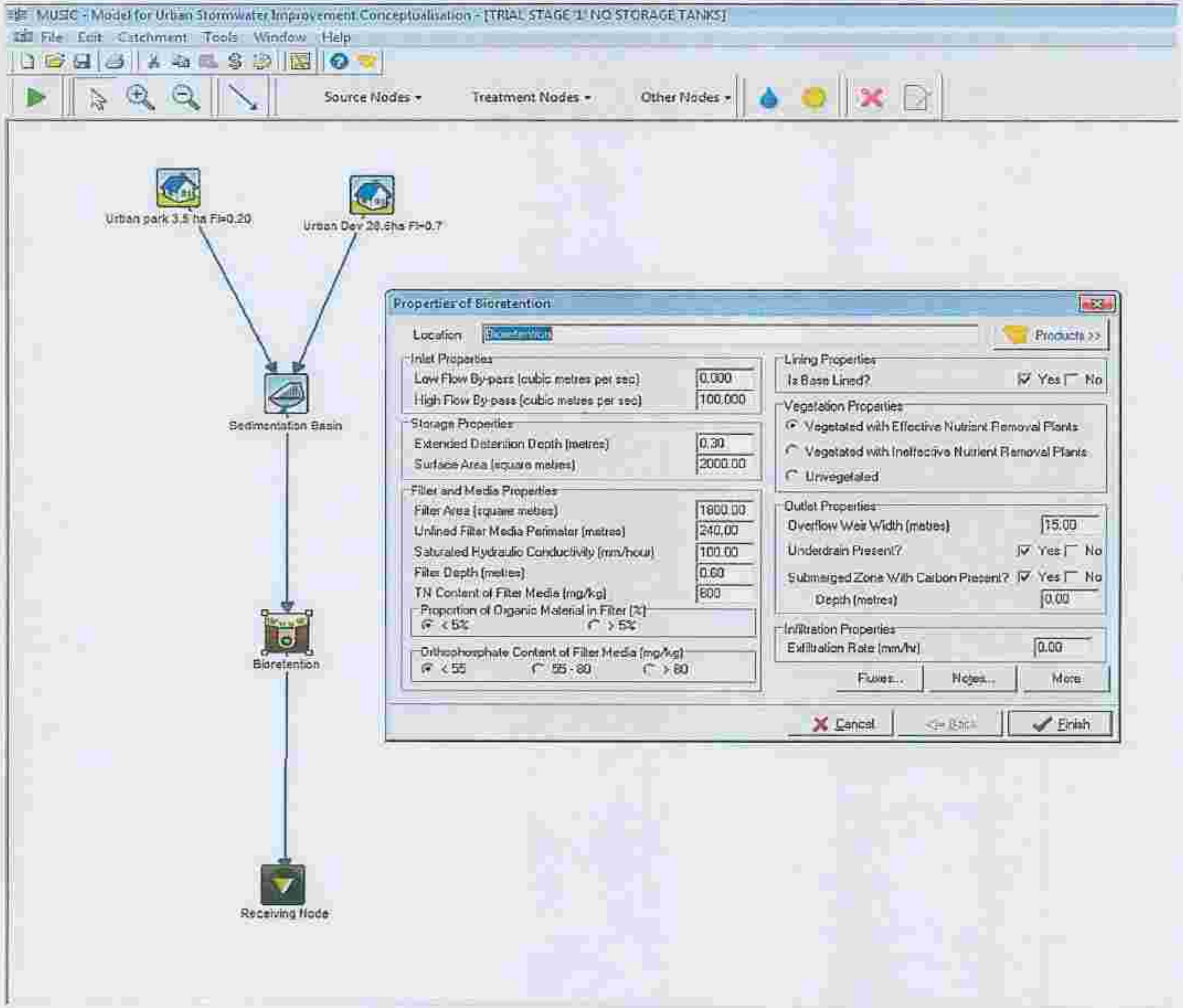
e-mail engineering@reedscon.com.au

ANNEXURE I

MUSIC Model Output Data


MUSIC - Model for Urban Stormwater Improvement Conceptualisation - [TRIAL STAGE '1' NO STORAGE TANKS]
File Edit Catchment Tools Window Help
Source Nodes
Treatment Nodes
Other Nodes
Urban park 3.5 ha FI=0.20
Urban Dev 28.6ha FI=0.7
Sedimentation Basin
Bioretention
Receiving Node
Treatment Train Effectiveness - Receiving Node
Sources
Residual Load
% Reduction
Flow (ML/yr) 66.5 61.7 7.2
Total Suspended Solids (kg/yr) 13.8E3 1.20E3 91.3
Total Phosphorus (kg/yr) 28.1 6.65 76.4
Total Nitrogen (kg/yr) 191 105 45.1
Gross Pollutants (kg/yr) 2.77E3 0.00 100.0


MUSIC - Model for Urban Stormwater Improvement Conceptualisation - [TRIAL STAGE '1' NO STORAGE TANKS]
MUSIC - Model for Urban Stormwater Improvement Conceptualisation - [TRIAL STAGE '1' NO STORAGE TANKS]
File Edit Catchment Tools Window Help
Source Nodes
Treatment Nodes
Other Nodes
Urban park 3.5 ha FI=0.20
Urban Dev 28.6ha FI=0.7
Sedimentation Basin
Bioretention
Receiving Node
Properties of Sedimentation Basin
Location
Inlet Properties
Low Flow By-pass (cubic metres per sec) 0.000
High Flow By-pass (cubic metres per sec) 1.800
Storage Properties
Surface Area (square metres) 1100.0
Extended Detention Depth (metres) 0.30
Permanent Pool Volume (cubic metres) 670.0
Exfiltration Rate (mm/hr) 0.00
Evaporative Loss as % of PET 75.00
Outlet Properties
Equivalent Pipe Diameter (mm) 100
Overflow Weir Width (metres) 30.0
Notional Detention Time (hrs) 7.18
Re-use...
Fluxes...
Notes...
More
Cancel
Back
Finish



MUSIC - Model for Urban Stormwater Improvement Conceptualisation - [TRIAL STAGE '1' NO STORAGE TANKS]
File Edit Catchment Tools Window Help
Source Nodes
Treatment Nodes
Other Nodes
Urban park 3.5 ha FI=0.20
Urban Dev 28.6ha FI=0.7
Sedimentation Basin
Bioretention
Receiving Node
Properties of Bioretention
Location
Bioretention
Products >>
Inlet Properties
Low Flow By-pass (cubic metres per sec) 0.000
High Flow By-pass (cubic metres per sec) 100.000
Storage Properties
Extended Detention Depth (metres) 0.30
Surface Area (square metres) 2000.00
Filter and Media Properties
Filter Area (square metres) 1800.00
Unlined Filter Media Perimeter (metres) 240.00
Saturated Hydraulic Conductivity (mm/hour) 100.00
Filter Depth (metres) 0.60
TN Content of Filter Media (mg/kg) 800
Proportion of Organic Material in Filter (%)
< 5%
> 5%
Orthophosphate Content of Filter Media (mg/kg)
< 55
55 - 80
> 80
Lining Properties
Is Base Lined? Yes No
Vegetation Properties
Vegetated with Effective Nutrient Removal Plants
Vegetated with Ineffective Nutrient Removal Plants
Unvegetated
Outlet Properties
Overflow Weir Width (metres) 15.00
Underdrain Present? Yes No
Submerged Zone With Carbon Present? Yes No
Depth (metres) 0.00
Infiltration Properties
Exfiltration Rate (mm/hr) 0.00
Fluxes...
Notes...
More
Cancel
Back
Finish

APPENDIX B – REEDS CONSULTING FUNCTIONAL BASIN PLAN AND OPINION OF PROBABLE COSTS.

RETARDING BASIN / BIORETENTION BASIN DATA

	NORMAL WATER LEVEL	EXTENDED DETENTION LEVEL	5YR FLOOD LEVEL	100YR FLOOD LEVEL
RETARDING BASIN	-	-	108.54	110.59
SEDIMENT POND	108.25	108.55	-	-
BIORETENTION BASIN	107.95	108.25	-	-

PRELIMINARY PLAN ONLY
NOT APPROVED FOR CONSTRUCTION

THIS DRAWING IS NOT TO BE COPIED OR SCALED

VERSION	REMARKS		
C	FUNCTIONAL LAYOUT UPDATE	19.06.15	SJ
B	FUNCTIONAL LAYOUT DESIGN	03.03.15	SJ
A	PRELIMINARY ISSUE	07.03.14	PC

DRAWN BY	P.CHINNOCK S.JELICIC	DESIGNED BY	M.McMAHON P.CHINNOCK S.JELICIC
MELWAY	-	CHECKED BY	
DATUM	AHD	AUTHORISED BY	R.BREWSTER

REEDS CONSULTING
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PLANNING
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p (03) 8660 3000

GREATER SHEPPARTON CITY COUNCIL
VERNEY ROAD, SHEPPARTON
STAGE 1
FUNCTIONAL LAYOUT RETARDING BASIN
PLAN VIEW

DRAWING No. 1Q1
VERSION C
REFERENCE 21656E
SHEET 1 OF 1

H:\21656\STAGE 1 - PRELIM GRADING & DRAINAGE\CAD\DWG SET\FUNCTIONAL\21656_1Q1C.DWG

SHEPARTON NEGC - STORAGE BASIN
SEDIMENT PONDS & TREATMENT SYSTEMS

JOB NO: 21656E
DATE: 20.07.2015
VER: C

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
1	**SITE ESTABLISHMENT**				
	Provision of all site amenities and site management as required under the Occupational Health and Safety Act - 2004 and as per Victorian Workcover Authority, the Principal's requirements and local authority requirements	1	Item	$25,000.00	$25,000.00
2.	**SITE & TRAFFIC MANAGEMENT PLAN**				
	Including documentation of all quality plan and procedures for QA, OH&S, Traffic & environmental measures and requirements relevant to this project including those of the Principal. Including supply & implementation of specific traffic / environmental measures/techniques required to minimise emission of dust, silt & polluted runoff from the site or related to the site	1	Item	$2,500.00	$2,500.00
3	**ENVIRONMENTAL MANAGEMENT PLAN**				
	Preparation of an approved EMP and all associated works for implementation, monitoring and maintenance.	1	Item	$25,000.00	$25,000.00
4	**EARTHWORKS**				
	Including removal and disposal, clearing and grubbing of all trees and vegetation, removal and disposal of all construction waste, rubbish and debris; desludging, desilting and pumping throughout the course of the contract; stripping, stockpiling, bulk earthworks, filling, shaping, formation of batters, final trimming, compaction (including testing to Level 1), disposal of all surplus, retopsoiling of all areas; provision of tree & grasslands protection.				
4.1	Clearing, stripping and all related preliminary earthworks as per description above (Approximate area 18,000 m2)	1	Item	$10,000.00	$10,000.00
4.2	**Retarding Basin to 150 mm below finished basin floor Level**				
4.2.1	Cut and disposal on site of spoil material.	62,000	m3	$12.50	$775,000.00
4.3	**Additional Earthworks to depth shown below finished surface level**				
	Sediment Pond				
4.3.1	Cut to 0.6m and on site disposal of all excessive material.	200	m3	$15.00	$3,000.00
4.3.2	Fill - 300mm Compacted depth clay liner to the base up to extended detention level. Fill material to be imported with suitable impervious qualities. Inclusive of all compaction and testing requirements.	100	m3	$9.50	$950.00
4.3.3	300 mm nom Rockwork in base of sediment pond to 300 mm above floor level	335	m2	$90.00	$30,150.00
4.4	**Additional Earthworks to depth shown below finished surface level**				
	Bioretention Basin				
4.4.1	Cut to 1.0m and on site disposal of all excessive material.	1,840	m3	$12.50	$23,000.00
4.5	**Additional Earthworks for Swale**				
	to 150 mm below finished surface Level				
4.5.1	Cut and on site disposal of all excessive material.	150	m3	$15.00	$2,250.00
4.5.2	300 mm nom Rockwork	640	m2	$90.00	$57,600.00
4.5.3	Final trimming, Shaping, and Clean Up.	1	Item	$10,000.00	$10,000.00
4.6	**Additional Earthworks pump well**				
4.6.1	Cut and off site disposal of all excessive material.	25	m3	$500.00	$12,500.00
4.6.2	Final trimming, Shaping, and Clean Up.	1	Item	$5,000.00	$5,000.00
4.7	**Additional Earthworks for spillway**				
	to 300 mm below finished surface Level				
4.7.1	Cut and on site disposal of all excessive material.	40	m3	$15.00	$600.00
4.7.2	150 mm nom Rockwork	55	m2	$45.00	$2,475.00
4.7.2.1	Extra Over for grouting between rocks.	55	m2	$39.10	$2,150.50
4.7.3	Final trimming, Shaping, and Clean Up.	1	Item	$2,500.00	$2,500.00
4.8	Retopsoiling of retarding basin, wetland, channel and to all disturbed areas within the Reserve area with 150mm of quality site topsoil Approx Area 18,000m2	18,000	m2	$1.00	$18,000.00
4.9	Hydroseeding of drainage reserve Approx Area 18,000m2	18,000	m2	$1.00	$18,000.00

ITEM	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
5	**DRAINAGE WORKS**				
	Including supply of all materials and incidentals, labour, equipment, machinery, and hire and diversions, preparation, installation, backfill, testing, etc.				
5.1	Class 2 R.C. RRJ Drainage Pipe with selected backfill.				
5.1.1	Twin 1050mm Diameter	60	L.m.	$1,550.00	$93,000.00
5.1.2	1050mm Diameter	16	L.m.	$800.00	$12,800.00
5.1.3	Twin 825mm Diameter	13	L.m.	$1,080.00	$14,040.00
5.1.4	525mm Diameter	171	L.m.	$300.00	$51,300.00
5.1.5	300mm Diameter (av. Depth 3m)	70	L.m.	$220.00	$15,400.00
5.2	Slotted uPVC - Including all Fittings for Bioretention basin				
5.2.1	100mm Diameter	600	L.m.	$28.00	$16,800.00
5.3	Un-Slotted uPVC - Including all uPVC fittings and riser pipes for Bioretention basin				
5.3.1	100mm Diameter	25	L.m.	$40.00	$1,000.00
5.3.2	150mm Diameter	25	L.m.	$72.00	$1,800.00
5.3.3	225mm Diameter	50	L.m.	$85.10	$4,255.00
5.4	Concrete structures/pits, as per MW Standards				
5.4.1	900mm x 600mm - Junction pit with HD grate	1	No.	$4,284.90	$4,284.90
5.4.2	900mm x 750mm - Junction Pit, with HD cover	3	No.	$2,451.30	$7,353.90
5.4.3	Bioretention outlet pit	1	No.	$3,381.90	$3,381.90
5.4.4	Small diversion structure as detailed plans.	1	No.	$8,000.00	$8,000.00
5.4.5	Big diversion structure as detailed plans.	1	No.	$22,000.00	$22,000.00
5.5	Rockwall endwall as detailed:				
5.5.1	To suit 525mm diameter pipe	4	No.	$3,000.00	$12,000.00
5.5.2	To suit 525mm diameter pipe including pipe grille	1	No.	$5,125.00	$5,125.00
5.5.3	To suit 1050mm diameter pipe	1	No.	$5,250.00	$5,250.00
5.5.4	To suit 1050mm diameter pipe including pipe grille	1	No.	$8,250.00	$8,250.00
5.5.5	To suit twin 825mm diameter pipes including pipe grilles	1	No.	$14,250.00	$14,250.00
5.6	**Bioretention Basin Works**				
5.6.1	Fill with approved filter material as detailed (approx area 1,840 m2) :				
5.6.1.1	450mm Depth Submerged Zone - Gravel and Carbon Source	830	m3	$45.00	$37,350.00
5.6.1.2	100mm Depth Transition Layer Coarse Sand	185	m3	$56.40	$10,434.00
5.6.1.3	500mm Depth Unsaturated Zone - Filter Media	920	m3	$44.50	$40,940.00
5.6.2	Inspection opening surrounds to suit 100mm riser	2	No.	$197.70	$395.40
5.6.3	Inspection opening surrounds to suit 150mm riser	2	No.	$300.00	$600.00
5.6.4	Inspection opening surrounds to suit 225mm riser	2	No.	$476.20	$952.40
5.6.5	Approved Geofabric waterproof liner	1,840	m2	$20.30	$37,352.00
5.7	**Pumping station Works**				
5.7.1	Aquatec SW packaged pump station	1	No.	$138,000.00	$138,000.00
5.7.2	DN PE 90 rising main	1,070	Lm	$60.00	$64,200.00
5.7.3	Pressure testing for PE main	1	Item	$1,000.00	$1,000.00
5.7.4	Construct concrete plinth for switchboard	1	Item	$1,500.00	$1,500.00
5.7.5	Bollards around pumping station	40	No.	$30.00	$1,200.00
5.7.6	Water tap and 20mm connection to water main for pump weell	1	Item	$2,000.00	$2,000.00
5.7.7	Connect rising main to GMW Drain with outlet structure and beaching	1	Item	$5,000.00	$5,000.00
5.7.8	Flow control and cabling	1,070	Lm	$28.00	$29,960.00
6	**MISCELLANEOUS**				
6.1	Supply & placement of rockwork using on site or imported material				
6.1.1	300mm nom. rock lining of drainage outlet areas (Approx 92 m2)	28	m2	$90.00	$2,520.00
6.1.2	Extra Over for grouting between rocks.	28	m2	$39.10	$1,094.80
6.2	Maintenance Access Tracks - 200mm depth concrete with SL 82 reinforcement, on 50mm consolidated depth CL 3, bedding	220	m2	$60.70	$13,354.00
6.3	Concrete footpaths - 1.5m wide, 75mm depth 25Mpa concrete, broom finish on 75mm Class 3 FCR	1,050	m2	$75.00	$78,750.00
6.4	Asset recording of 'as built' all works including RB & other bodies, pipes and pits	1	item.	$10,000.00	$10,000.00
	TOTAL ITEMS 1-6				**$1,802,568.80**

APPENDIX C – SPIIRE'S REVISED DRAINAGE CATCHMENT PLAN

DRG NO.	REV	DATE	DES/DOC	AUTH
305578LC100	A	02/07/2018	PB	JE

spiire

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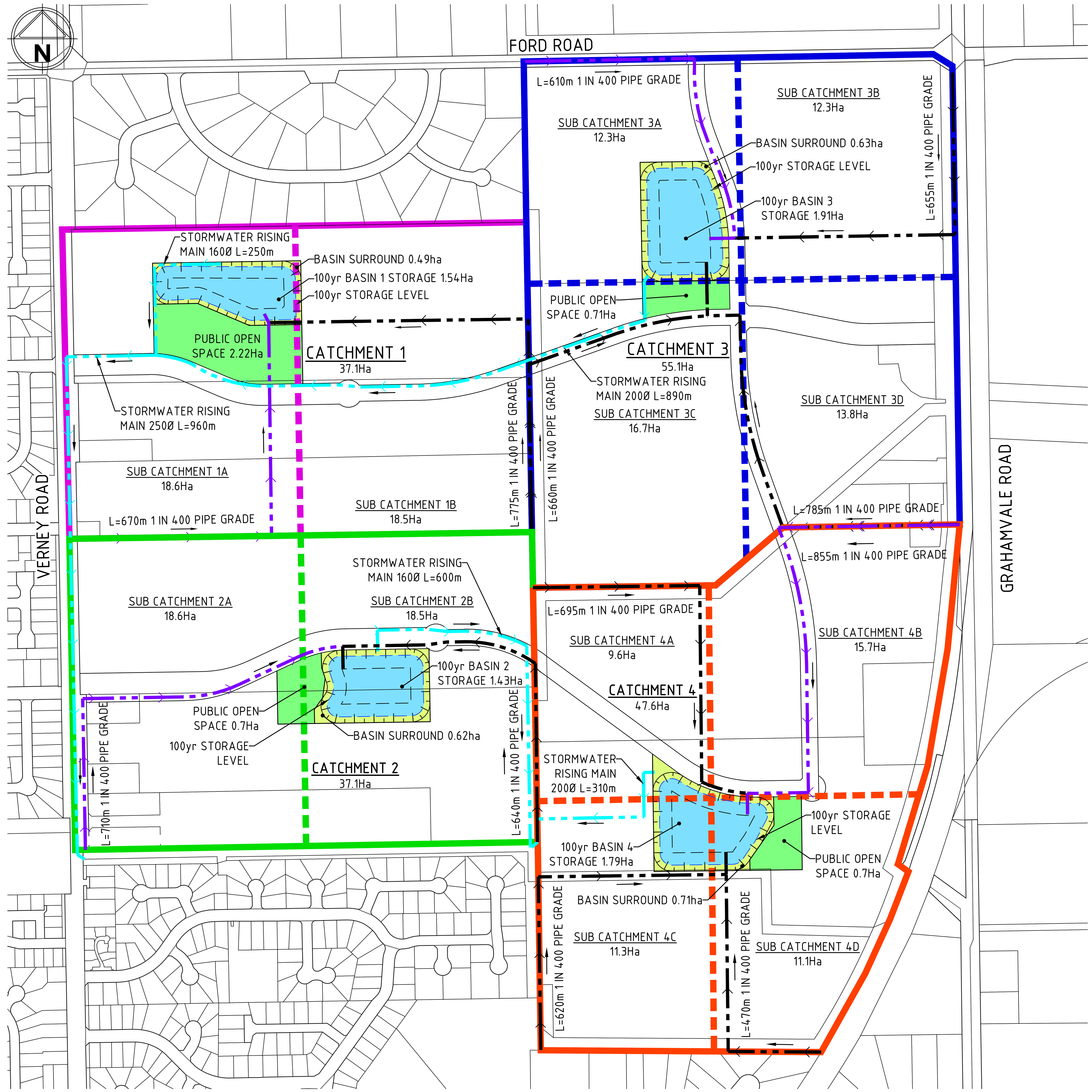
APPENDIX D – SPIIRE'S DETAILED DRAINAGE PLAN AND OPEN SPACE AREAS



LEGEND

- DRAINAGE BASIN 100YR STORAGE
- DRAINAGE OPEN SPACE RESERVE
- PUBLIC OPEN SPACE
- CATCHMENT 1 & SUB CATCHMENTS
- CATCHMENT 2 & SUB CATCHMENTS
- CATCHMENT 3 & SUB CATCHMENTS
- CATCHMENT 4 & SUB CATCHMENTS
- PIPE CONTROL
- PIPE CONTROL (CONTROLLING LINE)
- STORMWATER RISING MAIN

CATCHMENT DETAILS

CATCHMENT NO.	AREA (ha)	C OF R	100YR VOL (m³)
1	37.1	0.73	31,276
2	37.1	0.73	31,276
3	55.1	0.73	46,450
4	47.6	0.73	40,128

BASIN CONTROL DETAILS

CATCHMENT NO.	APPROXMATE CONTROL PIPE LENGTH (m)	PIPE GRADE	INITIAL PIPE COVER (m)	APPROXIMATE OUTFALL PIPE DIAMETER (m)	APPROXIMATE DEPTH OF BASIN (m)
1A	670	1 / 400	1.1	1.350	4.5
1B	775	1 / 400	1.1	1.350	
2A	710	1 / 400	1.1	1.350	4.4
2B	640	1 / 400	1.1	1.350	
3A	610	1 / 400	1.1	1.200	4.4
3B	655	1 / 400	1.1	1.200	
3C	660	1 / 400	1.1	1.200	
3D	785	1 / 400	1.1	1.200	
4A	695	1 / 400	1.1	1.050	4.3
4B	855	1 / 400	1.1	1.200	
4C	620	1 / 400	1.1	1.050	
4D	470	1 / 400	1.1	1.200	

file name 305578CD200.dwg layout name CD200 plotted by Anthony Scott
file location G:\30\305578\Civil\ACAD plot date 05/07/2018 4:28 PM Sheet of Sheets

Rev	Amendments	Approved	Date

H 1 : 4000 0 40 80 120 160 200
SCALE @ A1
V 1 : 4000 0 40 80 120 160 200

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144 Welsford Street Shepparton
Victoria 3630 Australia T 61 3 5840 1000
spiire.com.au ABN 55 050 029 635

Designed Checked
Authorised Date

NORTH EAST GROWTH CORRIDOR SHEPPARTON
FUNCTIONAL LAYOUT
CATCHMENT PLAN
CITY OF GREATER SHEPPARTON
GREATER SHEPPARTON CITY COUNCIL

PRELIMINARY Drg No 305578CD200 Rev ----

APPENDIX E– GEOTECHNICAL TESTING SERVICES, GEOTECHNICAL REPORT

ENGINEERING BOREHOLE LOG

GTS GEOTECHNICAL TESTING SERVICES

PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

Borehole no. 1
Sheet no. 1 of 1
Job no. 18C 0523

Client :	Greater Shepparton City Council	Date:	27/06/2018
Project :	North East Growth Corridor	Logged by:	BB
Location :	Shepparton		
Drill model :	Gemco HS7	Slope 90 deg	RL surface: *Not measured*
Hole diameter :	100mm	Bearing - deg	Datum :

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
Sandy Clayey SILT (ML), dark brown, low plasticity fines, fine to medium sand 100mm				M	MD				
Silty CLAY (CH), high plasticity, red/ brown 700mm				M	VSt				
Sandy Silty CLAY (CI), medium plasticity, orange/brown, fine to medium sand 2100mm	1.00			M	St		Sample 0.7-2.1m		
	2.00								
Silty CLAY (CH), high plasticity, brown, some fine sand 4000mm				M	VSt		Sample 2.1-3.0m		
	3.00								
	4.00								
Gravelly Clayey SAND (SW), fine to coarse, orange/brown, low plasticity fines, fine to medium gravels 5200mm				M	MD		Sample 4.0-4.5m		
	5.00								
Silty CLAY (CI), medium plasticity, grey 6000mm				M-W	F		Sample 5.2-6.0m		
	6.00								
BH1 terminated at 6.0m									
	7.00								
	8.00								

ENGINEERING BOREHOLE LOG

GTS GEOTECHNICAL TESTING SERVICES

PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

Borehole no. 2
Sheet no. 1 of 1
Job no. 18C 0523

Client :	Greater Shepparton City Council	Date:	27/06/2018
Project :	North East Growth Corridor	Logged by:	BB
Location :	Shepparton		
Drill model :	Gemco HS7	Slope 90 deg	RL surface: *Not measured*
Hole diameter :	100mm	Bearing - deg	Datum :

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
Clayey SILT (ML), dark brown, low plasticity fines 100mm				M	MD				
Silty CLAY (CH), high plasticity, red/brown 700mm				M	VSt				
Sandy Silty CLAY (CI), medium plasticity, pale brown/orange, fine to medium sand 2000mm	1.00			M	St		Sample 1.0-2.0m		
Silty CLAY (CH), high plasticity, brown, trace fine sand 5200mm	2.00 3.00 4.00 5.00			M	VSt		Sample 3.0-4.5m		
Silty CLAY (CI), medium plasticity, pale brown 6000mm	6.00			M	St		Sample 5.2-6.0m		
BH2 terminated at 6.0m	7.00 8.00								

ENGINEERING BOREHOLE LOG

GTS GEOTECHNICAL TESTING SERVICES

PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

Borehole no. 3
Sheet no. 1 of 1
Job no. 18C 0523

Client :	Greater Shepparton City Council	Date:	27/06/2018
Project :	North East Growth Corridor	Logged by:	BB
Location :	Shepparton		
Drill model :	Gemco HS7	Slope 90 deg	RL surface: *Not measured*
Hole diameter :	100mm	Bearing - deg	Datum :

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
Sandy Silty CLAY (CL), low plasticity, pale brown/yellow, fine to medium sand 400mm				M	F				
Silty CLAY (CH), high plasticity, red/brown 2600mm	1.00, 2.00			M	VSt		Sample 0.5-1.5m		
Sandy CLAY (CI), medium plasticity, orange/brown, fine to medium sand 3200mm	3.00			M	St				
Silty CLAY (CH), high plasticity, brown 5100mm	4.00, 5.00			M	VSt		Sample 3.5-4.5m		
Sandy Silty CLAY (CI), medium plasticity, pale brown/orange, fine to medium sand 6000mm	6.00			M	St		Sample 5.1-6.0m		
BH3 terminated at 6.0m	7.00, 8.00								

ENGINEERING BOREHOLE LOG

GTS GEOTECHNICAL TESTING SERVICES
PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

Borehole no. 4
Sheet no. 1 of 1
Job no. 18C 0523

Client :	Greater Shepparton City Council	Date:	27/06/2018
Project :	North East Growth Corridor	Logged by:	BB
Location :	Shepparton		
Drill model :	Gemco HS7	Slope 90 deg	RL surface: *Not measured*
Hole diameter :	100mm	Bearing - deg	Datum :

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
Sandy Clayey SILT (ML), dark brown, low plasticity fines, fine to medium sand				M	MD				
Silty CLAY (CH), high plasticity, red/brown 600mm				M	VSt				
				D	St	Dry from 0.6-0.8m			
Sandy Silty CLAY (CI), medium plasticity, orange/brown, fine to medium sand	1.00			M	St		Sample 0.8-1.5m		
2000mm	2.00								
Sandy Silty CLAY (CI), medium plasticity, brown, fine to coarse sand, trace fine gravel				M	VSt		Sample 2.0-3.0m		
	3.00								
3300mm									
Silty CLAY (CH), high plasticity, mottled grey/orange	4.00			M	VSt		Sample 3.5-4.5m		
5000mm	5.00								
Silty CLAY (CH), high plasticity, brown				M	VSt		Sample 5.0-6.0m		
6000mm	6.00								
BH4 terminated at 6.0m									
	7.00								
	8.00								

ENGINEERING BOREHOLE LOG

GTS
GEOTECHNICAL TESTING SERVICES

PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

Borehole no. 5
Sheet no. 1 of 1
Job no. 18C 0523

Client :	Greater Shepparton City Council	Date:	26/06/2018
Project :	North East Growth Corridor	Logged by:	BB
Location :	Shepparton		
Drill model :	Gemco HS7 — Slope 90 deg	RL surface:	*Not measured*
Hole diameter :	100mm — Bearing - deg	Datum :	

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
Clayey Sandy SILT (ML), brown, low plasticity fines, fine sand 300mm				M	MD				
Silty CLAY (CH), high plasticity, red/brown 800mm				M	VSt				
Sandy CLAY (CH), high plasticity, orange/ brown, fine to medium sand 1500mm	1.00			M	VSt		Sample 0.5-1.2m		
Silty CLAY (CI), medium plasticity, mottled brown/grey, some fine sand 3500mm	2.00 3.00			M	St		Sample 2.0-3.0m		
Silty CLAY (CH), high plasticity, dark brown 5000mm	4.00 5.00			M	VSt		Sample 3.5-4.5m		
Silt CLAY (CI), meidum plasticity, dark brown/ brown, some fine to medium sand 6000mm	6.00			M	St		Sample 5.0-6.0m		
BH5 terminated at 6.0m	7.00 8.00								

ENGINEERING BOREHOLE LOG

GEOTECHNICAL TESTING SERVICES

PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

Borehole no. 6

Job no. 18C 0523

Client :	Greater Shepparton City Council	Date:	26/06/2018
Project :	North East Growth Corridor	Logged by:	BB
Location :	Shepparton		
Drill model :	Gemco HS7 Slope 90 deg	RL surface:	*Not measured*
Hole diameter :	100mm Bearing - deg	Datum :	

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
SAND (SP), fine, orange 300mm				M	L				
Sandy CLAY (CL), low plasticity, orange, fine sand 700mm				M	St				
Silty CLAY (CH), high plasticity, brown 1200mm	1.00			M	VSt				
Silty CLAY (CI), medium plasticity, mottled grey/orange, trace fine sand	2.00, 3.00			M	St		Sample 1.0-1.5m		
3800mm									
Silty CLAY (CH), high plasticity, brown	4.00, 5.00			M	VSt		Sample 3.5-4.5m		
5200mm									
Sandy Silty CLAY (CH), high plasticity, dark brown, fine to medium sand 6000mm	6.00			M	VSt		Sample 4.5-6.0m		
BH6 terminated at 6.0m	7.00, 8.00								

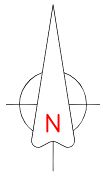
PO Box 13, Strathdale 3550
Ph (03) 54414881 Fax (03) 5441 5089

ENGINEERING BOREHOLE LOG

Borehole no. 7
Sheet no. 1 of 1
Job no. 18C 0523

Client :	Greater Shepparton City Council	Date:	26/06/2018
Project :	North East Growth Corridor	Logged by:	BB
Location :	Shepparton		
Drill model :	Gemco HS7	Slope 90 deg	RL surface: *Not measured*
Hole diameter :	100mm	Bearing - deg	Datum :

Material Description	Depth (m)	Graphic log	Water	Moisture condition	Consistency density, index	Structure, additional observations	Notes Samples Tests	Method	Support
Sandy CLAY (CL), low plasticity, mottled brown/orange, fine to medium sand				M	F				
Silty CLAY (CH), high plasticity, red/brown 800mm				M	VSt				
Sandy CLAY (CI), medium plasticity, orange/ brown, fine sand	1.00			M	St		Sample 0.8-2.0m		
	2.00								
3600mm	3.00								
Clayey SAND (SW), fine to medium, orange/ brown, medium plasticity fines 4800mm	4.00			M	MD		Sample 3.6-4.8m		
Sandy Silty CLAY (CI), medium plasticity, dark brown, fine to medium sand 6000mm	5.00			M	St		Sample 4.8-6.0m		
	6.00								
BH7 terminated at 6.0m	7.00								
	8.00								



GEOTECHNICAL INVESTIGATION	**CLIENT:** GREATER SHEPPARTON CITY COUNCIL **PROJECT:** NORTH EAST GROWTH CORRIDOR SHEPPARTON	
APPROXIMATE LOCATIONS NOT TO SCALE	GTS REF: 18C 0523	DATE: 29 JUNE 2018

GEOTECHNICAL INVESTIGATION	CLIENT: GREATER SHEPPARTON CITY COUNCIL PROJECT: NORTH EAST GROWTH CORRIDOR SHEPPARTON	
APPROXIMATE LOCATIONS NOT TO SCALE	GTS REF: 18C 0523	DATE: 29 JUNE 2018

APPENDIX F – CATCHMENT STORAGE CALCULATIONS

spiire

NEGC Catchment 1 - 100yr Storage Estimation

Project No.:	305578
Project:	NEGC
Designed:	A. Scott
Date:	20/06/2018

Calculation in accordance with Swinburne Institute of Technology 1987

Onsite storage calculation

Input data from calcs/external source
Calculated data

ARI	a	b	c	d	e	f	g
100	3.815643	-6.68E-01	-3.94E-02	8.35E-03	1.09E-03	-1.88E-04	-4.00E-05
Ref:	*Shepp IFD Data*						

Qa Peak inflow for design storm. (L/s) (Calculated for a given td)
Qp1 Peak permitted controlled outflow to drainage system (m3/s)
Qp2 Outflow to main drain at commencement of above ground storage or the capacity of the outfall drain running full. (m3/s)
Where Qp2 = 0.8 Qp1 approx
ts Site time of concentration usually 6 mins (mins)
td Duration of critical storm (mins)
Vs Volume of on site storage needed (cubic metres)
A Area of catchment (ha)
c10 Coefficient of runoff (for 10 year ARI)
I Intensity (design year ARI corresponding to td)

MAX 31276.1

I_{ARI}	c100	A	Ae	Qa	Qp1	Qp2	ts	td	Vs	Check
160.965	0.73	37.1	27.083	12.110	0.000	0.000	6.00	6.00	4359.4	
78.715	0.73	37.1	27.083	5.922	0.000	0.000	6.00	25.00	8882.6	More Storage
51.222	0.73	37.1	27.083	3.853	0.000	0.000	6.00	50.00	11560.3	More Storage
31.979	0.73	37.1	27.083	2.406	0.000	0.000	6.00	100.00	14434.7	More Storage
19.493	0.73	37.1	27.083	1.466	0.000	0.000	6.00	200.00	17597.2	More Storage
14.545	0.73	37.1	27.083	1.094	0.000	0.000	6.00	300.00	19696.0	More Storage
11.828	0.73	37.1	27.083	0.890	0.000	0.000	6.00	400.00	21356.5	More Storage
10.088	0.73	37.1	27.083	0.759	0.000	0.000	6.00	500.00	22768.0	More Storage
8.867	0.73	37.1	27.083	0.667	0.000	0.000	6.00	600.00	24013.4	More Storage
7.955	0.73	37.1	27.083	0.598	0.000	0.000	6.00	700.00	25136.5	More Storage
7.245	0.73	37.1	27.083	0.545	0.000	0.000	6.00	800.00	26163.8	More Storage
6.674	0.73	37.1	27.083	0.502	0.000	0.000	6.00	900.00	27112.7	More Storage
6.202	0.73	37.1	27.083	0.467	0.000	0.000	6.00	1000.00	27995.2	More Storage
5.804	0.73	37.1	27.083	0.437	0.000	0.000	6.00	1100.00	28820.3	More Storage
5.464	0.73	37.1	27.083	0.411	0.000	0.000	6.00	1200.00	29594.7	More Storage
5.168	0.73	37.1	27.083	0.389	0.000	0.000	6.00	1300.00	30323.7	More Storage
4.907	0.73	37.1	27.083	0.369	0.000	0.000	6.00	1400.00	31011.7	More Storage
4.812	0.73	37.1	27.083	0.362	0.000	0.000	6.00	1440.00	31276.1	More Storage

NEGC Catchment 2 - 100yr Storage Estimation

Project No.:	305578
Project:	NEGC
Designed:	A. Scott
Date:	20/06/2018

Calculation in accordance with Swinburne Institute of Technology 1987

Onsite storage calculation

Input data from calcs/external source
Calculated data

ARI	a	b	c	d	e	f	g
100	3.815643	-6.68E-01	-3.94E-02	8.35E-03	1.09E-03	-1.88E-04	-4.00E-05
Ref:	*Shepp IFD Data*						

Qa	Peak inflow for design storm. (L/s) (Calculated for a given td)
Qp1	Peak permitted controlled outflow to drainage system (m3/s)
Qp2	Outflow to main drain at commencement of above ground storage or the capacity of the outfall drain running full. (m3/s) Where Qp2 = 0.8 Qp1 approx
ts	Site time of concentration usually 6 mins (mins)
td	Duration of critical storm (mins)
Vs	Volume of on site storage needed (cubic metres)
A	Area of catchment (ha)
c10	Coefficient of runoff (for 10 year ARI)
I	Intensity (design year ARI corresponding to td)

MAX 31276.1

I_{ARI}	c100	A	Ae	Qa	Qp1	Qp2	ts	td	Vs	Check
160.965	0.73	37.1	27.083	12.110	0.000	0.000	6.00	6.00	4359.4	
78.715	0.73	37.1	27.083	5.922	0.000	0.000	6.00	25.00	8882.6	More Storage
51.222	0.73	37.1	27.083	3.853	0.000	0.000	6.00	50.00	11560.3	More Storage
31.979	0.73	37.1	27.083	2.406	0.000	0.000	6.00	100.00	14434.7	More Storage
19.493	0.73	37.1	27.083	1.466	0.000	0.000	6.00	200.00	17597.2	More Storage
14.545	0.73	37.1	27.083	1.094	0.000	0.000	6.00	300.00	19696.0	More Storage
11.828	0.73	37.1	27.083	0.890	0.000	0.000	6.00	400.00	21356.5	More Storage
10.088	0.73	37.1	27.083	0.759	0.000	0.000	6.00	500.00	22768.0	More Storage
8.867	0.73	37.1	27.083	0.667	0.000	0.000	6.00	600.00	24013.4	More Storage
7.955	0.73	37.1	27.083	0.598	0.000	0.000	6.00	700.00	25136.5	More Storage
7.245	0.73	37.1	27.083	0.545	0.000	0.000	6.00	800.00	26163.8	More Storage
6.674	0.73	37.1	27.083	0.502	0.000	0.000	6.00	900.00	27112.7	More Storage
6.202	0.73	37.1	27.083	0.467	0.000	0.000	6.00	1000.00	27995.2	More Storage
5.804	0.73	37.1	27.083	0.437	0.000	0.000	6.00	1100.00	28820.3	More Storage
5.464	0.73	37.1	27.083	0.411	0.000	0.000	6.00	1200.00	29594.7	More Storage
5.168	0.73	37.1	27.083	0.389	0.000	0.000	6.00	1300.00	30323.7	More Storage
4.907	0.73	37.1	27.083	0.369	0.000	0.000	6.00	1400.00	31011.7	More Storage
4.812	0.73	37.1	27.083	0.362	0.000	0.000	6.00	1440.00	31276.1	More Storage

NEGC Catchment 3 - 100yr Storage Estimation

Calculation in accordance with Swinburne Institute of Technology 1987

Project No.:	305578
Project:	NEGC
Designed:	A. Scott
Date:	22/06/2018

Onsite storage calculation

Input data from calcs/external source
Calculated data

ARI	a	b	c	d	e	f	g
100	3.815643	-6.68E-01	-3.94E-02	8.35E-03	1.09E-03	-1.88E-04	-4.00E-05

Ref: *Shepp IFD Data*

Qa Peak inflow for design storm. (L/s) (Calculated for a given td)
Qp1 Peak permitted controlled outflow to drainage system (m3/s)
Qp2 Outflow to main drain at commencement of above ground storage or the capacity of the outfall drain running full. (m3/s)
Where Qp2 = 0.8 Qp1 approx
ts Site time of concentration usually 6 mins (mins)
td Duration of critical storm (mins)
Vs Volume of on site storage needed (cubic metres)
A Area of catchment (ha)
c10 Coefficient of runoff (for 10 year ARI)
I Intensity (design year ARI corresponding to td)

MAX 46450.5

I_{ARI}	c100	A	Ae	Qa	Qp1	Qp2	ts	td	Vs	Check
160.965	0.73	55.1	40.223	17.985	0.000	0.000	6.00	6.00	6474.5	
78.715	0.73	55.1	40.223	8.795	0.000	0.000	6.00	25.00	13192.3	More Storage
51.222	0.73	55.1	40.223	5.723	0.000	0.000	6.00	50.00	17169.1	More Storage
31.979	0.73	55.1	40.223	3.573	0.000	0.000	6.00	100.00	21438.1	More Storage
19.493	0.73	55.1	40.223	2.178	0.000	0.000	6.00	200.00	26135.0	More Storage
14.545	0.73	55.1	40.223	1.625	0.000	0.000	6.00	300.00	29252.0	More Storage
11.828	0.73	55.1	40.223	1.322	0.000	0.000	6.00	400.00	31718.2	More Storage
10.088	0.73	55.1	40.223	1.127	0.000	0.000	6.00	500.00	33814.5	More Storage
8.867	0.73	55.1	40.223	0.991	0.000	0.000	6.00	600.00	35664.1	More Storage
7.955	0.73	55.1	40.223	0.889	0.000	0.000	6.00	700.00	37332.1	More Storage
7.245	0.73	55.1	40.223	0.810	0.000	0.000	6.00	800.00	38857.8	More Storage
6.674	0.73	55.1	40.223	0.746	0.000	0.000	6.00	900.00	40267.1	More Storage
6.202	0.73	55.1	40.223	0.693	0.000	0.000	6.00	1000.00	41577.8	More Storage
5.804	0.73	55.1	40.223	0.649	0.000	0.000	6.00	1100.00	42803.2	More Storage
5.464	0.73	55.1	40.223	0.610	0.000	0.000	6.00	1200.00	43953.4	More Storage
5.168	0.73	55.1	40.223	0.577	0.000	0.000	6.00	1300.00	45036.1	More Storage
4.907	0.73	55.1	40.223	0.548	0.000	0.000	6.00	1400.00	46057.7	More Storage
4.812	0.73	55.1	40.223	0.538	0.000	0.000	6.00	1440.00	46450.5	More Storage

NEGC Catchment 4 - 100yr Storage Estimation

Calculation in accordance with Swinburne Institute of Technology 1987

Project No.:	305578
Project:	NEGC
Designed:	A. Scott
Date:	20/06/2018

Onsite storage calculation

Input data from calcs/external source
Calculated data

ARI	a	b	c	d	e	f	g
100	3.815643	-6.68E-01	-3.94E-02	8.35E-03	1.09E-03	-1.88E-04	-4.00E-05

Ref: *Shepp IFD Data*

Qa Peak inflow for design storm. (L/s) (Calculated for a given td)
Qp1 Peak permitted controlled outflow to drainage system (m3/s)
Qp2 Outflow to main drain at commencement of above ground storage or the capacity of the outfall drain running full. (m3/s)
Where Qp2 = 0.8 Qp1 approx
ts Site time of concentration usually 6 mins (mins)
td Duration of critical storm (mins)
Vs Volume of on site storage needed (cubic metres)
A Area of catchment (ha)
c10 Coefficient of runoff (for 10 year ARI)
I Intensity (design year ARI corresponding to td)

MAX 40127.9

I_{ARI}	c100	A	Ae	Qa	Qp1	Qp2	ts	td	Vs	Check
160.965	0.73	47.6	34.748	15.537	0.000	0.000	6.00	6.00	5593.2	
78.715	0.73	47.6	34.748	7.598	0.000	0.000	6.00	25.00	11396.6	More Storage
51.222	0.73	47.6	34.748	4.944	0.000	0.000	6.00	50.00	14832.1	More Storage
31.979	0.73	47.6	34.748	3.087	0.000	0.000	6.00	100.00	18520.0	More Storage
19.493	0.73	47.6	34.748	1.881	0.000	0.000	6.00	200.00	22577.6	More Storage
14.545	0.73	47.6	34.748	1.404	0.000	0.000	6.00	300.00	25270.4	More Storage
11.828	0.73	47.6	34.748	1.142	0.000	0.000	6.00	400.00	27400.8	More Storage
10.088	0.73	47.6	34.748	0.974	0.000	0.000	6.00	500.00	29211.8	More Storage
8.867	0.73	47.6	34.748	0.856	0.000	0.000	6.00	600.00	30809.6	More Storage
7.955	0.73	47.6	34.748	0.768	0.000	0.000	6.00	700.00	32250.6	More Storage
7.245	0.73	47.6	34.748	0.699	0.000	0.000	6.00	800.00	33568.6	More Storage
6.674	0.73	47.6	34.748	0.644	0.000	0.000	6.00	900.00	34786.1	More Storage
6.202	0.73	47.6	34.748	0.599	0.000	0.000	6.00	1000.00	35918.4	More Storage
5.804	0.73	47.6	34.748	0.560	0.000	0.000	6.00	1100.00	36977.0	More Storage
5.464	0.73	47.6	34.748	0.527	0.000	0.000	6.00	1200.00	37970.6	More Storage
5.168	0.73	47.6	34.748	0.499	0.000	0.000	6.00	1300.00	38905.9	More Storage
4.907	0.73	47.6	34.748	0.474	0.000	0.000	6.00	1400.00	39788.5	More Storage
4.812	0.73	47.6	34.748	0.464	0.000	0.000	6.00	1440.00	40127.9	More Storage

APPENDIX G – SUB-CATCHMENT PIPE CALCULATIONS

North East Growth Corridor
Inlet Pipe Calculations
Rev 1.0

1A

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
18.6	0.73	13.578	17	51.89781	5	1957.41	391.48		1350	0.013	400	2667.35	1.86	0.73

1B

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
18.5	0.73	13.505	19	49.36418	5	1851.84	370.37		1350	0.013	400	2667.35	1.86	0.69

2A

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
18.6	0.73	13.578	18	50.89523	5	1919.60	383.92		1350	0.013	400	2667.35	1.86	0.72

2B

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
18.5	0.73	13.505	17	52.68282	5	1976.34	395.27		1350	0.013	400	2667.35	1.86	0.74

3A

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
12.3	0.73	8.979	16	53.49824	5	1334.34	266.87		1200	0.013	400	1948.38	1.72	0.68

3B

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
12.3	0.73	8.979	17	52.28663	5	1304.12	260.82		1200	0.013	400	1948.38	1.72	0.67

3C

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
16.7	0.73	12.191	17	52.15621	5	1766.21	353.24		1200	0.013	400	1948.38	1.72	0.91

3D

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
13.8	0.73	10.074	19	49.13864	5	1375.06	275.01		1200	0.013	400	1948.38	1.72	0.71

4A

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
9.6	0.73	7.008	18	51.26551	5	997.97	199.59		1050	0.013	400	1364.67	1.58	0.73

4B

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
15.7	0.73	11.461	20	47.62794	5	1516.29	303.26		1200	0.013	400	1948.38	1.72	0.78

4C

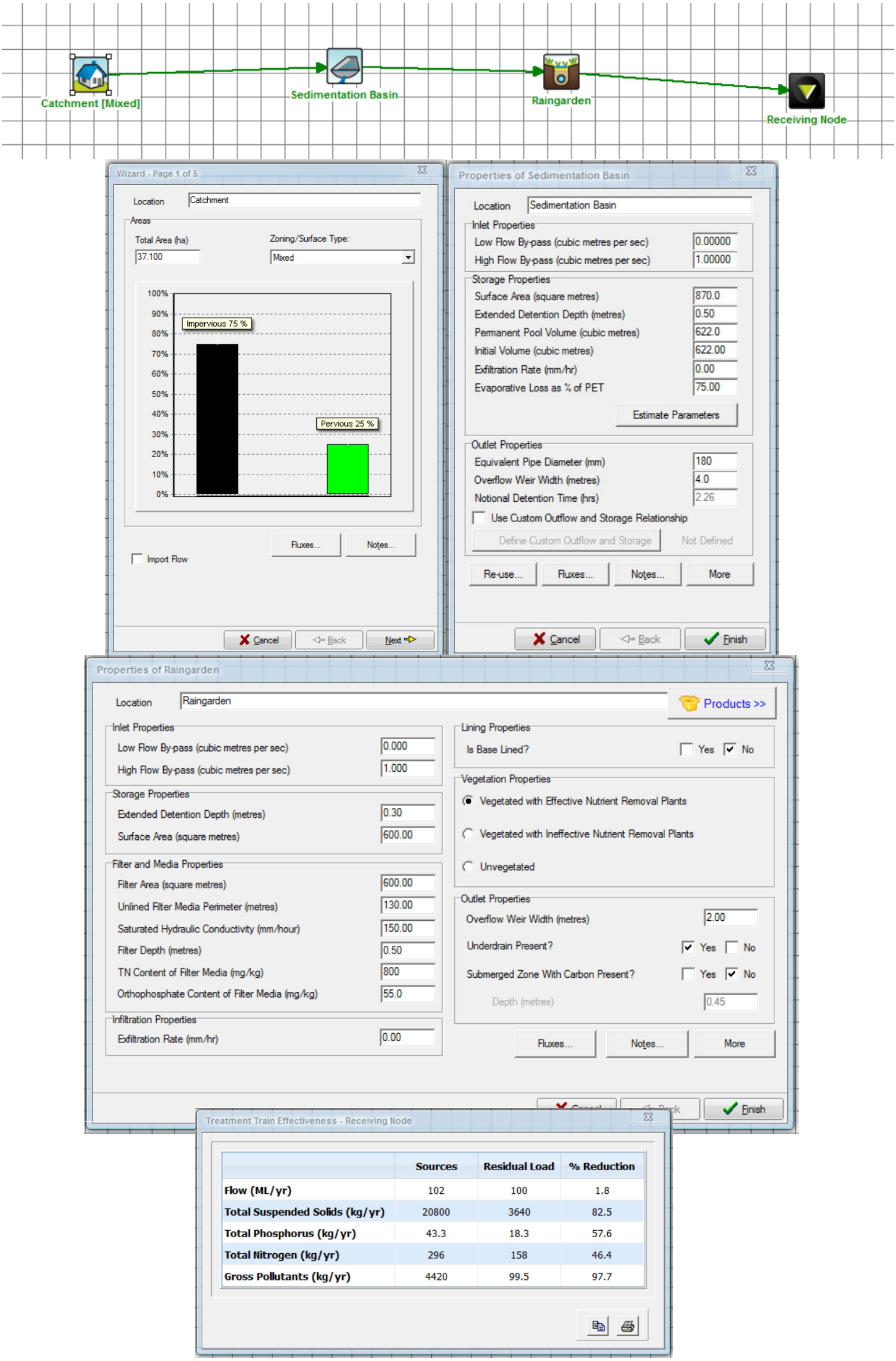
AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
11.3	0.73	8.249	16	53.22293	5	1219.54	243.91		1050	0.013	400	1364.67	1.58	0.89

4D

AREA	C of R	AE	TC	INT	ARI	Qact	Q3month		Diam	ROUGH	SLOPE	Qfull	Vfull	Qa/Qf
(ha)		(ha)	(min)	(mm/hr)	(yr)	(L/sec)	(L/sec)		(mm)	n		(L/sec)	(m/s)	
11.1	0.73	8.103	14	57.77233	5	1300.36	260.07		1200	0.013	400	1948.38	1.72	0.67

APPENDIX H – MUSIC TREATMENT TRAIN

BASIN 1 - MUSIC MODEL



	Sources	Residual Load	% Reduction
Flow (ML/yr)	102	100	1.8
Total Suspended Solids (kg/yr)	20800	3640	82.5
Total Phosphorus (kg/yr)	43.3	18.3	57.6
Total Nitrogen (kg/yr)	296	158	46.4
Gross Pollutants (kg/yr)	4420	99.5	97.7

APPENDIX I – SEDIMENTATION BASIN CALCUATIONS

Project Name	North East Growth Corridor - Basin 1
Project ID	305578
Designer	R Carnegie
Date	29/06/2018

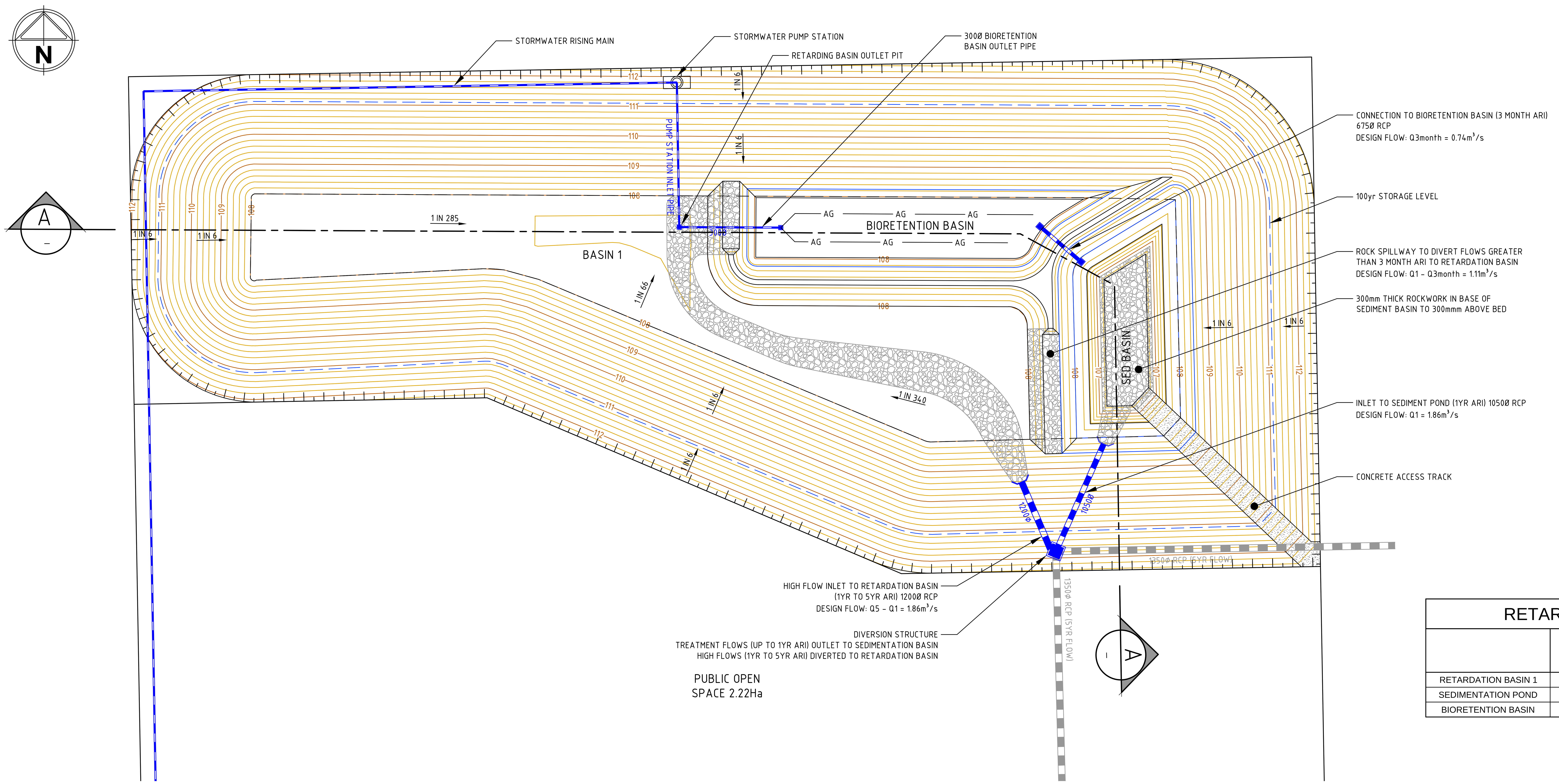
Sedimentation Basin Sizing Calculation

The purpose of this tool is to check potential sediment basin areas against design criteria and practical constructability. Only cells coloured green should be edited unless the designer has justification for altering other parameters.

Catchment Name	A		General fraction impervious	0.75
Catchment Area (ha)	37.1			
Sed basin surface area	870	m^2	**Sed pond OK?**	**Yes**

Design Outcomes			**Design Flows**			**Sediment Basin Sizing Parameters**			**Comment**
Sediment Capture			Q100	9.25	m^3/s	Settling Velocity of Target Sediment	11	mm/s	
Capture efficiency[2]	98.33%		Q5	3.72	m^3/s	Hydraulic Efficiency (λ)	0.41		
			Q1	1.85	m^3/s	Permanent Pool Depth, d_p	1.5	m	As per guidelines. Can potentially be increased to 2.0m.
Storage			Q3-month/Design flow	0.740	m^3/s	Extended detention depth, d_e	0.5	m	As per DtC guidelines. With IFD can be increased to a max of 0.50m.
Storage volume required	297	m^3				Number of CSTR's, n	1.69		Round to nearest whole number for MUSIC
Available storage volume[3]	305	m^3				Depth below permanent pool that is sufficient to retain sediment, d*	1.00	m	As per MWC advice
PP volume[4]	622	m^3				Sediment Loading Rate, L_o	1.6	m^3/ha/yr	
						Desired clean-out frequency, F_r	5	years	3-5 years is the preferred range
Surface area - Sediment Pond[5]						Assumed L:W ratio of basin	2	:1	2-3:1 should provide efficient area with acceptable hydraulic performance
Length at NWL	42	m				Batter slope of sed basin edge (1 in x) to 350mm below NWL	8		Either 1:8 (safety batter) or 1:3 (impenetrable planting) acceptable (per DtC)
Width at NWL	21	m				Batter slope of edge (1 in x) from 350mm below NWL	3		As per DtC guidelines.
Sediment dry-out area	594	m^2				Batter slope of edge (1 in x) from NWL to EDD	5		Either 1:5 (safety batter) or 1:3 (impenetrable planting) acceptable (per DtC)
						MWC permissible 'PP' depth	0.5	m	Top 500mm of basin not to be counted as sediment storage.

APPENDIX J – CATCHMENT 1 FUNCTIONAL BASIN DESIGN

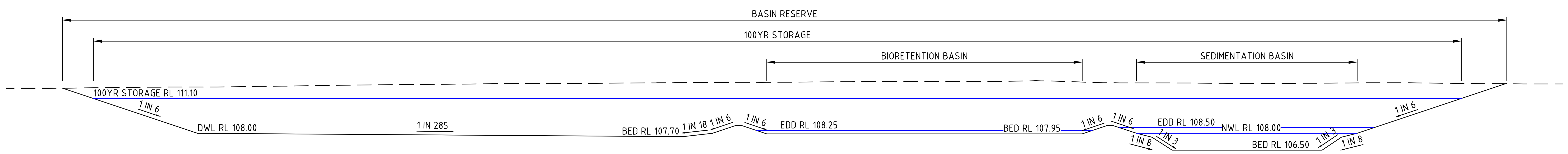


LEGEND

DESCRIPTION	EXISTING	PROPOSED
COUNCIL STORMWATER DRAIN & PIT		
STORMWATER DRAIN & PIT (BY DEVELOPER)		
AG DRAIN AND FLUSHER	AG	AG
RIDGE / CHANGE OF GRADE LINE		
SURFACE CONTOUR MINOR	168.90	168.90
SURFACE CONTOUR MAJOR	169.00	169.00
EARTHWORKS GRADE		1 in 150
BATTER		
FILL EXTENTS		
ROCK BEACHING		
PARKING BAY/PAVED AREA		
STORMWATER PUMP STATION		

RETARDATION BASIN & TREATMENT DETAILS

	NOMINAL WATER LEVEL	EXTENDED DETENTION LEVEL	100YR STORAGE LEVEL	100YR STORAGE VOLUME (m³)
RETARDATION BASIN 1	-	-	111.10	31,276
SEDIMENTATION POND	108.00	108.50	-	-
BIORETENTION BASIN	-	108.25	-	-



SECTION A-A

NOT TO SCALE

file name 305578CD200.dwg layout name CD201 plotted by Anthony Scott
file location G:\30\305578\Civil\ACAD plot date 02/07/2018 1:18 PM Sheet of Sheets

Rev	Amendments	Approved	Date

H 1:500 SCALE @ A1 0 5 10 15 20 25

spiire
144 Welsford Street Shepparton
Victoria 3630 Australia T 61 3 5840 1000
spiire.com.au ABN 55 050 029 635

Designed | Checked
Authorised | Date

NORTH EAST GROWTH CORRIDOR SHEPPARTON
FUNCTIONAL LAYOUT
RETARDATION BASIN 1
CITY OF GREATER SHEPPARTON
GREATER SHEPPARTON CITY COUNCIL

PRELIMINARY Drg No 305578CD201 Rev ----

APPENDIX K – OPINION OF PROBABLE COSTS

CATCHMENT 1 BASIN COSTS

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	<u>**WORKS**</u>					
1	**SITEWORKS AND EARTHWORKS**					
1.1	Site preparation		Item			Refer to item 4.6.
1.2	Stripping of topsoil	20300	m2	$0.25	$5,075	
1.3	Basin excavation	56000	m3	$5.00	$280,000	
1.4	Sedimentation Pond and Bio Retention Excavation	1230	m3	$10	$12,300	
1.5	Final Trimming and Shaping	1	Item	$10,000	$10,000	
1.6	Topsoil replacement	20300	m2	$0.50	$10,150	
2	**DRAINAGE STRUCTURES**					
2.1	DRAINAGE PIPES					
2.1.1	300dia. RCP	50	LM	$150	$7,500	
2.1.2	675dia. RCP	11	LM	$290	$3,190	
2.1.3	1050dia. RCP	25	LM	$590	$14,750	
2.1.4	1200dia. RCP	15	LM	$650	$9,750	
2.2	DRAINAGE PITS					
2.2.1	Diversion Pit	1	No.	$20,000	$20,000	
2.2.2	600x600 Grated Junction Pit	1	No.	$2,000	$2,000	
2.2.3	900x900 Grated Junction Pit	2	No.	$2,500	$5,000	
2.3	HEADWALLS					
2.3.1	1050dia	1	No.	$6,000	$6,000	
2.3.2	1200dia	1	No.	$7,000	$7,000	
2.4	BIO RETENTION AREA					

2.4.1	150dia. slotted pipe including filter media 0.5m deep	600	m2	$90	$54,000	
2.4.2	Permeable liner	750	m2	$7	$5,250	
2.4.3	Fitting, risers, non-return valves, etc	1	item	$5,000	$5,000	
3	**MISCELLANEOUS**					
3.1	General Rock work (150dia.)	670	m2	$40	$26,800	
3.2	Sedimentation Pond Rockwork Base (300dia.)	330	m2	$90	$29,700	
3.3	Sedimentation Pond Clay Lining	860	m2	$10	$8,600	
3.4	Concrete Access Track	250	m2	$80	$20,000	
	SUB-TOTAL WORKS				$542,065	
4	**DELIVERY**					
4.1	Council Fees	3.25	%		$17,617	
4.2	Traffic Management	5.00	%		$27,103	
4.3	Environmental Management	0.50	%		$2,710	
4.4	Survey & Design	10.00	%		$54,207	
4.5	Supervision & Project Management	5.00	%		$27,103	
4.6	Site Establishment	2.50	%		$13,552	
4.7	Contingency	15.0	%		$81,310	
	SUB-TOTAL DELIVERY				$223,602	
5	**TOTAL ESTIMATED COST**				**$765,667**	

OUTFALL INFRASTRUCTURE COSTS – CATCHMENT 1

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	<u>WORKS</u>					
1	**PUMPSTATION WORKS AND RISING MAIN WORKS**					
1.1	Stormwater Pump Station	1	Item	$140,000	$140,000	
1.2	Pump Station Installation	1	Item	$50,000	$50,000	
1.3	Pump Station Electrical Supply	1	Item	$10,000	$10,000	
1.4	160dia. Rising Main (100%) *Including flow control cable*	250	LM	$100	$25,000	
1.6	250dia. Rising Main (40%) *Including flow control cable*	960 x 40%	LM	$140	$53,760	Part share with catchment 3.
1.7	Dispersion Pit for Outlet	0.5	Item	$10,000	$5,000	
1.8	Rock Beaching in Drain	0.5	item	$2500	$1,250	
1.9	Rising Main Fittings	1	item	$10,000	$10,000	
	SUB-TOTAL WORKS				$295,010	
2	**<u>DELIVERY</u>**					
2.1	Council Fees	3.25	%		$9,588	
2.2	Traffic Management	5.00	%		$14,751	
2.3	Environmental Management	0.50	%		$1,475	
2.4	Survey & Design	10.00	%		$29,501	
2.5	Supervision & Project Management	5.00	%		$14,751	
2.6	Site Establishment	2.50	%		$7,376	
2.7	Contingency	15.0	%		$44,252	
	SUB-TOTAL DELIVERY				$121,694	
3	**TOTAL ESTIMATED COST**				**$416,704**	

OUTFALL INFRASTRUCTURE COSTS – CATCHMENT 2

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	<u>WORKS</u>					
1	**PUMPSTATION WORKS AND RISING MAIN WORKS**					
1.1	Stormwater Pump Station	1	Item	$140,000	$140,000	
1.2	Pump Station Installation	1	Item	$50,000	$50,000	
1.3	Pump Station Electrical Supply	1	Item	$10,000	$10,000	
1.4	160dia. Rising Main (100%) *Including flow control cable*	600	LM	$100	$60,000	
1.5	Dispersion Pit for Outlet	0.5	Item	$10,000	$5,000	
1.6	Rock Beaching in Drain	0.5	item	$2500	$1,250	
1.7	Rising Main Fittings	1	item	$10,000	$10,000	
	SUB-TOTAL WORKS				$276,250	
2	**<u>DELIVERY</u>**					
2.1	Council Fees	3.25	%		$8,978	
2.2	Traffic Management	5.00	%		$13,813	
2.3	Environmental Management	0.50	%		$1,381	
2.4	Survey & Design	10.00	%		$27,625	
2.5	Supervision & Project Management	5.00	%		$13,813	
2.6	Site Establishment	2.50	%		$6,906	
2.7	Contingency	15.0	%		$41,438	
	SUB-TOTAL DELIVERY				$113,954	
3	**TOTAL ESTIMATED COST**				**$390,204**	

OUTFALL INFRASTRUCTURE COSTS – CATCHMENT 3

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	**PUMPSTATION WORKS AND RISING MAIN WORKS**					
1.1	Stormwater Pump Station	1	Item	$140,000	$140,000	
1.2	Pump Station Installation	1	Item	$50,000	$50,000	
1.3	Pump Station Electrical Supply	1	Item	$10,000	$10,000	
1.4	200dia. Rising Main (100%) *Including flow control cable*	890	LM	$120	$106,800	
1.5	250dia. Rising Main (60%) *Including flow control cable*	960 x 60%	LM	$140	$80,640	Part share with catchment 1.
1.6	Dispersion Pit for Outlet	0.5	Item	$10,000	$5,000	
1.7	Rock Beaching in Drain	0.5	item	$2500	$1,250	
1.8	Rising Main Fittings	1	item	$10,000	$10,000	
	SUB-TOTAL WORKS				$403,690	
2	**DELIVERY**					
2.1	Council Fees	3.25	%		$13,120	
2.2	Traffic Management	5.00	%		$20,185	
2.3	Environmental Management	0.50	%		$2,018	
2.4	Survey & Design	10.00	%		$40,369	
2.5	Supervision & Project Management	5.00	%		$20,185	
2.6	Site Establishment	2.50	%		$10,092	
2.7	Contingency	15.0	%		$60,554	
	SUB-TOTAL DELIVERY				$166,523	
3	**TOTAL ESTIMATED COST**				**$570,213**	

OUTFALL INFRASTRUCTURE COSTS – CATCHMENT 4

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	<u>**WORKS**</u>					
1	**PUMPSTATION WORKS AND RISING MAIN WORKS**					
1.1	Stormwater Pump Station	1	Item	$140,000	$140,000	
1.2	Pump Station Installation	1	Item	$50,000	$50,000	
1.3	Pump Station Electrical Supply	1	Item	$10,000	$10,000	
1.4	200dia. Rising Main (100%) *Including flow control cable*	310	LM	$120	$37,200	
1.5	Dispersion Pit for Outlet	0.5	Item	$10,000	$5,000	
1.6	Rock Beaching in Drain	0.5	item	$2500	$1,250	
1.7	Rising Main Fittings	1	item	$10,000	$10,000	
	SUB-TOTAL WORKS				$253,450	
2	<u>**DELIVERY**</u>					
2.1	Council Fees	3.25	%		$8,237	
2.2	Traffic Management	5.00	%		$12,673	
2.3	Environmental Management	0.50	%		$1,267	
2.4	Survey & Design	10.00	%		$25,346	
2.5	Supervision & Project Management	5.00	%		$12,673	
2.6	Site Establishment	2.50	%		$6,337	
2.7	Contingency	15.0	%		$38,019	
	SUB-TOTAL DELIVERY				$104,552	
3	**TOTAL ESTIMATED COST**				**$358,002**	

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