This option was initially considered not to be cost effective due to the large tank size required to meet a reasonable demand reliability. However the cost effectiveness of this option may be improved through investigation of alternative options that consider smaller designated irrigation areas (hence improving the demand reliability) and the use of a more affordable storage system (than conventional proprietary tank systems).

This option will be further investigated as more information becomes available through the detailed planning and design process for the current and subsequent development stages.

Stormwater harvesting and reuse can have significant benefits in terms of reducing the demand on potable water supplies while also reducing pollutant loads to receiving environments, thereby protecting the environmental values of the Ross River.

An opportunity may also exist to gain federal funding under a stormwater harvesting and reuse grant that the Labour government has pledged (if elected) to assist in securing and diversifying water supplies for a sustainable Australia (ABC News, 2010).

Table 4-3 Stormwater Harvesting Model Results

Stormwater Harvesting Tank Size (m^3)	In (ML)	Out (ML)	Yield (kL)	Annual Irrigation Demand (kL)	% of Demand Satisfied	Stormwater Harvesting Tank Size (m^3)
10	331	328	3000	21482	14%	10
50	331	328	3000	21482	14%	50
100	331	327	4000	21482	19%	100
250	331	324	7000	21482	33%	250
500	331	321	10000	21482	47%	500
1000	331	318	13000	21482	61%	1000
1500	331	316	15000	21482	70%	1500
2000	331	314	17000	21482	79%	2000

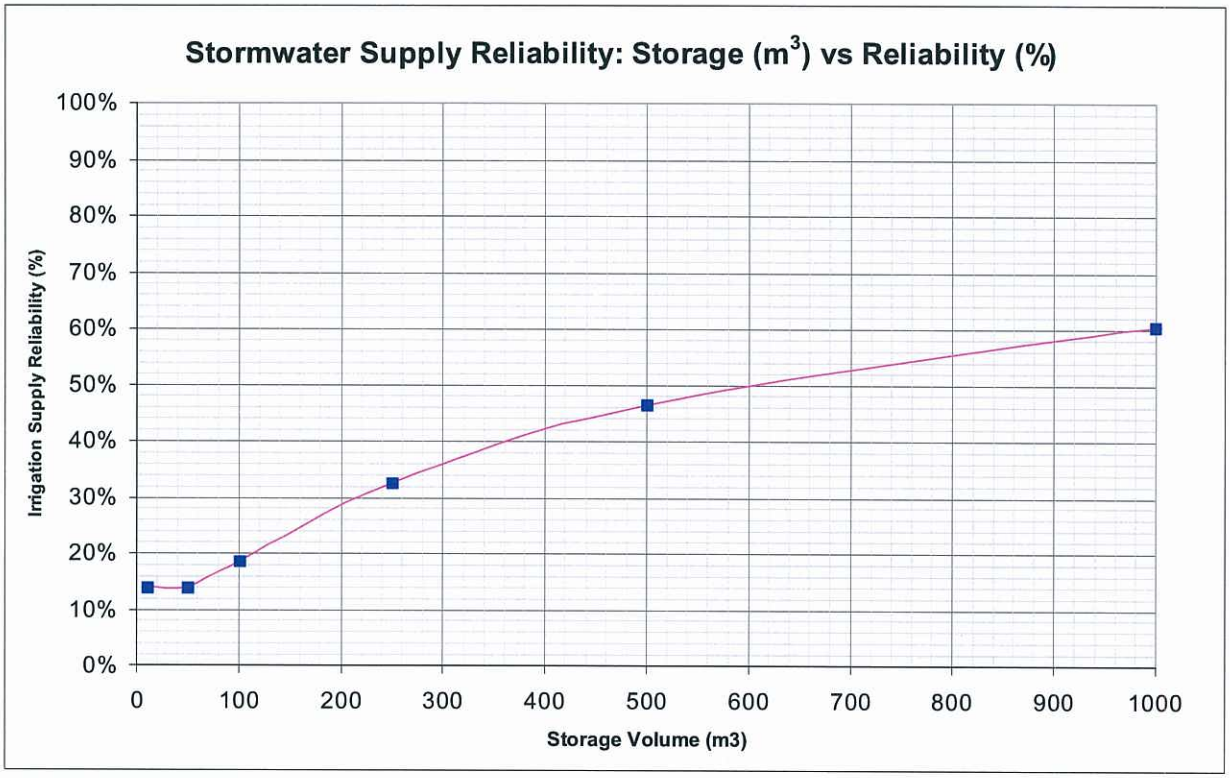

Figure 4-3 Stormwater Harvesting Supply

4.2.1.3 Model Conclusions

From the conceptual modelling results of the MUSIC model, it can be concluded for the site of the proposed development that with the integration of Water Sensitive Urban Design principles and Stormwater Quality Improvement Devices, the pollutant export loads from the site can be significantly reduced compared to the base case and unmitigated scenario for pollutants of concern. Furthermore, the Townsville City Council load reduction targets (see Table 3-4) for solids, phosphorus, nitrogen and gross pollutants will be achieved with the proposed treatment train.

Further simulations at a more detailed level of design may be required to verify the model outcomes only if the final development layout differs significantly from the conceptual layout and prevented the implementation of the proposed treatment measures.

Details of these systems, assumed for the purposes of the conceptual modelling approach, are provided in Section 3.4 of this report. Table 4-4 also provides the approximate sizing of bioretention filter areas required for each subcatchment to meet Townsville City Council's Load Based Reduction Targets. ***From the modelling undertaken it is evident that the bioretention filter area required for treatment will be approximately 1.6% of the catchment area.*** Typical road sections for the development that show how bioretention systems can be incorporated into the road reserve and some examples of drawings for streetscape bioretention systems are included in Appendix D.

Table 4-4 Sizing of Bioretention Areas

	Sources	Residual	Reduction	Objective	Bioretention Top Surface Area Required (m^2)	Bioretention Filter Area Required (m^2)
Subcatchment 1: Approximate Bioretention Filter Area as a % of Subcatchment Area = 1.6%						
Flow (ML/yr)	101	101	0	-	**2785**	**2359**
Total Suspended Solids (kg/yr)	17100	2720	84%	65%		
Total Phosphorus (kg/yr)	35	11	68%	55%		
Total Nitrogen (kg/yr)	211	127	40%	35%		
Gross Pollutants (kg/yr)	1910	0	100%	90%		
Subcatchment 2: Approximate Bioretention Filter Area as a % of Subcatchment Area = 1.6%						
Flow (ML/yr)	132	132	0%	-	**3030**	**2961**
Total Suspended Solids (kg/yr)	23900	4560	81%	65%		
Total Phosphorus (kg/yr)	48	17	65%	55%		
Total Nitrogen (kg/yr)	271	172	36%	35%		
Gross Pollutants (kg/yr)	2240	0	100%	90%		
Subcatchment 3: Approximate Bioretention Filter Area as a % of Subcatchment Area = 1.6%						
Flow (ML/yr)	173	173	0%	-	**3926**	**3847**
Total Suspended Solids (kg/yr)	25400	4250	83%	65%		
Total Phosphorus (kg/yr)	93	26	72%	55%		
Total Nitrogen (kg/yr)	361	218	40%	35%		
Gross Pollutants (kg/yr)	3040	0	100%	90%		
Subcatchment 4: Approximate Bioretention Filter Area as a % of Subcatchment Area = 1.6%						
Flow (ML/yr)	51	51	0%	-	**1250**	**1161**
Total Suspended Solids (kg/yr)	11600	1860	84%	65%		
Total Phosphorus (kg/yr)	22	7	69%	55%		
Total Nitrogen (kg/yr)	104	63	39%	35%		
Gross Pollutants (kg/yr)	910	0	100%	90%		
Total					***10991***	***10328***

5 MAINTENANCE PLANS

Maintenance plans may be required for the following Stormwater Quality Best Management Practice (SQBMPs) proposed for the development:

- Gross pollutant traps;
- Bioretention systems.

Maintenance inspection forms and plans would be developed for these SQID's during the detailed design phase of the development and would include the following information:

- Inspection frequency;
- Maintenance frequency;
- Data collection/storage requirements (eg. information collected during inspections);
- Detailed clean-out procedures (main element of the Plans). These procedures cover aspects such as:
  - Equipment needs;
  - Maintenance techniques;
  - Occupational health and safety;
  - Public safety;
  - Environmental management considerations;
  - Disposal requirements (polluted water and solid waste);
  - Access issues;
  - Stakeholder notification requirements;
  - Data collection requirements (if any);
- SQID design details and supplier contacts (in case modifications to the design need to be made in future).

Indicative maintenance requirements for bioretention systems are provided in Appendix E.

In addition, the asset transfer checklist will need to be completed and approved by Townsville City Council prior to asset handover to Council for maintenance after the conclusion of the off-maintenance period. This checklist is contained in Appendix F.

6 CONCLUSIONS

This conceptual SBSQMP provides a Stormwater Management Strategy broadly outlining the planning, management and maintenance issues for stormwater treatment measures or water quality issues. The SBSQMP has demonstrated that adequate treatment of stormwater is possible under the proposed conceptual design. Sufficient consideration of stormwater controls has been made at this conceptual stage of the development to demonstrate compliance with relevant Townsville City Council water quality objectives.

The plan has identified the existence of natural opportunities and constraints in relation to stormwater management. Opportunities present on the site include the available open space and streetscape areas where SQBMP's can be sensitively incorporated, and the potential to use alternative water sources to meet on site demands. The principal constraint involved the flat topography (and lack of gradient to drain stormwater off site), and potentially high groundwater levels identified in isolated areas of the site.

Water quality objectives have been derived from current criteria set by Townsville City Council in terms of annual stormwater discharge loads. Total pollutant load results were subsequently predicted with the use of the MUSIC modelling software to provide a representation of how the site will perform under different development and stormwater management scenarios.

The following development scenarios have been modelled using MUSIC:

1. The Base Case - Undeveloped Site (no development);
2. Developed Case - Unmitigated Site (with no WSUD measures implemented);
3. Developed Case - Mitigated Site (with WSUD measures implemented);
4. Developed Case - Mitigated Site Option 1 (rainwater tanks); and
5. Developed Case- Mitigated Site Option 2 (stormwater harvesting);

The results show that with the integration of Water Sensitive Urban Design principles and Stormwater Quality Improvement Devices, the pollutant export loads from the site can be significantly reduced compared to the unmitigated scenario. The Townsville City Council load removal targets (see Table 3-4) for solids, phosphorus, nitrogen and gross pollutants can be achieved through the proposed treatment train consisting of education, gross pollutant traps and streetscape bioretention (Scenario 3). For the purposes of this report, we have provided an estimate of the approximate bioretention filter area (and, of less importance in terms of overall treatment effectiveness, bioretention surface area) required for streetscape bioretention systems within each of the catchment areas of the proposed development. Some of this area may be located immediately adjacent to impervious areas in parklands.

Modelling of the overall development site has indicated that a **bioretention filter area of approximately 1.6% of the catchment size will be required to meet water quality treatment objectives**. The configuration, size and number of the individual bioretention systems required to satisfy the given WQOs will be determined during subsequent design stages. However an indicative cross section of the typical proposed configuration has been provided. The typical configuration

proposed includes the use of a saturated zone, which will allow for improved pollutant removal. The saturated zone also provides an innovative method to reduce the watering requirements of vegetation within bioretention systems, with the water in the saturated zone used to sustain vegetation for extended dry periods without the need for irrigation. The vegetation selected for the bioretention systems will also be drought tolerant native species to ensure a sustainable climate smart solution to managing water quality on site.

The option to use alternate water supply sources including rainwater and stormwater as a best practice options to assist in conserving potable water supplies was also investigated. Although Townsville has an exemption under the QDC for installing mandatory rainwater tanks, the water savings from rainwater tanks was investigated as a potential climate responsive and water saving solution. Results indicated that approximately 38% of on site water demands for toilet flushing, laundry use and irrigation may be met with the use of rainwater tanks, with further improvement to water quality discharged from the site also. This is less than the typical demand met in climates such as South East Queensland (where approximately 70% of demands can be met), however it may still be considered as a water savings option.

Preliminary results for stormwater harvesting indicated that stormwater harvesting for all parkland area was not likely to be feasible/cost effective due to the large tank size required to meet reasonable demand reliability. However it is noted that feasibility of stormwater harvesting may be improved through investigation of alternative options that consider smaller designated irrigation areas (hence improving the demand reliability) and the use of a more affordable storage system (than conventional proprietary tank systems). This option will be further investigated as more information becomes available through the detailed planning and design process for the current and subsequent development stages. Stormwater harvesting is an innovative, climate smart solution which may also be given federal funding under a stormwater harvesting and reuse grant that the Labour government has pledged (if elected) to assist in securing and diversifying water supplies for a sustainable Australia (ABC News, 2010).

Although the options of sewer mining or greywater reuse were not investigated as part of this study, it is noted that these options may also provide viable alternative climate smart options for satisfying a significant portion of irrigation demands (due to consistent supply throughout the year). These alternative water savings options would therefore warrant further investigation by suitably qualified professionals during subsequent design stages.

7 REFERENCES

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APPENDIX A: DETAILED SITE SURVEY

brazier motti

surveying | town planning | project management | mapping and GIS

Brazier Motti Pty Ltd (ACN 009 411 041)

Townsville - 885 Flinders St. Townsville, Q. 4810
Phone 07 4772 1144 Fax: 07 4772 2567
Email: townsville@brazier.com.au

CAIRNS Ph: 07-4038 3377 Fax: 07-4038 3999
MACKAY Ph: 07-4963 1655 Fax: 07-4963 1855
BURDEKIN Ph: 07-4783 5755 Fax: 07-4783 3480

Level Datum : A.H.D.	
B.M. Used :	
F.B:	
Rec. in O.B. by : JS	Date : 12/7/10
Comp. File: 29060_003A.dwg	Disk: 07/10
Surveyed by : SJ	
Plotted :	Drawn : JS
Checked :	Approved :

REVISIONS

No.	Date	Details	By	Check
A		ORIGINAL ISSUE		
B				

NOTES :

The title boundaries as shown hereon were not marked at the time of survey and have been determined by plan dimensions only and not by field survey. Services shown hereon have been located where possible by field survey. If not able to be located, services have been plotted from relevant authority records and have been noted accordingly on this plan. Prior to any demolition, excavation or construction on the site, the relevant authority should be contacted for possible location of further underground services and detailed locations of all services.

- *Background information from Conics plan B3540-01A.*
- *Only selected buildings have been located and shown on this drawing.*

Client : **ULDA**

Project :

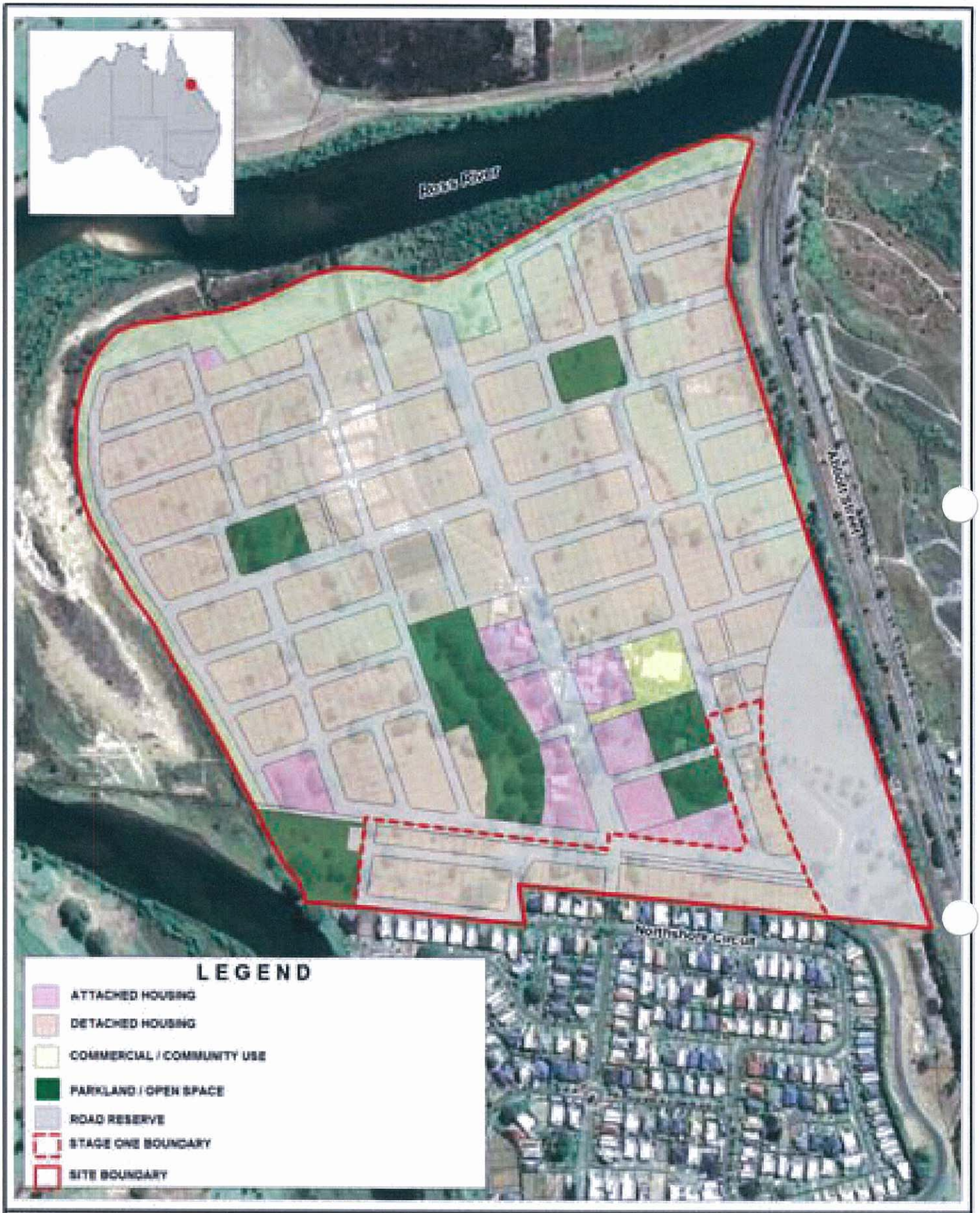
DIGITAL DATA PROOF PLOT ONLY
OONOONBA DPI
DATA COMPILATION

Parish of : STUART | County of : Elphinstone

Local Authority : Townsville City Council | Orig | Search Packet: 202

SCALE : 1:2000	Revision No.
Job No : 29060/009-02	
Date : 14th July, 2010	
Sheet 1 of 1 Sheets	
Drawing Number 29060/003	Orig Issue A

APPENDIX B: SITE LAYOUT (SUPERCEDED) USED FOR WATER QUALITY MODELLING



Title:

Site Layout (Superceded) Used for Water Quality Modelling

Figure: Appendix B

Rev: A

N

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B17916_1_JLB Stormwater Management Review for ULDA BAD\Concordia\DRG\WQU_005_100814_Layout.wor

APPENDIX C: BIORETENTION CONSTRUCTION CHECKLIST

BIORETENTION BASIN CONSTRUCTION INSPECTION CHECKLIST

Asset I.D.		**Inspected By:**	
Site:		**Date:**	
		Time:	
Constructed By:		**Weather:**	
		Contact During Visit:	

Items inspected	Checked		Satisfactory		Items inspected	Checked		Satisfactory	
	Y	N	Y	N		Y	N	Y	N
DURING CONSTRUCTION & ESTABLISHMENT									
A. FUNCTIONAL INSTALLATION					**Structural components**				
Preliminary Works					17. Location and configuration of inflow systems as designed				
1. Erosion and sediment control plan adopted					18. Location and levels of overflow pits as designed				
2. Temporary traffic/safety control measures					19. Under-drainage connected to overflow pits as designed				
3. Location same as plans					20. Concrete and reinforcement as designed				
4. Site protection from existing flows					21. Set down to correct level for flush kerbs (streetscape applications only)				
Earthworks and Filter Media					22. Kerb opening width as designed				
5. Bed of basin correct shape and slope					23. Level of saturated zone weir/up-turned pipe as designed (if required)				
6. Batter slopes as plans									
7. Dimensions of bioretention area as plans					**B. SEDIMENT & EROSION CONTROL (IF REQUIRED)**				
8. Confirm surrounding soil type with design					24. Stabilisation immediately following earthworks and planting of terrestrial landscape around basin				
9. Confirm filter media specification in accordance with Step 4					25. Silt fences and traffic control in place				
9. Provision of liner (if required)					26. Temporary protection layers in place				
10. Under-drainage installed as designed									
11. Drainage layer media as designed					**C. OPERATIONAL ESTABLISHMENT**				
12. Transition layer media as designed (if required)					27. Temporary protection layers and associated silt removed				
14. Extended detention depth as designed					**Vegetation**				
15. Weir/up-turned pipe is clear of debris (if required)					28. Planting as designed (species and densities)				
16. Water level in saturated zone as designed (if required)					29. Weed removal and watering as required				

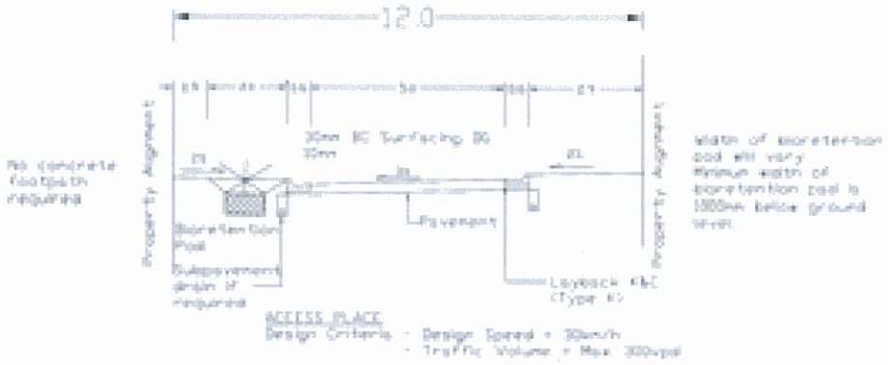
FINAL INSPECTION									
1. Confirm levels of inlets and outlets					6. Check for uneven settling of banks				
2. Confirm structural element sizes					7. Under-drainage working				
3. Check batter slopes					8. Inflow systems working				
4. Vegetation as designed					9. Maintenance access provided				
5. Bioretention filter media surface flat and free of clogging									

COMMENTS ON INSPECTION
ACTIONS REQUIRED
Inspection officer signature:

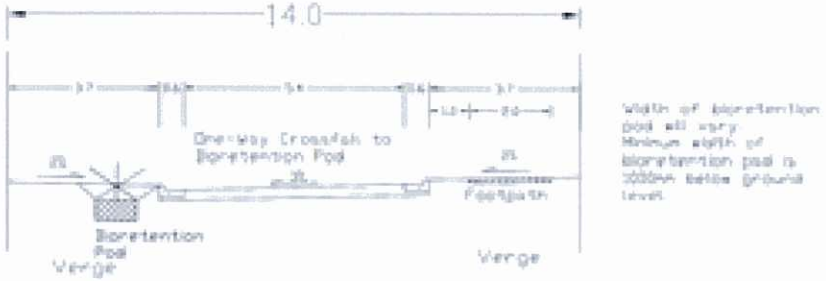
APPENDIX D: TYPICAL ROAD SECTIONS WITH WATER QUALITY TREATMENT & EXAMPLES OF DESIGN DRAWINGS FOR BIORETENTION 'PODS'

Oonooba Subdivision Cross Sections –Water Treatment Options

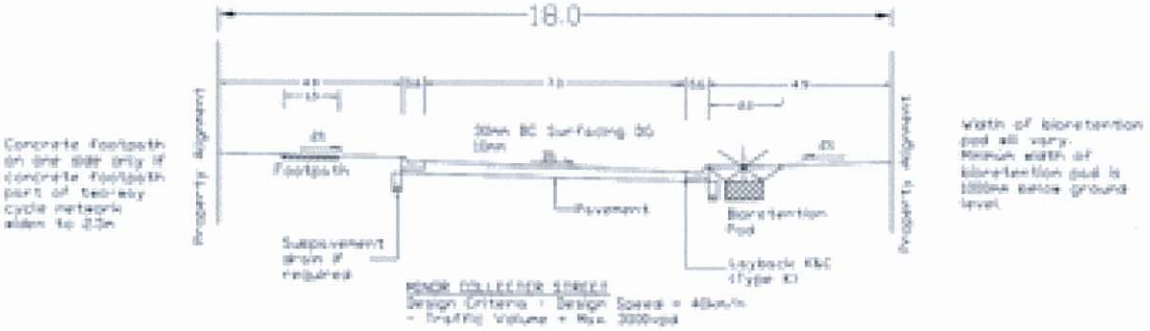
Standard cross section for **Access Place**



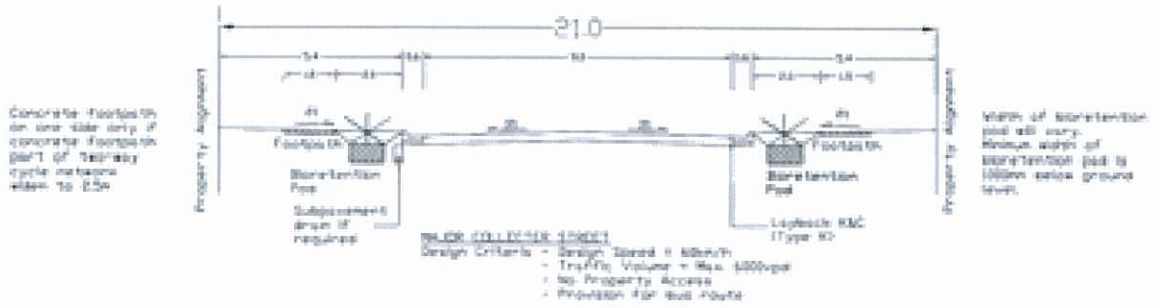
Standard cross section for **Access Street**



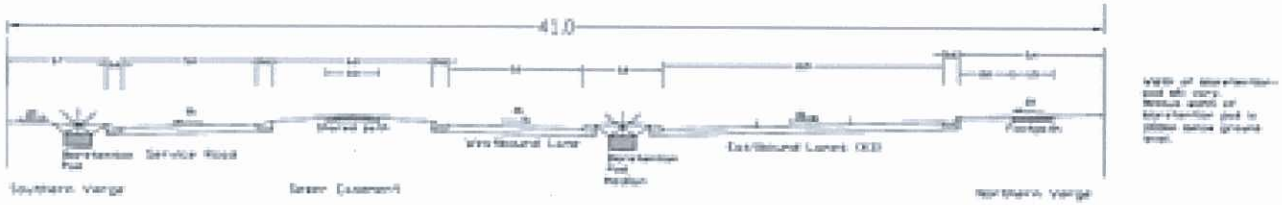
Standard cross section for **Minor Collector**



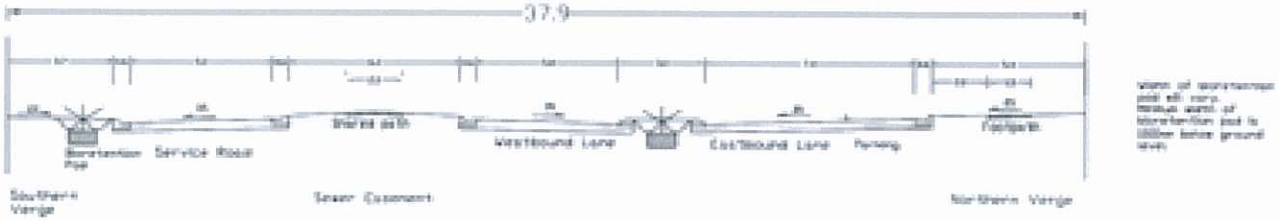
Standard cross section for **Major Collector**



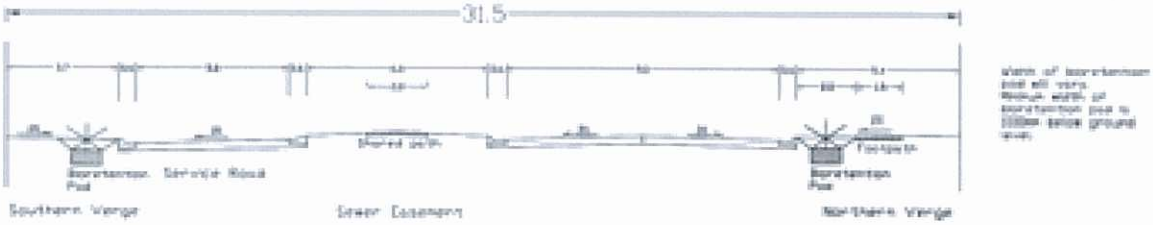
Special Cross Section for **Section A** – eastern portion of access road (near Lakeside Dr)



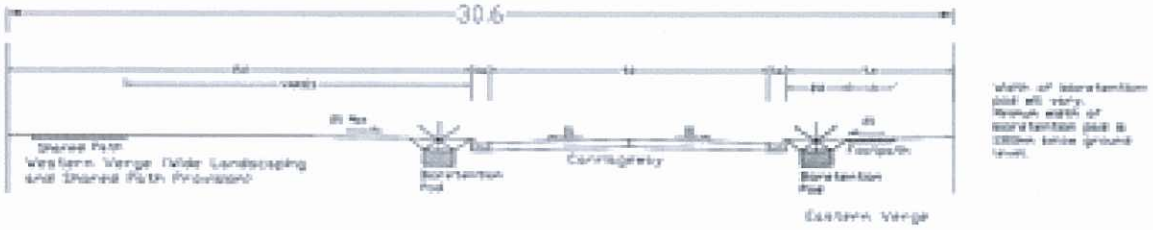
Special Cross Section for **Section B** – central portion of access road (east of roundabout)



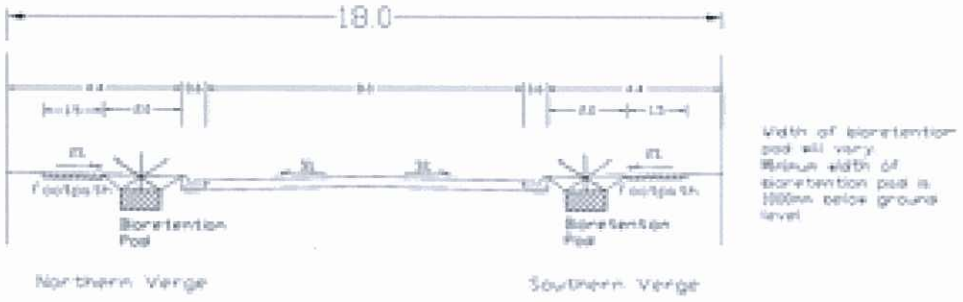
Special Cross Section for **Section C** – western portion of access road (west of roundabout)

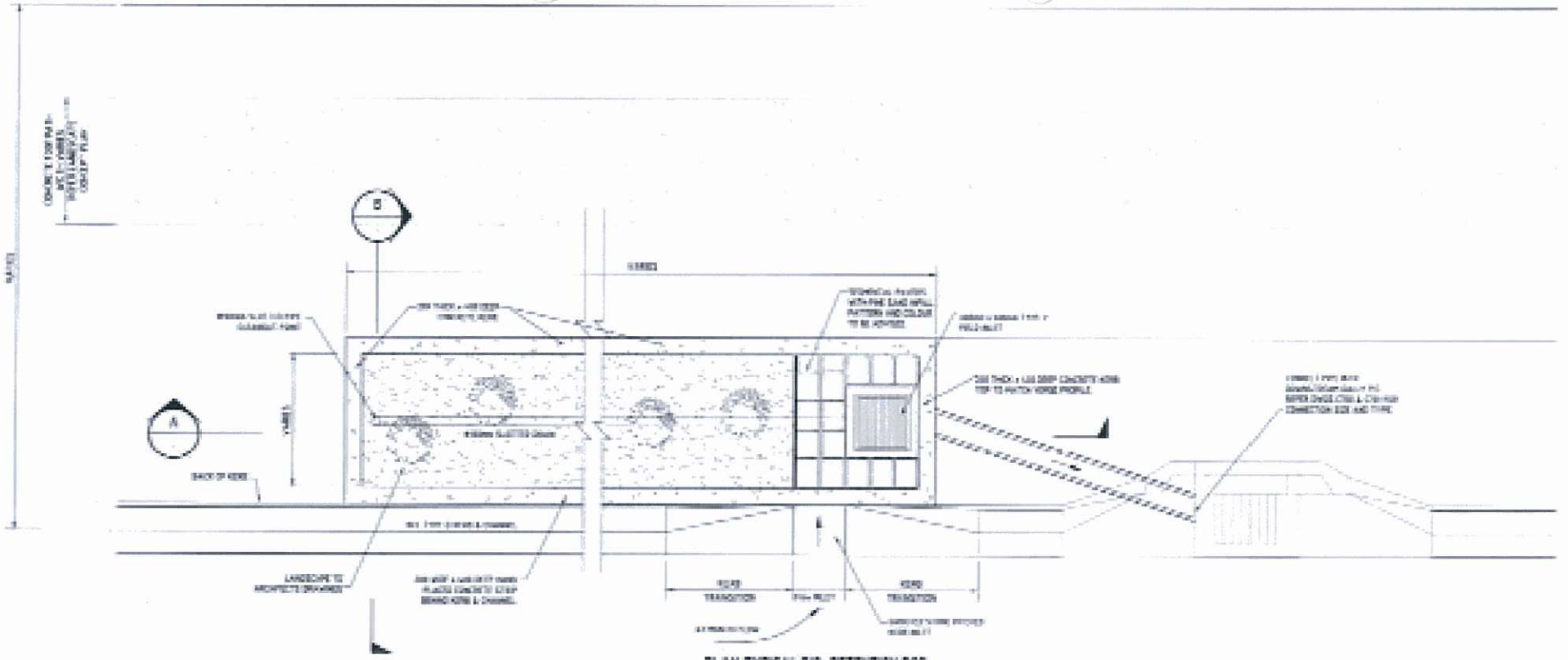


Special Cross Section for **Section D** – north-south spine road

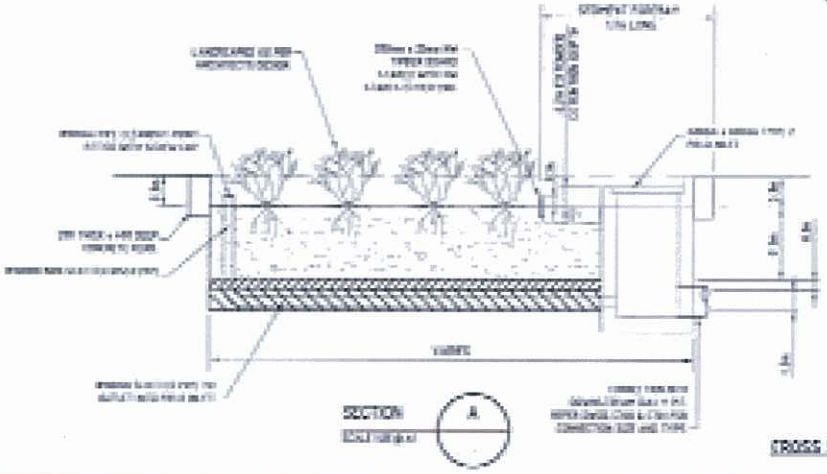


Special Cross Section for **Section E** – bus route on Minor Collector

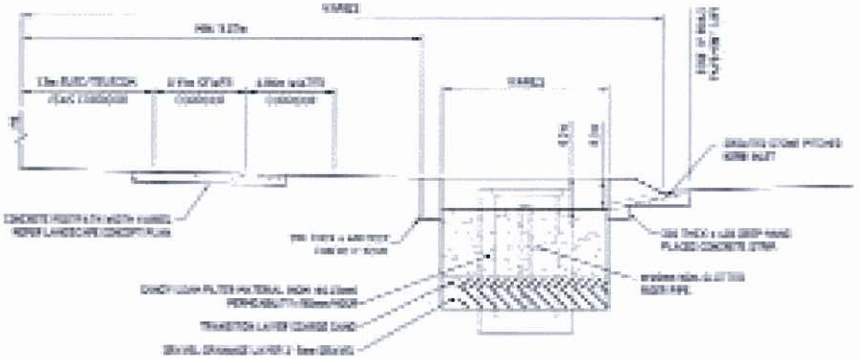




PLAN TYPICAL BIO-RETENTION POD



SECTION A



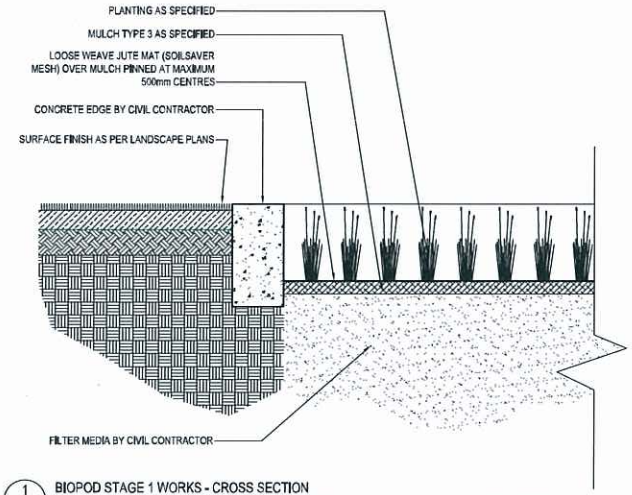
CROSS SECTION TYPICAL BIO-RETENTION POD

TENDER

SECTION B

	URBAN LAND DEVELOPMENT AUTHORITY		
	RESIDENTIAL SUBDIVISION - STAGE 6		
	253 TIRPERGRAPH ROAD, FITZGIBBON		
	BIO-RETENTION POD DETAIL		
		ULDBPOE1	
		C702	A

ARCHITECTS - CIVIL & STRUCTURAL ENGINEERS



1 BIOPOD STAGE 1 WORKS - CROSS SECTION
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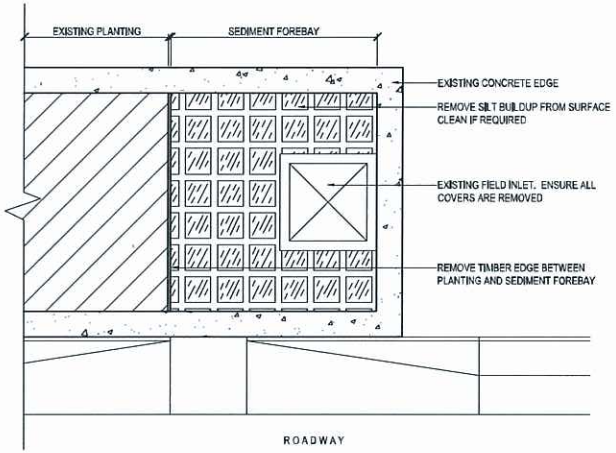


2 BIOPOD STAGE 2 WORKS - PLAN
1:20

BCC STANDARD SOFTSCAPE DETAILS

Streetscape	
Tree planting to turf footpath	UMS 511
Tree planting with planted footpath	UMS 513
Parks	
Typical tree & shrub planting	UMS 791
Typical planting bed	UMS 792

PLACE
PLANNING
DESIGN
ENVIRONMENT

BRISBANE
LEVEL 1, 262 WICKHAM STREET
FORTITUDE VALLEY, QLD 4006
AUSTRALIA
T (07) 3852 4921
F (07) 3852 4488

PROJECT

Fitzgibbon Chase
Area E1

CLIENT

ULDA

NOTES

ISSUE	CODE	ISSUE DESCRIPTION	BY	CHK	DATE
P1	PRE	CLIENT REVIEW	KC	TS	23.05.10

PRE = Preliminary | CA = Council Approval | T = Tender | CON = Construction

DRAWING TITLE

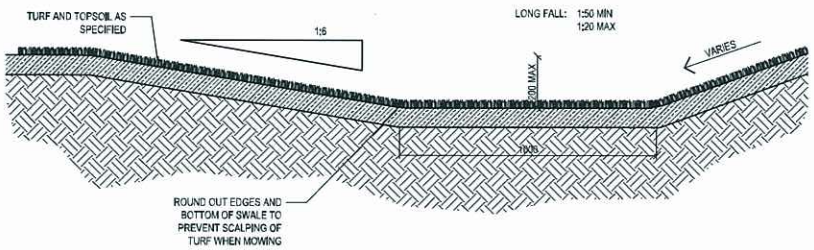
SOFTSCAPE DETAILS

DESIGN : KC
DOCUMENT : KC
PROJECT : ULD 05
SCALE :

NORTH

SCALE AS SHOWN @ A1

SHEET NUMBER	REVISION
902	P1



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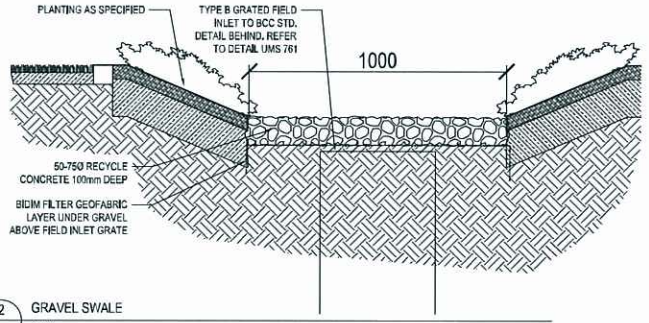

2 GRAVEL SWALE
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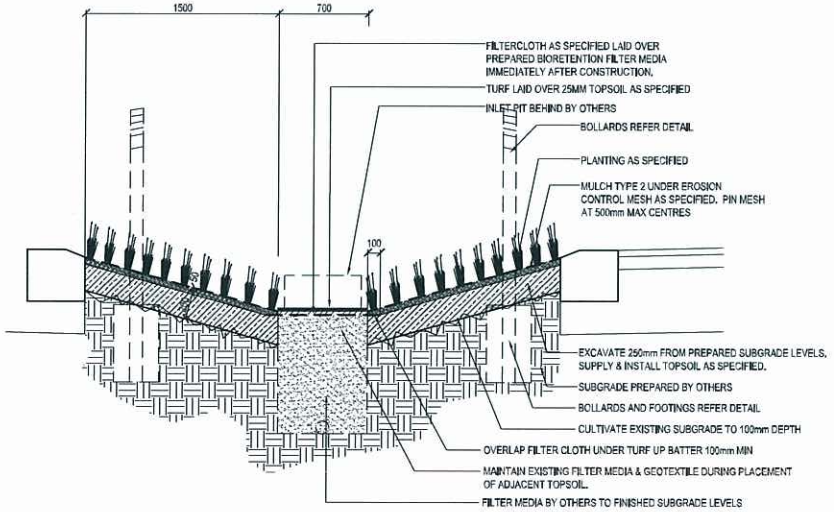

3 CENTRE MEDIAN - STAGE 1 WORKS
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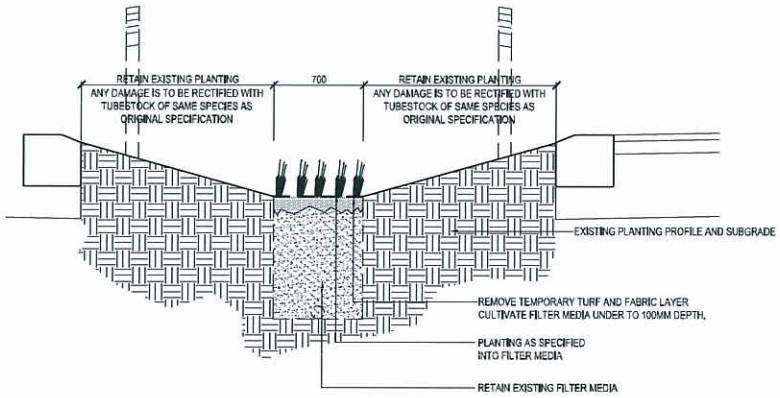

4 CENTRE MEDIAN - STAGE 2 WORKS
1:20

PLACE
PLANNING DESIGN ENVIRONMENT

BRISBANE
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PORTSIDE VALLEY, QLD 4006
AUSTRALIA
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PROJECT

Fitzgibbon Chase
Area E1

CLIENT

ULDA

NOTES

ISSUE	CODE	ISSUE DESCRIPTION	BY	CHK	DATE
P1	PRE	CLIENT REVIEW	KC	TS	23.03.10

PRE - Preliminary | CP - Council Approval | T - Tender | CON - Construction

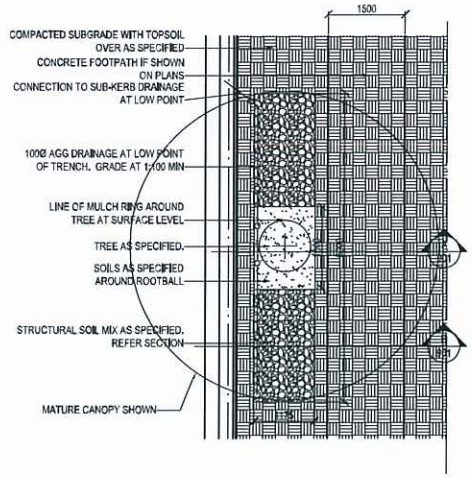
DRAWING TITLE

SOFTSCAPE DETAILS

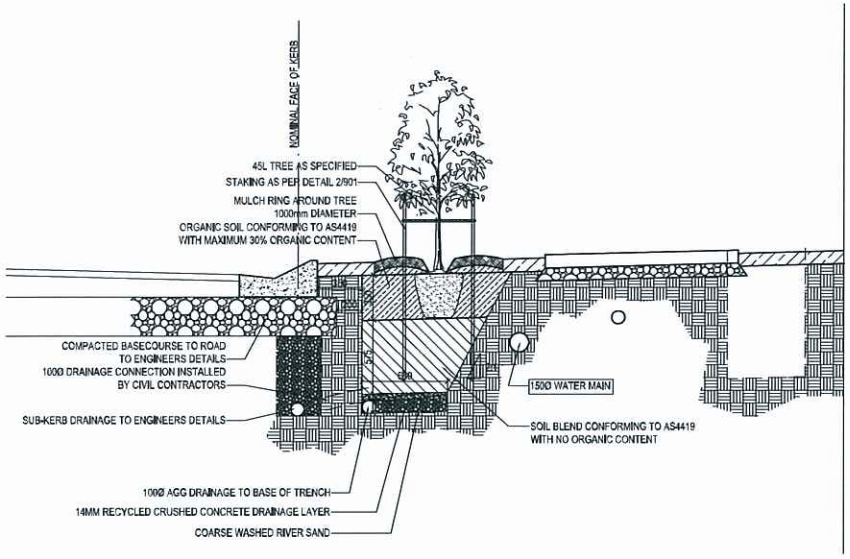
DESIGN : KC
DOCUMENT : KC
PROJECT : ULD 05
SCALE :

SCALE AS SHOWN @ A1

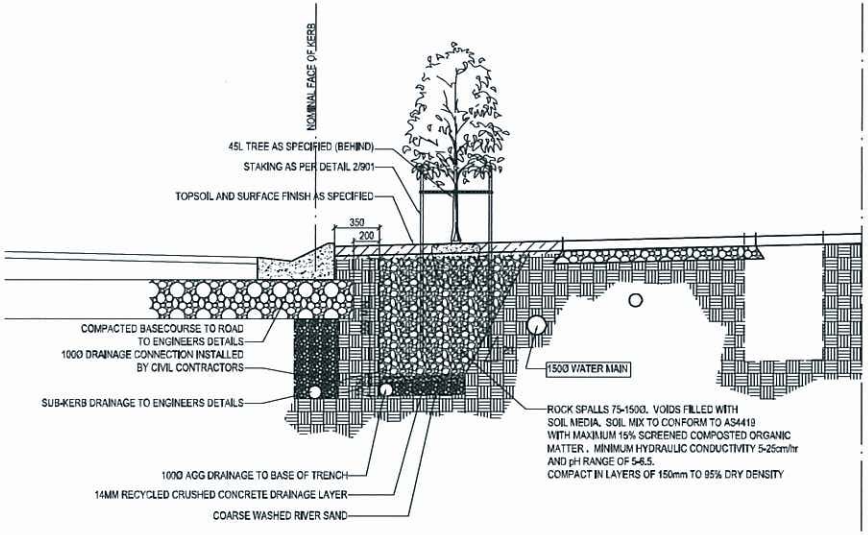
SHEET NUMBER 901
REVISION P1



1 STRUCTURAL SOIL PIT - PLAN
1:50



2 STRUCTURAL SOIL PIT SECTION A
1:20



3 STRUCTURAL SOIL PIT SECTION B
1:20

PLACE
PLANNING
DESIGN
ENVIRONMENT

BRISBANE
LEVEL 1, 262 VICTORIA STREET
FORTITUDE VALLEY, QLD, 4006
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PROJECT

Fitzgibbon Chase
Area E1

CLIENT

ULDA

NOTES

ISSUE	CODE	ISSUE DESCRIPTION	BY	CHK	DATE
P1	PRE	CLIENT REVIEW	KC	TS	23.05.10

PRE - Preliminary | CA - Council Approval | T - Tender | CON - Construction

DRAWING TITLE

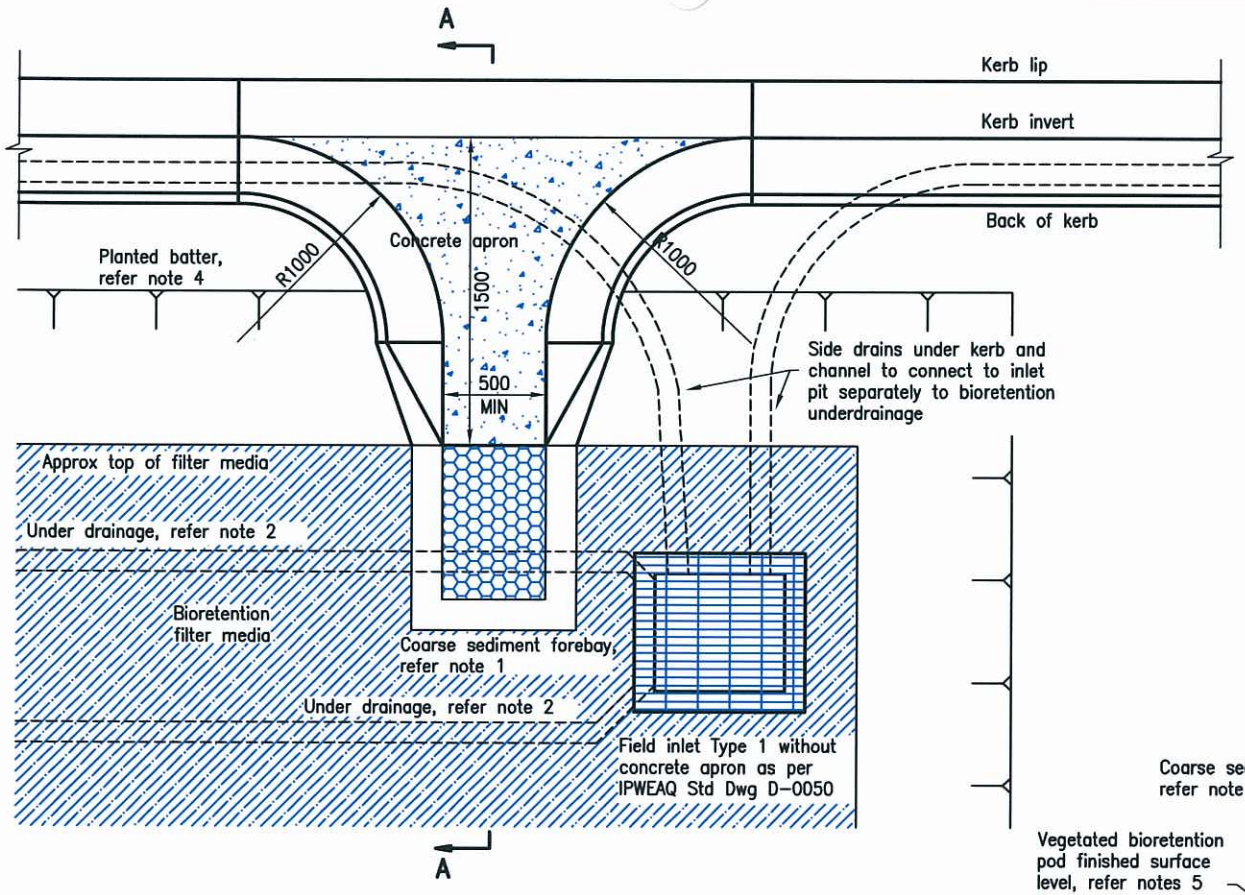
HARDSCAPE DETAILS

DESIGN : KC
DOCUMENT : KC
PROJECT : ULD 05
SCALE :

NORTH

SCALE AS SHOWN @ A1

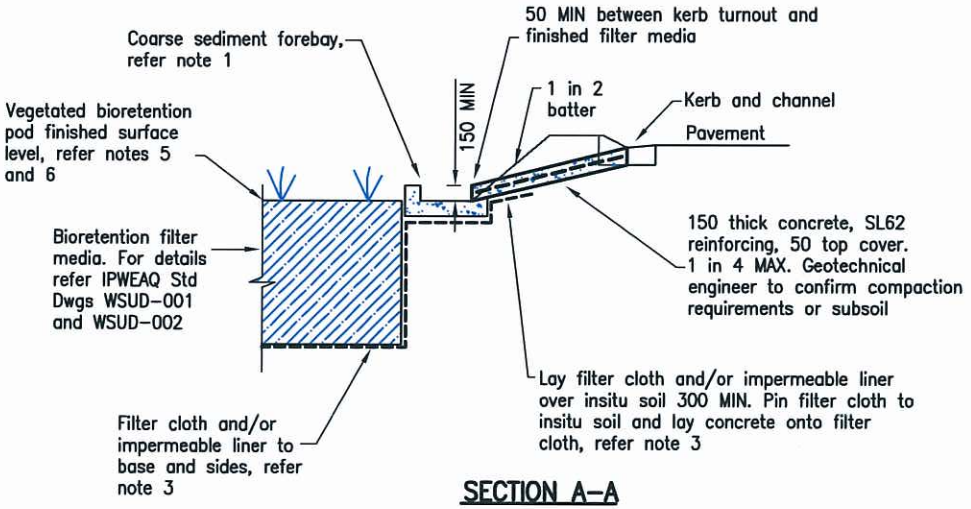
SHEET NUMBER	REVISION
903	P1



PLAN

NOTES:

1. Refer to relevant section of the "Water sensitive Urban Design Technical Design Guidelines" (Water by Design) and project drawings for sizing of coarse sediment forebay.
2. Under-drain: slotted rigid pipe to AS 2439.1 or approved equivalent, 0.5% MIN. grade. Refer project drawings for diameter and invert level (Typically ø100-150). Pipe should not be installed with a filter sock surrounding pipe. Under-drainage pipes shall be sealed into pits using grout or other approved watertight seal.
3. Filter cloth – non-woven geotextile. Filter cloth not to be placed between any filter layers. Impervious liner may be required subject to soil testing requirements in accordance with the "Water Sensitive Urban Design Technical Design Guidelines" (Water by Design).
4. Refer to project drawings for vegetated batter slope (1 in 3 MAX, 1 in 4 typical) and batter topsoil requirements.
5. Construction tolerances as documented in the "Water Sensitive Urban Design Construction and Establishment Guidelines – Swales, Bioretention Systems and Wetlands" (Water by Design) must be achieved. Construction tolerances must be noted on project plans. Invert levels of pits, pipes and base levels must be noted on project drawings.
6. Refer landscape drawings for plant specification. Plant specification and density shall be in accordance with the "Water Sensitive Urban Design Technical Design Guidelines for South-East Queensland" (Water by Design).
8. All dimensions are in millimetres unless otherwise noted.



SECTION A-A

waterbydesign

These drawings have been developed in consultation between the participating councils.
BEFORE USE, the user shall confirm that the drawing has been adopted by the appropriate council

Rv.	DATE	REVISIONS
A	13/01/2010	ORIGINAL ISSUE

INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALIA
QUEENSLAND DIVISION INC.
STANDARD DRAWINGS

BIORETENTION POD
KERB CUTOUT

DRAWING No.
WSUD-007
Rv. A

APPENDIX E: BIORETENTION MAINTENANCE REQUIREMENTS

SCHEDULE OF SITE VISITS													
Purpose of Visit	**Frequency**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Routine inspection	12/year	√		√		√		√		√		√	
Annual inspection	1/year					√							
Routine Maintenance	4/year	√			√			√			√		

The above schedule is a guideline only. Inspection and maintenance activities during the plant establishment period (first two years) are likely to be more frequent when frequent weed removal and replanting may be required. Inspections should also be performed after large rainfall events to check for damage or significant pollutant accumulation. Maintenance should only occur after a reasonably rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage. Resetting (i.e. complete reconstruction) of the bioretention basin will be required if the system fails to drain adequately after tilling of the surface.

Mowing will be required at frequent (approximately monthly) intervals if the bioretention system (floor and/ or batters) has been planted with turf.

INSPECTION	
1	**Routine Inspection**
1.1	Routine inspection should be carried out on a regular bi-monthly basis. The purpose of the inspection is to check for weed invasion, litter accumulation and any damage/vandalism.
1.2	The bioretention system (including floor and batters) should be inspected for weed growth.
1.3	The bioretention system (including inflow points, overflow pits, under-drains and vegetation) should be checked for litter accumulation.
1.4	Identify areas of obvious sediment deposition, damage from vehicles and/ or clogging within the bioretention basin (evident by ponding and/ or 'boggy' filter media surface). If there is shallow ponding or evidence of clogging, firstly ensure that cause is not a build up of sediment. Investigate effect of "turning over" or "tilling" filter media soil, and inspect outflow pipes for clogging.
1.5	Identify areas of erosion, including scouring from storm flows and rill erosion of the batters from lateral inflows.
1.6	Any structures such as maintenance accesses, weirs, piping and access restrictions (eg. lock-rails, fencing) should be inspected for damage and or vandalism.
2.	**Annual Inspection**
2.1	Once per year, the condition of the bioretention basin should be closely inspected. Any damage or problems should be noted on the inspection form for action by the relevant maintenance agency.

ROUTINE MAINTENANCE	
3	**Purpose**
3.1	Routine maintenance of the bioretention system involves weed control and the collection of any litter and minor remedial works if required. If turf has been planted across the surface of the bioretention system, this will obviously require mowing (with mowed grass deposited offsite at an appropriate waste management facility).
4	**Weed Management**
4.1	If weeds have been observed within the bioretention system during routine inspection, these weeds should be removed by hand.
4.2	Where physical removal has been specified, the aim is to remove the weed including the roots when the weeds are less than 3 months old.
4.3	Herbicides should not be used.
4.4	The weeds should be disposed of offsite at an appropriate waste management facility.
4.5	Replant plant species as necessary in areas that have been extensively weeded.
4.6	*In general, the planted species should not be harvested. Harvesting plants has little, if any, benefit for treatment performance.*
5	**Litter Management**
5.1	Remove and dispose of any accumulated litter/debris within the bioretention basin.
6	**Surface Tilling**
6.1	If there is evidence of clogging of the bioretention system, tilling the bioretention basin surface or remove of the surface layer.
7	**Sediment Removal**
7.1	Removal of sediment where it is smothering the bioretention basin vegetation. Remove accumulated sediments by surface scraping (if it does not damage the vegetation too much) or reforming of the bio-retention system.
8	**Under-Drainage Cleaning**
8.1	If the bioretention system is not draining, a reason may be due to the under-drainage being blocked by sediment or litter/ debris. This blockage should be removed by 'rodding' or 'jetting' (using high pressure water) of the under-drainage. As a result, 'rodding' points should be provided at the upstream ends of all under-drainage.
9	**Remedial Works**
9.1	Routine inspection may detect minor damage to the bioretention system after storms that should be repaired. This may include erosion on the bioretention system or scouring at the inlet and/or outlet. This damage should be repaired as part of the routine maintenance of the bioretention system. Measures to reduce future damage (eg. erosion) from occurring should also be investigated and, if possible, implemented.
9.2	Resetting (i.e. complete reconstruction) of the bioretention system will be required if the system fails to drain adequately after tilling of the surface and no evidence of sediment accumulation or under-drainage blockage can be identified.

BIORETENTION SYSTEM MAINTENANCE CHECKLIST				
Asset I.D.				
Inspection Frequency:	1 to 6 monthly	**Date of Visit:**		
Location:				
Description:				
Site Visit by:				
INSPECTION ITEMS			**Y**	**N**	**ACTION REQUIRED (DETAILS)**
Sediment accumulation at inflow points?					
Litter within bioretention system?					
Erosion at inlet or other key structures?					
Traffic damage present?					
Evidence of dumping (building waste)?					
Vegetation condition satisfactory (density, weeds etc)?					
Watering of vegetation required?					
Weed removal required ?					
Mowing/slashing required?					
Pruning and/ or removal of dead or diseased vegetation required?					
Replanting required?					
Damage/vandalism to structures present?					
Set down from kerb still present (if road-side bioretention swale)?					
Evidence of ponding?					
Surface clogging visible?					
Drainage system inspected?					
Clogging of drainage points (sediment or debris)?					
Resetting of system required?					
COMMENTS					

APPENDIX F: BIORETENTION ASSET TRANSFER CHECKLIST

BIORETENTION BASIN ASSET TRANSFER CHECKLIST			
Asset I.D.			
Asset Location:			
Construction by:			
'On-maintenance' Period:			
TREATMENT		**Y**	**N**
System appears to be working as designed visually?			
No obvious signs of under-performance?			
MAINTENANCE		**Y**	**N**
Maintenance plans and indicative maintenance costs provided for each asset?			
Vegetation establishment period completed (2 years)?			
Inspection and maintenance undertaken as per maintenance plan?			
Inspection and maintenance forms provided?			
ASSET INSPECTED FOR DEFECTS AND/OR MAINTENANCE ISSUES AT TIME OF ASSET TRANSFER		**Y**	**N**
Sediment accumulation at inflow points?			
Litter within basin?			
Erosion at inlet or other key structures?			
Traffic damage present?			
Evidence of dumping (e.g. building waste)?			
Vegetation condition satisfactory (density, weeds etc)?			
Watering of vegetation required?			
Replanting required?			
Mowing/slashing required?			
Clogging of drainage points (sediment or debris)?			
Evidence of ponding?			
Damage/vandalism to structures present?			
Surface clogging visible?			
Drainage system inspected?			
Weir/up-turned pipe is clear of debris (if required)?			
Water level in saturated zone as designed (if required)?			
COMMENTS/ACTIONS REQUIRED FOR ASSET TRANSFER			
ASSET INFORMATION		**Y**	**N**
Design Assessment Checklist provided?			
As constructed plans provided?			
Copies of all required permits (both construction and operational) submitted?			
Proprietary information provided (if applicable)?			
Digital files (e.g. drawings, survey, models) provided?			
Asset listed on asset register or database?			

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