AND

Neil M Craigie Pty Ltd

Berwick Waterways

Drainage Assessment, Options Development and Appraisal

Draft Report for Comment

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Report by:

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Contents

1. Introduction

Berwick Waterways refers to a study area that is currently zoned for rural living development in Berwick. The area is also known as the Homestead Road Extension Development Services Scheme (DSS) by Melbourne Water Corporation (MWC). The area is bounded by the levee banks of Hallam Valley Contour Drain and Berwick Town Drain to the west, Greaves Road to the south and existing residential development to the east and north. MWC have an existing drainage strategy incorporating a linear wetland and filling of land to facilitate development.

A major obstacle to rezoning is the acquisition, construction and maintenance of the land required for drainage. In April of 2008, Melbourne Water agreed to purchase the land required for the wetland reserve, on the condition that Council can demonstrate development for urban purposes is viable given the very high cost of providing the infrastructure.

To enable future development of the area, further investigation and conceptual planning was required to overcome factors limiting feasibility, and address Melbourne Water's concerns. Therefore the Growth Areas Authority (GAA) has initiated this project to enable:

- cost effective development of Berwick Waterways; and,
- coordinated and equitable delivery of drainage infrastructure.

In September 2009 Stormy Water Solutions and Neil M Craigie Pty Ltd produced a report entitled "Berwick Waterways, Summary Issues Paper, 14 September 2009". This first report specifically:

- summarised the current drainage strategy for the area as documented within MWC's Homestead Road Extension DSS,
- detailed the history of drainage in the area,
- identified issues and constraints in regard to the drainage infrastructure, and
- identified possible changes to the current drainage strategy which could be utilised to meet the objectives described above.

The Summary Issues Paper should be read in conjunction with this report.

On 22 September 2009 the GAA, MWC, City of Casey and the consultant team workshopped all issues identified. Following this input the consultant team developed three "Themes" and identified the relative benefits of each. Following this work the GAA, MWC, City of Casey and the consultant team met on the 26 October 2009. At this meeting "Theme 2" as presented in this report was adopted as the most viable drainage strategy for the area. Section 4 describes the adopted strategy in detail.

This current report:

- Details the September 2009 workshop outcomes,

- Describes the drainage strategy themes investigated the comparison analysis relating to the themes,
- Describes the adopted Berwick Waterways Drainage Strategy including the
    - Reasons for adoption,
    - The opportunities it generates,
    - The constraints in regard to its implementation,
    - The technical challenges, and
    - The staging implications.

In conclusion, it is considered that the drainage strategy presented in Section 4 of this report can result in development of the subject area for urban purposes without prohibitive fill costs. However, the costs associated with providing drainage infrastructure will be higher than in conventional developments. Allowing as much higher density development as possible will increase the benefits cf. the costs of developing the area. In addition, external MWC funding outside of the DSS system will probably be required. This is in line with the external drainage and WSUD benefits attributed to the drainage strategy. This funding could reduce the applicable DSS contribution rate within the Homestead Road DSS.

2. Workshop Outcomes

On 22 September 2009 the GAA, MWC, City of Casey and the consultant team workshopped all issues identified within the September 2009 Summary Issues Paper.

A number of opportunities, constraints and design requirements were discussed with the aim of optimising the drainage system cost, reserve acquisition cost and fill levels on adjacent development. These are discussed below.

2.1 Engineering Requirements

It was agreed that the original DSS strategy of providing an on line wetland system to meet the flood storage and water quality requirements of the Homestead Road Extension DSS, the Homestead DSS and O'Sheas Road DSS was an appropriate engineering solution. In fact, without an on line wetland system, development of Berwick Waterways cannot occur as:

- Outfall for piped drainage can not be accommodated as in a conventional pipe to drain connection due to existing shallow drainage invert constraints,
- Fill requirements would be significant (over 1.5 metres fill typically expected), and
- The flood storage requirements would severely limit the developable area without the major cut allowed for by the wetland system.

The primary objective of the current work therefore is to optimize the existing DSS drainage strategy incorporating an on line wetland and flood storage system. The aims are to minimise:

- drainage infrastructure costs,
- drainage reserve acquisition, and
- adjacent development fill requirements.

In order to facilitate these objectives the following principles were agreed to by Council, the GAA and MWC.

- In general the wetland alignment should aim to be aligned 50/50 over existing drainage lines, however this aim could be varied given other town planning objectives as discussed below.

- It was recognised that, in this area, the land is so flat that the alignment can be varied considerably from the existing drainage line.

- Wetland extension "fingers" can be incorporated. These are wetland branches connecting a small local catchment to the main on line wetland system. They are considered part of the primary wetland, and incorporate the same normal water level and extended detention. Wetland fingers will require some upstream catchment for flushing. Alternatively a pump arrangement could be considered in a risk management sense if water quality issues are a concern in dry times (i.e. pump from main wetland to upstream extent of the wetland finger areas), although MWC do not support the use of pumped systems.

- A 60 metre minimum wetland reserve requirement was agreed to ensure wetland, batters and maintenance access paths can be accommodated. It should be noted that this is an average width. Up to 80 metres may be required where major pipe outfalls require sediment pond treatment. There may also be opportunities to reduce the reserve width to 45 metres along short sections. In addition the use of connecting balance or link pipes could in short sections replace the wetland altogether. However, there will be a requirement to make compensatory increases in the reserve width elsewhere in strategic locations if balance pipes are incorporated, because the overall wetland area is essentially fixed so as to provide the necessary flood storage below the 100 year ARI flood level.

- The existing Buddhist temple could be accommodated by constructing a wetland though the southern portion of the site (if allowed by current landowners) or construction of a balance pipe though the southern portion of the property.

- Any wetland normal water level must be at least 15 metres from a private allotment boundary.

- The development fill level is required to be not less than 300 mm above 100 Year ARI flood Level of 18.15 m AHD. This results in a minimum fill level of 18.45 m AHD. A S173 agreement will be required to ensure all future floor levels are 600 mm above 100 Year ARI flood level.

- Road low points can be constructed at the 100 Year ARI flood level.

- Minimum pipe slopes can be 1 (vertical) to 600 (horizontal) to minimise fill requirements over pipelines. Pipe flow velocities meet current MWC requirements for flushing purposes.

- “Saw tooth” longitudinal road profiles are considered an appropriate design response. However there must be a legal point of discharge for all lots and no surface ponding in the road reserves. This should be stated as a requirement in structure plan documentation. Development levels and floor levels must be referenced to a line across the high points of a saw tooth road profile and not follow the profile into the low points.

- The pipe system must be constructed to a 5 year ARI design capacity.

- It is required to assess the suitability of wetland cut for development fill. At this stage it is assumed that, in general, site cut is suitable for filling adjacent development. This accords with experiences on the Berwick Springs and Beaumont Waters Estates immediately to the south of Greaves Road.

2.2 Minimisation of Drainage System and Fill Costs

The following initiatives were identified by the team as being suitable to use to minimise fill costs. It should be noted that many of the engineering requirements above were also agreed to achieve this objective.

1. Land value adjacent to wetland systems can increase significantly if higher density development occurs as apposed to normal residential development. As such, the planning process should encourage appropriate higher density residential and related development of the area. It was noted that the greater the population density the greater the requirements for POS interaction.

2. wetland “fingers” should be incorporated into the development to maximise wetland frontage, land value and public interaction with the asset and to reduce pipe run lengths and fill depths. MWC recognize that wetland fingers are part of the MWC flood storage system.

3. Balance pipes could be used to integrate Public Open Space (POS) uses along and within the wetland reserve and wetland finger locations.

4. MWC prefer the developer to contribute land rather than to acquire. Where acquisition is necessary, MWC prefer land to be acquired in line with development so as not to spend upfront DSS funds and thus increase the DSS rate.

5. It may be prudent to approach individual landowners to assess if they are willing to sell part of their property directly to MWC without a development process in play . MWC is open to initiating this valuation process once agreed engineering reserve plans are available.

6. MWC indicated that they will initiate the reserve valuation process once agreed engineering reserve plans are available. Reserve land which is not currently subject to inundation (ie., above the 100 year ARI flood level of 18.15 m, including the MWC-owned lands) should be valued as unencumbered residential land.

7. MWC will investigate apportioning water quality and/or flood storage costs between O’Sheas Road DSS, Homestead Road DSS and Homestead Road Extension DSS. To assist in this

process some preliminary apportioning of costs based on RORB and MUSIC modelling is presented in this report (Appendix D). Apportioning costs could reduce the DSS rate applicable to the Homestead Road Extension DSS. The information presented in this report in no way predicts how MWC may apportion costs. It is presented for background and discussion purposes only at this stage to assist in the decision making process.

In general, MWC have indicated that they prefer to get the engineering and town planning correct and in place prior to organizing financing issues. MWC reiterated that they are prepared to acquire the reserve provided the development is shown to be economically viable.

2.3 Drainage System and Development Staging

Staging was agreed to be relatively flexible and general principles agreed to as in the Summary Issues Paper and in Section 5 of this report.

However, in some cases part of the wetland system can be built in conduction with a development and although not connected to the main wetland system, could have a temporarily higher normal water level and temporarily drowned inlet pipes. The structure planning documentation could include appropriate direction to indicate that this could occur as development proceeds.

2.4 Constraints

The following constraints were indentified in addition to the constraints highlighted in the Summary Issues Paper.

1. Any developed strategy must meet original DSS flood storage and water quality objectives and requirements.

2. A 4% POS component in any future subdivision is required without including wetland reserve allowances in this calculation.

3. The wetland reserve is to be determined on drainage and MWC requirements only.

4. Any council POS must be “unencumbered” . For instance, for the purposes of POS area calculation, football ovals (or the like) are to be at or above 100 year ARI flood level. Oval areas to be well drained to ensure space is usable even in wet seasons.

5. The team recognized that the principle of developers contributing land in lieu of acquisition is difficult when there are many small lots involved and especially where an individual developer may be losing a large proportion of the property.

2.5 Opportunities

The following opportunities were indentified in addition to the opportunities highlighted in the Summary Issues Paper.

1. Investigation of placement of reserve as far east as possible in the development should occur to centralize the system in regard to public access.

2. This is an opportunity to link the major wetland system and wetland finger areas to a future activity centre and/or major public open space facility.

3. It is recognised that part of councils 4% POS could be placed adjacent to “drainage” reserve for seamless integration of POS. This would work best if the wetland system is in a central location for resident access.

2.6 Initiatives Deemed not Suitable for Further Investigation

The team discussed the use of additional retarding basins, rainwater tanks etc to supplement and reduce the on line flood storage requirement. Systems of this type would fill and empty long before the peak flood storage built up in the main storage area. As such, there is very little benefit in reducing flood storage requirement in the main storage area due to initiatives of this type. Previous DSS investigations had investigated this option and found the above to be proven.

In addition, the use of road swales to supplement flood storage was discussed. A 500 mm deep (typical) swale would only provide an additional 50 m^3 flood storage for the 100 metres of swale directly upstream of the main drainage reserve. This is negligible given 172,000 m^3 total flood storage requirement, even if quite a few roads incorporate this feature. There would also be the issue of ongoing maintenance concern for Council.

As such, the above two initiatives were not further investigated. However this does not rule out the use of landscaped swales to assist with passive watering of vegetation in roadways and reserves.

2.7 Workshop Outcomes

Given the opportunities identified above it was required for the consultant team:

- To investigate the sensitivity of the flood storage requirement to the assumption of normal density and medium density development within the Homestead Road Extension DSS,
- To investigate the sensitivity of the flood storage requirement to the outlet design arrangements with regard to optimising this requirement,
- To investigate the apportioning of the flood storage requirements by assessing the flood storage contribution of:
  - The existing Homestead Road DSS,
  - The future Homestead Road extension DSS,
  - The 1 m^3/s O'Shea Road pipe system input, and
- To investigate the apportioning of water quality requirements by assessing Total Nitrogen (kg/yr) contribution of:
  - The existing Homestead Road DSS,
  - The future Homestead Road Extension DSS, and
  - The 1 m^3/s O'Shea Road pipe system input.

The consultant team completed the flood various flood storage trials. The results are detailed below.

1. The base case (original DSS proposal) results in storage volume of 174,000 m^3, peak outflow is 2.51 m^3/s and the critical duration 30 hours.
2. If the O'Sheas Rd DSS inflow of 1 m^3/s is removed the storage volume reduces to 129,000 m^3, peak outflow is 1.95 m^3/s and the critical duration 36 hours.
3. If the outlet is augmented (eg., by doubling the 900 mm diameter outfall to Berwick Town Drain) the storage volume is 169,000 m^3 and the peak outflow is 2.45 m^3/s.
4. Assuming normal residential development only with no allowance for higher density in floodplain area the storage volume is 171,000 m^3 and the peak outflow is 2.47 m^3/s.

The results confirm the only critical factor is the O'Sheas Rd DSS inflow. That is, this inflow is accounting for 26% of the overall flood storage requirement. The inflow is required (i.e. cannot be removed) to ensure the wetland health and turnover and to provide stormwater treatment for stormflow developed within the O'Sheas Road DSS. Therefore, going forward in developing various drainage themes, the consultant team assumed that any updated DSS will augment the existing outlet to minimise flood storage requirements to 169,000 m^3.

In addition, RORB and MUSIC modelling resulted in the following apportioning of flood storage and water quality benefits:

Wetland Benefits (based on contributing Total Nitrogen Load, best practice will be met):

- Homestead Road Extension DSS - 21%
- Homestead Road DSS - 16%
- OSheas Road DSS - 63%

Flood Storage Benefits (based on removing input (or assuming no catchment development) in RORB model and assessing reduction in the flood storage requirement):

- Homestead Road Extension DSS - 65%
- Homestead Road DSS - 16%
- OSheas Road DSS - 26%

As such, there is good evidence for significant cost contribution for the external catchments via MWC.

As such, after the workshop, it was determined that the consultant team should develop 3 themes for discussion which incorporate the workshop agreements, opportunities and constraints.

In addition, the GAA and Council were required to:

- Investigate POS, activity centre, reserve requirements etc,
- Give direction to team of probable development density required, and
- Investigate suitability of wetland cut for development fill. The GAA indicated that they could check council records or any other available data.

3. Developed Drainage Strategy Themes

The three Themes developed given the workshop outcomes described in Section 2 are discussed below. All three themes are shown in Appendix A.

3.1 Theme 1

Theme 1 is the optimisation of the original DSS Strategy. It assumes:

- Incorporation of a central (or east of central) wetland reserve location to maximize access potential of residents to the wetland area,
- Maximization of wetland frontage,
- Incorporation of 60 m wide reserve areas (average) to allow for wetland water width, batters, MWC access paths etc,
- Incorporation of a 80 m reserve where major pipe inlets are proposed for sediment pond construction,
- An allowance of at least 15 metres offset to NWL from the reserve boundary, which results in a maximum average batter slope of about 1 in 10,
- A drainage reserve extent which just allows for drainage functions,
- A minimal flood storage volume of 169,000 at 18.15 m as per the minimum flood storage requirement detailed above,
- The 100 Year ARI flood extent is contained within the drainage reserve (on average at least 3 m within the reserve line given a 1 in 10 batter from the top of the fill line),
- Incorporation of 300 mm fill above 100 Year ARI flood level (min),
- All roads assumed to not require fill and to be at or above the 100 Year ARI flood level,
- Incorporation of a saw tooth road design and 1 in 600 pipe slopes (meeting pipe flushing requirements) to minimise fill requirement, and
- Apportioning the wetland in as equitable a way as possible between existing landowners, given consideration of existing drain alignment and issues detailed above.

3.2 Theme 2

Theme 2 incorporates all the optimisation considerations as Theme 1. However, a wetland finger is extended into the development area to reduce the pipe run length and fill requirement. In addition, Theme 2 allows for a balance pipe in the Buddhist temple land to minimise impact.

3.3 Theme 3

Theme 3 incorporates all the optimisation considerations as Theme 1 and the wetland finger and balance pipes as in Theme 2. However, some provision is shown for incorporation of POS within the wetland environment. The POS land shown will be at or above the 100 Year ARI flood level and will not require filling. Council is assumed to own the POS shown. The POS land shown could contribute to the 4% POS requirement.

3.4 Comparison Analysis

To assist in adoption of an appropriate theme by the GAA, Casey City Council and MWC the themes were assessed against the required performance criteria.

Performance criteria assessed were:

- Developable area,
- Wetland and DSS drainage infrastructure construction costs,
- Fill costs,
- Reserve acquisition costs,
- Equitable delivery of drainage infrastructure,
- The ability of the theme to meet the original DSS requirements,
- The ability of the theme to limit the impact of the strategy on existing land uses (e.g. the existing Buddhist Temple),
- The ability of the theme to maximize amenity, financial and community value of drainage assets, and
- The ability of drainage strategy and adjacent residential development to be staged.

As detailed in Appendix B, all themes represent a significant optimisation of fill and acquisition costs when rated against the original DSS strategy. All themes result in comparable reserve acquisition and fill requirements.

The only differences are wetland orientation, wetland alignment and integration of POS. Themes 2 and 3 score better in some of these additional aesthetic and social aspects and therefore, in theory, seem to provide a direction for the way forward.

Obviously the decision of which theme to adopt is the drainage strategy which can be best utilised in a town planning sense to maximise the value of the residential development and provide the best blueprint going forward. As such, the workshop team decided that Theme 2 was the best theme to adopt for development of the drainage strategy and MWC DSS for the area. This adopted Theme is further discussed below. As with all drainage strategies, provided the design intent is met, variations in reserve/wetland form and alignment can occur to best meet the town planning requirements.

4. Adopted Drainage Strategy

Theme 2 was further developed into the adopted drainage strategy detailed in Figure 1 below.

4.1 Adopted Drainage Strategy Description

The adopted drainage strategy results in:

- The total water surface area of the wetland pondage systems = 10.0 ha,
- The normal top water level (NWL) of the wetland pondage areas = 16.90 m AHD,
- The 100 year ARI flood level = 18.15 m (existing MWC declared level),
- 100 Year ARI flood area = 17.1 ha (approx),
- 100 Year ARI flood storage = 169,000 m^3 above NWL, assuming restricted outflow below top of extended detention (TED) level of 17.3 m AHD (30- 48 hours critical duration).
- Permanent pool = water volume of water impounded at Normal Top Water Level = 85 ML (Appendix C).
- The total volume of cut = 280,000 m^3 (Appendix C).
- Total (approximate) volume of fill on adjacent developable land is in the order of 250,000 m^3 (Appendix D). However, all cut material is assumed to be able to be used to fill abutting development land to optimise wetland construction costs, subject to confirmation of suitable quality. This is results in fill levels about 50 mm higher than the minimum fill levels detailed in Figure 1.
- The proposed wetland system will achieve the best practice pollutant removal targets for all parameters for the combined O'Sheas Rd and Homestead Rd DSS and Homestead Road Extension DSS catchments. This was confirmed using MUSIC Version 4 by Stormy Water Solutions in November 2009.

The preliminary "land take" calculations indicate:

- The total DSS area is about 85.5 ha,
- The total drainage/recreation reserve area shown in Figures 1 is approximately 20.3 ha which infers about 3.2 ha of flood-free recreation land. This flood free land is still required within the wetland reserve area to:
  - Meet the MWC 15 m offset requirement to the reserve boundaries, and
  - To ensure adequate fill over the pipelines at the reserve boundary (in most cases adjacent roads will need to be 300 mm above the 100 Year flood level to ensure adequate cover in road reserve pipes),
- The existing road reserves incorporate about 6.2 ha of the DSS area, and
- The total developable area (including the 4% POS provision) is about 59.0 ha.

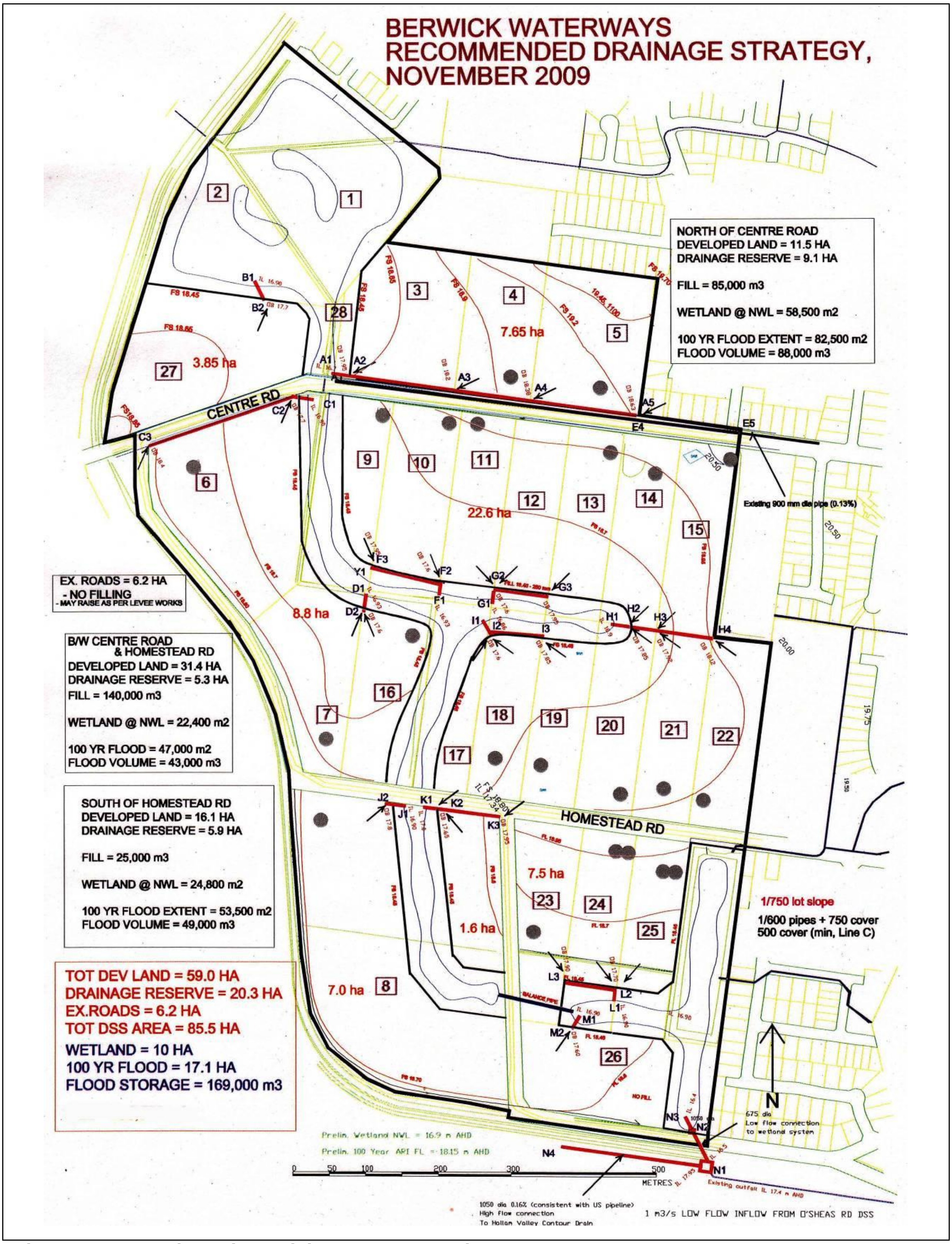


Figure 1 Adopted Berwick Waterways Drainage Strategy
(Preliminary Homestead Road Extension DSS Requirements)

4.2 Preliminary Drainage and Reserve Acquisition Costs

A preliminary cost estimate of the main drainage and drainage reserve acquisition costs was undertaken using the current MWC DSS costing spreadsheet and the drainage infrastructure requirements shown in Figure 1. The preliminary cost estimate is detailed in Appendix C. The summary is shown in Table 1 below.

It should be noted that this estimate has been completed for discussion and planning purposes only at this stage. It in no way predicts the final DSS rate to be adopted by MWC. All estimates are subject to change given GAA, MWC and Council review. The estimate does not include any net present value analysis or consideration.

Table 1
Summary of Preliminary Drainage Infrastructure and Drainage Reserve Acquisition Costs

Works Description	Estimated Construction Cost	Estimated Land Acquisition Cost
Pipes	$512,715	$0
Channels	$0	$0
Culverts	$712,016	-
Retarding Basins - Flood Storage function above Wetland NWL	$1,605,900	$2,110,819
Levee Bank Works	$820,200	-
Swales	$0	-
Wetlands	$1,741,936	$1,614,181
Sediment Basins	$0	-
Litter Traps	$0	-
Buffer Strips	$0	-
Bio-Retention Basins	$0	-
Bio-Retention Swales	$0	-
Related Costs/Works	$0	-
Sub-total 'A'	$5,392,767	$3,725,000
'A' x Engineering Fee @ 15%	$808,915	-
Sub-total 'B'	$6,201,682	$3,725,000
'B' x Administration Fee @ 9%	$558,151	-
(Land Acq only) 'B' x Administration Fee @ 1%	-	$37,250
Sub-total 'C'	$6,759,833	$3,762,250
'A' x Contingencies @ 20%	$1,078,553	$745,000
FORECAST EXPENDITURE	**$7,838,387**	**$4,507,250**
TOTAL COST	**$12,345,637**	

As detailed:

- The total drainage construction costs, including pipelines, Hallam Valley Bypass levee bank augmentation works, balance pipes, wetlands and flood storage provisions is estimated at $7.8M. This is similar to the MWC estimate of $7.7M in their 2004 strategy.
- The total reserve acquisition cost is estimated at about $4.5M assuming a rough acquisition rate of $500,000 per hectare. It is recommended that the MWC confirm the likely acquisition rate so that this value can be more accurately predicted and reflected in the future DSS rate. It should be noted that the acquisition area is assumed to be the reserve area required minus the area already owned by MWC minus an allowance for a 30 metre reserve either side of the existing drain. MWC traditionally requires a 30 (typical) metre reserve along existing drainage lines. Thus, only reserve acquisition of land in excess to the 30 metre reserve is required (as advised by MWC, November 2009)

The above estimate is considered to represent an optimization of the DSS costs in relation to the adopted strategy given all of the considerations discussed previously in this report.

The funding of most of the works will be obtained by application of a MWC DSS contribution rate to developable land. However, in this case the final DSS rate will be significantly affected by:

- The assumed development density, and
- The MWC contribution outside of the Homestead Road Extension DSS based on the proven premise that the wetland and flood storage area are providing significant benefits to external catchments.

Appendix D presents some (hypothetical) scenarios given variations in the above assumptions. A summary of the results are presented below in Table 2 below. It should be noted that the apportioning of flood storage and water quality benefits is based on detailed RORB and MUSIC modelling. All scenarios are presented for discussion purposes only at this stage an in no way predict the final DSS rate which will be adopted by MWC in the future.

Table 2 Various Cost Drainage Cost Apportioning Scenarios

CASE 1 - Homestead Road Extension DSS Contributing Solely to Works			
% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$209,248**	**$185,998**	**$167,398**
CASE 2 - Homestead Road Extension DSS Contributing Solely to Flood Storage, Wetland Costs Apportioned			
% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$149,194**	**$132,617**	**$119,355**
CASE 3 - Homestead Road Extension DSS Contributing Solely to Wetland Costs, Flood Storage Costs Apportioned			
% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$180,250**	**$160,222**	**$144,200**
CASE 4 - Homestead Road Extension DSS , Flood Storage and Wetland Costs Apportioned			
% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$120,196**	**$106,841**	**$96,157**

As detailed:

- The higher the density of development within the Homestead Road extension DSS, the more cost effective it is to actually develop the land (based on the reduced DSS rate), and
- Apportioning costs can significantly decrease the DSS rate.

Preliminary discussions with MWC indicate that a likely scenario is for MWC to recognise that the scheme offers significant water quality benefits to the O'Sheas Road DSS. Given a 50/50% assumed split in high density and normal density development, a likely DSS rate is in the order of $130,000 per hectare (for normal density land).

This rate is about 60% more than the rate of any existing applied DSS rate in Melbourne. The surrounding development will be required to be very high quality to give a good rate of return on development. The wetland social, landscape and amenity potential should significantly aid in achieving this requirement.

4.3 Preliminary Fill Requirements and Costs

Total (approximate) volume of fill on adjacent developable land = 250,000 m^3 (Appendix D). However, all cut material is assumed to be able to be used to fill abutting development land to optimise wetland construction costs, subject to confirmation of suitable quality. The wetland and flood storage “cut” volume is 280,000 m^3. Therefore, final fill levels may be in the order of 50 mm higher than those detailed in Figure 1 (on average).

Using the higher figure of 280,000 m^3 also adds some flexibility in the development design in regard to pipe cover, road form etc. As such 280,000 m^3 is the assumed fill requirement on adjacent development land.

Table 3 estimates that the costs of filling the adjacent developable land is in the order of $4.5M. This assumes a fill rate of $10/$m^3$ for filling with onsite cut (obtained from the wetland and flood storage construction). This rate is greater than the current MWC recommended rate of $6/$m^3$ for this activity.

Table 3
Summary of Preliminary Fill Costs

Description	Quantity	Rate	Amount
Strip Topsoil (200mm)	12,000 m^3	$6.00 /$m^3$	$72,000
Filling with onsite cut	280,000 m^3	$10.00 /$m^3$	$2,800,000
Topsoiling	12,000 m^2	$17.00 /$m^3$	$204,000
		Sub-total 'A'	$3,076,000
		'A' x Engineering Fee @ 15%	$461,400
		Sub-total 'B'	$3,537,400
		'B' x Administration Fee @ 9%	$318,366
	(Land Acq only)	'B' x Administration Fee @ 1%	-
		Sub-total 'C'	$3,855,766
		'A' x Contingencies @ 20%	$615,200
		FORECAST EXPENDITURE	**$4,470,966**

4.4 Opportunities

As with all drainage strategies, provided the engineering design intent is met, variations in reserve/wetland form and alignment can occur to best meet the town planning requirements.

The adopted drainage strategy for Berwick Waterways offers the opportunity to demonstrate the significant complementary benefits for on line wetland and flood storage systems of this type. As was the case for other similar projects such as The Waterways, Berwick Springs and Beaumont Waters this will showcase innovative use of wetland systems to not only provide water quality treatment, but also:

- Show how this concept can actually facilitate adjacent development by accommodating piped drainage systems in area with very shallow and flat drainage outfall systems,
- Show how incorporating wetland systems of this type can significantly reduce adjacent development fill requirements, and

- Show how the wetland systems can maximise developable area by maximising flood storage in the airspace above the wetland system.

In addition to the above there is a significant opportunity to fully integrate the wetland and drainage reserve into the adjacent development and POS design. The drainage strategy detailed in Figure 1 shows the minimum drainage requirements only. There is significant scope to vary the shape and form of the wetland system to (say) provide significant landscape open water areas close to activity centres and POS areas provided the constraints detailed below are adhered to.

Investigation of placement of reserve area as far east as possible in the development should occur to centralize the system in regard to public access. Certainly incorporation of wetland “fingers” into the development will maximise wetland frontage, land value and public interaction with the asset. Balance pipes could be used to integrate Public Open Space (POS) uses along and within the wetland reserve and wetland finger locations.

In essence, provided the engineering intent of the drainage strategy is met, the final landscape form has significant potential to be varied to maximise the amenity and social benefits of the drainage reserve and hence maximise the land value of the developable area of Berwick Waterways.

Of course this local landscape benefit could also be utilised regionally via the use of walking and bicycle paths linking this major green system to the large Berwick Springs/Beaumont Waters open water and wetland systems located to the south of Greaves Road.

It is recognised that part of councils 4% POS could be placed adjacent to “drainage” reserve for seamless integration of POS. This would work best if the wetland system is in a central location for resident access.

There is an opportunity to design the wetland as a long term self sustaining system which minimises the maintenance requirements and ongoing MWC/Council drain maintenance costs well into the future. On line wetlands of this type can significantly aid in reducing invert maintenance problems (typical in shallow drainage paths). Both MWC and Council current experience significant difficulties and costs in maintaining the present network of open drains.

In addition the new wetland would provide areas of ecological diversity in the development landscape and include ecological refuges (such as small islands) for locally engaged species such as the Growling Grass Frog.

Adjacent Council POS land could supplement this ecological role by providing, in addition to sporting and traditional parkland assets (such as playgrounds), ecological grassland and woodland areas which maximise local ecological diversity while facilitating recreational pursuits such as walking and bike riding.

4.5 Constraints

As stated above, the drainage strategy detailed in Figure 1 shows the minimum drainage requirements only. There is significant scope to vary the shape and form of the wetland system. However, the following constraints apply:

- Prior to ANY development occurring within the Homestead Road Extension DSS, the Hallam Valley Levee augmentation works should occur to ensure 100 Year ARI flood protection to any future development from this external drainage system.
- Any developed strategy must meet original DSS flood storage and water quality objectives and requirements,
- All engineering requirements specified in Section 2.2 and Section 4 must be adhered to.
- The general location of all wetland water entry and exit points must not change,
- The general location of the wetland crossing points at Ward Road, Homestead Road and Centre Road must not change,
- Any wetland fingered areas must have a reasonable upstream catchment to ensure flushing of the entire system during storm events,
- All developable land must be filled to the minimum fill levels specified in Figure 1 to ensure adequate outfall pipe cover and adequate flood protection in the 100 Year ARI flood event.

In addition to the above engineering constraints, the small landholdings and large number of landowners may provide some constraints in regard to implementing the “regional” landscape and social objectives of the drainage reserve and potential activity centres in the area. The principle of developers contributing land in lieu of acquisition is difficult when there are many small lots involved and especially where an individual developer may be losing a large proportion of the property.

As far as possible Council and MWC should work to engage all affected landowners as works proceed to ensure an integrated approach to the drainage strategy and development application.

Lastly, Council will require a 4% POS component in any future subdivision without including wetland reserve allowances in this calculation. This has implications for the placement of this POS. If located close to the drainage reserve the council POS must be “unencumbered”. For instance, football ovals (or the like) are to be at or above 100 year flood level. Oval areas are to be well drained to ensure space is usable even in wet seasons.

It should be noted that public open space areas could still be landscaped to be in flood prone areas. However the governing principle for the development will be that 4% POS must be external to flood area.

4.6 Technical Challenges

In general, although large and mutli-purpose in design intent (i.e. incorporating more than just a traditional WSUD role), the wetland and flood storage area is similar to many existing systems which have been shown to function successfully and should not result in any major technical challenges. The exception to this statement is the staging of the system which is discussed below.

The major technical issue within Berwick Waterways itself is to ensure all piped drainage systems can in fact outfall to the wetland system incorporating either a 1 in 600 slope (min) or adequate pipe slopes for flushing. The piped system shown in Figure 1 has been sized assuming these requirements (See Appendix C). However, care must be taken to ensure:

- Pipes are not drowned out at the wetland (i.e. a maximum of 200 mm permanent ponding in the pipes at the wetland is assumed (Pipeline A). In general the invert level of the pipes at the boundary of the wetland reserve is assumed to be the wetland NWL of 16.9 m AHD),
- Pipes incorporate adequate cover. In pipes running along the wetland boundary the constant fill level of 18.45 m AHD essentially limits pipe runs along and parallel to the wetland boundary, to about 100 metres.

In general, the above technical challenges will require developers to clearly show the following before approval of drainage plans:

- The location of all proposed pipes,
- The location of the outfall to the proposed wetland,
- The sediment pond details at the wetland outfall location,
- A longitudinal section of the pipeline clearly showing pipe sizes, invert levels, pit locations and design cover to final fill levels,
- A clear fill level plan of the development clearly showing minimum council lot grades and/or any saw tooth or similar design incorporated to minimise fill requirements, and
- The wetland design (including any temporary water level control measures) in the vicinity of the development where wetland cut will be used for subdivisional fill.

5. Development Staging

Staging was agreed to be relatively flexible and general principles agreed to as in the Summary Issues Paper.

With the "level-pool" wetland system and uniform flood level throughout, the concept was designed to allow for progressive wetland and development implementation. It is not necessary to build all of the wetland system in one go. It is entirely feasible to construct the system as a "patchwork" provided that drainage lines are not dislocated for intervals by filling.

Any staging plan must address the following issues:

- A developed parcel of land should aim to be able to achieve an outfall. That is the parcel of land must slope to a low point at the required surface grade and the piped drainage servicing that parcel of land must also incorporate a slope (and pipe cover) to drain the land. As the outfall level at the wetland is set (by the NWL), these slopes may be required to be achieved via extensive filling in excess of that required for flood protection.
- In some cases part of a wetland can be built in conjunction with a development and although not connected to the main wetland system, could have a temporarily higher normal water level and temporarily drowned inlet pipes. The structure planning documentation could include appropriate direction to indicate that this could occur as development proceeds.
- No down slope development must cause increased flooding on an (undeveloped) upslope parcel of land due to filling.

Therefore, in general, the staging will work best if:

- the wetland is constructed from downstream to upstream (north to south) so that all constructed wetland cells essentially have a "wetland" outfall.
- A development stage will generally require a constructed wetland cell either adjacent to, or just downstream of its main outfall point. In this way all development will incorporate adequate pipe outfall provisions.
- Upslope developments should generally precede or be built in conjunction with down slope developments.

As MWC may contribute funds outside the DSS, it may be prudent for MWC to:

- Construct the wetland north of Centre Road prior to development occurring, and
- Undertake the levee augmentation works prior to development occurring.

If these works are constructed using external MWC funding, their early construction should not increase the DSS rate.

If these works are completed first this could provide the catalyst for the “open for business” works and reduce the risk of development proceeding over a very long time period. By implementing these works MWC will:

- Reduce the risk of the remainder of the wetland works being required out of sync with the adjacent development,
- Ensure any future development is protected from flooding from the Hallam Valley Contour Drain, and
- Essentially be providing an outfall for the northern half of Berwick Waterways, thus decreasing the risk of any development proceeding with a drowned piped drainage system in the short to medium term.

6. Recommendation

It is recommended that the Growth Areas Authority, Melbourne Water Corporation and the City of Casey review this draft report and provide feedback to the consultant team by 11 December 2009.

In particular, MWC should investigate apportioning water quality and/or flood storage costs between O'Sheas Road DSS, Homestead Road DSS and Homestead Road Extension DSS. To assist in this process the preliminary apportioning of costs based on RORB and MUSIC modelling is presented in this report (Appendix D) should be considered. Apportioning costs could reduce the DSS rate applicable to the Homestead Road Extension DSS. The information presented in this report in no way predicts how MWC may apportion costs. It is presented for background and discussion purposes only at this stage to assist in the decision making process.

MWC is also required to investigate the probable drainage reserve acquisition rates as this value will directly affect the applicable DSS rate. MWC indicated that they will initiate the reserve valuation process once agreed engineering reserve plans are available. This process should commence on finalisation of this report and its contents. Reserve land, separated into land above and below the existing 100 year ARI flood level, should be valued as unencumbered residential land.

In addition, the GAA and Council are required to:

- Investigate POS, activity centre, reserve requirements etc,
- Advise on how the landscape and social opportunities could be incorporated into the planning process,
- Give direction to the consultant team of probable development density required, and
- Investigate suitability of wetland cut for development fill. The GAA indicated that they could check council records or any other available data.

The Berwick Waterways Drainage strategy detailed in this report optimises:

- development fill volumes,
- MWC Development Services Scheme (DSS) costs, and
- reserve area requirements to minimise reserve acquisition costs.

In conclusion, it is considered that the drainage strategy presented in Section 4 of this report can result in development of the subject area for urban purposes without prohibitive fill costs.

However, the costs associated with providing drainage infrastructure may be about 60% higher then simular developments.

The surrounding development will be required to be very high quality to give a good rate of return on development. The wetland social, landscape and amenity potential should significantly aid in achieving this requirement.

Allowing as much high density development as possible will increase the cost benefits of developing the area. In addition, external MWC funding outside of the DSS system will probably be required. This is in line with the external drainage and WSUD benefits attributed to the drainage strategy. This funding could reduce the applicable DSS contribution rate within the Homestead Road DSS.

7. Abbreviations, Descriptions and Definitions

The following Table lists some common abbreviations and drainage system descriptions and their definitions which are referred to in this report.

Abbreviation Descriptions	Definition
AHD - Australian Height Datum	Common base for all survey levels in Australia. Height in metres above mean sea level.
ARI - Average Recurrence Interval.	The average length of time in years between two floods of a given size or larger
Ephemeral Waterways	Waterways which flow for only short periods of time after rainfall events.
Bio-retention swale	A swale where the base contains a filter zone which storm water slowly seeps though to assist in stormwater pollutant removal
Council	Casey City Council
Ephemeral Wetlands	Wetlands which are either rarely inundated or only inundated for a very short period of time.
DSS	Refers to a Melbourne Water Corporation Development Services Scheme
Evapotranspiration	The loss of water to the atmosphere by means of evaporation from free water surfaces (eg. wetlands) or by transpiration by plants
Groundwater	All water stored or flowing below the ground surface level
GAA	Growth Areas Authority
Groundwater Level	The level of groundwater below the surface level at a particular point of interest (usually given in AHD or relative to surface level)
Inlet Pond	See Sediment Pond
Hectare (ha)	10,000 square metres
Hec Ras	Hydraulic computer program used to calculate flood depths (usually to AHD) and extents given a flood flow
Kilometre (km)	1000 metres
m^3/s -cubic metre/second	Unit of discharge usually referring to a design flood flow along a stormwater conveyance system
CKC	Charter Keck Cramer – Authors of the “Civil Engineering Development Cost Report, Proposed Residential Development, Berwick Waterways”, October 2008
Megalitre (ML) (1000 cubic metres)	1,000,000 litres = 1000 cubic metres. Often a unit of water body (eg pond) size

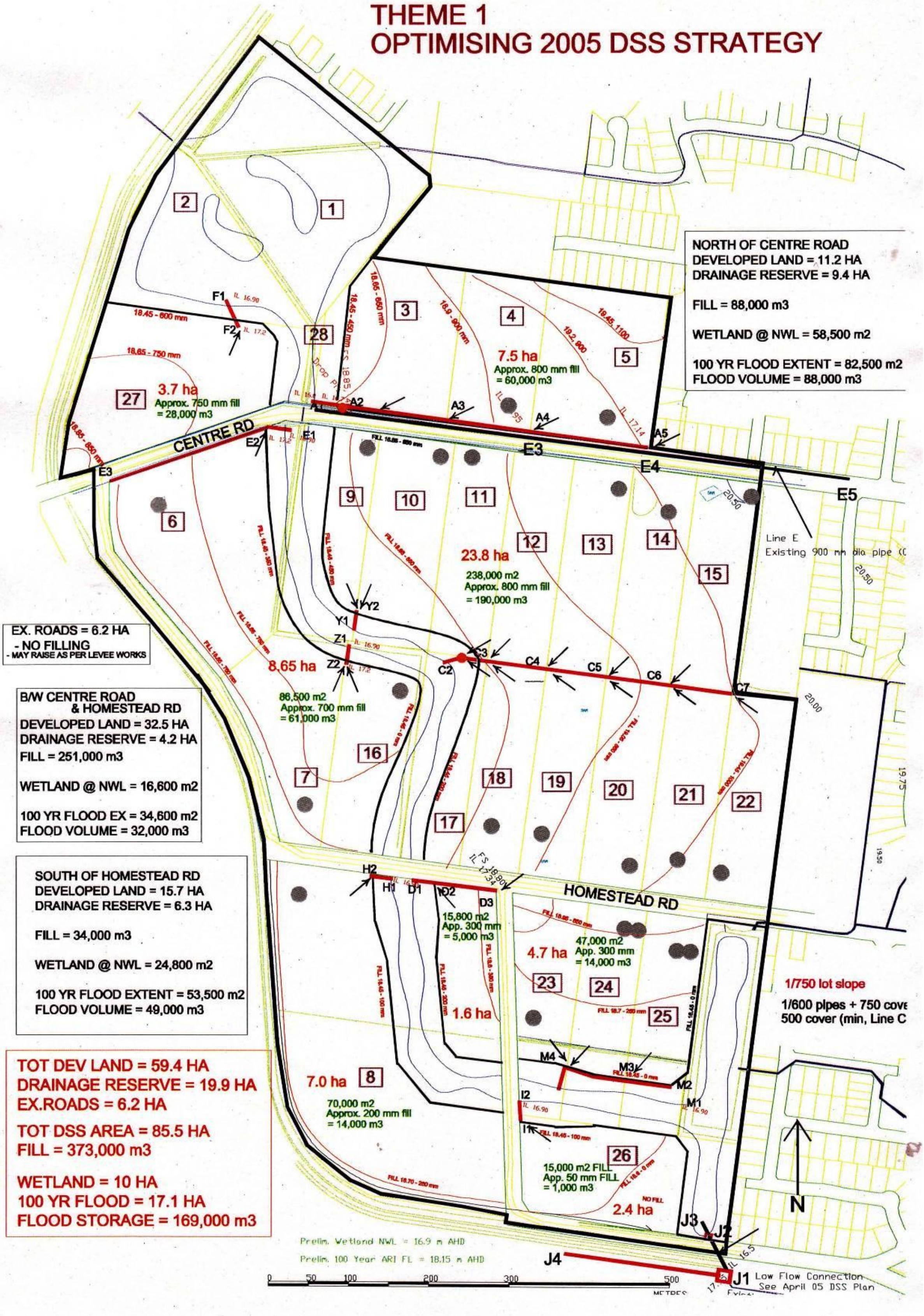
Abbreviation Descriptions	Definition
MUSIC	Hydrologic computer program used to calculate stormwater pollutant generation in a catchment and the amount of treatment which can be attributed to the WSUD elements placed in that catchment
MWC	Melbourne Water Corporation
Pond	A small artificial body of open water (eg. dam or small lake)
POS	Public Open Space
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base
RORB	Hydrologic computer program used to calculate the design flood flow (in m^3/s) along a stormwater conveyance system (eg waterway)
Sedimentation basin (Sediment pond)	A pond that is used to remove coarse sediments from inflowing water mainly by settlement processes.
Surface water	All water stored or flowing above the ground surface level
Swale	A WSUD element used to collect primarily course sediments and TSS. Essentially trapezoidal cross-sectional form. Often fully vegetated with indigenous species, or grassed.
Total Catchment Management	A best practice catchment management convention which recognises that waterways and catchments do not stop at site boundaries and decisions relating to surface water management should consider the catchment as a whole
TSS	Total Suspended Solids – a term for a particular stormwater pollutant parameter
TP	Total Phosphorus – a term for a particular stormwater pollutant parameter
TN	Total Nitrogen – a term for a particular stormwater pollutant parameter
Vegetated Channel	A floodway vegetated and landscaped into a naturalistic form. A complementary function to the flood conveyance task is its WSUD role (where the vegetation in the base acts as a swale).
Waterlogging	Term used to describe saturated surface soil conditions where some free surface water may also be present
WSUD - Water Sensitive Urban Design	Term used to describe the design of drainage systems used to o Convey stormwater safely o Retain stormwater pollutants o Enhance local ecology o Enhance the local landscape and social amenity of built areas
Wetland	WSUD element permanently or periodically inundated with shallow water and either permanently or periodically supports the growth of aquatic macrophytes

APPENDIX A

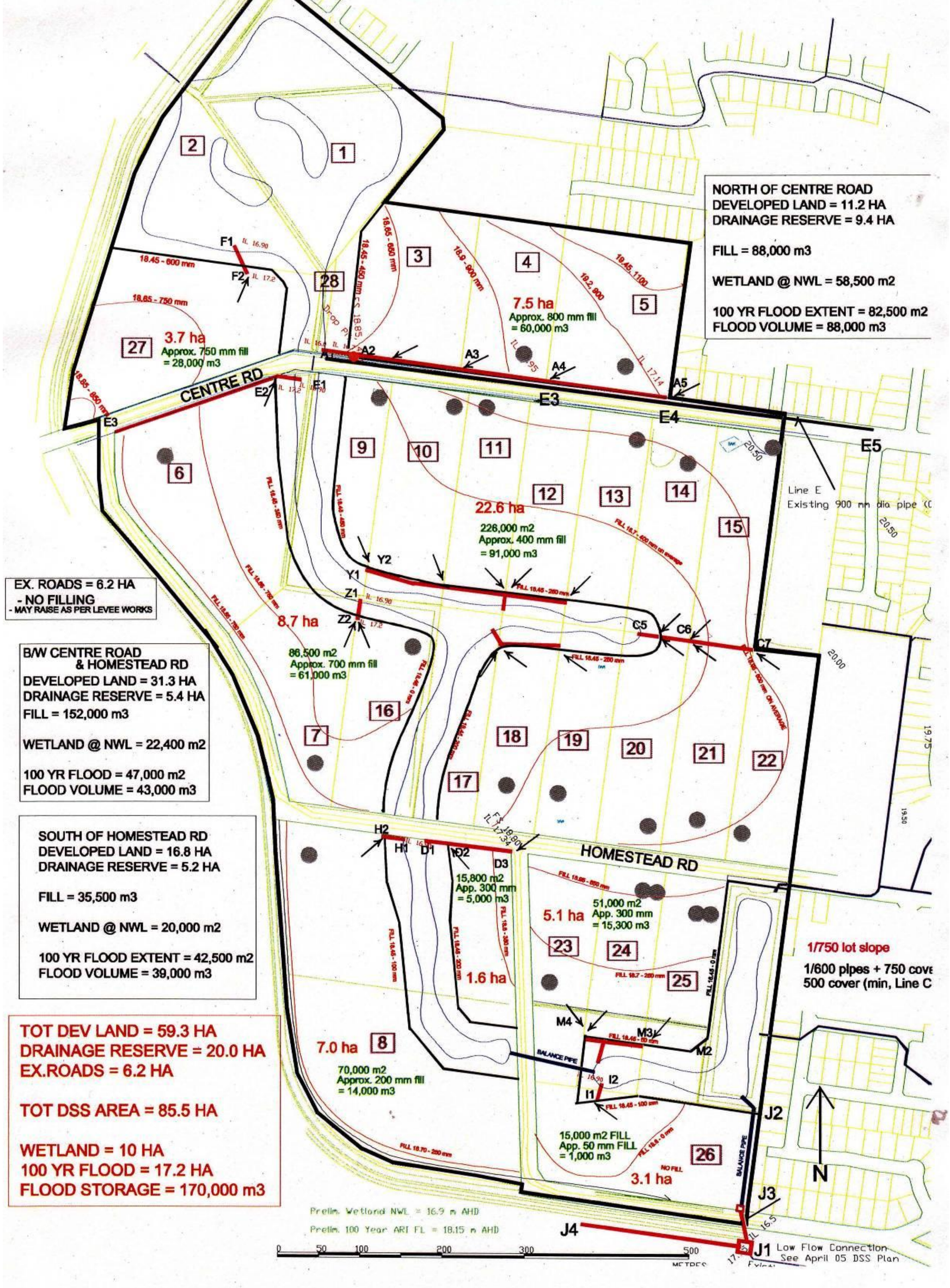
THEMES INVESTIGATED

The themes below are presented as background to the process which resulted in the Theme detailed in Section 4 being adopted. The reserve requirements, drainage requirements and fill requirements detailed are approximate only. All proposals are superseded by the proposals detailed in Section 4 in regard to the adopted theme.

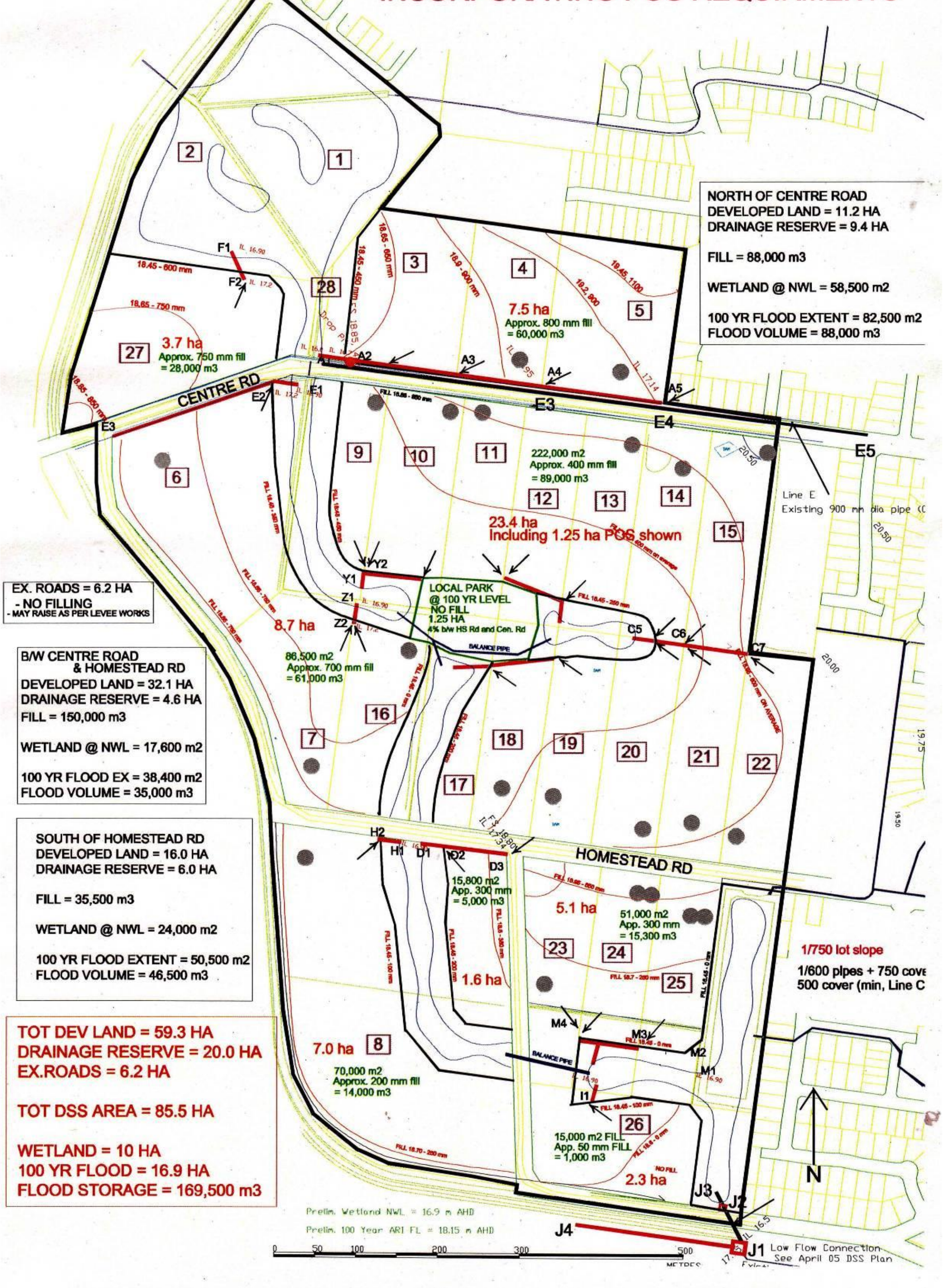
THEME 1
OPTIMISING 2005 DSS STRATEGY



THEME 2
WETLAND "FINGERS" TO REDUCE FILL



THEME 3
INCORPORATING POS REQUIRMENTS



APPENDIX B

PRELIMINARY THEME COSTINGS AND COMPARISION ANALYSIS

The costs and comparisons below are presented as background to the process which resulted in the Theme detailed in Section 4 being adopted. The reserve costs, drainage costs and fill costs detailed are approximate only. All estimates are superseded by the estimated costs detailed in Appendix C and Section 4 in regard to the adopted theme.

Strategy Comparison

Notes:

Costs detailed below are very rough only - for comparison purposes only
Costs include design or contingency provisions at this stage
Costs are only shown for fill and acquisition impact - it is assumed DSS costs are about he same for all Themes.
Costs, areas and volumes are only intended to provide a basis to compare the cost effectiveness of various themes
Actual costs may vary considerably from those detailed

All Themes are based on original DSS wetland Strategy developed by Neil Craigie and Pat Condina in 2004
All Themes incorporate the defined design considerations to minimise the DSS and fill costs

Land Take

Option	Reserve Area ha	Developable area ha	
Original 2004 DSS Strategy	24.0	55.3	Reserve Included POS Requirement
Theme 1 - Optimization of Original Strategy given agreed team design optimization considerations	19.9	59.4	Only Drainage Function for Reserve
Theme 2 - As with Theme 1. Incorporates wetland fingers into development to reduce fill. Allows for balance pipe through Buddhist temple land.	20.0	59.3	Only Drainage Function for Reserve
Theme 3 - As with Theme 2. Incorporates POS provision within wetland system. All POS at or above 100 Year ARI flood level.	20.0	59.3	Only Drainage Function for Reserve

Assumes total DSS area = 85.5 ha
Assumes Ex roads = 6.2 ha

Earthwork Volumes

Option	Wetland cut volume (assuming 1.5 m deep) (m^3)	Flood storage Volume (m^3)	Approx. Total Cut in DR Reserve (m^3)	Fill Requirement (m^3)	Approx Average Fill Depth (mm)	Approx Fill Cost $M
Original 2004 DSS Strategy	156000	172000	328000	613000	1108	9.0
Theme 1 - Optimization of Original Strategy given agreed team design optimization considerations	150000	169000	319000	373000	628	4.3
Theme 2 - As with Theme 1. Incorporates wetland fingers into development to reduce fill. Allows for balance pipe through Buddhist temple land.	150000	170000	320000	275500	465	2.8
Theme 3 - As with Theme 2. Incorporates POS provision within wetland system. All POS at or above 100 Year ARI flood level.	150000	169500	319500	273,500	461	2.7
NOTES			ALL OPTIONS HAVE ABOUT HE SAME CUT. IT IS ASSUMED ALL OPTIONS CAN MEET THE REQUIRED VOLUME REQUIREMENT IF OUTLET AUGMENTED			ASSUMED $20/m^3$ FOR IMPORTED FILL, $10/m^3$ FOR FILL SOURCED ON SITE

Acquisition Costs

Option	Reserve Acquisition ha	Reserve Acquisition (= requirement - ex. MWC owned land) ha	Approx Cost $500,000 /ha $M	
Original 2004 DSS Strategy	24	13.45	6.7	Included POS Requirement
Theme 1 - Optimization of Original Strategy given agreed team design optimization considerations	19.9	9.35	4.7	Only Drainage Function
Theme 2 - As with Theme 1. Incorporates wetland fingers into development to reduce fill. Allows for balance pipe through Buddhist temple land.	20.0	9.45	4.7	Only Drainage Function
Theme 3 - As with Theme 2. Incorporates POS provision within wetland system. All POS at or above 100 Year ARI flood level.	20.0	9.45	4.7	Only Drainage Function

10.55 ha Centre Road RB and Homestead Road RB already owned by MWC

Strategy Comparison

KEY:	Score rating	
	10 -	Project outcome extremely good
	0 -	Project outcome neutral

Performance Criteria	Score = 0	Score = 10
Developable area	40	65
Wetland and DSS Costs	All options assumed approximately the same impact and allocated a score of 5	
Fill costs	$10M	$0M
Acquisition Costs	$7M	$3.5M
Equitable Delivery of Drainage Infrastructure	Subject to interpretation and discussion with project team - VM assessment included below	
Meet original DSS requirements	No requirements met	All requirements met
Limit impact on existing land uses	Subject to interpretation and discussion with project team - VM assessment included below	
Maximize amenity, financial and community value of drainage assets	Subject to interpretation and discussion with project team - VM assessment included below	
Ability of Strategy and Development to be staged	Subject to interpretation and discussion with project team - VM assessment included below	

Strategy/Theme	Weighted Score	Developable area Score	Wetland and DSS Costs Score	Fill costs Score	Acquisition Costs Score	Equitable Delivery of Drainage Infrastructure Score	Meet original DSS requirements Score	Limit impact on existing land uses Score	Maximize Amenity and financial and community value of drainage assets Score	Ability of Strategy and Development to be staged Score
Original 2004 DSS Strategy	**4.6**	6.1	7	1.0	0.8	5.0	10	7	7	7
Theme 1 - Optimization of Original Strategy given agreed team design optimization considerations	**7.2**	7.8	7	5.7	6.6	8.0	10	7	7	7
Theme 2 - As with Theme 1. Incorporates wetland fingers into development to reduce fill. Allows for balance pipe through Buddhist temple land.	**7.5**	7.7	7	7.2	6.5	7.0	10	8	8	7
Theme 3 - As with Theme 2. Incorporates POS provision within wetland system. All POS at or above 100 Year ARI flood level.	**7.5**	7.7	7	7.3	6.5	7.0	10	8	9	7
Weighting 100%		**20%**	**10%**	**20%**	**20%**	**5%**	**10%**	**5%**	**5%**	**5%**

APPENDIX C
ADOPTED THEME – PRELIMINARY DSS COSTING

The following is a preliminary estimate of the adopted drainage strategy using the current MWC DSS costing spreadsheet.

All estimates are subject to change given GAA, MWC and Council review.

The estimate does not include any net present value analysis or consideration.

Summary

Works Description	Estimated Construction Cost	Estimated Land Acquisition Cost
Pipes	$512,715	$0
Channels	$0	$0
Culverts	$712,016	-
Retarding Basins - Flood Storage function above Wetland NWL	$1,605,900	$2,110,819
Levee Bank Works	$820,200	-
Swales	$0	-
Wetlands	$1,741,936	$1,614,181
Sediment Basins	$0	-
Litter Traps	$0	-
Buffer Strips	$0	-
Bio-Retention Basins	$0	-
Bio-Retention Swales	$0	-
Related Costs/Works	$0	-
Sub-total 'A'	$5,392,767	$3,725,000
'A' x Engineering Fee @ 15%	$808,915	-
Sub-total 'B'	$6,201,682	$3,725,000
'B' x Administration Fee @ 9%	$558,151	-
(Land Acq only) 'B' x Administration Fee @ 1%	-	$37,250
Sub-total 'C'	$6,759,833	$3,762,250
'A' x Contingencies @ 20%	$1,078,553	$745,000
FORECAST EXPENDITURE	**$7,838,387**	**$4,507,250**
TOTAL COST	**$12,345,637**	

Pipe Costs

VELOCITY REQUIREMENTS

- Minimum velocity - at least 1.0 m/s for pipe running full and at least 0.8 m/s for pipe running 1/3 full
- Maximum full flow velocity < = 6.0 m/s

PIPE COVER:

minimum pipe cover = 750 mm in general (500 mm for short lengths as agreed in the workshop.

Pipe Ref.	Developable Area Excluding roads	Upstream Area A	ARI (y)	Cumulative Effective Area SA_e	Time of Concentration t_c	Rainfall Intensity I_y	Design Flow Q_y	Length L	Obvert Elev u/s	Obvert Elev d/s	Slope S	Pipe Diameter	Full Flow Q_{full}	Full Velocity v_{full}	Estimated Cost	Estimated Cost including Engineering, Admin & Contingencies			
		ha	year	ha	min	mm/hr	m^3/s	m	m	m	1 in ...	mm	m^3/s	m/s	$	$	**Fill Level**	**Cover (mm)**	
						-	-				-								
LINE A						-	-				-								
	A5 - A4 (EXISTING SUBDIVISION /				Existing pipe - 900 dia @1/760, Capacity =				0.65	m^3/s									
				Design flow of new pipe = calculated flow minus 0.65 m3/s															
A5-A4		17.95	5	8.98	9.00	63.75	0.94	150	18.63	18.38	600	1050	1.11	1.3	$ 65,250	$ 94,841	19.2	575	OK
A4-A3	2.85	2.85	5	10.54	10.94	58.23	1.06	105	18.38	18.20	600	1050	1.11	1.3	$ 45,675	$ 66,389	19	625	OK
A3-A2	2	2	5	11.64	12.30	55.01	1.13	150	18.20	17.95	600	1200	1.59	1.4	$ 78,600	$ 114,245	18.8	600	OK
A2-A1	2.8	4.3	5	14.01	14.08	51.42	1.35	25	17.95	17.90	500	1200	1.74	1.5	$ 13,100	$ 19,041	18.45	500	OK
	7.65							430											
LINE B																			
B2-B1	3.85	3.85	5	2.12	12.00	55.68	0.33	30	17.70	17.60	300	600	0.35	1.25	$ 6,600	$ 9,593	18.45	750	OK
						-	-				-								
LINE C																			
C3-C2		1.1	5	0.55	8.00	67.17	0.10	220	18.40	17.70	314	450	0.16	1.01	$ 49,280	$ 71,628	18.9	500	OK
C2-C1	4.5	4.5	5	3.03	11.63	56.56	0.48	20	17.70	17.65	400	750	0.56	1.3	$ 5,740	$ 8,343	18.45	750	OK
								240											
LINE D																			
Z2-Z1	4.3	4.3	5	2.37	12.00	55.68	0.37	25	17.65	17.60	500	675	0.38	1.1	$ 4,975	$ 7,231	18.45	800	OK
LINE F																			
F3-F2	1.2	1.2	5	0.66	11.00	58.07	0.11	100	17.95	17.60	286	450	0.17	1.06	$ 17,400	$ 25,291	18.45	500	OK
F2-F1	2.2	2.2	5	1.87	12.57	54.42	0.28	25	17.60	17.53	357	600	0.32	1.15	$ 4,425	$ 6,432	18.45	850	OK
	3.4																		
LINE G																			
G3-G2	1.75	1.75	5	0.96	11.00	58.07	0.16	75	17.85	17.60	300	450	0.16	1.03	$ 13,050	$ 18,968	18.45	600	OK
G2-G1	3.5	3.5	5	2.89	12.21	55.23	0.44	25	17.60	17.53	357	750	0.59	1.33	$ 5,625	$ 8,176	18.45	850	OK
	5.25																		

Pipe Ref.	Developable Area Excluding roads	Upstream Area A	ARI (y)	Cumulative Effective Area SA_e	Time of Concentration t_c	Rainfall Intensity I_y	Design Flow Q_y	Length L	Obvert Elev u/s	Obvert Elev d/s	Slope S	Pipe Diameter	Full Flow Q_{full}	Full Velocity v_{full}	Estimated Cost	Estimated Cost including Engineering, Admin & Contingencies			
		ha	year	ha	min	mm/hr	m^3/s	m	m	m	1 in ...	mm	m^3/s	m/s	$	$	Fill Level	Cover (mm)	
						-	-				-								
LINE H																			
H4-H3	2.05	2.05	5	1.13	11.00	58.07	0.18	80	18.12	17.92	393	525	0.22	1.00	$ 15,520	$ 22,558	18.95	830	OK
H3-H2	4	4	5	3.33	12.33	54.94	0.51	40	17.92	17.85	602	825	0.59	1.09	$ 9,920	$ 14,419	18.6	684	OK
H2-H1	3.9	3.9	5	5.47	12.94	53.66	0.82	25	17.85	17.80	500	1050	1.22	1.41	$ 8,600	$ 12,500	18.45	600	OK
	9.95																		
LINE I																			
I3-I2	1.7	1.7	5	0.94	11.00	58.07	0.15	75	17.85	17.60	300	450	0.16	1.03	$ 13,050	$ 18,968	18.45	600	OK
I2-I1	2.3	2.3	5	2.20	12.21	55.23	0.34	25	17.60	17.53	357	675	0.44	1.24	$ 4,975	$ 7,231	18.45	850	OK
	4																		
LINE J																			
J2-J1	7.0	7.4	5	4.07	12.00	55.68	0.63	25	17.80	17.73	357	825	0.76	1.4	$ 6,200	$ 9,012	18.45	650	OK
LINE K																			
K3-K2		1.6	5	0.80	13.00	53.52	0.12	90	17.95	17.65	300	450	0.16	1.0	$ 20,160	$ 29,303	18.6	650	OK
K2-K1	1.6	1.6	5	1.68	14.45	50.75	0.24	20	17.65	17.60	400	600	0.31	1.09	$ 5,520	$ 8,023	18.45	800	OK
LINE L																			
L3-L2	2.0	2	5	1.10	11.00	58.07	0.18	75	17.90	17.70	375	525	0.22	1.0	$ 14,550	$ 21,148	18.45	550	OK
L2-L1	3.1	3.1	5	2.81	12.22	55.21	0.43	25	17.70	17.65	500	750	0.50	1.13	$ 5,625	$ 8,176	18.45	750	OK
LINE M																			
M2-M1	2.4	2.4	5	1.32	12.00	55.68	0.20	25	17.60	17.50	250	525	0.27	1.3	$ 6,150	$ 8,939	18.45	850	OK
LINE N																			
JANUARY 2005 Neil Craigie design																			
N1-N2								50				675			$ 12,400	$ 18,023			
N2-N3								25				1050			$ 11,525	$ 16,752			
N1-N4								200				1050			$ 68,800	$ 100,001			
						-	-				-		-		$ -	$ -			
															$512,715	**$745,231**			

Culvert/ Balance Pipe Costs

Ward Road Culverts/Balance Pipes		**To be confirmed at Fucntional design stage of wetland - Q wetland filling assumed to be less than**						
	Design ARI	**11.5 m3/s due to flood strage effect og upstream cell(s), 0.05 m head loss when acting as a balanc**						
	Design Flow (m^3/s)	11.5						
	Pipe diameter (mm)	2100	1	110	m			
	Installation (Laying)	RRJ-100% FCR	1	110	m	$2,186	$312,598	$454,361
		Minor & Major Roads						
	Headwalls & Endwalls		2	6.54	m^3	$2,200	$28,776	$41,826
	Minor regrading of channel d/s of culverts		item				$5,000	$7,268
	Road re-surfacing		item	264	m^2	$250	$66,000	$95,931
	Traffic management		item			$20,000	$20,000	$29,070
						Subtotal	**$432,374**	**$628,456**

Homestead Road Culverts/Balance Pipes		**To be confirmed at Fucntional design stage of wetland - Q wetland filling assumed to be less than**						
	Design ARI	**11.5 m3/s due to flood strage effect og upstream cell(s), 0.05 m head loss when acting as a balanc**						
	Design Flow (m^3/s)	11.5						
	Pipe diameter (mm)	2100	1	25	m			
	Installation (Laying)	RRJ-100% FCR	1	25	m	$2,186	$71,045	$103,264
		Minor & Major Roads						
	Headwalls & Endwalls		2	6.54	m^3	$2,200	$28,776	$41,826
	Minor regrading of channel d/s of culverts		item				$5,000	$7,268
	Road re-surfacing		item	60	m^2	$250	$15,000	$21,803
	Traffic management		item			$20,000	$20,000	$29,070
						Subtotal	**$139,821**	**$203,230**

Centre Road Culverts/Balance Pipes		**To be confirmed at Fucntional design stage of wetland - Q wetland filling assumed to be less than**						
	Design ARI	**11.5 m3/s due to flood strage effect og upstream cell(s), 0.05 m head loss when acting as a balanc**						
	Design Flow (m^3/s)	11.5						
	Pipe diameter (mm)	2100	1	25	m			
	Installation (Laying)	RRJ-100% FCR	1	25	m	$2,186	$71,045	$103,264
		Minor & Major Roads						
	Headwalls & Endwalls		2	6.54	m^3	$2,200	$28,776	$41,826
	Minor regrading of channel d/s of culverts		item				$5,000	$7,268
	Road re-surfacing		item	60	m^2	$250	$15,000	$21,803
	Traffic management		item			$20,000	$20,000	$29,070
						Subtotal	**$139,821**	**$203,230**
						TOTAL	**$712,016**	**$1,034,915**

Wetland Costs

Wetland Ref No.	Wetland Basic Cost (see below)	Total Wetland Cost excluding Land Acquisition	Estimated Cost including Engineering, Administration & Contingencies	Total Area to be Acquired , not including existing MWC land (as per GAA Oct 2009 Plan)	Land Acquisition		Estimated Land Acquisition Cost including Administration & Contingencies
	$		$	m^2	Rate ($/ha)	$	$
North of Centre Road	$964,080	$964,080	$ 1,401,290	2,571	500,000	$ 128,571	$ 155,571
B/W Centre Road and Homestead Road	$369,152	$369,152	$ 536,562	14,370	500,000	$ 718,491	$ 869,374
South of Homestead Road	$408,704	$408,704	$ 594,051	15,342	500,000	$ 767,119	$ 928,214
		$1,741,936	**$2,531,904**			**$1,614,181**	**$1,953,159**

Note:
Wetland costs exclude excavation and landscaping of the drainage reserve area above NWL. These costs are attributable to flood storage costs.

North of Centre Road

Volume Cut above NWL to Finished Surface Levels (FSL) = 88,000 m^3
Volume Cut below NWL (including topsoil cut provision, tot 0.8 deep on average) = 46,800 m^3
Wetland Area = 58,500 m^2
Wetland Planted Area (80% wetland area) = 46,800 m^2
Reserve Area = 9.1 *ha*
Land already owned by MWC 8.4 *ha*
Land which could be associated with a traditional 30 m reserve in a normal DSS 0.3 *ha*
Cut line area (= area requiring striping)= 82,500 m^2
Average cut depth to (cut line to NWL) = 1.25 *m*
Peripheral Planting and Landscaping (Reserve Area - Wetland Area) = 32,500 m^2
Area requiring topsoil (=planted area) = 46,800 m^2

(Areas as per Val Mag's and Neil Craigie's preliminary wetland design - October 2009)

Item	Quantity	Rate	Cost
1. Strip and stockpile topsoil	9,360 m^3	$6.00 ./$m^3$	$56,160
2. Excavate Wetland System	46,800 m^3	$6.00 ./$m^3$	$280,800
3. Topsoiling	9,360 m^3	$17.00 ./$m^3$	$159,120
4. Wetland Plants	46,800.00 m^2	$10.00 /$m^2$	$468,000
5. Grassing	0 m^2	$1.00 /$m^2$	$0
6. Light Landscape Planting	0.00 ha	$20,000 /ha	$0
		TOTAL	**$964,080**

Reserve associated with wetland
0.64 % reserve area

Land to acquire 0.4 ha

84,560

Reserve associated with wetland
0.42 % reserve area

Land to acquire 3.4 ha

Between Centre Road and North Road

Volume Cut above NWL to Finished Surface Levels (FSL) =	43,000 m^3
Volume Cut below NWL (including topsoil cut provision, tot 0.8 deep on average) =	17,920 m^3
Wetland Area =	22,400 m^2
Wetland Planted Area (80% wetland area) =	17,920 m^2
Reserve Area =	5.3 *ha*
Land already owned by MWC	0.0 *ha*
Land which could be associated with a traditional 30 m reserve in a normal DSS	1.9 *ha*
Cut line area (= area requiring striping)=	47,000 m^2
Average cut depth to (cut line to NWL) =	1.25 *m*
Peripheral Planting and Landscaping (Reserve Area - Wetland Area) =	30,600 m^2
Area requiring topsoil (=planted area) =	17,920 m^2

(Areas as per Val Mag's and Neil Craigie's preliminary wetland design - October 2009)

Item	**Quantity**	**Rate**	**Cost**
1. Strip and stockpile topsoil	3,584 m^3	$6.00 ./$m^3$	$21,504
2. Excavate Wetland System	17,920 m^3	$6.00 ./$m^3$	$107,520
3. Topsoiling	3,584 m^3	$17.00 ./$m^3$	$60,928
4. Wetland Plants	17,920.00 m^2	$10.00 /$m^2$	$179,200
5. Grassing	0 m^2	$1.00 /$m^2$	$0
6. Light Landscape Planting	0.00 ha	$20,000 /ha	$0
		TOTAL	**$369,152**

Reserve associated with wetland
0.42 % reserve area

Land to acquire 3.7 ha

South of Homestead Road

Volume Cut above NWL to Finished Surface Levels (FSL) =	63,000 m^3
Volume Cut below NWL (including topsoil cut provision, tot 0.8 deep on average) =	19,840 m^3
Wetland Area =	24,800 m^2
Wetland Planted Area (80% wetland area) =	19,840 m^2
Reserve Area =	5.9 *ha*
Land already owned by MWC	2.05 *ha*
Land which could be associated with a traditional 30 m reserve in a normal DSS	0.2 *ha*
Cut line area (= area requiring striping)=	59,000 m^2
Average cut depth to (cut line to NWL) =	1.50 *m*
Peripheral Planting and Landscaping (Reserve Area - Wetland Area) =	34,200 m^2
Area requiring topsoil (=planted area) =	19,840 m^2

(Areas as per Val Mag's and Neil Craigie's preliminary wetland design - October 2009)

Item	**Quantity**	**Rate**	**Cost**
1. Strip and stockpile topsoil	3,968 m^3	$6.00 ./$m^3$	$23,808
2. Excavate Wetland System	19,840 m^3	$6.00 ./$m^3$	$119,040
3. Topsoiling	3,968 m^3	$17.00 ./$m^3$	$67,456
4. Wetland Plants	19,840.00 m^2	$10.00 /$m^2$	$198,400
5. Grassing	0 m^2	$1.00 /$m^2$	$0
6. Light Landscape Planting	0.00 ha	$20,000 /ha	$0
		TOTAL	**$408,704**

Flood Storage Costs

Wetland Ref No.	RB Basic Cost (see below)	Total RB Cost excluding Land Acquisition	Estimated Cost including Engineering, Administration & Contingencies	Total Area to be Acquired , not including existing MWC land (as per GAA Oct 2009 Plan)	Land Acquisition		Estimated Land Acquisition Cost including Administration & Contingencies
	$		$	m^2	Rate ($/ha)	$	$
North of Centre Road	$625,500	$625,500	$ 909,164	1,429	500,000	$ 71,429	$ 86,429
B/W Centre Road and Homestead Road	$349,800	$349,800	$ 508,434	19,630	500,000	$ 981,509	$ 1,187,626
South of Homestead Road	$480,600	$480,600	$ 698,552	21,158	500,000	$ 1,057,881	$ 1,280,036
Outlet Works	$ 150,000	$150,000	$ 218,025				
		$1,605,900	$2,334,176			$2,110,819	$2,554,091

Note:
Flood Storage costs exclude excavation and planting of the drainage reserve area below NWL. These costs are attributable to wetland costs.

North of Centre Road

Reserve associated with wetland
0.64 % reserve area

Land to acquire 0.4 ha

Volume Cut above NWL to Finished Surface Levels (FSL) =	88,000	*m^3*
Volume Cut below NWL (including topsoil cut provision, tot 0.8 deep on average) =	46,800	*m^3*
Wetland Area =	58,500	*m^2*
Wetland Planted Area (80% wetland area) =	46,800	*m^2*
Reserve Area =	9.1	*ha*
Land already owned by MWC	8.4	*ha*
Land which could be associated with a traditional 30 m reserve in a normal DSS	0.3	*ha*
Cut line area (= area requiring striping)=	82,500	*m^2*
Average cut depth to (cut line to NWL) =	1.25	*m*
Peripheral Planting and Landscaping (Reserve Area - Wetland Area) =	32,500	*m^2*
Area requiring topsoil (=planted area) =	46,800	*m^2*

(Areas as per Val Mag's and Neil Craigie's preliminary wetland design - October 2009)

Item	Quantity	Rate	Cost
1. Strip and stockpile topsoil	0 m^3	$6.00 /$m^3$	$0
2. Excavate Flood Storage System	88,000 m^3	$6.00 /$m^3$	$528,000
3. Topsoiling	0 m^3	$17.00 /$m^3$	$0
4. Wetland Plants	0.00 m^2	$10.00 /$m^2$	$0
5. Grassing	32,500 m^2	$1.00 /$m^2$	$32,500
6. Light Landscape Planting	3.25 ha	$20,000 /ha	$65,000
		TOTAL	$625,500

Reserve associated with wetland
0.42 % reserve area

Land to acquire 3.4 ha

Between Centre Road and North Road

Volume Cut above NWL to Finished Surface Levels (FSL) =	43,000 m^3
Volume Cut below NWL (including topsoil cut provision, tot 0.8 deep on average) =	17,920 m^3
Wetland Area =	22,400 m^2
Wetland Planted Area (80% wetland area) =	17,920 m^2
Reserve Area =	5.3 *ha*
Land already owned by MWC	0.0 *ha*
Land which could be associated with a traditional 30 m reserve in a normal DSS	1.9 *ha*
Cut line area (= area requiring striping)=	47,000 m^2
Average cut depth to (cut line to NWL) =	1.25 *m*
Peripheral Planting and Landscaping (Reserve Area - Wetland Area) =	30,600 m^2
Area requiring topsoil (=planted area) =	17,920 m^2

(Areas as per Val Mag's and Neil Craigie's preliminary wetland design - October 2009)

Item	**Quantity**	**Rate**	**Cost**
1. Strip and stockpile topsoil	0 m^3	$6.00 /$m^3$	$0
2. Excavate Flood Storage System	43,000 m^3	$6.00 /$m^3$	$258,000
3. Topsoiling	0 m^3	$17.00 /$m^3$	$0
4. Wetland Plants	0.00 m^2	$10.00 /$m^2$	$0
5. Grassing	30,600 m^2	$1.00 /$m^2$	$30,600
6. Light Landscape Planting	3.06 ha	$20,000 /ha	$61,200
		TOTAL	**$349,800**

Reserve associated with wetland
0.42 % reserve area

Land to acquire 3.7 ha

South of Homestead Road

Volume Cut above NWL to Finished Surface Levels (FSL) =	63,000 m^3
Volume Cut below NWL (including topsoil cut provision, tot 0.8 deep on average) =	19,840 m^3
Wetland Area =	24,800 m^2
Wetland Planted Area (80% wetland area) =	19,840 m^2
Reserve Area =	5.9 *ha*
Land already owned by MWC	2.05 *ha*
Land which could be associated with a traditional 30 m reserve in a normal DSS	0.2 *ha*
Cut line area (= area requiring striping)=	59,000 m^2
Average cut depth to (cut line to NWL) =	1.50 *m*
Peripheral Planting and Landscaping (Reserve Area - Wetland Area) =	34,200 m^2
Area requiring topsoil (=planted area) =	19,840 m^2

total cut = 278,560

(Areas as per Val Mag's and Neil Craigie's preliminary wetland design - October 2009)

Item	**Quantity**	**Rate**	**Cost**
1. Strip and stockpile topsoil	0 m^3	$6.00 /$m^3$	$0
2. Excavate Flood Storage System	63,000 m^3	$6.00 /$m^3$	$378,000
3. Topsoiling	0 m^3	$17.00 /$m^3$	$0
4. Wetland Plants	0.00 m^2	$10.00 /$m^2$	$0
5. Grassing	34,200 m^2	$1.00 /$m^2$	$34,200
6. Light Landscape Planting	3.42 ha	$20,000 /ha	$68,400
		TOTAL	**$480,600**

Levee Bank Costs

Levee bank estimate volumes as per 2004 DSS calculation

Description	Quantity		Rate		Amount	
Strip Topsoil (200mm)	11,000	m^3	$6.00	$/m^3$	$66,000	
Excavation	1,200	m^3	$6.00	$/m^3$	$7,200	
Clay Fill	28,000	m^3	$20.00	$/m^3$	$560,000	
Topsoiling & Grassing	11,000	m^2	$17.00	$/m^2$	$187,000	
					$820,200	$1,192,161

APPENDIX D

POSSIBLE MWC COST APPORTIONING

CASE 1 - Homestead Road Extension DSS Contributing Solely to Works

Total Wetland Construction Cost = $1,741,936
Total Wetland Acquisition Cost = $1,614,181 ($500K/ha)
Total Flood Storage Construction Cost = $1,605,900
Total Flood Storage Acquisition Cost = $2,110,819 $500K/ha)

			Wetland Construction Apportioning			Wetland Acquisition Apportioning			Flood Storage Construction Apport.			Flood Storage Acquisition Apport.		
			Based on predicted MUSIC Nitrogen Production in the catchment			*Based on predicted MUSIC Nitrogen Production in the catchment*			*Based on predicted RORB flood storage contribution*			*Based on predicted RORB flood storage contribution*		
Works Description	**Estimated Construction Cost**	**Estimated Land Acquisition Cost**	Homestead Road Ex DSS	Homestead Road DSS	O'Sheas Road DSS	Homestead Road Ex DSS	Homestead Road DSS	O'Sheas Road DSS	Homestead Road Ex DSS	Homestead Road DSS	O'Sheas Road DSS	Homestead Road Ex DSS	Homestead Road DSS	O'Sheas Road DSS
			21%	**16%**	**63%**	**21%**	**16%**	**63%**	**65%**	**9%**	**26%**	**65%**	**9%**	**26%**
Pipes	$512,715	$0												
Channels	$0	$0												
Culverts	$712,016	-												
Retarding Basins - Flood Storage function above Wetland NWL	$1,605,900	$2,110,819							$1,605,900			$2,110,819		
Levee Bank Works	$820,200	-												
Swales	$0	-												
Wetlands	$1,741,936	$1,614,181	$1,741,936			#######								
Sediment Basins	$0	-												
Litter Traps	$0	-												
Buffer Strips	$0	-												
Bio-Retention Basins	$0	-												
Bio-Retention Swales	$0	-												
Related Costs/Works	$0	-												
Sub-total 'A'	$5,392,767	$3,725,000												
'A' x Engineering Fee @ 15%	$808,915	-												
Sub-total 'B'	$6,201,682	$3,725,000												
'B' x Administration Fee @ 9%	$558,151	-												
(Land Acq only) 'B' x Administration Fee @ 1%	-	$37,250												
Sub-total 'C'	$6,759,833	$3,762,250												
'A' x Contingencies @ 20%	$1,078,553	$745,000												
FORECAST EXPENDITURE	**$7,838,387**	**$4,507,250**												
TOTAL COST	**$12,345,637**													

Total Developable Land **59.0 ha**

CASE 1 - Homestead Road Extension DSS Contributing Solely to Works

% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$209,248**	**$185,998**	**$167,398**

CASE 2 - Homestead Road Extension DSS Contributing Solely to Flood Storage, Wetland Costs Apportioned

Total Wetland Construction Cost = $1,741,936
Total Wetland Acquisition Cost = $1,614,181 ($500K/ha)
Total Flood Storage Construction Cost = $1,605,900
Total Flood Storage Acquisition Cost = $2,110,819 $500K/ha)

			Wetland Construction Apportioning *Based on predicted MUSIC Nitrogen Production in the catchment*			Wetland Acquisition Apportioning *Based on predicted MUSIC Nitrogen Production in the catchment*			Flood Storage Construction Apport. *Based on predicted RORB flood storage contribution*			Flood Storage Acquisition Apport. *Based on predicted RORB flood storage contribution*		
Works Description	**Estimated Construction Cost**	**Estimated Land Acquisition Cost**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**
			21%	**16%**	**63%**	**21%**	**16%**	**63%**	**65%**	**9%**	**26%**	**65%**	**9%**	**26%**
Pipes	$512,715	$0												
Channels	$0	$0												
Culverts	$712,016	-												
Retarding Basins - Flood Storage function above Wetland NWL	$1,605,900	$2,110,819							$1,605,900			$2,110,819		
Levee Bank Works	$820,200	-												
Swales	$0	-												
Wetlands	$365,807	$338,978	$365,807	$278,710	$1,097,420	$338,978	$258,269	$1,016,934						
Sediment Basins	$0	-												
Litter Traps	$0	-												
Buffer Strips	$0	-												
Bio-Retention Basins	$0	-												
Bio-Retention Swales	$0	-												
Related Costs/Works	$0	-												
Sub-total 'A'	$4,016,638	$2,449,797												
'A' x Engineering Fee @ 15%	$602,496	-												
Sub-total 'B'	$4,619,133	$2,449,797												
'B' x Administration Fee @ 9%	$415,722	-												
(Land Acq only) 'B' x Administration Fee @ 1%	-	$24,498												
Sub-total 'C'	$5,034,855	$2,474,295												
'A' x Contingencies @ 20%	$803,328	$489,959												
FORECAST EXPENDITURE	**$5,838,183**	**$2,964,255**												
TOTAL COST	**$8,802,437**													

Total Developable Land **59.0 ha**

CASE 2 - Homestead Road Extension DSS Contributing Solely to Flood Storage, Wetland Costs Apportioned

% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$149,194**	**$132,617**	**$119,355**

CASE 3 - Homestead Road Extension DSS Contributing Solely to Wetland Costs, Flood Storage Apportioned

Total Wetland Construction Cost = $1,741,936
Total Wetland Acquisition Cost = $1,614,181 ($500K/ha)

Total Flood Storage Construction Cost = $1,605,900
Total Flood Storage Acquisition Cost = $2,110,819 ($500K/ha)

			Wetland Construction Apportioning			Wetland Acquisition Apportioning			Flood Storage Construction Apport.			Flood Storage Acquisition Apport.		
			Based on predicted MUSIC Nitrogen Production in the catchment			*Based on predicted MUSIC Nitrogen Production in the catchment*			*Based on predicted RORB flood storage contribution*			*Based on predicted RORB flood storage contribution*		
Works Description	**Estimated Construction Cost**	**Estimated Land Acquisition Cost**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**
			21%	**16%**	**63%**	**21%**	**16%**	**63%**	**65%**	**9%**	**26%**	**65%**	**9%**	**26%**
Pipes	$512,715	$0												
Channels	$0	$0												
Culverts	$712,016	-												
Retarding Basins - Flood Storage function above Wetland NWL	$1,043,835	$1,372,033							$1,043,835	$144,531	$417,534	$1,372,033	$189,973.74	$548,813.03
Levee Bank Works	$820,200	-												
Swales	$0	-												
Wetlands	$1,741,936	$1,614,181	$1,741,936			$1,614,181								
Sediment Basins	$0	-												
Litter Traps	$0	-												
Buffer Strips	$0	-												
Bio-Retention Basins	$0	-												
Bio-Retention Swales	$0	-												
Related Costs/Works	$0	-												
Sub-total 'A'	$4,830,702	$2,986,213												
'A' x Engineering Fee @ 15%	$724,605	-												
Sub-total 'B'	$5,555,307	$2,986,213												
'B' x Administration Fee @ 9%	$499,978	-												
(Land Acq only) 'B' x Administration Fee @ 1%	-	$29,862												
Sub-total 'C'	$6,055,285	$3,016,075												
'A' x Contingencies @ 20%	$966,140	$597,243												
FORECAST EXPENDITURE	**$7,021,425**	**$3,613,318**												
TOTAL COST	**$10,634,743**													

Total Developable Land **59.0 ha**

CASE 3 - Homestead Road Extension DSS Contributing Solely to Wetland Costs, Flood Storage Costs Apportioned

% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$180,250**	**$160,222**	**$144,200**

CASE 4 - Homestead Road Extension DSS, Flood Storage and Wetland Costs Apportioned

Total Wetland Construction Cost = $1,741,936

Total Wetland Acquisition Cost = $1,614,181 ($500K/ha)

Total Flood Storage Construction Cost = $1,605,900

Total Flood Storage Acquisition Cost = $2,110,819 ($500K/ha)

Works Description	Estimated Construction Cost	Estimated Land Acquisition Cost
Pipes	$512,715	$0
Channels	$0	$0
Culverts	$712,016	-
Retarding Basins - Flood Storage function above Wetland NWL	$1,043,835	$1,372,033
Levee Bank Works	$820,200	-
Swales	$0	-
Wetlands	$365,807	$338,978
Sediment Basins	$0	-
Litter Traps	$0	-
Buffer Strips	$0	-
Bio-Retention Basins	$0	-
Bio-Retention Swales	$0	-
Related Costs/Works	$0	-
Sub-total 'A'	$3,454,573	$1,711,011
'A' x Engineering Fee @ 15%	$518,186	-
Sub-total 'B'	$3,972,758	$1,711,011
'B' x Administration Fee @ 9%	$357,548	-
(Land Acq only) 'B' x Administration Fee @ 1%	-	$17,110
Sub-total 'C'	$4,330,307	$1,728,121
'A' x Contingencies @ 20%	$690,915	$342,202
FORECAST EXPENDITURE	**$5,021,221**	**$2,070,323**
TOTAL COST	**$7,091,544**	

	Wetland Construction Apportioning *Based on predicted MUSIC Nitrogen Production in the catchment*			**Wetland Acquisition Apportioning** *Based on predicted MUSIC Nitrogen Production in the catchment*			**Flood Storage Construction Apport.** *Based on predicted RORB flood storage contribution*			**Flood Storage Acquisition Apport.** *Based on predicted RORB flood storage contribution*		
Works Description	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**	**Homestead Road Ex DSS**	**Homestead Road DSS**	**O'Sheas Road DSS**
	21%	**16%**	**63%**	**21%**	**16%**	**63%**	**65%**	**9%**	**26%**	**65%**	**9%**	**26%**
Retarding Basins - Flood Storage function above Wetland NWL							$1,043,835	$144,531	$417,534	$1,372,033	$189,973.74	$548,813.03
Wetlands	$365,807	$278,710	$1,097,420	$338,978	$258,269	$1,016,934						

Total Developable Land **59.0 ha**

CASE 4 - Homestead Road Extension DSS , Flood Storage and Wetland Costs Apportioned

% Normal Density Development	**100%**	**50%**	**0%**
% High Density Development	**0%**	**50%**	**100%**
Effective Residential Area (ha)	**59**	**66.4**	**73.8**
Approximate Residential Rate	**$120,196**	**$106,841**	**$96,157**

APPENDIX D

ADOPTED THEME – PRELIMINARY FILL ESTIMATE

(Based on detailed survey information and fill contours SWS November 2009)

North of Centre Road

PROPERTIES 3, 4 AND 5

Existing "Airspace " below 19.7 m AHD = 106,783 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
17.9	0				0
18	5800	2900	0.1	290	290
18.2	28000	16900	0.2	3,380	3,670
18.45	60000	44000	0.25	11,000	14,670
18.65	70000	65000	0.2	13,000	27,670
18.9	75000	72500	0.25	18,125	45,795
19	76000	75500	0.1	7,550	53,345
19.45	76500	76250	0.45	34,312	87,658
19.7	76500	76500	0.25	19,125	106,783

Filled "Airspace " below 19.7 m AHD = 51,313 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
17.9	0				0
18	0	0	0.1	0	0
18.2	0	0	0.2	0	0
18.45	0	0	0.25	0	0
18.65	7750	3875	0.2	775	775
18.9	31400	19575	0.25	4,894	5,669
19	36150	33775	0.1	3,378	9,046
19.45	70200	53175	0.45	23,929	32,975
19.7	76500	73350	0.25	18,338	51,313

Fill = 55,470 m^3

Fill area = 76,500 m^2
Average Fill = 725 mm *(checks OK with previous rough calculation of 800 mm)*

PROPERY 27

Existing "Airspace " below 18.85 m AHD = 34,163 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
17.6	0				0
17.8	5000	2500	0.2	500	500
18	22000	13500	0.2	2,700	3,200
18.2	38000	30000	0.2	6,000	9,200
18.45	38500	38250	0.25	9,563	18,763
18.65	38500	38500	0.2	7,700	26,462
18.85	38500	38500	0.2	7,700	34,163

Filled "Airspace " below 18.85 m AHD = 8,150 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
17.6	0				0
17.8	0	0	0.2	0	0
18	0	0	0.2	0	0
18.2	0	0	0.2	0	0
18.45	0	0	0.25	0	0
18.65	21500	10750	0.2	2,150	2,150
18.85	38500	30000	0.2	6,000	8,150

Fill = 26,013 m^3

Fill area = 38,500 m^2
Average Fill = 676 mm *(checks OK with previous rough calculation of 750 mm)*

Total Fill North of Centre Road = 81,483 m^3

85,000 m^3 (say)

Between Centre Road and Homestead Road

PROPERTIES 6,7 and 16

Existing "Airspace " below 18.9 m AHD = 69,020 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
17.9	0				0
18	11200	5600	0.1	560	560
18.2	74400	42800	0.2	8,560	9,120
18.45	88000	81200	0.25	20,300	29,420
18.7	88000	88000	0.25	22,000	51,420
18.9	88000	88000	0.2	17,600	69,020

Filled "Airspace " below 18.9 m AHD = 18,138 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
17.9	0				0
18	0	0	0.1	0	0
18.2	0	0	0.2	0	0
18.45	0	0	0.25	0	0
18.7	41500	20750	0.25	5,188	5,188
18.9	88000	64750	0.2	12,950	18,138

Fill = 50,883 m^3

Fill area = 88,000 m^2
Average Fill = 578 mm *(checks OK with previous rough calculation of 700 mm)*

PROPERTIES 9-15 and 17-22

Existing "Airspace " below 19.5 m AHD = 249,943 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
18	10700				0
18.2	81900	46300	0.2	9,260	9,260
18.45	156200	119050	0.25	29,763	39,023
18.7	182500	169350	0.25	42,338	81,360
18.95	209050	195775	0.25	48,944	130,304
19.5	226000	217525	0.55	119,639	249,943

Filled "Airspace " below 19.5 m AHD = 163,050 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
18	0				0
18.2	0	0	0.2	0	0
18.45	0	0	0.25	0	0
18.7	94000	47000	0.25	11,750	11,750
18.95	193500	143750	0.25	35,938	47,688
19.5	226000	209750	0.55	115,363	163,050

Fill = 86,893 m^3

Fill area = 226,000 m^2
Average Fill = 384 mm *(checks OK with previous rough calculation of 400 mm)*

Total Fill Centre to Homestead R 137,775 m^3 140,000 m^3 (say)

South of Homestead Road

PROPERTY 8

Existing "Airspace " below 18.9 m AHD = 26,400 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
18.2	1000				0
18.25	26000	13500	0.05	675	675
18.45	55000	40500	0.2	8,100	8,775
18.7	86000	70500	0.25	17,625	26,400

Filled "Airspace " below 18.9 m AHD = 10,750 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
18.2	0				0
18.45	0	0	0.25	0	0
18.7	86000	43000	0.25	10,750	10,750

Fill = 15,650 m^3

Fill area = 86,000 m^2

Average Fill = 182 mm *(checks OK with previous rough calculation of 200 mm)*

PROPERTIES 23-25

Existing "Airspace " below 19.5 m AHD = 37,435 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
18.3	0				0
18.45	53900	26950	0.15	4,042	4,042
18.6	67000	60450	0.15	9,068	13,110
18.95	72000	69500	0.35	24,325	37,435

Filled "Airspace " below 19.5 m AHD = 28,475 m^3

Level	Area (m^2)	Average Area (m^2)	Height Difference (m)	Volume (m^3)	Cumulative Volume (m^3)
18.3	0				0
18.45	0	0	0.15	0	0
18.6	67000	33500	0.15	5,025	5,025
18.95	67000	67000	0.35	23,450	28,475

Fill = 8,960 m^3

Fill area = 67,000 m^2

Average Fill = 134 mm *(checks OK with previous rough calculation of 50-300 mm)*

Total Fill South of Homestead = 24,610 m^3 25,000 m^3 (say)