Berwick Waterways

Drainage System Requirements

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1. Introduction

Berwick Waterways refers to the area is also known as the Homestead Road Extension Development Services Scheme (DSS) by Melbourne Water Corporation (MWC). This is a proposed DSS and has yet to be formally adopted by 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.

In late 2009 The Growth Areas Authority (GAA) produced a report by Stormy Water Solutions (SWS) and NM Craigie Pty Ltd entitled "Berwick Waterways, Drainage Assessment, Options Development and Appraisal, November 2009" (Report 2). This report followed on from a September 2009 report by Stormy Water Solutions and Neil M Craigie Pty Ltd "Berwick Waterways, Summary Issues Paper, 14 September 2009" (Report 1).

The outcome of both these reports was the adoption of the preferred drainage strategy for Berwick Waterways given the primary objective of minimising filling and drainage costs associated with the future development of the area. Theme 2, the adopted drainage strategy as detailed in Report 2, can result in development of the subject area for urban purposes without prohibitive fill costs. However, the costs associated with providing drainage infrastructure will still be higher than in conventional developments.

However, planning initiatives such as allowing as much higher density development as possible to increase the benefits versus the costs of developing the area, obtaining external MWC funding outside of the DSS system may be required to ensure development ultimately occurs.

Since the distribution of Report 2, the GAA has commissioned separate geotechnical and ecological studies of the area. In addition the Department of Sustainability and Environment (DSE), Casey City Council and Melbourne Water Corporation (MWC) have provided feedback and been involved in various site visits and meetings during 2010. This has resulted in minor modifications to the proposed drainage strategy.

This report:

- Updates the proposed drainage strategy as of February 2011, and
- Updates projected drainage and filling costs given the feedback obtained from various organisations,

The proposed drainage strategy is shown in Stormy Water Solutions drawing set 1101/1-4, February 2011.

The proposals in regard to the proposed drainage reserve and wetland system are considered relatively locked in and the design of this element is almost at a functional design level at this stage (i.e. design levels, system extent etc have been determined given full stakeholder input and consideration of all physical constraints such as ecological requirements, downstream invert level etc).

However, MWC Development Services Scheme (DSS) pipe sizes, alignments etc have yet to be set by MWC. Also, final wetland design levels are required to be confirmed given existing downstream invert level and wetland levels.

The flood event of 4 and 5th February 2011 indicates that additional system outlet and Hallam Valley Contour drain levee investigations are required to ensure the proposals to date are adequate to protect any future development outside the leveed system from flooding.

The aims of the plans presented are to set the direction of a future drainage strategy or DSS by MWC, not to define the full DSS or drainage requirements at this time.

2. Proposed Drainage Strategy

2.1 Description of the Proposed Drainage Strategy

The proposed drainage strategy is shown in Stormy Water Solutions drawing set 1101/1-4, February 2011.

The Strategy is based on Theme 2 detailed in Report 2. This strategy was developed given consideration of a number of opportunities, constraints and design requirements. These are discussed in detail in Section 2 of Report 2.

The strategy provides 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. 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.

The proposed drainage strategy aims to minimise:

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

However, some changes to those detailed in Theme 2, Report 2 have been made, primarily to accommodate the ecological and environmental constraints of the area.

The updated drainage strategy is shown in Stormy Water Solutions drawing set 1101/1-4 incorporates:

- A central wetland reserve location to maximize access potential of residents to the wetland area and equitable apportioning between landowners, while maximising retention of the existing ecological attributes of the existing drainage lines,
- Maximization of wetland frontage,
- A wetland normal water level (NWL) of 16.9 m AHD,
- A wetland top of extended detention level of 17.3 m AHD,
- A 100 Year ARI flood level in the reserve area of 18.15 m AHD (existing MWC declared level),
- A total water surface area of the wetland pondage systems of 10.7 ha,

- A 100 Year ARI flood area of 17.6 ha (approx),
- A 100 Year ARI flood storage of 176,000 m^3 above NWL, assuming restricted outflow below top of extended detention (TED) level of 17.3 m AHD (48 hours critical duration to optimise flood storage objectives of the system (see 1101/4),
- A Permanent pool of the wetland below Normal Water Level = 84 ML,
- A total volume of cut = 260,000 m^3 (Approx),
- A Total (approximate) volume of fill on adjacent developable land in the order of 265,000 m^3,
- Alignment of the wetland to maximise retention of the existing drainage line to protect existing swamp scrub vegetation and drain habitat (see 1101/1 and 1101/3),
- Directing some low flows from future adjacent subdivisions to retained existing drainage lines to ensure adequate flushing of these systems (see 1101/1 and 1101/3),
- modifications of the drainage system outlet at the Hallam Valley Contour drain involving head wall modifications of the existing low flow outlet syhpon outlets to ensure the wetland and flood storage design levels can be achieved (see 1101/4),
- Upgrades to the existing Hallam Valley Contour Drain levee to ensure adequate flood protection from external catchment flows (see 1101/2),

The preliminary "land take" calculations indicate:

- The total DSS area is about 85.5 ha,
- The total drainage/recreation reserve area is approximately 20.3 ha,
- A wetland area of about 10.7 ha,
- 100 Year flood affected land within the reserve = 17.6 ha (i.e. 2.7 ha of flood-free recreation land within the reserve),
- 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.

It is anticipated that 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. Proposed fill levels are shown on 1101/1. A S173 agreement will be required to ensure all future floor levels are 600 mm above 100 Year ARI flood level.

2.2 Constraints

As with previous strategy iterations, 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 (see 1101/2).
- All engineering requirements specified in Section 2.2 and Section 4 of Report 2 must be adhered to,

- The feasibility of the proposed NWL must be checked at the functional design stage of the project given downstream wetland NWL's and downstream invert level constraints,
- 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 and retained existing drainage paths must have a reasonable upstream catchment to ensure flushing of the entire system during storm events, and
- All developable land must be filled to the minimum fill levels specified in 1101/1 to ensure adequate outfall pipe cover and adequate flood protection in the 100 Year ARI flood event.

2.3 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 1101/1 must be sized assuming these requirements (the updated pipe system has yet to be sized). 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),
- 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 pipelines 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.

In addition, the flood event of 4 and 5th February 2011 indicates that additional system outlet and Hallam Valley Contour drain levee investigations are required to ensure the proposals to date are adequate to protect any future development outside the leveed system from flooding.

3. Development Staging

Staging was agreed to be relatively flexible (See Section 5, Report 2).

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 a DSS arrangement, 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 any future 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 would:

- 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.

4. Stakeholder Feedback 2010

The following summarises the feedback received from the primary stakeholders in 2010 in regard to Report 2.

4.1 Geotechnical Investigations

In 2009 AECOM undertook a limited geotechnical and environmental assessment mainly focusing on potential soil contamination.

The primary findings were that:

- There is some minor excavation activity in the area and stockpiles will need to be removed.
- There is potential for acid sulphate soils which may affect excavation works associated with the wetland system. Acid sulphate investigations suggest levels are not high, but still a concern in regard to future wetland construction requirements.
- Reusing the wetland excavation spoil on site for fill of adjacent development will require moisture conditioning and lime treatment. This will add to the construction cost but be cheaper than removing onsite soils and bringing in clean fill. It is preferable for soils removed during construction of the waterways be reused by developers within the Berwick Waterways area. If used by developers on site the lime treatment will be considered a development cost by Melbourne Water and the developer will need to pay. If the soils are removed from the site, it will be considered a construction cost and Melbourne Water will pay, which may make development unfeasible.
- Construction of the wetlands will need to occur at the same time as the development of adjacent landholdings in order to reuse the soils as soon as possible in order to reduce the risk of acid sulphate soils.

Further work is required to:

- Check the flow rates from groundwater and stormwater to fully understand the interaction between groundwater and surface water within the wetland systems, and
- Costings for the excavation and development filling works required will need to be sought.

In light of the above, the preliminary costings in this report allow for (prior to engineering and contingencies) an excavation rate of \$15/m^3 (from \$6/m^3 in 2009) to excavate the flood storage and wetland areas and a fill rate of \$20/m^3 (form \$10/m^3 in 2009). This accounts for

- lime stabilisation required for use of the spoil as fill,

- potential lime stabilisation required for possible acid sulphate soil problems during wetland construction, and
- issues involved in staging wetland construction with development filling.

4.2 Ecological Investigations

In 2010 Ecology Partners undertook an ecological assessment of the Berwick Waterways area for the GAA. Given this investigation the DSE has indicated that the existing drainage lines and associated vegetation should be retained if possible.

Primarily the assessment found the major issue to be the existing swamp scrub located along the road reserves and original drainage lines. There were also areas of plains grassy wetlands, however these were low quality and modified.

The existing swamp scrub is an endangered EVC, however, it is considered easy to replace and grow.

The proposed drainage strategy as detailed in this report, is required to be assessed and commented on in regard to both requirements of implementation and the opportunities the strategy provides in regard to possibly increased ecological diversity in the area in the future. For instance, significant ephemeral marsh areas in wetland areas will offer a significant habitat opportunity for species such as Latham's Snipe. Deep pool areas will provide diversity in wet areas for other fauna. Also, significant swamp scrub (existing and future) areas can be accommodated within the wetland reserve areas.

The upgraded drainage strategy as detailed in this report has been formulated to retain as much of the existing vegetation as possible along the drainage lines.

One issue highlighted as requiring further investigation is the issue of Dwarf Galaxias. This species **HAS NOT** been observed within the Berwick Waterways boundary. However, it has been observed downstream of the study area. The issue is that the existing drainage system within Berwick Waterways been assessed as potentially very good habitat for this species.

It is considered that the opportunity for Dwarf Galaxias to migrate upstream into Berwick Waterways (both now and in the future) is extremely low. This is because of the structural barriers afforded by the existing low flow outlet to the Hallam Valley Coutour drain and the syhpon outlet to the Golf Links Road drainage system.

The low flow outlet has (or should have) a flood gate at its outlet. In times of flood in the Hallam Valley Contour drain, this gate is closes, preventing migration of fish upstream. In times of low flow, the invert of the low flow outlet is above the water level within the contour drain.

The syhpon outlet works under gravity, on the assumption that the headwater level (within Berwick Waterways) will always be higher than the tail water level in major flow events. In the 100 Year event, velocities in the system are in the order of 2 m/s in the downstream direction. In the 1 Year ARI event velocities are in the order of 1 m/s in the downstream direction. As such, any small fish species will struggle to swim upstream, against significant current and within a long enclosed pipeline system (60m) and into the Berwick Waterways system. The existing Berwick drainage system has been assessed as good Dwarf Galaxias habitat, however NO fish of this species have been observed in the area of interest. It appears this structural barrier has, and will probably continue to be, an impassable barrier for this species. As such, the existing drainage system, although exhibiting good habitat, probably has a low chance of being used by this fish species.

Given the above, the strategy has aimed to retain as much of the existing drainage system as possible. However, some areas (particularly along road reserves) may be lost in the development process. Given the probably negligible impact on the dwarf galaxias, this minor removal of some drainage paths (and associated swamp scrub) is considered reasonable.

4.3 Council Feedback

In 2010 Casey City Council reviewed “Berwick Waterways, Drainage Assessment, Options Development and Appraisal, SWS, November 2009” and raised various questions in regard to some aspects of the proposed strategy (Theme 2).

The following summarises the council concerns and GAA’s response.

Council were concerned about the scenario of one property deciding to develop directly next to another that remains as is. The GAA is partially addressing this issue by incorporating a development facilitator. However, some initiatives aimed at reducing potential problems are discussed in Section 5 of Report 2.

The GAA confirmed that future roads incorporating their existing natural surface levels were, in general not flood prone. Almost all of the existing roads are above 18.15 m AHD (the existing and future 100 Year flood level). A small portion of Centre Road near the existing drain crossing is at about 18.0 m AHD now. This would need to be raised 150 mm to give 100 yr protection. In addition, roads adjacent to the Hallam Valley Levee may need to be raised to match the levee protection works proposed by MWC.

It was confirmed that the proposed to gravity outlet for the wetlands into the Hallam Valley Contour Drain is achievable via the existing MWC syhpon and low flow outlet located at the north western edge of Berwick Waterways (i.e. the top end of the wetland system). No upgrade so the system is necessary. Some minor changes are required at the upstream end of the outlet system to set wetland NWL, TED etc. It is understood that there is an existing flood gate of the low flow outlet to Hallam Valley Contour drain and this will be required to be maintained in good working order at all times in the future.

MWC confirmed that they will be responsible for the wetland areas. Actual delineation of responsibilities (e.g. areas inside and outside walking paths, mown areas, active recreation areas etc) will occur as the project progresses.

SWS confirmed that the strategy to date has accounted for existing road levels and also how development will drain towards the road pipe network. This work is based on detailed survey information. The design is expected to change as the process moves forward. But enough work has been performed to show the drainage strategy is feasible.

SWS confirmed that in 2009 agreement was obtained from MWC and Council in a workshop that, provided a pipe full velocity of above 1m/s can be achieved, 1/600 pipe grades are suitable within Berwick Waterways. This was part of the strategy to minimise development fill costs. Preliminary calculations show this velocity can be achieved. If this is a real issue for Council in the future, design development could consider reducing cover requirements from 750 mm to 500 mm and/or, partially inundating more pipes at their outfall with the wetland system.

It was confirmed that pipes of less than 60 ha catchment will ultimately become council's responsibility.

Given the above review and Council feedback during a site visit and workshop held on 14 December 2010, it is understood that Council are generally in agreement that Theme 2, as presented within Report 2. Council did suggest some modifications to the wetland alignment given the ecological constraints detailed above.

Given the flood event of 4 and 5th February 2011 it is anticipated that Council will require MWC to complete additional system outlet and Hallam Valley Contour drain levee investigations. These are required to ensure the proposals to date are adequate to protect any future development outside the leveed system from flooding. Council are also concerned about maintain access during extreme flood events. More details on this aspect of the design may be required.

4.4 Melbourne Water Corporation Feedback

The following is the MWC feedback provided in a meeting with the GAA on 15th December 2010.

- MWC are in agreement that Theme 2, as presented within Report 2 meets all of the engineering drainage wand water sensitive urban design requirements of a future MWC in the most cost effective manner.

- MWC required the RORB modelling be reviewed to assess if a fraction impervious of 65% for future development within Berwick Waterways may increase the flood storage requirement. This was undertaken by SWS in February 2011. The updated RORB model not only increased this fraction impervious value, but also updated the stage/storage discharge relationship to correspond to the current design (see Drawing 1101/4). The updated RORB results are:
    - Critical Outflow Duration = 30 hours,
    - Inflow at 30 hours duration storm = 7.5 m^3/s,
    - Outflow from total system = 2.5 m^3/s,
    - 100 Year ARI flood level in Berwick Waterways Drainage Reserve = 18.15 m AHD,
    - 100 Year Flood storage in Berwick Waterways Drainage Reserve = 176,000 m^3 (increased from the 2009 requirement of 169,000 m^3)

- MWC support the concept that the wetland portion to be located north of Centre Road will have high ecological values, and as such can be designed deeper than the normal MWC requirements (e.g. 0.5 – 1.0 m deep below NWL on average).

- MWC require the remainder of the wetland system (apart from sediment pond zones) to meet current water quality depth requirements of 0.5 – 0.6 m deep on average to achieve 80% vegetation coverage.

- MWC require the wetland NWL to be at least 15 metres to road reserves and 20 m to lot boundaries.

- All final DSS pipelines within Berwick waterways will be Council's, and as such may be required to be Rubber Ring Jointed.

- MWC agree to the concept of apportioning the DSS (or drainage strategy) water quality funding between O'Sheas Road DSS, and the Homestead Road Extension DSS (Berwick Waterways) (apportioning regarding the existing Homestead Road DSS was not discussed, however it is

assumed that this scheme has already contributed to this item via the existing Homestead Road retarding basin and wetland construction and land acquisition).

- MWC, at this stage, indicated that they did not support the apportioning of flood storage costs between O'Sheas Road DSS, Homestead Road DSS and the Homestead Road Extension DSS (Berwick Waterways). However, the previous acquisition of 10.45 ha in the area (Homestead Road and Centre Road retarding basin sites) probably more them covers any theoretical contribution.

- MWC indicated that all land acquisition costs should be apportioned to the Berwick Waterways. Again, MWC has already contributed to the acquisition of 10.45 ha within the Berwick Waterways boundary leaving only 9.85 ha of drainage reserve to be acquired by MWC (if a DSS is adopted for the area) or contributed by the developers 9if the scheme remains as a drainage strategy).

- MWC consider the assumed land acquisition works (at $500,000 per ha) is too low. The rate has been increased to $1,500,000 in the preliminary costings detailed below.

- MWC consider the assumed excavation rates and fill rates are too low given the potential acid sulphate problems in the area and the probable need to lime stabilise cut prior to use as fill. The rates have been increased for the preliminary costing exercise detailed below.

- MWC will consider apportioning required Hallam Valley Levee works between various DSS's.

- MWC have previously indicated that they 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 any potential DSS rate.

- It was agreed that development may only be feasible if MWC can treat the entire area as one "landowner" (i.e. all landowners are part of an overall coalition and the drainage plan implementation is as a "drainage strategy" rather than a DSS).

- If the scheme is a "drainage strategy" rather than a DSS, MWC indicated they would contribute the funds for water quality component of the O'Sheas Road DSS (and possibly some funds for the levee protection works). MWC will also require upfront construction of the wetland north of Centre Road and the levee protection works.

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 (if a DSS is implemented) provided the development is shown to be economically viable.

5. Approximate Drainage and Fill Costs

Obviously the final drainage strategy funding arrangements will vary depending on whether MWC develops a Development Services Scheme (DSS) for the area or if all (or the majority) of the affected landowners can form a consortium and implement a drainage strategy without the need to a DSS.

Table 1 details a very preliminary cost estimate of drainage and fill costs going forward. These estimates are preliminary only and in no way reflect potential final costs.

In summary:

- Estimated “Drainage System Construction Costs” (pies, culverts, and wetland and flood storage excavation) have increased from $8M in 2009 to $12M in 2011, primarily due to increased excavation costs associated with possible acid sulphate soil issues.

- Estimated “Development Fill Costs” have increased from $5M in 2009 to $9M in 2011, primarily due to increased fill costs associated with lime stabilisation and staging of fill with wetland construction.

- Estimated “Reserve Acquisition Costs” have increased from $6M in 2009 to $18M in 2011, due to MWC advice regarding possible acquisition cost rates.

ITEM	2009 Estimate	2011 Estimate given Stakeholder Feedback	Comments
Drainage Strategy Construction Works			
. Strategy pipes	$745,000	$745,000	*Not reviewed in Feb 2011 analysis. Assumed not to change significantly from 2009 proposal, although slight changed to design have occurred*
. Strategy Culverts	$1,035,000	$1,035,000	*Not reviewed in Feb 2011 analysis. Assumed not to change significantly from 2009 proposal, although slight changed to design have occurred*
Hallam Valley Contour Drain Levee Bank Works	$1,190,000	$1,350,000	*Not reviewed in Feb 2011 analysis. Assumed not to change significantly from 2009 proposal, although slight changed to design have occurred*
Drainage Reserve			
. Wetland Below Normal Water Level	$2,533,000	$3,872,000	*Excavation $15/m^3 in 2011 (increased from $6/m^3), assumed disposed of on site - 3 times DSS rate for possible acid sulphate treatment*
. Flood Storage above Normal Water Level	$2,335,000	$4,866,000	*Excavation $15/m^3 in 2011 (increased from $6/m^3), assumed disposed of on site - 3 times DSS rate for possible acid sulphate treatment*
Total Drainage Construction Costs	**$7,838,000**	**$11,868,000**	
Reserve Acquisition (Developers 9.85 ha)	$6,000,000	$18,000,000	*Change based on $0.5m/ha 2009, $1.5M/ha 2011. Land yet to be accurately valued*
Reserve Acquisition (MWC land 10.45 ha)	$0	$0	*Land previously purchased as part of Ex Homestead Road DSS Scheme*
Approx Fill Costs	$4,471,000	$8,873,000	*Fill costs $20/m^3 in 2011 (increased from $10/m^3), to allow for lime treatment for fill material and costs involved with coordinating wetland construction and development filling*
	280,000 m^3 fill assumed	265,000 m^3 fill assumed, Topsoil Volume increased	

Table 1 Preliminary Cost Estimate Summary

As detailed in Report 2 (2009), there is the potential to distribute costs as per the benefits attributed to the various contributing catchments. This apportioned is detailed below.

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%

MWC have indicated that the agree to the concept of apportioning the DSS (or drainage strategy) water quality funding between O'Sheas Road DSS, and the Homestead Road Extension DSS (Berwick Waterways). As such, if a "Drainage Strategy" is implemented, rather than a DSS, MWC may contribute in the order of 63% of $3,872,000 = $2.4M. MWC have also indicated they will consider contributing further funds for the Hallam Valley Levee works required. It is proposed that these funds be used to:

- Construct the wetland and flood storage area north of Centre Road as the first stage of the drainage strategy implementation, and
- Construct the Hallam Valley Levee works within the first stage of the drainage strategy implementation to ensure adequate flood protection as development of the area proceeds.

MWC, at this stage, indicated that they did not support the apportioning of flood storage costs . However, the previous acquisition of 10.45 ha in the area (Homestead Road and Centre Road retarding basin sites) probably more them covers any theoretical contribution.

MWC has also indicated that all land acquisition costs should be apportioned to the Berwick Waterways area. Again, MWC has already contributed to the Acquisition of 10.45 ha within the Berwick Waterways boundary leaving only 9.85 ha of drainage reserve to be acquired by MWC (if a DSS is adopted for the area) or contributed by the developers if the scheme remains as a drainage strategy.

All remaining drainage works, as detailed above, will need to be accounted for as requirements on development (if a drainage strategy is implemented) or via a Development Services Scheme rate (if a DSS is initiated).

Although the revised cost estimates are greater than the 2009 estimates, costs are still considered to represent an optimization of the drainage costs in relation to the adopted strategy given all of the considerations discussed previously in this Reports 1 and 2.

As previously discussed, encouraging a high density of development within Berwick Waterways will provide a more cost effective development scenario.

6. Recommendations

It is recommended that the Growth Areas Authority, Melbourne Water Corporation, City of Casey and Ecology Partners review this draft report and provide feedback to the consultant team by 31 March 2011.

In particular, MWC should confirm any potential contributions towards water quality wetland works and the construction of the Hallam Valley Contour drain levee augmentation. MWC also need to confirm a commitment to construction the wetland and flood storage area north of Centre Road and the levee augmentation works as Stage 1 of the implementation of the proposed Drainage Strategy.

Given the flood event of 4 and 5th February 2011 it is anticipated that that additional system outlet and Hallam Valley Contour drain levee investigations are required to be completed by MWC. This work should:

- Confirm the Average Recurrence Interval (ARI) of the February 2011 event,
- Identify what caused the high flood level within Berwick Waterways during this event (i.e. levee overtopping, an extreme event of ARI greater than 100 Years, backflow through the outlet system, blockage of the outlet system or a combination of the above),
- Review the Hallam Valley Contour Drain declared flood levels given changes to system roughness over time,
- Review required levee heights and how these levee works may be incorporated into the Berwick Waterways design,
- Confirm the assumed operation of the sysphon and low flow pipe outlet system, especially the operation of the flood gate on the low flow outlet pipe,
- Ensure the Hallam Valley Contour Drain levee and outlet system proposals are adequate to protect any future development outside the leveed system from flooding.

In addition, the GAA and Council are required to:

- Continue to investigate POS, activity centre, reserve requirements etc,
- Obtain Ecology Partners feedback regarding the impact of the proposed strategy in regard to ecological and environmental objectives,
- Obtain a more detailed estimate of projected wetland and flood storage excavation costs and potential development fill costs,
- Consult with the DSE regarding the impact of the proposed drainage strategy on existing drainage lines and vegetated areas within the Berwick Waterways area, and
- Advise on how the landscape and social opportunities could be incorporated into the planning process

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.
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
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
Abbreviation Descriptions	**Definition**
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.
SWS	Stormy Water Solutions – A Hydrological and Environmental Engineering Consultancy
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 macrophysics