10th February 2017

Essential Services Commission
Level 37/2 Lonsdale Street
Melbourne Victoria 3000

RE: Melbourne Water's – 2017 Quiet Lakes Bore Flushing Tariff Proposal

Thank you for the opportunity to submit our concerns regarding Melbourne Water's (MW) 2017 Quiet Lakes Bore Flushing Proposal to the Essential Service Commission (ESC).

Firstly, please let me introduce myself. My name is Anthony Moffatt, I am a resident of the Patterson Lakes Quiet Lakes, former member of Melbourne Water's Patterson Lakes Advisory Committee (PLAC), current resident's representative on the Patterson Lakes Independent Review Steering Committee and current President of the Patterson Lakes Quiet Lakes Owners and Residents Association Inc. (PLQLOR Inc. A005028B) Committee Member since September 2008, Committee Vice President since July 2009 and Committee President since July 2010.

On behalf of the current financial members of PLQLOR Inc. I hold a mandate and I am well versed to speak in relation to the ongoing management issues by Melbourne Water that are adversely affecting the proper operation Patterson Lakes Quiet Lakes in accordance with the 2013 Patterson Lakes Independent Review.
I note from the various 'Pricing Submissions' that Melbourne Water has publicly committed to implement the recommendations from the Independent Review, however as a member of the IR Steering Committee I have only experienced Melbourne Water's determined attempts to misrepresent and avoid at all cost the implementation of the recommendations of the Independent Review.
In the Independent Review Steering Committee process, currently 6 of 7 Quiet Lakes related recommendations continue to remain at an impasse (i.e. Recommendations 2, 3, 4, 6, 9 & 15).
In the meanwhile, Melbourne Water has continued to not call a IR Steering Committee meeting since the 13/08/2015, which is the primary consultation action as outlined in the Independent Review (IR Page vii), "to ensure that agreed actions and funding sources are provided for the ongoing management of the lakes".
In an effort to continue the IRSC forum for the original purpose of moving toward the creation of a management plan Daniel Freer, Kingston City Council (KCC), invited all stakeholders to a IRSC meeting held at the council office on the 02/09/2016. KCC, QL, TWW and PV were represented. Unfortunately, Melbourne Water simply didn't turn up, which hindered any opportunity to address unresolved recommendations relating to the Quiet Lakes.
Appendix A – minutes to most recent IR Steering Committee meeting 02/09/2016

Despite unresolved IR recommendations by the Steering Committee forum, Melbourne Water pushed forward in November 2015 with their community consultation to residents, conveying false and misleading statements for the purpose of 'gaining a financial advantage by deception.' Melbourne Water's false and misleading statements conveyed within their survey simply gave residents the ultimatum of 'agree to pay for the running of the bore or suffer the consequence of the bore being switched off'.
As you are aware the PLQLOR Association conducted a survey of its own collecting 581 signatures of which Angeline Bilas, ESC Project Manager – Pricing Water Division, has been

provided a copy of previously. The PLQLOR survey containing 581 signatures calls for the Water Minister to compel Melbourne Water to honor the recommendations of the Independent Review, in particular, Recommendations 3 & 6 requiring the Design Flow Plan to be implemented and funded from the Melbourne Metropolitan Waterways and Drainage Charge funds.

In response to Melbourne Water's unscrupulous survey, placing residents in the compromising position to pay for the running of the bore or suffer the adverse health consequence of returning to a stagnant series of lakes with no regular flow, PLQLOR took the action to advise residents to vote in favour of running the bore, whilst PLQLOR continued to deal with MW on this issue. **Appendix B – PLQLOR communication to the residents recommending a Yes vote to MW's survey**

THE OBJECTIVE OF MW'S TARIFF PROPOSAL AND THE RESPONSE SUBMISSIONS

The MW tariff proposal and response submissions is NOT about whether the bore should run or not.

Melbourne Water, Design Flow and the residents all agree that running the bore has created the desired effect of managing safe levels of Blue Green Algae in Lakes Legana and Illawong over the past 5 years.

Absolutely the bore must continue to run to create flow and water renewal to avoid returning to a stagnant waterway persistently affected by hazardous Blue Green Algae as was clearly the case prior to reinstating the bore flow as can be verified by MW's water quality testing charts. **Appendix C – MW's water quality testing charts.**

The MW tariff proposal and response submissions is NOT about achieving a higher water quality suitable for swimming.

The MW tariff proposal and response submissions is NOT about establishing a willingness to pay.

The MW tariff proposal and response submissions for the running of the bore IS ALL about the ESC determining who is financially responsible for managing a healthy and safe waterway to protect human health by achieving secondary contact water quality as the minimum standard. The residents are not yet at the point of requesting a water quality 'over and above' secondary contact water quality. As stated in IR Recommendation 9, achieving water quality 'over and above' secondary contact as the minimum standard would require Quiet Lakes property owners to consider what, if any, capital projects they may jointly require to achieve water quality 'over and above' secondary contact standard. The bore, the ground water extraction licence, the pumps, the bore water pipes and the interconnecting pipes are all existing infrastructure put in place by the developer with a licence and capability to run 2ML/day for 365 days per year. Running the system of interconnecting water flows between the three Quiet Lakes requires no capital investment. As stated in IR Recommendation 6, this system just needs to be managed, funded and operated by Melbourne Water to deliver healthy and safe secondary contact water quality as the minimum standard. These are to be funded from the Melbourne Metropolitan Waterways and Drainage Charge.

If the ESC considers the issue of who is financially responsible to run the bore confusing, unclear or ambiguous, then unless the ESC is 100% confident 'beyond reasonable doubt' the financial responsibility for running the bore to improve waterway health and protecting human health to secondary contact water quality must fall with Melbourne Water as the Authority. It is not appropriate for the ESC to place the financial burden of running the bore to manage a safe and healthy waterway to protect human health to the secondary contact water quality for the Quiet Lakes and those downstream. The Quiet Lakes residents already pay for MW to manage a safe and healthy waterway in their Melbourne Metropolitan and Waterways Drainage Charge.

The Independent Review Steering Committee (IRSC) sought clarification from Chris Harty, Chairperson of the Independent Review panel. Chris Harty responded to the IRSC with the following words of advice: **Appendix D – Chris Harty letter to the IRSC**

> *"If there are differences or confusion regarding the interpretation of recommendations, I would suggest that they be accepted as to their meaning on face value and in plain English or to utilise the discussion contained within the body of the report to obtain an idea of what is meant by the recommendations. If the discussion contained in the report is not helpful in reaching a clear interpretation of the meaning of a recommendation, then I would suggest that the key action for PLMPSC is to work through the recommendations and issues in a collaborative manner and to reach a general consensus that allows the Committee to move forward to progress the recommendations and their intent as best as possible for the benefit of the Patterson Lakes Tidal Waterways and Quiet Lakes.*

For sure, what's NOT BEST for the Patterson Lakes Quiet Lakes or the interconnected public waterways that the Quiet Lakes discharge to, is a stagnant series of lakes persistently affected by unsafe levels of hazardous Blue Green Algae in the absence of the running of the bore for flushing/ water renewal purposes.
It should be noted by the ESC that unlike other lakes that MW manage, the Quiet Lakes have no reliable flushing flow from storm water activity. The Quiet Lakes are designed such that the local storm water actually flows away from the Lakes toward either the Gladesville pump station to Patterson River or to the McLeod Rd pump station to Eel Race creek. The Quiet Lakes only receive input from the local storm water system when there is an extreme storm event i.e. once or twice /yr. The Independent Review established that the water received from storm events is not sufficient to achieve the required residence time in the Quiet Lakes of 2 months. Design Flow determined that the residence time in the lakes when restricted to input from severe storm events only, is more than 5 years. Hence, it is no wonder the Quiet Lakes were persistently affected by hazardous Blue Green Algae prior to the commencement of the running of the bore.

ESTABLISHING CLARIFICATION AS TO WHO'S FINANCIALLY RESPONSIBLE.

The Hon. Lisa Neville, Minister for Water, wrote to myself regarding the running of the bore to manage water quality and responded by confirming the residents were not the sole beneficiaries stating: **Appendix E – Hon Lisa Neville letter to Anthony Moffatt**

> *"I have asked Melbourne Water to continue to use the bore pump to top up the water levels in the lakes during summer, as has been the case since the lakes were developed. However any additional use of the bore pumps will need to be funded by the primary beneficiaries – in this case the residents of the Quiet Lakes. "*

Whilst I am at a loss as to how the Hon. Lisa Neville concluded a 'primary beneficiary' of a safe and healthy waterway that discharges all the way to Port Philip Bay, she has at least confirmed in line with the IR that there is more than one beneficiary of the water quality in the Quiet Lakes that discharge into the publicly accessible waterways of Eel Race Creek, Kananook Creek, and Patterson River and Port Philip Bay. The Hon. Lisa Neville also confirmed in her letter to me that MW should continue to use the bore as it was intended by the developer.

The Independent Review's 'Chapter 5 – Water Quality and Quantity' clearly informs us of:

- the original design concept of managing retention time,
- the original purpose of the bore for providing flow to manage water quality
- the beneficiaries of secondary contact water quality including safe levels of Hazardous Blue Green Algae

The Independent Review is clear on its view that the drainage function of the Quiet Lakes and the associated requirement to maintain 'Secondary Contact Water Quality as the Minimum Standard' **(Recommendation 2)** and to manage safe levels hazardous Blue Green Algae **(Recommendation 3)** via the implementation of the Design Flow Water Quality Management Plan provides a clear benefit to the wider community as a repeated message in the references detailed through Chapter 5.

The Independent Review states:

5. WATER QUALITY AND QUANTITY

The following first provides some background information with respect to the design of the Patterson Lakes Waterways and secondly considers issues regarding water quality and water quantity for both the Quiet Lakes and Tidal Waterways.

5.1 Background

The Quiet Lakes were designed such that stormwater would primarily fill each lake, and that a system of interconnecting pipelines and outflows would balance the water levels in each lake. This would also ensure that inter-flows of water were sufficient to maintain appropriate retention times in each water body. Retention periods (or hydraulic residence times) relate to the primary anaerobic treatment function of the

water body. Expressed simply, too short a period does not allow natural treatment processes to occur, and too long a period can create stagnancy and algal blooms.

The issue of water quality and water residency in particular within the Quiet Lakes was highlighted by the Chief Engineer-Manager of the Dandenong Valley Authority in 1974 when, in correspondence to the Australian Conservation Foundation[26] it was stated that:

> *A second advantage of the design system lies in the drainage system which ensures discharge of the first portions of run-off from roads and roofs and it has always been our view that a complete water change-over in the vicinity of every two months would, in the light of the other conditions, ensure satisfactory water quality.*

There was also a seawater pipeline installed to provide back-up flows in the event that rainwater and evaporation could not be balanced to maintain adequate water levels. A groundwater bore was used initially to help fill the Quiet Lakes and later for topping up water levels when required. As a result, the seawater pipeline was deemed to not be required (the developer notified the Dandenong Valley Authority of this position in January 1982, who later endorsed the de-commissioning[27]).

The bore therefore provided the crucial back-up inflows to Lake Legana (the highest level of the 3 lakes), and ensured that water would overflow to Lake Illawong, and then into Lake Carramar. The 1976 groundwater license (in favour of the Dandenong Valley Authority) was originally for 73 mega litres per annum, but the Rural Water Commission reduced this to 20 ML in 1991, when the usage patterns indicated an average annual volume of approximately 9 ML was required.[28]

5.2 Current situation

The Tidal Waterways are subject to tidal movement and hence water levels regularly fluctuate. They are less contained than the Quiet Lakes. Stormwater run-off discharges into the Tidal Waterways, which then drain into Port Phillip Bay (via the arterial drain, being the Patterson River). Several of the far-reaching parts of the Tidal Waterways are also topped-up with inflows being pumped from the Patterson River, to provide flushing and to achieve appropriate water retention periods. Both the Quiet Lakes and the Tidal Waterways also outflow into the neighbouring drains leading to the Kananook Creek, which flows into Port Phillip Bay at Frankston.

This demonstrates that the Patterson Lakes Waterways were designed, situated, and created to perform a floodplain management and drainage retention function. The Review also acknowledges that the inter-connectedness of the Patterson Lakes Waterways reflects the high reliance upon the broader catchment as a source of water. They also play an important role in the primary treatment of stormwater before it is discharged into Port Phillip Bay.

5.3 Water Quality

The water quality of the Patterson Lakes Waterways affects those who live there, use them, and those downstream abutting drainage and watercourse areas (via the outflows). This includes not only human activity but also flora and fauna species and broader ecosystems.

Water quality in the Quiet Lakes has been affected by the occurrence of blue green algal blooms. In response, Melbourne Water has investigated these events in 2001,[30] and reviewed in a report *Review of Water Quality and Lake Management*[31] which provided a detailed analysis of the Quiet Lakes and management options. The report provided a comparison between the ANZECC Guidelines for the highest potential beneficial use and the reasonable water quality expectations for each of the three quiet Lakes. The report highlighted that there will always be changes to water quality levels after stormwater inflows and urban inputs, and that many factors impact upon the consistency of reasonable levels being achieved. It stated that:

> *Water quality guidelines or objectives are just that. They establish a standard to be aimed for and worked for, while acknowledging that they may not be always achieved.*
>
> *There are many complex physical, chemical, and biological relationships within a lake, and changing one factor can often lead to unpredictable changes in others. Minimal, targeted intervention should be a key principle of lake management.*

The Water Quality Management Plan compiled by Design Flow Pty Ltd[32] in 2011 focussed upon the sustainable management of blue-green algae and improving water quality. It concluded that the overall water quality at that time to be *reasonably good in comparison to other urban lakes.*

The Plan listed previous initiatives including, water plant planting, sediment sampling, water column profiling, daphnia release into Lake Legana, groundwater sampling, continuous sampling of groundwater, introducing estuary perch fish into Lake Legana, active barriers, and aeration and pumping in Lake Legana.

As has already been established by the ESC Draft Decision issued March 2016, the ESC rejected MW's two proposed tariffs to 'recover cost' and 'ongoing maintenance' to be levied on solely the Marina operator. The ESC rejected MW's proposed pricing on the Marina operator on the basis that the Marina operator is in fact not the sole beneficiary of the Tidal Gates, which also provides a benefit to the Approx. 900 dwellings positioned within the Tidal Waterways. Similarly, as has been stated by the Independent Review, the Quiet Lakes residents are not the sole beneficiary of safe and healthy secondary contact water quality, which clearly provides a regional and community benefit as the water discharge into the publicly accessible waterways of Eel Race Creek, Kananook Creek, Patterson River and Port Philip Bay.
I note that MW makes a similar claim in its Dec2016 submission to that of the Hon Lisa Neville in her letter to me. Melbourne Water identifies the Quiet Lakes residents as the 'primary beneficiary'. This by default, in both instances, acknowledges that the Quiet Lakes are not the 'sole beneficiary' of the water quality that discharges from the Quiet Lakes.

As previously established with the rejection of MW's proposal to charge the Marina operator as the sole beneficiary of the Tidal Gates, the Quiet Lakes residents need to be the 'sole beneficiary' of the water quality in order to be responsible for the special tariff to run the bore. In a further twist to Melbourne Water's submission, it omits the journey that the Quiet Lakes discharged water takes in Eel Race Creek before getting to Kananook Creek. I'm particularly amazed that Melbourne Water highlights that the Quiet Lakes discharge water becomes 1% of the flow of Kananook Creek in a self-admission of its intervention in managing the water quality in Kananoook Creek. The reason the Quiet Lakes discharge flow becomes 1% at Kananook Creek is due to the Kananook Creek pump station, which pumps between 100ML and 164ML/day into Kananook Creek to provide reliable flushing flows to manage algae in the

nutrient rich water just as is required to manage safe levels algae in the nutrient rich Quiet Lakes discharge water. Melbourne Water will have you believe that they don't intervene in the management of Blue Green Algae or that intervening is a special service not covered under the MMWDC, yet as close as the TWW and Kananook Creek MW is doing just that - utilising the MMWDC at a rate of 100 times that required in the Quiet Lakes.

Please refer to MW's Kananook Creek Management Plan - Section 6.2.1 page 18

"As development occurred in the late 1940s through to the 1970s, the area was progressively sewered and the sewage treatment plant discharged treated effluent into the creek providing increased flows. However the water quality was poor due to high nutrient levels and the high algal content. In response to the need for reliable flushing flows, the Dandenong Valley Authority commissioned the Kananook Creek Pump Station in 1982 and the Station commenced pumping in February 1984 which supplemented the Boggy Creek catchment flows and the treated effluent from the Frankston Sewage Treatment Plant. The recent upgrade to the Kananook Creek Pump Station by Melbourne Water has slightly increased the pumping capacity and it now delivers a normal pumping flow of 100ML/day and a peak flow of approximately 164ML/day (ASM, 2007)."

Appendix F – MW's Kananook Creek Corridor Management Plan 2009

MW could always look to reduce the flow at the Kananook Creek pump station, which for the past 5 years has been supplemented with safe water discharged from the Quiet Lakes

I also note the Essential Services Commission's reference taken from page 83 to establish the Independent Review's recommendation with respect to funding.

> *The primary source of ongoing funding is considered to be either associated with the Melbourne Metropolitan Waterways and Drainage Charge for those services considered to have a regional and community benefit or the application of user pays funding alternatives for those services and assets that are linked to private recreational benefits. Options for user pay funding sources include the charging of a tariff under the Water Act or private contractual arrangements. The Review considers that whatever source of funding is selected, the approach to cost recovery should be informed by the principle that cost recovery is appropriate for services that only provide private benefits.*[70]

This point of discussion is further supported by the Independent Review's 'Conclusion 11' detailed on pages viii & 102.

> **11. A variety of funding sources are available to support a sustainable management framework. The primary sources of ongoing funding are considered to be associated with the Melbourne Metropolitan Waterways and Drainage Charge for those services considered to have a regional and community benefit, and the application of user pays funding alternatives for those services and assets that are linked to private recreational benefit.**

In order for the Quiet Lakes residents to be financially responsible for the management, funding and operation of the bore to create safe and healthy secondary contact water quality, the residents need to be the sole beneficiaries of the secondary contact water quality that the influence of the bore creates, which the Quiet Lakes residents clearly are not.

ACHIEVING SECONDARY CONTACT WATER QUALITY

5.4 Discussion

The reasonable and practical view for the Quiet Lakes suggested by Pat Condina in 2001 was that swimming could occur but at one's individual risk, as it is in Port Phillip Bay, rivers and other lakes in Victoria and elsewhere. The goal should be to maintain water quality to secondary contact standard as a minimum benchmark, and warnings posted when the quality falls below this.

This will require the implementation and maintenance of the recommendations contained in the Design Flow Water Management Plan. This is fundamentally dependent upon the system operating as it was originally engineered. It appears from the site inspections undertaken by the Review, and several of the submissions, that the system physicality has been altered over time. The recommended through-flow of water volumes needs to reach all three lakes, not just Lake Legana. Flows are being diverted from Lake Illawong to the Wadsley Drain, not allowing adequate flushing flows to enter Lake Carramar.

Melbourne Water should undertake an immediate review of the headworks infrastructure to determine what has been changed from the original engineering design, and rectify this issue.

As stated above, achieving secondary contact water quality requires the implementation of the Design Flow Water Quality Management Plan (DFWQMP). The DFWQMP requires the implementation of:

1. carp removal
2. continuing to run the flow
3. aquatic planting
4. eventual need to remove the nutrient rich sediment

Appendix G – DFWQMP FLOW CHART (figure 10)

As discussed earlier MW, Design Flow and the residents all agree that running the bore has a positive effect on managing safe levels of Blue Green Algae. It is ridiculous for Melbourne Water to then suggest that if the Quiet Lakes were to be affected with prolonged blue green algae blooms that this would be the trigger to turn off the bore.

As it stands the bore has a current annual ground water extraction licence of 400ML, which is currently utilising just 273ML/year (i.e. 1.5ML/day x 182 days 1st Oct -31st Mar). This, in the first instance would allow for the bore inflow to be increased to 2ML/day for a total of 200 days/ year.

Originally the bore extraction licence was created in 1976 with a total extraction limit of 730ML/Year at a daily extraction rate of 2ML/day. That's an original ground water licence that allows for 2ML/day, 365 days/yr. In 1991 Melbourne Water unilaterally decided to decrease the ground water extraction licence from 730ML/yr to 20ML/yr incorrectly advising Southern Rural Water that the bore was for filling an ornamental lake and effectively starving the lakes of water for the next 20 years resulting in persistent BGA. As it happens, the lakes were

actually filled and opened in 1974, whilst the original bore licence of 730ML/YR was approved for water renewal and water quality management in 1976 – 2 years after filling the lakes.
Appendix H – Original Ground Water Licence in 1976 for 730ML/yr
Appendix I – MW file note to Southern Rural Water in 1991 for licence reduction for ornamental lake
Appendix J – MW Ground Water Licence Renewal in 1991 for 20ML/yr
Appendix K – MW Ground Water Licence increase in 2010 to 400ML/yr

In 2010 the ground water licence was increased at the instruction of The Hon. Peter Walsh (former Water Minister). To fast track the approval process it was agreed to increase the licence to 400ML/yr so as to commence the bore trial at the earliest opportunity with a provision to increase the licence back to 730ML/yr if ever required. Again, if the Blue Green Algae was to become persistent it would be appropriate after the use of the currently available 400ML/yr to increase the licence to the original amount of 730ML/yr. Increasing the bore licence back to the original 730ML/yr would provide an additional 457ML/yr allowing the bore to run 2ML/day, 365 days/yr until such time as the BGA was brought back under control.
It has been well established and agreed by all parties that the bore assists with the management of safe levels of Blue Green Algae. Needless to say, simply turning off the bore would only assist the Blue Green Algae to bloom.

Failing success in controlling Blue Green Algae by running the bore at 400ML/yr followed by a subsequent increase to the full 730ML/yr, Melbourne Water will be required to follow the exact same advice it demands of Developers looking to construct a shallow lake system.

Constructed Shallow Lake Systems - MW Design Guidelines for Developers
Section 2, page 7 states:

> *"Residents and managing authorities must be aware that as the lake system ages, it has a greater chance of problem algal growth and algal blooms. The frequency and duration of a green algal bloom or cyanobacterial bloom that would be considered an unattractive appearance to residents or provide a health risk, should reflect community expectations about the appearance and management of the waterbody. It is possible that a lake system may require desilting and a total 'reset' if algal blooms become a recurrent and persistent problem."*

In line with fulfilling IR Recommendation 3 – the implementation of the DFWQMP requires the eventual desilting of the lake and a total reset as detailed in MW's Design Guidelines for Developers of Shallow Lake System.
Appendix L – Constructed Shallow Lake Systems - MW Design Guidelines for Developers

The Independent Review concludes in Section 5.5 on page 74:

5.5 Conclusions and Recommendations

Achieving secondary contact standard in all the Patterson Lakes Waterways is a reasonable and practical aspiration, and the residents and the general public should depend upon a 'duty-of-care' being exercised by all the relevant Authorities. The residents clearly also have a responsibility to care for their own environment.

The practical function that the Quiet Lakes and Tidal Waterways play in the regional drainage network is not insignificant. The Review concludes from the literature and the submissions that Melbourne Water operates the drainage components of Patterson Lakes to the benefit of the broader catchment, and that this is consistent with the Authority's metropolitan waterways role.

Whilst the pipeline and pumping system operation does directly benefit the water quality in the Patterson Lakes, it also provides benefit to the Patterson River, Kananook Creek, and Port Phillip Bay waterway health and the associated recreational uses.

The Review concludes that Melbourne Water should manage, operate, and maintain these functions from the Melbourne Metropolitan Waterways and Drainage Charge funds.

WHAT IS SECONDARY CONTACT WATER QUALITY

Melbourne Water claims, that achieving the goal to maintain secondary contact water quality as the minimum bench mark does not apply to maintaining safe levels of Blue Green Algae, This belief by MW is inconsistent with the NHMRC Guidelines for Managing Risks in Recreational Water and the Blue Green Algae Circular that DELWP (formerly DEPI) and the Department of Health direct MW to follow respectively. MW will tell you that they are meeting each Departments requirement but as you will learn, they are not.

The Department of Health wrote the MW is required to follow Chapter 6 of the NHMRC Guidelines:

I understand the Patterson Lakes are promoted for secondary contact activities such as boating, rather than activities such as swimming. If this is the case, Melbourne Water should consider undertaking a risk assessment for cyanobacteria using the approach detailed in Chapter 6 of the NHMRC guidelines.

Appendix M – Department of Health letter to Melbourne Water

The 2008 NHMRC Guidelines for Managing Risks in Recreational Water state the following in Section 1.5 on page 16.

1.5 DESIGNATION OF RECREATION ACTIVITIES

Recreational activities can be classified by the degree of water contact as follows:

- *Whole-body contact (primary contact)* — activity in which the whole body or the face and trunk are frequently immersed or the face is frequently wet by spray, and where it is likely that some water will be swallowed or inhaled, or come into contact with ears, nasal passages, mucous membranes or cuts in the skin (eg swimming, diving, surfing or whitewater canoeing).
- *Incidental contact (secondary contact)* — activity in which only the limbs are regularly wet and in which greater contact (including swallowing water) is unusual (eg boating, fishing, wading), and including occasional and inadvertent immersion through slipping or being swept into the water by a wave.
- *No contact (aesthetic uses)* — activity in which there is normally no contact with water (eg angling from shore), or where water is incidental to the activity (such as sunbathing on a beach).

In whole-body contact activities, the probability that some water will be ingested is high, although data on the quantities swallowed during recreational water use are difficult to obtain (WHO 2003). Inhalation can be important where there is a significant amount of spray, such as in waterskiing or even sunbathing at a surf beach. In water sports, the skill of the participant will also be important in determining the extent of involuntary exposure, particularly ingestion.

Further, in Section 6 on page 67:

6 CYANOBACTERIA AND ALGAE IN FRESH WATER

Guidelines

Fresh recreational water bodies should not contain:

- ≥10 µg/L total microcystins; or ≥ 50 000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent of ≥ 4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume; or
- ≥ 10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present; or
- cyanobacterial scums consistently present.

- The NHMRC Guidelines clearly stated that Fresh recreational water should **NOT** contain >10mm3/L of Blue Green Algae.
- The NHMRC Guidelines clearly list Recreational Water as falling under 3 classifications being Non Contact, Secondary Contact & Primary Contact water quality.

Clearly, according the NHMRC, managing Blue Green Algae needs to be managed for all three levels of Fresh Recreational Water.

The Department of Environment, Land, Water and Planning wrote that MW, as the responsible local water manager for the Quiet Lakes, is required to manage any blue green algae event as outlined in the Blue Green Algae Circular.

As the responsible local water manager for Quiet Lakes, Melbourne Water needs to manage any blue-green algae events as outlined in the Blue-Green Algae Circular.

Appendix N – DEPI letter to Melbourne Water 04/09/2013

The Blue Green Algae Circular states the following on page 3:

1. *OVERVIEW*
   As environmental conditions become favourable, typically in the warmer months, algae numbers can start to increase rapidly resulting in a BGA bloom, often making recreational water unappealing and possibly unsafe for activities such as swimming, boating and fishing. While BGA blooms are more prevalent in the warmer months, they can occur all year round and without warning.

2. *BGA Coordination Framework*
   The response to BGA blooms in Victoria is managed through the coordination framework outlined within the BGA Circular. The objectives of this framework are for parties to work together to effectively manage BGA blooms through:
   - *communicating potential risk to water and waterway users and the broader community promptly and effectively;*
   - *investigating the likely cause of the bloom and identifying what actions to take to minimise future occurrences; and*

3. *Waterways Included in BGA Framework*
   - *The BGA framework applies to all water bodies accessible to public or waterways that discharge into publically accessible water bodies such as rivers, streams, wetlands, lakes, estuaries, inlets, water supply storages, irrigation channels and drains, wastewater treatment plant storages, ornamental lakes, marinas, stormwater and recycled water storages and treatment wetlands*

Appendix O – 2016-17 Blue Green Algae Circular with particular reference to page 3

The BGA Circular clearly identifies the secondary contact activities of boating and fishing as being part of the Blue Green Algae Circular overview, supporting the NHMRC guideline figure of <10mm3/L .

Within the BGA Framework DELWP requires MW to communicate the potential serious health effects of BGA issuing severe warnings to stay away from the affected water.
The BGA Framework then requires MW to determine the cause of the BGA outbreak an implement actions to take to minimise future occurrences. This is achieved within the DFWQMPL that identifies the cause of BGA in the Quiet Lakes as being triggered by stagnant nutrient rich water disturbed by the action of ground foraging carp.
Design Flow goes on to recommend as the actions to take to minimise future occurrences as:

- Carp removal
- Continuing to run the bore
- Aquatic planting
- Eventual requirement to remove the nutrient rich sediment.

The BGA Circular also advises us which waterways need to be managed by MW. These include public waterways and waterways that discharge to publicly accessible waterways, such as the Quiet Lakes into Eel Race Creek that flows into Kananook Creek and Port Philip Bay or the Quiet Lakes via its connection to the Patterson River that flows into Port Philip Bay.

At no stage do either the Department of Health or the Department of Environment down play the severe health implications of being exposed to unsafe levels of Blue Green Algae. However MW would have you believe that managing safe levels of Blue Green Algae is not part of achieving secondary contact water quality as the minimum standard and that Blue Green Algae poses little or no health threat.

Appendix P – Warning signs posted when BGA exceeds 10mm3/l
Appendix Q – Community Bulletin distributed to residents when unsafe levels of BGA are present in the Quiet Lakes

1. The suggestion by Melbourne Water that the outcome of the bore trial initiated in 2010 by the former Minister for Water, would be a 'resident funded activity' under the former Precept Rate, actually pre-dates the commissioning of the Independent Review in 2012 and the subsequent abolishment of the former Precept Rate.
   The Independent Review informs us that based on the combined elements of status, use, function and now water quality and quantity issues means that the application of a funding source based on a special Precept Rate is not relevant or suitable **(IR 5.5 page 74).**
   The purpose of having the Independent Review was for the review panel, not Melbourne Water, to assess management of Patterson Lakes. In principle this process requires all parties to let go of all ideas that predate the Independent Review and "to work together collaboratively to develop a management plan for the ongoing management and enjoyment of the lakes" from the discussions, conclusions and recommendations of the Independent Review **(IR page vii).**

2. Melbourne Water's consultation process has been misleading both to the Hon. Lisa Neville, Minister for Department of Environment, Land Water and Planning and to the residents of Patterson Lakes.
   Melbourne Water has intentionally misled the Hon. Lisa Neville and unknowing residents of the Quiet Lakes by stating that the original purpose of the bore was for 'topping up' against eveporation. Melbourne Water statement regarding the original use of the bore could not be further from the truth as is explained in Chapter 5 of the Independent Review
   Melbourne Water has used this untruth as its corner stone to convincing the Hon. Lisa Neville and the unknowing residents that use of the bore to manage secondary contact water quality **(Recommendation 2)** and safe levels of Blue Green Algae **(Recommendation 3)** would be considered an additional service that residents would be required to pay for under a user pays model.
   - Nowhere in the Independent Review does it state that the Quiet Lakes residents should pay for the running of the bore to maintain secondary contact water quality to manage safe levels of Blue Green Algae

- Nowhere in the Independent Review does it state that the Quiet Lakes residents are the sole beneficiaries of secondary contact water quality to manage safe levels of hazardous Blue Green Algae.
- Nowhere within the Independent Review does it state that the original purpose of the bore was for 'topping up' against evaporation to create a stagnant body of water that is persistently affected by hazardous Blue Green Algae.

3. That MW has made no mention of Lake Carramar within its submission to be incorporated as part of the through flow of this three lake system makes MW's submission instantly incomplete. MW cannot feasibly consider that it is meeting any part of the Independent Reviews requirements
   - secondary contact (IR Rec 2),
   - implementing the Design FlowWQMP (IR Rec 3),
   - Guaranteeing flow through Lake Carramar (IR Rec4)

   MW ignores Lake Carramar in its submission as if it does not exist.

ADDITIONAL ITEMS WHERE MELBOURNE WATER IS FAILING TO MEET ITS OBLIGATIONS AS ALREADY APPROVED BY THE ESC 2014 FINAL DECISION

1. WATER QUALITY TESTING

In Melbourne Waters Pricing Proposal issued 13 Jan 2014 on page 3 under 'Background" states:

> Key recommendations of the review report, released in March 2013, included:
>
> - The management and replacement of jetty infrastructure including dredging is of a private benefit nature and therefore user pays
> - All other aspects of the system have a public benefit and therefore the Special Precept Rate should be discontinued from 1 July 2013
> - Melbourne Water is not obligated to maintain water quality in the Quiet Lakes at a level higher than secondary contact standard except on a user pays basis
> - Under a proposed shared governance arrangement responsibility for funding and delivery of services would be distributed to Melbourne Water, Kingston City Council and Parks Victoria.
>
> In response to the April 2013 Water Plan draft decision, Melbourne Water proposed to provide a price submission to the Essential Services Commission (ESC) taking account of the independent review and further consultation and engagement with the Patterson Lakes community and key stakeholders.
>
> Melbourne Water proposed that until the Commission rules on the price submission the existing precept rate would cease and services would continue to be provided as normal. Customers would also still pay the general waterways and drainage charge. The Commission accepted this proposal.

Services that would continue to be provided as normal include water quality testing to identify unsafe levels of Hazardous Blue Green Algae, which Melbourne Water itself goes on to specify on page 4 under the heading 'Proposal' which states:

- For all other services considered to have a regional and community benefit, these will continue to be funded through the Waterways & Drainage Charge. These services and capital works in the Tidal Waterways include:
  - operation, maintenance and dredging of the floodgates
  - retaining wall maintenance & monitoring
  - interconnecting pipes maintenance
  - general civil assets monitoring & works
  - community communications/consultations

  In the Quiet Lakes, these include:
  - carp removal
  - water quality testing
  - general civil assets monitoring & works
  - community communications/consultations

Contrary to Melbourne Water's 2014 Pricing Proposal that was approved by the Essential Services Commission, Melbourne Water ceased to conduct water quality testing on the 30/06/2015 and furthermore flatly refuses to conduct Water Quality Testing to detect unsafe levels of Blue Green Algae as was previously conducted weekly as a normal service to provide a regional and community benefit.

As stated in the Independent Review section 5.3 on page 68

> Melbourne Water commissions weekly water quality testing, to ascertain the conditions for recreational use, and any warnings that need to be disseminated regarding algal blooms. These notices are publicly displayed and warnings provided to individual residents as needed. Submissions suggested that these Melbourne Water processes have been inadequate due to Notice Boards being relatively remote, and internet connectivity not widespread amongst residents.

Melbourne Water's refusal to conduct water quality testing on a weekly basis to detect and report unsafe levels of Blue Green as was previous conducted as a normal service providing a regional and community benefit is inconsistent with its 2014 Price Submission, inconsistent with the ESC's 2014 Pricing Approval Decision and inconsistent with the findings of the Independent Review.

2. SAND RETRIEVAL

In Melbourne Waters Pricing Proposal issued 13 Jan 2014 on page 3 under 'Background" states:

> - In response to the recommendations of the independent review findings, Parks Victoria has decided it is unwilling to take over jetty management accountabilities as this would not fall within its charter. Melbourne Water will therefore continue to manage these activities as set out in this submission. Parks Victoria has however, agreed to extend its existing "Recreational Water Manager" role on Patterson River into the Tidal Waterways.

In the same manner as jetty management, Parks Victoria has decided that it is unwilling to take over the maintenance functions of 'sand retrieval' and 'weed control' within the Quiet Lakes leaving these items unattended. As per for the jetty management accountabilities Melbourne Water needs to retain its previous responsibility for the sand retrieval and weed control activities.

In the 2014 ESC submission Melbourne Water agreed to conduct general civil assets monitoring and works.

Over time the sand from the beach area of the reserve is washed into the water as a result of rainfall, consequently exposing the compacted clay layer that provides the critical foundation of the drainage reserve. The sand cover on the beach area of the reserve acts to protect the clay layer from exposure to the elements including drying and cracking over the warmer months and the slip hazard that exists when the compacted clay layer becomes damp or wet when left exposed.

Must residents wait for the integrity of the clay base to crack and fail before Melbourne Water applies responsible management practices consistent with the Independent Reviews findings the Quiet Lakes, as a Public Asset, are an integral part of the local and regional drainage system.

3. WATER WEED CONTROL

In achieving secondary contact water quality the 2008 NHMRC Guidelines also require Melbourne Water to manage physical hazards within the waterway with respect to its requirement to manage secondary contact water quality.

Melbourne Water has advised Quiet Lakes residents in its September 2015 Community Bulletin that it is funded to manage water quality suitable for secondary contact activities such as boating, canoeing and fishing yet Melbourne Water flatly refuses to conduct maintenance activities to ensure the water is safe, not only from hazardous levels of Blue Green Algae but from the severe consequence of drowning by entanglement from excessive localised weed present on and just below the water's surface on all three lakes.

The 2008 NHMRC Guidelines state on page 5

Physical hazards

Guideline

It is acknowledged that recreational water and adjacent areas should be free of physical hazards, such as floating or submerged objects that may lead to injury, as much as a reasonable person would deem realistic. Where permanent hazards exist (eg rips and sandbars), appropriate warning signs should be clearly displayed.

Drowning, impact injuries and puncture injuries represent the highest priority for recreational water-quality management programs because these injuries can cause death or lead to permanent or temporary incapacitation. Most injuries can be prevented by appropriate measures, especially at the local level.

Physical hazards in or around a recreational water body should be removed. If removal is not possible, the hazards should be mitigated, or measures should be taken to prevent or reduce human exposure. Physical hazards that cannot be dealt with in these ways should be subject to additional preventive or remedial measures — for example, general warning notices or special warnings, especially at times of increased risk.

Must residents wait for a 'drowning by entanglement' tragedy as occurred at Lake Lysterfield on 5th January 2013 before Melbourne Water applies responsible management practices consistent with the Independent Reviews findings that the Quiet Lakes, as a Public Asset, are an integral part of the local and regional drainage system.

The Herald Sun reported the incident on the 06 January 2013 as follows:
"The 34-year-old disappeared around 4pm when he entered the lake near Narre Warren to help two children after their dinghy became stuck in some reeds.
The man then got into difficulty and disappeared while the two children, an 11-year-old girl and 12-year-old boy, made it to shore.
Two men had tried to help the man before he disappeared beneath the water."

CONCLUSION

Inconsistent with the findings of the Independent Review, Melbourne Water is requesting the Essential Services Commission approve that the Patterson Lakes Quiet Lakes residents pay twice for maintaining secondary contact water quality, which clearly includes managing Blue Green Algae. Once via the MMWDC under Melbourne Water's charter to protect waterway and public health and then a second time via a special tariff imposed on Quiet Lakes residents only for maintaining secondary contact water quality for the repeatedly express benefit of those at the Quiet Lakes and those downstream, including not only humans but flora and fauna species.

Melbourne Water is neglecting its duty-of-care to protect waterway and public health by refusing to 'aim for or work for' the goal of maintaining safe levels of Blue Green Algae via running of the bore along with weekly testing and reporting of the water quality for the benefit of those at the Quiet Lakes and those downstream, including not only humans but flora and fauna species.

Melbourne Water is neglecting its duty-of-care to protect human health by refusing to manage the localised excessive volume of weed that has grown up to and that sitting just below the

water's surface of all three lakes effectively turning its back on any responsibility for the severe consequence and real possibility of drowning by entanglement.

RECOMMENDATIONS

On behalf of the members of the PLQLOR's Association I request that the Essential Services Commission:

1. Reject Melbourne Water's proposal to apply a special tariff charge to be applied only to the Quiet Lakes Residents of Lakes Legana and Illawong on the basis of being inconsistent with the findings of the Independent Review.
2. Reject Melbourne Water's intention to stop the running of the bore if prolonged periods of BGA bloom occur.
3. Instruct Melbourne Water to 'aim for and work for' achieving the goal of maintaining secondary contact water quality consistent with the findings of the Independent Review. This requires implementation of the Design Flow Water Quality Management Plan to manage safe levels of Blue Green Algae via use of ground water flushing from the bore at 1.5ML/day, carp removal, aquatic planting, desilting of the nutrient rich sediments, guaranteeing flow through Lake Carramar and weed control to protect against drowning by entanglement all to be managed and operated by Melbourne Water to deliver the outcomes of the review funded from the MMWDC.
4. Instruct MW to be exploring extend use of the bore and if necessary increase the bore licence back to its original 730ML/yr and desilting of lakes to remove the nutrient rich sediments if prolonged periods of BGA Algae bloom are experienced in the future.
5. Instruct Melbourne Water to reinstate weekly Blue Green Algae water quality testing and reporting as an activity providing a regional and community benefit for the safety of those at the Quiet Lakes and those downstream, not only humans but flora and fauna species consistent with the findings of the Independent Review as approved by the Essential Services Commission in Melbourne Water's 2014 Price Submission.
6. Instruct Melbourne Water retain its previous responsibility for conducting annual sand retrieval to protect the asset from catastrophic failure should the clay base continue to be further exposed on the sand reserve, whilst also addressing the slip hazard that exists around each lake where the sand cover is missing.

I welcome the opportunity to meet with the Essential Services Commission to discuss my submission. I am readily available at short notice to meet with you.

Please accept my permission for you to post my submission on the ESC website for public viewing

Yours Sincerely,
Anthony Moffatt
President - PLQLOR Association Inc.

Community Bulletin

Important information for Lake Carramar residents

1 May 2015

Important Notice - Lake Carramar Water Quality

The latest test results measured on 23 April in Lake Carramar show that a toxic form of blue green algae, Microcystis has risen above the threshold level of 4mm^3/L (Blue Green Algae Circular 2013-14, DEPI).

Until further advice from Melbourne Water, we strongly advise that you and your guests avoid unnecessary contact with the water in Lake Carramar. We also advise that as far as possible you prevent your pets from entering or drinking the water.

Our weekly test results have shown that there may be an increased risk to people and pets that come in contact with the water in Lake Carramar. This is because of the increased volume of a toxic form of blue-green algae above the level determined to be safe for recreational use.

Risks from contact with, or ingestion of blue-green algae
Skin contact with either toxic or non-toxic forms of blue-green algae when participating in water-based activities can cause problems such as skin rashes, swollen lips, blisters, eye irritation and redness, ear ache and itchiness, sore throat, hay fever symptoms, asthma and possibly promotion of skin tumours. The risk is likely to increase with repeated exposure to the water and especially if water is swallowed.

Pets can also be affected, if they drink the water. Dogs are particularly susceptible because they tend to lick their coats after swimming.

Relative risks from activities
The risk from various activities ranges from zero where there is no skin contact, to high depending on the likelihood of an activity bringing an individual into contact with the algae. **The table on page 2 of this bulletin indicates of the level of risk for some water activities.** Wearing wet suits may result in greater risk of skin irritation because algal material trapped inside the wet suit may be in close contact with the skin for long periods.

See over the page for more

Risk	Activity
High	Swimming, diving, sail-boarding, paddling.
Medium	Canoeing, sailing, rowing (assumes avoidance of algal material when launching and landing and no rollovers or capsize).
Low	Fishing, passive shoreline recreation (picnicking, walking).

Blue-green algae blooms are a common, natural occurrence in Victorian waterways and can be triggered by many factors including nutrient loads, low inflows, low storage volumes and higher than normal temperatures. It is not known how long the warning will remain in place.

We will continue to monitor this situation and provide you with updates via noticeboards and Quiet Lakes water quality monitoring webpage at melbournewater.com.au/pattersonlakes. Should you have any queries or concerns please do not hesitate to contact us.

How do I find out more information?
For more information contact 131 722 or visit *melbournewater.com.au/pattersonlakes*

To find out about other Melbourne water projects to enhance life and liveability contact 131 722 or visit *melbournewater.com.au*

Melbourne Water

ATTENTION

Blue green algae is currently present in this water body

Melbourne Water recommends that you do not come into contact with this water as it may cause skin and eye irritations to both humans and animals.

For information or emergency phone 131 722 or visit our website www.melbournewater.com.au

Victoria
The Place To Be

Blue-Green Algae Circular 2016-17

Management Framework

VICTORIA State Government | Environment, Land, Water and Planning

ISBN VGLS29802

Contents

1 Overview 3

2 BGA Coordination Framework 3

3 Waterways Included in BGA Framework 3

4 Responsibilities 4

4.1 Department of Environment, Land, Water and Planning 4

4.2 Department of Health and Human Services 5

4.3 Regional Coordinator 6

4.4 Local Water Managers 6

4.5 Response Groups 7

4.6 Other Agencies 7

5 Management of Water Bodies 9

5.1 Regional Coordination Plan 10

5.2 BGA Risk Management Plan 10

5.3 Monitoring Water Bodies 10

6 Reporting of Blue-Green Algae 11

6.1 Notification to DELWP and the Regional Coordinator 11

6.2 Biovolume versus Cell Counts 11

6.3 Additional Notifications 12

7 Laboratory Testing of Samples 14

7.1 Removal of Warning Signs 15

8 Use of Algaecides 15

9 References 16

Appendix A – BGA Emergency Management Flowchart 17

Appendix B - Murray River Regional BGA Response Arrangements 18

Appendix C- Regional Coordinator Contact Details 19

Appendix D - Regional Coordinator Boundaries 20

Appendix E- Allocation of Local Water Managers – Guidance for Regional Coordinators 21

Appendix F - Agency Contact Details 22

Appendix G - Sample Blue-Green Algae Warning Sign 23

Appendix H -Media Release 23

Appendix I - Testing Contractor Contact Details 25

Appendix J - List of stakeholder Agencies 26

List of Acronyms 27

Definitions 28

1 Overview

This Circular provides updated information, roles and responsibilities on Cyanobacteria (blue-green algae) bloom coordination within Victoria for 2016 -17.

Blue-green algae (BGA) or cyanobacteria are not true algae but are a type of bacteria. They are a natural part of most aquatic environments and are found in streams, lakes, estuaries and the sea. Significant levels of BGA in water bodies can affect the natural ecosystem and potentially impact on human health.

Some species of BGA can produce chemical compounds that can taint the drinking water supply by causing discoloration and a musty odour and taste. More significantly, some species produce toxins that have serious health implications for humans, animals, birds and livestock if they are consumed, inhaled or come into contact with the skin.

As environmental conditions become favourable, typically in the warmer months, algae numbers can start to increase rapidly resulting in a BGA bloom, often making recreational water unappealing and possibly unsafe for activities such as swimming, boating and fishing. While BGA blooms are more prevalent in the warmer months, they can occur all year round and without warning.

BGA blooms require a prompt response in the form of monitoring and communication to minimise health and environmental impacts and risks they could place on humans, animals, birds and livestock and crops. Management of BGA blooms should be undertaken through cooperation between all relevant stakeholder agencies. The BGA Circular provides information about roles and responsibilities on blue-green algae bloom response and coordination within Victoria for 2016 -17.

2 BGA Coordination Framework

The response to BGA blooms in Victoria is managed through the coordination framework outlined within the BGA Circular. The objectives of this framework are for parties to work together to effectively manage BGA blooms through:

- minimising the impact of BGA blooms on waterways, public health and safety and local amenity;
- providing a coordinated response;
- communicating potential risk to water and waterway users and the broader community promptly and effectively;
- investigating the likely cause of the bloom and identifying what actions to take to minimise future occurrences; and
- where appropriate, providing timely and effective briefings and communication to the relevant Minister.

The BGA incident management is based on emergency management principles described in the Emergency Management Manual Victoria (EMMV) in terms of prevention, response and recovery and is classified as a class 2 emergency During a substantial regional BGA bloom, regional emergency arrangements will be implemented in managing the incident by DELWP. Refer to Appendix A – BGA Emergency Management Flowchart for the BGA Regional Incident Management flowchart.

3 Waterways Included in BGA Framework

The BGA framework applies to all water bodies accessible to public or waterways that discharge into publically accessible water bodies such as rivers, streams, wetlands, lakes, estuaries, inlets, water supply storages, irrigation channels and drains, wastewater treatment plant storages, ornamental lakes, marinas, stormwater and recycled water storages and treatment wetlands.

Excluded waterways include open coasts, closed water storages/tanks and lakes, storages and marinas on private land unless there is discharge to other waterways or the water body is used by the public for primary contact recreational purposes.

Marine Algae blooms in Port Phillip Bay are covered separately, in the "Port Phillip Bay Marine Algal Bloom Response Plan" available from the Algal Blooms in Port Phillip Bay page of the Department of Environment, Land Water and Planning (DELWP) website.

Management of the Murray River falls under the jurisdiction of New South Wales (NSW). However, as the Murray River is the water supply source to many Victorian towns and regional cities and receives flows from Victorian waterways, the NSW Murray and Sunraysia Regional Algal Coordinating committees include representatives from the Regional Coordinators in Victoria. Likewise if a BGA bloom in Victoria poses a risk to the Murray River, the relevant agencies in NSW should be included in the Regional Response Group.

NSW has produced a "Guidelines to Management response to harmful algal blooms" for application in the Murray Region.

When BGA levels in the Murray River are above the trigger level, Water NSW will inform all stakeholders.

Consequence management of a BGA bloom in the Murray River in Victoria will be managed through the declaration of an Area of Operation within the Victorian Emergency management Arrangements. Appendix B - Murray River Regional BGA Response Arrangements – Lead Agency Water NSW describes the proposed incident management arrangements. Six Victorian Water Corporations namely North East Water, Goulburn Murray Water, Goulburn Valley Water, Coliban Water, Grampians Wimmera Mallee Water and Lower Murray Water will be working with Water NSW in managing their area of interest.

If a BGA bloom is likely to impact on South Australian waters, relevant water manager should notify SA Health should through public.health@health.sa.gov.au.

4 Responsibilities

The roles and responsibilities for BGA coordination are discussed in the text below and are summarised in Figure 1.

4.1 Department of Environment, Land, Water and Planning

DELWP is the Control agency for BGA management. DELWP collects data on BGA to monitor trends throughout the State which helps to manage BGA blooms. During an algal bloom, DELWP will co-ordinate the management activities so that all relevant stakeholders can perform their respective roles and responsibilities at the regional level.

Key Area	Roles
Prevention (incorporating Planning and Preparedness actions)	• Supports relevant research and development. • Identifies sources of BGA knowledge and expertise. • Identifies high risk water bodies/reaches based on water sampling data collected, in consultation with Regional Coordinators. • Maintains a database of BGA blooms to monitor trends. • Updates the DELWP BGA Circular annually. • Convenes the BGA Working Group. • Allocates Regional Coordinators. • Ensures Regional Coordinators have prepared and updated Regional Coordination Plans. • Assists in training of Regional Coordinators and Local Water Managers to enact the Regional Coordination Plans. • Liaises with national, interstate and other agencies to maintain and disseminate information through the BGA Working Group and provide best practice in managing BGA. • Assists Regional Coordinators in allocation of Local Water Managers if required. • Facilitates a mediation process with respective parties and relevant government agency/body in the event of a dispute over roles and responsibilities of Regional Coordinators and Local Water Managers.
Response	• In a regional BGA bloom, where more than a single water body is impacted, DELWP will set up Incident Control centres and Emergency Management Teams to manage under the AIIMS structure which will be at the appropriate scale. • Produces monthly summary reports on significant BGA blooms (DELWP website). • Liaises with Department of Health and Human Services (DHHS). • Obtains technical advice and information/advice for Local Water Managers. • Advises the relevant Minister, where required. •
Recovery	• Attends debrief meetings and ensures that a debrief report is prepared for regional BGA blooms. • Prepares an Annual Report on BGA blooms for the season.

4.2 Department of Health and Human Services

The Department of Health and Human Services (DHHS) provides advice about the potential public health impacts of BGA blooms and administers the Victorian *Safe Drinking Water Act 2003* (SDWA).

Key Area	Roles
Prevention (incorporating Planning and Preparedness actions)	• Assists DELWP to update the BGA Circular each year. • Liaises with national, interstate government departments and other agencies to maintain, disseminate and manage information on BGA.

Key Area	Roles
Response	• Participates as a member of Response Groups as required. • Provides advice on public health issues relating to BGA. • Provides advice on seafood safety with respect to BGA, to Water Managers and PrimeSafe (regulators of commercial seafood safety). • Is the Control Agency for retail food contamination and drinking water contamination. • Provides advice to the Minister for Health, where required.
Recovery	• Assists with the assessment of social and environmental impacts in accordance with the Emergency Management Manual Victoria.

4.3 Regional Coordinator

The Regional Coordinator is responsible for coordinating the management of local BGA blooms, as well as coordinating planning and preparedness for managing regional BGA blooms.

For a list of Regional Coordinators and their contact details please refer to Appendix C- Regional Coordinator Contact Details. For the Regional Coordinator boundaries please refer to Appendix D - Regional Coordinator Boundaries.

Key Area	Roles
Prevention (incorporating Planning and preparedness actions)	• Liaises with Catchment Management Authorities, Water Corporations, Local Government and others to encourage river and catchment improvement works are carried out in areas that may reduce risks of blooms. • Nominates Local Water Managers (refer to Appendix E- Allocation of Local Water Managers – Guidance for Regional Coordinators for further information). • Annually prepares updates and distributes the BGA Regional Coordination Plan, before the start of summer. • Convenes the pre-season coordination meeting. • Checks that local water managers have prepared and updated Risk Management Plans. • Ensures sufficient training has been undertaken by Regional Coordinators and Local Water Managers to enact the Coordination Plans. • Identifies sources of BGA knowledge and expertise.
Response	• Is informed of local blooms. • Declares when a BGA bloom is regional. • Convenes and chairs the Response Group meetings during a regional BGA bloom. • Appoints the Incident Controller during a regional bloom. • Coordinates the response to regional blooms through the Response Group including monitoring, management, signage and media releases. • Reports to DELWP and DHHS on the management of regional BGA blooms. • Documents and records all actions taken. • Provides information to tourism bodies on regional BGA blooms. • Coordinates ongoing monitoring of regional BGA blooms.
Recovery	• Conducts a debrief meeting and prepares a debrief report on regional BGA blooms. This report may include likely cause of bloom (if known), management actions taken, and any improvements that can be made with future responses.

4.4 Local Water Managers

Local Water Managers are responsible for managing BGA blooms in their local water body. The main role of the Local Water Manager is to minimise impacts of the bloom including public health risks.

A Local Water Manager in the context of this circular relates only to managing BGA blooms in a section of a waterway or a water body. It does not imply any other waterway/water body management responsibilities, although many Local Water Managers in the BGA context may have other roles in water body management.

A Local Water Manager is generally the agency with on ground management responsibilities for a particular water body. In areas where no management arrangement exists, local water manager is usually the agency with responsibility for public health in that area.

Key Area	Roles
Prevention (incorporating Planning and preparedness actions)	• Reviews the BGA risk for the water body, determines and implements any risk mitigation measures (see Section 5.2 BGA Risk Management Plan). • Develops and updates the Risk Management Plan annually to guide monitoring and response activities. • Monitors and takes samples for BGA. • Organises local water management staff training. • Participates in the Regional Coordinators pre-season meeting. • Ensures that sufficient preparedness training has been undertaken to enact the Regional Coordination Plans.
Response	• Informs the regional coordinator, DELWP and DHHS of local BGA blooms. • Manages local BGA blooms in accordance with BGA Risk Management Plan including monitoring, signage and media releases. • Documents and record all actions taken. • Notifies the Regional Coordinator if a local BGA bloom could become or has become a regional BGA bloom. • Notifies Regional Coordinator if a regional bloom is identified during routine monitoring. • Participates in the Response Group during regional BGA bloom if required. • Provides information to tourism bodies on local BGA blooms, if required.
Recovery	• Provides ongoing monitoring. • Considers preparing a debrief report for internal purposes for BGA blooms that exceed the public health limits outlined in Section 6.3.1 and 6.3.2 for an extended period. This report may include likely cause of BGA bloom (if known), management actions taken, and any improvements that can be made with future responses. • Provides feedback to DELWP relating to the BGA Circular.

4.5 Response Groups

Response Groups are formed to manage a regional BGA bloom on behalf of the Regional Coordinator. The Regional Coordinator is responsible for convening and chairing the Response Groups, which should include stakeholder agencies that have responsibilities or an interest in the area affected by a regional BGA bloom.

Further advice on Response Groups is provided in the sample BGA Regional Coordination Plan found on the Blue-green algae resources page of the DELWP website. Details include information on a preferred structure and potential members a Response Group, based on the Emergency Management Manual of Victoria and Australasian Inter-Service Incident Management System (AIIMS).

4.6 Other Agencies

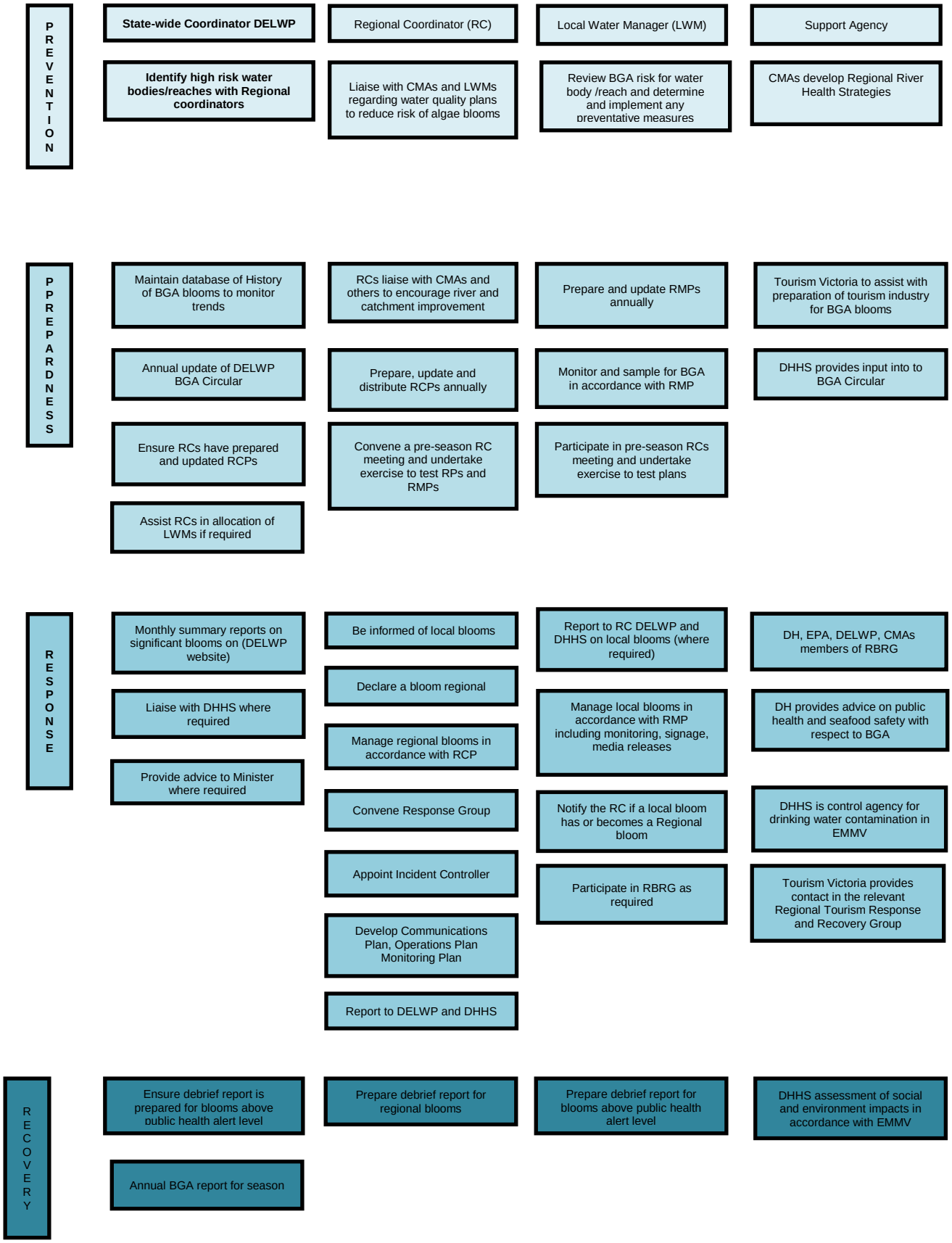
A number of other agencies, work together to manage BGA blooms in water bodies. The key agencies are EPA, PrimeSafe, Catchment Management Authorities, Emergency Services, Tourism Victoria, Seafood Industry Victoria.

Please see a complete list of agencies that may be involved in managing a BGA bloom in Appendix F - Agency Contact Details.

Key Area	Roles
Prevention (incorporating Planning and preparedness actions)	**Catchment Management Authorities** (CMAs) undertake water quality activities including testing and catchment improvement works through implementing their Regional River Health Strategies. **Tourism Victoria** has a role in preparing the tourism industry for the possibility of BGA blooms at key recreational sites.
Response	**EPA, DELWP and CMAs** may participate as members of Response Groups, as required. **DELWP** provides advice for BGA blooms in private storages such as farm dams. Emergency service providers can be involved if a BGA bloom becomes an emergency as defined in the EMMV. **Tourism Victoria** assists with identifying contacts in the relevant Regional Tourism Response and Recovery Group. **PrimeSafe** is responsible for the regulation of seafood safety

The **EPA** is responsible for incident management of fish deaths under the EPA Fish Death Response Procedure (2007). Fish deaths are sometimes associated with algal blooms, either as a consequence of a bloom (due to depletion of oxygen) or due to a common causal factor (such as freshwater inputs after heavy rainfall).

Figure 1. Summary of the Major Roles and Responsibilities under the BGA Framework



5 Management of Water Bodies

5.1 Regional Coordination Plan

Regional Coordinators should have in place a Regional Coordination Plan for their area outlining the approach to protect public health and minimise social, environmental and economic impacts.

The Regional Coordination Plan details the methodology of preparing for and managing a regional BGA bloom including the roles and responsibilities of the Regional Coordinator, Local Water Manager and other agencies to ensure a consistent and effective response before, during and after a BGA bloom.

The plan should identify stakeholder agencies as local water managers and identify potential agencies as a Response Group to manage a regional BGA bloom. The Regional Coordination Plan should be reviewed and updated at the start of each BGA season (October -November). A copy of the plan should be sent to DELWP.

A sample BGA Regional Control Plan incorporating the principles of risk management and broadly consistent with the EMMV framework can be found on the Blue-green algae resources page of the DELWP website.

Regional Coordinators are requested to use this template when preparing or updating Regional Control Plans.

Local Water Managers should be familiar with the Regional Control Plans for managing regional BGA blooms in their area and be aware of the extent of their roles and responsibilities in the plan.

5.2 BGA Risk Management Plan

Local water managers should develop BGA Risk Management Plans for water bodies under their responsibility and monitor the water bodies for BGA accordingly, to ensure early detection and management of BGA blooms. BGA Risk Management Plans should link to the regional coordination plan established by the regional coordinators. These plans should be reviewed and updated on an annual basis.

Where a water body is used to supply drinking water, BGA Risk Management Plans should interface with, or be included in the Risk Management Plan that has been developed to comply with the SDWA.

A Sample BGA Risk Management Plan which incorporates principles of risk management and is compatible with the Emergency Management Manual Victoria framework can be found on the DELWP Website. Local Water Managers are requested to use this template when preparing or updating plans.

The sample BGA Risk Management Plan also provides advice for Local Water Managers on how to conduct risk based planning for BGA management.

Local Water Managers should update their BGA Risk Management Plans annually and take into account any changes to organisations both within and outside of the water sector and linkages to state-wide and municipal emergency management planning strategies and developments. They should also consider the best way for their BGA Risk Management Plans to be linked to the EMMV and to municipal Emergency Management Plans and any other related planning instruments.

For more information about, or to obtain copies of the EMMV visit the Emergency Management Victoria's Policies webpage.

5.3 Monitoring Water Bodies

Water bodies should be monitored in accordance with the BGA Risk Management Plan.

Monitoring results should be kept in a readily accessible format in case they are required for future investigations.

6 Reporting of Blue-Green Algae

6.1 Notification to DELWP and the Regional Coordinator

When sampling and testing has confirmed the existence of all BGA at or in excess of a biovolume of 0.2mm3 Local Water Managers are required to advise the Regional Coordinator and DELWP.

The Water Industry Portal should be used for this notification. A login for this website can be obtained by contacting the DELWP BGA State Coordinator (refer to Appendix Appendix C- Regional Coordinator Contact Details for contact details). Once logged into the website the details of the bloom can be recorded. The Regional Coordinator and DELWP will be able to view the details of the bloom via this database.

If you are experiencing problems with the Water Industry Portal website please contact DELWP State Coordinator.

6.1.1 Local BGA Blooms

When reporting local BGA blooms, Local Water Managers are requested to provide the following details to DELWP via the portal or a notification form:

- Species (if known);
- Biovolume;
- Name of water body; and
- Actions taken to date.

When updating existing blooms Local Water Managers are asked to enter BGA bloom updates as new results become available and when the BGA bloom has ceased.

When logging blooms also consider:

- Whether the bloom is likely to become a regional problem;
- If the bloom has caused a water supply to be interrupted, public warnings to be issued or water bodies to close; and
- Whether treatment is required.

6.1.2 Regional BGA Blooms

When reporting regional BGA blooms, Response Groups should provide advice, similar to a local bloom. Response Groups are asked to advise the Regional Coordinator (refer to Appendix C- Regional Coordinator Contact Details) and DELWP.

6.2 Biovolume versus Cell Counts

BGA are a diverse group of organisms, which range dramatically in size, shape and toxicity. Quantifying BGA in terms of cell numbers alone does not account for variability in the size between different species, and this can lead to inappropriate management actions, particularly in circumstances where there may be large numbers of a particular species with a very small cell size. Measurement of biovolume is therefore used as a means of providing a more accurate description of cell density, as it is more closely related to toxin concentrations than total cell numbers.

Biovolume can either be directly measured by analytical laboratories, or alternatively the biovolume calculation tool can be used. DELWP has developed a biovolume calculator to estimate the biovolume of BGA species, based on the cell counts that are reported by analytical laboratories. Standard reference BGA cell volumes within the biovolume calculation tool are based upon BGA from Australian freshwaters, and are taken from the National Protocol for the Monitoring of Cyanobacteria and their Toxins in Surface Fresh Waters.

The biovolume calculator is available from the Blue-green algae resources page on the DELWP website. Alternatively you can obtain a copy by contacting the DELWP BGA State Coordinator (refer to Appendix C- Regional Coordinator Contact Details).

Risk-based trigger values for BGA in water bodies used for drinking and recreation are provided in the following section. These trigger values have been derived *from Management Strategies for Cyanobacteria (BGA): a Guide for Water Utilities* (Water Quality Research Australia 2010) and the *Guidelines for Managing Risks in Recreational Water* (NHMRC 2008).

Microcystis aeruginosa is the only BGA species currently characterised sufficiently to provide a trigger value based on cell counts alone. Trigger values for all other species are based on biovolume.

6.3 Additional Notifications

In some circumstances, other organisations, groups or individuals will need to be notified of BGA blooms. This will depend on the use of the water body and density and nature of the BGA bloom. These additional notifications are illustrated in the flowchart in Figure 2 and discussed in more detail in this section.

6.3.1 Drinking Water

BGA blooms in drinking water supplies that may pose a risk to public health or may result in widespread public complaint, for example through taste and odour issues, must be notified to the Department of Health and Human Services using the notification arrangements under Section 22 of the *Safe Drinking Water Act 2003* (SDWA). This notification should be made immediately via telephone (on 1300 761 874 during business hours or 1300 790 733 after hours) and followed up with written notification using *"Reporting known or suspected contamination of drinking water or the supply of non-complying water"* form. For information about reporting notifications and to obtain copies of the relevant form, visit the Notifications page of the DHHS Water webpage.

Department of Health and Human Services must be notified when:

Water supplied for drinking[1] may place public health at risk due to one or more of the following:

- Total microcystins are detected at ≥1.3 ug/L (microcystin-LR toxicity equivalents)
- *Microcystis aeruginosa* is present at ≥ 6,500 cells/mL
- Total combined biovolume of known toxic cyanobacterial species ≥ 0.6 mm^3/L
- Total combined biovolume of all cyanobacterial species ≥ 10 mm^3/L

OR

- BGA is present in drinking water at levels that may cause widespread public complaint, for example through taste and odour.

Because Water Storage Managers (as defined under the SDWA) do not generally treat and supply drinking water to the public in Victoria, they may not be best placed to determine whether BGA in the raw water of a drinking water supply may place public health at risk. This means that the water supplier (as defined under the SDWA) may be the most appropriate entity to notify DHHS of BGA incidents under Section 22 of the Act. There are exceptions however, and the SDWA places obligations on both Water Storage Managers and Water Suppliers. As such this Circular cannot be prescriptive about who should notify DHHS of Section 22 incidents.

In all cases, DHHS expects the BGA Risk Management Plans of the Water Storage Manager and the Water Supplier to be integrated so a suitable communication protocol is in place. This protocol must clearly outline how details of BGA blooms are communicated between the water storage manager and water supplier, and who will notify DHHS if such a notification is required. This is a requirement under the SDWA.

A recommended framework for monitoring and managing BGA in drinking water supplies can be found in *Management Strategies for Cyanobacteria (Blue-Green Algae): A Guide for Water Utilities* (Water Quality Research Australia 2010).

[1] DHHS does not need to be notified where:

- Drinking water is not, or has not been, supplied from the water body during the period when the BGA bloom occurred (i.e. the water body has been isolated from supply).

- Drinking water treatment processes are in place that will effectively remove blue-green algal toxins or the potential cause of widespread public complaint.

6.3.2 Recreational Water

Notifications are required when a BGA bloom poses a public health risk in water bodies used for primary contact recreation.

BGA blooms in recreational water bodies are considered to pose a potential public health risk, for primary contact recreation. The Department of Health and Human Services must be notified when one or more of the following occurs:

- *Microcystis aeruginosa* is present at ≥ 50,000 cells/mL
- Total combined biovolume of known toxic cyanobacterial species is ≥ 4 mm^3/L
- Total combined biovolume of all cyanobacterial species is ≥ 10 mm^3/L
- Cyanobacterial scums are consistently present[2]

In the case of these BGA blooms, the following groups should be notified:

- Recreational users of the water body (for example, through signage (refer to Appendix Appendix G - Sample Blue-Green Algae Warning Sign) or media (refer to), as appropriate);
- DHHS (on 1300 761 874 during business hours or by emailing mailto:water@dhhs.vic.gov.au); and
- Relevant stakeholders (such as local government, tourism bodies and recreation clubs).

Additional information on monitoring and managing BGA risks in recreational water bodies can be found in the *Guidelines for Managing Risks in Recreational Water (NHMRC 2008).*

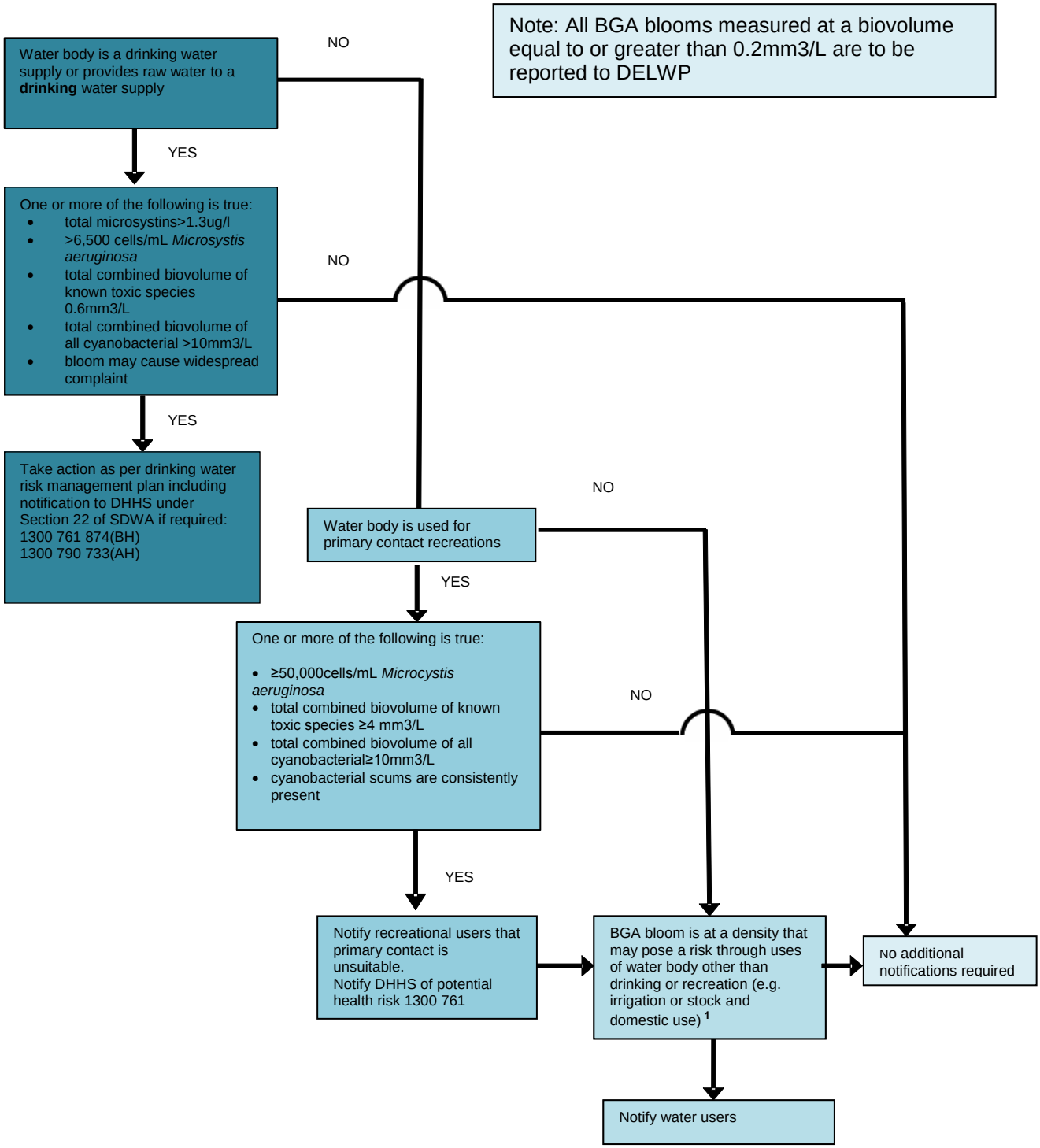
6.3.3 Other Water Supplies

- Currently there is insufficient data to set risk-based trigger levels for BGA in water bodies used for other purposes, such as stock and domestic supplies or irrigation water. The Local Water Manager should undertake a risk assessment for BGA blooms in these water bodies to determine whether the water is potentially hazardous. If it is considered that a risk may be posed due to the presence of BGA, then all relevant users of the water should be notified.
- For untreated domestic water uses (such as showering and bathing, cooking or other kitchen purposes and domestic garden watering), the use of the drinking water trigger levels for BGA are recommended. While this is likely to be conservative, it can be used in the absence of a more detailed risk assessment for the specific scenario in question.

Less conservative approaches can be adopted if a detailed risk assessment is completed.

[2] Decisions should be based on the extent of scum; whether the scum is a known toxic cyanobacteiral species; and whether scum are present in close proximity to a known major recreational area.

Figure 2: Additional Notifications for Blue-Green Algae Blooms



7 Laboratory Testing of Samples

When local monitoring and field testing indicate the presence of BGA in a water body it is recommended that samples be tested by a competent testing laboratory. National Association of Testing Authorities (NATA) accredited laboratories that can assist with algae identification, toxicity and toxin testing are listed in Appendix I - Testing Contractor Contact Details.

7.1 Removal of Warning Signs

During a BGA bloom, warning signs (refer to Appendix G - Sample Blue-Green Algae Warning Sign) should remain in place until two consecutive results from representative samples confirm that levels of BGA have fallen below the alert levels. Sample results should be taken at a minimum of seven to ten days apart for testing. *Guidelines for Managing Risks in Recreational Water (*NHMRC 2008*)*.

Warning signs should not be removed if scum continues to be present.

8 Use of Algaecides

Local Water Managers should only use appropriately registered (or permitted) products for the control of BGA. It is important to note the need to obtain temporary permits for use of copper sulphate.

Information relating to the registration and issue of permits for algaecide use is available from the Australian Pesticides & Veterinary Medicines Authority (APVMA) website.

Local Water Managers are reminded that before considering the use of an algaecide in any water body, they should contact the Environment Protection Authority (EPA).

Local Water Managers who are water suppliers or water storage managers under the SDWA are also reminded that their risk management plan under this Act must include details of procedures to control any residue or chemical by-products imparted to drinking water, as a result of the addition of chemicals to water supplied for drinking purposes (Regulation 6(1) (e) of the Safe Drinking Water Regulations 2005).

This means that where an algaecide has been applied in any water body normally used as a source of drinking water, the Local Water Manager needs to ensure that their procedure for returning the water body to supply includes an assessment of safe levels of any algaecide residue or chemical by-products that could be transferred to the drinking water supply.

9 References

Gayle Newcombe, Jenny House, Lionel Ho, Peter Baker and Michael Burch, Management Strategies for Cyanobacteria: A guide for water utilities. Water Quality Research Australia, 2010 (http://www.wqra.com.au/publications/report74_management_strategies_BGA.pdf)

National Health and Medical Research Council*, Guidelines for Managing Risks in Recreational Water*, Australian Government, 2008.

Safe Drinking Water Act (Vic) 2003

Safe Drinking Water Regulations (Vic) 2015

DEPI Blue-Green Algae webpage - http://www.depi.vic.gov.au/water/rivers-estuaries-and-wetlands/blue-green-algae

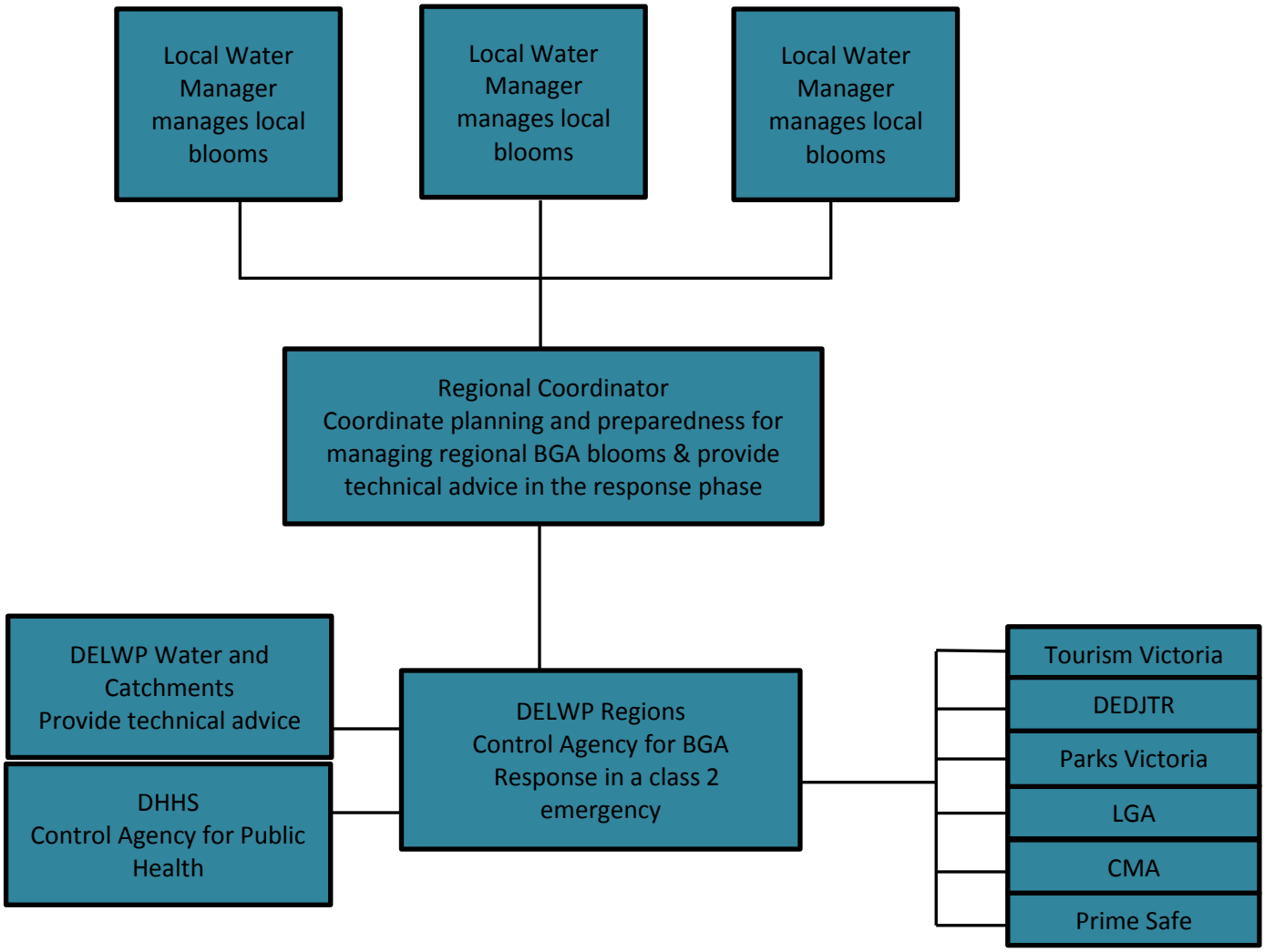
DHHS Blue-Green Algae webpage - http://www.health.vic.gov.au/water/recreational/bluegreenalgae.htm

Emergency Management Manual Victoria - www.oesc.vic.gov.au

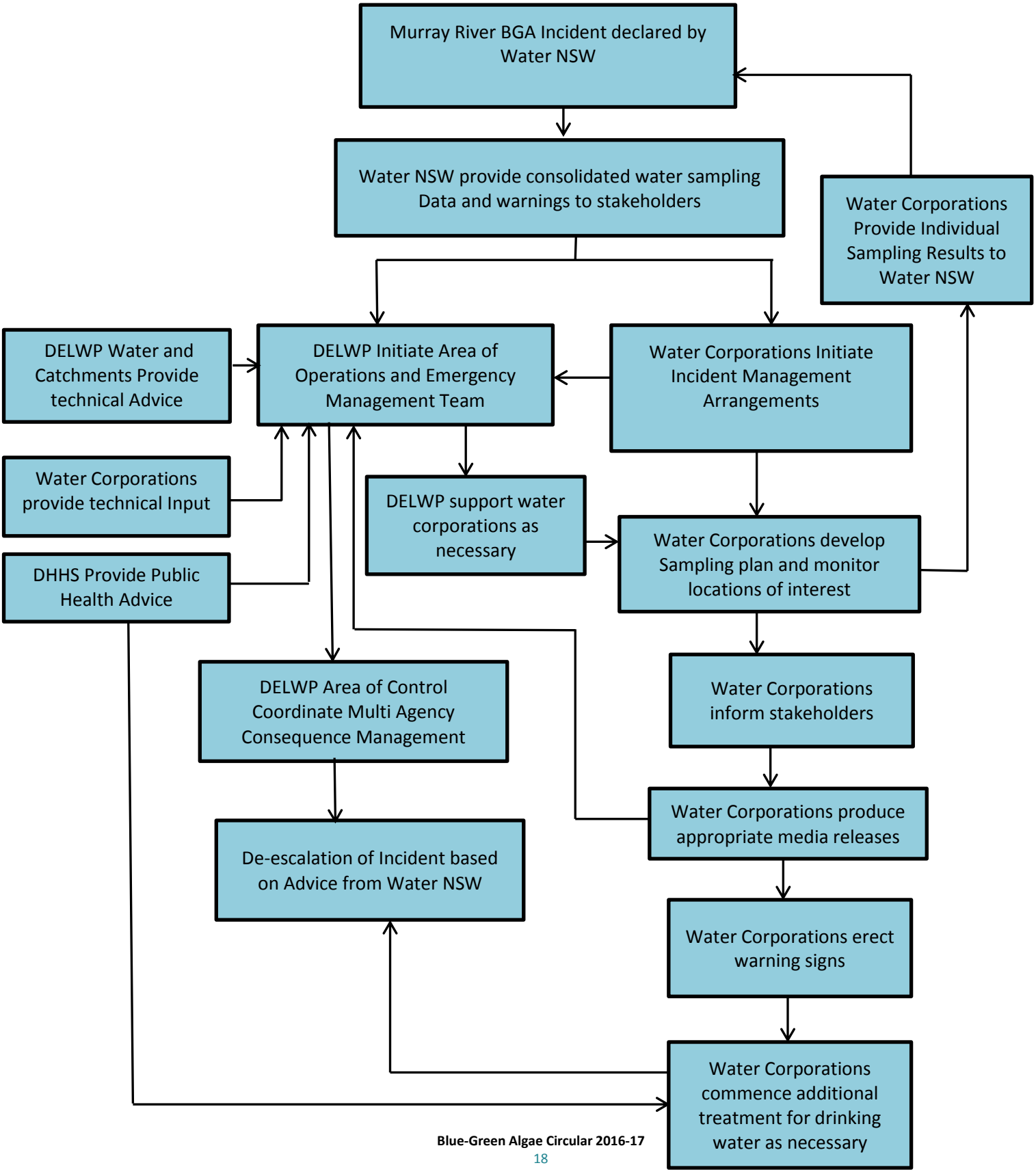
Australian Pesticides & Veterinary Medicines Authority website - www.apvma.gov.au/index.asp

Port Phillip Bay Marine Algal Bloom Response Plan - http://www.depi.vic.gov.au/environment-and-wildlife/environmental-partnerships/a-cleaner-yarra-river-and-port-phillip-bay/algal-blooms-in-port-phillip-bay

Appendix A – BGA Emergency Management Flowchart



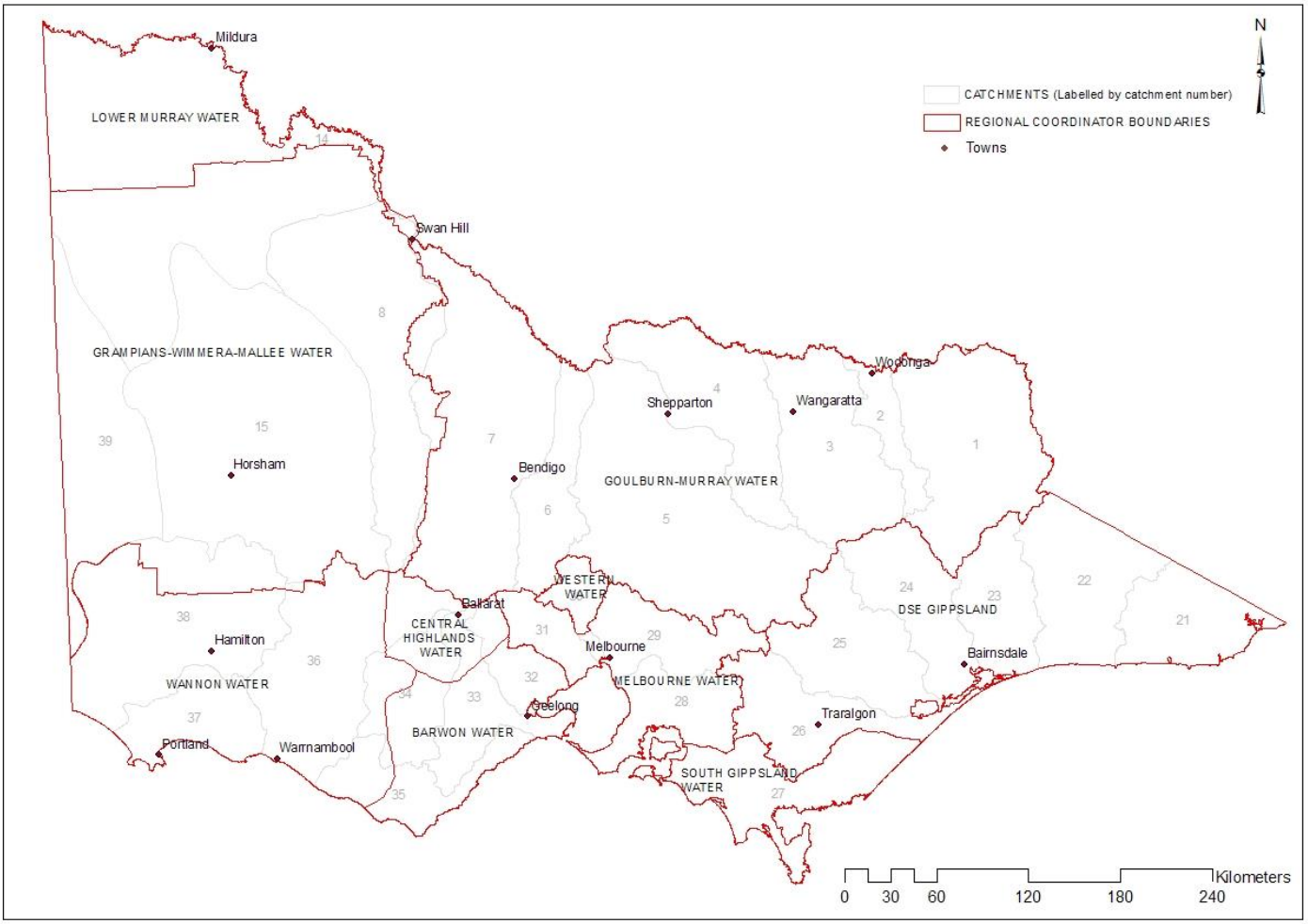
Appendix B - Murray River Regional BGA Response Arrangements – Lead Agency Water NSW



Appendix C- Regional Coordinator Contact Details

Drainage Basin or Area	Regional Coordinator	Contact Person	Email	Telephone
1, 2, 3, 4, 5, 6, 7, Pt 8	Goulburn-Murray Water	Greg Smith	greg.smith@gmwater.com.au	T: (03) 5826 3732
Pt 8, Pt 14, 15, Pt 38, 39	Grampians Wimmera Mallee Water	Mark Ferguson	mark.ferguson@gwmwater.org.au	T: (03) 5381 9841
Pt 14	Lower Murray Urban & Rural Water	Owen Russell	Owen.russell@lmw.vic.gov.au	T: (03) 5051 3400
21, 22, 23, 24 Gippsland Lakes 25, 26	DELWP, Gippsland	Julianne Sargant	Julianne. Sargant@delwp.vic.gov.au	T:(03) 5152 0404 M: 0448806830
27	South Gippsland Water	Kerry Matthews	kmatthews@sgwater.com.au	T: 03 5682-0448 M: 0438 318 487
28, 29, Pt 30, 31	Melbourne Water	Trish Grant	trish.grant@melbournewater.com.au	T: (03) 9679 7382/ 131 722
Pt 30	Western Water	William Rajendram	William.Rajendram@westernwater.com.au	T: (03) 9218 5486 M: 0409 027 134
Pt 32, Pt 33, Pt 34, Pt 35	Barwon Water	William Buchanan	William.Buchanan@barwonwater.vic.gov.au	T: (03) 5226 9175 M: 0418 300 483
Pt 32, Pt 33, Pt 34, Pt 36	Central Highlands Water	Richard Carty	richard.carty@chw.net.au	T: (03) 5320 3219
Pt 34, Pt 35, Pt 36, 37, Pt 38	Wannon Water	Jenith Jesuthasan	jenith.jesuthasan@wannonwater.com.au	T: (03) 5565 6666

Appendix D - Regional Coordinator Boundaries



Regional Coordinator	Drainage Basin or Area
Goulburn-Murray Water	1, 2, 3, 4, 5, 6, 7, Pt 8
Grampians Wimmera Mallee Water	Pt 8, Pt 14, 15, Pt 38, 39
Lower Murray Urban & Rural Water	Pt 14
DELWP, Gippsland	21, 22, 23, 24, Gippsland Lakes, 25, 26
South Gippsland Water	27
Melbourne Water	28, 29, Pt 30, 31
Western Water	Pt 30
Barwon Water	Pt 32, Pt 33, Pt 34, Pt 35
Central Highlands Water	Pt 32, Pt 33, Pt 34, Pt 36
Wannon Water	Pt 34, Pt 35, Pt 36, 37, Pt 38

Appendix E- Allocation of Local Water Managers – Guidance for Regional Coordinators

The BGA framework is a cooperative framework designed to minimise the health and environmental risk from BGA. One of the roles of the regional coordinator is to allocate local water managers. The following advice is a guide to assist with the allocation process.

Within the BGA coordination framework, the following agencies are options for local water managers:

- Water Corporations;
- CMAs;
- Local councils;
- Parks Victoria ;
- DELWP ;
- Coastal – Committee of Management;
- Alpine Resort Management Boards ; and
- Private Companies (e.g. AGL for Hydro-power Lakes such as Rocky Valley at Falls Creek).

A local water manager should fulfil the criteria below for allocation to a waterway:

- Management responsibility for the waterway at a location. If there are multiple responsibilities consider :
    - Who is the appointed / designated / legislated manager of the water body and / or foreshore where recreational access occurs?
    - Which organisation(s) benefit most economically, socially and environmentally, from the maintenance of acceptable water quality in the water body (ies) that may be subject to BGA blooms?
    - Who has legislated and / or perceived responsibility and duty of care for addressing public health risks attributed to blue - green algae blooms?
    - Which organisation(s) is/are at most risk socially, economically and environmentally from a blue - green algae bloom?
- Local presence (office and field crew).
- Adequate resources both in experience and number (i.e. does the delegated manager have the financial and technical capability to manage BGA.).

In the event that an agreement on an allocation of local water manager cannot be reached with a regional coordinator, DELWP, (as state-wide coordinator) will facilitate a dispute resolution process with the respective parties.

Appendix F - Agency Contact Details

Company	Contact Person	Email	Telephone
Department of Environment, Land, Water and Planning BGA State Coordinator Level 11, 8 Nicholson Street East Melbourne VIC 3002	Pradeepa Adihetty	bluegreen.algae@delwp.vic.gov.au	T: (03) 9637 9526
Department of Health and Human Services Water Program Health Protection Branch Level 15, 50 Lonsdale Street Melbourne VIC 3000	Rachael Poon	water@dhhs.vic.gov.au	T: 1300 761 874
Department of Environment, Land, Water and Planning	Customer Service Centre	customer.service@delwp.vic.gov.au	T: 136 186
Tourism Victoria	Stuart Toplis	stuart.toplis@tourism.vic.gov.au	T: (03) 9653 9777 M: 0412 541 460
Department of Environment, Land, Water and Planning – Regional Contacts			
Gippsland Region 574 Main St Bairnsdale 3875	Julianne Sargant	Julianne.Sargant@delwp.vic.gov.au	T:(03) 5152 4530 M: 408 325 768
Hume Region Regional Manager Environment and Natural Resources 1 McKoy Street Wodonga Vic 3690	Sue Berwick	Sue.Berwick@delwp.vic.gov.au	T: (02) 60437945 M: 0407 463 081
Port Phillip Region Regional Fire and Emergency Preparedness 609 Burwood Highway, Knoxfield 3180	Bernard Barbetti	Bernard.Barbetti@delwp.vic.gov.au	T: (03) 9210 9288 M:0419 008 600
Grampians Region Regional Manager Environment and Natural Resources 219A Main Street, Bacchus Marsh, Victoria 3340	Allyson Lardner	allyson.lardner@delwp.vic.gov.au	T: (03) 53660057 M: 0417 369 951
Barwon South West Region Regional Manager Environment and Natural Resources Cnr Fenwick & Little Malop St, Geelong 3220	Peter Lawson	peter.lawson@delwp.vic.gov.au	T: (03) 5226 4401 M: 0419 875 840
Loddon Mallee Region Team Leader Healthy Landscapes Cnr Midland & Taylors St, Epsom 3551	Andrea Keleher	Andrea.Keleher@delwp.vic.gov.au	T: (03) 5430 4367 M: 0409 018 910

Appendix G - Sample Blue-Green Algae Warning Sign

Note: This is a sample plan to be used only as a guide and may be varied based on individual situation.

Appendix H - Media Release

Date:

Media Contact:

BLUE-GREEN ALGAE WARNING FOR *(; INSERT WATER BODY NAME)*

(Insert Local Water Manager Name) announced that a blue-green algae (BGA) bloom is currently affecting *(insert Water body name)*.

The public is warned not to swim in and to avoid any direct contact with blue-green algae affected water.

Direct contact with blue-green algae can cause allergic reactions such as skin rashes or itchiness; sore eyes ears and nose or if swallowed gastroenteritis, nausea or vomiting.

People who come in to contact with contaminated water should wash immediately in fresh water. Seek medical advice if experiencing illness after contact with BGA affected water.

Any fish harvested from BGA affected water should have gills and guts removed prior to cooking. People should not eat whole fish, or shellfish or crustaceans collected from the (Insert water body name). The type of algae affecting *(insert water body name)* produces toxins that can concentrate in shellfish and crustaceans and also accumulate in the liver and internal organs of fish. Ingesting BGA toxins can lead to serious illness.

Water from the affected water body should not be used for drinking, cooking or other domestic uses. Boiling the affected water will not make it safe for use.

For any health issues experienced after contact with BGA affected water please seek medical advice immediately.

Irrigators are encouraged to take extra care to avoid spray drift, the pooling of water and inhaling mist from BGA affected water. Affected water should not be sprayed onto leafy vegetables or, florets or allowed to flood pastures.

Pet owners should prevent pets from drinking or having direct contact with contaminated water.

Visitors to the area are advised that they can still enjoy other recreational activities such as bushwalking, boating and sightseeing around the water body.

There are many land-based activities in the region to try. Please contact or visit local tourist information outlets for more information.

Members of the public are asked to report any potential BGA blooms to their local water manager on *(insert telephone number)*

Media please note:
For media enquiries please contact *(insert name)* on *(insert phone number)*

Appendix I - Testing Contractor Contact Details

Company	Contact Person	Email	Telephone
Testing for Algal Toxins			
Australian Water Quality Centre (AWQC) 250 Victoria Square Adelaide SA 5000	Customer Service Unit	awqccsu@sawater.com.au	T: 1300 653 366
ALS Global 22 Dalmore Drive Caribbean Business Park Scoresby VIC 3179	Kirsten Mudie	Kirsten.mudie@alsglobal.com	T: (03) 87568000
Algal Identification and Enumeration			
ALS Global 22 Dalmore Drive Caribbean Business Park Scoresby VIC 3179	Kirsten Mudie	Kirsten.mudie@alsglobal.com	T: (03) 87568000
ALS Global Barwon Laboratory 49 Carr Street South Geelong VIC 3220	Frank Matthies	Frank.matthies@alsglobal.com.au	T: (03) 5226 9249

Note: The laboratories listed above for algae identification are those laboratories that are NATA accredited for identification and enumeration of algae. The listing is purely for information purposes and does not imply DELWP or DHHS endorsement of any one of the laboratories.

Appendix J - List of stakeholder Agencies

Department of Health and Human Services
Department of Environment, Land, Water and Planning
Primesafe
Destination Gippsland
East Gippsland Marketing Inc
Local Government
Environment Protection Authority
Parks Victoria
Gippsland Ports
Lakes Entrance Fisherman's Co-operative Society
Catchment Management Authority
Victorian Water Corporations
Barwon Coast
Alpine Resort Management Boards
Coastal /rural – Committee of Managements
Private and community organisations with responsibility for water bodies

List of Acronyms

AIIMS	Australasian Inter-Service Incident Management System
APVMA	Australian Pesticides & Veterinary Medicines Authority
AWQC	Australian Water Quality Centre
BGA	Blue-Green Algae
CMA	Catchment Management Authority
DHHS	Department of Health and Human Services
DELWP	Department of Environment, Land, Water & Planning
EMMV	Emergency Management Manual Victoria
EPA	Environment Protection Authority
LWM	Local Water Manager (for BGA management)
NATA	National Association of Testing Authorities
NHMRC	National Health and Medical Research Council
RBRG	Regional Bloom Response Group
RC	Regional Coordinator (previously Convening Agency)
RCP	Regional Coordination Plan
BGA RMP	BGA Risk Management Plan
SDWA	Safe Drinking Water Act 2003
WSM	Water Storage Manager

Definitions

Blue-Green Algae (BGA) bloom: An increase in algal numbers which could discolour the water, introduce taste, odour, toxins and/or other compounds to the water, adversely affect the other biotic components of the aquatic ecosystem (i.e. fish, birds, amphibians, etc.) or generally render the water unsuitable for drinking, irrigation, recreation, stock watering or maintaining ecosystems). A BGA bloom may occur without any visible changes to the water.

Drinking Water: Water that is intended for human consumption or for purposes connected with human consumption, such as the preparation of food or the making of ice for consumption or for the preservation of unpackaged food, whether or not the water is used for other purposes (*Safe Drinking Water Act (Vic) 2003*).

Recreational Water Bodies: Any areas where a significant number of people use water for recreation (National Health and Medical Research Council (NHMRC) 2008). The recreational trigger levels defined in this Circular are based on primary contact recreation.

Local Bloom: Confined to a single water body.

Regional Bloom: Affects multiple interconnected water bodies and BGA is present at the public health alert levels defined in Section 6.3.

Primary Contact Recreation: Includes all water-related activities where immersion in water is the intended action or a probable outcome of the activity (for example swimming, water skiing, surfing or white water canoeing).

www.delwp.vic.gov.au

Department of Environment and Primary Industries

8 Nicholson Street
PO Box 500 East Melbourne
Victoria 8002 Australia
Telephone: (03) 9637 8000
Facsimile: (03) 9637 8100
ABN 90 719 052 204
DX 210098

Gavan O'Neil
Manager Special Ares Team
Melbourne Water
990 La Trobe Street
Docklands VIC 3008

Dear Gavan

RE Water Quality Quiet Lakes

Thank you for the letter dated 12 August 2013 regarding the management of water quality in Quiet Lakes.

In the absence of clear requirements, Melbourne Water needs to work with the responsible department and EPA to ensure that the requirements for public health and water quality are addressed.

I understand that you are working with the relevant officers from the Department of Health regarding clarification of appropriate secondary contact criteria for the management of this water body.

As the responsible local water manager for Quiet Lakes, Melbourne Water needs to manage any blue-green algae events as outlined in the Blue-Green Algae Circular.

Yours sincerely

Pradeepa Adihetty
Manager Emergency and Risk Management
Water Group
04/9/2013

Victoria

Department of Health
Incorporating: Health, Mental Health and Ageing

50 Lonsdale St
Melbourne
Victoria 3000
GPO Box 4541
Melbourne
Victoria 3001
Telephone: 1300 253 942
Facsimile: 1300 253 964
www.health.vic.gov.au
DX 210311

0 4 SEP 2013

Our Ref: DHD/13/16332

Mr Gavan O'Neil
Manager, Special Areas Team
Melbourne Water
PO Box 4342 VIC 3001

Dear Mr O'Neil,

Thank you for your letter dated 12 August 2013 requesting advice about Melbourne Water's interpretation of the ANZECC *Australian and New Zealand guidelines for fresh and marine water quality (2000) and the* NHMRC *Guidelines for managing risks in recreational water (2008)*.

The NHMRC guidelines promote the preventive risk management approach and provide guideline levels for cyanobacteria and algae in fresh, coastal and estuarine water. These guideline levels were derived for primary contact recreational activities. The ANZECC guidelines also provide a framework for water quality monitoring. However, the recreational water aspects of the guidelines were superseded by the NHMRC guidelines when published in 2008.

While the Department of Health has no formal regulatory role to administer these guidelines, I would advise Melbourne Water (as the local water manager for Patterson Lakes) to manage risk to protect public health as described in the NHMRC guidelines.

I understand the Patterson Lakes are promoted for secondary contact activities such as boating, rather than activities such as swimming. If this is the case, Melbourne Water should consider undertaking a risk assessment for cyanobacteria using the approach detailed in Chapter 6 of the NHMRC guidelines.

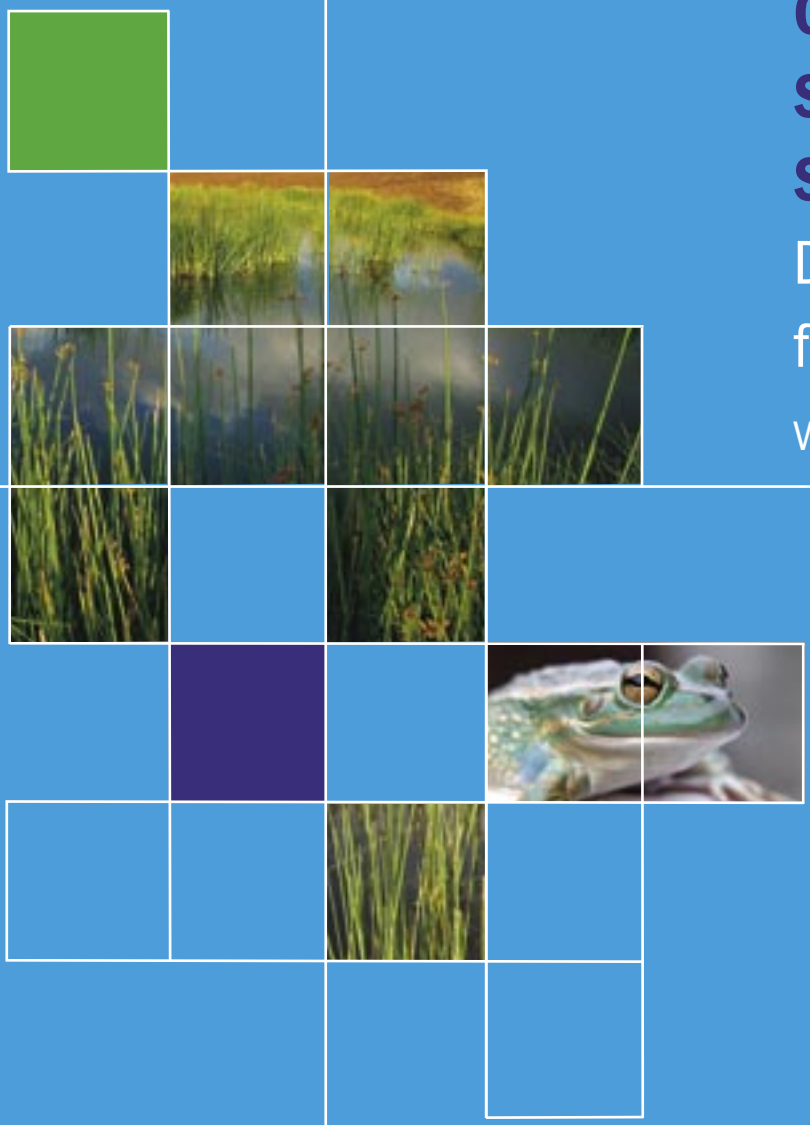
For further information please do not hesitate to contact Rachael Poon on 9096 0414.

Yours sincerely

Rodney Dedman
Manager Water

cc. Ms Cathy Bates, DEPI

State Government Victoria



Constructed Shallow Lake Systems

Design Guidelines for Developers

Version 2, November 2005

Victoria
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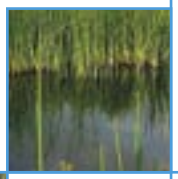


Contents

	Introduction	3
1.	**Risk Assessment**	4
2.	**Shallow Lake Eutrophication**	6
3.	**Main Factors Controlling Algal Blooms**	7
3.1.	Water Residence time	7
3.2.	Nutrients	7
3.3.	Light	8
4.	**Design Intent**	8
5.	**Modelling**	8
5.1.	Catchment Modelling	8
5.2.	In-lake Modelling	9
6.	**Design Considerations**	9
6.1.	Waterbody residence time	9
6.2.	Morphology	9
6.3.	Vegetation	11
6.4.	Organic Matter	11
6.5.	Inflow Water Quality	12
6.6.	In-lake Water Quality	12
6.7.	Surrounding open space	13
6.8.	Make up water	13
6.9.	Groundwater interaction	13
6.10.	Safety	13
7.	**Management of flora and fauna**	14
8.	**Maintenance and Operation**	15
9.	**Signage**	15
10.	**Monitoring**	15

APPENDIX 1 - Flow chart of approval process

APPENDIX 2 - Phosphorus Cycling in the Aquatic Environment

APPENDIX 3 - Nitrogen Cycling in the Aquatic Environment

APPENDIX 4 - Basic Lake Ecology

Acknowledgments

This document is a review of the document published in September 2003. This review has been undertaken to reflect the increasing knowledge and understanding of constructed shallow lake systems. Major contributions by Dr Mike Grace, Water Studies Centre, Monash University were gratefully accepted in the first version of this document.

Introduction

Constructed shallow lake systems within urban developments are normally designed for amenity or recreational purposes. This contrasts with wetland systems designed specifically for stormwater quality treatment. Constructed shallow lakes are generally considered to have a higher probability of algal blooms than wetlands due to the longer residence times of stormwater, lower abundance of rooted macrophytes and an increased likelihood of thermal stratification. The likelihood of algal blooms can however be minimised by appropriate design and management of the waterbody.

Melbourne Water does not have recreation functions as part of its Operating Charter and therefore does not plan or construct water bodies designed primarily for amenity or recreation as opposed to water quality treatment.

Whilst constructed shallow lakes are not encouraged, where they can be demonstrated to be sustainable, are appropriately managed and pose minimal threats to downstream waterways and receiving waterbodies, Melbourne Water does not object to their construction.

When algal blooms do occur, they are in general short lived. Warning notices should be put into place to prevent access to the waterbody. However, if they are frequent and persistent, more substantial actions may be required. Further information can be obtained from The Department of Sustainability and Environment (136 186) and from The Department of Human Services (9616 7777), state-wide coordinators for the management of blue green algae. Melbourne Water acts as a regional coordinator and can be contacted for blooms occurring within Port Phillip and Western Port regions (131 722).

The purpose of this document is to provide a basic description of the function and behaviour of lake systems and highlight the risks and issues that need to be considered in their design and management. This document will help ensure a consistent approach to modelling, designing and constructing shallow lake systems using best practice design. A flow chart summarising the different steps towards a successful approval is given in Appendix 1.

This document should be read in conjunction with:

- Melbourne Water's *Constructed Wetland Systems, Design Guidelines for Developers*, which is available as a download from Melbourne Water's web page: http://www.melbournewater.com.au/content/library/rivers_and_creeks/wetlands/Design_Guidelines_For_Shallow_Lake_Systems.pdf
- WSUD – Engineering Procedures. Stormwater, MWC, 2005.

1. Risk Assessment

The design of the lake should be the result of a thorough analysis of the level of risk of algal blooms (green and blue green algae) and any other issues that may impact on lake sustainability. Overall three main factors are considered to control algal blooms (see conceptual model). The right adequacy of these factors will most likely engender an algal bloom.

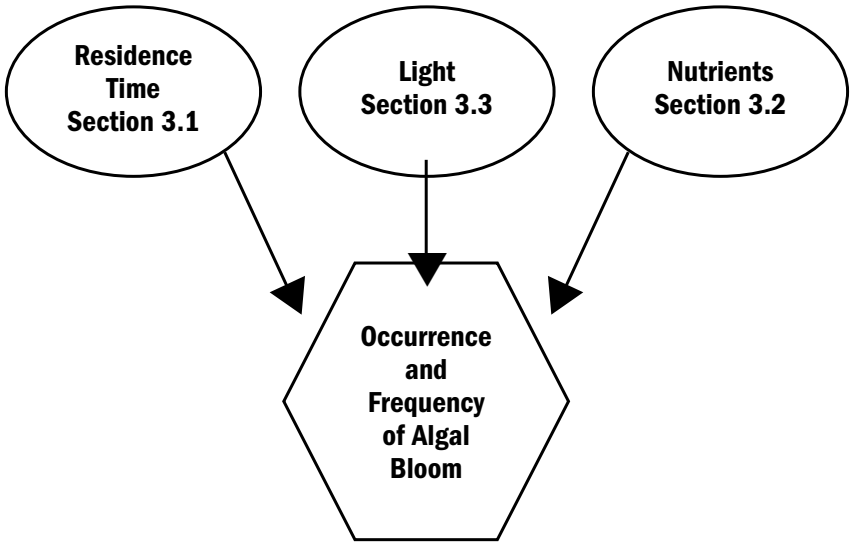


Figure 1. Conceptual model showing the main factors controlling an algal bloom.

To best understand the severity of the risk, consideration needs to be given to both the consequence of the threat and the probability of the threat occurring. The risk assessment should provide a matrix of consequence and likelihood to help guide the importance of the risk in the lake design and management plans.

Risks should not be discussed in isolation, as they are often interdependent. A risk assessment needs to be integrated with the design intent and must clearly demonstrate that the developer understands the risks.

Nutrient inputs can be managed by installing pre-treatment measures upstream. Treatment of stormwater to protect receiving water bodies is now common practice in Victoria (Urban Storm Water: Best Practice Environmental Management Guidelines, 1999). Targets are to retain 80% of the suspended solid annual load, 45% of total phosphorus and 45% of total nitrogen annual loads.

Light can be managed to a certain extent but some blue green algae are able to regulate their position in the water column and migrate vertically, increasing their exposure to optimum light intensities.

Residence time is also amenable to management action and constitutes a tangible tool to assess the likelihood of potential algal problems within a lake.

Table 1 gives examples of several scenarios for the setting of a lake with their associated risk of developing algal blooms, in particular blue green algal ones. It is assumed in all cases that the macrophyte community is established in at least 50% of the lake area. These examples apply to a water body with a summer water column temperature of 20°C. More detailed information is provided in the WSUD Engineering Procedures: Stormwater (MWC, 2005) document. This table should be read as a guide only and is based on the best information available to date. The guidelines will be redefined as more data becomes available.

Table 1. Risks of lakes developing algal blooms

	Risk of Algal Bloom	Recommended Action
Residence time < 20 days more than 80% of the time Pretreatment in place Macrophyte cover > 50% lake area	Very low risk	Provide an overview of the lake's function to residents (Appendix 4)
Residence time < 30 days at least 80% of the time Pretreatment in place Macrophyte cover > 50% lake area	Low risk	Provide an overview of the lake's function to residents (Appendix 4)
Residence time < 30 days at least 80% of the time No Pretreatment in place Macrophyte cover > 50% lake area	Low to Medium risk	Investigate the feasibility and implementation of pre-treatment structures (Section 5.1)
Residence time >30 days more than 20% of the time Pretreatment in place Macrophyte cover > 50% lake area	Medium risk	As above and change the design of the lake to minimise the residence time (Section 5.2)
Residence time >30 days more than 20% of the time No Pretreatment in place Macrophyte cover > 50% lake area	High risk	Construction of the lake not recommended

A report should be provided to the relevant authority demonstrating the identification and understanding (consequence and likelihood) of the risks associated with the proposed waterbody.

2. Shallow Lake Eutrophication

Shallow lakes are dynamic systems that change over time in response to internal and external inputs and processes. The most pervasive system change that can lead to problems is the process of eutrophication, which is the enrichment of the system with inorganic nutrients, either in soluble form or associated with organic matter or silt. In shallow lake systems, this enrichment often leads to the excessive growth of algae, also called algal bloom.

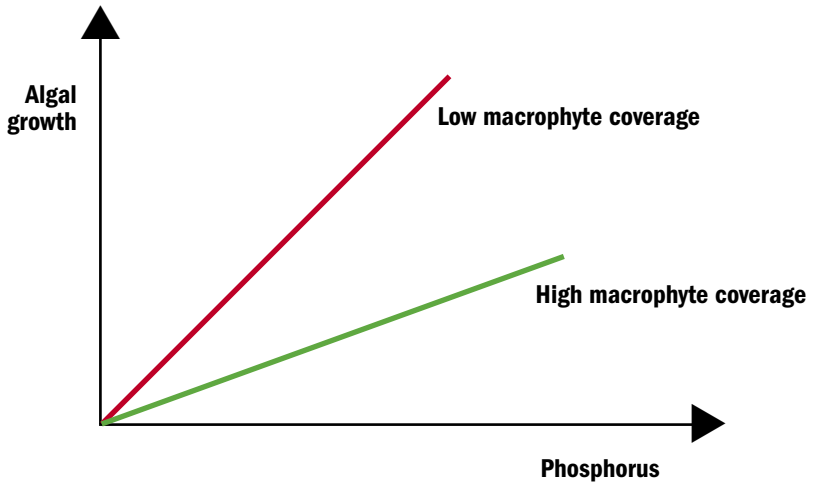
Microscopic and macroscopic forms of algae can produce a bloom. Blue green algae (or cyanobacteria) are often classified as part of the microscopic algal populations, despite the fact that these micro-organisms are bacteria. However, like algae, they rely on sunlight for energy. Nuisance green algal blooms may occur more frequently than cyanobacterial blooms and possibly affect the amenity of the system, particularly in residential areas.

Plants are important to maintenance of both biological processes and water quality. They take up dissolved nutrients for their growth and provide food and shelter for zooplankton, which may graze on algal species. The oxygen released during photosynthesis is important in maintaining oxygen saturation in the water column that is depleted by animal, plant and bacteria respiration and decomposing organic matter. Vegetation also helps stabilise sediments and reduce release of sediment-bound nutrients arising from resuspension processes.

A shallow lake is considered healthy when a balance exists between algal and rooted macrophyte (large plant) populations. Once the environmental conditions are suitable for sustaining an excessive growth of algae (either micro or macroalgae), it will be very difficult to reverse the situation to a healthier system. Maintaining a diverse, extensive and healthy rooted macrophyte population is a critical element in maintaining a system that is appropriate for residential estates.

Figure 2 is conceptual only and illustrates the value of macrophyte establishment. It suggests that in a lake system with poor rooted macrophyte coverage, low levels of phosphorus would result in greater algal growth. Alternatively, in a lake system with extensive macrophyte establishment, the lake may be able to deal with higher levels of phosphorus without increased algal growth.

Figure 2. Conceptual rooted macrophyte benefit on algal growth (freshwater environment).



The shallow lake design should aim to minimise the excessive growth of algae by maximising the growth of rooted macrophytes. Processes that can contribute to the loss of rooted macrophytes and therefore impact on the state of the lake system include:

- Elevated nutrients and associated rapid growth of algae that compete with macrophytes for light and can smother submerged vegetation
- Changes in water depth, colour or turbidity reducing light penetration to submerged vegetation

- Disturbance events such as storms or droughts causing increasing levels of sediment and smothering of submerged vegetation with silt
- High densities of herbivorous fish over grazing submerged vegetation
- High densities of benthivorous fish such as carp that stir up lake sediments and dislodge submerged vegetation.

Residents and managing authorities must be aware that as the lake system ages, it has a greater chance of problem algal growth and algal blooms. The frequency and duration of a green algal bloom or cyanobacterial bloom that would be considered an unattractive appearance to residents or provide a health risk, should reflect community expectations about the appearance and management of the waterbody. It is possible that a lake system may require desilting and a total 'reset' if algal blooms become a recurrent and persistent problem.

3. Main Factors Controlling Algal Blooms

The design of a sustainable shallow lake system should take into account the following issues, identified as the main factors controlling algal blooms:

3.1. Water Residence Time

Water quality problems associated with algal growth, are likely to arise as a consequence of insufficient water inflows to circulate and/or displace the water stored in the lake. Under long residence times, blooms of blue green algae (cyanobacteria) can occur. When the residence time is reduced, the algal biomass becomes regulated by the rate at which it is removed from the shallow lake by flushing. Waterbody residence time analyses are a very useful indicator as to whether the waterbody is at significant risk of algal blooms (see section 6.1).

3.2. Nutrients

Algal blooms in constructed lakes will be driven by phosphorus and nitrogen. It is important that the design process considers both diffuse and point sources of nutrients so that appropriate management strategies or interventions can be planned for.

Diffuse sources of nutrients originate from the catchment and reach the receiving waterbody via rainfall runoff and flooding of the land. Diffuse sources may be generated from forests and rangelands, pasture, enhanced soil erosion, hard surfaces not connected to the local drainage network, groundwater, septic tank or sewage leakage and ground fill leachate.

Point sources are delivered directly to the waterbody via stormwater drains, sewage treatment plants and irrigation drains. The lake sediments themselves constitute a potentially large point source of nutrients. Sediments act as a large reservoir, which, under the appropriate physico-chemical conditions, will release nutrients into the water column.

Thermal stratification is important in potentially making phosphorus available. In the sediment, phosphate is usually bound to iron coatings on the surface of mineral particles and is not available to the biota. However, in the absence of oxygen, bacteria can dissolve the iron coating, which releases the phosphate back into the water column. Thermal stratification facilitates this process by establishing oxygen-free conditions on the sediment surface. Therefore, the design of the lake should ensure that thermal stratification is minimised by orientating the lake to the dominant winds to facilitate mixing of the water column.

No inflows should enter the lake unless adequately treated through a wetland or infiltration system to reduce nutrients as well as organic loads and suspended solids.

3.3. Light

In Australian climatic conditions, surface light is rarely a limiting factor for algal growth. Throughout the water column, turbidity and mixing conditions will determine the light environment that algal populations are exposed to. Some cyanobacterial species can regulate cell buoyancy (capacity to adjust their position in the water column by means of gas vacuoles) and migrate vertically, increasing their exposure to optimum light intensities. The depth of light penetration can be reduced by turbidity and therefore limit algal biomass.

However, the depth of light penetration will also be a limiting factor for submerged aquatic plants. Turbidity should be reduced to maximise the development of the rooted macrophyte community. Therefore, suspended sediment loads should be low enough to allow light penetration to the maximum depth of the lake. This may only be exceeded for extremely short periods of time after a significant storm event.

4. Design Intent

A design intent must be produced for the construction of any waterbody and should clearly articulate the objectives of the lake and consider the surrounding environment. The design intent should be developed in consultation with relevant authorities and when completed will provide direction to the functional and detailed design.

The design intent should capture the expected recreation use, public safety, amenity and community expectations regarding water quality and associated algal growth. The design intent should:

- Articulate what is an acceptable frequency and duration of algal blooms and acceptable level of floating surface algae to the local community
- Communicate the performance requirements for all surface hydrology issues, such as surface drainage, flood retardation and flood passage. It should also describe the level of hydraulic and water quality modelling required
- Communicate habitat, environmental and cultural issues, such as desirable fauna, proximity to significant flora and fauna or preservation of cultural sites
- Consider the surrounding topography and geology and its impact and integration into the lake design.

The design intent must be produced during feasibility discussion and communicated to all relevant stakeholders (including Local Government, Melbourne Water and community groups where appropriate).

5. Modelling

As part of the risk assessment, the catchment and lake system should be modelled using an appropriate software package. Modelling shallow urban lakes is essential to predict the likely evolution of water quality. The level of modelling to be undertaken should relate to the risk profile developed from the risk assessment.

5.1. Catchment Modelling

To determine the likely inputs into a receiving waterbody, catchment modelling should be performed through considering catchment uses and any treatment measures that may be constructed upstream. The time step of the model should be appropriate for the size of the catchment and for the range of treatment measures proposed.

A catchment model should be submitted as part of the lake application proposal to simulate pollutant generation loads (gross pollutants, Total Nitrogen, Total Phosphorus & Total Suspended Solids) and the performance of any treatment measures.

5.2. In-lake Modelling

For lakes that have a high risk profile the catchment model should then be linked to an in-lake hydrodynamic and water quality model. Model selection should depend on the nature of the dominant physics/water quality processes of each lake. In general, either a 1-D or 2-D model should be sufficient, depending on whether or not stratification is deemed to be an important consideration. All models must allow extraction of in-lake model results as time series outputs, so that statistical analysis can be performed on the output.

At a minimum, the in-lake water quality model should be capable of simulating:

- Water depth
- Water temperature
- Salinity
- Impacts of catchment derived inflows
- Internal cycling processes including as a minimum
  - Denitrification
  - Sediment nutrient release/uptake
  - Conversion of available and unavailable nutrients via adsorption/desorption and organism uptake
  - Settling of particulate bound nutrients
- Impacts of rainfall
- Impact of tidal exchange or other flushing mechanisms (if appropriate)
- Phytoplankton growth and decay.

An in-lake modelling exercise should be undertaken and be provided to the relevant authority for approval.

6. Design Considerations

6.1. Waterbody Residence Time

Waterbody residence time (or turnover frequency) analysis can be undertaken using probabilistic monthly evaporation and rainfall data or daily historical data. Average residence times are calculated by modelling continuous simulation of flows into and out of the lake. Further details on how to estimate waterbody residence time are provided in "WSUD Engineering Procedures: Stormwater, MWC, 2005".

6.2. Morphology

Lake morphology is important to create a functional ecosystem. Figures 3, 4 and 5 give a schematic illustration of a shallow lake system to provide a general concept only.

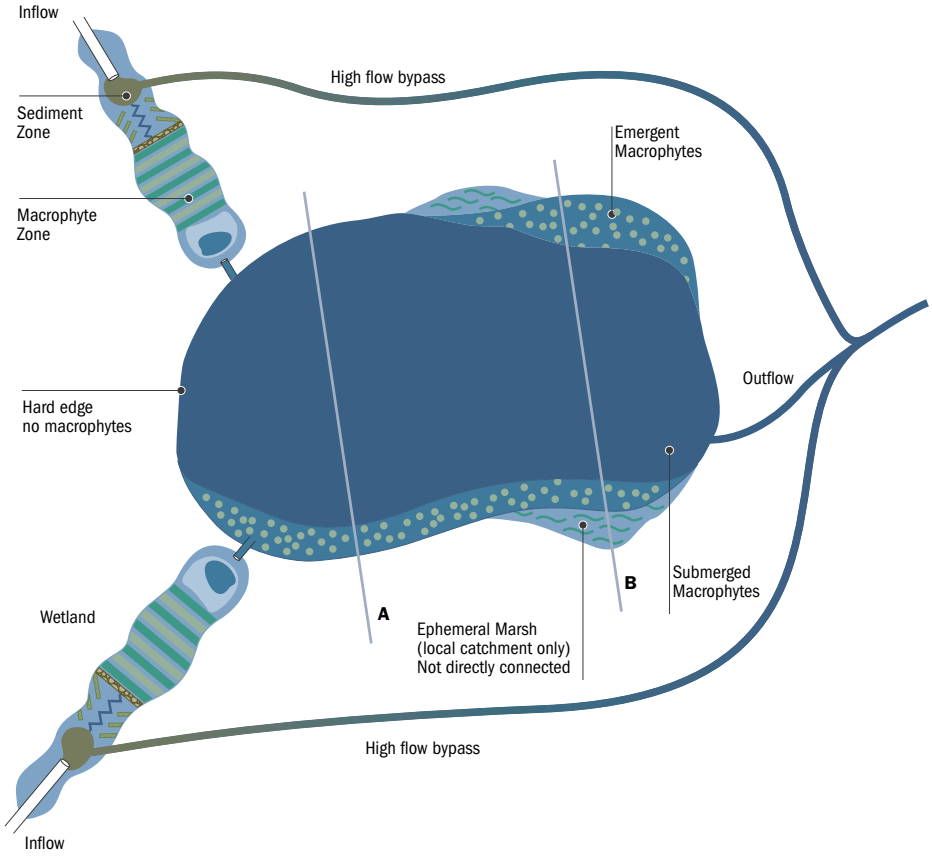


Figure 3. Schematic representation of a constructed shallow lake system.

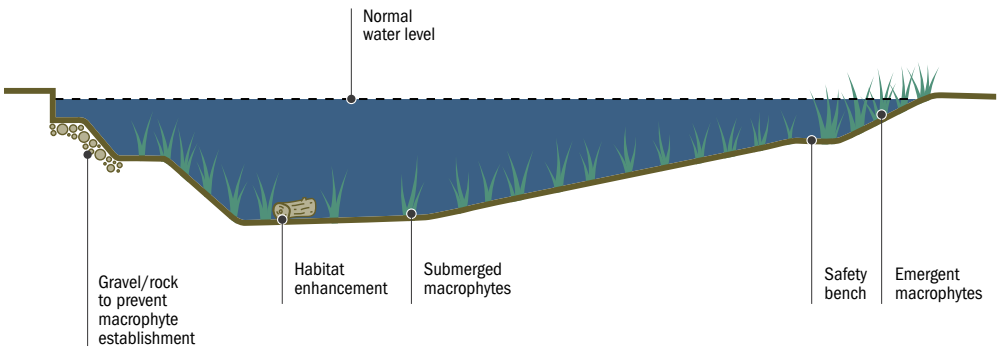


Figure 4. Cross Section A - schematic representation.

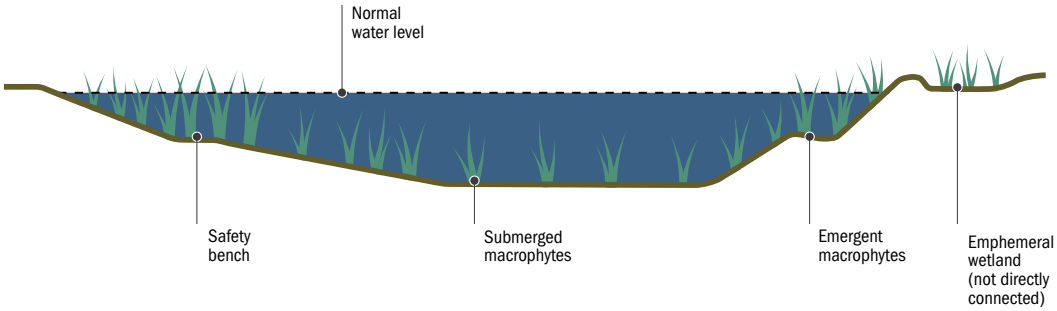


Figure 5. Cross Section B – schematic representation.

The lake should be oriented to the dominant winds to facilitate mixing, particularly for summer and autumn and edge treatments must be designed to minimise wave damage.

The lake depth should be no greater than 3.0 meters to ensure sufficient light penetration to maintain submerged plants and to minimise the likelihood of stratification by allowing wind mixing. It is preferable that the lake is between 1.5 – 2.0 m in depth to maintain the most productive biological system possible. The lake depth should vary to create an opportunity for the most diverse ecological system possible.

6.3. Vegetation

Rooted macrophytes should include a minimum of 50% areal cover and 50% volumetric coverage of the lake. A greater cover is highly recommended.

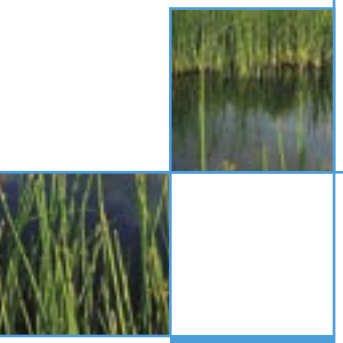
To assist in vegetation establishment, the entire bed of the lake and fringing ephemeral areas must be topsoiled with a minimum of 150mm of locally derived topsoil with a minimum of 5% organic matter.

The lake should be filled in three stages; 0.5 m above the lake bottom to allow planting and establishment of the submerged macrophytes, 1.5 m above invert to allow planting of any Deep Marsh species and final filling and planting of any Shallow Marsh species. Two months should be a minimum period between stages to allow establishment.

For a comprehensive list of appropriate species please refer to Melbourne Water document "Constructed Wetland Systems, Design Guidelines for Developers (2005)".

6.4. Organic Matter

The amount of organic matter entering the lake system needs to be minimised as much as possible by diverting high flows around the lake system and adequately treating all low flows through wetland or infiltration systems. Sudden increases of organic matter from large catchment flows or the death of in-lake macrophytes fuels greater bacterial respiration, and can lead to a substantial reduction in dissolved oxygen levels, resulting in fish kills and death of other oxygen requiring organisms.



The lake must include a high flow bypass capable of bypassing all flows that cannot be treated by upstream wetlands or bioretention systems, and the design must demonstrate how the input and internal levels of organic matter have been considered and will be managed.

6.5. Inflow Water Quality

The water entering the lake systems must be pre-treated to reduce sediment, organic load and nutrient levels.

Catchment modelling must demonstrate that as a minimum Best Management Practice (BMP) for nutrient removal is achieved (45% reduction in Phosphorus, 45% reduction in Nitrogen, 80% reduction in Suspended Solids of a typical urban annual load).

It is highly likely that inflow nutrient levels should be treated beyond BMP to background concentrations to achieve the water quality criteria described in Section 6.6.

6.6. In-lake Water Quality

Both phytoplankton and macro algae need to be considered. It is expected that algal counts above 15,000 cells/mL represent a likely phytoplankton bloom where either aesthetics or health impacts may occur. In a water sample, algal abundance can be estimated by measuring the amount of pigment or chlorophyll *a*. It is estimated that 15,000 cells/mL would approximately equate to a chlorophyll *a* concentration in the range of 10.15 µg/L. This figure can be used in modelling to determine the frequency and duration of unacceptable algal growth. Macroalgae can be estimated by measuring their biomass or their area coverage.

It is important to note that blooms of blue green algae can have a significant impact with levels much lower than 15,000 cells/mL because they are able to produce toxins. Alert levels can begin as low as 2,000 cells/mL. An ongoing monitoring program should be used to identify increases in blue-green algae levels.

Figure 6 provides a range of nutrient and chlorophyll *a* concentrations, within which the lake is most likely to have manageable algal growth. The closer to the lower end of the range, the less likelihood of a regular algal bloom and the closer to the higher end the more likely. Detailed biogeochemical cycles for both nutrients are provided in Appendices 2 and 3.

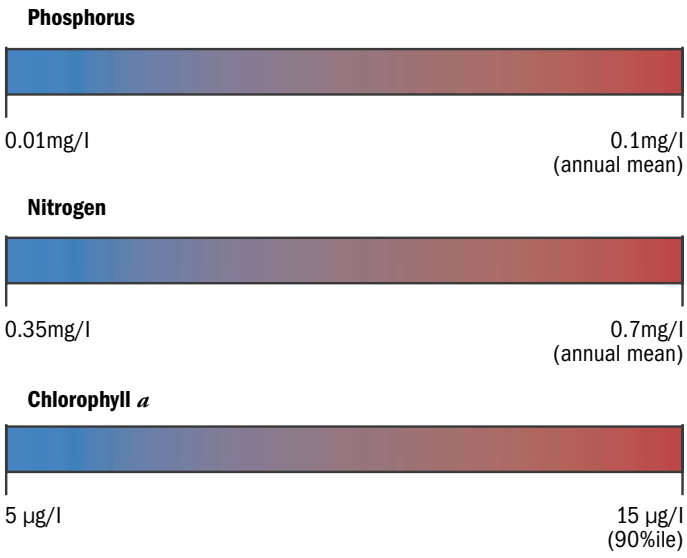


Figure 6. Acceptable range of Phosphorus, Nitrogen and Chlorophyll *a* concentrations for a "manageable" lake.

Demonstrating that the in-lake water quality is within this range and utilising all best management options in the design, it is predicted that the lake will not have excessive management issues relating to the growth of phytoplankton and macro algae.

If the in-lake model produces results above this range, it is likely the lake will not satisfy the expected lake performance that would be acceptable to residents.

6.7. Surrounding Open Space

Surrounding open space should be designed to incorporate low or preferably zero fertilizer requirements.

Adjacent lawn areas that require fertiliser inputs should be discouraged or appropriate treatment measures should be installed (e.g. vegetated swales as buffer strips). Grassed areas should ensure that surface flow does not discharge directly into the lake system.

Any irrigation of grassed areas surrounding the lake must have a scheduling system advanced enough to reduce the amount of surface flow in a rain event and minimise infiltration to groundwater.

6.8. Make Up Water

The lake system should be designed with consideration to the yield of treated stormwater from the catchment and should not rely on make-up water from other sources. The use of potable water to maintain water levels is not acceptable. Only where groundwater can clearly meet yield and quality criteria should it be considered as a source of top up water. The long-term impact on the lake ecology and impact on the groundwater resource must be considered.

6.9. Groundwater Interaction

Lake systems have a high potential to interact with groundwater. They can become sources of groundwater recharge and impact on surrounding areas lower in the landscape. Alternatively, groundwater may discharge directly into the lake impacting on its water quality.

A geotechnical investigation is normally required to determine groundwater depth and quality (including nitrate, dissolved metals and organic contaminants), and the likelihood of the lake either acting as a recharge or discharge area. Clay lining may be required to control groundwater interaction.

6.10. Safety

Melbourne Water is not responsible for managing any waterbodies that are constructed for recreation or amenity and advises that qualified professionals should conduct an adequate safety audit on the design.

Please refer to "The Royal Life Saving Society Australia, Guidelines for Water Safety in Urban Water Developments (2004)" for detailed information on safety issues.

7. Management of flora and fauna

Residents should be made aware of the primary objectives of the lake and be given an overview of the lake's biology to assist them in developing realistic expectations (Appendix 4). They should be aware that waterbodies tend to be variable in condition and at times water quality may be temporarily poor (such as during a drought or immediately following a storm), and should contribute to protecting the health of the waterbody through responsible household practices.

The lake should provide a robust, resilient and diverse biological system that can buffer against any inflow storm events or prolonged dry conditions. Habitat requirements for all plants and animals should be considered early in the conceptual design. Consideration needs to be given to all levels of life ranging from zooplankton through to fish and bird life.

The lake system should only include indigenous species. Non-indigenous fauna species such as carp or trout and exotic flora species must never be introduced to the lake and if established should be removed.

Introduced species such as carp pose a significant risk to a lake system and it is essential that an appropriate management plan is created. Stocking of native species may be a component of the lake management[1]. Fish introduction should only occur when the lake is established (i.e. adequate habitat and food). Not all species may breed in lakes, therefore on-going stocking may be required.

A list of possible species based on geographical drainage basins and salt content of the waterbody is provided in Table 2. Advice should be sought from The Department of Primary Industries and The Department of Human Services regarding suitability of introducing sporting species. It is important to note that there may be issues associated with obtaining certain stock species.

Table 2. Potential fish species suitable for stocking in shallow lake systems.

Species	Stocking Region/Catchment	Brackish /Freshwater
Southern pygmy perch	All	Fresh
Dwarf galaxiasa	Dandenong, Western Port	Fresh
River blackfish	Dandenong, Western Port, Yarra	Fresh
Australian smelt	Western Port, Yarra, Maribyrnong, Werribee	Both
Shortfinned eel	All	Boths
Flathead gudgeon	Dandenong, Yarra, Maribyrnong, Werribee	Both
Estuary perch	All	Brackish
Australian bass	Dandenong, Western Port	Brackish
Smallmouthed hardyhead	All	Brackish
Blue-spot goby	All	Brackish
Black bream	All	Brackish

A fish management plan must be prepared for the control of carp. If fish introduction and manipulation is considered, this plan should be prepared by an appropriately qualified professional. Under no circumstances will stocking with carp, trout or other non-indigenous species be acceptable.

[1]A permit from the Department of Sustainability and Environment will be required for any stocking with native species.

8. Maintenance and Operation

Poor maintenance and operation will invariably lead to poor water quality and it is expected that the lake system is designed to minimise future maintenance requirements. Lake systems can require operational inputs to maintain acceptable performance, such as recirculation systems or dredging activity. These maintenance activities should be carefully examined, particularly in regard with their impact on the lake biota.

All maintenance and operation issues should be identified and fully costed and it is essential all stakeholders clearly understand their roles, responsibilities and liabilities before any works begin. A detailed management plan should be written for the responsible authority to implement. The maintenance schedule should be flexible enough to be guided by the results of monitoring. It is worth considering that some lakes may require a total reset if algal problems are persistent.

A maintenance agreement with the developer, council or other relevant authority must be established prior to any earthworks. In-lake, ephemeral and terrestrial areas in and surrounding the waterbody should be clearly marked on a site plan to identify maintenance responsibilities. The site plan and an associated legally binding agreement must be signed off by all stakeholders.

9. Signage

Please refer to the signage requirements documented in the Melbourne Water document "Constructed Wetland Systems – Design Guidelines for Developers (2005)".

10. Monitoring

Monitoring is an essential component to managing a shallow lake system and will allow the manager to understand the behaviour of the lake and better predict potential algal problems.

Monitoring must be performed on a routine basis and should consider the 'Water's of Victoria' policy released by the EPA Victoria and seek guidance from the AS/NZS 5667 standard. Monitoring must include a range of biological, physical and chemical parameters.

It is expected that the monitoring program will include pH, electrical conductivity, water temperature, turbidity, dissolved oxygen concentration, algae and cyanobacterial counts and chlorophyll *a* concentrations, macrophyte coverage and phosphorus and nitrogen concentrations.

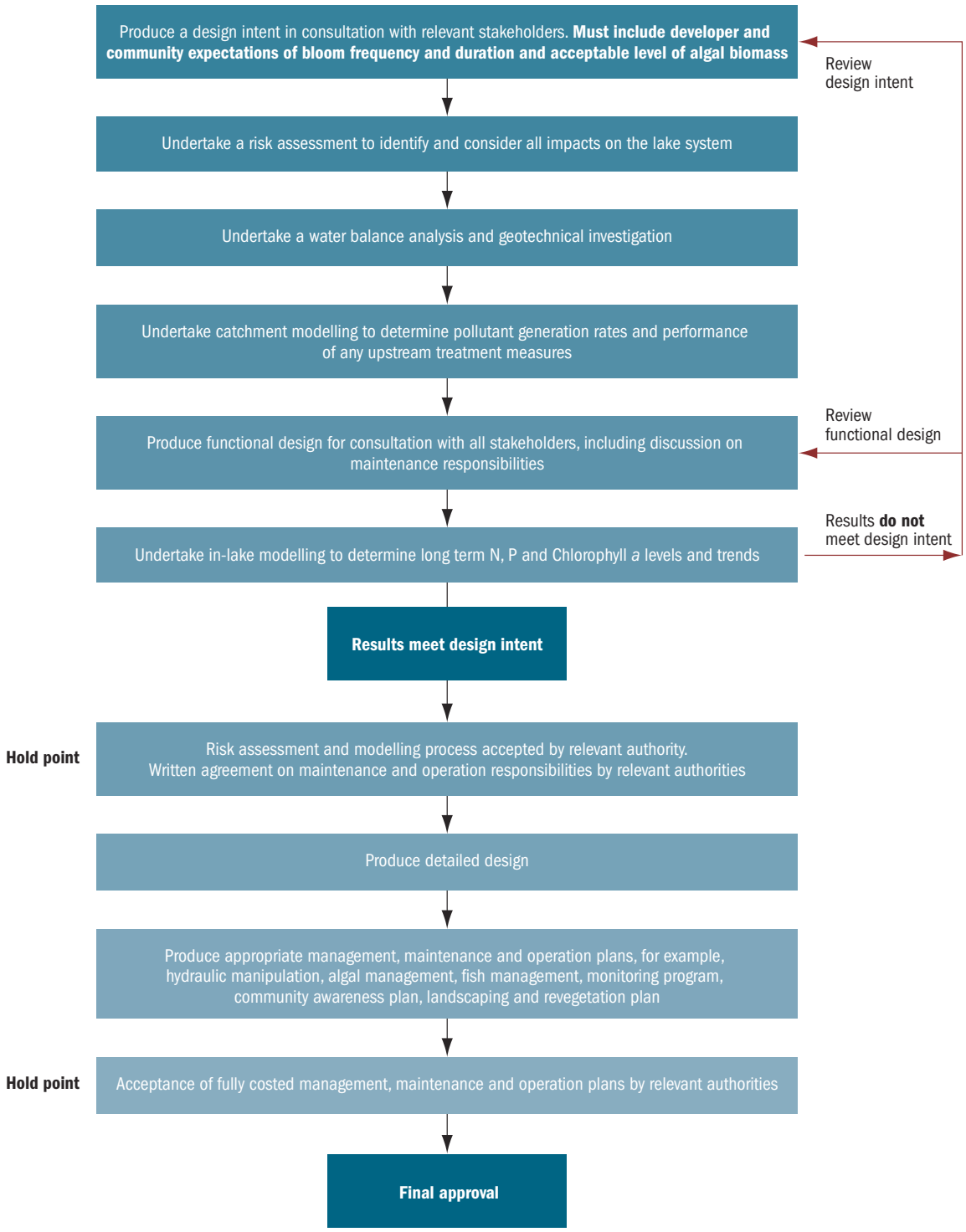
Two measures of phosphorus concentration are frequently performed in water quality monitoring. They are Total Phosphorus (TP) and Dissolved Reactive Phosphorus (DRP). DRP is synonymous with SRP (soluble reactive phosphorus) and FRP (filterable reactive phosphorus). It is DRP that is considered to be the most readily bioavailable, that is, algae can consume this form of phosphorus but cannot easily consume other forms.

Likewise, the most commonly measured forms of nitrogen are:

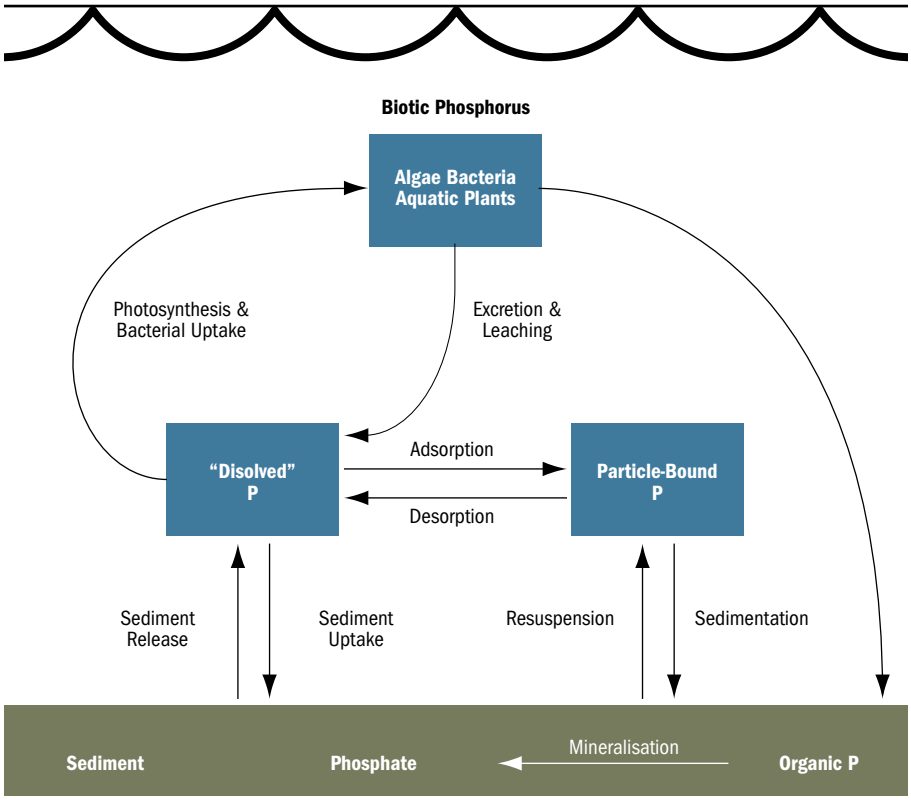
- Total Nitrogen (TN)
- Ammonium (NH_4^+) concentration
- Combined nitrate (NO_3^-) and nitrite (NO_2^-), expressed as (NO_x) concentration
- Total Kjeldahl Nitrogen (TKN).

A monitoring program must be developed that details the parameters to be sampled and the frequency of sampling. This monitoring program must be approved by the relevant authority. It will help build a better understanding of the constructed lake behaviour and potentially be used to refine the lake management.

APPENDIX 1 - Flow Chart of Approval Process



APPENDIX 2 - Phosphorus Cycling in the Aquatic Environment

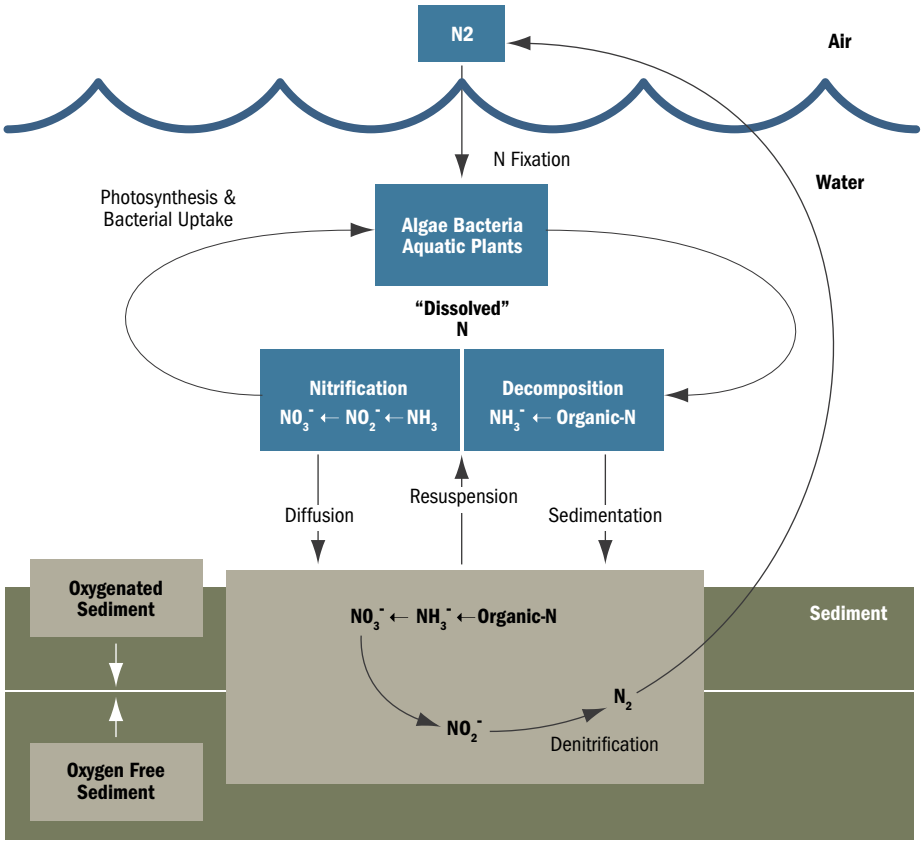


In the aquatic environment, phosphorus undergoes cycling where it is taken up by living organisms and ultimately excreted or remineralized upon the death of the biota. Phosphorus can also be either adsorbed or desorbed from suspended particles and/or the sediment.

Higher trophic levels (e.g. zooplankton, invertebrates and fish) have been omitted from the diagram for clarity but are important in the cycling process. It is also important to note that the time scale of various parts of this cycle may vary enormously – from hours in cycling through water column bacteria up to years for release from sediments.

In freshwater lakes, phosphorus is typically the limiting nutrient, meaning that algae deplete all available phosphorus before depleting other nutrients. Therefore, phosphorus levels often regulate the abundance of algae. In saline and brackish systems, nitrogen however is more likely to be the limiting nutrient.

APPENDIX 3 - Nitrogen Cycling in the Aquatic Environment



Nitrogen can be removed from the aquatic ecosystem as a totally inert product, nitrogen gas (N_2). This removal is carried out by bacteria and is called denitrification. Denitrification is the only true sink for nitrogen as the gas is lost to the atmosphere.

As illustrated in this figure, ammonia arising from the decomposition of organic matter is converted to nitrate (NO_3^-) during the multi-step nitrification process. Nitrification, also carried out by bacteria, requires the presence of oxygen and hence occurs primarily in the water column and at the interface between the water and sediments where bacterial populations are generally high. However, the conversion of nitrate to nitrogen gas (denitrification) requires the absence of oxygen, and occurs predominantly in the subsurface sediments.

The forms of nitrogen most readily taken up by biota (bioavailable) are the dissolved inorganic species NO_x (NO_3^- + NO_2^-) and ammonia.

Higher trophic levels have been omitted from the diagram for clarity purpose.

APPENDIX 4 - Basic Lake Ecology

This section helps to explain some of the basic ecological principles that should be considered in the lake design.

Lake biology can be broadly divided based on the organism's biological function within the water body:

- **Primary Producers (Algae and Rooted Macrophytes)**

  Primary producers form the lowest order in the food chain. Their growth is largely controlled by the amount of sunlight and available nutrients in the water column.

  Microscopic forms of algae that float in water are called phytoplankton. Blue green algae (or cyanobacteria) are often classified as part of the phytoplankton despite the fact that these micro-organisms are bacteria. However, like algae, they rely on sunlight for energy. Algae that occur in larger forms are called macro-algae. Macro-algae can be free floating moving with wind and currents similar to phytoplankton or attached to any substrate in the lake. Rooted macrophytes are large aquatic plants, either emergent or submerged.

- **Consumers**

  Primary consumers such as zooplankton graze on algae, bacteria, detritus (partially decayed organic material) or predate on other zooplankton. Secondary consumers, such as planktivorous fish or predaceous invertebrates, predate on zooplankton and tertiary consumers that prey on smaller fish include larger fish and other carnivorous animals.

- **Decomposers**

  Decomposers include fungi, bacteria and other organisms that feed on the remains of aquatic organisms and decaying organic matter. The decomposition process does contribute to oxygen depletion, and in extreme cases can lead to anoxic conditions.

Organisms in a lake can be broadly classified according to their mobility:

- **Organisms that are highly mobile**

  This includes fish, amphibians, turtles, larger zooplankton and insects. These organisms will move to utilise preferred habitat areas in the lake.

- **Organisms that drift with water currents and wind**

  This includes bacteria, micro and macro algae and zooplankton. These organisms tend to move with the water currents and impacts from water reticulation systems will need to be considered.

- **Organisms that live on (or in) the lake bottom**

  This includes bacteria, fungi, submerged plants and invertebrates (such as worms and molluscs).

Who we are

Melbourne Water is owned by the Victorian Government. We manage Melbourne's water supply catchments, remove and treat most of Melbourne's sewage, and manage rivers, creeks and major drainage systems in the Melbourne region.

We are a significant business, managing $8.1 billion of natural and built assets.

An independent Board of Directors is responsible for the governance of Melbourne Water. The responsible Minister is the Minister for Water.

Our people have diverse skills and expertise and we place a high priority on building strong partnerships and relationships with the community and all our other stakeholders. Our customers include the metropolitan retail water businesses, other water authorities, local councils and the land development industry.

Melbourne Water®

Melbourne Water
100 Wellington Parade, Melbourne 3002
PO Box 4342 Melbourne, 3001
Telephone: 131 722 Facsimile: 03 9235 7200
www.melbournewater.com.au

November 2005

For information on Melbourne's water resources in languages other than English, call 131 722 or visit www.melbournewater.com.au and click on the Community Languages link.

SOUTHERN Rural Water

GROUNDWATER LICENCE APPLICATION FORM

Water Act 1989, Section 51, 58, 62
Licence to take and use groundwater and to operate works.

This Groundwater Licence Application Form is to be completed by a person who has access to groundwater through a bore or well and wants to take and use the water for any purpose other than domestic and/or stock. Groundwater licences are issued for a maximum period of up to fifteen years.

Before you begin completing this Form, please read the accompanying Fact Sheet and Fee Schedule. Your cheque or money order must accompany this Form.

On completing the Form, please check the details you have provided as any missing information can delay the application and incorrect information may result in the licence being revoked. Send this Form, the photocopied map showing the location of your bore(s) and your payment to Southern Rural Water, PO Box 153, Maffra 3860.

If you have any questions or concerns about your application, phone us on 1300 139 510.

Please identify if you are applying for a new groundwater licence or wanting to change or amend an existing licence.

☐ New licence

☑ Change to existing licence(s)

☑ Increase entitlement

☐ Amalgamate existing licences

Your existing groundwater licence number(s) 9037910

☐ Renew existing licence

☐ Other *(please specify)* _____

1. Applicant's details (Name to appear on Licence)

PLEASE COMPLETE ONE OF THE OPTIONS BELOW. These details will be documented on your groundwater licence, if approved. If you are changing or amending your existing groundwater licence, the name(s) must be the same as those detailed on your current licence. All correspondence from us will be sent to this postal address. All parties shown must sign the declaration in Section 6 of this form.

OPTION 1:

1. Title: _____ Surname: _____ Given Name(s): _____

2. Title: _____ Surname: _____ Given Name(s): _____

(If more than two individual applicants please attach on a separate page).

OR OPTION 2:

Company/Business/Trading Name: MELBOURNE WATER

Company Contact Person: TIM SEIPOLT

Position within Company: PROGAM LEADER OF PRECEPT AREAS

Postal Address: PO BOX 4342, MELBOURNE, VIC, 3001

Street Address: _____

Telephone Number: 09784 6467 Mobile: 0429 454 522

Facsimile Number: _____ Email: TIMOTHY.SEIPOLT@MELBOURNEWATER.COM.AU

2. Proposed use

All applicants must provide details about how the groundwater is to be used.

☐ Domestic and/or stock

☐ Urban supply ☐ De-watering ☐ Disposal

☐ Irrigation ☐ Dairy ☐ Commercial ☐ Industrial supply

Area to be irrigated (hectares) _____ Type of crop _____

☑ Other *(please specify)* WATER RENEWAL & TREATMENT FOR WATER QUALITY ISSUES IN PATTERSON LAKES "QUIET LAKES"

3. Bore details

To add, remove or amend existing bore details, you need to list the bore number(s) here and highlight them on your property sketch. If you don't know the exact number(s), identify them with site identifiers such as A, B, C and use these same identifiers on your sketch.

Bores to be added	**Bores to be removed**	**Bores to be amended**
Bore number _____	Bore number _____	Bore number S903 7940/1
Bore number _____	Bore number _____	Bore number _____
Bore number _____	Bore number _____	Bore number _____

If you are adding a bore(s) please provide the following information. It will be detailed on the Bore Completion Report, provided by your driller. If you don't have a copy of the report, please provide as many details as you can. You will also need to complete extraction rate details. See Note 3. Remember, bore yield is the maximum volume per day that your groundwater source is capable of delivering.

Bore Construction Licence number(s) S903 7940

Year(s) constructed (if known) 2010

Bore yield(s) (ML/day) 5 ML

☑ Drilled bore ☐ Spear point ☐ Dragline hole* ☐ Dug well or shaft*

Bore depth 80 * Length and width (metres) _____

Bore casing (steel/PVC and class) _____

Bore diameter (mm) ☐ 50mm ☐ 100mm ☐ 150mm ☐ 200mm ☐ 250mm ☐ 300mm

Location Coordinates (See Note 7) ☐ AGD 66 ☐ GDA 94 ☐ Other, please specify _____

Easting _____ Northing _____ Zone _____

4. Quantity to be extracted from each bore

Please provide bore use details as well as proposed daily and annual volumes to be extracted from each bore. Two examples are provided for your reference.

- ***If you are applying for a new licence,*** *you need to provide details of proposed daily and annual volumes. These can be shared between bores or allocated to an individual bore. See examples below and Note 3.*
- ***If you are amending an existing licence,*** *you must include the bores that are to remain on the licence as well as any new bores that are to be added.*

If your application is approved, your licence will detail your bore information, as shown below.

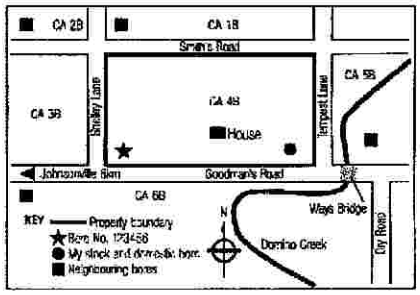
Bore number	Maximum rate (ML/day)	Maximum volume (ML/day)	Maximum volume (ML/annum)	Type of use
Example 1 123456	0.05	0.01	1.2	Dairy
Example 2 S632112/01 GMS-999	2.00 2.00	1.00 1.00	200.0	Irrigation
S903 7940/1	3.4	3.4	730	OTHER-

5. Property and location of proposed or existing bore(s)

Please highlight the general location of the property on a photocopy of a VicRoads, Melways or CFA map. Then, using the picture at right as a guide, use different colours or symbols to identify:

- *the location of all existing bore(s) on the property*
- *your property boundaries*
- *the location of neighbouring bores not owned by you.*

Specific property details can be found on a Certificate of Title or Council rates notice



Property address: _____

_____ Postcode: _____

Lot number: _____ Plan number: _____ Allotment: _____

Section: _____ Parish: _____ Volume: _____ Folio: _____

REFER BORE CONSTRUCTION REPORT

6. Applicant's declaration

ALL APPLICANTS LISTED IN SECTION 1 MUST SIGN THIS DECLARATION.

I/we, the undersigned certify that the information provided in this Groundwater Licence Application Form is true and correct.

I/we understand that this information may be referred to other organisations and/or advertised as part of our application and assessment process or released if reasonably required by government business, requested by lawful orders, or in the public interest - particularly in regards to the open disclosure of generally collected water entitlements.

Applicant's signature: _____ Date: 26/5/10

Please print name: TIM SEIBOLT.
AND POSITION WITHIN COMPANY IF APPLICABLE

Applicant's signature: _____ Date: 26/5/2010

Please print name: NATHAN ACKLAND - PROGRAM LEADER, Maintenance South East
AND POSITION WITHIN COMPANY IF APPLICABLE

Remember, the person who signs on behalf of the company in Section 6 of this form, must be authorised to do so, such as a Company Secretary or Director. Southern Rural Water will take no liability if this form is signed by a person who is not authorised to do so.

GW13
November 1990

Rural Water Commission of Victoria

WATER ACT 1989

Sections 51 and 67

GROUNDWATER LICENCE No 7003704

(Licence to take and use groundwater from a bore and to operate works)

The Rural Water Commission of Victoria authorises:

MELBOURNE WATER CORPORATION
208 PRINCES HIGHWAY
DANDENONG 3175

To take and use groundwater from the bore or bores specified in the First Schedule and to operate works for that purpose and subject to the conditions in the Second Schedule

This licence is valid for a period of 15 years from 1 September 1990

Authorising Officer
Date 19/11/91

FIRST SCHEDULE

1. Type of use MISCELLANEOUS

2. Total Annual Volume 20.0 megalitres

3. Area to be irrigated - hectares

4. Land on which the water is to be used as bordered red on the attached plan

Lot(s) -
Allotment(s) PT OF ALLOTS 100 AND 104
Parish/Township LYNDHURST
Plan of subdivision no. 99475
Section -

5. Annual fee at date of issue $ 35.00

6. Quantities to be extracted from each bore

Bore no	Type of use	Maximum rate of extraction megalitres/day	Maximum volume to be extracted per day megalitres	Maximum volume to be extracted per annum megalitres
3025/10043	MISCELLANEOUS	2.0	2.0	20.0

Southern Region, Rural Water Commission of Victoria
590 Orrong Road Armadale 3143

All communications should be addressed to:

Rural Water Commission of Victoria

MEMORANDUM

To: John Couche (R.M.S. Southern). Con. No: GWL/7003704.

From: Frank. Cramers. Date: 29-7-91

Subject: Dandenong Valley Westernport Authority, Re-usage from bore 3025/10043. Office/Branch: Koo-Wee-Rup.

I have been advised by Mr Ken Connor Ex. Engineer of D.V.W.P.A, that bore 3025/10043 is only used during the summer months to top up ornamental lake, due to evaporation and seepage loss that occur

Records kept, indicate that bore usage on average over past five years is that pump has been in operation for 350 hours per year with extraction rate of 409 litres per minute. Therefore 350 hours (15 days) X 409 litres (0.58 ML/d) = annual volume of 8.82 ML or 9 ML.

I questioned Mr Connor on why the Authority held annual licence authorising 730 ML, but usage only averaged about 9 ML. His response was that in his opinion the developer of the lake may initially applied for volume of 730 ML to fill lake; but once filled from bore its level is maintained by run off, and then only topped up during summer.

I therefore recommend that consideration be given to reduce annual volume entitlement from 730 ML to say 10 to 20 ML.

Frank. Cramers
Diversion Inspector

GW. 13A

GROUNDWATER ACT 1969

GROUNDWATER LICENCE No. 3704

State Rivers and Water Supply Commission (hereinafter called " the Commission ") pursuant to the powers conferred by the *Groundwater Act* 1969 hereby authorizes [illegible] FTY. LTD.

of [illegible] (hereinafter called " the licensee ") subject to the conditions contained in the Second Schedule during Fifteen (15) years from the first day of September One thousand nine hundred and seventy-five to extract groundwater from the bore specified in the First Schedule.

Dated the Twenty-fourth day of February, One thousand nine hundred and seventy-six.

By direction of the Commission.

Secretary,
State Rivers and Water Supply Commission.

FOR ENDORSEMENT SEE BACK OF DOCUMENT

FIRST SCHEDULE

1. Annual fee : $12.00
2. Bore No. : 1015/66 located in the position marked " A " on the plan annexed hereto.
3. Type of use : Recreational.
4. Land on which water is to be used (hereinafter called " the said land ")—Lot [illegible] plan of subdivision No. 99475 part of allotment s 100 [illegible] section [illegible] town or township of [illegible] parish of Lyndhurst.
5. Quantities to be extracted :
   Maximum rate of extraction : 2.0 megalitres/day gallons per hour.
   Maximum amount to be extracted per day 2.0 megalitres gallons.
   Maximum amount to be extracted per annum 730 megalitres acre-feet/gallons.

GW13
November 1990

Rural Water Commission of Victoria

WATER ACT 1989

Sections 51 and 67

GROUNDWATER LICENCE No 7003704

(Licence to take and use groundwater from a bore and to operate works)

The Rural Water Commission of Victoria authorises:

MELBOURNE WATER CORPORATION
208 PRINCES HIGHWAY
DANDENONG 3175

To take and use groundwater from the bore or bores specified in the First Schedule and to operate works for that purpose and subject to the conditions in the Second Schedule

This licence is valid for a period of 15 years from 1 September 1990

Authorising Officer
Date 19/11/91

FIRST SCHEDULE

1. Type of use MISCELLANEOUS

2. Total Annual Volume 20.0 megalitres

3. Area to be irrigated - hectares

4. Land on which the water is to be used as bordered red on the attached plan

Lot(s) -
Allotment(s) PT OF ALLOTS 100 AND 104
Parish/Township LYNDHURST
Plan of subdivision no. 99475
Section -

5. Annual fee at date of issue $ 35.00

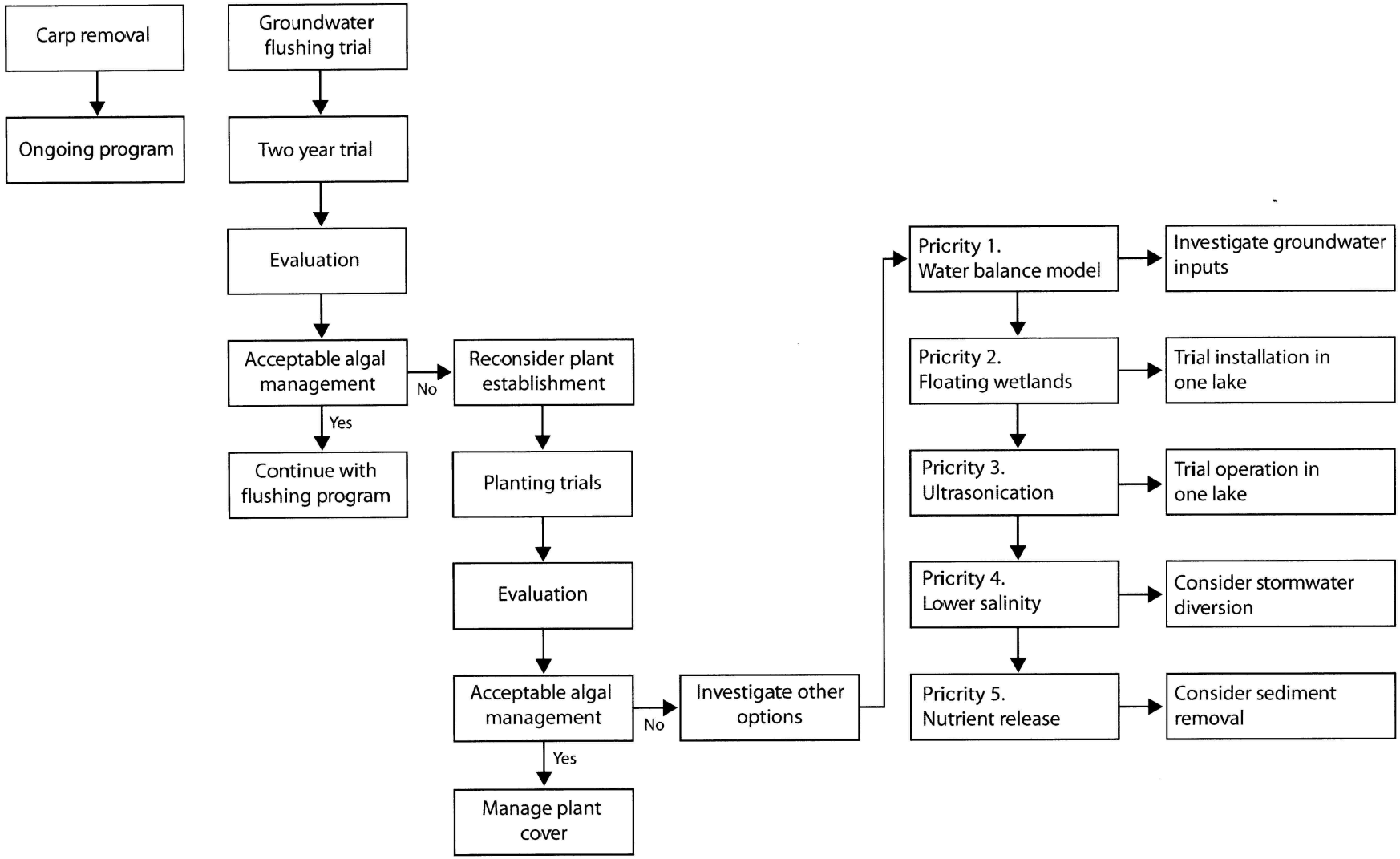
6. Quantities to be extracted from each bore

Bore no	Type of use	Maximum rate of extraction megalitres/day	Maximum volume to be extracted per day megalitres	Maximum volume to be extracted per annum megalitres
3025/10043	MISCELLANEOUS	2.0	2.0	20.0

Southern Region, Rural Water Commission of Victoria
590 Orrong Road Armadale 3143

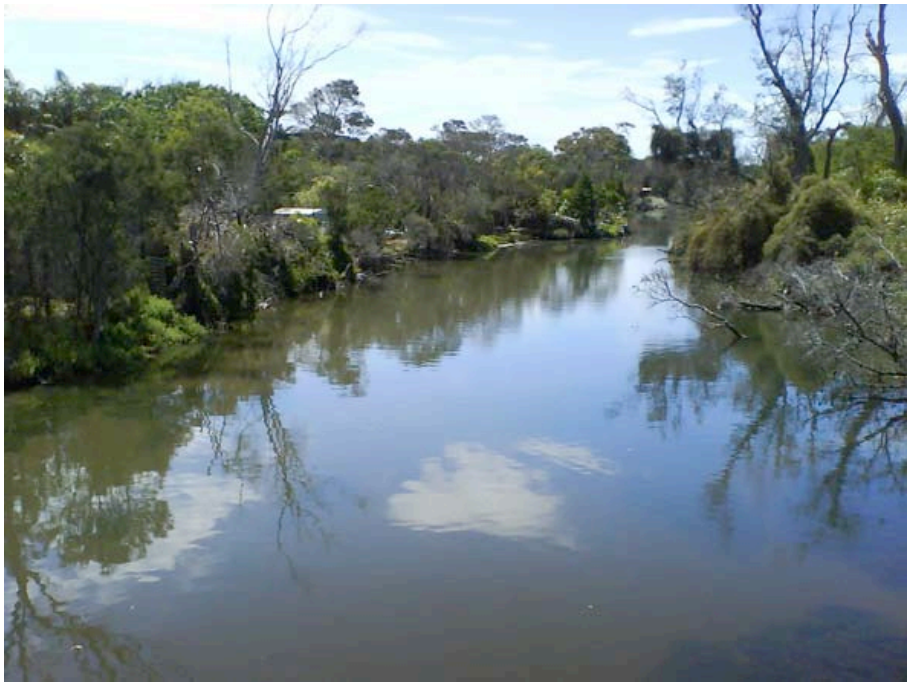
All communications should be addressed to:

Figure 10. Proposed implementation plan for improving water quality within the Quiet Lakes.



FINAL

Kananook Creek Corridor Management Plan



Prepared for
Melbourne Water and **Frankston City Council**

by

Thompson Berrill Landscape Design Pty Ltd
in association with Aquatic Systems Management Pty Ltd, Bushland Management Services and Environment & Land Management Pty Ltd

JULY 2009

TABLE OF CONTENTS

		Page No.
	ACKNOWLEDGEMENTS	
	GLOSSARY	
	EXECUTIVE SUMMARY	
1.	**INTRODUCTION**	**1**
1.1	Project scope	1
1.2	Project aim	1
1.3	Draft objectives	1
1.4	Project methodology	2
1.5	Relevant strategies and polices	2
2.	**BACKGROUND INFORMATION**	**12**
2.1	Regional context	12
2.2	Local context	15
2.3	Open space and recreation	16
2.4	Geology and geomorphology	17
2.5	Drainage and flood management	17
2.6	Flow management and water quality	18
2.7	Flora and fauna	19
2.8	Cultural heritage and historical values	22
2.9	Land Use	24
2.10	Community consultation	25
2.11	Management responsibilities	27
3.	**ISSUES AND ACTIONS APPLICABLE TO ALL REACHES OF KANANOOK CREEK**	**31**
3.1	Introduction	31
3.2	Land use	32
3.3	Drainage and flood management	35
3.4	Water quality	37
3.5	Stream system values	39
3.6	Vegetation	40
3.7	Recreation and community use	42
3.8	Cultural heritage and historical values	45
4.	**REACH DESCRIPTION, ISSUES AND ACTIONS**	**47**
4.1	Reach 1 - Mornington Peninsula Freeway to Eel Race Road	48
4.2	Reach 2 - Eel Race Road to Armstrongs Road	55
4.3	Reach 3 - Armstrongs Road to Seaford Road	62
4.4	Reach 4 - Seaford Road to Mile Bridge	70
4.5	Reach 5 - Mile Bridge to Wells Street	77
4.6	Reach 6 - Wells Street to Port Phillip Bay	84
4.	**IMPLEMENTATION**	**91**
4.1	Summary	91
4.2	Actions by priority	91
	REFERENCES	**103**

Page No.

DRAWINGS **105**

Existing Condition Plans

KCMP-01 Existing Conditions Plan Reach 1
KCMP-02 Existing Conditions Plan Reach 2
KCMP-03 Existing Conditions Plan Reach 3
KCMP-04 Existing Conditions Plan Reach 4
KCMP-05 Existing Conditions Plan Reach 5
KCMP-06 Existing Conditions Plan Reach 6

Existing Vegetation Communities Plans

KCMP-07 Vegetation Communities Plan Reach 1
KCMP-08 Vegetation Communities Plan Reach 2
KCMP-09 Vegetation Communities Plan Reach 3
KCMP-10 Vegetation Communities Plan Reach 4

Management Plans

KCMP-11 Management Plan Reach 1
KCMP-12 Management Plan Reach 2
KCMP-13 Management Plan Reach 3
KCMP-14 Management Plan Reach 4
KCMP-15 Management Plan Reach 5
KCMP-16 Management Plan Reach 6

LIST OF FIGURES

Figure 1 Kananook Creek Regional Context Diagram 12

Figure 2 Kananook Creek Catchment Diagram *Source: Melbourne Water* 14

Figure 3 Map of Frankston 1927 *Source: Stories of Kananook Creek by JA Douglas* 17

Figure 4 Map of Reach breakdowns for Kananook Creek Corridor Management Plan 47

Figure 4.1-1 Eel Race Drain Mornington Peninsula Freeway to Kananook Creek Pump Station *Extract from Drawing KCMP-11* 48

Figure 4.1-2 Eel Race Drain Kananook Creek Pump Station to Eel Race Road *Extract from Drawing KCMP-11* 48

Figure 4.2-1 Kananook Creek Eel Race Road to Armstrongs Road 2 *Extract from Drawing KCMP-12* 55

Figure 4.3-1 Kananook Creek Armstrongs Road to Station Street *Extract from Drawing KCMP-13* 62

Figure 4.3-2 Kananook Creek Station Street to Seaford Road *Extract from Drawing KCMP-13* 62

Figure 4.4-1 Kananook Creek Seaford Road to McCulloch Avenue *Extract from Drawing KCMP-13* 70

Figure 4.4-2 Kananook Creek McCulloch Avenue to Mile Bridge *Extract from Drawing KCMP-13* 70

Figure 4.5-2 Kananook Creek Mile Bridge to Wells Street *Extract from Drawing KCMP-15* 77

Figure 4.6-1 Kananook Creek Wells Street to Port Phillip Bay *Extract from Drawing KCMP-16* 84

APPENDICES

A Kananook Creek Corridor Management Plan Waterway Geomorphology, Flow Management, Water Quality and Habitat Issues, prepared by Aquatic Systems Management Pty Ltd, Feb 2007

B Overview of Vegetation Condition and Management Issues for Kananook Creek - Discussion Paper, prepared by Bushland Management Services, Jan 2007

C List of bird species, extract from 'Flora and Fauna Surveys of Kananook Creek Reserve by Hans Brunner and Bev Courtney, Nov 1999

ACKNOWLEDGEMENTS

The project team would like to thank the Project Partners Working Group who have attended meetings and contributed to the development of the Draft Issues and Actions Paper including:

Melbourne Water

Matt Francey	Manager, River Health team (December 2007 - current)
Jamie Ewert	Team Leader, Waterway Improvement (South East), River Health team
Greg Bain	Team Leader, Waterway Improvement (South East), River Health team
Joanne Thom	Senior Waterway Planner, Waterway Improvement (South East), River Health team
Joanna Frame	Waterway Planner, Waterway Improvement (South East), River Health team
Sophie Bourgues	Aquatic Scientist, Waterway Improvement (South East), River Health team
Phillip Neville	Manager, Floodplain Services (October 2007 – current) Former Manager, River Health team (to October 2007)
Keith Boniface	Section Leader, Investigations and Surveys
Rod Watkinson	Team Leader, Floodplain Mapping and Mitigation
Mark Warren	Drainage Engineer, Floodplain services
Kate Kinsella	Team Leader, Developer Services
George Lattouf	Senior Town Planner
George Tsemtsidis	Team Leader, Asset Services
Nathan Ackland	Civil Maintenance Systems
Deane Anderson	Civil Maintenance Systems
Peter Damen	Civil Maintenance Systems
Mark Scida	Civil Maintenance Systems

Frankston City Council

Libby Anthony	Environment Manager
Julie Bright	Former Environment Protection Officer, Infrastructure Team (between September and December 2006)
Narelle Chambers	Former Environment Protection Officer, Infrastructure Team (from January to December 2007)
Jenny Symons	Former Environmental Planner (September 2006 to July 2008)
Nathalie Smallman	Environmental Planner
Craig Hinton	Biodiversity Coordinator
Damien O'Kearney	Urban Designer
Glenn Aitken	Councillor & former Mayor (2007)
Kevin Van Boxtel	Former Urban Strategy Manager
David Gray	Open Space Coordinator
Ken Poulier	Engineering Development Coordinator
Kevin Alexander	Natural Reserves Team Leader
Ossie Martinz	Infrastructure Manager
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Nick Charalambakis	Urban Strategy Manager
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Tom Walsh	Fire Management Officer
Elizabeth Bensz	General Manager Development
Louise Bugiera	Governance Services Coordinator
Michael Craighead	Governance and Customer Relations Manager

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Agencies

Robert Medley	Environment Protection Authority
Rebecca Cohn	Kingston City Council
Wade Bland	Port Phillip and Westernport Catchment Management Authority
Phillip Wierzbowski	Department of Sustainability and Environment

Ian Ellis	Parks Victoria
Michelle (on behalf of Caroline Briggs)	Victorian Boonerwrung Elders Land Council

Community organisations and individuals (alphabetical by organisation)

Peter Buckley	Atlas Boat Hire Company
Barry Priestley	Former Frankston Boat Owners and Anglers Club
Bruce Waixel	Frankston Boat Owners and Anglers Club
Bob Maughan	Frankston Business Chamber
Rod Butcher	Frankston Yacht Club
Glenn Firth	Friends of Seaford Foreshore
Olwen Bawden	Kananook Creek Association
Robert Thurley	Kananook Creek Association
Chris Arkell	Local Resident
Sandy Arkell	Local Resident
Nick Clark	Local Resident
John Curran	Long Island Residents Group
Eve Welch	Long Island Residents Group
Daniel Dew	Patterson River Secondary College
Robin Date	Seaford Football Club
Kerrie Douglas	Seaford Primary School
Tony Scott	Seaford Scouts
Allan Howes	Seaford Village Traders Association

GLOSSARY

The Glossary of terms and abbreviations listed below are described as used specifically in this Issues and Actions Paper.

Abbreviation/Term	Definition in this Paper
ARI	The Average Recurrence Interval that is defined as the average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration.
Associated terrestrial vegetation	For the purposes of this report this term refers to vegetation on the land side of the riparian zone that is above the mapped floodplain (LSIO) and forms an integral part of the vegetation habitat corridor.
Bank	A term for the margin of the river best marked where a channel with distinct sides has been cut into the floor of a valley by a stream with powers of vertical erosion (Monkhouse, 1978).
BFC	Boon Wurrung Foundation Limited
BLCAC	Bunurong Land Council Aboriginal Corporation
CAD	Central Activities District for Frankston (Also referred to as PAC in State planning documents such as Melbourne 2030. Refer to PAC in this glossary)
DDO	Design and Development Overlay in the Frankston Planning Scheme
DPI	Department of Primary Industries
Ephemeral stream/wetlands	Temporary or intermittent water bodies
EPA	Environment Protection Authority Victoria
ESO	Environmental Significance Overlay in the Frankston Planning Scheme
Eutrophic	Applied to an environment (e.g. lake or waterway) rich in plant nutrients, and hence with a great abundance of plant and animal organisms.
EVC	Ecological Vegetation Classes
FCC	Frankston City Council
Floodplain	The area of a river or watercourse valley, adjacent to the watercourse channel, which is covered with water when the river overflows its banks during floods (Monkhouse, 1978).
GPT	Gross Pollutant Trap is a structure used to trap large pieces of debris (greater than 5mm) transported through the stormwater system.
KCA	Kananook Creek Association
KCC	Kingston City Council
KCLC	Kananook Creek Liaison Committee
LSIO	Land subject to Inundation Overlay in the Frankston Planning Scheme
Macrophyte	Aquatic plant large enough to be seen easily with the unaided eye such as mosses, ferns or rooted plants.
MW	Melbourne Water Corporation
PAC	As part of the hierarchy of Activity Centres, PACs are larger centres with a mix of activities that are well served by public transport (eg. Box Hill, Knox City, Frankston). The size and/or location of PACs mean that they have an especially important role to play as a focus for community activity, services and investment. Melbourne 2030 identifies them as a location for priority government investment and support. At a local level the Council staff commonly refer to PAC as the CAD or Central Activity District.
PCRZ	Public Conservation and Resource Zone

Abbreviation/Term	Definition in this Paper
PPRZ	Public Park and Recreation Zone
PV	Parks Victoria
Ramsar	The town in Iran where an International Convention on Wetlands was held in 1971 for the protection of wetlands around the world as habitat for international migratory waterbirds. Wetlands of International Importance are listed under this Convention that places an obligation on the country to ensure the listed sites are managed to maintain their ecological character.
Ramsar Convention	This Convention places an obligation on countries to ensure that listed wetlands for habitat for international migratory waterbirds are managed to maintain their ecological character. The Government of Victoria is responsible for ensuring the Australian Government's commitments are met for the Ramsar listed wetlands in Victoria.
Riparian zone	The land that adjoins or directly influences a water body and includes land immediately alongside creeks and rivers including the riverbank itself, gullies and dips which sometimes run with surface water, wetlands on river floodplains that interact with the river in times of flood, and areas surrounding lakes (LWDRC, 1996).
SEPP	State Environment Protection Policy. A SEPP is a policy declared by the Victorian Government under Section 1b of the Environment Protection Act 1970. It provides a framework for protecting a nominated component of the environment (e.g. 'surface waters'). It identifies beneficial uses of the environment, environmental indicators that can be used to assess the state of those beneficial uses and a program of actions to protect those beneficial uses. There are different SEPPs for different parts of the environment. The EPA Victoria administers the SEPP.
SWMP	Stormwater Management Plan. All municipalities have a Stormwater Management Plan to guide future improvements to urban stormwater quality with an integrated approach.
Waterway corridor	The corridor of land along the waterway including the waterway itself, the riparian zone and associated floodplain. This includes the public reserves within the creek corridor and the adjoining private property, where it directly adjoins the creek.

EXECUTIVE SUMMARY

Purpose of the plan

At the initiation of the Kananook Creek Liaison Committee, Frankston City Council and Melbourne Water have jointly prepared the Kananook Creek Corridor Management Plan with advice from the Kananook Creek Liaison Committee, the Kananook Creek Reference Group, the Kananook Creek Association and the broader community. This Plan is aligned with current policies, work practices and community expectations and will guide the future direction for works in the Kananook Creek corridor over the next 15 years. This Management Plan replaces the 1992 Kananook Creek Management Plan.

Study area

The study area includes 2.1 kilometres of Eel Race Drain (downstream of the Mornington Peninsula Freeway) and 7.4 kilometres of Kananook Creek extending from Patterson Lakes in the north to Frankston in the south. Seaford Wetlands and the Seaford Foreshore are major areas of environmentally significant open space in close proximity to Kananook Creek, and contribute to the overall regional context, existing and potential values of the Kananook Creek corridor.

Objectives

Melbourne Water and Frankston City Council have developed the objectives with consideration of the findings from community consultation and scientific research undertaken during the project. All the objectives are of equal priority and importance.

- Achieve sustainable management of this modified creek that protects and, where possible, improves the environmental, economic and social values (including recreational and cultural heritage) of the Kananook Creek corridor.
- Protect and interpret Aboriginal cultural heritage values and historical values.
- Continue to investigate opportunities to improve water quality.
- Improve appropriate recreational use and access to the Kananook Creek corridor compatible with environmental and waterway values.
- Continue to recognise and involve the community in the preparation and implementation of this Management Plan.
- Protect where appropriate and improve habitat corridor values by achieving continuity of the riparian corridor between Mornington Peninsula Freeway and Beach Street.
- Further encourage and educate landholders within the waterway corridor to undertake land management practices consistent with the objectives of this Management Plan.
- Adjoining land use and development to complement the environmental, recreational and landscape values of the Kananook Creek corridor.
- Protect and where possible improve the navigability and amenity of the waterway for small shallow-draft watercraft.

Summary of key issues and actions

Land use

Summary of key issues	Summary of actions to address the issues
• Structures and built form adjacent to the waterway including sheds, fences, jetties, boat ramps, decks, etc can preclude the ability to rehabilitate the riparian zone and associated terrestrial vegetation. • Systems and processes for approvals of jetties, built structures and edge treatments are not clear and timely.	• Introduce planning scheme provisions and enforcement, which covers the riparian zone and associated terrestrial vegetation in Kananook Creek corridor to ensure impacts on environmental values are considered in future planning applications. • Prepare fencing guidelines for the Kananook Creek corridor. • Finalise and promote guidelines for the construction and maintenance of jetties and built structures on the creek banks. • Undertake an audit of jetties and creek bank structures and establish an enforceable regulatory regime for existing structures.
• Loss of riparian and associated terrestrial vegetation leading to loss of in-stream and terrestrial habitat values.	• Revegetate the gaps in the riparian zone on public land and encourage landowners to revegetate private land along Kananook Creek.
• Impact of earthworks and fencing on the flood flows and floodplain capacity.	• Continue to use the Land Subject to Inundation Overlay to manage the floodplain. • Finalise and promote guidelines for the construction and maintenance of jetties and built structures on creek banks.
• Height, bulk and proximity of buildings to the creek impacting on the environmental values and visual amenity of the creek corridor.	• Use Frankston City Council's proposed Neighbourhood Character Guidelines to assist in protecting and improving the visual landscape and recreational values of the corridor. • Investigate the expanded use of he Neighbourhood Character Guidelines to address impacts from development adjacent to the creek. • Investigate the extent of Acid Sulphate Soils along the creek.

Drainage and flood management

Summary of key issues	Summary of actions to address the issues
• Change in catchment size and flood control measures has resulted in a change to creek flow patterns. • Reduction in event flows has reduced the frequency and extent of periodic inundation of the riparian zone and restricted the ability of the creek to maintain its original cross-sectional size.	• Investigate options and feasibility to improve the flow regime in Kananook Creek to provide periodic inundation of the riparian zone and flush out the system.
• Saline flows pumped into Kananook Creek from Patterson Lakes have provided continual base flows, but increased salinity levels. The increased salinity level may be the cause of the progressive change of the riparian vegetation from brackish to saline communities and in-stream habitat conditions.	• Investigate options and feasibility to increase alternative seasonal freshwater flows to Kananook Creek. This may address the periodic cessation of flows, improve water quality by increasing the brackish profile, provide increased seasonal freshwater flows into Seaford Wetlands and reduce the pumped saline flows during late autumn, winter and early spring.
• Potential impact of climate change on the creek and its floodplain.	• Investigate the impacts of climate change on the creek once current studies are complete.

Water quality

Summary of key issues	Summary of actions to address the issues
• Diversion of flows from Patterson Lakes into Kananook Creek has caused increased salinity levels in the creek changing in-stream habitat values and riparian vegetation.	• Investigate options and feasibility to increase alternative seasonal freshwater flows into the system to establish an estuary gradient.
• Elevated contaminant and litter levels associated with urban runoff.	• Incorporate snag maintenance for litter in creek maintenance program where feasible and consistent with river health outcomes. • Investigate capture of pollutants and litter at source. • Plan and implement cost effective systems that will significantly reduce litter and pollutants going into the waterways. • Incorporate Water Sensitive Urban Design into all local government projects in the catchment where feasible. • Ensure new developments meet appropriate standards for stormwater quality through the development approvals process.

Stream system values

Summary of key issues	Summary of actions to address the issues
• In-stream fauna values threatened by lack of shade to the creek, periodic cessation in flows and large macro algal blooms.	• Address the cessation in flows with implementation of actions outlined in the Drainage section. • Investigate means to improve management of large algal blooms in Kananook Creek.
• In-stream fauna values are threatened by lack of shading of the stream due to dieback and removal of terrestrial vegetation.	• Protect in-stream and terrestrial fauna by minimising further loss of indigenous vegetation and revegetation in the waterway corridor.
• Lack of recent data and protection programs for native terrestrial fauna.	• Undertake fauna survey and use data to plan habitat restoration in management of vegetation in the corridor.
• High sediment loads in the creek due to the sandy nature of the catchment impacts on in-stream habitat values.	• Undertake an overall investigation into the environmental issues associated with sedimentation and the feasibility of potential options to address the river health impacts of sediment build up.

Vegetation

Summary of key issues	Summary of actions to address the issues
• Gaps in the riparian vegetation reducing habitat connectivity and function of the riparian and associated terrestrial vegetation.	• Revegetation in the gaps in the riparian zone to improve continuity on both private and public land. • Provide education and support to adjoining landowners in revegetating the riparian zone on their properties. • Provide support and supervision to Kananook Creek Association and other community groups undertaking revegetation works on public land.
• Stressed condition of remnant vegetation and lack of recruitment of indigenous species. • Marinisation of the creek may have potential impact on the condition of remnant vegetation.	• Establish a detailed quadrat and floristic survey to provide a benchmark for long-term changes and adjust species used in revegetation to suit changing conditions.
• Weed invasion threatening the condition of indigenous vegetation.	• Undertake accurate weed mapping on all public land and prioritise control of new and emergent

Summary of key issues	Summary of actions to address the issues
	weeds. These works will build on the existing RRR mapping completed by Frankston City Council. • Remove non-indigenous plantings. • Discourage uncontrolled access through vegetation by improved definition of paths and selective fencing where required.
• The Kananook Creek Association and other community groups have made a valuable contribution to the existing indigenous vegetation values by undertaking regular weed control and revegetation works in the creek corridor.	• Continue to support the Kananook Creek Association and community groups assisting with weed control and revegetation.
• Bushfire management to minimise the potential fire risk that mature vegetation in the waterway corridor poses to adjoining properties.	• Regularly review the fire management program for the creek corridor integrating vegetation conservation and management works.

Recreation and community use

Summary of key issues	Summary of actions to address the issues
• Lack of an accessible, linked and well signed trail along Kananook Creek and Eel Race Drain. • Lack of clarity on the status of trails.	• Prepare a trail network plan that considers all-ability access, pubic safety, environmental values, cultural heritage values, floodplain values and aims to establish a linked trail along the length of the creek and Eel Race Drain. • Determine the status of sections of the trail network, i.e. 'shared use', 'walking only' or 'nature trail' and sign appropriately.
• Open space reserves adjoining the creek lack appropriate diversity of recreational facilities, sympathetic with environmental values, restricting their recreational appeal and use.	• Sensitively improve the quality and diversity of recreational facilities in the open space reserves along the creek and the natural landscape and visual character of creek corridor. • Maximise the opportunity provided by the upgrade of the Kananook Creek Boulevard to improve the visual amenity of the Long Island creek bank and surrounding open space.
• Sediment build up and fallen trees in the creek has reduced its navigability and amenity for small watercraft.	• Improve navigability at Beach Street for canoes by actively managing silt to align with the development of Kananook Creek Boulevard. • Improve safety and navigability by moving or cutting back snags that interfere with canoes. • Investigate long term options for navigability for small shallow-draft watercraft, including developing long term maintenance plan and funding options for this maintenance. • Investigate issues associated with sedimentation and feasibility of potential options to address sediment build up in accordance with Best Management Practice. • Where feasible implement Water Sensitive Urban Design treatments in the catchment to reduce sediment loads entering the creek where feasible. • Refer also to Stream System Values recommendations regarding sediment build up in the Creek.
• The Regional River Health Strategy (RRHS) outlines the management objectives for Kananook Creek. The review of the RRHS will occur in about two years time.	• Council to conduct with the community a Visioning exercise for Kananook Creek to inform the revision of the Regional River Health Strategy to consider environmental, social and recreational aspects of the creek.
• Kananook Creek Association and other community groups promote the recreational use	• Agencies will continue to provide support to Kananook Creek Association and other

Summary of key issues	Summary of actions to address the issues
and understanding of the natural values of the creek corridor by running community education events.	community groups in holding community educational events in the creek corridor including the Celebration Day.
• Existing community groups promote the recreational use and understanding of the natural values of the creek corridor by running community education events.	• Agencies will continue to provide support to community groups holding community educational events in the creek corridor.
• Incremental impact of adjoining development on peaceful enjoyment and use of the creek corridor.	• Refer to land use actions to address impacts of adjoining development on peaceful enjoyment of the creek corridor.

Cultural heritage and historical values

Summary of key issues	Summary of actions to address the issues
• Lack of interpretation of the Aboriginal cultural heritage and archaeological values in the creek corridor.	• Consultation with the Registered Aboriginal Party to determine if future works that involve significant ground disturbance in the corridor require a Cultural Heritage Management Plan. • Consultation with the Registered Aboriginal Party to identify opportunities to integrate interpretation of Aboriginal cultural heritage values in future upgrade works in the creek corridor.
• European historical values in the lower reaches of the creek include the boating and fishing use of the creek and the footbridges, and these require interpretation and protection in future works.	• Prepare a signage plan for the creek corridor, which identifies suitable information and interpretive signage, including where appropriate, Aboriginal cultural heritage values and European historical values.

Implementation

Frankston City Council and Melbourne Water are primarily responsible for implementing the Management Plan over a 15-year timeframe. A number of community organisations assisted in the implementation of the 1992 Plan with the Kananook Creek Association having had a long history of involvement in the creek restoration.

Since 1971, a collaborative approach between the government agencies and the community has been practiced in the restoration of the creek and this will continue via the Kananook Creek Liaison Committee and through other avenues. To maintain and enhance this collaboration, a review of the current Kananook Creek Liaison Committee will be undertaken to maximise its effectiveness and align its purpose to the Management Plan.

The Management Plan will be updated every 5 years through a review of completed actions in consultation with relevant community organisations. Implementation will be influenced by a number of variables including available allocation of funds and the outcomes of future investigations identified in the Plan.

1. INTRODUCTION

1.1 Project scope

The study area for the Kananook Creek Corridor Management Plan includes the entire length of the creek and Eel Race Drain extending from Mornington Peninsula Freeway to the mouth at Port Phillip Bay in Frankston. This includes the waterway, the public reserves and adjoining private property within the creek corridor.

The study is to include:

- an overview assessment of the study area on a defined reach basis including an overall assessment of the issues, constraints and opportunities to improve and enhance the corridor;
- plans developed on a reach basis clearly outlining the various issues and appropriate actions to alleviate the problems;
- tables with issues and actions for each reach consistent with current state, regional and local policies and directions for waterway health and management; and
- prioritised actions for relevant agencies to implement over the next 15 years.

Melbourne Water and Frankston City Council are the two key public management agencies responsible for the creek corridor and are jointly preparing this Management Plan. For a full description of management responsibilities refer to Section 2.11. Private land directly adjoins the waterway in many locations and therefore private land management practices and works have a direct influence on the waterway's health and condition. A key role for the public management agencies is to work cooperatively with the adjoining landholders to achieve the project aims and objectives and to ensure that private development contributes to these.

This new plan is aligned with current policies, work practices and community expectations and will guide the future direction for works in the Kananook Creek corridor over the next 15 years. This Management Plan replaces the 1992 Kananook Creek Management Plan.

1.2 Project aim

The aim of the Kananook Creek Corridor Management Plan is to focus attention on the actions required to manage, remediate and improve stream health for sustainable multi-objective outcomes including improved community use with retention and renewal of as much naturalness as possible.

1.3 Objectives

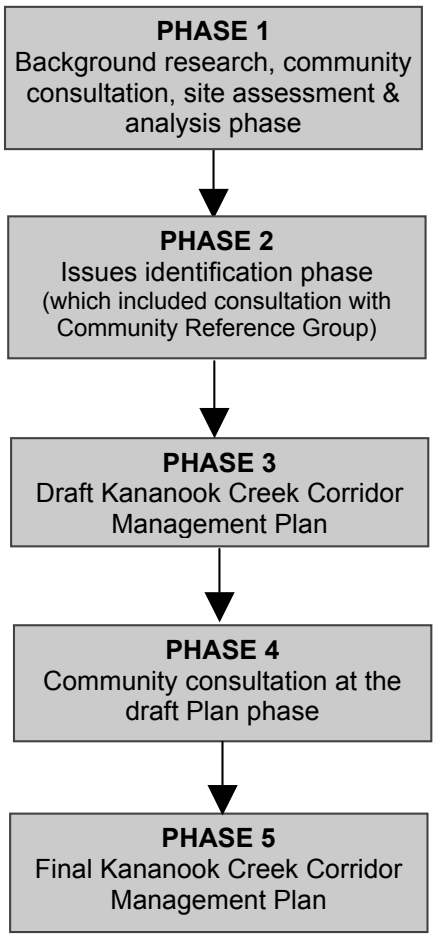
The Project Partners and Consultant team have prepared the Objectives based on the consultation outcomes and findings during the research phase.

- Achieve sustainable management of this modified creek that protects and, where possible, improves the environmental, economic and social values (including recreational and cultural heritage) of the Kananook Creek corridor.
- Protect and interpret Aboriginal cultural heritage values and historical values.
- Continue to investigate opportunities to improve water quality.
- Improve appropriate recreational use and access to the Kananook Creek corridor compatible with environmental and waterway values.
- Continue to recognise and involve the community in the preparation and implementation of this Management Plan.

- Protect where appropriate and improve habitat corridor values by achieving continuity of the riparian corridor between Mornington Peninsula Freeway and Beach Street.
- Further encourage and educate landholders within the waterway corridor to undertake land management practices consistent with the objectives of this Management Plan.
- Adjoining land use and development to complement the environmental, recreational and landscape values of the Kananook Creek corridor.
- Protect and where possible improve the navigability and amenity of the waterway for small shallow-draft watercraft.

1.4 Project methodology

FCC and MW are preparing this Management Plan with comment and input from a Reference Group made up of a number of other Agencies who have some responsibility for specific actions, and community based groups including the Kananook Creek Association and the Kananook Creek Liaison Committee.



1.5 Relevant strategies and policies

1.5.1 Relevant regional strategies

Victorian River Health Strategy (2002)
This Strategy provides the framework in which the Government, in partnership with the community, will make decisions on the management and restoration of Victoria's rivers. The

key objective for the Strategy is to achieve healthy rivers, streams and floodplains that meet the environmental, economic, recreational and cultural needs of current and future generations. The Strategy outlines state wide issues associated with river health, which are addressed at a more local level by the regional strategies. Kananook Creek is located within the Dandenong Creek catchment of the Port Phillip and Westernport region.

Port Phillip and Westernport Regional River Health Strategy (2006)
The Port Phillip and Westernport Region contains approximately 8000 kilometres of rivers and creeks and includes Kananook Creek. There has been significant improvement in recent decades, however, nearly half are in poor or very poor condition. This Strategy provides a five year blueprint for Melbourne Water, the Port Phillip and Westernport Catchment Management Authority, councils, community groups and environmental and industry associations to work together to improve the rivers and creeks. This is an important part of the Port Phillip and Westernport Regional Catchment Strategy, which sets the framework for the overall coordination of natural resource management. Prioritisation of creeks to address as a priority in the region used a process based on the Victorian River Health Strategy (2002). This included:

- degree of public perception/support
- opportunity to improve river health
- multiple benefits
- return of investment
- downstream benefits
- protecting healthy sections of the waterway

According to the Regional River Health Strategy, the Kananook Creek Management Unit is described as:

- *Significance: High*
- *Current condition: Poor*
- *Target: Halt further decline*
- *Current social value: High*
- *Target: High*
- *River Health Program: Prospects for improving environmental condition are low because the creek has been heavily modified. Activities in the next five years will involve the implementation of the local stormwater management plan, protection and enhancement of Seaford Wetlands and maintaining recreation. The long term program will address other risks and improvement in condition is expected in this timeframe.*

Further to the Regional River Health Strategy (2006), an Addendum was developed in 2007 by Melbourne Water to provide further detail and guidance to internal Melbourne Water teams in terms of actions and implementation programs required to meet the objectives of the RRHS.

Linking People and Spaces (2002)
In parallel with Melbourne 2030, Parks Victoria prepared this strategy and vision for the continued growth and improvement of the regional open space network across metropolitan Melbourne. The vision is for *'A linked network of open space for all to enjoy as part of everyday life, preserved and enhanced into the future'*. Relevant to the Eel Race Drain and Kananook Creek corridor include some longer term actions (2012+):

- *Link the Eel Race Drain to Port Phillip Bay at Carrum*
- *Complete gaps along the Bay Trail between Seaford and Frankston*

Melbourne 2030 (2002)
This Metropolitan Strategy plans for sustainable growth of Melbourne over the next 25 years. The main thrust is to continue to protect the liveability of established areas and to increasingly concentrate major change in strategic redevelopment sites such as activity centres and underdeveloped land. While a good supply of land for development will be maintained in growth areas, there will be a shift away from growth on the fringe of the city. For Frankston, the growth is concentrated around the public transport network with Frankston CAD as a Principal Activity Centre (PAC). More information on the development

of Frankston PAC is described in the Frankston TAFE to Bay Structure Plan. The intent is to diversify land use in Activity Centres to include mixed use including residential, commercial, business and retail use. Other broader principles that are relevant to the Kananook Creek Corridor Management Plan are creating attractive, walkable and diverse communities, improving safety in public spaces and improving the environmental health of the bays and their catchments. The Strategy promotes public transport and walking/cycling to reduce reliance on vehicles.

Aboriginal Heritage Act 2006
This legislation came into effect in May 2007 to protect Victorian Aboriginal cultural heritage. The Act created the Victorian Aboriginal Heritage Council, with membership of Traditional Owners, to implement the Act. The Act requires that any high impact activities in culturally sensitive landscapes that could cause significant harm to Aboriginal cultural heritage require the preparation of a Cultural Heritage Management Plan to protect and manage the cultural heritage with involvement of Registered Aboriginal Parties (RAP).

Land and Biodiversity at a time of climate change : Green Paper (2008)
This Green Paper is the second phase in the development of the 'Land and biodiversity at a time of climate change White Paper'. Feedback on this Green Paper will inform the development of the White paper due to be released in the first half of 2009. The Green Paper includes the following:

- outlines that predicted climate change will have a range of serious impacts on ecosystem health and ecosystem services. The rapid change requires a coordinated response from all land managers and owners, and a fundamental shift in the way we design and implement environmental policies
- recognises that over the past 200 years biodiversity has declined due to a number of key threatening processes including: climate change; changing demographics; resource constraints; new technologies; and social change including consumer behaviour
- identifies the vision for Victoria's land and biodiversity: Victorians actively conserving and restoring ecosystems to ensure our land, seas and waterways are healthy, resilient and productive
- includes a range of key outcomes and goals to achieve the vision.

Other strategies and legislation
There is a range of other State Government Strategies and legislation, which guide the overall management of waterways and coastal areas. These include:

- Catchment and Land Protection Act 1994
- Coastal Protection and Management Act 1995
- Victorian Coastal Strategy (2008)
- Victoria's Biodiversity Strategy
- Victoria's Native Vegetation Management : A Framework for Action (2002)
- Our Environment, Our Future (2005)
- Indigenous Partnership Strategy 2001
- Indigenous Partnership Framework 2007-2010
- Indigenous Partnership Framework : Port Phillip Region Action Plan 2006-2008
- Learning to Live Sustainably: Victoria's approach to learning based change for environmental sustainability (2005)
- Our Water, Our Future: The next stage of the Victorian Government's Water Plan (2007)
- Port Phillip and Westernport Regional Catchment Strategy (2004-2009)
- Native Vegetation Plan (2006)
- Draft Strategy for Coastal Acid Sulfate Soils in Victoria (2008)

1.5.2 Relevant local strategies and policies

1.5.2.1 Frankston Planning Scheme

Municipal Strategic Statement (MSS)
North of Mile Bridge the Kananook Creek is highlighted as an area of botanical and zoological significance as part of the linear system associated with the Seaford Foreshore Reserve. Seaford Wetlands adjoining Eel Race Drain is also included as a site of botanical and zoological significance.

The MSS states that development proposals need to address the following:

- identifying and protecting sites of significance
- maintaining the habitat and flood retarding values of waterways and wetlands
- developing appropriate guidelines to ensure environmental and heritage values

Specific actions from the MSS include purchasing the remaining section of the Seaford Wetlands and the few remaining strips of land along Kananook Creek that are in private ownership.

In the Recreation, Leisure and Tourism section of the MSS relevant strategies include identifying land required for passive recreation and other leisure activities including links between parcels of regional open space.

In the Foreshore and Bay section of the MSS the Seaford Foreshore and nearby Kananook Creek reserve are recognised to support regionally significant vegetation and the areas are managed to protect these values. Improvements include links between the Foreshore and other regional open space, and enhancing connections between the Frankston Principal Activity Centre and the foreshore. Specific relevant actions include undertaking works to enhance the area of the foreshore near the Kananook Creek mouth.

Public Conservation and Resource (PCRZ), Public Park and Recreation (PPRZ) and Public Use (PUZ1 and PUZ4) Zones

These zones apply to Kananook Creek and its reserves and indicate public ownership of land. The zones support public access, and use and development consistent with the zone objectives. The PCRZ identifies land with natural values. The PPRZ is an open space zone. The PUZ1 is land owned by Melbourne Water and the PUZ4 is the railway corridor.

Residential 1 Zone (R1Z)

This is the "default" residential zone. The R2Z, which encourages higher densities, is used along parts of Kananook Creek. Following recommendations of the recent Council Housing Strategy, this area is now to be rezoned to R1Z as part of Amendment C24, which was submitted to the Minister for Planning for approval in June 2007. New housing development in the R1Z is governed by Clause 54 (one dwelling on a lot) and Clause 55 (two or more dwellings on a lot). Single dwellings on lots greater than 300 square metres and works normally associated with a dwelling are exempt from permit requirements.

Business 1 (B1Z) and Business 5 (B5Z) Zone

These are the business zones used along Kananook Creek for small activity centres and for the linear business area between Kananook Creek and the Nepean Highway north of the Frankston Principal Activity Centre.

Comprehensive Development Zone (CDZ2)

This is the existing zone in the Frankston Principal Activity Centre on both sides of the mouth of Kananook Creek. This is a zone developed specifically for this area. New provisions for this area will be based on the TAFE to Bay Structure Plan, which is being translated into the planning scheme.

Green Wedge (GWZ) and Urban Floodway (UFZ) Zones

These zones apply to rural land south of Eel Race Drain near the Mornington Peninsula Freeway. Only limited development can occur in these zones. Land was recently purchased by Council as an addition to the Seaford Wetlands. It is likely to be included in the PCRZ to be consistent with the zoning of the balance of Council owned land.

Design Development Overlay 6 (DDO6)

This is a "built form" control that applies to buildings and works on land adjoining the west side of Kananook Creek throughout the north-south creek corridor and the east side of Kananook Creek from Mile Bridge south to a point north of Beach Street. The objectives of DDO6 include the following:

Design Objectives:

- *To protect and enhance the visual amenity of the coastal strip extending from Olivers Hill to Seaford.*
- *To ensure that building height and bulk are compatible with and enhance the appearance and character of the locality.*
- *To ensure that development consists of relatively low rise buildings.*

- *To encourage new buildings, renovations and extensions which are compatible with the form of nearby buildings and sympathetic to the character of nearby natural reserves.*

Within this overlay, buildings will generally be limited to 2 storeys or 6 metres in height. This can be varied to 9 metres with a permit in two locations, north of Mile Bridge and south of Mile Bridge on the east side of Kananook Creek.

Design Development Overlay 5 (DDO5)

This overlay applies to buildings and works on land adjoining the east side of Kananook Creek. The overlay applies to land within the Kananook Creek Precinct of the Frankston Principal Activity Centre, specifically the land between Kananook Creek and the Nepean Highway, and from a point north of Beach Road south to the mouth of Kananook Creek. This overlay was recently amended and is an interim provision only, in effect until 31 October 2009. The objectives of DDO5 include the following:

Design Objectives:

- *To provide for the height of development to scale down from the Transit interchange to the Kananook Creek precinct, to follow the topography of the centre and enable maximum view sharing of the coastal outlook.*
- *To reinforce Beach Street, Wells Street and Playne Street as key pedestrian and visual linkages to the Bay and enhance pedestrian links between the TAFE, transport interchange, activity centre, and creek and foreshore.*
- *To ensure the massing, articulation and spacing of buildings optimises solar access to buildings, adjoining open spaces and key pedestrian routes, and provides for view sharing.*
- *To improve the environmental and visual quality of the public realm and to create attractive and vibrants streets and new public places or connections that encourage pedestrian movement and enhance safety and security.*
- *To encourage the aggregation and integrated redevelopment of sites to facilitate high quality built form and public realm outcomes.*

The specific objective for the Kananook Creek Precinct is:

- *To provide for low to medium scale development along the creek frontage with taller development setback from the creek and at nominated 'gateway' sites; and to ensure development contributes positively to the amenity of the public and private realm with regards to access to sunlight, protection from prevailing winds, engagement with the public realm and connectivity between Nepean Highway and the Creek.*

Buildings and works within the Kananook Creek Precinct are to address and activate the creek frontage, locate the main building mass toward the Nepean Highway with levels above 12 metres setback away from the creek frontage, allowing for gaps between buildings at upper levels, reconfigure service access away from the Creek, and provide public realm improvements, including a new public plaza at Wells Street and a gateway site on the northern and southern most ends of the precinct.

The mandatory maximum building height is 12 metres within 10 metres of the Kananook Creek title boundary. Beyond this, the maximum height is 20 metres except at the northern and southern gateway sites where a discretionary height limit of 26 metres applies.

Environmental Significance Overlay (ESO)

ESO1

This applies to the public land only along the Kananook Creek corridor between Eel Race Road and Mile Bridge, with the exception of RF Miles Reserve, and Mile Bridge. Downstream of Mile Bridge to Beach Street it extends over the creek itself and not the public or private adjoining land. The ESO1 recognises the remnant indigenous vegetation in Frankston and its important contribution to the biological diversity of the City. Council has agreed to implement the findings of the Frankston City Vegetation Study 2006 through the planning scheme and that will result in refinements to the ESO1 boundary, e.g. to include vegetation along part of Eel Race Drain (public land).

The following information is taken from the existing ESO1:

Environmental objective to be achieved
To provide for the implementation of Frankston's local policy for indigenous flora and fauna, particularly to:

- *Ensure that the development and management of land within Areas of Botanical or Zoological Significance as specified in Table 1 and shown on Map 1 to this schedule is compatible with the long term protection and enhancement of their botanical and zoological values.*
- *Protect populations or communities of native plants and/or fauna.*

ESO4

This overlay identifies significant trees and areas of vegetation in Frankston. The reference documents are the Council and National Trust Tree Registers.
The following information is taken from the existing ESO4:
Environmental objective to be achieved

- *To protect and enhance trees and areas of vegetation that have been identified as being significant.*

A permit is only needed if the tree or vegetation is affected or if construction is proposed within the Tree Protection Zone. The decision guidelines call up the Tree Protection Guidelines for Construction Sites, September 2005.

This overlay is interim and does not apply after 31 December 2008.

Special Building Overlay (SBO)

This overlay applies to the eastern side of Kananook Creek between land just north of Seaford Road and Mile Bridge. The SBO indicates stormwater flooding during heavy rain. A permit is required for buildings and works including fences and roadworks, although exemptions may include the following:

- Landscaping, driveway, vehicle crossovers, footpath, bicycle path
- Small building extensions and small outbuildings, and upper story extensions
- Pergola or open deck where the foundations are not enclosed
- Carport
- In-ground swimming pool
- Tennis court
- Open sided verandah, picnic shelter and other open space infrastructure
- Fence with at least 25% openings and a plinth at least 300mm above the flood level

Exemptions generally require that there is no (significant) change to the existing ground surface level or else use of a construction design that does not impede flood flows.

Any planning application must be referred by Council to Melbourne Water as the floodplain management authority under Section 55 of the Planning and Environment Act 1987.

Land Subject to Inundation Overlay (LSIO)

This overlay applies to the section of the creek between the railway bridge and Wells Street and affects both public and private land to the extent of the 1:100 year flood line. A planning permit is required for buildings and works including fences and roadworks, although exemptions include the following:

- A post and wire or post and rail fence
- Footpath, bicycle path, elevated boardwalk
- Pergola
- Carport, hay shed or similar building provided there is no walls
- Tennis court and associated lighting
- Radio mast
- Swimming pool

Exemptions generally require that there is no change to the existing ground surface level.

Under the LSIO Council must refer applications to Melbourne Water as the floodplain management authority under Section 55 of the Planning and Environment Act 1987. As such, all proposed development in the Kananook Creek floodplain must meet Melbourne Water's requirements.

Public Acquisition Overlay (PAO3)

This overlay is over freehold land that has been identified for acquisition by Frankston City Council for the purposes of open space / recreation. This applies to private land on the western side of Kananook Creek immediately upstream of Armstrongs Road and both sides of the creek south of the Mile Bridge. This is to achieve a continuous public open space reserve along the western side of the creek.

Local Planning Policy 22.05
This is a new planning policy (part of Amendment C49) that provides guidance on development in the Frankston Principle Activity Centre. The Kananook Creek Precinct includes land between the Creek and the Nepean Highway, from a point just north of Beach Street to the mouth of the Creek. The objective for this precinct is quoted: "*To create an activated waterfront precinct which becomes a recognised destination for leisure and entertainment, with substantial residential development supported by commercial uses.*" Overall, the emphasis is on orienting development toward the Creek, encouraging new residential and commercial uses, rationalising carparking along the Creek frontage and improving the public realm. A gateway site is envisaged at the northern and southern most ends of the precinct. Wells Street is nominated as a short term priority linkage from the Activity Centre to the foreshore.

Local Planning Policy 22.17
This is a new planning policy (part of Amendment C24) that will be used to implement the Neighbourhood Character Study. The policy applies to Residential 1 areas. The character areas in the Kananook Creek corridor are SF4, SF5, SF7, SF8 and F10. The detailed implementation of preferred character is through the Neighbourhood Character Precinct Brochures. These address building height, massing and setback, materials and vegetation in each of the character areas, encouraging a more sympathetic built form interface with the creek and use of indigenous vegetation.

1.5.2.2 Frankston TAFE to Bay Structure Plan Executive Summary (2005) Cox Architects and Planners
The Victorian State Government identified Frankston as a Principal Activity Centre as part of the metropolitan plan Melbourne 2030. A key strength of Frankston is its substantial civic, commercial and retail hub on the edge of the bay with a major public transport network already in place. The Structure Plan focuses around the Frankston Principal Activity Centre (PAC) and includes revitalisation of the Kananook Creek precinct. Following is the vision from the Structure Plan. The following is a direct quote from this report: *"The redevelopment of the Kananook Creek Precinct will include residential accommodation and limited commercial and retail development generally located along the creek frontage. A landmark building will be located at the southern and northern extremes of the Precinct, marking the arrival at the Frankston PAC for highway travellers. A boardwalk along the creek will connect the new residential tenancies to the foreshore and beyond. Improved pedestrian pathways will connect the new boardwalk to the Nepean Highway and east to the Frankston PAC. The Creek will be enhanced through treatment of its edges with the aforementioned boardwalk on the eastern side and a new 'beach' edge to the foreshore park. Parkland on the foreshore will be improved, with new landscape treatments and rationalised parking throughout the foreshore park.*"

1.5.2.3 Kananook Creek Management Plan (1992) Melbourne Water and Frankston City Council
This original Management Plan has guided the management of Kananook Creek by Melbourne Water and Frankston City Council over the past 15 years. The 1992 plan did not include Eel Race Drain and was prepared prior to the more extensive changes and directions in the past 5 years for future development in Frankston, particularly the Frankston PAC. The Kananook Creek Corridor Management Plan (this document) will replace the 1992 Kananook Creek Management Plan.

Summary of changes between the 1992 Management Plan and this KCCMP

- The KCCMP provides a useful overview of Kananook Creek in a regional context and expands upon the history, cultural and indigenous heritage of the Kananook Creek Corridor captured in the 1992 Management Plan. Many new state and local government policies and strategies have been developed since 1992, which have a bearing upon the way the creek is now managed. The new Management Plan provides a review of all of these relevant strategies.
- The KCCMP provides a more extensive range and a more comprehensive overview of themes, compared to the 1992 Management Plan. Existing conditions of each theme are thoroughly documented with recommended actions assigned to each issue illustrated in a clear format. Responsibilities and a recommended timeline are also assigned to each action.

- Given that agency responsibilities, operations and practise management have changed since 1992, it is appropriate that the KCCMP provides an updated table of management responsibilities of the agencies and authorities involved with the Kananook Creek Corridor.
- Reach definitions – the 1992 management plan described five reaches, however in developing the KCCMP there was an opportunity to incorporate Eel Race Drain as a sixth reach.
- Reach plans were not part of the 1992 management plan, but are a key feature of the KCCMP. There are three different plan types in the KCCMP, illustrating existing conditions, vegetation communities and the Management Plan locating the issues and actions for each reach onto the drawings. These plans represent a good visual management overview of the Kananook Creek corridor.

Summary of works undertaken between 1992 and 2008 by Melbourne Water
Since the 1992 Kananook Creek Management Plan was developed, some recommended actions for Melbourne Water have been undertaken and Melbourne Water has also implemented many other activities not identified in the 1992 Management Plan. To this end, Melbourne Water has spent over $3.9 million on Kananook Creek between 1992 and August 2008. Melbourne Water activities have included: Riviera Street complex upgrades; pump station upgrades, installation of a telemetry system; grants funding for community and Council projects in the creek corridor; general maintenance works including litter management, sediment management, vegetation management, mechanical and electrical maintenance; and providing resources at annual Kananook Creek Celebration Days and assistance during regular Kananook Creek Clean-Up days. Melbourne Water has provided the Kananook Creek Liaison Committee (which includes a representative of the Kananook Creek Association) 3-monthly period expenditure reports for Kananook Creek since early 2005.

1.5.2.4 Kananook Creek Reserve Landscape Master Plan (1997) Jill Orr-Young and Frankston City Council
The scope of this study was Kananook Creek Reserve from Eel Race Road to Mile Bridge. The plan was prepared in consultation with the Kananook Creek Advisory Committee and the Friends Group (KCA). A major initiative of the plan is the strategic consideration of the creek, foreshore and the wetlands as one system for developing recreation and wildlife corridor links between them the strengthen the regional character.

1.5.2.5 Frankston Recreation Strategy (1999) Frankston City Council
The Strategy was prepared by the Council and involved extensive consultation with the community and key stakeholders. Key relevant outcomes for Kananook Creek include:
- walking for exercise was the highest participation activity across all age groups
- walking/cycle paths ranked as the fifth most important area that should be developed in the future.

Note: The Strategy did not specifically mention or comment on water-based recreational use of Kananook Creek.

1.5.2.6 Frankston City Open Space Strategy Vol 1: Main Report (July 2002) Robin Crocker & Associates et al
The Strategy identifies all open space in the City, researched community expectations, developed standards and identified future needs for open space. It is intended that the open space strategy guides Council's decisions about acquisition, management and development of open space. The Strategy identified key goals for open space in Frankston including:
- Progressively improve the quality of existing open space.
- Provide improved open space access, diversity and safety.
- Develop a shared pathway network.
- Increase community use, appreciation and involvement in open space.
- Plan new subdivisions to link open space and protect natural values.
- Ensure sound and sustainable management and allocation of resources.

More recently, Frankston City Council has developed a hierarchy of parks in order to assess open space provision. The hierarchy consists of Regional, Municipal, District, Local, Linear, Lane and Road Reserve. Kananook Creek Reserve is ranked as a Municipal Park as it is

seen as a piece of open space that has the potential to attract residents from across the whole municipality. Municipal parks are parcels of open space that are treasured by residents and are integral to creating a liveable city. These parks usually provide features and facilities, which attract residents from a broader catchment (greater than 500 metres) and encourage stays for more than 2 hours. This usually includes a range of informal leisure experience with picnic facilities, public toilets and car parking in key locations.

1.5.2.7 Frankston City Council Stormwater Management Plan Part Two (2000) WBM Oceanics Australia

This Plan provides a framework for Council to identify actions to improve the environmental management of urban stormwater and protect environmental values and beneficial uses of receiving waters. The existing Plan has 3 volumes. A summary of relevant information for Kananook Creek Catchment includes:

- Threats from existing residential areas include sediment and pollutant loads entering the creek.
- Future residential development in the Boggy Creek catchment is a key threat.
- Impacts of commercial and industrial runoff on the catchment.
- Recommendations of existing plan include a range of structural and non-structural measures. Structural measures include installation of GPTs on major drains in priority locations, and investigation of water quality treatment wetlands into a range of retarding basin and open space sites. Non-structural measures include reviewing the effectiveness of street sweeping, education programs, and changed practices within the organisation.

The SWMP is currently being reviewed and updated by Council.

1.5.2.8 Frankston City Neighbourhood Character Study (2001) Planisphere

This study addresses the residential character through the City and recommends guidelines policies and new planning controls to maintain, enhance and improve the residential character in each part of the City. Relevant to this study are the character areas along the Kananook Creek, where the coastal and natural character is recognised along with acknowledgement of the different housing styles. The study recommends a range of guidelines and new controls along Kananook Creek south and north of Mile Bridge. The recommendations on new polices and controls have been adopted by Council, following public exhibition and an independent Panel hearing and they have been submitted to the Minister for inclusion in the Frankston Planning Scheme.

1.5.2.9 Frankston City Council Aboriginal Cultural Heritage Assessment (1998), Austral Heritage Consultants

The study included a literature review, analysis of distribution of Aboriginal places in the municipality utilising existing information from Aboriginal Affairs Victoria (AAV), a systematic sample survey of the Municipality to confirm areas requiring identification and protection, and analysis and mapping of priority areas for inclusion in an overlay control if applicable. There were three AAV registered sites within the Kananook Creek Corridor study area, one of which was recommended to be protected and the other two were recommended to be removed from AAV register. Kananook Creek is identified as an area of high archaeological sensitivity.

1.5.2.10 Kananook Creek Reserve A Fire Management Works Plan (Sept 1998) Frankston City Council

Summary of recommendations include:

- patrolling the reserve during Fire Danger Periods
- signage to encourage residents to monitor use
- undertake fuel reduction between Boonung Avenue and Seaford Road to achieve a Moderate Fuel Hazard rating. Fuel reduction will involve manual removal, not fire.
- maintain current program of slash breaks at strategic locations
- on-site display during Fire Awareness Week to advise residents of bushfire preparedness
- assist local community to undertake fire prevention activities through the KCA

1.5.2.11 Long Island Reserve Cultural Heritage Assessment (June 2005) Andrew Long & Associates

This assessment was undertaken for Long Island Reserve and Kananook Creek adjacent to Long Island. No Aboriginal sites were identified in the study area with the area adjacent to Kananook Creek identified to be of low Aboriginal archaeological sensitivity. Monitoring is

advised during future works in the reserve. No historical sites were found and the Davey Street Footbridge over Kananook Creek is confirmed to have been rebuilt, and is not the original bridge.

1.5.2.12 Frankston Vegetation Study (2006) Ecology Australia

This study was prepared by Ecology Australia and provides an inventory of existing remnants, vegetation types and range of vegetation quality across the municipality. A total number of 108 sites were assessed. Generally, for the sites in the urban and semi-rural landscapes, degradation of vegetation was more marked in small and linear remnants. Kananook Creek is noted as Site 24 and has a Very High significance rating applied to the vegetation. The dominant EVC noted for the Kananook Creek site includes Coast Banksia Woodland (EVC 2) with a conservation status of Vulnerable, and Swamp Scrub (EVC 53-61) with a conservation status of Endangered.

1.5.2.13 Kananook Creek Reserve, Long Island Environmental Management and Development Plan (2006) Frankston City Council

The following recommendations are relevant to Kananook Creek for this plan:

- A road bridge across Davey Street into Long Island is preferred, however, due to the high cost of this, it was agreed to retain the roadway through the reserve until external funds were made available to construct an additional road bridge.
- Without additional funds being made available, the plan proposes to realign the roadway along the Kananook Creek edge and widen it to be a dual carriageway. The road has a sandy-beige waved concrete design.
- A footpath opposite Davey Street with a white painted timber handrail is intended to become the focus of the site's interpretative information. It is likely this was the main trail link to the Yangs Pier Hotel development in the 1880s which included a hotel, suspension bridge over the creek and sea baths offshore.
- An all-weather picnic shelter with views to McCoomb Reserve, Frankston Park and the pier forecourt is designed to face the creek.
- A boardwalk along the creek bank with two large grassed embankments grading down to the boardwalk provide viewing areas to the eastern bank of the creek.
- An all-ability access ramp to existing bridge crossings is proposed.
- Three pontoons are proposed along the creek edge to provide access points to the water. One pontoon is located in the north/east side of the creek immediately upstream of landmark bridge. Two fixed pontoons are located on the west side, one downstream of Playne Street footbridge and the other between Wells Street and Playne Street footbridge.

1.5.2.14 Frankston Bicycle Strategy (Oct 1997) Sinclair Knight Merz

The document investigated and made recommendations with a view to providing Council with a long term management plan for bicycles in Frankston City including its on and off road routes, community recreational and tourism network. Under the section of the Strategy - Developing Frankston's Tourism Potential, a trail alignment along the Kananook Creek from Frankston Pier precinct to Seaford Wetlands is recommended. The Strategy acknowledges there are some competing environmental and recreational needs. However, Kananook Creek was recommended because it:

- Provides a variety of landscapes
- Provides cyclists with a uniquely Frankston experience
- This route would be more useful to local cyclists and pedestrians than the alternative inland route
- Would be less affected by traffic and traffic noise

The Strategy suggests that it should be more than just building a bicycle path, and should be seen as part of revegetation, erosion control and weed management program. The Frankston Bicycle Strategy is currently under review and scheduled to be updated in 2008. In January 2008 Council passed a motion to re-assess the route of the Bay Trail.

1.5.2.15 Fish Survey of Kananook Creek 2006/2007 (Feb 2008) Kananook Creek Association

Kannaook Creek Association in conjunction with the Museum of Victoria undertook a fish survey of Kananook Creek over 14 months, during which time three surveys conducted at three sites including Fiocchi Avenue, Station Street and Eel Race Road, south of the bridge.

2. BACKGROUND INFORMATION

2.1 Regional context

The study area for Kananook Creek commences at Eel Race Drain which flows in an east-west direction at the northern end of Kananook Creek and transmits flows to Kananook Creek from the Boggy Creek catchment. The total length of Eel Race Drain is 2.1 kilometres and Kananook Creek is 7.4 kilometres. Refer to *Figure 1* Regional context Diagram and *Figure 2,* Catchment Diagram.

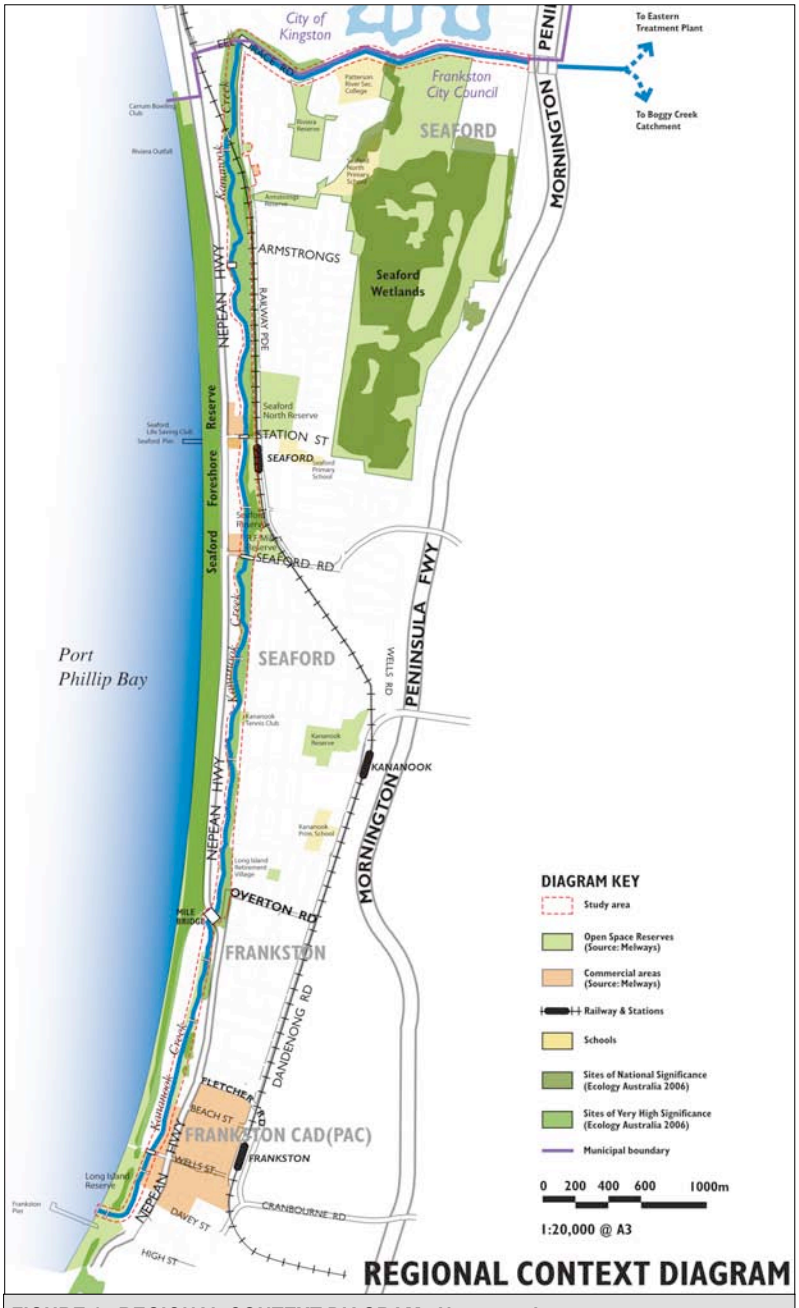


FIGURE 1 REGIONAL CONTEXT DIAGRAM Not to scale

Kananook Creek flows in a north south direction extending from Seaford to Frankston just inland from the coastline of Port Phillip Bay, approximately 35 kilometres south east of Melbourne. The Creek, which has been highly modified over the past century, is a remnant from an earlier significant extensive 4,400 hectare natural wetland (Carrum Carrum Swamp) which originally extended from Moordialloc Creek in the north to Frankston in the south. The Dandenong and Eumemmering Creeks fed this extensive swamp with a catchment area of approximately 740km^2. The Carrum Carrum Swamp's outlets to the Bay were Moordialloc Creek in the north and Kananook Creek in the south. The swamp teemed with wildlife and is of significance to the *Boonerwrung* people as it was a rich food source in the region. Today the remnants of this larger system include Edithvale-Seaford Wetlands, Wannarkladdin Wetlands, Moordialloc Creek and Kananook Creek. The coastline around Port Phillip Bay had extensive Banksia Woodland which has been reduced by urban development, with an important remnant of this vegetation type along the Seaford foreshore that is of Very High Significance. The foreshore reserve is located within approximately 300 metres of Kananook Creek and contributes to its overall environmental character and value. Seaford Wetlands extends from Eel Race Drain in the north to Austin Road in the south,

which is approximately one third the length of Kananook Creek. The presence of this large wetland complex within 500 metres of the creek contributes to its overall environmental value. The Boggy Creek catchment upstream of the Mornington Peninsula Freeway contributes flows to Kananook Creek and Melbourne Water have a plan in place to improve water quality and other values in this catchment. The Frankston Vegetation Study (2006) rates the vegetation of Kananook Creek upstream of Mile Bridge as being of Very High Significance and the nearby Seaford Wetlands of National Significance protected under the international Ramsar Wetlands Treaty.

During early settlement the Carrum Carrum Swamp was drained to create land suitable for agricultural purposes. The first main drainage works was the Patterson's Cut, which is now known as the Patterson River. This significantly reduced the catchment of Kananook Creek and there were reports of changes to the creek morphology, namely closure of the creeks mouth as far back as the late 1880s. This reduction in catchment continues to be an issue for creek management today with the creek closing down and becoming smaller and shallower due to its reduced catchment size. Additionally the effects of urbanisation of the catchment on the creek and its floodplain are a key issue that influences management of the creek corridor today. A more detailed history of the catchment is described in Appendix A (ASM, 2007).

Kananook Creek and Eel Race Drain provide an important open space and recreational link between Frankston and Seaford. It is the only creek in Frankston which can be used by small watercraft and the open space corridor directly connects to other open space in Frankston including the Foreshore Reserve south of the creek mouth and, east to Beauty Park and George Pentland Botanic Gardens.

Frankston Central Activity District (CAD) is adjacent to Kananook Creek and there has been extensive recent work undertaken by Council in conjunction with Department of Planning and Community Development to re-vision the use of this area of the CAD. Kananook Creek is a key focus of this vision with the major sites in the CAD to face the creek and establish an interactive promenade open space adjacent to the waterway. The development will have mixed use including medium and high density residential which will increase the level of use and access to the lower reach of Kananook Creek.

Adjoining land use and development is a key influence on Kananook Creek's health, habitat value, recreational use and landscape character and this influence varies along its length. Private land directly adjoins the water’s edge on at least one side of the creek for approximately half its length. Where this occurs, development and land management practices vary including cleared riparian and associated terrestrial vegetation, fences, retaining walls, decks, jetties and boat ramps. Other private land directly adjoins the public land which forms part of the Kananook Creek reserves where rear boundary fences (or lack of fences) to open space create management and surveillance issues. These actions affect the condition and habitat connectivity of the riparian corridor, the natural landscape character, the recreational use, and the recreational and visual amenity of the creek corridor.

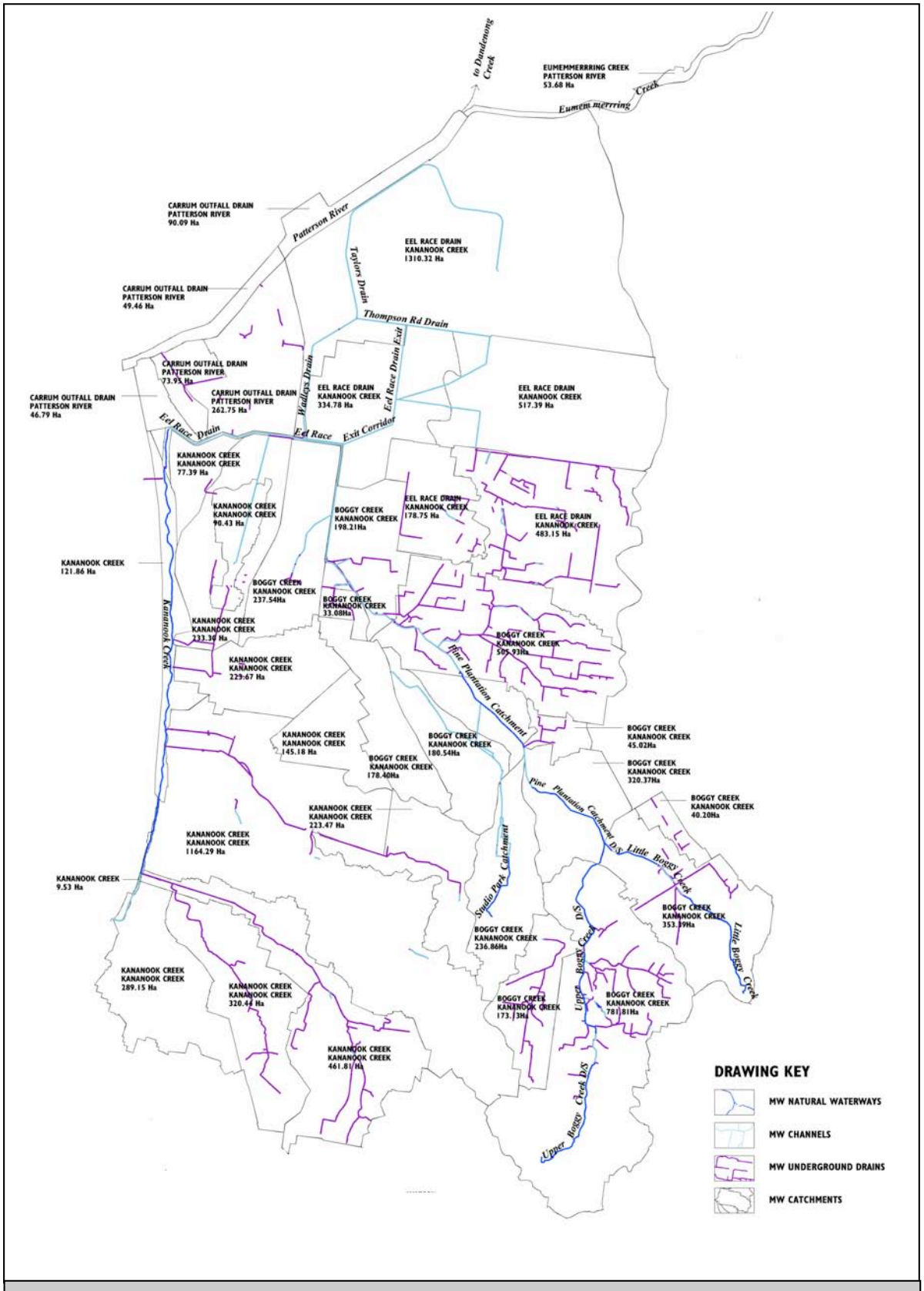


FIGURE 2 KANANOOK CREEK CATCHMENT DIAGRAM Source: Melbourne Water

2.2 Local context

Kananook Creek is highly valued by the local community and there has been a long history of community involvement in its management. Many individuals and community groups are involved with the creek, both protecting and improving its environmental, social, recreational and economic values and opportunities it offers. Over time as the redevelopment of Frankston CAD is implemented, and residential densities increase in the local area, the values and pressures placed on the creek corridor will increase.

A brief summary description of the existing character and condition of the creek is described below.

Eel Race Drain

This constructed drain transmits the upper catchment flows from Boggy Creek to Kananook Creek and the floodplain storage of Seaford Wetlands which protects Patterson Lakes and Seaford from flooding. Supplementary saline flows are pumped into Kananook Creek from Patterson Lakes at Eel Race Drain. Public land adjoins both sides of the drain with a trail system established for some of its length. Seaford Wetlands abuts the southern side of Eel Race Drain and the drain provides a potential habitat corridor connection between Seaford Wetlands and Kananook Creek. The elevated levee banks provide views across the drain to adjoining land between Mornington Peninsula Freeway and Whatley Street Footbridge. The lack of trees along the levee bank means development on adjoining land is highly visible from the paths along the drain.

Kananook Creek

In the northern reaches there is open space on both sides of the creek which allows an established canopy of Coast Banksia Woodland to shade the creek and provide a continuous habitat corridor. The open space corridor varies in width along the creek from between 50 and 100 metres.

Between Armstrongs Road and the Nepean Highway a continuous public open space corridor exists along the eastern side of the creek which provides habitat and open space connectivity. The western side is mostly residential land to the water's edge, with the commercial precinct of Seaford and a supermarket. The vegetation is discontinuous along this west side and some landholders have removed the riparian vegetation to establish open grassed areas, construct retaining walls, plant exotic vegetation, and construct jetties, decks and outbuildings. This vegetation removal has reduced its habitat connectivity and where it is in the riparian zone, has also reduced the in-stream health due to lack of shade over the stream. The waterway is used for recreational purposes by motorised and non-motorised watercraft and there are existing public launching ramps along the creek to facilitate water based recreational use.

Between Mile Bridge and Wells Street, adjoining land use is a combination of residential and narrow areas (approximately 15 to 20 metres wide) of open space on both sides of the waterway. The creek retains its natural form to Beach Street, and thereafter changes to a concrete walled channel. The riparian zone is highly variable with some scattered remnant Banksias and Swamp Scrub and a more extensive range of introduced species and gaps in vegetation. Between Wells Street and the mouth to Port Phillip Bay there is currently no open space on the eastern side and Long Island Reserve adjoins the west. This area is included in the Frankston PAC and there are plans for redevelopment on the eastern side to establish an interactive promenade with mixed residential and business use facing the creek downstream of Wells Street. Powered boat access is provided between the boat launch ramp and the creek mouth, with non-powered small craft upstream of the boat ramp.

Overall Eel Race Drain and Kananook Creek provide an important environmental and recreational corridor linking Seaford and Frankston. As development occurs with increased numbers of people using the corridor, the need to proactively manage the corridor and the interface treatment will become increasingly important.

For the purposes of this Management Plan the creek has been divided into six reaches which are as follows:

- Reach 1 - Mornington Peninsula Freeway to Eel Race Road
- Reach 2 - Eel Race Road to Armstrongs Road
- Reach 3 - Armstrongs Road to Seaford Road
- Reach 4 - Seaford Road to Mile Bridge
- Reach 5 - Mile Bridge to Wells Street
- Reach 6 - Wells Street to Port Phillip Bay

Refer to *Figure 3* in this report for a diagram of the reach breakdown.

2.3 Open space and recreation

Kananook Creek corridor (including Eel Race Drain) is approximately 9.5 km in length, with Kananook Creek 7.4 km and Eel Race Drain 2.1 km. It is an important environmental and recreational linear open space corridor that links the Frankston CAD and the Waterfront to the City's northern boundary in Seaford. This linear open space has the potential to be a popular recreational corridor, offering opportunities for a peaceful retreat and the physical challenge of canoeing, walking and cycling. Recently Council has developed a classification for all open space in the municipality and Kananook Creek is identified as a Municipal open space (Refer Section 1.5.2.6). The existing trail is highly valued by the local community for its natural and informal character.

The corridor provides the opportunity for municipal recreational links north to Seaford and an east-west connection via Eel Race Drain to Seaford Wetlands. Seaford Wetlands is a major regional open space recognised to be of international significance for migratory waterbirds and protected as part of the international Ramsar Convention. The wetland has an existing shared trail connection through it which could potentially link to the Kananook Creek trail and the Patterson River. There is potential for municipal recreational links from Kananook Creek, south to Sweetwater Creek and to the George Pentland Botanical Gardens.

The Kananook Creek trail runs for the majority of its length, with some missing links downstream of Mile Bridge where private land ownership to the stream has been an impediment to providing walking trail access. Council has more recently been negotiating with private landowners to achieve trail access through this lower reach. The surface of the trail varies from a compacted crushed rock trail in the south to a sand/mulch trail with steps in the north.

There are currently three locations along Kananook Creek corridor where the open space reserve widens out to provide the potential for a more diverse range of recreational activities. This includes Riviera Street Reserve, adjacent to the Seaford Community Centre in Seaford township, and in Frankston CAD. There is potential for the facilities in these locations to be improved some of which is already in development as part of the Seaford Life Saving Club Precinct Masterplan and the Long Island Environmental Management and Development Plan.

A range of motorised and non-motorised watercraft use Kananook Creek, including motorboats, personal watercraft, kayaks and canoes with a speed limit of 5knots or 8km p/hr. There are four public small craft launching platforms currently provided along the creek corridor and a boat ramp down near the creek mouth in Frankston and an additional one in Eel Race Drain near the Patterson River Secondary College. The Kananook Creek Association (KCA) promotes water-based recreational use of the waterway during events and community days along the creek. The creek is generally navigable for small watercraft in the upstream reaches, however access can be compromised during the low stream flow periods of summer and autumn. This is the only creek in the municipality of Frankston that is used for water-based recreation and it is highly valued for this.

2.4 Geology and geomorphology

The area is characterised by the Recent Quaternary deposits including dune sands and beach sands forming coastline sand dunes as well as peaty clay and clay swamp deposits from the creek. The surrounding catchment for the creek is situated on sandy soils and this contributes to the high sediment loads entering the creek.

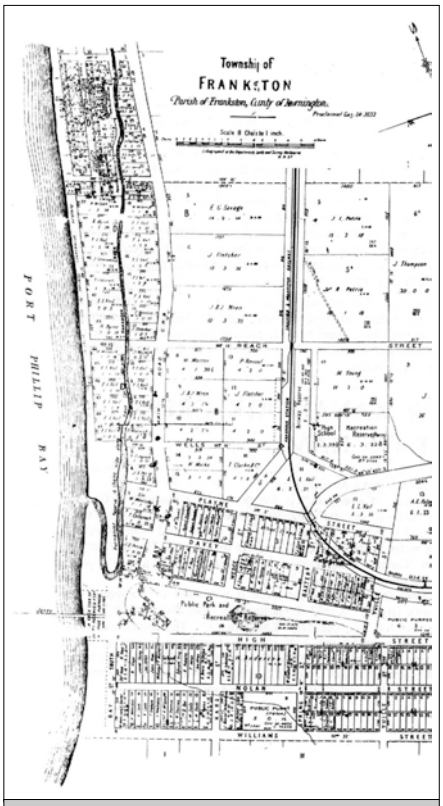


FIGURE 3 MAP OF FRANKSTON 1927
Source: Stories of Kananook Creek, J.A. Douglas

Kananook Creek was formed as a parallel dunal estuarine creek formed by the combination of waterway and coastal influences. The creek sits between the old coastal dune system (to its east) and the current dune system today. The formation of the large channel present today was developed in response to its much larger catchment of approximately 740km^2 prior to Patterson's Cut in the late 1800s. The flows and water level in the creek would have fluctuated and coastal sand movement during times of low rainfall would have blocked the creek mouth. During high rainfall events, the flows would build up and naturally break through the sand bar at the mouth and flow to the sea. The location of the mouth of the creek would have varied over time, and as illustrated in *Figure 3*, it was originally north of the current mouth. Since the reduction in the overall catchment size, closure of the mouth of the creek has been a constant issue, as the larger flows are no longer available to naturally break through the sand bars that form. There have been various attempts to establish an open and navigational mouth to the creek, with the dredging being the only successful option (ASM, 2007).

Other impacts on the creek morphology arise from retaining walls being constructed along the banks. Concrete walls were constructed downstream of Beach Street in the 1970's. These walls have deteriorated over time and replacement of these walls will be required. In addition to the major walled section, private landholders have variously constructed retaining walls further upstream to address erosion, formalise the creek edge or reclaim additional land area. These walls are generally low and vary in condition, size and materials.

2.5 Drainage and flood management

Currently Kananook Creek has a catchment of approximately 100km^2 and includes the Boggy Creek Catchment and Wadsleys Drain. This has reduced from a much larger catchment of approximately 740km^2 as described in Section 2.4. The reduction in catchment size has had a major impact on the creeks morphology and water quality described in Appendix A, (ASM, 2007). During early urbanisation of the catchment, some of the buildings in the Kananook Creek floodplain were constructed below the current 1:100 year flood level. Therefore flood flows in Kananook Creek need to be managed and the Riviera Street Flood Control Complex was constructed to divert the larger event flows from the upper catchments directly out the Bay and also provide flood relief for large storm events within the creek. In a flood event the 100 year ARI flows will pond upstream of the Flood Control Complex and potentially overtop the low point in the southern levee bank of Eel Race Drain into Seaford Wetlands.

The flood flows are controlled by the Riviera Street Flood Control Complex which directs approximately 30 m^3/s to the bay and 2m^3/s to Kananook Creek, once the opening to Kananook Creek is closed at the Flood Control Complex. 100 year ARI flood levels through Kananook Creek are set at 1.7m AHD, following flood modelling undertaken by GHD in

1987. Some sections of the older drainage system in the Frankston CAD area are unable to transmit the 100 year ARI flows and Melbourne Water is currently proposing to upgrade the outfall of the Sandgate Avenue and Beach Street Drains to protect the Frankston CAD from flooding (ASM, 2007).

2.6 Flow management and water quality

2.6.1 Flow management

Kananook Creek is a tidally influenced estuary subject to normal tidal influences of Port Phillip Bay. Historically the creek was a barrier estuary which regularly closed during low rainfall (generally during late summer and autumn) and opened when higher flows naturally broke through the sand bars which formed across the creek mouth during dry periods. Prior to European settlement Kananook Creek was the southern outlet for the extensive Carrum Carrum Swamp with a total catchment of around 740km^2. When the Carrum Carrum Swamp was drained for agricultural purposes back in the 1870s, Patterson's Cut (River) was constructed along with some other drainage modifications which effectively reduced Kananook Creek's catchment to around 100km^2. Kananook Creek originally formed in response to its large catchment including a wide channel with deep holes in the creek. Today, with the vastly reduced catchment size, primarily from Boggy Creek and some other minor local catchments, the flows are significantly reduced from their original volume and seasonal dynamics. As a result of the creek not receiving the larger continual flows and the high flow events, there is no natural method to move the sediment through the system and naturally maintain a deep and wide creek channel. The sediment build up in the creek is a result of this and exacerbated by the erosion from a sandy catchment which is efficiently transported into the creek via the stormwater drainage system established after settlement.

The issue of lower flows and sediment build up in the stream have been long lived, with newspaper reports back to 1889 and 1890 reporting the closure of the mouth, along with reports on poor water quality. The first known creek works occurred in 1888 with a timber weir and loch construction at the mouth in an attempt to improve access and flushing. Attempts to artificially flush the creek first occurred in the 1920s with the installation of a pump on Seaford Pier. The flood outlet at Riviera Street was planned in 1958 at which time Eel Race Drain was enlarged and levee banks built to prevent all but major flood events entering Seaford via the Seaford Wetlands. As development occurred in the late 1940s through to the 1970s, the area was progressively sewered and the sewage treatment plant discharged treated effluent into the creek providing increased flows. However the water quality was poor due to high nutrient levels and the high algal content. In response to the need for reliable flushing flows, the Dandenong Valley Authority commissioned the Kananook Creek Pump Station in 1982 and the Station commenced pumping in February 1984 which supplemented the Boggy Creek catchment flows and the treated effluent from the Frankston Sewage Treatment Plant. The recent upgrade to the Kananook Creek Pump Station by Melbourne Water has slightly increased the pumping capacity and it now delivers a normal pumping flow of 100ML/day and a peak flow of approximately 164ML/day (ASM, 2007).

2.6.2 Water quality

Since the alteration to the creek's catchment, Kananook Creek has experienced water quality problems. The catchment developed high organic loads via partially treated septic and sullage waters entering the creek, and this was replaced later with treated effluent from Frankston Treatment Plant. The creek's poor water quality was widely recognised and led to the commencement of the Kananook Creek Pump Station in 1982 with the aim to provide continual flushing flows of sea water to the creek. The Frankston Treatment Plant ceased operation in 1989 and the water quality in Kananook Creek rapidly improved. Additionally improvements to water quality in the Dandenong Creek Catchment (which flows into Patterson River and in turn Patterson Lakes) contributed to water quality improvements in Kananook Creek.

Water quality in Kananook Creek is currently dominated by the saline flows from Kananook Creek Pump Station (sourced from Patterson Lakes), which has low turbidity and suspended solids and high dissolved oxygen levels. However, based on the most recent monitoring, the total carbon and nutrient levels are generally high and there are increased levels of Cr, Cu, Ni, Pb and Zn, therefore Kananook Creek can be regarded as a Eutrophic waterway (Bourges in prep). A sediment survey which followed the water quality investigation has highlighted some very high levels of Zinc. Also organotins (dibutyl and tribuyl tin compounds) have been detected in all sampled sites (Bourges in prep).

The eutrophic conditions in Patterson Lakes supports large algal blooms of *Enteropmorpha intestinalis* and the algae are transported into Kananook Creek. These are of concern in estuary systems particularly as algae respiration and death creates a large oxygen demand that has potential to turn the creek anaerobic and odorous if pumped flows cease for any reason.

The urban stormwater entering the system contributes organic material, sediment, oils, heavy metals, bacterial loads from annual wastes or sewer overflows and litter. Generally the sediments settle quickly when they come in contact with saline water. The sediments have accumulated contaminants as confirmed in recent sediment survey work undertaken by Melbourne Water. Litter levels have reduced over time with Council addressing source litter as part of the Frankston City Council Stormwater Management Plan (SWMP). The SWMP is currently under review by Council. Organically rich groundwater with acid sulphate potential discharges into the creek via the stormwater drainage infrastructure, largely in the section between Seaford Road and Overton Road. The potential impacts of the groundwater intercepted by the deep main drains entering the creek is reduced by flushing flows from the Patterson Lakes pumping station (ASM, 2007).

2.7 Flora and fauna

2.7.1 Flora

Kananook Creek flows in the north south direction parallel with Port Phillip Bay, located between coastal dunes and more recent swamp deposits further east in Seaford Wetlands. Frankston supports significant natural features of flora and fauna conservation and amenity of which Kananook Creek forms an integral part. Kananook Creek is identified to be of Very High Significance, Seaford Foreshore of High Significance and Seaford Swamp of National Significance due to the presence of international migratory waterbirds (Ecology Australia, 2006). Refer to *Figure 1, Regional Context Diagram*.

The diversity of mature and remnant vegetation along the open space and riparian corridor contributes to the environmental values of Kananook Creek. The vegetation ranges from Swamp Scrub along the fringes of the Riparian Zone grading back to the Coast Banksia Woodland. The presence of this vegetation provides shade to the stream improving the in-stream habitat values, and habitat for terrestrial fauna including birds, mammals and reptiles. The existing vegetation communities have been mapped as part of this project and this mapping is shown on Drawings KCMP-07 to KCMP-10 in this report.

There have been two previous vegetation surveys undertaken for the Kananook Creek, including the 1999 Flora and Fauna Surveys of Kananook Creek Reserve (Brunner et al) and the 1977 Vegetation Survey of the Kannanook Creek Reserve (Hook) plus a recent overview, Frankston Vegetation Study completed by Ecology Australia in 2006. It is evident from reviewing the earlier studies that the vegetation is gradually changing over time to adjust to the increased saline levels in the system, as a result of the pumping of salt water through the system from Patterson Lakes (Refer to Section 2.3). Currently the broader Ecological Vegetation Classes (EVCs) that are identified as present in the creek corridor by BMS (refer Appendix B) include:

EVC No.	Vegetation Community
904	Coast Banksia Woodland/Swamp Scrub mosaic
53-61	Swamp Scrub
308	Aquatic Sedgeland
842	Saline Aquatic Meadow
10	Estuarine Wetland
952	Estuarine Reedbed
821	Tall Marsh
953	Estuarine Scrub (which best fits the description of areas currently classified as Swamp Scrub)

The Frankston Vegetation Study (Ecology Australia, 2006) identified the vegetation along the Kananook Creek corridor and Eel Race Drain between Whatley Street Footbridge and Mile Bridge to be of Very High Significance.

In terms of quality and condition of vegetation, weed invasion is widespread throughout the study area including introduced grasses, Tradescantia, Cape Ivy and Bridal Creeper. The vegetation in this study has been assessed for quality on a 1 to 5 system, with 1 being the highest quality and 5 being the lowest. Overall the most degraded sections of the creek in terms of vegetation quality are upstream of the Whatley Street Footbridge and downstream of Mile Bridge. The highest quality vegetation is in the middle reaches.

Comparative changes in vegetation since the original survey in 1977 as identified by BMS (2006) include:

- Significant reduction in density and distribution of Common Reed within the middle reaches where it had originally formed dense beds. This is possibly due to increase in salinity and decrease in nutrient loads.
- Changes to Melaleuca dominated Swamp Scrub with some areas experiencing loss of mature Melaleuca and little recruitment, whilst other areas experiencing extensive root sucker recruitment.
- General decline in the health and vigour of the Coast Banksia which is likely caused by a range of complex factors including increased wind exposure, lack of fire, impact of smothering weeds, insect predation, insect infestation (*Banksia longicorn* beetles, Source: FCC) and natural senescence.
- Overall reduction in woody weeds including Boxthorn, Mirror Bush, Boneseed reflecting past management actions by agencies and the Kananook Creek Association.
- Successful Spiny Rush control program undertaken by Melbourne Water over the past 3 years in Eel Race Drain and Kananook Creek.
- Significant increase in the distribution and density of Bridal Creeper and is the most serious weed species present. (Appendix B, Bushland Management Services, 2006)

In 2006-2007 Frankston City Council commenced a new bushland management approach for their land referred to as the RRR Mapping program. This methodology collects data on vegetation quality, weed density and weed distribution through field surveys by Council staff which is entered into a database and mapped on Council's GIS System. The maps provide a benchmark of the extent of the quality of native vegetation in Council managed natural reserves. Regular periodic surveys will be conducted and compared against the benchmark maps to monitor the effectiveness of on-ground works by Council and volunteers on Council owned land towards improving the quality of vegetation. Areas are mapped with Retention (<30% weed cover), Restoration (between 30% to 70% weed cover) and Rehabilitation (>70% weed cover). Council use this mapping to determine priority areas for vegetation management, and the areas of best quality (Retention value) are worked on first in accordance with best management practice.

Amateur surveys for fungi in the reserve by John Eichler have identified approximately 70 species of fungi. this data has not been verified and there have been no professional surveys for fungi.

The vegetation community mapping and recommendations for future works in this Management Plan have been prepared for the whole public land corridor including Melbourne Water and Council owned land.

2.7.2 Fauna

Hans Brunner and Bev Courtney undertook a flora and fauna survey for the Kananook Creek Reserve section of the study area in November 1999. The study area included the public land from Kananook Creek Road south to Mile Bridge. The potential threatened species recorded in the vicinity of the study area during the 1990s include:

- Azure Kingfisher (rare)
- Black-browed Albatross (endangered)
- Baillon's Crake (vulnerable), listed on the *State Flora and Fauna Guarantee Act* 1998 (*FFG Act* 1998)
- Black-faced Cormorant (rare)
- Shy Albatross (vulnerable), included in the *Environment Protection and Biodiversity Conservation Act* 1999 (*EPBC Act* 1999)
- Caspian Tern (rare), listed on the *FFG Act* 1998
- Pacific Gull (rare)
- Great Egret (vulnerable), listed on the *FFG Act* 1998

Species recorded in the 1999 study are described below.

Mammals

The 1999 survey identified that the following native mammals were present or likely to be present in the Kananook Creek Reserve include:

- Short-beaked Echidna
- Brushtail Possum
- Ringtail Possum
- White-striped Freetail Bat
- Gould's Wattled Bat
- Lesser Long-eared Bat
- Little Forest Bat

Whilst Possums were well represented, the Short-beaked Echidna has become rare and may only exist in very low numbers in the most northern section of the Reserve.

During the site visit evidence of a Native Water Rat *(Hydromys chrysogaster)* was found immediately downstream of Armstrongs Road.

Reptiles and Amphibians

Nine species of lizards were recorded in the reserve with the sand dune and extensive areas of swamp area with diverse flora providing good food and shelter for the large number of lizards. Three of the species are locally and regionally significant including:

- White's Skink
- Delicate Skink
- Bougainville's Skink

Therefore the Kananook Creek Reserve is a significant habitat for the conservation of these and other species of lizards. Whilst the Scaly-foot Lizard was not located during the survey, there is potential habitat for it there. There were four species of snakes found during the survey but in very low numbers. Increasing the habitat for frogs will potentially improve the habitat values for snakes. Frogs are currently rare and in low numbers in the reserve given the lack of suitable habitat for them.

Birds

A large number of bird species recorded in the reserve is thought to be due to the presence of water and the proximity of this reserve to the Seaford Foreshore and Seaford Wetlands. The report states it appears these three areas (including Kananook Creek) have become interdependent habitat for many birds, and disturbance in any of the three could affect the birdlife in the other reserves. Refer to Appendix C for a list of the bird species recorded (as an extract from this report).

A fish study undertaken by Melbourne Water (McGuckin, 2006) identified the following fish in Kananook Creek and Eel Race Drain:

Fish and marine crustacea
Estuarine species include:
- Yellow Eyed Mullet
- Bream
- Goby
- Small mouthed hardyhead
- Flat headed gudgeon.

Migratory species include:
- Eels
- Galaxids
- Tupong

M*arine crustacea includes:* crabs, barnacles and shrimp.

A subsequent fish survey undertaken by Kananook Creek Association in 2006/2007 identified the following additional fish and marine crustacea:
- Black Bream
- Longsnout Flounder
- Tamar River Goby
- Climbing Galaxias
- Jollytail
- Blue Spot Goby
- Pilchard
- Pest Fish *(Gambusia affinis)*

Evident during the site visit was the large algal bloom of predominantly *Enteropmorpha intestinalis* which can preclude other species and provides habitat for Biting Saltwater Midge. (ASM, 2007)

2.8 Cultural heritage and historical values

2.8.1 Cultural heritage

The Aboriginal people known as the *Bun Wurrung* occupied the coastal areas of the central and eastern Port Phillip Bay. Whilst there are different spellings of the name, Frankston City Council have adopted the spelling *Boonerwrung* and this will be used in this report. The *Boonerwrung* comprised six clans, with the specific clan that occupied the Frankston area called the *Ngaruk willam* whose approximate location includes Brighton, Mordialloc, Dandenong and between Mt Eliza and Mt Martha. Other records indicate that the *Bunerong-balluk* were said to occupy the area from Mordialloc to the Tarwin including all the Mornington Peninsula. The land mammals provided raw materials for clothing and other items, including possum and kangaroo. Eels were an important resource and were obtained in large numbers from the Carrum Carrum Swamp from December to July. When the *Boonerwrung* travelled through Frankston area it is likely the places for base camps were south of the municipality. It is thought there were about 500 *Boonerwrung* people prior to Melbourne settlement. By 1850 it is thought the *Boonerwrung* utilised Gippsland with only a small number of them remaining on a small reserve in Mordialloc (which opened in 1841) living partly by traditional life supplemented by selling ducks and eels to European settlers with only eleven surviving by 1863. In 1996, there were three AAV registered sites in the study area with one being an artefact scatter in Eel Race Road (AAV No. 7921-0187) and two scar trees on Kananook Creek (AAV No. 7921-0294 and 7921-0295). The site in Eel Race Road was recorded in 1988 and revisited in 1996 and found to be eroding with a track through it. Austral Heritage recommended realignment of the track and covering the site to protect it. Kananook Creek sites 1 and 2 (AAV No. 7921-0294 and 7921-0295) were recommended to be removed from the register as the small size of the trees means it is highly unlikely they were scar trees. Kananook Creek is a landform that has high potential

for Aboriginal archaeological sites, particularly the areas which retain remnant vegetation. (Austral Heritage, 1998)

More recently a study of the cultural heritage values of Kananook Creek adjacent to Long Island was completed. This study investigated the Aboriginal archaeological values in the creek corridor and was prepared for the Long Island Reserve and adjoining creek near the mouth. Due to high level of modification to this section of creek no Aboriginal archaeological sites were found (Andrew Long and Associates, 2005). It appears there are no other Aboriginal archaeological studies for the remainder of the study area, and therefore there are no records of sites of Aboriginal cultural significance in the study area.

Under the new *Aboriginal Heritage Act* 2006 Cultural Heritage Management Plans are required to be prepared and approved prior to commencement of site works in locations which are identified to be of high archaeological sensitivity. Kananook Creek corridor is identified as an area of high archaeological sensitivity.

Currently two Aboriginal groups are representing indigenous cultural values in the Frankston area, and as yet neither of these groups have been confirmed as the Registered Aboriginal Party by AAV. These two groups are the Boon Wurrung Foundation Limited (BFL) and the Bunurong Land Council Aboriginal Corporation (BLCAC).

2.8.2 Historical values

The following historical account is summarised from the Frankston City East Heritage Study, 1997, Vol 2.

The first Europeans who arrived in Port Phillip Bay were attracted to the mouth of Kananook Creek looking for a reliable freshwater supply. They supplied their boats with fresh drinking water from the creek and explored the surrounding Carrum Carrum Swamp. During the late 1800s the Carrum Carrum Swamp was drained which altered the hydrology of Kananook Creek and caused deterioration of the creek. A visit by the Premier of Victoria to the creek in 1928 reported in the *Argus* reported what was once a clear waterway 'suitable for boating and fishing' had become a 'dirty stagnant drain' and its stench was driving visitors away from the Frankston shops and beach. During the 1920s Frankston was promoted as a popular holiday resort and promoted it as such. Small shacks for fishermen and scrub-cutters were erected near the foreshore and the Kananook Creek.

Boat building occurred along the creek spanning two generations from 1920's to the 1960's. Herbert Maumill arrived in Frankston in the 1920's and built wooden fishing boats, ketches, racing yachts and racing eights in addition to running a boat hire business. In 1954, Bruce McComb took over his mentor Bert Maumill's boating business and continued the wooden boat building tradition, introducing fibreglass compound into his vessels in the late 1950's. Of note, McComb's father, Ted, taught Sir Keith Murdoch the art of sailing yachts and Bruce built a 12 square sharpie yacht for him. (pp 22-24, Stories of Kannaook Creek by JA Douglass, 1985).

Between World War I (WWI) and World War II (WWII), the Council embarked on works to improve the surrounding area of Kananook Creek and cleared large areas of Ti-tree between the creek and Seaford Wetlands in order to construct a Boulevard along the eastern side. In 1930 the Minister for Lands had to order cessation of these works. However, the intent to create the boulevard continued until in 1955 the MMBW Chief Planner Mr Borrie argued strongly against the 'scenic drive' along the creek. The MMBW took over works along the creek banks and many local residents resisted the MMBW works and considered they were not in the local residents' interests. In 1957 fishermen, local sea scouts and others interested in the creek formed the Kananook Creek Improvement Association and continued to work in the creek. After WWII an expanse of cheap housing for commuters was built in Frankston especially to the north of the town centre. Frankston today is largely a product of the years between 1950 and 1990. Long Island has been popular for long-term residents building retirement homes or holiday homes close to the water. This group continued to lobby to have works improved, and in 1961, the new flushing scheme of outlet culvert drains into the Eel Race Drain was opened, as was a tidal gate to Patterson River and a new

flushing system taking flows out into the Bay at the Riviera Hotel were opened. There were concerns the gates were not successful and additional works were then undertaken. The timber footbridges in the downstream section provide a reference back to the holiday and beach character of Frankston (Frankston City East Heritage Study 1997, Vol 2).

The Frankston Pier (originally constructed in 1863) has attracted recreational use and the Kananook Creek mouth and Long Island have been home to water based recreational clubs over since the early 1900s. The Crown Land was declared a recreation reserve in 1910 and the Frankston City Council was appointed Committee of Management in 1911. There has historically been much controversy over the construction of club rooms near the creek, and over the condition and water quality of Kananook Creek. The Frankston Dinghy and Yacht Club constructed their club rooms on the north side of Kananook Creek in 1937, and in 1955 the Frankston Sea Scouts applied to build a club house on the banks of Kananook Creek. Other buildings near the creek mouth included the Surf Life Saving Clubhouse built in 1959.

2.9 Land use

2.9.1 Land use adjoining the Kananook Creek Corridor

The adjoining land use is a combination of public open space and private residential and commercial land use. More broadly, beyond the creek corridor, the land use is predominantly residential on the west and east sides, with the exception of the lower reaches where Kananook Creek flows through central Frankston. Within the Frankston CAD adjoining land use on the west side of Kananook Creek is open space and forms part of the foreshore reserve, and on the east side is private commercial land.

2.9.2 Land use within the Kananook Creek Corridor

Refer to Reach Diagram, *Figure 3*.

The land use within and adjoining the creek corridor is predominantly public open space and residential, with some smaller sections of commercial and business use and railway land.

Reach 1 Mornington Peninsula Freeway to Eel Race Road
Eel Race Drain has a narrow drainage reserve on both sides of the drain along its length which functions as open space. Residential land uses are located both north and south of the drain. On the southern side of the drain, there is a large area of Council-owned rural land east of Seaford Wetlands and an open space reserve and secondary school to the east.

Reach 2 Eel Race Road to Armstrongs Road
Kananook Creek from Eel Race Road to Armstrongs Road has public open space on both sides of the creek for the majority of its length with the exception of the southern section on the west side which has residential land extending to the creek edge immediately north of Armstrongs Road. There is a section of residential land north of Armstrongs Road which has an existing Public Acquisition Overlay in favour of Council for public open space.

Reach 3 Armstrongs Road to Seaford Road
South of Armstrongs Road to Seaford Road public open space is on the eastern side of the creek and a combination of commercial and residential land is on the western side. From Victor Avenue to an area south of Station Street on the west side is the Seaford Town Centre which is a mixture of business and commercial land use extending to the creek. Additionally there is another area of commercial land immediately north of Seaford Road on the west side.

Reach 4 Seaford Road to Mile Bridge
South of Seaford Road there is public open space on both sides of the creek for a short section, and then public open space extends on the east side only through to Nepean Highway (Mile Bridge). Residential land use adjoins the western side of the creek through this reach.

Reach 5 Mile Bridge to Wells Street
South of Mile Bridge to Beach Street has a combination of public open space and residential land use on the west side and on the east a combination of public open space and mixed use including residential and business use. South of Beach Street, the west side is residential use and the east side is business use with a road directly adjoining the creek in this location. There are some Public Acquisition Overlays in favour of Council for open space on both sides of the creek in this reach.

Reach 6 Wells Street to Port Phillip Bay
South of Wells Street there is public open space on the west (foreshore reserve) and mixed use on the east including commercial and business use.

2.10 Community consultation

2.10.1 Community survey

Please note the community survey form, methodology for its distribution and description of the survey method below is authored by Frankston City Council.

In 2006, Frankston City Council, in partnership with Melbourne Water, prepared and distributed a community survey. The survey asked the community and residents who live near the creek corridor what they value, how they use the corridor and what they see as some of the issues or problems that need to be addressed in the new Corridor Management Plan.

The survey sampling methodology targeted residences within a geographical radius of 0.5km along Kananook Creek, and was distributed by postal survey to 3,560 addresses. (Copies of the survey were also available at Frankston City Council's website and Customer Service Centres). In sampling this population, the survey sought to achieve a balance of population characteristics by cohorts of age and gender. The number of valid survey responses processed was 282, giving a response rate of 7.9%.

Council advises that of the responses received 71% of respondents were older than 45 years, with the dominant age range being 45-74 years. According to Australian Bureau of Statistics approximately 30.9% of residents of Frankston City were aged between 45-74 years in June 2006 (Source: Population by Age and Sex, Australia 2006 cat. no. 3235.0). Therefore, it is necessary to acknowledge that there are limitations with this survey, namely that the population sample did not achieve a response pool that was representative of all age groups across the community, nor was the response rate statistically significant.

However, as the survey was geographically prescriptive (i.e. it was aimed at properties within 0.5km of the creek), the results still provide us with valuable insights into what some local residents value, how they use the creek corridor and what they see as some of the key issues that need to be addressed in the future.

Below is a summary of the community survey outcomes.

Personal information
- Gender - 52% male
- Age range - 71% older than 45, with the dominant response age being 45 - 74.
- Household type - 44% from two person households, followed by 21% from single person households
- Nearly 30% of respondents are members of a volunteer or Friends Group of the creek
- 60% of respondents come from postcode 3198 (Seaford) and 31% come from 3199 (Frankston)

Frequency of visitation
- 41% visit the creek daily, 40% visit the creek weekly

Reasons for visiting:
- 86% walking
- 63% peace and quiet
- 38% wildlife
- 29% dog walking
- 21% cut through, canoeing/boating

Perceived health of Kananook Creek
- 44% fair
- 21% good
- 17% poor
- 12% very poor
- 51% think water quality has improved

What do you value most about the creek
- 55% natural environment, vegetation, natural beauty
- 47% wildlife, birds, fish
- 33% walking track, running track
- 26% quiet setting, tranquillity

Issues to be addressed:
- 51% flushing flow, cleaning up water, improve smell, deepen water level, remove algae, water quality issues
- 27% clean up rubbish, litter, litter traps at Beach Street
- 24% improve native vegetation, remove weeds, stop private destruction of native vegetation, replanting program
- 13% maintain/improve/extend walking and bicycle paths, seating, lighting, access
- 13% leave it natural
- 12% overdevelopment, high use, multi-unit, need for buffer
- 11% vandalism, fire bugs, anti-social behaviour

Suggested improvements / changes:
- 32% water quality/flow/depth, improve water quality
- 17% clean up rubbish/litter
- 15% improve native vegetation
- 15% maintain/extend walking path

Differences between uses of the creek corridor between residents of Frankston and Seaford include:
- residents of Frankston more frequently use Picnic/BBQ facilities and use the creek for cycling.
- residents of Seaford have a higher use of the corridor for jogging, dog walking and use as a cut-through.

2.10.2 Community stakeholders

A meeting was held with the Kananook Creek Reference Group to gain an understanding of the key values that need protection and issues to be addressed in the plan. This group includes representatives from Victorian Boonerwrung Elders Land Council, Frankston Boat Owners and Anglers Club, Frankston Business Chamber, Frankston Yacht Club, Friends of Seaford Foreshore, Kananook Creek Association, Long Island Residents Group, Patterson River Secondary College, Seaford Scouts and the Kananook Creek Canoe Club. There are also three local residents who attend as representatives of the nearby residential community. Below is a brief summary of the Community Stakeholder Workshop:

Key Values
- Community ownership and involvement
- Environmental value
- Refuge from the urban environment and restorative for people to visit it
- Passive recreation and water based recreation
- Landscape and habitat connection it provides between Seaford and Frankston

- Cultural heritage values to the *Boonerwrung* community
- Aesthetic and economic value to adjoining residents

Weaknesses
- Poor development interface to the creek without adequate controls to protect the environmental and landscape qualities of the creek
- Silt in the stream
- Lack of flows during the time of the year people would like to use it
- Dieback of vegetation and no recruitment/replacement
- Weeds
- Poor vegetation management on private land and of the native grasses along the railway by the rail authority
- Lack of archaeological surveys and information on the Aboriginal cultural heritage values of the creek corridor
- Lack of community understanding of the ecological values of the creek and an overemphasis on the aesthetic values
- Lack of clarity of management responsibilities and lack of ongoing management by the agencies over time
- Limited access to the creek and lack of recognition of its water-based recreational use
- Poor condition of track surface
- Personal safety

Opportunities
- Improve the creek environment so the community is proud of the creek and attracts regional visitors and tourism to the area
- Improve the public perception of Kananook Creek particularly with the Transit City project in Frankston
- Improve the creek as part of the Seaford Village redevelopment
- Build on community interest and passion for the creek

Threats
- Fire
- Overdevelopment of the area and along the creek
- Bay Trail and the impacts on the corridor the trail will have
- Global warming
- Increased salinity

2.11 Management responsibilities

The following table summarises the management responsibilities for Melbourne Water, Frankston City Council and other management agencies in the Kananook Creek corridor in alphabetical order:

Agency	Management responsibilities
Department of Sustainability and Environment	• Land owner of Crown Land downstream of Wells Street to the mouth including Long Island Reserve and the public reserve south of Davey Street (Refer to Drawing No. KCMP-06). FCC is the appointed Committee of Management for the Crown Land reserves. • Approval of the dredging undertaken by FCC at the mouth of Kananook Creek
Environment Protection Authority	• Implementation of the State Environment Protection Policy regarding water quality. • Administration of the dredging protocols. • Approval of the dredging undertaken by FCC at the mouth of Kananook Creek.
Frankston City Council	**Maintenance** (reserves, dredging of mouth of creek) • Ownership of some of the public land in the creek corridor, and management and maintenance of all public land zoned PPRZ and PCRZ. • Maintenance of the local municipal drainage system and gross

Agency	Management responsibilities
	pollutant traps (GPTs) on council drains. • Dredging of the creek mouth to maintain boating access to the public launching ramp. • Maintenance of the Fiocchi Avenue canoe launch ramp in Frankston. • Provision and maintenance of land-based recreational infrastructure (including the above named Canoe Launching Platform, and recreational infrastructure on FCC land), on the southern side of Eel Race Drain and the length of the Kananook Creek corridor including pedestrian bridge crossings. **Land Management** • Committee of Management for the Crown Land downstream of Wells Street. • Retention, restoration and regeneration of the indigenous flora and fauna in Council reserves along the creek corridor. **Water Quality** • Water quality improvement from council drains. **Drainage** • The identification and management of the anticipated threats such as global warming & sea level rises on the council drainage system. **Local Flooding** • Local flooding issues arising from the local council drainage system. **Town Planning and enforcement** • Kananook Creek is subject to the Land Subject to Inundation Overlay (LSIO) of the Frankston Planning Scheme. Under the LSIO, Council must refer applications to Melbourne Water as the floodplain management authority and then ensure that Melbourne Water's requirements are incorporated into the planning application approval. • Land use planning and development approvals under Planning and Environment Act 1987, including administration of the LSIO. • Enforcement of planning permit conditions and local laws. **Environment Protection** • Enforcement of "Building and Works Code of Practice" (under Local Law No.7). **Recreation** • Authorisation of recreation activities in Council reserves.
Kingston City Council	• Provision and maintenance of all recreational infrastructure on the northern side of Eel Race Drain. • Water quality improvement from Kingston City Council drains. • Maintenance of Kingston City Council municipal drainage system and gross pollutant traps on Kingston council drains.
Melbourne Water	**Caretaker of River Health** Melbourne Water's role as caretaker of river health will continue to change and evolve to reflect increased knowledge of waterways and drainage infrastructure, changing community expectations, the capacity of our stakeholders and environmental issues such as climate change and drought. As caretaker of river health, we strive to: • Manage our rivers, creeks and drainage systems to improve waterway health and the wellbeing of the community • Provide a safe level of flood protection for communities • Show leadership and work collaboratively with stakeholders and the community • Provide opportunities for community involvement to strengthen

Agency	Management responsibilities

	connections with waterways and encourage contribution to waterway health
	• Make long-term decisions based on the best available science by undertaking or supporting collaborative research and an extensive monitoring and investigations program
	• Take an integrated and sustainable approach to our work by balancing social, economic and environmental outcomes
	• Evaluate our performance in a transparent manner that promotes our achievements and identifies areas for improvement
	
	A number of Government agencies, organisations and community groups contribute to the management of waterways, drainage and floodplains. Melbourne Water's key responsibilities for Kananook Creek are outlined below:
	
	• **Managing river health** – we manage rivers, creeks, estuaries, wetlands and floodplains, provide flood and drainage management, and monitor river health and undertake community involvement programs. This includes:
	  • Ongoing maintenance of the bed and banks of Eel Race Drain and Kananook Creek, including debris and litter removal, as well as the ongoing operation of the litter boom upstream of Mile bridge. . Management responsibility for the constructed creek walls downstream of Beach Street are currently being negotiated by Frankston City Council and Melbourne Water.
	  • Maintenance of canoe launching ramps in Seaford at McCulloch Avenue, Station Street, Riviera Street and also at Patterson River Secondary College at Eel Race Rd
	  • Operation and maintenance of Patterson Lakes pump station and Riviera Street flood control complex
	  • Floodplain management for Eel Race Drain and Kananook Creek.
	  • Removal of silt from drainage outlets to creek as required to maintain the hydraulic capacity of both the drainage system and the creek
	  • Maintenance of all Melbourne Water-owned land and drains
	  • Responding to pollution events and blue-green algal outbreaks on waterways in consultation with, or under direction from, EPA Victoria
	
	• **Managing development** – Melbourne Water is a statutory referral authority for planning applications under the Land Subject to Inundation Overlay (LSIO). Under the LSIO, Council must refer applications to Melbourne Water as the floodplain management authority under Section 55 of the Planning and Environment Act 1987. As such, all proposed development in the Kananook Creek floodplain must meet Melbourne Water's requirements.
	
	• Melbourne Water prepares long term strategies and schemes to ensure all new urban development meets flood and environmental protection standards. This includes Melbourne Water being a statutory referral authority for all development applications submitted to Council for development in the floodplain and for all works along the bed and banks of the creek, including jetties, moorings, landings and bank edge treatments.
	
	• **Stormwater management** – EPA Victoria, councils, industry and Melbourne Water work in partnership to improve the environmental management of stormwater and incorporate water sensitive urban design.
	
	• **Floodplain management** - Melbourne Water is the Floodplain Management Authority for the Port Phillip and Westernport region. We are responsible for managing drainage systems in catchments generally greater than 60 hectares, and local Councils are responsible for drainage systems in catchments generally less than 60 hectares. We operate a flood-warning network on major rivers and creeks, undertake flood-risk mapping, maintain

Agency	Management responsibilities
	drainage and flood protection infrastructure, and implement flood-risk awareness education programs. Flood protection is also achieved through the planning and provision of infrastructure to service urban growth and placing condition on new developments.
Parks Victoria	• Responsible waterway manager under the *Marine Act 1988*
VicTrack	• Management of land within the railway reserve. • Containment, collection, and disposal of litter on railway reserves.

Community

Kananook Creek Association (KCA)
The Kananook Creek Association was formed in 1974 by a group of residents concerned about the degraded condition of the creek. The Association has grown to over 400 members. Members volunteer their time with hands-on conservation work within the natural reserve including weeding, revegetation, litter clean up days, running community education events such as the annual Kananook Creek Celebration Day and in representing their views on the Kananook Creek Liaison Committee and in other forums.

Kananook Creek Liaison Committee (KCLC)
The Kananook Creek Liaison Committee was formed to support improved cooperation between the agencies of Council, Melbourne Water, Parks Victoria, EPA and community groups working along the creek.

Kananook Creek Canoe Club
A canoe club has recently been formed and holds monthly excursions along the creek.

Local Schools
Four schools are within close proximity to the creek including Patterson River Secondary, Seaford Primary, Seaford North Primary and Kananook Primary. Teachers and students from these schools have utilised the creek for educational activities and have contributed in planting and weeding and other conservation efforts such as Clean Up Australia Day.

Long Island Residents Group
This incorporated body is a group of residents who live on Long Island - a section of land between the creek and foreshore from Wells Street to Allawah Avenue. While the group tends to focus on issues that directly impact the amenity of Long Island, most members are also members of the KCA.

Sporting Groups
A number of sports groups operate from facilities that border the creek. There are opportunities to involve these groups in supporting the preservation of the creek, educating their members about the creek and undertaking conservation activities such as litter reduction and clean up activities.

Non-Profit Service Groups
Several community service groups have a direct or indirect involvement with Kananook Creek. An example is the recent establishment by a service group of a Sunday Farmers Market at a reserve along side the creek. Local scouting groups also have utilised the creek for activities.

Businesses
A range of businesses is located adjacent to the creek. Boating clubs and boat hire companies and tourism businesses have strategic interests in the welfare of the creek. Frankston Tourism Association and the Frankston Business Chambers are two organisations that are likely to have members with commercial interest in the creek.

Kananook Creek Walking Club
Set up with the support of Peninsula Health and the Kananook Creek Association the club promotes walking in the Kananook Creek corridor.

3. ISSUES AND ACTIONS APPLICABLE TO ALL REACHES OF KANANOOK CREEK

3.1 Introduction

The Kananook Creek corridor has been divided into six reaches and Section 4 of the report describes each of these reaches in detail with specific issues and actions relevant to each reach. This Section describes the issues and actions which are applicable to the whole of the creek corridor.

Throughout the Plan the issues and actions have been separated into seven categories which are:

- **Land use (LU)**
  All interface issues along Eel Race Drain and Kananook Creek between private and public land, including in locations where freehold land extends into the riparian zone including to the water's edge.

- **Drainage and flood management (D)**
  This includes flow management along with drainage and flood management issues

- **Water quality (Q)**

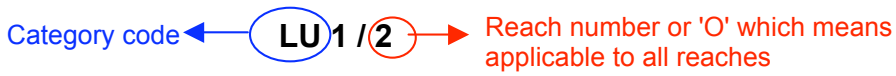
- **Stream system values (S)**
  All stream related issues including stream form, stability and habitat values (including the in-stream and terrestrial values).

- **Vegetation (V)**

- **Recreation and Community use (R)**
  All community related issues including values, community involvement and recreation use

- **Cultural heritage and historical values (H)**
  This includes the Aboriginal (Cultural) and European (Historical) values that require protection

Each of the Issues and Actions in the report has been numbered to easily identify it in the report and locate its position on the plans. The numbering uses abbreviations to link it to its category and reach number. The first part is an abbreviation of the seven categories (headings) listed above. The number after the slash indicates the reach number or it is an abbreviation code of 'O' prior to indicate it is applicable to all reaches.



Priorities are assigned to each of the Issues and Actions to give an indication of the priority order in which they are to be addressed. Implementation of the actions may vary subject to appropriate levels of funding and resourcing being available.

The lead agency/s responsible for leading the implementation the action is indicated first by their initials whilst the support or referral agencies are indicated with brackets. Where responsibility is jointly shared brackets have not been used, but the lead agency will be listed first.

Priority	Indicative timeframe
High	Years 1 to 5
Medium	Years 6 to 10
Low	Years 11 to 15

Abbreviations used in the Issues and Actions Tables include:

Code	Description
AAV	Aboriginal Affairs Victoria
BFL	Boon Wurrung Foundation Limited
BLCAC	Bunurong* Land Council Aboriginal Corporation
C	Community
DPCD	Department of Planning and Community Development
DSE	Department of Sustainability and Environment
EPA	Environment Protection Agency
FCC	Frankston City Council
FOESW	Friends of Edithvale Seaford Wetlands
KCA	Kananook Creek Association
KCC	Kingston City Council
MW	Melbourne Water
PV	Parks Victoria
RAIL	Rail authority

** Please note the spelling of Bunurong is taken directly from the BLCAC website.*

3.2 Land use

The use, values and appearance of the Kananook Creek corridor and Eel Race Drain is influenced by the adjoining land use. There are two types of adjoining land use including :

- **Public land** which includes land owned by public agencies including Council, Melbourne Water and Department of Sustainability and Environment.
- **Private land**

3.2.1 Public land

The majority of public adjoining the creek is managed for nature conservation and passive recreational use. Some of the Melbourne Water owned land is primarily managed for drainage and flood management (e.g. the levee banks to Eel Race Drain). Other areas of public land in the corridor are managed for sporting purposes, transport (railway and public roads/carparks) and community facilities (e.g. community centres).

3.2.2 Private land

Some private land extends to the creek whilst in other locations it adjoins the open space corridor. These have been described in two categories below:

- **Category (a)**
  Private land extending to the edge of the creek which occurs on the western side of Kananook Creek (Reaches 2, 3, 4 and 5), and some properties on the eastern side in the section downstream of Mile Bridge (Reaches 5 and 6).
- **Category (b)**
  Private land adjoining the open space corridor which occurs on both sides of the creek in Reaches 1, 2, 3, 4, 5 and 6.

Locations where private land adjoins roads that front the open space corridor have been assessed in the plan where they are visible from the waterway corridor, e.g. Eel Race Road and Kananook Creek Boulevard.

In both categories, there are potential environmental and visual amenity impacts associated with the proximity and design of the development on adjoining land. In Category (a) the impacts on riparian zone is potentially higher as these properties directly adjoin the creek. In Category (b) the impacts on the habitat values of the corridor are present, but the impacts on the riparian zone are reduced, as they do not directly adjoin the creek. In both categories, development has potential to influence the natural landscape character and the recreational and visual amenity of public users of Kananook Creek and Eel Race Drain.

Below is a summary of the issues associated with development on adjoining private land in each category:

Category (a) Private land extending to the creek edge

- removal of vegetation in the riparian zone and associated terrestrial vegetation
- filling in the floodplain and associated construction to stabilise this fill including retaining walls and fencing;
- lack of space between buildings and the creek to establish sufficient width and height of vegetation to create suitable shading of the stream and vegetation buffer to improve the in-stream and terrestrial habitat values;
- visual prominence of buildings, fences, outbuildings, rear and side fences, retaining walls, decks, jetties and ramps when viewed from within the public open space corridor;
- construction of garages, carports and other outbuildings, decks, jetties, rear and side fences, retaining walls and boat launching ramps at the creek edge breaking the continuity of the vegetated corridor along the creek and impeding flood flows;
- planting non-indigenous vegetation (especially weeds) along the waterway corridor including the riparian zone and floodplain; and
- potential activity including noise and light within the waterway corridor which may have an impact on terrestrial fauna habitat values, however, it is acknowledged there is insufficient terrestrial fauna data to confirm the impacts.

Category (b) Private land adjoining the open space corridor

- construction of buildings close to rear property boundary necessitating removal or trimming of large remnant trees in the adjoining public open space;
- visual prominence of buildings and fences when viewed from within the open space corridor;
- construction of fences which can potentially impact on flooding (e.g. increased roughness in the floodplain causing potential change to flood heights);
- high boundary fences reducing passive surveillance into the public reserve;
- weeds in private gardens spreading into the adjoining open space;
- encroachment into public land where there is no defined boundary between private and public land; and
- filling in the floodplain and associated construction to stabilise this fill including retaining walls and fencing.

3.2.3 Summary of key issues and outcomes for land use

Summary of key issues applicable to all reaches:

- height, bulk and proximity of buildings to the creek corridor impacting on the environmental values and visual landscape amenity of the creek corridor;
- structures and built form adjacent to the waterway including jetties, boat ramps, decks, rear and side fences, carports and other outbuildings, boatsheds and retaining walls which preclude the opportunity to rehabilitate the riparian zone and associated terrestrial vegetation;
- loss of riparian vegetation and associated terrestrial vegetation in adjoining land leading to loss of in-stream and terrestrial habitat values; and
- potential impact of noise, light and activity on the habitat values of the creek corridor (subject to further studies on terrestrial fauna values).

Summary of key outcomes to be achieved in all reaches:

- development to meet Melbourne Water requirements for Kananook Creek including set back minimum 10 metres from top of bank or to land with existing surface levels above the 1.5 metre contour, whichever is the greater distance from top of bank, and no change to the floodway capacity or flows;
- allow adequate set back from the creek to protect and reinstate indigenous overstorey to improve habitat values and break up the visual height and bulk of buildings from within the open space corridor;
- minimise built form directly adjacent to the creek, including jetties, boat ramps, decks and fences, to protect and re-establish indigenous vegetation in the riparian zone;
- reduce visual prominence of built form from within the open space corridor and manage future development to retain recreational and visual amenity through preservation and enhancement of the natural landscape character;
- protect and reinstate existing indigenous vegetation in the riparian zone and associated terrestrial vegetation and increase its presence where gaps currently exist to improve the environmental values of the creek corridor; and
- minimise impacts of noise/light and activity on the habitat values of the waterway corridor by achieving adequate set back and vegetation screening as outlined above.

No.	Issue	Action	Priority	Respons-ibility
LU1/O	Adjoining development impacts on Kananook Creek and Eel Race Drain's environmental, landscape, recreational and visual amenity values of the creek, including the proximity of buildings, their height, bulk, and materials, and the clearing or lack of opportunity to reinstate riparian and associated terrestrial vegetation.	Introduce planning scheme provisions which cover the riparian zone and associated terrestrial vegetation, to ensure the impact on environmental values of the Kananook Creek floodplain (including habitat continuity) are considered in future development applications. The provision should highlight the environmental significance and intent of the Agencies to protect and, where feasible and appropriate, reinstate the environmental and biodiversity values of Kananook Creek. It should target development (eg. those buildings and works, landscaping plans) and vegetation removal, which affect floodplain, environmental and biodiversity values.	High	FCC MW
		Encourage planting with indigenous or other appropriate species in existing developments on private land through community education and information. Provide education and support to adjoining landowners in revegetating the riparian zone on their properties	High	FCC
		Use Frankston City Council's proposed Neighbourhood Character Guidelines to assist in protecting the landscape and recreational/visual amenity values of Kananook Creek and Eel Race Drain. Some of the provisions of the guidelines complement the above environmental and biodiversity action.	High	FCC
		Investigate through the Planning Scheme Review the expanded use of Neighbourhood Character Guidelines.	High	FCC
		Investigate the extent of Acid Sulphate Soils along the creek	High	FCC DSE

No.	Issue	Action	Priority	Respons-ibility
LU2/O	Earthworks and structures along Kananook Creek potentially change flood flows and flood capacity.	Continue to use the LSIO to manage the floodplain to address potential impact of earthworks and structures along Kananook Creek.	High and Ongoing	FCC MW
LU3/O	Structures adjacent to the waterway, including buildings, jetties, boat ramps, decks and fences result in adverse environmental changes and preclude the opportunity to rehabilitate the riparian zone and associated terrestrial vegetation.	Introduce planning scheme provisions which cover the riparian zone and associated terrestrial vegetation, to ensure the impact on environmental values of the Kananook Creek floodplain (including habitat continuity) are considered in future development applications. See also LU1/O.	High	FCC MW
	Systems and processes for approvals of jetties, built structures and edge treatments are not clear and timely.	Finalise and promote the guidelines for the construction and maintenance of jetties and built structures on the creek banks.	High	FCC (MW)
		Undertake an audit of jetties and creek bank structures and establish an enforceable regulatory regime for existing structures.	High	FCC
		Apply and enforce existing and future controls for approvals and maintenance of jetties, built structures and edge treatments to Kananook Creek in an effective and timely manner.	Ongoing	FCC
LU4/O	Fencing between private land and Kananook Creek or the creek reserves potentially impact on the floodplain, create surveillance issues and affect the visual character of the creek corridor. Lack of boundary fencing in some locations allows private uses to encroach on public land.	Prepare fencing guidelines for the Kananook Creek Corridor to address potential impact of fences on the floodplain, surveillance issues, visual character of the creek corridor and in some locations encroachment of private uses on public land.	High	FCC MW

3.3 Drainage and flood management

Overall there is a need to recognise that the large catchment flows that created the size and width of Kananook Creek are no longer naturally available to the creek. Even though flows have been increased with the pumping of Patterson Lakes water through the Kananook Creek system, these will not be sufficient to maintain the original sized creek channel. The current operation of the Riviera Street Flood Control Complex to protect floodplain lands from adverse flooding limits the extent of benefit that could be derived from the larger flood flows arriving in the Boggy Creek Catchment, as these are diverted out through the Riviera Street Flood Control Complex. Whilst the current arrangements provide base and small event flows, the creek would benefit from having increased frequency of event flows to flush out the system, and periodically inundate the riparian zone which is showing signs of stress from a combination of lack of periodic inundation and higher salinity levels. A large proportion of medium and large event flows is diverted out through the Riviera Street Flood Control Complex and in major events (e.g. 1:100 year ARI) storage and ponding in the upstream Boggy Creek floodplain and overflow into the Seaford Wetlands will occur.

There is a need to investigate the feasibility to source alternative seasonal freshwater flows in addition to the saline flows from Patterson Lakes. This has the benefit of increasing the freshwater input to provide a fresh brackish gradient to the upper estuary area consistent with a more natural profile and potentially reduce the effects of marinisation on Kananook Creek and Eel Race Drain (Refer to 3.3 for more information regarding water quality). All options would need to ensure they do not have a detrimental impact on the environmental values from where they are sourced. Increased freshwater flows into Eel Race Drain will also provide a freshwater source to Seaford Wetlands which requires additional seasonal freshwater flows to improve its ecology including appropriate vegetation communities for the migratory birds. Installation of a submerged weir upstream of the Kananook Creek Pump Station may be required to limit saline intrusion (ASM, 2007).

Kananook Creek is likely to be susceptible to the future impacts of human-induced climate change. Potential rises in sea level and/or storm surges may have some impact on the drainage outfalls that discharge into the creek, and on flood management. However, these climate change impacts have not been investigated as part of this management plan study. The Westernport Greenhouse Alliance, of which Frankston City Council is a member, has engaged consultants to undertake the 'Climate Change Impacts and Adaptations Study' which is gauging the impacts of climate change on the built environment of member councils. Council will receive data on the impacts of climate change on the municipality in 2008 and will apply this data to Kananook Creek.

Melbourne Water is providing support to the Department of Sustainability and Environment and CSIRO on a climate change study. The study involves the capture of up-to-date contours (0.5 metres) and storm surge analysis.

Summary of key issues applicable to all reaches:

- the change in catchment size and flood control measures has resulted a change in the creeks flow patterns and a lack of event flows in Kananook Creek which are needed to naturally maintain the creeks original cross-sectional size and periodic inundation of the riparian zone;
- reduction in base flows when the Kananook Creek Pump Station loses power (during local blackouts);
- future impacts of climate change will be addressed once the anticipated impacts are quantified; and
- saline flows from the Patterson River have increased salinity levels in the creek resulting in the potential change of the riparian vegetation from brackish to saline communities.

Summary of key outcomes to be achieved in all reaches:

- develop a system to allow the creek to have an increased number of event flows from the upper catchment to naturally retain some of the creek cross-sectional area and inundate the riparian zone to help protect it; and
- investigation into the reintroduction of a fresh brackish gradient to the upper estuary areas of the creek consistent with a more natural profile and protect the remnant riparian vegetation.

No.	Issue	Action	Priority	Respons-ibility
D1/O	Lack of smaller event flows downstream of Riviera Street Flood Control Complex to flush out the system and periodically inundate the riparian zone.	Investigate options and the feasibility to improve the flow regime in Kananook Creek downstream of Riviera Street Flood Control Complex to provide some periodic inundation to the riparian zone and to flush out the Kananook Creek system.	High	MW

No.	Issue	Action	Priority	Respons-ibility
D2/O	Existing flows are reliant on the ongoing operation of the Kananook Creek Pump Station, and when there are power failures, the flows cease in the creek causing impacts on downstream ecology and amenity values. Additionally all the flows being pumped into the system are saline which impacts on the creek's ecology.	Investigate options and the feasibility to increase alternative seasonal freshwater flows into the system to achieve the following: • provide additional base freshwater flows to compensate for occasions when there is cessation of flows from the Kananook Creek Pump Station; • improve the water quality and establish a salinity gradient for the stream by increasing freshwater flows to achieve a brackish profile; • potential reduction in the volume of flows required to be pumped into the system during late Autumn, Winter and early Spring, which reduces seasonal pump use and energy consumption; and • potential to provide increased seasonal freshwater flows into Seaford Wetlands to improve habitat for migratory waterbirds.	High	MW
D3/O	Projected impacts of climate change may have impacts on drainage and flood management.	Investigate the impacts of climate change on Kananook Creek once the two separate studies currently being undertaken are complete. These two studies include one by the CSIRO for DSE/MW and a second prepared by the Westernport Greenhouse Alliance titled 'Impacts of Climate Change on Settlements in the Western Port Region'.	High	FCC MW
D4/O	Sediment build up at major drain outlets.	Melbourne Water to continue the existing maintenance program to clear drain outlets where sediment build up causes flood risks.	Ongoing	MW

3.4 Water quality

Historically the water quality in Kananook Creek was relatively poor due to a range of factors outlined in the 2.3.2. The introduction of increased saline flows via the Kananook Creek Pump Station has addressed the historical issues with water quality, including maintaining reasonable dissolved oxygen levels, and flushing flows to reduce effects of acid sulphate groundwater in the system. The saline flows have, however, altered both the in-stream ecology of the creek and the riparian vegetation along the fringes. There is potential to investigate the feasibility of introducing additional seasonal (late autumn, winter and early spring) freshwater flows into the system with the aim of achieving a number of improvements listed in D2/O. This will assist in reducing the favourable conditions for the major marine algal blooms by introducing freshwater to achieve a seasonal salinity gradient, and higher turbidity levels reducing light penetration to the creek. The creek has blooms of opportunistic macro algae such as *Enteromorpha* intestinalis due to a range of factors including nutrient levels, salinity levels, water temperature and water column turbidity.

Water quality monitoring results indicate elevated nutrients from all sources including contaminants commonly associated with urbanised catchments. There will be a need to seek opportunities to reduce these contaminants via stormwater quality treatment and WSUD in the catchment. .

Whilst the system is largely marinised, the State Environment Protection Policy (Waters of Victoria) (SEPP) prepared by the Environment Protection Authority Victoria, categorise this

as a freshwater stream which means that inappropriate criteria is used to assess the water quality of Kananook Creek.

The sandy nature of the catchment delivers high sediment loads into the creek via the existing underground stormwater drainage system. This combined with the historical reduction in flows to the creek has resulted in a build up of sediment over time, in part as a natural response to the aggradation of the channel as the volume of flows are not available to keep the channel as wide as it once was. Dredging of the creek has not occurred since the Draft EPA Guidelines for Dredging were introduced in 1992 and adopted in 2001. In recent times the only dredging that has occurred in the stream is at the creek mouth to Port Phillip Bay. Frankston City Council undertakes this under license from the EPA and DSE to maintain an open channel for boat access into the lower reach of the creek. Melbourne Water has a maintenance program to regularly clean out the drain outlets where sediment build up causes flood risks.

Summary of key issues applicable to all reaches:

- increased salinity of the system by the diversion of flows into the creek from Patterson Lakes changing the in-stream habitat values and riparian vegetation;
- high sediment loads in the creek due to the sandy nature of the catchment, which has required periodic dredging, however, EPA Guidelines adopted in 2001 have made it difficult to dredge due to higher environmental standards regarding disposal of sediment; and
- elevated contaminant levels associated with urban runoff.

Summary of key outcomes to be achieved in all reaches:

- Investigation into the reintroduction of a fresh brackish gradient to the upper estuary areas of the creek consistent with a more natural profile and protect the remnant riparian vegetation (Refer to 3.3); and
- Investigation into options to potentially reduce sediment build up in the stream to retain recreational boating access and minimise impact on water quality.

No.	Issue	Action	Priority	Respons-ibility
Q1/O	Marinisation of the creek downstream of the Kananook Creek Pump Station limits the establishment of an estuary gradient.	Refer D2/O for action to address marinisation of the creek downstream of the Kananook Creek Pump Station. Refer also to S1/O regarding macro algal blooms.	Refer D2/O	Refer D2/O
Q2/O	Sediment build up in Kananook Creek impacts on in-stream habitat values, and reduces navigability of the stream affecting recreational use and amenity.	Commit to WSUD for all local government infrastructure projects where feasible to reduce sediment build up in the stream.	High and Ongoing	FCC
		Ensure new development meets appropriate standards for stormwater quality through the development approvals process to reduce impacts on in-stream habitat values.	High and Ongoing	FCC
		Melbourne Water will actively manage sediment in the lower reaches of Kananook Creek in order to provide appropriate access for canoes.	High	MW
		Incorporate snag maintenance for litter in creek maintenance program where feasible and consistent with river health outcomes.	Ongoing	MW
		Refer to S5/O	Refer S5/O	Refer S5/O

No.	Issue	Action	Priority	Respons-ibility
Q3/O	Sandy nature of the catchments delivers high sand/sediment load to the Kananook Creek via the existing stormwater drainage system.	As part of the review of Council's SWMP continue to investigate catchment based stormwater quality improvement works and water sensitive urban design adoption opportunities to reduce sand/sediment and other contaminant loads reaching the creek.	High	FCC (MW)
Q4/O	EPA's SEPP water quality criteria for Kananook Creek are currently based on fresh water criteria whereas the stream is a saline system.	Liaise with EPA to investigate revising the SEPP criteria for Kananook Creek to a saline system to allow appropriate criteria to be applied to the water quality of Kananook Creek.	High	MW EPA
Q5/O	Impact of urban stormwater on the Kananook Creek.	Investigate capture of pollutants and litter at source.	High	FCC
		Continue to investigate stormwater quality treatment opportunities and WSUD in the catchments where possible. Commit to WSUD for all local government infrastructure projects where feasible.	High and Ongoing	FCC MW
		Plan and implement cost effective systems that will significantly reduce litter and pollutants going into the waterways	High	FCC MW
		Ensure new development meets appropriate standards for stormwater quality through the development approvals process to reduce impacts of stormwater on Kananook Creek.	High and Ongoing	FCC

3.5 Stream system values

Kananook Creek has records of rare and threatened species occurring within it, and the most recent fauna survey which included terrestrial fauna for part of the Kananook Creek corridor, was undertaken in 1999. The 1999 study identified a large diversity of birds in the corridor and linked this to the presence of the Foreshore and Seaford Wetlands nearby. The habitat values of all three areas were noted to be linked and a significant change in one could impact on the values of the other areas.

The in-stream fauna values are up to date with the fish study undertaken in 2006 (McGuckin, 2006*)* and a current study being undertaken by the Kananook Creek Association via a Melbourne Water funding contribution.

Summary of key issues applicable to all reaches:

- a high diversity of birds were recorded in the Kananook Creek corridor in 1999, however, there has been no recent study of the terrestrial fauna values;
- impact on fauna values from feral animals; and
- in-stream fauna values are threatened by periodic cessation in flows and large macro algal blooms.

Summary of key outcomes to be achieved in all reaches:

- protect and improve terrestrial fauna values in the Kananook Creek corridor; and
- protect and improve the in-stream fauna habitat values.

No.	Issue	Action	Priority	Respons-ibility
S1/O	In-stream fauna values are threatened by large algal blooms (*Enteropmorpha intestinalis)* which can reduce available oxygen in the stream.	Investigate means to improve the management of large algal blooms in Kananook Creek to improve the in-stream habitat values. This issue will potentially be addressed in D2/O.	High	MW
S2/O	Previous records and surveys indicated there are some rare and threatened terrestrial fauna along the Kananook Creek corridor, however, there is a lack of recent terrestrial fauna survey for the Kananook Creek corridor.	In the short-term protect existing terrestrial fauna values by minimising further loss of indigenous vegetation in the waterway corridor, and revegetation with appropriate indigenous species where appropriate to strengthen the links. Refer to LU1/O and LU3/O. For medium-term action refer to S3/O.	High & Ongoing	FCC MW
S3/O	Refer to S2/O	Prepare a habitat assessment for the terrestrial component of the Kananook Creek corridor including desktop review of existing information, conduct additional field survey work, and prepare management recommendations for the ongoing protection and improvement of terrestrial habitat values including any requirement for feral animal control. This should be undertaken prior to finalising revegetation priorities, as the habitat assessment will inform appropriate priorities.	Medium	FCC (MW)
S4/O	Loss of riparian vegetation has resulted in less shading over the stream and loss of in-stream habitat values.	Protect existing riparian vegetation from further loss, and where possible, increase the presence of riparian vegetation to improve the in-stream habitat values. Refer to LU1/O and LU3/O.	High & Ongoing	FCC MW
S5/O	High sediment loads in the creek due to the sandy nature of the catchment impacts on in-stream habitat values.	Undertake an overall investigation into the environmental issues associated with sedimentation and the feasibility of potential options to address the river health impacts of sediment build up.	High	MW FCC PV EPA

3.6 Vegetation

The Kananook Creek corridor been identified by Ecology Australia (2006) to be of Very High Significance in the Kananook Creek Corridor. The nearby Seaford Foreshore Reserve which runs adjacent to Kananook Creek has been identified to be of Very High Significance, and the nearby Seaford Wetlands is of International Significance.

The more detailed assessment of vegetation in the corridor undertaken as part of the Management Plan (Bushland Management Services, 2007) has identified that the riparian vegetation is under stress, which could in part be due to the increased marinisation of the creek affecting the salinity levels and vegetation. The gaps in riparian vegetation, particularly on the west side of the creek have decreased the habitat connectivity and potential values of the corridor.

Weed invasion and the degradation it causes is a significant threat to the survival or remnant vegetation. Major weeds include introduced grasses and smothering ground covers and climbers such as Wandering Creeper (*Tradescantia)*, Buffalo Grass, Kikuyu, Bridal Creeper and Cape Ivy. Council, the community and Melbourne Water have undertaken extensive works to address the woody weeds in the catchment and whilst these are still scattered

through the corridor they are less of a threat than the other categories of weeds. The community advise the Rust Fungus and potentially the Leaf Hopper appear to be having an impact on Bridal Creeper in the reserve.

Included in this section are some of the overall issues and recommendations that affect most or all of the reaches. Refer to the Reach Issues and Recommendations in Section 4 for specific actions.

Summary of key issues applicable to all reaches:

- gaps in the riparian vegetation reducing the habitat connectivity and function of the riparian corridor and the associated terrestrial vegetation;
- stressed condition of remnant riparian vegetation, the cause of which is unknown, however is assumed to be the increased marinisation of the stream; and
- weed invasion threatening the condition of indigenous vegetation and the lack of consistent weed mapping on all public land and monitoring to address this.

Summary of key outcomes to be achieved in all reaches:

- re-establish and rehabilitate a continuous riparian corridor with associated terrestrial vegetation along Kananook Creek on public and private land;
- identify the cause of the decline in remnant riparian vegetation and implement works to prevent further decline; and
- continue to control major weeds in the corridor including recent emergent weeds.

No.	Issue	Action	Priority	Respons-ibility
V1/O	Fire management particularly due to large amounts of debris generated by the vegetation type and fire being integral to the recruitment of native species in this vegetation community.	Undertake regular formal reviews the outcome of works from the ongoing fire management program in the *Kananook Creek Reserve A Fire Management Works Plan (FCC, 1998)*, and refine recommendations where required to integrate with ongoing conservation and vegetation management works in the corridor.	Ongoing	FCC
V2/O	Poor longitudinal continuity restricting biodiversity function of the riparian corridor.	Undertake revegetation works in the gaps in the riparian zone to improve continuity along the Kananook Creek Corridor, along with weed control in the areas with existing indigenous vegetation. Refer to the Reach recommendations for locations of future weed control and revegetation. Refer to LU1/O and LU3/O for vegetation on adjoining freehold land.	Refer Section 4 for site specific actions.	Refer to Section 4 for site specific actions
V3/O	Potential long-term changes to vegetation within the Kananook Creek corridor due to increased marinisation of the creek system.	Establish a detailed quadrat and floristic survey to provide a benchmark for long-term changes in the Kananook Creek corridor due to potential impacts from increased salinity. Monitor the site, and adjust and amend the species used in revegetation to suit the changing conditions.	Medium	FCC (MW)
V4/O	Ongoing loss of riparian vegetation to the creek on private land leading to a decline in in-stream and riparian habitat values.	Refer Action LU1/O to address ongoing loss of Riparian vegetation to the creek on private land.	Refer LU1/O	Refer LU1/O

No.	Issue	Action	Priority	Respons-ibility
V5/O	Ongoing loss of riparian vegetation to the creek on public land leading to a decline in in-stream and riparian habitat values.	Investigate the cause of vegetation loss along the riparian zone, and aim to ensure suitable species are used in regeneration works on public land. Provide support and supervision to the Kananook Creek Association and other community groups undertaking revegetation works on public land.	Medium Ongoing	FCC (MW) FCC
V6/O	Use of non-indigenous natives which have the potential to become weeds in the Kananook Creek corridor.	Remove the plantings of non-indigenous *Carpobrotus glaucescens* and replace with *Carpobrotus rossii.*	Medium	FCC
V7/O	Use of non-indigenous natives which have the potential to become weeds in the Kananook Creek corridor.	Progressively remove the non-indigenous *Eucalyptus botryoides* and replace with appropriate indigenous overstorey (refer to EVC templates for appropriate species for where removal occurs).	Ongoing	FCC
V8/O	Weed invasion in the Kananook Creek corridor is impacting on the habitat values and health of the remaining remnant vegetation. This includes a lack of consistent weed mapping, control and monitoring.	Undertake accurate weed mapping for all public land (in addition to recent RRR mapping on FCC Council land), in the Kananook Creek corridor in accordance with Reach Recommendations. Prioritise control of new and emergent weeds to minimise opportunity for them to spread further through the system. Develop a practical monitoring system to allow evaluation of the success of weed control techniques including biological controls and adjust where required.	High	FCC MW KCC
V9/O	Unrestricted human access along some sections of the Kananook Creek corridor causing disturbance and degradation of vegetation structure and introduction of weeds.	Discourage uncontrolled access through improved definition of paths, as recommended in R1/O, monitor, and selectively fence areas where trail improvements do not prevent unrestricted access.	Ongoing	FCC
V10/O	Suitable species for revegetation, particularly given the changed conditions in the waterway corridor	Develop a Vegetation Implementation Plan that includes suitable species lists for revegetation in different parts of the waterway corridor. The Implementation Plan will need to address the issues identified in this Management Plan.	High	FCC MW

3.7 Recreation and community use

The Kananook Creek open space corridor provides excellent linear open space opportunities including a continuous trail, access by watercraft, the opportunity to link to other major reserves including the Frankston Foreshore, Seaford Foreshore and the Seaford Wetlands, and the opportunity to cross through the reserve to link the residential areas on both sides of the creek and to connect residents who live on the east to the foreshore.

The community use the creek corridor both informally and via some organised community based recreational clubs including sports, boating and walking clubs.

Private land to the creek's edge on some sections of Kananook Creek limits public access and use for looped walking trails, and the east-west access. Development on adjoining private land is highly visible from within the waterway corridor, and impacts on the natural

character of the creek in Reaches 2 to 5. High solid rear boundary fences and lack of passive surveillance from adjoining properties has made some sections of the trail feel unsafe. As Eel Race Drain is further developed for environmental and recreational purposes, development on private land will become more important to the natural character of this corridor.

Summary of Key issues applicable to all reaches

- the lack of a well signed and accessible linked trail along Kananook Creek corridor including Eel Race Drain;
- open space reserves adjoining the creek lack a diversity of recreational facilities which restricts its appeal and use to the diverse community including local and regional visitors;
- incremental impact of adjoining development on the peaceful enjoyment and use of the Kananook Creek/Eel Race Drain open space corridor; and
- small watercraft use of the creek is limited by the poor condition of launch ramps and the lack of associated facilities at these points.

Summary of Key outcomes applicable to all reaches

- a continuous accessible trail along the length of Kananook Creek and Eel Race Drain linking the other regional open space reserves including the Foreshore reserve and Seaford Wetlands;
- passive recreational facilities provided at key entry points to the Kananook Creek trail as destination points along linear trail and accessible entry points into the reserve;
- well integrated directional and interpretive signage reflecting the natural values and qualities of Kananook Creek; and
- successful balance of passive surveillance of the open space from adjoining properties and sensitive interface treatment to adjoining development such that it does not overwhelm the natural character of the creek corridor.

No.	Issue	Action	Priority	Respons-ibility
R1/O	Kananook Creek Corridor is a Municipal open space, yet the existing facilities are inconsistent with this level of open space, particularly facilities for longer stay use.	Sensitively improve recreation facility provision along the Kananook Creek corridor to improve accessibility and compatible with the environmental values.	Refer Section 4	Refer Section 4
R2/O	The existing trail network has variable surface treatments and steps throughout its length. This makes all-ability access more difficult. Additionally the community identified personal safety concerns.	Prepare a trail network plan that considers all-ability access and public safety in the context of being sensitive to the environmental values. The trail network plan is to include: • options to remove/reduce steps along the path; • improve all-ability access in regards to trail surface; and • address personal safety concerns including review of the trail alignment and adjacent vegetation to allow longer sightlines down the trail to assist people make decisions regarding their personal safety.	Medium	FCC
	Lack of clarity on the status of trails.	Determine the status of sections of the trail network i.e. 'shared use', 'walking only' or 'nature trail' and sign appropriately. The trail is to be maintained as a nature trail north of Station Street.	Medium	FCC

No.	Issue	Action	Priority	Respons-ibility
R3/O	Lack of on-site interpretative material about the creek, its cultural, historical and natural values, including the habitat connectivity to Seaford Wetlands and the Foreshore. Additionally, there is a need for directional and regulatory signage.	Prepare a Signage Plan for the Kananook Creek corridor which includes consideration of the following: • identify visible points at which to install directional, regulatory and interpretive signage; • identify appropriate scope of content to be included at each of the interpretive sign locations; • designs to be robust in a public setting to address vandalism and graffiti whilst being sensitive to the environmental and landscape values of the site; and • refer to H2/O for consideration of Aboriginal cultural heritage and European historical values.	Medium	FCC
R4/O	The lack of quality visitor destination points in the larger open space reserves within the Kananook Creek corridor.	Investigate the potential to establish facilities that improve the community use including seats, picnic facilities and play compatible with environmental values. Two locations for these upgrades include: • Seaford Community Centre in accordance with the Seaford Life Saving Club Precinct Masterplan (2004) • Riviera Street Reserve	Refer Section 4	Refer Section 4
R5/O	Non-motorised watercraft use of Kananook Creek is popular and associated facilities including parking, picnic, paths etc are not well provided for. The increased number of private launching points/ jetties is degrading the riparian zone.	Upgrade the visitor facilities associated with the canoe launching ramps where space permits. This includes parking, paths and picnic areas. There is space to upgrade the ramps with associated facilities at the following locations: • Seaford Community Centre as part of the Seaford Life Saving Club Masterplan (2004); • Riviera Street Reserve; and • Long Island Reserve as part of the Kananook Creek Reserve, Long Island Environmental Management and Development Plan.	 Medium Low High	 FCC FCC FCC
R6/O	Lack of navigability of Kananook Creek for watercraft due to build up of sediment along its length and woody debris.	• Clarify responsibilities for water-based recreation in Kananook Creek and how these will be delivered. • Lack of navigability due to sediment build up in the creek to be assisted by implementing S5/O and Q2/O. • Whilst woody debris in the creek provides important in-stream habitat, Melbourne Water will actively manage woody debris to provide appropriate access for canoes. • Investigate long term options of navigability of small shallow-draft watercraft, including developing a long term maintenance plan and funding options for this maintenance. • Refer also to S5/O	High Refer S5/O & Q2/O Ongoing Medium Refer S5/O	MW PV FCC Refer S5/O & Q2/O MW FCC MW Refer S5/O

No.	Issue	Action	Priority	Respons-ibility
R7/O	Kananook Creek Association and other community groups promote the recreational use and understanding of the natural values of the creek corridor by running community education events.	Agencies will continue to provide support to Kananook Creek Association and other community groups in holding community educational events in the creek corridor including the Celebration Day.	Ongoing	FCC MW C
R8/O	Recreational fishing	Recreational fishing to continue in Kananook Creek where it is compatible with waterway health values described in the plan.	Ongoing	FCC PV (MW)
R9/O	The Regional River Health Strategy (RRHS) outlines the management objectives for Kananook Creek. The review of the RRHS will occur in about two years time.	Council to conduct with the community a Visioning exercise for Kananook Creek to inform the revision of the Regional River Health Strategy to consider environmental, social and recreational aspects of the creek.	High	FCC

3.8 Cultural heritage and historical values

The Kananook Creek corridor is identified to have high Aboriginal archaeological sensitivity with high potential for Aboriginal archaeological sites (Austral Heritage, 1998).

The only European historical values occur in the lower reaches of the creek and are discussed in Reaches 5 and 6, Sections 4.5 and 4.6.

Summary of key issues applicable to all reaches:

- the creek corridor has high Aboriginal cultural heritage and archaeological sensitivity; and
- the lower reaches have some European historical values that require protection in future works.

Summary of key outcomes to be achieved in all reaches:

- protect and interpret the Aboriginal cultural heritage and archaeological values of the Kananook Creek corridor; and
- protect and interpret the European historical values of the lower reaches of Kananook Creek corridor.

No.	Issue	Action	Priority	Respons-ibility
H1/O	The Kananook Creek corridor is identified as an area of high Aboriginal heritage sensitivity.	Any future works in the Kananook Creek corridor that involve significant ground disturbance is likely to require a Cultural Heritage Management Plan to be prepared and approved by AAV prior to commencement of works under the current *Aboriginal Heritage Act 2006*. This applies to public and private land.	Ongoing	FCC MW Land-holders

No.	Issue	Action	Priority	Respons-ibility
H2/O	Lack of interpretation of the Aboriginal archaeological and cultural heritage values, along with the European historical values for the Kananook Creek corridor.	In consultation with the BLCAC and BFL identify opportunities to integrate interpretation of the Aboriginal archaeological and cultural heritage values of the Kananook Creek corridor at the key visitor destination points identified for the site including: • Eel Race Drain in conjunction with Seaford Wetlands the school • Riviera Street Reserve • Seaford Township • Long Island Reserve Identify appropriate European historical information to interpret and include in the Signage Plan including reference to the fishing and boating use of Kananook Creek, refer R3/O and H3/6.	Medium	FCC BLCAC BFL (AAV) (MW)

4. REACH DESCRIPTIONS, ISSUES AND ACTIONS

This section of the paper describes each of the six sections in more detail with specific issues and actions applicable to each reach. The reaches are:

- Reach 1 - Mornington Peninsula Freeway to Eel Race Road
- Reach 2 - Eel Race Road to Armstrongs Road
- Reach 3 - Armstrongs Road to Seaford Road
- Reach 4 - Seaford Road to Mile Bridge
- Reach 5 - Mile Bridge to Wells Street
- Reach 6 - Wells Street to Port Phillip Bay

Figure 3 illustrates the reach breakdown. For Existing Conditions in the creek corridor, refer to Drawing Numbers KCMP-01 to KCMP-06. The existing vegetation communities are illustrated on Drawing Numbers KCMP-07 to KCMP-10. The Management Plan actions are illustrated on Drawing Numbers KCMP-11 to KCMP-16.

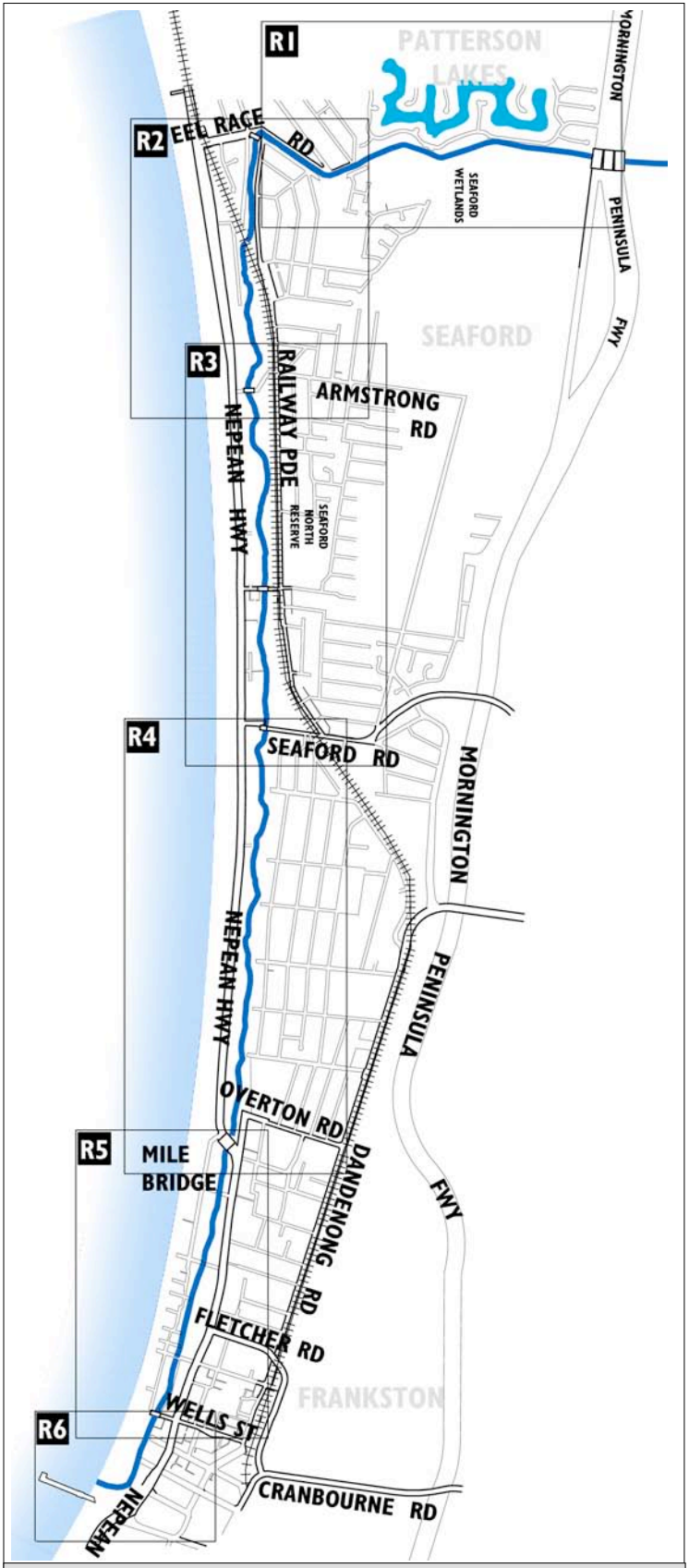


FIGURE 4 REACH BREAKDOWN FOR KANANOOK CREEK CORRIDOR MANAGEMENT PLAN

4.1 REACH 1
Mornington Peninsula Freeway to Eel Race Road

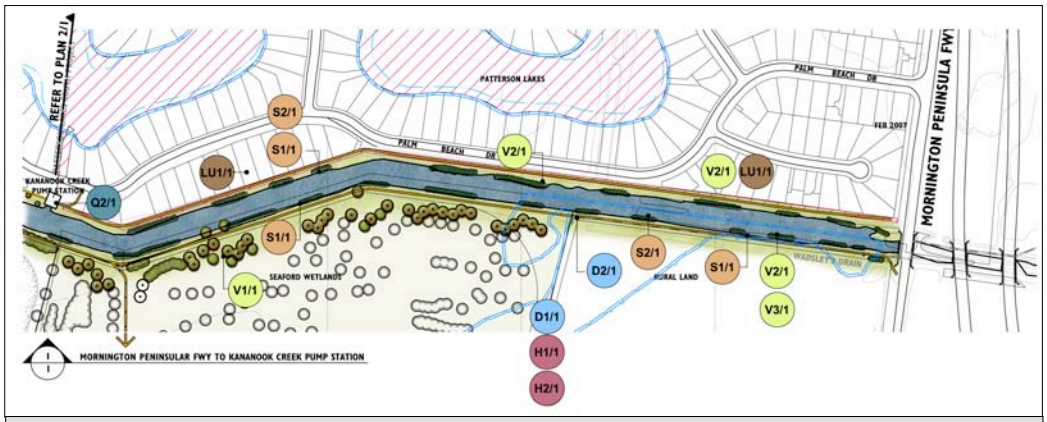


FIGURE 4.1~1 EEL RACE DRAIN MORNINGTON PENINSULA FWY TO KANANOOK CREEK PUMP STATION
Extract from Drawing KCMP-11 Not to scale

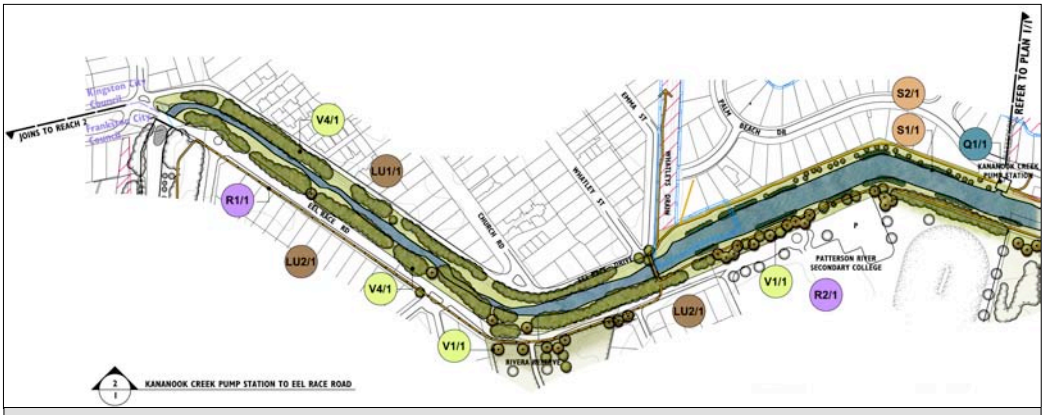


FIGURE 4.1~2 EEL RACE DRAIN KANANOOK CREEK PUMP STATION TO EEL RACE ROAD
Extract from Drawing KCMP-11 Not to scale

4.1.1 Introduction

Eel Race Drain was originally cut as part of drainage and flood protection works undertaken by the Carrum Trust in the late 1800s. A series of drains were constructed to convey Boggy Creek and its catchment to Eel Race Drain and the former head of Kananook Creek at Eel Race Road, Carrum. Eel Race Drain was enlarged after the 1934 floods and again in the 1950s and late 1970s. Refer to the Overall Summary in Section 2.3 Flow Management and Water Quality regarding the former Carrum Carrum Swamp and brief overview of historical drainage pattern.

The drain, flood protection levee banks and adjoining public land is owned and managed by Melbourne Water and forms the boundary between the municipalities of Frankston and Kingston, with City of Kingston to the north and Frankston City Council to the south. The drain is a constructed channel and the levee banks of the channel upstream of Whatley Street Footbridge were modified in the 1980s in conjunction with the construction of Patterson Lakes to prevent flooding. Downstream of Whatley Street footbridge the channel appears more 'natural' in character with established vegetation. The banks of Eel Race Drain form levee banks to protect the adjoining residential areas from flooding. Whilst there

is limited vegetation on the levee banks, there is remnant vegetation in Seaford Wetlands, Patterson River Secondary College and Riviera Reserve.

Seaford Wetlands adjoins the southern side of Eel Race Drain downstream of the Mornington Peninsula Freeway. The wetlands form part of the Edithvale-Seaford Wetlands complex and are protected under the Ramsar Convention for habitat values. The Wetlands are currently linked to event flows from Eel Race and Wadsleys Drains and provide an important flood storage area to protect the urban area south of Eel Race Drain from flooding. Patterson Lakes adjoins the northern side and sea water from Patterson Lakes is pumped into Eel Race Drain via the Kananook Creek Pump Station to provide continual flows to Kananook Creek and prevent stagnation of the waters in Patterson Lakes. The pump station is located on the north side of Eel Race Drain and has recently been upgraded by Melbourne Water.

There is an existing trail on both sides of Eel Race Drain between Mornington Peninsula Freeway and Whatley Street Footbridge. Downstream of Whatley Street Footbridge there is no trail on the either side of Eel Race Drain, and access is via existing footpaths on Eel Race Road. Patterson River Secondary College adjoins the southern side of the drain and a large residential community live to the north in Patterson Lakes. There is potential to involve the community in on-going environmental and recreational improvements to the drain.

Key issues that need to be resolved in this reach include:

- Lack of environmental and recreational links between Eel Race Drain, Seaford Wetlands and Kananook Creek
- Marinisation of Eel Race Drain and impacts of increased salinity on Seaford Wetlands and Kananook Creek
- Two schools are located nearby Eel Race Drain including Patterson River Secondary College and Seaford North Primary School however they are currently not actively involved in any restorations programs.

4.1.2 Adjoining land use and landscape character

Patterson Lakes and Carrum are residential areas located to the north of the Eel Race Drain. The residential area of Carrum was constructed largely after the mid 1940s, and Patterson Lakes was constructed in the early 1980s. There are good views over Eel Race Drain and Seaford Wetlands from the levee bank on the north adjacent to Patterson Lakes.

- Adjoining land use south of the drain is a combination of residential area of Seaford, the Patterson River Secondary College, Seaford Wetlands and rural land. The Seaford Wetlands has remnant vegetation and is listed on the Ramsar Convention as habitat for migratory waterbirds. Frankston City Council has recently purchased the adjoining rural land and will work with Melbourne Water to expand Seaford Wetlands to improve the environmental character and values of this area. The Edithvale-Seaford Wetlands Ramsar Management Plan guides the management of Seaford Wetlands.
- Seaford is an established residential area with Riviera Reserve linking through to Eel Race Drain, and road frontage which provides good views of the riparian vegetation.
- Environmental values of the Seaford Wetlands and Kananook Creek are recognised in the Frankston Planning Scheme with Environmental Significance Overlays. As the environmental values improve along Eel Race Drain there is potential for its role as a part of the habitat corridor between the two areas to be increased and recognised in the Scheme if appropriate.
- Eel Race Drain is the boundary between the Frankston and Kingston Municipalities. The majority of the land adjoining the drain in both Municipalities is zoned Public Use 1 recognising Melbourne Water use and ownership of the drain. There is a small area of Green Wedge and Urban Floodway Zones near the Mornington Peninsula Freeway, which will be rezoned for public use following the recent acquisition of the land by the City of Frankston. In the older established residential areas of Carrum and Seaford the land is zoned Residential 1 incorporating Eel Race Road on both sides of the drain. The Land Subject to Inundation Overlay (LSIO) applies to the southern side of the drain extending from the Mornington Peninsula Freeway downstream to Seaford Wetlands. There are Environmental Significance Overlays (ESO1 and ESO4) including over Seaford

Wetlands, adjoining rural land and adjoining Kananook Creek south of Eel Race Road. To the north there is a Design and Development Overlay (DDO2) over Patterson Lakes which includes the road frontage to Palm Beach Drive, but does not extend to the residential properties directly adjoining the drain.

- Frankston City Council Amendment C24 (if approved) would allow use of the neighbourhood character guidelines in the application assessment for residential buildings and works already requiring a permit e.g. medium density housing and single houses on small sites in SF5 and SF8 (south of Eel Race Drain). Some exempt residential development has potential to reduce the landscape character of the area which will affect open space recreational and landscape amenity in the longer term.

No.	Issue	Action	Priority	Respons-ibility
LU1/1	Eel Race Drain provides an environmental corridor link between Seaford Wetlands and Kananook Creek. Due to constraints of not being able to plant on levee banks upstream of Whatley Street Footbridge, the adjoining open space and properties provide the only opportunity for habitat link.	FCC and KCC to investigate potential measures to encourage landholders to plant and retain native trees on their properties to improve the environmental corridor values of Eel Race Drain between Mornington Peninsula Freeway and Whatley Street footbridge. Refer to Actions S2/1 and V1/1.	Medium	FCC KCC
LU2/1	Over time, development on Eel Race Drain Road may increase visual dominance of buildings and reduce presence of established vegetation on properties. Eel Race Road will continue to be used as a future trail link between Whatley Street footbridge and Kananook Creek.	• FCC to consider updating the SF8 requirements at the next opportunity to reinforce the association with Eel Race Drain and reinforce preferred vegetation controls and planting. • FCC to provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Eel Race Road and Eel Race Drain.	Medium Medium	FCC FCC

4.1.3 Drainage and flood management

- Eel Race Drain is a constructed channel and transmits flows from Boggy Creek catchment down Kananook Creek.
- The Kananook Creek Pump Station pumps sea water from Patterson Lakes into Eel Race Drain which reduces stagnation in the Lakes and provides continual flows to Kananook Creek. This continual pumping of sea water has altered the estuarine nature of Kananook Creek and established a saline ecosystem. This is discussed in more detail in Section 3.2 and 3.3.
- The levee banks along Eel Race Drain were raised to protect Patterson Lakes from flooding, whilst the levee bank on the southern side is lower. This allows flows greater than 1:100 year ARI to discharge into Seaford Wetlands which is designed to provide extensive flood storage capacity.
- The flows in the upstream section of the Eel Race Drain from the Boggy Creek catchment are seasonal depending on rainfall events.
- Flows downstream of the Kananook Creek Pump Station are continually fed and controlled by the Pump Station providing saline flows from Patterson Lakes. When there are interruptions to the power supply the pumps cease to work and flows cease and sometimes has an effect on the creek ecology downstream which is dependent on the continual flows (ASM, 2007).

No.	Issue	Action	Priority	Respons-ibility
D1/1	Flood management involves side-casting flows from Eel Race Drain into the Seaford Wetlands for flood storage.	Investigate the flood storage function of Seaford Wetlands and any requirement for additional protection to properties along Austin Road for above design event. As part of these works, investigate the need for levee augmentation along Eel Race Drain and provision of a structured controlled overflow point into Seaford Wetlands where required.	High	MW
D2/1	New increased flow monitoring and level information will be required for the management of any future change to recommended high and low flow management regime	Pending outcomes of D2/O, investigate the potential requirements for gauging station upgrades and or new provisions to enable the integration into the future flow and level management system.	High	MW

4.1.4 Water quality

- The upstream section of Eel Race Drain is influenced by the water quality of flows from Boggy Creek catchment and Wadsleys Drain. Currently there are high nutrient levels in both these flows. Melbourne Water will soon commence construction of a stormwater water quality treatment wetland in the Boggy Creek catchment that will primarily address stormflow loads to Port Phillip Bay, as well as improving water quality in the downstream catchment including Kananook Creek.
- As part of the need to protect the Seaford Wetland from adverse salinity impacts, investigate the provision of a submerged weir in Eel Race Drain to limit salt wedge intrusion into the head of Eel Race Drain and Seaford Wetlands.
- Downstream of the Kananook Creek Pump Station water quality is directly influenced by the saline flows from Patterson Lakes.
- As described in Section 3.3 and 3.4 of the report, it is recommended that Melbourne Water investigate the potential for additional freshwater inputs to the system. This may have a number of benefits including offsetting the effects of saline flows on the habitat values in Kananook Creek and the Seaford Wetlands. Refer Sections 3.3 and 3.4.

No.	Issue	Action	Priority	Respons-ibility
Q1/1	Marinisation of the reach from Kananook Creek Pump Station limits the establishment of an estuary gradient	Refer D2/O regarding marinisation of the Creek from inputs from Kananook Creek Pump Station.	Refer D2/O	Refer D2/O
Q2/1	Impacts of increased salinity in Seaford Wetlands from increased salinity in Eel Race Drain.	Investigate the provision of a submerged weir in Eel Race Drain to limit salt wedge intrusion into the head of Eel Race Drain and Seaford Wetlands.	High	MW

4.1.5 Stream system values

- The constructed trapezoidal channel provides poor in-stream habitat values.
- The adjoining Seaford Wetlands is a Ramsar listed wetland for the protection of habitat for migratory waterbirds. As this directly adjoins the site, these values contribute to the overall habitat values of the Eel Race Drain and Kananook Creek.
- There is potential to improve the in-stream values by constructing low benches to allow for plant colonisation along the toe of the bank which will increase the diversity of habitat provided.

- Between Mornington Peninsula Freeway and Whatley Street Footbridge the more recent levee banks have limited overstorey and mid-storey vegetation due to their flood protection role. This creates a gap in the overstorey vegetation link along Eel Race Drain and Kananook Creek. Due to constraints on planting overstorey trees on the levee banks, seek opportunities to strengthen corridor values by protecting and increasing presence of indigenous overstorey vegetation on adjoining land.
- Downstream of the Whatley Street Footbridge to Kananook Creek, the edge vegetation increases with a relatively continuous indigenous over-storey which provides habitat values and shading to the waterway.

No.	Issue	Action	Priority	Respons-ibility
S1/1	In-stream habitat of the engineered Eel Race Drain channel is poor and needs improvement	Investigate the provision of low benches for plant colonisation along the toe of the banks in Eel Race Drain from Mornington Peninsula Freeway downstream to Whatley Street Footbridge to improve in-stream habitat values of the engineered Eel Race Drain channel.	Medium	MW
S2/1	Lack of habitat connectivity including mid-storey and over-storey along Eel Race Drain between Mornington Peninsula Freeway and Whatley Street Footbridge.	In addition to planting indigenous vegetation in adjoining private and public land (as per Action LU1/1 and V1/1), investigate opportunities to undertake revegetation of shrubs along both banks of Eel Race Drain as described in V2/1 to improve overall habitat values of this corridor including habitat connectivity and shading of the stream to improve in-stream habitat whilst not posing threat or risk to the function and purpose of the levee banks on both sides of Eel Race Drain in line with the RRHS. Refer to LU1/1.	Medium	MW (C)

4.1.6 Vegetation

- Dense algal growth in-stream, with some narrow bands of Common Reed along the toe of the batter on both sides of the stream.
- The north bank between the Freeway and Whatley Street Footbridge has low vegetation quality. It is dominated by Kikuyu on the banks along with some narrow bands of revegetation of variable age and species including from Coastal Woodland and Riparian vegetation. There is some Gazania planted to rear of private properties which has the potential to become an environmental weed.
- The south bank between the Freeway and Whatley Street Footbridge has low vegetation quality, however, it is recognised there is critical connectivity through to remnant vegetation areas in Seaford Wetlands. The top of bank is dominated by Kikuyu with a narrow band of revegetation which includes a non-indigenous planted *Melaleuca*, along with some older stands of Swamp Paperbark.
- The remnant vegetation and values of Seaford Wetlands contributes to the overall habitat values of this reach. Improvement to and expansion of appropriate revegetation along Eel Race Drain will improve the overall habitat connectivity to the Seaford Wetlands and potentially upstream to the new Boggy Creek Wetlands.
- Downstream of Whatley Street Footbridge there is some indigenous Coast Banksia woodland present on both sides of the stream. Whilst the vegetation is dominated by Coast Ti-tree, there are scattered mature Coast Banksia on the south side, however these are almost absent on the north side. The understorey is degraded and dominated by Kikuyu and Bridal Creeper. Overall the vegetation condition is fair to poor.
- Whilst there is mature indigenous vegetation along the downstream sections, the overall values are impacted by the widespread weeds in the mid-storey and ground layer.

Targeted weed control to protect and improve the mature indigenous vegetation is recommended.

- Lack of indigenous vegetation in the upstream section of the reach to provide habitat connectivity to the remnant indigenous vegetation in Seaford Wetlands.

No.	Issue	Action	Priority	Respons-ibility
V1/1	Lack of opportunity to plant trees and large shrubs along the levee banks of Eel Race Drain due to the need to protect their structural integrity.	Increase the presence of indigenous overstorey vegetation where appropriate on adjoining public land given there are limited opportunities to plant into the levee banks. This could include Seaford Wetlands, Patterson River Secondary College and the Eel Race Road reserve. Refer also to LU1/1 and S2/1.	Medium	FCC KCC (MW)
V2/1	Lack of indigenous vegetation along the north side of Eel Race Drain between the Mornington Peninsula Freeway and Whatley Street Footbridge.	Investigate opportunities to revegetate the north and south sides of the channel along Eel Race Drain between Mornington Peninsula Freeway and Whatley Street footbridge, sympathetic to the function and purpose of the levee banks. Revegetate where possible, with modified Swamp Scrub EVC in line with the RRHS.	Refer S2/1	Refer S2/1
V3/1	Non-indigenous *Melaleuca parvistaminea* planted along the Eel Race Drain has the potential to spread into the creek system, threaten the structural integrity of the levee banks and impact on their flood protection function.	Remove the non-indigenous *Melaleuca parvistaminea* planted along the channel to contain further spread and investigate the potential to replace with *Melaleuca ericifolia*.	High	MW (C)
V4/1	Weeds present throughout the mature indigenous vegetation downstream of Whatley Street Footbridge degrade the vegetation community and habitat values.	Map the extent of weed invasion and identify extent of impact as basis to developing an integrated weed management program for Eel Race Drain.	Low	FCC KCC (MW)

4.1.7 Recreation and community use

- There is a well used regional trail link over the Whatley Street footbridge linking the communities on the north and south sides of Eel Race Drain. It is anticipated that secondary school students use this crossing extensively as Patterson River Secondary College services all of Patterson Lakes and Carrum.
- There is an existing shared trail on the north side of Eel Race Drain between Whatley Street Footbridge and the Mornington Peninsula Freeway, and an informal trail on the south side over the same length. The shared trail through Seaford Wetlands links into the trail along the south side of Eel Race Drain and over the footbridge. In between there is no trail on either side of the drain downstream of the Whatley Street Footbridge to the Eel Race Road bridge. There are footpaths along Eel Race Road which link to the Secondary College, although pedestrians need to cross a number of local roads along this length.

No.	Issue	Action	Priority	Respons-ibility
R1/1	Lack of formal recreational trail along Eel Race Drain between Whatley Street Footbridge and the end of the Kananook Creek trail.	Investigate the potential to construct an off-road trail along Eel Race Drain or Eel Race Road to connect the Kananook Creek trail to Eel Race Drain and Seaford Wetlands. Undertake an evaluation of the potential feasibility of the trail and its impact on the existing vegetation and habitat values prior to construction.	High	FCC (MW)
R2/1	There is an opportunity for the Patterson River Secondary College and Seaford North Primary School to be involved in future restoration works along Eel Race Drain, given their close proximity to the Drain and Seaford Wetlands.	Liaise with Patterson River Secondary College and Seaford North Primary School to seek their involvement in future revegetation works on the school grounds, Eel Race Drain and Seaford Wetlands.	Ongoing	FCC MW Schools (KCA) (FOESW) (MW)

4.1.8 Cultural heritage and historical values

- The adjoining Seaford Wetlands is a remnant of the former Carrum Carrum Swamp which is identified to be of high archaeological sensitivity, and likely to have been of cultural significance to the *Boonerwrung* people. Eel Race Drain is a constructed channel and there is an AAV registered site (AAV No. 7921-0187) identified as an artefact scatter in Eel Race Road (Austral Heritage, 1998).
- There are no specific European historical values associated with Eel Race Drain.

No.	Issue	Action	Priority	Respons-ibility
H1/1	Eel Race Drain and the adjoining Seaford Wetlands are areas of high Aboriginal heritage and archaeological sensitivity.	Prior to any future works that require disturbance to the ground in this location, prepare a Cultural Heritage Management Plan in accordance with H1/O.	Ongoing	Refer H1/O
H2/1	Lack of interpretive information regarding Aboriginal archaeological values of Eel Race Drain and the adjoining Seaford Wetlands.	Refer to H2/O regarding provision of interpretive information regarding Aboriginal archaeological values of Eel Race Drain and the adjoining Seaford Wetlands.	Medium	FCC BLCAC BFL MW (AAV) (MW)

4.2 REACH 2
Eel Race Road to Armstrongs Road

4.2.1 Introduction

This reach is the commencement of Kananook Creek. The upper section is a modified channel form similar to Eel Race Drain, whilst the lower section of the reach is the original natural alignment of the creek. Public land flanks both sides of the creek for the majority of this reach, with some freehold land to the waters edge on the western side immediately upstream of Armstrongs Road. Melbourne Water owns the land on the western side between Eel Race Road and the Railway, and a parcel of land with remnant swamp scrub near Ti-tree Grove. Council owns the remaining land on the western side, and all the adjoining land on the eastern side. Residential areas to the west sit between the creek and the coastline and there is potential to improve the recognition and future establishment of an environmental link across this area. The residential area to the east sits between Seaford Wetland the creek and similarly, has the potential for improved recognition of the potential environmental link between the two.

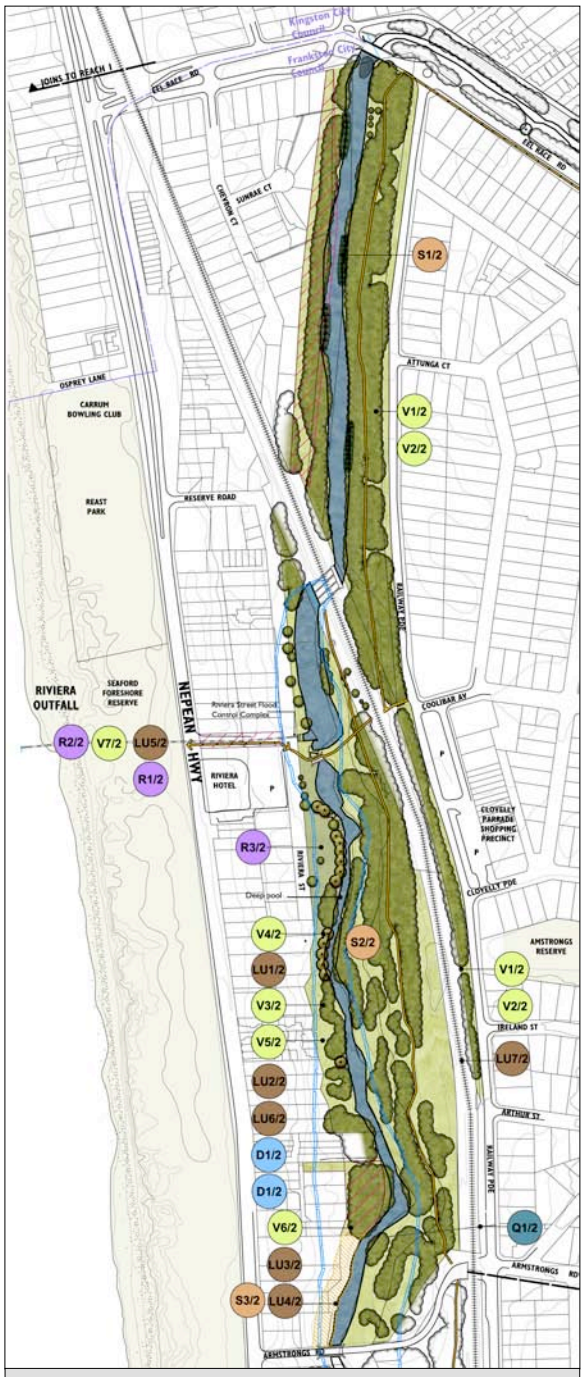


FIGURE 4.2~1 KANANOOK CREEK EEL RACE ROAD TO ARMSTRONGS ROAD Extract from Drawing KCMP-12 Not to scale

Riviera Street Flood Control Complex is a major flow diversion drain in this reach downstream of the railway which diverts flood flows from the creek out to Port Phillip Bay via a large outfall drain. This is to protect downstream properties from flood events associated with flood flows from the Boggy Creek catchment.

This is the only reach of Kananook Creek where there is public land on both sides of the creek. Existing remnant vegetation cover on both banks provides excellent habitat values particularly between the Railway and Armstrongs Road. The presence of large areas of indigenous vegetation in this reach contributes to the habitat values of the corridor.

The Kananook Creek trail is located on the eastern side of the creek, and there is a pedestrian underpass at the railway at the end of Coolibar Avenue. The trail links to the footbridge at Riviera Street and potentially through Riviera Street Drainage Reserve to the foreshore. The creek is also used by small non-powered watercraft with a small launching ramp located at Riviera Street Reserve.

Key issues that need to be resolved in this reach include:

- Operation of the Riviera Street Flood Control Complex to address some of the flow and stream value issues downstream
- Weeds
- Protection and recruitment of remnant indigenous vegetation
- Loss of riparian and associated terrestrial vegetation on freehold land
- Lack of continuity of the open space corridor along the western side of the creek
- Lack of passive recreational facilities at Riviera Street Reserve

4.2.2 Adjoining land use and landscape character

- The majority of land along the creek corridor is zoned Public Conservation and Resource Zone (PCRZ) in the Frankston Planning Scheme. The railway corridor, which crosses over the creek is zoned Public Use Zone 4, and the Melbourne Water owned land upstream of Armstrongs Road is zoned Public Use Zone 1. The freehold land immediately upstream of Armstrongs Road on the west side is zoned Residential 1 and there is some Business 1 zoning.
- Some of the residential properties at the southern end of the reach to the west have titles to the waterway and in some cases they extend into the creek. This does not allow the land-holder the right to build structures and fill out into the creek corridor without obtaining a planning permit from Council (through which for matters such as this Melbourne Water is a referral authority). The Water Act specifically expunges any private right over the bed and banks of the creek. There is potential for jetties and decks to be built to the creek edge, and areas where land owners may fill out into the waterway.
- Development extending over the creek with decks and jetties has greater visual impact than a garden/natural interface to creek edge and is not the preferred landscape character given the high value placed on the natural habitat corridor values of the waterway upstream. Vegetation clearing for construction of structures affects habitat values and interrupts the riparian habitat corridor.
- The western side of the creek the Residential 1 land is within a Design Development Overlay (DDO6), and the Overlay also includes the Melbourne Water owned land on the western side. Refer to Section 3.2 for further description of the requirements of DDO6.
- An Environmental Significance Overlay (ESO1) extends over the existing Council-owned land along the creek including the railway reserve. This ESO does not extend over any of the adjoining freehold land on the western side of the creek, but the ESO4 applies to some nearby lots.
- The Land Subject to Inundation Overlay (LSIO) is located along the western side of the creek.
- There is a Public Acquisition Overlay (PAO3) in favour of Council for public open space. Acquisition of this land would establish a continuous public open space corridor along the western side of the creek.
- Amendment C24 (if approved) would allow use of Neighbourhood character guidelines in the application assessment for residential buildings and works already requiring a permit e.g. medium density housing and single houses on small sites for Neighbourhood character precincts SF5 and SF7. Some exempt residential development has potential to reduce the landscape character of the area which will affect open space recreational and landscape amenity in the longer term.

No.	Issue	Action	Priority	Respons-ibility
LU1/2	Adjoining development impacts on environmental values of the creek and waterway corridor. There is also vegetation clearing or lack of opportunity to reinstate riparian and associated terrestrial vegetation.	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S3/2 and V4/2.	High	FCC MW
LU2/2	Proposed Neighbourhood character planning controls will not capture single dwelling development and ancillary buildings for residential properties abutting Kananook Creek and the creek reserve, with longer term effects on landscape and recreational amenity.	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU3/2	Fencing abutting the creek and on side boundaries can lead to floodplain, visual character and land use issues. Currently there are no controls over fencing types used except in relation to flood flows.	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	Refer LU4/O	Refer LU4/O
LU4/2	Lack of continuity of public land on the western side of Kananook Creek.	Continue to support securing a public open space corridor along the western side of the creek via the existing Public Acquisition Overlay Control upstream of Armstrongs Road. This will provide a habitat and open space link.	High	FCC
LU5/2	Parking from the Riviera Hotel adjacent to Riviera Street Drainage Reserve encroaches into public land.	Upgrade the reserve to exclude vehicle parking from the Riviera Street Drainage Reserve and improve its use as an open space link between the Seaford Foreshore Reserve and Kananook Creek (Refer to R4/2)	Medium	MW
LU6/2	Private land downstream of Riviera Street is encroaching into and using public land for private access to Kananook Creek.	Consider encroachment issues from private land into public land in any redevelopment application, Refer to LU3/2 and V5/2.	Ongoing Refer to LU3/2 and V5/2.	FCC Refer to LU3/2 and V5/2.
LU7/2	Railway reserve is a major part of the east boundary of the creek and there are some impacts associated with poor land management practices including rubbish dumping and spreading of Gazania along the rail reserve.	Liaise with Railway authority and its contractors to improve land management practices.	Medium & Ongoing	FCC (Rail authority)

4.2.3 Drainage and flood management

- The section of Kananook Creek from Eel Race Road downstream to the Riviera Street Flood Control Complex has been channelised and modified as part of the flood control and management regime for the creek. The majority of large event flows are diverted

away from Kananook Creek with these flood flows diverted via the Riviera Street Flood Control Complex to Port Phillip Bay. At the same time, automate controls were constructed to control the flow split, with 30m^3/s going to the bay and 2m^3/s going down Kananook Creek.

- This Riviera Street Flood Control Complex was originally built in 1962. In 2002 Melbourne Water constructed new gates and at this time the old creek side weir was completely removed (excavated down to existing invert level of the creek, creating an increased cross-sectional area available to pass flows).
- Significant changes to the larger Dandenong and Kananook Creek catchments have resulted in an overall reduction in the flows down Kananook Creek. The lack of flows has contributed to significant aggradation of the channel in the downstream reaches. There is potential to investigate the potential to increase the number of catchment flood flows to move through the creek which will naturally scour and maintain the channel dimensions. Refer to Section 3.3 for issues and actions relevant to this.
- Adjoining development may impact on the 1:100 year floodplain storage capacity.

No.	Issue	Action	Priority	Respons-ibility
D1/2	Some private land-holders on the western bank between Riviera Street and Armstrongs Road appear to have placed fill and structures below the 1:100 year flood level.	Ensure new developments meet Melbourne Water requirements for developments in flood prone areas such as Riviera Street and Armstrongs Road. Refer also to LU2/O.	Ongoing	FCC MW

4.2.4 Water quality

- Water quality is dominated by the flows from Kananook Creek Pump Station.
- Lack of catchment flows and loss of the freshwater flows results in the marine water quality being maintained over the year. Refer to Section 3.3 and 3.4 for discussion and recommendations to address this issue.
- There are some high nutrient levels in Wadsleys Drain which may increase likelihood of macro algae blooms in this area.

No.	Issue	Action	Priority	Respons-ibility
Q1/2	High nutrient levels from the Wadsleys Drain contribute to the presence of macro algae blooms in this reach.	Investigate the source of high nutrient levels from Wadsleys Drain and, where appropriate, address at source.	High	EPA (MW)

4.2.5 Stream system values

- The lower section of this reach is the original natural stream form and is in good condition. The floodplain had a series of ephemeral wetlands, some remnants of which remain today. Protection of these wetlands and the associated natural stream form was aided by the public land purchase in the vicinity of Ti-Tree Grove.
- The presence of riparian vegetation and natural stream form between the Riviera Street Flood Control Complex and Armstrongs Road provides good in-stream habitat. There is some encroachment into the riparian zone which impacts on the overall habitat values of this reach.
- Bream have been recorded in this reach, and their use of this area is threatened by the macro-algae blooms which occur seasonally.
- The stream immediately downstream of the Control structure was dredged in the late 1980s and the dredging material is stockpiled on the bank adjacent to Riviera Street.

Further dredging of this area to create an island is not recommended as it is preferred to minimise further disturbance.

- The presence of remnant indigenous vegetation and the wider open space corridor, particularly on the east side of the creek suggest that the habitat values for fauna including birdlife is high in this reach. The community consultation revealed that wildlife is highly valued by residents.

No.	Issue	Action	Priority	Respons-ibility
S1/2	Kananook Creek between Eel Race Road and the Riviera Street Flood Control Complex is low in habitat diversity.	Investigate insertion of low banks and berms to allow colonisation by ephemeral macrophytes between Eel Race Road and the Riviera Street Flood Control Complex in line with the RRHS.	Medium	MW
S2/2	Habitat complexity of the old course and wetland downstream of Riviera Street Flood Control Complex is low in habitat diversity.	Seek to rehabilitate the old course and floodplain wetland downstream of Riviera Street for habitat diversity through a staged program of vegetation enhancement.	Low	MW
S3/2	In-stream habitat is high and needs protection from inappropriate development on adjoining land, particularly loss of riparian vegetation.	Continue to support the need for public acquisition of remaining freehold titles upstream of Armstrongs Road on the western side of Kananook Creek in order to protect and restore the riparian vegetation and stream edge. Refer to LU1/2, LU3/2, LU4/2 and LU6/2.	Refer LU1/2, LU3/2, LU4/2 and LU6/2	Refer LU2/2, LU3/2, LU4/2 and LU6/2

4.2.6 Vegetation

- The west bank between Eel Race Road and the Railway has a band of remnant Coastal Banksia Woodland dominated by Coast Ti-tree with a sparse distribution of Coast Banksia. The understorey is degraded and dominated by Kikuyu and Bridal Creeper. There are some small remnant patches of Swamp Paperbark overhanging the water in relatively good condition. Overall the vegetation condition is rated as poor.
- The east bank between Eel Race Road and the Railway is dominated by Coast Ti-tree dominated Coastal Banksia Woodland, along with scattered Coast Banksia. There is a variable age class and open areas where the Ti-tree has senesced and collapsed with a high load of dead branches. Some of the understorey is in good condition with Bower Spinach and Rhagodia. However, there are large areas of weed dominated understorey with Kikuyu, Bridal Creeper and Tradescantia. Overall the vegetation condition is rated as fair to poor.
- West Bank downstream of the Railway to Armstrongs Road has a relatively narrow corridor of fragmented riparian vegetation with several large thickets of Swamp Paperbark on public and private land. The open space reserve immediately downstream of the Riviera Street Flood Control Complex is dominated by Kikuyu that is spreading into the remnant vegetation.
- East bank downstream of the Railway to Armstrongs Road is a comparatively wide corridor with Dense Coast Ti-tree along the outer boundary edge with the rail reserve grading to mature Coast Banksia Woodland, with Swamp Paperbark thickets fringing the lower slopes and the creek. The understorey to the Swamp Paperbark includes Common Reed and Bower Spinach along with Austral Seablite and Creeping Brookweed which are indicative of increasing saline conditions. There are good remnant patches of understorey to the Coast Banksia Woodland including Bower Spinach and Rhagodia, along with some weeds. Overall the vegetation condition is fair to poor.

No.	Issue	Action	Priority	Respons-ibility
V1/2	Understorey weed invasion throughout the Coastal Banksia Woodland throughout this reach. Specific weeds that require priority control include the new emerging Dolichos Pea, Cape Ivy and Rambling Dock.	Develop an integrated weed management program in the Coastal Banksia Woodland, with priority control to emerging new weeds including Dolichos Pea, Cape Ivy and Rambling Dock.	Medium	FCC (MW)
V2/2	Remnant vegetation in this reach, particularly the Coast Banksia is in decline in some areas.	Ensure ongoing protection of remnant vegetation and encourage recruitment of Coast Banksia where it is senescing.	Ongoing	FCC MW
V3/2	Dead branches and wood provides habitat value and also fuel loads for potential bushfires.	Assess fuel loads and remove or consolidate patches to reduce the bushfire threat, whilst retaining some areas for habitat value.	Medium	FCC (MW)
V4/2	Fragmented vegetation along the western bank due to clearing in adjoining private land.	Liaise with adjoining residents via incentives and/or education programs to encourage protection of remnant indigenous vegetation and appropriate revegetation on private land along the western bank to re-establish habitat corridor link. Refer also to LU1/2.	Ongoing	FCC (MW)
V5/2	Some adjoining land holders are clearing vegetation in public land on western bank.	Investigate the potential to improve the condition of the riparian zone downstream of Riviera Street by providing maintenance access track to define the boundary between private and public land to prevent encroachment into public land. The track alignment will need to ensure it does not unduly damage existing indigenous vegetation in this reach.	High	FCC
V6/2	Kikuyu spreading into remnant vegetation from open space at Riviera Street and upstream of Armstrongs Road.	Contain and control Kikuyu by initially spraying outer edges of populations to contain further spread into remnant vegetation. Where appropriate, expand presence of indigenous vegetation along Creek edge and continue to contain Kikuyu to open grassed area only. Refer to R3/2 for upgrade of Riviera Street Reserve.	Medium & Ongoing	FCC (MW)
V7/2	Lack of vegetation in the Riviera Street Drainage Reserve, which has the potential to be an open space link between the Seaford foreshore and Kananook Creek.	Plant indigenous vegetation which does not compromise the drainage infrastructure in Riviera Street Drainage Reserve and improves the visual and habitat link between the Seaford Foreshore Reserve and Kananook Creek Reserve. Refer to R2/2 for other works in this reserve.	Low	MW (FCC)

4.2.7 Recreation and community use

- The creek corridor and railway create a barrier to east-west pedestrian movement between the coast and residential area of Seaford to the east of the creek. The crossing points over the creek are well used and important to retain. There is one crossing point between Eel Race Road and Armstrongs Road near the Riviera Street Flood Control Complex.
- Small watercraft attempt to navigate through Riviera Street flood control structure which is dangerous and unsafe.

- Riviera Street Reserve lacks a diversity of non-water based passive recreational facilities in a location that has potential to provide improved use and access to this area of the creek.
- Public land on western side of stream has no maintenance or trail access limiting its use and ongoing maintenance of values.

No.	Issue	Action	Priority	Respons-ibility
R1/2	Small watercraft attempt to pass through Riviera Street flood control structure which is dangerous and unsafe.	Consider modifications to the Riviera Street flood control structure and/or provide signage to users of small watercraft to disembark at the canoe launch ramp provided and then re-enter the creek upstream of the structure at a safer more appropriate point.	High	MW
R2/2	Poor condition of public land through Riviera Street Drainage Reserve.	Provide a public trail link through this Melbourne Water Riviera Street Drainage Reserve. This will establish a direct link between the Seaford Foreshore Reserve, Kananook Creek and residents to the east of Kananook Creek. Refer also to LU4/2 and V7/2.	Low	FCC (MW)
R3/2	Riviera Street Reserve requires upgrade to improve recreational and environmental values.	Develop a Concept Plan for Riviera Street Reserve to achieve the following: • improve the area around the small non-motorised watercraft launching ramp; • improve interface between the street and the reserve with improved vegetation management and vehicle control measures if required; • integrate the trail on the east side of the creek with the proposed watercraft launching area and park management/maintenance, along with access over creek, and access through to the Seaford Foreshore Reserve; • provide seating and picnic facilities; • undertake appropriate revegetation of the reserve to increase presence of indigenous vegetation along the bank, with some viewing locations; • develop integrated interpretive signage regarding the creek's values, access points and liaise with BLCAC and BFL regarding potential integration of Aboriginal archaeological and cultural heritage values of Kananook Creek corridor; and • control Kikuyu in accordance with Action V5/2.	Medium	FCC
R4/2	Lack of clarity of the trail status north of Station Street.	The existing nature trail north of Station Street is to be maintained as a nature trail.	Ongoing	FCC

4.2.8 Cultural heritage and historical values

- Kananook Creek is identified as an area of high Aboriginal cultural heritage sensitivity, particularly areas that retain their natural remnant vegetation (Austral Heritage, 1998). The creek downstream of Rivera Street to Armstrongs Road retains a relatively natural channel form and remnant vegetation.
- The overall recommendations H1/O and H2/O are relevant to this reach.

4.3 REACH 3

Armstrongs Road to Seaford Road

4.3.1 Introduction

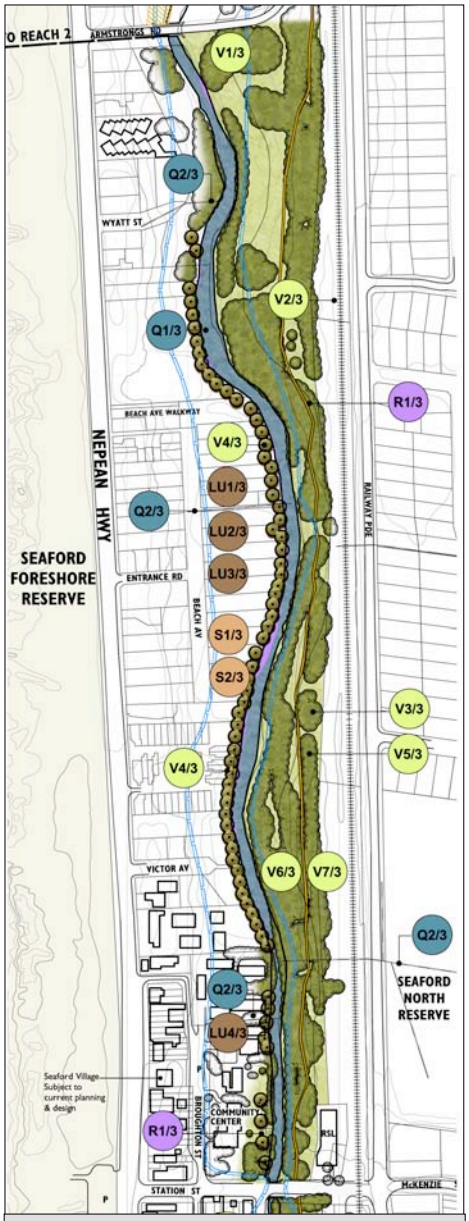


FIGURE 4.3~1 KANANOOK CREEK ARMSTRONGS ROAD TO STATION STREET
Extract from Drawing KCMP-13 Not to scale

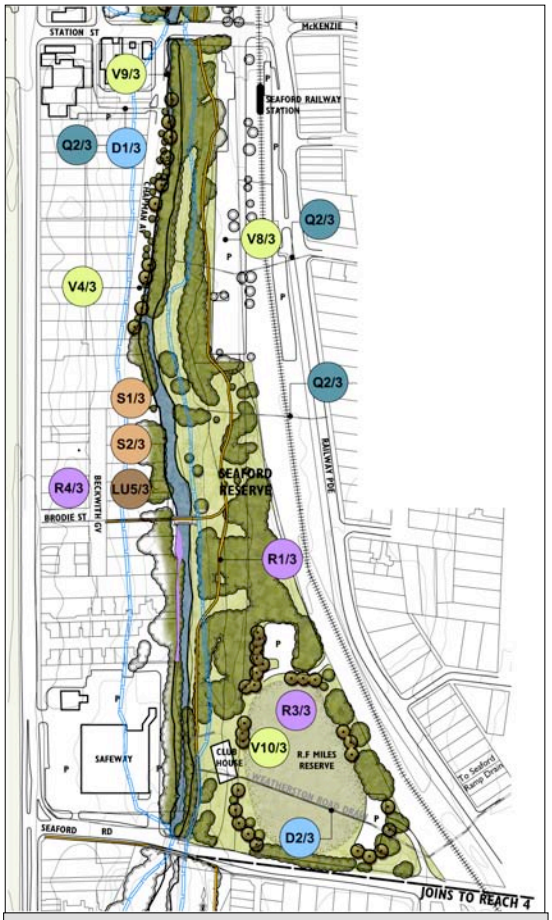


FIGURE 4.3~2 KANANOOK CREEK STATION STREET TO SEAFORD ROAD
Extract from Drawing KCMP-13 Not to scale

The stream form in this reach is relatively natural with the exception of road crossings where the inverts have been hardened. A continuous public open space reserve flanks the eastern side of the creek and includes larger reserves including RF Miles Reserve and Seaford Reserve and they contribute to the environmental value and character. Residential areas to the west sit between the creek and the coastline and there is potential to improve the recognition and future establishment of an environmental link across this area. The residential area to the east sits between Seaford Wetland the creek and similarly, has the potential for improved recognition of the potential environmental link between the two.

The railway adjoins the eastern boundary of the public open space reserve and creates a physical barrier to safe pedestrian access between the residential area to the east and the Kananook Creek corridor. The western side is predominantly in private ownership with the exception of the Seaford Village area where public land extends to the creek, however, it is not currently zoned as public open space.

There are good vegetation values in the open space reserves on the eastern side of the creek with Coast Banksia Woodland present. The western side is highly fragmented, with some areas of indigenous vegetation remaining and others where there is almost no vegetation remaining. One major Melbourne Water drain, Weatherston Road Drain, enters the stream upstream of Seaford Road, and then the remaining drains are local Council stormwater drains from the adjoining local catchment.

Council has recently prepared a Masterplan for the *Seaford Village Seaford Life Saving Club Precinct Master Plan, August 2004.* This plan has included recommendations to improve the interface with Kananook Creek. The focus of the improvements include the open grassed area adjacent to the Community Centre immediately upstream of Station Street, increasing car parking capacity to the north of the Senior Citizens Club from 18 to 39 bays. Council have also advised it is proposed that the riparian zone width adjacent to Chapman Avenue be increased by relocating parking away from the creek.

Armstrongs Road to Station Street is approximately 1.2km in length and is the longest stretch of creek without a crossing point. This makes access into the trail and linear reserve difficult. The frequency of bridge crossings elsewhere are in the order of every 500 to 600 metres with the other longer stretch being 900 metres between Mile Bridge and McCulloch Avenue footbridge. The zoning in this area is Residential 2 which encourages medium density housing on both sides of the creek, however, this is proposed to be changed back to Residential 1 as part of Amendment C24. The need for improved access and crossing point over the creek will increase as the area develops.

Safeway is a large landholder adjoining the creek immediately upstream of Seaford Road, and there are opportunities to improve their interface treatment between the Supermarket and the creek, particularly in the longer term, given the presence of mature Coast Banksias on the opposite side of the stream.

Key issues that need to be resolved in this reach include:

- Improve the interface treatment between private land and the creek on the western side including protecting remaining indigenous vegetation and increasing the presence of indigenous riparian and associated terrestrial vegetation
- Reduce sediment and litter entering the stream
- Weed control and management
- Path surface improvement
- Implement the *Seaford Life Saving Club Precinct Masterplan (2004)* to improve the interface between the creek and Seaford Village, particularly improving continuity of riparian vegetation and the open space adjacent to the Community Centre which is used by the Kananook Creek Association (KCA) for the annual Kananook Creek Celebration Day that Melbourne Water contributes resources to each year
- Improve the open space character and use with more diverse facilities and better trail connectivity given projected residential growth in this area

4.3.2 Adjoining land use and landscape character

- The majority of land along the creek corridor is zoned Public Conservation and Resource Zone (PCRZ) in the Frankston Planning Scheme. The railway corridor along the eastern boundary is zoned Public Use Zone 4.
- The majority of adjoining freehold land on the western side of the creek is zoned Residential 1 with a Design Development Overlay (DDO6).
- An Environmental Significance Overlay (ESO1) extends over the existing Council-owned land along the creek including the railway reserve. This ESO does not extend over any of

the adjoining freehold land on the western side of the creek, but the ESO4 applies to some adjoining and nearby lots.

- Seaford Village is Business 1 Zone, with Business 5 Zone in the northern area. Business 5 Zone encourages office or multi-dwelling units.
- Safeway, immediately upstream of Seaford Road is in the Business 1 Zone.
- There is an increasing amount of medium density housing occurring along the western side of the creek which results in increased built form and hard surface areas, and a reduction in vegetation. The lack of public access through this reach on the western side makes on-going monitoring of freehold land management practices difficult. Some properties immediately downstream of Armstrongs Road in the vicinity of Wyatt Street appear to have reasonable riparian vegetation remaining. However, further downstream to Victor Avenue there is limited vegetation present.
- Residential properties to the west have titles to the waterway and in some cases they extend into the creek. This does not allow the land-holder the right to build structures and fill out into the creek corridor without obtaining a planning permit from Council who will refer such applications to Melbourne Water as a statutory referral authority. The Water Act specifically expunges any private right over the bed and banks of the creek. There are some jetties and decks built to the creek edge, and areas where land owners are filling out into the waterway.
- Development extending over the creek with decks and jetties has greater visual impact than a garden/natural interface to creek edge and is not the preferred landscape character given the high value placed on the natural habitat corridor values of the waterway upstream. Vegetation clearing for construction of structures affects habitat values and interrupts the riparian habitat corridor.
- The Community Centre in Seaford Village lacks indigenous overstorey, and there are opportunities to address this.
- Chapman Avenue has parking and limited indigenous vegetation buffer to the creek corridor. This has been identified as an issue to address in the Seaford Village Structure Plan.
- South of Chapman Avenue to Safeway near Seaford road there are varying amounts of vegetation along with some platforms and jetties. This area is identified for medium to high density residential use and the redevelopment needs to be well designed to retain and improve habitat values.
- Downstream of Seaford Village along the western boundary land is zoned Residential 2 which encourages medium to higher densities. Similarly the land east of the railway from Hayman Avenue south is zoned Residential 2. This is the residential area being rezoned from Residential 2 (R2Z) to Residential 1 (R1Z).
- Amendment C24 (if approved) would allow use of Neighbourhood character guidelines in the application assessment for residential buildings and works already requiring a permit e.g. medium density housing and single houses on small sites for Neighbourhood character precincts SF4, SF5 and SF7. Some exempt residential development has potential to reduce the landscape character of the area which will affect open space recreational and landscape amenity in the longer term. There are no similar guidelines for development of commercial land.
- Both the Special Building Overlay (SBO) and Land Subject to Inundation Overlay (LSIO) are applied to land subject to flooding.

No.	Issue	Action	Priority	Respons-ibility
LU1/3	Adjoining development impacts on environmental values of the creek and waterway corridor. There is also vegetation clearing or lack of opportunity to reinstate riparian and associated terrestrial vegetation.	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S1/3 and V4/3.	High	FCC MW

No.	Issue	Action	Priority	Respons-ibility
LU2/3	Proposed Neighbourhood character planning controls will not capture single dwelling development and ancillary buildings for residential properties abutting Kananook Creek and the creek reserve, with longer term effects on landscape and recreational amenity.	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU3/3	Fencing abutting the creek and on side boundaries can lead to floodplain, visual character and land use issues. Currently there are no controls over fencing types used except in relation to flood flows.	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	High	FCC (MW)
LU4/3	Lack of indigenous riparian vegetation adjacent to Seaford Village and the business land upstream of Seaford Road.	In future redevelopment in the business area of Seaford Village, landscape plans are to demonstrate protection of existing indigenous vegetation and utilising indigenous species in future landscaping and revegetation. This is to provide habitat continuity through this area. Mature exotic vegetation (not weed species) that contributes to the creek's landscape character should be retained. Refer to R1/3 and S1/3.	Ongoing	FCC
LU5/3	Pedestrian bridge crossing and public access point at Brodie Street is less than 2 metres wide, and with increased residential densities and use, increased width to improve recreational amenity and physical access would be preferred.	In future development applications on either side of the Brodie Street crossing point, review the potential for a suitable easement/reserve at a minimum width of 3.5m to improve safety and physical access to this crossing point. Introduce a provision in the planning scheme to achieve this.	High	FCC

4.3.3 Drainage and flood management

- Weatherston Road Drain is the major drain entering this reach from the surrounding catchment with untreated urban stormwater and high sediment load from the sandy catchment. This drain connects to the drain from Seaford Wetlands, and management of the tidal back up and flood management of Seaford Wetlands require review to ensure functionality of this system.
- Private land title to the majority of the western bank of the creek results in the need to ensure that redevelopment of this land maintains adequate floodplain capacity and buffer to the creek.

No.	Issue	Action	Priority	Respons-ibility
D1/3	Some adjoining private land holders between Seaford Road and Station Street on the western bank have altered or removed bank materials.	Ensure all future developments meet Melbourne Water requirements for developments in flood prone areas, such as between Seaford Road and Station Street. Refer also to LU2/O.	High and Ongoing	FCC MW

No.	Issue	Action	Priority	Respons-ibility
D2/3	Weatherston Road Drain and Swamp Drain systems require review for management of tidal back up and flooding.	Review the capacity and operation of the Weatherston and Swamp Drains for system performance and institute upgrades where required.	High	MW

4.3.4 Water Quality

- A number of Council stormwater drains discharge untreated urban stormwater into the creek in this reach.
- Weatherston Road Drain is the only Melbourne Water managed drain which contributes urban stormwater.

No.	Issue	Action	Priority	Respons-ibility
Q1/3	Catchment sourced contaminated sediment accumulates in the Kananook Creek.	Investigate opportunities for potential sediment and other contaminant control in the catchment and ensure ongoing implementation of Council's SWMP and prevent further accumulation of contaminated sediment in Kananook Creek. Refer Q5/O.	High & Ongoing	FCC (MW)
Q2/3	High organic content groundwater discharging to Kananook Creek via the drainage system may have impacts on water quality.	Continue to monitor the Dissolved Oxygen levels to minimise potential impacts of the groundwater discharges on in-stream habitat values	Ongoing	MW

4.3.5 Stream system values

- The rate of sedimentation in this reach is relatively minor when compared with the downstream reaches. Refer to Section 3.4 regarding sediment control.
- The stream form is relatively natural with the exception of road crossings.

No.	Issue	Action	Priority	Respons-ibility
S1/3	In-stream habitat being compromised by adjoining land holders clearing vegetation or construction activity.	Investigate implementation of an incentives and/or education program for private landholders with frontage to the creek. The program will aim to improve the management of the riparian zone and in-stream habitats on private land. Refer also to LU1/3 and V4/3.	High	FCC MW Land-holders
S2/3	Some older creek bank treatments are encroaching into the waterway or are deteriorating and need replacement. Some may not have appropriate approvals.	Undertake an inventory of treatments and assets and investigate and report on the approvals for development along the western bank of the creek both for Melbourne Water and Council approvals. Seek removal and /or remediation of unapproved encroaching assets.	High	MW FCC

4.3.6 Vegetation between Armstrongs Road and Seaford Road

- West bank has a narrow vegetation corridor adjoining private properties with one to two small Swamp Paperbark thickets in the northern section of this reach, however, access to assess weeds and condition was not undertaken.
- The linear open space downstream of Station Street on the western side has some revegetation areas with a mix of remnant and indigenous species.

- East bank from Armstrongs Road to Station Street has dense Coast Ti-tree along the eastern most boundary grading to mature Coast Banksia Woodland along through the main part of the reserve, with some Coast Wattle present. Small sections of overhanging vegetation along the stream bank provides good habitat. The understorey is degraded with weeds including Bridal Creeper, Rambling Dock, Cape Ivy and some isolated patches of Dolichos Pea. Woody weeds include Mirror Bush and Fig. There are two main areas of Swamp Paperbark with the middle section thicket featuring a Common Reed bed on swampy low-lying island to the edge of the thicket.
- A significant grassland remnant is located along the rail reserve between Armstrongs Road and Station Street adjoining the eastern side of the public open space, and there appears to be a lack of consistent management which is threatening the values of this remnant.
- East bank from Station Street to Seaford Road features mature Coast Banksia Woodland on the upper part of the slope with some dense senescent patches of Black Wattle and Coast Ti-tree, and some scattered patches of Boobialla, Coast Wattle and Coast Beard Heath. There is an increased frequency of woody weeds in this section including Boxthorn, Cape Leewin Wattle and Mirror Bush. Understorey weeds including Rambling Dock, Cape Ivy and Bridal Creeper along with isolated patches of Dolichos Pea and Sweet Pea upstream of the Brodie Street footbridge. Dieback in the Coast Banksia on the lower slope upstream of Brodie Street footbridge is evident.
- Kikuyu is dominant along the edge of the Railway Station car park with a small patch of *Baumea* noted along the fringe of the creek below the car park. A mature senescent Swamp Paperbark stand is located downslope of the car park along with dense stands of Common Reed. Bridal Creeper is widespread through here.
- There are a number of significant mature Banksia Trees noted in RF Miles Reserve which require protection.
- It was noted there is one remnant Swamp Paperbark in the Reserve indicating the former vegetation community in this area. Providing increased riparian vegetation along the western side will be an important improvement to be made in the future to complement the good vegetation values on the east side.
- Overall condition of vegetation is poor.

No.	Issue	Action	Priority	Respons-ibility
V1/3	Large area of dense Kikuyu and Angled Onion adjacent to Armstrongs Road, which is actively spreading into the creek floodplain and adjoining remnant vegetation.	Control the Kikuyu and Angled Onion adjacent to Armstrongs Road with appropriate control techniques, to prevent it spreading further into the remnant indigenous vegetation.	High	FCC
V2/3	Significant native grassland along rail reserve between Armstrongs Road and Station Street is being threatened by poor land management practices including uncontrolled weeds (particularly *Gazania* sp.*)* and dumping of spoil.	Liaise with Railway authority to provide adequate ongoing management of this vegetation and control of weeds, particularly *Gazania* sp.	High	FCC Rail authority
V3/3	Areas of remnant vegetation contribute to the environmental character including the habitat corridor values.	Establish an integrated vegetation management program to protect and enhance the present values.	High	FCC MW

No.	Issue	Action	Priority	Respons-ibility
V4/3	Fragmented vegetation along the western bank of Kananook Creek due to clearing in adjoining private land.	Liaise with adjoining private landowners along the western bank of the Creek via incentives and/or education programs to encourage protection of remnant indigenous vegetation and appropriate revegetation to re-establish habitat corridor link. Refer to S1/3 and LU1/3	Refer S1/3 and LU1/3	Refer S1/3 and LU1/3
V5/3	Weed invasion, particularly English Ivy, Cape Ivy, Rambling Dock and Dolichos Pea.	Identify the extent of impact of weeds in this reach, particularly English Ivy, Cape Ivy, Rambling Dock and Dolichos Pea, as the basis of developing an integrated weed management program.	High	FCC
V6/3	Dead branches and wood provides habitat value and also fuel loads for potential bushfires.	Assess fuel loads and remove or consolidate patches to reduce the bushfire threat, whilst retaining some areas for habitat value.	High	FCC (MW)
V7/3	Evidence of dieback and tree decline most notably Coast Banksia.	Plant out select patches of Coast Banksia and other suitable tree species where appropriate to address dieback and tree decline.	Ongoing	FCC
V8/3	The railway car park adjoins an area that has remnant values which are degrading with spreading weeds from the car park.	Undertake control of Kikuyu adjacent to the railway car park which is spreading into adjoining vegetation. Investigate incorporating additional indigenous overstorey trees into the car park design.	High	FCC
V9/3	Lack of riparian vegetation adjacent to Chapman Avenue.	Revegetate the riparian zone adjacent to Chapman Avenue once angled parking on the east side has been removed as part of the Structure Plan works at Seaford Village.	High	FCC
V10/3	Lack of indigenous vegetation in the vicinity of car park at RF Miles Reserve.	Increase the presence of Coast Banksia with additional trees around the oval and car park area in RF Miles Reserve to improve the natural character, overall habitat values, and the shade and character of the reserve. Refer R4/3.	High	FCC

4.3.7 Recreation and community use

- The Kananook Creek trail is located on the eastern side of the creek. The community requested improvement to the path surface in the questionnaire outcomes. Between Armstrongs Road and Station Street there are no bridge crossings over the creek and this is approximately 1.1km length of the trail. In the longer term an additional crossing over the creek may be needed to address the safety issues of a long length of trail with no access out.
- The open space adjacent to the community centre at Seaford is used by the KCA for community days including the canoe launching ramp. The Seaford Life Saving Club Masterplan has identified this open space will be improved.
- Future residential development and increased densities on both sides of the creek will increase the need for improved access and use of the Kananook Creek open space corridor.

No.	Issue	Action	Priority	Respons-ibility
R1/3	Surface of the Kananook Creek trail requires upgrade.	Refer R2/O regarding upgrade of the surface of the Kananook Creek trail. The trail is to be maintained as a nature trail north of Station Street.	Refer R2/O Ongoing	Refer R2/O FCC
R2/3	Open space adjacent to the Community Centre has the potential to have improved environmental values and community use as identified in the Seaford Life Saving Club Precinct Masterplan.	Upgrade of the open space area to address the following: • revegetate the riparian zone with indigenous vegetation, retaining views to the creek from the reserve; • upgrade the small non-motorised watercraft launching facility, integrated with revegetation works; • install paths to improve pedestrian access in the reserve and to the creek; • provide picnic and potential BBQ facilities designed to complement the natural creek character and meet flood plain requirements; • retain open grassed areas to allow for use during events and informal passive use; • develop integrated interpretive signage regarding the creek's values, access points and liaise with appropriate RAP regarding potential integration of Aboriginal archaeological and cultural heritage values of Kananook Creek corridor; • investigate potential re-establish stand of Swamp Paperbark in the area where one remnant tree remains; • plant indigenous overstorey trees to reduce the visual prominence of the community centre building whilst retaining some filtered views.	High	FCC RAP (AAV)
R3/3	RF Miles Reserve has the potential to improve its environmental character.	Improve the interface between the oval at RF Miles Reserve and the walking trail by planting indigenous overstorey and ground layer vegetation. When upgrading pavilion, revise the layout of the club rooms to store the waste away from the creek. Refer also V10/3 for increased Coast Banksia planting.	Low	FCC
R4/3	Brodie Street crossing has a very narrow access way (i.e. approx 1.5 metres wide) and requires improvement in the longer term for safety and access.	Continue to seek opportunities to increase the public reserve width for access to Brodie Street crossing. Refer to LU5/3.	Refer LU5/3	Refer LU5/3

4.3.8 Cultural heritage and historical values

- Kananook Creek is identified as an area of high Aboriginal cultural heritage sensitivity, particularly areas that retain their natural remnant vegetation (Austral Heritage, 1998).
- The overall recommendations H1/O and H2/O are relevant to this reach.

4.4 REACH 4
Seaford Road to Mile Bridge

4.4.1 Introduction

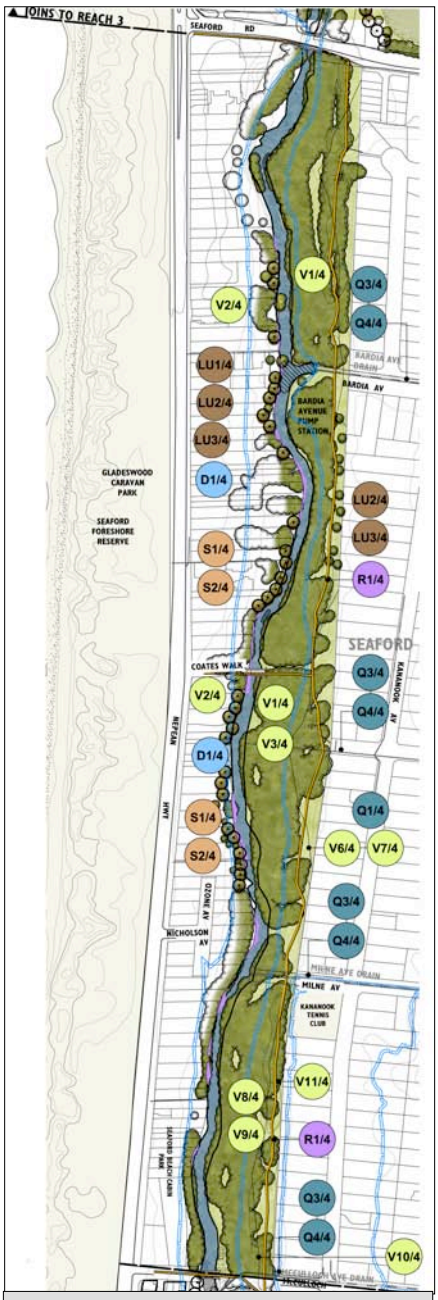


FIGURE 4.4~1 KANANOOK CREEK SEAFORD ROAD TO McCULLOCH AVENUE
Extract from Drawing KCMP-13 Not to scale

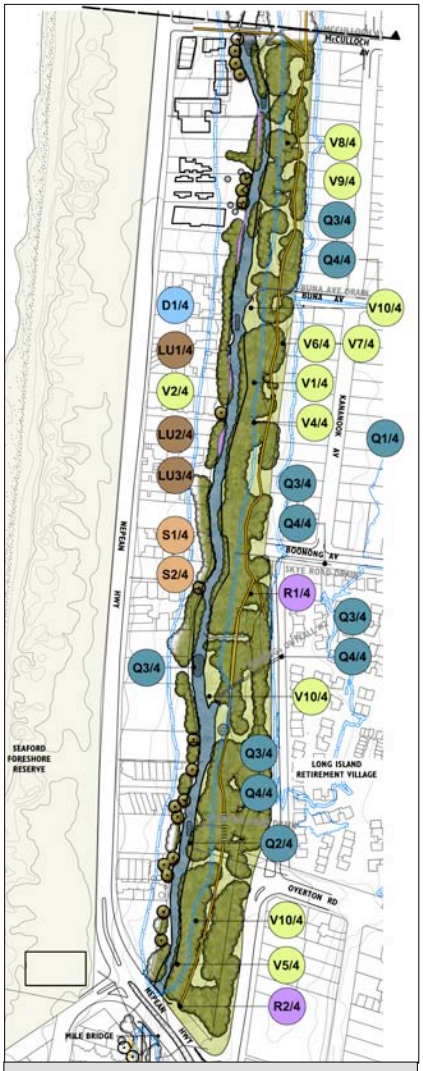


FIGURE 4.4~2 KANANOOK CREEK McCULLOCH AVENUE TO MILE BRIDGE
Extract from Drawing KCMP-13 Not to scale

The Creek alignment is relatively natural through this reach with seven larger Melbourne Water drains entering the creek. Seaford Road is the northern extent of active tidal intrusion into the creek. The drains have brought a large amount of sediment into this reach over time and its cross sectional area has been reduced in the vicinity of the drain outfalls. Melbourne Water has an ongoing maintenance program in place to clear drain outlets where sediment build up causes flood risks.

There is a consistent public open space reserve to the east side with the Kananook Creek walking trail along its length. The western side is predominantly private land to the waters edge with the exception of some smaller parcels of public land immediately downstream of Seaford Road and at the two pedestrian bridge crossing points in this reach. Residential areas to the west sit between the creek and the coastline and there is potential to improve the recognition and future establishment of an environmental link across this area. The residential area to the east has rear boundary fence lines to the reserve along its length, however there are plenty of access points into the reserve with entry points at the end of each of the east-west streets which are at 200 to 300 metre intervals. The crossing points function to provide good access between the coastline and the residential area to the east.

The fire risk in this reach is greater as residential properties directly adjoin the linear open space reserve on the eastern side which means there is no physical break such as the railway or roadway between the indigenous vegetation and private property. Council currently has a Fire Management Works Plan for Kananook Creek which effectively manages this fire risk.

The Kananook Creek trail is generally located along the ridgeline of the former dune and some distance from the creek and there are number of sets of steps along the trail.

The riparian vegetation is a dominated by Coast Banksia Woodland on the eastern side of the stream along with some large areas of Swamp Scrub dominated by Swamp Paperbark with a saline tolerant understorey. There are some sections where buildings are set back on adjoining freehold land and there are opportunities to improve the environmental values of the interface to Kananook Creek.

Mile Bridge provides a highly visible entry point to the Kananook Creek trail and there is potential to improve this with appropriate planting and signage.

Summary of key issues in this reach:
- private land to the creek on the western side of the creek impacting on the environmental values
- high sediment loads entering the stream in this reach from the seven major drain outfalls resulting in the stream becoming un-navigatable during low tide
- inputs of acid sulphate groundwater and urban stormwater impacting on the water quality and in-stream health
- fire management, particularly with residential properties directly adjoining the eastern boundary of the reserve upstream of Boonong Avenue
- surface and condition of the Kananook Creek trail

4.4.2 Adjoining land use and landscape character

- Adjoining land to the west is zoned Residential 2 (R2Z) which encourages medium to higher density residential housing. This land is being rezoned to Residential 1 (RZ1).
- Adjoining land to the east is zoned Residential 1.
- The open space corridor is zoned PCRZ in recognition of the conservation values.
- The zoning to the west has encouraged redevelopment of larger land titles along the western bank with medium density housing, and this trend is likely to continue.
- Long Island Retirement Village adjoins the eastern side along the residential properties with low density residential north of Boonong Avenue.
- Residential properties to the west have titles to the waterway and in some cases they extend into the creek. This does not allow the land-holder the right to build structures and fill out into the creek corridor without obtaining a planning permit from Council who will refer the application to Melbourne Water as a statutory referral authority. The Water Act specifically expunges any private right over the bed and banks of the creek. There are numerous jetties and decks built to the creek edge, and areas where land owners are filling out into the waterway.
- Development extending over the creek with decks and jetties has greater visual impact than a garden/natural interface to creek edge and is not the preferred landscape character given the high value placed on the natural habitat corridor values of the

waterway upstream. Vegetation clearing for construction of structures affects habitat values and interrupts the riparian habitat corridor.

- The Residential 1 land is within a Design Development Overlay (DDO6).
- An Environmental Significance Overlay (ESO1) extends over the existing Council-owned land along the creek including the railway reserve. This ESO does not extend over any of the adjoining freehold land on the western side of the creek, but the ESO4 applies to some adjoining and nearby lots.
- Both the Special Building Overlay (SBO) on the eastern side of the creek and Land Subject to Inundation Overlay (LSIO) over the creek and western edges are applied to land subject to flooding.
- Amendment C24 (if approved) would allow use of Neighbourhood character guidelines in the application assessment for residential buildings and works already requiring a permit e.g. medium density housing and single houses on small sites for Neighbourhood character precincts SF4, SF5 and SF7. Some exempt residential development has potential to reduce the landscape character of the area which will affect open space recreational and landscape amenity in the longer term.

No.	Issue	Action	Priority	Respons-ibility
LU1/4	Adjoining development impacts on environmental values of the creek and waterway corridor. There is also vegetation clearing or lack of opportunity to reinstate riparian and associated terrestrial vegetation.	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S2/4, V2/4 and V7/4.	High	FCC MW
LU2/4	Proposed Neighbourhood character planning controls will not capture single dwelling development and ancillary buildings for residential properties abutting Kananook Creek and the creek reserve, with longer term effects on landscape and recreational amenity.	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU3/4	Fencing abutting the creek and on side boundaries can lead to floodplain, visual character and land use issues. Currently there are no controls over fencing types used except in relation to flood flows.	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	Refer LU4/O	Refer LU4/O

4.4.3 Drainage and flood management

- There are seven large Melbourne Water drains entering Kananook Creek in this reach including Bardia Avenue Drain, Milne Avenue Drain, McCulloch Avenue Drain, Buna Venue Drain, Skye Road Drain, Jennings Outfall # 2 and Overton Road Drain. (Refer Dwg No. KCMP-04 for location of drain).
- Private land title to the majority of the western bank of the creek results in the need to ensure that redevelopment of this land maintains adequate floodplain capacity and buffer to the creek.

No.	Issue	Action	Priority	Respons-ibility
D1/4	Some adjoining private land holders between Station Street and Mile Bridge on the western bank have altered or removed bank materials.	Ensure future developments meet Melbourne Water requirements for developments in flood prone areas, such as between Station Street and Mile Bridge. Refer to LU3/4 and LU2/O.	High and Ongoing	FCC MW

4.4.4 Water Quality

- The seven large Melbourne Water drains entering the catchment bring untreated urban stormwater runoff into the stream along with organically rich groundwaters that are intercepted and transported to the creek via the drainage system. Along with diurnal sag from the high algal levels, this contributes to lower dissolved oxygen levels which can potentially contribute to fish kills during summer and autumn when levels can become depressed elevated due to lower fresh water inputs.

No.	Issue	Action	Priority	Respons-ibility
Q1/4	Litter accumulation in the lower portion of the reach from the adjoining catchments.	Investigate opportunities for potential litter control measures in the catchment and ensure ongoing implementation of Council's SWMP and address litter accumulation in the lower portion of the reach. Refer Q5/0.	Ongoing	FCC (MW)
Q2/4	Litter accumulation in the lower portion of the reach from the adjoining catchments.	Continue to maintain the Overton Road Litter boom.	Ongoing	MW
Q3/4	Catchment sourced contaminated sediment accumulating in the waterway reducing the cross-section of the creek.	Refer Q2/O, S5/O and Q5/O regarding accumulation of contaminated sediment in the waterway.	Refer Q2/O, S5/O & Q5/O	Refer Q2/O, S5/O & Q5/O
Q4/4	Organically rich groundwater discharging to the stream having impacts on water quality.	Continue to monitor the dissolved oxygen levels to minimise impacts of groundwater discharges on in-stream habitat values.	Ongoing	MW

4.4.5 Stream system values

- High sediment load entering the stream through this reach. The sediments consist predominantly of sands and silts and a range of contaminants derived from urban runoff including hydrocarbons, heavy metals, nutrients and animal faeces. Melbourne Water removes sediment from drain outlets to ensure flood protection. Melbourne Water will actively manage sediment in the lower reaches of Kananook Creek to provide for appropriate canoe access. Refer to Section 3.4 for actions regarding sediments in the reach.
- There are fauna values in this reach particularly given the presence of indigenous vegetation and over-storey in the reach. Refer to Section 3.5 for recommendations regarding improvement to fauna values.

No.	Issue	Action	Priority	Respons-ibility
S1/4	Some older creek bank treatments are encroaching into the waterway or are deteriorating and need replacement and may not have appropriate approvals.	Undertake an inventory of treatments and assets and investigate and report on the approvals for development along the western bank of the creek both for Melbourne Water and Council approvals. Seek removal and /or remediation of unapproved encroaching assets.	High	MW FCC
S2/4	In-stream habitat being compromised by adjoining land holders clearing vegetation or construction activity.	Investigate and implement an incentives and/or education program for private landholders with frontage to the creek. The program will aim to improve the management of the riparian zone, in-stream habitats and sediment control during construction on private land. Refer also to LU1/4, V2/4 and V7/4.	High	FCC (MW)

4.4.6 Vegetation

- The riparian vegetation along the west bank is narrow and fragmented due to private properties. The vegetation is fragmented due to clearing for boat moorings, decks and launching ramps. There are some small patches of Swamp Scrub along the western bank, however unable to access this during site assessment so condition is unknown.
- The east bank is a relatively wide corridor of predominantly mature Coast Banksia Woodland with some dense senescent patches of Coast Ti-tree. Scattered mature Coast Manna Gum and patches of Boobialla, Coast Wattle and Coast Beard Heath are also present. The groundstorey is mixed with some good patches of indigenous vegetation including Bower Spinach, Rhagodia, Hill Sword-sedge and Austral Stork's-bill.
- Major areas of weed infestation associated with former dredging areas including Kikuyu dominated areas with Angled Onion. There are also some areas introduced native vegetation including Mahogany Gum and Pigface.
- Large stands of Swamp Scrub with senescing Swamp Paperbark and an understorey indicative of increased saline conditions with Sea Rush, Streaked Arrow-grass, Sea Celery and Creeping Brookweed. Increased dominance of Austral Seablite and Beaded Glasswort is present in the downstream areas. These areas are relatively weed free and in good condition.
- Near Boonong Avenue there is a small *Baumea* dominated swamp along the creek flat.
- Small Saltmarsh area upstream of McCulloch Avenue footbridge with large patches of Rounded Noon-flower, Austral Seablite, Beaded Glasswort and Australian Salt-grass which is comparatively weed free and in good condition.

No.	Issue	Action	Priority	Respons-ibility
V1/4	Areas of remnant vegetation contribute to the environmental values and habitat corridor.	Establish an integrated vegetation management program to protect and enhance the present values.	High	FCC (MW)
V2/4	Fragmented vegetation along the western side of creek due to clearing in adjoining private land.	Liaise with adjoining private landowners on western side of creek via incentives and/or education programs to encourage protection of remnant indigenous vegetation and appropriate revegetation on private land to re-establish habitat corridor link. Refer also to V7/4, S2/4 and LU1/4.	Ongoing	FCC (MW)

No.	Issue	Action	Priority	Respons-ibility
V3/4	Weed invasion, particularly Desert Ash, Angled Onion, Ivy Groundsel, Rambling Dock, Dolichos Pea and assorted garden escapees.	Identify extent of impact of weeds including Desert Ash, Angled Onion, Ivy Groundsel, Rambling Dock and Dolichos Pea as the basis of developing an integrated weed management program.	High	FCC (MW)
V4/4	Bridal Creeper has been very invasive, in recent years, and whilst it appears to be in decline, it may increase its presence when current dry period ends.	Continue to monitor and target Bridal Creeper around the boundaries of the saline wetland areas to contain its spread.	High	FCC
V5/4	Desert Ash (near Mile Bridge) and other woody weeds in the riparian zone require control.	Control Desert Ash near Mile Bridge as a priority followed by other woody weeds in the riparian zone.	Medium	MW FCC
V6/4	A number of weeds are spreading from residential properties adjoining the eastern boundary of the reserve.	Target control of weeds in public land near the boundary fence with residential properties adjoining the eastern boundary of the reserve to contain their spread into the reserve.	High	FCC
V7/4	A number of weeds are spreading from residential properties adjoining the eastern boundary of the reserve.	Liaise with the adjoining residents on eastern boundary of the reserve via incentives and/or education programs to encourage control or replacement of weed species in their gardens to reduce the ongoing management issue in the reserve. Refer also to V2/4, S2/4 and LU1/4.	High	FCC Land-owners
V8/4	Dead branches and wood provides habitat value and also fuel loads for potential bushfires that may damage adjoining properties given that they directly adjoin the eastern boundary of the reserve.	Assess fuel loads and remove or consolidate patches to reduce the bushfire threat, whilst retaining some areas for habitat value.	High	FCC
V9/4	Evidence of dieback and tree decline most notably Coast Banksia.	Plant out select patches of Coast Banksia and other suitable tree species where appropriate to address dieback and tree decline.	Ongoing	FCC
V10/4	Spread of Kikuyu, Tradescantia and other smothering groundlayer weeds at the former spoil dumping sites from dredging near Overton Road Drain.	Initially spray outer edges of Kikuyu, Tradescantia and other smothering groundlayer weed populations to contain further spread. Expand spraying to reduce total weed cover and eradicate over time where feasible. Follow up with revegetation as weeds are fully eradicated using appropriate EVC species.	High & Ongoing	MW (FCC)
V11/4	Areas of indigenous ground-layer vegetation near the walking trail could be used for interpretation of these values.	Refer to R3/4 regarding interpretation of indigenous ground-layer vegetation.	Refer R3/O	Refer R3/O

4.4.7 Recreation and community use

- There is a continuous open space reserve along the eastern side of the creek and freehold land to the west. There is a small section of open space in the west side downstream of Seaford Road.
- The Kananook trail is located on the eastern side of the creek. The community requested improvement to the trail surface in the questionnaire outcomes. There are a number of sets of steps in this section of the trail which limits all-ability access.
- Along this reach, housing backs onto the reserve with access provided at the end of the east-west roads. The trail is located along the dune and close to property boundaries in some locations.
- Future residential development and increased densities will increase the need for improved access and use of the Kananook Creek open space corridor.
- Coates footbridge has a very narrow reserve and is an important east-west link for residents to the east linking to Kananook Creek and the Seaford Foreshore Reserve.

No.	Issue	Action	Priority	Respons-ibility
R1/4	Surface of the trail requires upgrade.	Refer R2/O regarding upgrade of trail surface.	Refer R2/O	Refer R2/O
R2/4	Highly visible entry point to the Kananook Creek trail	Upgrade the entry to promote the values of Kananook Creek at this highly visible crossing. Consider the following in this upgrade: • establish open views into the trail; and • interpretative and directional signage developed as part of the Signage Plan for the creek (Refer R3/O)	Medium	FCC

4.4.8 Cultural heritage and historical values

- Kananook Creek is identified as an area of high Aboriginal cultural heritage sensitivity, particularly areas that retain their natural remnant vegetation (Austral Heritage, 1998). This study identified two registered AAV sites which are scar trees within this reach (AAV No. 7921-0294 and 7921-0295). However, the author of the report recommended these two trees be removed from the AAV Register as they are not of an adequate size to be scar trees. The nearby Seaford Reserve contains two AAV registered sites which are shell middens. The relatively in-tact nature of the dunes along Seaford Foreshore Reserve contributes to the archaeological values of this area.
- The overall recommendations H1/O and H2/O are relevant to this reach.
- There are no specific locations of historical European values identified in this reach, however, additional values may be identified during further research.

4.5 REACH 5

Mile Bridge to Wells Street Frankston

4.5.1 Introduction

There is a combination of freehold and public land on both sides of the creek through this reach. Adjoining land use includes predominantly residential on the west and a combination of residential, business/commercial land use on the east. Development is being encouraged on the eastern side of the creek with the southern portion of this reach, downstream of north Fletcher Road, within the TAFE to Bay Structure Plan area.

Residential areas to the west sit on the dune between the creek and the coast and there is potential to improve the recognition and future establishment of an environmental link across this area. There is a mixture of private land extending to the creek and private land with rear boundaries to the open space reserve. The residential and mixed use area to the east has rear boundaries to open space reserves in some locations, and in others the private land titles extend to the creek. There are access points into the reserve at the end of each of the east-west streets, and two pedestrian bridges over the creek in this reach. This provides good connectivity over the creek to the coast.

The stream banks have been modified in this reach with the section between Mile Bridge and Beach Street essentially retaining a natural channel form, however the edge treatment varies with a range of different wall and natural batter treatments. A concrete wall to the east side of the creek between Beach and Wells Streets was constructed by Council during the 1970s.

There is only a narrow strip of riparian vegetation along the creek between Mile Bridge and Beach Street and in some locations this has been completely removed with decks and jetties built in

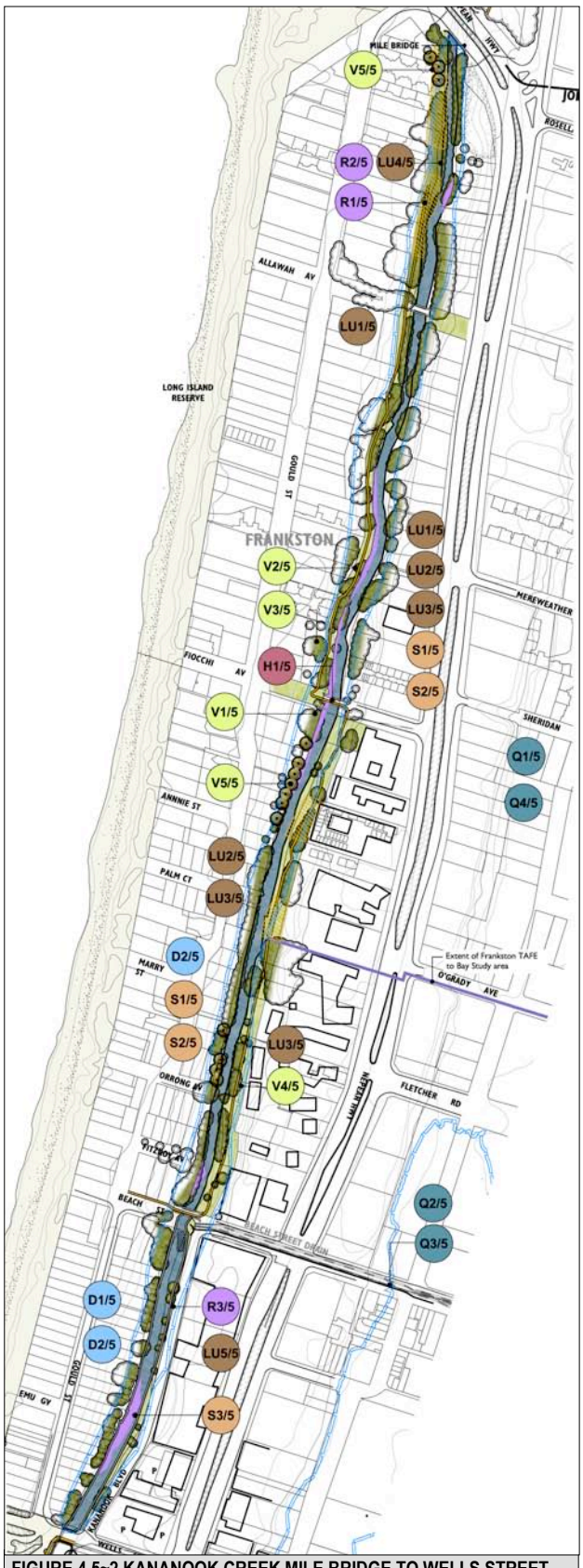


FIGURE 4.5~2 KANANOOK CREEK MILE BRIDGE TO WELLS STREET
Extract from Drawing KCMP-15 Not to scale

its place. Downstream of Beach Street on the eastern side of the creek there is no riparian vegetation remaining as the creek has been walled.

Public access is provided along the creek on at least one side, from Allawah Avenue to Beach Street, however, no off-road trail link has been established between Allawah Avenue and Mile Bridge. Pedestrian access over and under the Nepean Highway at Mile Bridge requires investigation to establish a safe connection for this municipal link.

There is some remnant vegetation along the reach between Beach Street and Fiocchi Avenue and this remnant vegetation has been strengthened with some recent revegetation work as part of a Corridors of Green program implemented by Frankston City Council and funded through Melbourne Water.

Key issues to be addressed in this reach include:

- completion of the trail through this reach
- safe shared trail access under or over Nepean Highway at Mile Bridge
- improve development interface to Kananook Creek including set backs and controls on private jetties and decks to the water's edge
- protect remnant vegetation and improve presence of indigenous vegetation where appropriate, including on adjoining freehold land; and
- implementation of the TAFE to Bay Structure Plan for the PAC in the area south of Fletcher Road.

4.5.2 Adjoining land use and landscape character

- Adjoining land to the west is zoned Residential 1 (R1Z) and to the east is Business Zone 5 (B5Z). B5Z extends from Mile Bridge to Beach Street and encourages development of offices or multi-dwelling units between Kananook Creek and the Nepean Highway. DDO6 applies generally to this area. It is envisaged that development on the east side will progressively increase in intensity and scale.
- The narrow creek corridor is zoned Public Conservation and Resource (PCRZ) and the adjoining narrow reserves are zoned Public Park and Recreation (PPRZ) to recognise their primary use of the trail link.
- Adjoining land on the east side from Beach Street to Wells Street is zoned Business 1 (B1Z) and this permits the use of the land for business rather than residential use. DD05 applies to this area.
- The Residential 1 land is within a Design Development Overlay (DDO6).
- An Environmental Significance Overlay (ESO1) extends over the existing Council-owned land along the creek including the railway reserve. This ESO does not extend over any of the adjoining freehold land on the western side of the creek, but the ESO4 applies to adjoining and nearby lots.
- Residential properties to the west have titles to the waterway and in some cases they extend into the creek. This does not allow the land-holder the right to build structures and fill out into the creek corridor without obtaining a planning permit from Council who refers the application to Melbourne Water as a statutory referral authority. The Water Act specifically expunges any private right over the bed and banks of the creek. There are numerous jetties and decks built to the creek edge, and areas where land owners are filling out into the waterway.
- Development extending over the creek with decks and jetties has greater visual impact than a garden/natural interface to creek edge and is not the preferred landscape character given the high value placed on the natural habitat corridor values of the waterway upstream. Vegetation clearing for construction of structures affects habitat values and interrupts the riparian habitat corridor.
- Adjoining land use on the east side extends to the creek or in some locations there is a narrow open space corridor between the adjoining land and the creek. Between Beach Street and Wells Street Kananook Boulevard adjoins the creek providing a physical barrier and public access between adjoining development and the creek. The east bank is a steeply graded mown grass bank between the road and the creek with scattered planted native trees.

- There is a Land Subject to Inundation Overlay (LSIO) over the creek and edges which applies to land subject to flooding.
- There is a Public Acquisition Overlay (PAO3) in place for some parcels of land adjoining the creek, and some of these parcels of land have been already been purchased by Council for public open space.
- Amendment C24 (if approved) would allow use of Neighbourhood character guidelines in the application assessment for residential buildings and works already requiring a permit e.g. medium density housing and single houses on small sites for Neighbourhood character precinct F10. Some exempt residential development has potential to reduce the landscape character of the area which will affect open space recreational and landscape amenity in the longer term. There are no similar guidelines for development of commercial land.

No.	Issue	Action	Priority	Respons-ibility
LU1/5	Adjoining development impacts on environmental values of the creek and waterway corridor. There is also vegetation clearing or lack of opportunity to reinstate riparian and associated terrestrial vegetation.	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S2/5 and V5/5. The provisions are not required in the TAFE to Bay precinct south of Beach Street where the creek becomes a concrete lined channel on the east side of the creek.	High	FCC MW
LU2/5	Proposed Neighbourhood character planning controls will not capture single dwelling development and ancillary buildings for residential properties abutting Kananook Creek and the creek reserve, with longer term effects on landscape and recreational amenity.	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU3/5	Fencing abutting the creek and on side boundaries can lead to floodplain, visual character and land use issues. Currently there are no controls over fencing types used except in relation to flood flows.	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	Refer LU4/O	Refer LU4/O
LU4/5	Lack of continuity of public land on the western and eastern side of Kananook Creek.	Continue to support securing a public open space corridor along the western side of the creek via the existing Public Acquisition Overlay Control. This will provide a habitat and open space link.	High	FCC
LU5/5	There is a section of the TAFE to Bay Precinct in the lower portion of this reach extending from north of Fletcher Road to Wells Street. Between Fletcher Road and Booth Street land adjoins open space reserve with remnant indigenous vegetation.	Integrate principles outlined in LU1/6 in new TAFE to Bay planning scheme provisions, including specific controls on the riparian and terrestrial vegetation. For commercial areas not covered by the TAFE to Bay provisions, consider using the residential character planting guidelines to guide assessment of landscaping plans for commercial development applications. Retain mature exotic vegetation (not weed species) that contributes to the creek's landscape character.	Ongoing Ongoing	FCC FCC

4.5.3 Drainage and flood management

- Private jetties and decks constructed along the waterway by private landholders may impact on the flooding, and require approval from Melbourne Water prior to construction.
- Flooding has the potential to impact on adjoining land use and the creek corridor in this reach and some properties have recently built flood walls to allow development into the floodplain. This is a high risk approach and whilst it can meet the flood protection levels it allows for no safety factor from a king tide or greater than 1 in 100 year ARI event.
- Additional 1200mm drain outlet is to be constructed around 2009/2010 at Beach Street by Melbourne Water.

No.	Issue	Action	Priority	Respons-ibility
D1/5	Some adjoining development on the western bank between Beach Street and Wells Street may not have been approved and may be below the declared flood levels.	Ensure future developments on the western bank meet Melbourne Water requirements for developments in flood prone areas, such as between Beach Street and Wells Street. Refer also to LU 2/O.	High	FCC MW
D2/5	Structures and jetties have been constructed along the western bank of this reach, potentially without approval and may impact on flood levels.	Review the existing planning scheme controls to ensure that permits are required for all new jetty and boat launching and retrieval structures along the waterway on private land, and that there is enforcement of this requirement. Refer to LU1/5, also to LU2/O.	High	FCC MW

4.5.4 Water Quality

- Tidal exchange in this reach assists with diluting the relatively poor water quality that flows from the urban catchments.
- Melbourne Water's Beach Street Drain has an extensive catchment through the urban area of Frankston through which catchment generated sediment and litter enters into the creek.

No.	Issue	Action	Priority	Respons-ibility
Q1/5	Litter accumulation in the reach from the adjoining catchments.	Continue to investigate and implement at source litter control measures in the catchment to address litter accumulation in the reach.	Ongoing	FCC (MW)
Q2/5	Catchment sourced sediment accumulating in the waterway reducing the cross-section of the creek.	Refer Q2/O and S5/O regarding sediment accumulation in the waterway.	Refer Q2/O & S5/O	Refer Q2/O & S5/O
Q3/5	Future additional drain outfall in this reach by Melbourne Water has the potential to increase the sediment and pollutant loads to the creek.	As part of the design development of the new drain diversion to Beach Street, investigate measures to reduce the sediment and pollutant loads entering Kananook Creek. Refer to Q2/O and S5/O	High	MW
Q4/5	Untreated stormwater discharging from the catchment into Kananook Creek and Port Phillip Bay.	Investigate opportunities to improve stormwater quality in the catchment. Refer Q5/O to reduce untreated stormwater discharging into Kananook Creek and Port Phillip Bay.	High	MW FCC

4.5.5 Stream system values

- The stream form is more natural from Mile Bridge to Beach Street although bank encroachment is evident on the western bank. There is some evidence of sediment build up on the banks with stands of Common Reed. Increasing public land to provide the trail through this reach will improve management of the creek banks and in the longer term the habitat values.
- Downstream of Beach Street to Wells Street Council concrete walls to the east side were constructed in the late 1970s, which has significantly reduced the natural values of the stream.
- Site observations suggest that during a low spring tide there are reasonable velocities in this lower reach to maintain a deeper channel.

No.	Issue	Action	Priority	Respons-ibility
S1/5	Some private walling systems and jetties are encroaching into the waterway or are deteriorating and need replacement and impact on the stream system values.	Refer D2/5 and LU1/5 regarding private walling systems and jetties encroaching into the waterway.	Refer D2/5	Refer D2/5
S2/5	In-stream habitat being compromised by adjoining land holders clearing vegetation or construction activity on the western and eastern banks.	Investigate implementation of an incentives and/or education program for private landholders with frontage to the creek. The program will aim to improve the management of the riparian zone, in-stream habitats and sediment control during construction on private land. Refer also to V5/5 and LU1/5.	High	FCC MW
S3/5	Walling system constructed in the 1970s is deteriorating and needs replacement.	Investigate a walling system design for Kananook Creek that provides for retention of critical cross section, channel maintenance and improved visual character. Also refer to LU1/6 and LU2/6.	High	FCC MW

4.5.6 Vegetation

- East and western banks contain narrow corridors of riparian vegetation with a small number of mature Coast Banksia in patches along the creek bank, and scattered small stands of Swamp Scrub dominated by Swamp Paperbark.
- Scattered patches of Saltmarsh along the fringe of the creek banks.
- Woody weed, notably Mirror Bush, present in dense thickets at the rear of some properties, along with as small number of Weeping Willows.
- Seagrass noted in-stream.

No.	Issue	Action	Priority	Respons-ibility
V1/5	Areas of remnant vegetation contribute to the environmental values and habitat corridor.	Establish an integrated vegetation management program to protect and improve the existing values.	High	FCC (MW)

No.	Issue	Action	Priority	Respons-ibility
V2/5	Weed invasion, particularly Mirror Bush and a range of garden escapees.	Identify extent of impact of weed invasion, particularly Mirror Bush and garden escapees, as the basis of developing an integrated weed management program. This should consider the following: • target woody weeds with drill/fill or cut/paint and remove from site when practical • control impact of climber weeds including Cape Ivy and Rambling Dock.	Medium	FCC (MW)
V3/5	Spread of Kikuyu, Tradescantia and other smothering groundlayer weeds.	Initially spray outer edges of Kikuyu, Tradescantia and other smothering ground-layer weed populations to contain further spread. Expand spraying to reduce total weed cover and eradicate over time where feasible. Weed eradication is to be followed by revegetation using appropriate EVC species.	Medium	FCC
V4/5	Extensive revegetation works on the east side of the creek between Fiocchi Avenue and Beach Street requires ongoing maintenance.	Continue to maintain the existing revegetation area between Fiocchi Avenue and Beach Street and extend over time.	Ongoing	FCC
V5/5	Loss of indigenous vegetation on adjoining freehold land.	Investigate implementation of an incentives and/or education program for private landholders to protect indigenous vegetation on their land and plant additional indigenous vegetation on their land to improve the environmental values of the waterway corridor. Refer to LU1/5 and S2/5.	Ongoing	FCC MW

4.5.7 Recreation and community use

- Off-road shared trail access over or under Mile Bridge is not currently provided and requires design investigation to achieve this important link.
- There is a need to purchase additional open space to achieve future off road trail link north of Allawah Avenue.
- The trail is constructed on the west side as an unsealed trail between Allawah Avenue and Fiocchi Avenue footbridge. Downstream of Fiocchi Avenue to Beach Street the trail is on the east side, with a recently planted revegetation along the open space corridor. The revegetation work was a Corridors of Green project undertaken by Council and funded by Melbourne Water.
- There is no off-road trail between Beach Street and Wells Street with a steeply graded mown grass bank extending from Kananook Avenue to the creek.

No.	Issue	Action	Priority	Respons-ibility
R1/5	Lack of trail link from Allawah Avenue to the northern side of Mile Bridge.	Undertake a specific trail design investigation for this section of the trail reviewing the final alignment in the context of a crossing point over or under Mile Bridge.	High	FCC (DSE)
R2/5	Lack of open space in this reach.	Continue to secure open space corridor through this reach in accordance with LU4/5.	Refer LU4/5	Refer LU4/5

No.	Issue	Action	Priority	Respons-ibility
R3/5	Lack of off-road trail from Beach Street to Wells Street.	Investigate design for trail in conjunction with final size and alignment of Kananook Boulevard. There may be opportunities to reduce the width of Kananook Avenue to allow additional space for an off-road trail as part of the current transit city planning.	High	FCC (DPCP)
R4/5	Recreational boating use may potentially increase downstream of Beach Street as redevelopment of the adjoining land in the TAFE to Bay Structure Plan occurs. Sediment build up is limiting navigability of this section of Kananook Creek.	Address recreational boating use of the creek downstream of Beach Street, refer R6/O.	Refer R6/O	Refer R6/O

4.5.8 Cultural heritage

- Kananook Creek is identified as an area of high Aboriginal cultural heritage sensitivity, particularly areas that retain their natural remnant vegetation (Austral Heritage, 1998).
- The overall recommendations H1/O and H2/O are relevant to this reach.
- The white timber bridge crossings in this reach are not listed as being historically significant. However the bridges have become an iconic feature of Kananook Creek, reminiscent of European inhabitation from early settlement.

No.	Issue	Action	Priority	Respons-ibility
H1/5	The white timber footbridge at Fiocchi Avenue provides some historical reference to earlier dominant use of this area as a holiday destination for people of Melbourne.	Continue to protect the white painted timber footbridge at Fiocchi Avenue as a reminder of the earlier use of the area as a holiday destination. Interpretation of this former earlier use to be provided through interpretive signage, refer to R3/O and clarify if the footbridge is a more recent structure to avoid confusion.	Ongoing	FCC

4.6 REACH 6
Wells Street to Port Phillip Bay

4.6.1 Introduction

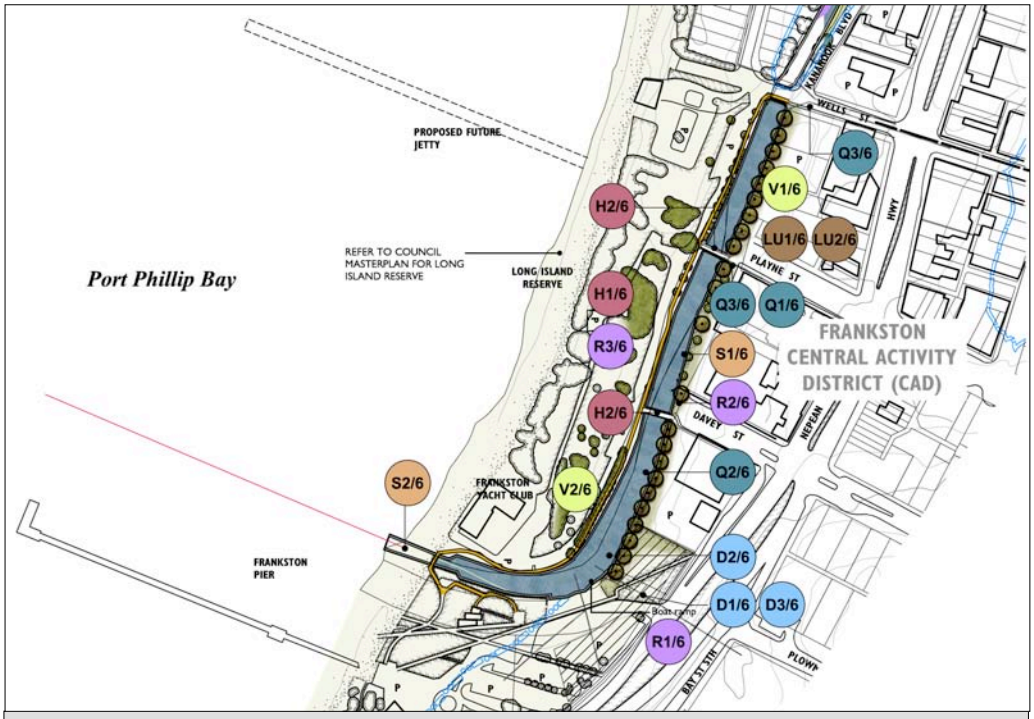


FIGURE 4.6~1 KANANOOK CREEK WELLS STREET TO PORT PHILLIP BAY
Extract from Drawing KCMP-16 Not to scale

The creek in this reach is a 'canal' style waterway with concrete walling to both sides of the creek. The wall is in poor condition in places and will require reconstruction which provides an opportunity to reset the wall to meet the new urban design and landscape outcomes. There are no significant environmental values present in this highly modified lower reach of the creek. A large amount of recreational boat traffic occurs in this lower reach between the boat ramp and Port Phillip Bay. The mouth of the creek is dredged by Frankston City Council (under a consent from the Department of Sustainability and Environment with EPA approval) to allow this recreational boating to continue.

This reach of Kananook Creek flows adjacent to and defines the eastern extent of the Frankston Principal Activity Centre (PAC). The *Frankston TAFE to Bay Structure Plan* is a jointly funded project with Department of Planning and Community Development and outlines the vision for this precinct including future direction for development on the east side of Kananook Creek. The proposed redevelopment includes a combination of residential and commercial land use adjacent to the creek with buildings facing the creek. It aims to establish a public pedestrian precinct adjacent to the creek similar in concept to Southbank in Melbourne. This treatment could include natural sections as well as a harder paved urban edge. Buildings will scale down in height towards the creek from the Nepean Highway and there is an option to establish public plazas and open space in Davey Street and Playne Street road reserves. The State Government has committed $8 million dollars funding to the project over the next three years.

Long Island Reserve on the western bank of this reach is a major open space reserve between the creek and the coastline. The Reserve recently had an Environmental Management and Development Plan prepared for it to complement the works on the PAC side of the creek. The proposal is to establish a boardwalk along the west side of the creek and relocate vehicles away from the creek edge where possible. Long Island Reserve

provides a natural public open space interface to the creek that will become more important as the Frankston PAC develops over time. An increased number of residents will live in the area opposite the reserve in medium to high density housing adjacent to the creek and connectivity between the creek and natural character of the Long Island Reserve will be important. Remnant Coast Banksias (*Banksia integrifolia*) are of significant size and age. Future management of these and retaining them will influence design of the open space interface to the creek.

The existing footbridges at Davey Street and Playne Street are to be retained and meet the required flood heights, and provide reference to the historical character of this area when it was predominantly a holiday destination point back in the early 1920s. The bridges are not registered heritage items. However, their character and material use with timber are similar to the original bridges evident in early photographs. The recreational value these bridges provide to facilitate east-west pedestrian access is extremely valuable. Recreational values in this reach are high and will increase as residential development occurs on the eastern side of the creek in this reach.

Melbourne Water is to undertake major flood mitigation and drainage upgrade works in the catchment with a new outfall proposed at Davey Street.

In 1995 the Minister of Planning advised Council that any proposed development in the Kananook Creek/Frankston Foreshore precinct would require the preparation of an Environmental Effects Statement (EES). Kinhill Engineers developed options for development and the environmental effects of each proposed development plans. For this, a Structure Plan was developed for the area and elements of the EES and Structure Plan were incorporated into the Comprehensive Development Zone (CDZ2) which includes the Frankston Principal Activity Centre and Long Island Reserve on both sides of Kananook Creek.

Relevant elements relating to Kananook Creek include:

- Maintain an open, natural and informal environment. These favour the development of informal pathways, picnic facilities and open space.
- Removal of road along the western edge of the creek and introduce a new two way road and a rationalised car parking area through the centre of Long Island.
- Upgrade existing bridges across the creek and improve pedestrian paths to the beach
- Provide an emergency access only boat ramp
- Provide for pedestrian walking along both sides of the creek
- Continue to improve water quality and creek side vegetation

The TAFE to Bay Structure Plan has been translated into a new interim control in the Frankston Planning Scheme (Amendment C49).

4.6.2 Adjoining land use and landscape character

- All adjoining land use in this precinct is zoned Comprehensive Development Zone 2 (CD2Z). In summary some of the relevant dot points from the purpose of this zone is to:
  - *Improve the contribution of Kananook Creek foreshore area to the safety, amenity, economy and lifestyle of Frankston.*
  - *Provide a high level of service to boat users.*
  - *Be physically and visually integrated with the PAC and the foreshore*
- This zone is made up of a mixture of precincts which included the Retail Edge and Long Island precincts. Specific details regarding the purpose of each precinct can be found in the Frankston Planning Scheme.
- The recent TAFE to the Bay Structure Plan (225) prepared for the Frankston PAC is the relevant guide for future design principles in the Kananook Creek precinct. The future adjoining land use to Kananook Creek is anticipated to include the following:
  - *Residential living is to be encouraged within the Kananook Creek precinct; height levels generally not to exceed 12 metres along the creek and 20 metres along Nepean Highway.*
  - *Commercial and retail uses are to be encouraged along the Nepean Highway alignment, and along the Wells Street alignment. Retail premises are also to be encouraged throughout new housing developments.*

- *Cafes and restaurants are to be encouraged throughout the precinct.*
- *Hotels and Institutional facilities on key strategic sites.*
- *Public and recreational space including boardwalks (promenades) and public plazas.*

- Below is a summary of the development principles included in the TAFE to Bay Structure Plan (225) relevant to the future design of Kananook Creek:
  - *The environmental and visual quality of the creek should be enhanced as part of the overall redevelopment of the precinct*
  - *Redevelopment should incorporate public open space along the foreshore edge. The character of this edge will vary north and south of Wells Street in accordance with the different conditions on the western edge of the creek*
  - *Public space along the creek edge should have a pedestrian focus*
  - *New development should facilitate improved pedestrian linkages north-south and east-west through the precinct*
  - *New development should contribute to improving adjacent public spaces (pavements, boardwalks etc) (Cox Architects & Planners, 2005).*

- Interface treatment with the creek should respond to the constructed nature of adjoining land use and cater to the high levels of use whilst introducing some elements of the cultural and environmental values of Kananook Creek.
- The Design and Development Overlay (DDO5) applies to land within the CDZ2 on the eastern side of the creek. There is one Environmental Significance Overlay (ESO4) between the creek and the Nepean Highway.

No.	Issue	Action	Priority	Respons-ibility
LU1/6	Adjoining private land on the eastern side of the creek will be redeveloped in accordance with the TAFE to Bay Structure Plan.	Ensure the following principles are integrated into future TAFE to Bay Planning Scheme provisions: • public open space of adequate width to ensure pedestrian and all-ability access along the eastern frontage to Kananook Creek which is open and accessible to the public at all times; • reflect some of the cultural and environmental character of Kananook Creek in the detailing of the interface treatment; • adequate flood protection to be achieved; and • utilise indigenous plants in the landscape treatment in the public open space and on freehold land where applicable. Refer also to V1/6.	High and Ongoing	FCC (MW)
LU2/6	Flood capacity of Kananook Creek is to be retained.	Ensure there are adequate controls to ensure future development does not reduce the flood capacity of Kananook Creek.	Ongoing	FCC MW

4.6.3 Drainage and flood management

- Frankston City Council are aware that the existing constructed walls to the creek are in poor condition and will need to be rebuilt as part of future works proposed in the TAFE to Bay Structure Plan.
- The flood level within this section is controlled by the cross sectional area of the creek, with the bay level also having an influence. The applicable flood level upstream of Wells street is 1.7m AHD, while the 100 year bay level is 1.4m AHD. Given that the area is subject to wave action and within the possibility of greenhouse induced sea level rises, 1.7m AHD should be adopted as a flood level for all of this reach.
- Whilst the 1 in 100 year flood level for Kananook Creek is currently specified as 1.7 metres to Australian Height Datum (AHD), the creek is directly affected by tidal levels on

Port Phillip Bay and the potential impacts of climate change driven sea level changes should be considered in determining flood levels for these proposed works. The Draft Victorian Coastal Strategy developed by the Victorian Coastal Council, currently out for public comment, assumes a sea level rise of 0.4 metres to 0.8 metres by the end of the century. The appropriate value to be adopted to account for sea level change has not yet been determined. Melbourne Water recommends that Council consult with Melbourne Water during detailed design to determine the appropriate flood level.

- MW is planning flood mitigation works to the Sandgate Avenue and Lee Street catchments. Stage 1 of these works will involve construction of a drain of up to 1950mm diameter with the outlet possibly being 1800mm diameter at Davey Street. This outlet will discharge increased sand load in the lower end of the creek due to the sandy nature of the catchment. Detailed design is to commence in 2007/8 financial year, with construction occurring after detailed design and taking approximately three years.

No.	Issue	Action	Priority	Respons-ibility
D1/6	Future flood protection works will result in augmentation of the drains to the creek to transmit larger flows	Investigate possibility of drain inlets being integrated into the existing or new walling designs and, where possible, hidden from view.	High	MW FCC
D2/6	Potential need to increase cross sectional area at the mouth for flood transmission.	Investigate the need for increased cross sectional area and potential alternations to the cross section at the mouth for flood transmission. Refer to LU2/6.	Medium	MW
D3/6	Potential increased sediment deposition in this reach from the one new drain diversion being proposed by Melbourne Water.	During detailed design investigate measures to incorporate sediment control and removal prior to it reaching Kananook Creek as part of the proposed drain diversion. Refer also to Q2/O and S5/O.	High	MW

4.6.4 Water Quality

- The water quality is a reflection of the total catchment upstream and is influenced by the tidal flux. Generally the water quality is reasonably good but the influences of large algal bloom and presence of litter can occur, although the litter problem has been improved recently by Council's at-source litter control program.
- Sedimentation along the waterway is evident and continues to be an issue within the catchment. Melbourne Water is currently investigating a few sites in the catchment to retrofit some sediment control measures. Council is to continue to identify sediment control measures within the catchment consistent with the Frankston SWMP, as there is no room within the Kananook Creek Corridor itself. Removal of the sediment from the waterway is difficult as described in Section 3.3.

No.	Issue	Action	Priority	Respons-ibility
Q1/6	Litter accumulation in Kananook Creek in the reach sourced from the adjoining catchments.	Continue to investigate further improvements throughout the broader catchment by at-source litter control consistent with Frankston SWMP and maintain current litter patrols to address litter accumulation in the creek. Refer Q5/O.	High	FCC MW
Q2/6	Catchment sourced sediment accumulating in the lower estuary.	Refer to Q2/O, S5/O and Q4/O regarding accumulation of sediment in the lower estuary. Maintain access for removal of sediment in the future.	Refer Q2/O, S5/O & Q4/O	Refer Q2/O, S5/O & Q4/O

No.	Issue	Action	Priority	Respons-ibility
Q3/6	Untreated stormwater discharging from the catchment into Kananook Creek and Port Phillip Bay.	Investigate opportunities to improve stormwater quality in the catchment to reduce untreated stormwater discharging into Kananook Creek and Port Phillip Bay.. Refer Q5/O.	High	MW FCC

4.6.5 Stream system values

- Habitat values are limited due to the structural nature of the channel. The bed of the channel is colonised by seagrass and limited fish habitat is available.

No.	Issue	Action	Priority	Respons-ibility
S1/6	Concrete walling system constructed in the 1970s is deteriorating and needs replacement.	Investigate a walling system design that provides for retention of critical cross section, channel maintenance and improved visual character. Also refer to LU1/6 and LU2/6.	High	FCC MW
S2/6	Sedimentation in the reach and closure of the mouth by a bar is only maintained by periodic dredging of the accumulated sediments and bar deposits downstream of the boat ramp to the mouth.	Council to continue dredging at the mouth in accordance with current arrangement with DSE to allow boat access between the boat ramp and the creek mouth. Refer to Q2/O and S5/O	Refer Q2/O and S5/O	Refer Q2/O and S5/O

4.6.6 Vegetation

- There is no remnant indigenous riparian vegetation along the creek through this reach due to the highly modified and structural form to the channel.
- There is remnant Coast Banksia in Long Island Reserve along with native revegetation works.

No.	Issue	Action	Priority	Respons-ibility
V1/6	There is no remnant indigenous riparian vegetation	In future plantings to both sides of the creek, investigate use of indigenous species to reflect the upstream habitat values of the creek corridor. Suitable species could include Coast Banksia and Manna Gum, where appropriate in the highly modified context. Refer to LU1/6.	High and Ongoing	FCC
V2/6	Remnant Coast Banksia in Long Island Reserve	Ensure ongoing protection and recruitment of remnant Coast Banksia in Long Island Reserve to improve the natural values of this reserve.	High and Ongoing	FCC

4.6.7 Recreation and community use

- Recreational boat traffic in the lower reach between the boat ramp and Port Phillip Bay.
- The Adopted Development Plan and Environment Management Plan for Long Island Reserve aims to improve the interface with Kananook Creek, establish recreational spaces adjacent to the creek with a boardwalk proposed along the creek. The plan proposes moving vehicles away from the creek edge where possible and improving overall user safety in the reserve including vegetation management to improve sightlines. This plan has been presented to the community and adopted by Frankston City Council, and council is currently implementing Phase 1 which involves the works to the foreshore to establish a trail through the reserve.

- Remnant Coast Banksias (*Banksia integrifolia*) are of a significant size and age. Future management of these and retaining them will influence design of the open space interface to the creek.

No.	Issue	Action	Priority	Respons-ibility
R1/6	Recreational boat traffic between the Boat Ramp and the Bay is to continue	Refer to S2/6 regarding maintaining access for boats.	Refer S2/6	Refer S2/6
R2/6	Lack of public access along the eastern bank of Kananook Creek.	Provide a public reserve and access along the eastern side integrating with future development and incorporating principles included in LU1/6.	High	FCC
R3/6	Long Island Reserve upgrade will cater for existing visitors and residents, along with the new community who will move into the CAD redevelopment.	Maximise the opportunity provided by the upgrade of Kananook Creek Boulevard to improve the visual amenity of the Long Island creek bank and surrounding open space. Future design for Long Island Reserve interface treatment to Kananook Creek corridor to include: • ensure safe off-road access between the bridge over the creek mouth along the western bank; • where possible, incorporate open grassed areas adjacent to the proposed creek wall to provide a usable soft edge treatment as a contrast to the hard urban edge on the eastern side; • integrate access between the Long Island Foreshore Reserve and the existing footbridge crossings over Kananook Creek; • create open safe lines of sight along paths and at key crossing points to encourage safe access for all; and • incorporate indigenous species into the open space interface treatment design utilising predominantly overstorey and low vegetation to retain clear sight lines, where appropriate.	High and Ongoing	FCC
R4/6	Recreational boating use may potentially increase downstream of Wells Street as redevelopment of the adjoining land in the TAFE to Bay Structure Plan occurs. Sediment build up is limiting navigability of this section of Kananook Creek.	Address recreational boating use of the creek downstream of Wells Street, refer R6/O. Improve navigability at Beach Street for canoes by actively managing silt to align with the development of Kananook Creek Boulevard.	Refer R6/O High	Refer R6/O MW

4.6.8 Cultural heritage and historical values

- Kananook Creek is identified as an area of high Aboriginal cultural heritage sensitivity, particularly areas that retain their natural remnant vegetation (Austral Heritage, 1998).
- In 2005 Andrew Long & Associates undertook a Cultural Heritage Assessment on Kananook Creek Reserve Long Island and concluded that no Aboriginal sites were visible in the study area and only limited potential for Aboriginal site material to occur in the study area. This is mainly due to the post-European settlement disturbance to the study area.

- Historically, Long Island appears to have been the focus for recreational visitors with the southern tip of Long Island popular for camping. It is likely the creek was used for recreational purposes such as fishing on the foreshore and in the creek along with commercial boat and fishing related uses. Early photographs include a timber suspension bridge at the end of Davey Street, however, it is unlikely there are any remnants of the original bridge on the site today. The existing footbridges were not identified to be of historical significance (Andrew Long & Associates, 2005). However, the bridges have become an iconic feature of Kananook Creek, reminiscent of European inhabitation from early settlement, along with the boating use of this lower end of the creek.
- More information about Frankston's heritage values, including the bridges, may come to hand upon completion of the 'Frankston CAD Heritage Review', particularly in terms of the historical values of Kananook Creek's CAD footbridges.

No.	Issue	Action	Priority	Respons-ibility
H1/6	Aboriginal archaeological sensitivity adjacent to the creek in Long Island Reserve is low.	Notify the relevant Registered Aboriginal Party prior to works commencing on site to give the opportunity for monitoring during the works, consistent with the recommendations in the Andrew Long & Associates Cultural Heritage Assessment (2005).	Ongoing	FCC RAP (AAV)
H2/6	The existing white timber footbridges present in the creek today do not have historical value, however, the white painted timber appearance is reminiscent of the earlier footbridges seen in historical photos.	In future redevelopment of the Frankston CAD and Long Island Reserve, clarify the origins of the footbridges (if they are retained) to avoid misinterpretation of the historical values.	Ongoing	FCC
H3/6	European historical values including boating and fishing related uses in the lower reaches of the creek require consideration in future works and interpretation of the historical values of Kananook Creek.	Incorporate suitable information regarding European historical values into the future interpretive signage plan for the Creek - Refer to R3/O and H2/O.	Refer R3/O	Refer R3/O

5. IMPLEMENTATION

5.1 Summary

Frankston City Council and Melbourne Water are the two Agencies primarily responsible for implementing the Kananook Creek Corridor Management Plan, with a range of other groups responsible for implementing some actions. The plan identifies over 200 Actions to undertake which range from on-ground works to education programs and further investigations in to specific issues to be implemented over an approximate 15-year timeframe. The priority for each Action gives an indication of the order in which they are to be addressed. Implementation of the actions may vary subject to appropriate levels of funding and resourcing being available. Some Actions have an Ongoing priority which indicates they require ongoing resources and/or monitoring.

Indicative timeframes

High	Years 1 to 5
Medium	Years 6 to 10
Low	Years 11 to 15

5.2 Actions by priority

All the Actions identified in the Kananook Creek Corridor Management Plan have been sorted into their priorities. For the full description of the Issue that accompanies each Action, please refer to Sections 3 and 4 of the Management Plan. These tables by priority are intended as a useful implementation tool and summary checklist.

The Actions are sorted by their categories in alphabetical order within each of the priorities, for example, drainage appears first, followed by cultural heritage, land use, water quality, recreation, stream system values and vegetation. Within each category 'O' actions always appear first, followed by the reach numbers in descending order.

Some issues had a number of actions to address it with different priorities. Where this occurs each action has its own line item with the same number repeated. Some ongoing actions have two priorities assigned - i.e. High and Ongoing. Where this occurs, they appear in both categories, i.e. in High and in the High & Ongoing list.

5.2.1 High priority actions

No.	Action	Priority	Respons-ibility
D1/O	Investigate options and the feasibility to improve the flow regime in Kananook Creek downstream of Riviera Street Flood Control Complex to provide some periodic inundation to the riparian zone and to flush out the Kananook Creek system.	High	MW
D1/1	Investigate the flood storage function of Seaford Wetlands and any requirement for additional protection to properties along Austin Road for above design event. As part of these works, investigate the need for levee augmentation along Eel Race Drain and provision of a structured controlled overflow point into Seaford Wetlands where required.	High	MW
D1/3	Ensure all future developments meet Melbourne Water requirements for developments in flood prone areas, such as between Seaford Road and Station Street. Refer also to LU2/O.	High & Ongoing	FCC MW
D1/4	Ensure future developments meet Melbourne Water requirements for developments in flood prone areas, such as between Station Street and Mile Bridge. Refer to LU3/4 and LU2/O.	High & Ongoing	FCC MW
D1/5	Ensure future developments on the western bank meet Melbourne Water requirements for developments in flood prone areas, such as between Beach Street and Wells Street. Refer also to LU 2/O.	High	FCC MW

No.	Action	Priority	Respons-ibility
D1/6	Investigate possibility of drain inlets being integrated into the existing or new walling designs and, where possible, hidden from view.	High	MW FCC
D2/O	Investigate options and the feasibility to increase alternative seasonal freshwater flows into the system to achieve the following: • provide additional base freshwater flows to compensate for occasions when there is cessation of flows from the Kananook Creek Pump Station; • improve the water quality and establish a salinity gradient for the stream by increasing freshwater flows to achieve a brackish profile; • potential reduction in the volume of flows required to be pumped into the system during late Autumn, Winter and early Spring, which reduces seasonal pump use and energy consumption; and • potential to provide increased seasonal freshwater flows into Seaford Wetlands to improve habitat for migratory waterbirds.	High	MW
D2/1	Pending outcomes of D2/O, investigate the potential requirements for gauging station upgrades and or new provisions to enable the integration into the future flow and level management system.	High	MW
D2/3	Review the capacity and operation of the Weatherston and Swamp Drains for system performance and institute upgrades where required.	High	MW
D2/5	Review the existing planning scheme controls to ensure that permits are required for all new jetty and boat launching and retrieval structures along the waterway on private land, and that there is enforcement of this requirement. Refer to LU1/5, also to LU2/O.	High	FCC MW
D3/O	Investigate the impacts of climate change on Kananook Creek once the two separate studies currently being undertaken are complete. These two studies include one by the CSIRO for DSE/MW and a second prepared by the Westernport Greenhouse Alliance titled 'Impacts of Climate Change on Settlements in the Western Port Region'.	High	FCC MW
D3/6	During detailed design investigate measures to incorporate sediment control and removal prior to it reaching Kananook Creek as part of the proposed drain diversion. Refer also to Q2/O and S5/O.	High	MW
LU1/O	Introduce planning scheme provisions which cover the riparian zone and associated terrestrial vegetation, to ensure the impact on environmental values of the Kananook Creek floodplain (including habitat continuity) are considered in future development applications. The provision should highlight the environmental significance and intent of the Agencies to protect and, where feasible and appropriate, reinstate the environmental and biodiversity values of Kananook Creek. It should target development (eg. those buildings and works, landscaping plans) and vegetation removal, which affect floodplain, environmental and biodiversity values.	High	FCC MW
LU1/O	Encourage planting with indigenous or other appropriate species in existing developments on private land through community education and information. Provide education and support to adjoining landowners in revegetating the riparian zone on their properties	High	FCC
LU1/O	Use Frankston City Council's proposed Neighbourhood Character Guidelines to assist in protecting the landscape and recreational/visual amenity values of Kananook Creek and Eel Race Drain. Some of the provisions of the guidelines complement the above environmental and biodiversity action	High	FCC
LU1/O	Investigate through the Planning Scheme Review the expanded use of Neighbourhood Character Guidelines.	High	FCC
LU1/2	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S3/2 and V4/2.	High	FCC MW
LU1/3	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S1/3 and V4/3.	High	FCC MW
LU1/4	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S2/4, V2/4 and V7/4.	High	FCC MW
LU1/5	Introduce planning scheme provisions to ensure loss of environmental and biodiversity values as well as opportunities for vegetation reinstatement are considered in future development. Refer to LU1/O and LU3/O, also to S2/5 and V5/5. The provisions are not required in the TAFE to Bay precinct south of Beach Street where the creek becomes a concrete lined channel on the east side of the creek.	High	FCC MW

No.	Action	Priority	Respons-ibility
LU1/6	Ensure the following principles are integrated into future TAFE to Bay Planning Scheme provisions: • public open space of adequate width to ensure pedestrian and all-ability access along the eastern frontage to Kananook Creek which is open and accessible to the public at all times; • reflect some of the cultural and environmental character of Kananook Creek in the detailing of the interface treatment; • adequate flood protection to be achieved; and • utilise indigenous plants in the landscape treatment in the public open space and on freehold land where applicable. Refer also to V1/6.	High & Ongoing	FCC (MW)
LU2/O	Continue to use the LSIO to manage the floodplain to address potential impact of earthworks and structures along Kananook Creek.	High and Ongoing	FCC MW
LU2/2	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU2/3	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU2/4	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU2/5	Provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Kananook Creek and its reserves to protect the visual landscape character of Kananook Creek.	High	FCC
LU3/O	Introduce planning scheme provisions which cover the riparian zone and associated terrestrial vegetation, to ensure the impact on environmental values of the Kananook Creek floodplain (including habitat continuity) are considered in future development applications. See also LU1/O.	High	FCC MW
LU3/O	Finalise and promote the guidelines for the construction and maintenance of jetties and built structures on the creek banks	High	FCC (MW)
LU3/O	Undertake an audit of jetties and creek bank structures and establish an enforceable regulatory regime for existing structures.	High	FCC
LU3/2	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	Refer LU4/O	Refer LU4/O
LU3/3	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	High	FCC (MW)
LU3/4	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	Refer LU4/O	Refer LU4/O
LU3/5	Prepare fencing guidelines for the Kananook Creek Corridor. Refer to LU4/O.	Refer LU4/O	Refer LU4/O
LU4/O	Prepare fencing guidelines for the Kananook Creek Corridor to address potential impact of fences on the floodplain, surveillance issues, visual character of the creek corridor and in some locations encroachment of private uses on public land.	High	FCC MW
LU4/2	Continue to support securing a public open space corridor along the western side of the creek via the existing Public Acquisition Overlay Control upstream of Armstrongs Road. This will provide a habitat and open space link.	High	FCC
LU4/5	Continue to support securing a public open space corridor along the western side of the creek via the existing Public Acquisition Overlay Control. This will provide a habitat and open space link.	High	FCC
LU5/3	In future development applications on either side of the Brodie Street crossing point, review the potential for a suitable easement/reserve at a minimum width of 3.5m to improve safety and physical access to this crossing point. Introduce a provision in the planning scheme to achieve this.	High	FCC
LU6/2	Refer to LU3/2 and V5/2.	Refer to LU3/2 & V5/2.	Refer to LU3/2 and V5/2.
Q1/O	Refer D2/O for action to address marinisation of the creek downstream of the Kananook Creek Pump Station. Refer also to S1/O regarding macro algal blooms.	Refer D2/O	Refer D2/O
Q1/1	Refer D2/O regarding marinisation of the Creek from inputs from Kananook Creek Pump Station.	Refer D2/O	Refer D2/O
Q1/2	Investigate the source of high nutrient levels from Wadsleys Drain and, where appropriate, address at source.	High	EPA (MW)

No.	Action	Priority	Respons-ibility
Q1/3	Investigate opportunities for potential sediment and other contaminant control in the catchment and ensure ongoing implementation of Council's SWMP and prevent further accumulation of contaminated sediment in Kananook Creek. Refer Q5/O.	High & Ongoing	FCC (MW)
Q1/6	Continue to investigate further improvements throughout the broader catchment by at-source litter control consistent with Frankston SWMP and maintain current litter patrols to address litter accumulation in the creek. Refer Q5/O.	High	FCC MW
Q2/O	Commit to WSUD for all local government infrastructure projects where feasible to reduce sediment build up in the stream.	High & Ongoing	FCC
Q2/O	Ensure new development meets appropriate standards for stormwater quality through the development approvals process to reduce impacts on in-stream habitat values.	High and Ongoing	FCC
Q2/O	Melbourne Water will actively manage sediment in order to provide appropriate access for canoes. Refer to S5/O.	High	MW
Q2/1	Investigate the provision of a submerged weir in Eel Race Drain to limit salt wedge intrusion into the head of Eel Race Drain and Seaford Wetlands.	High	MW
Q2/5	Refer Q2/O and S5/O regarding sediment accumulation in the waterway.	Refer Q2/O & S5/O	Refer Q2/O & S5/O
Q2/6	Refer to Q2/O, S5/O and Q4/O regarding accumulation of sediment in the lower estuary. Maintain access for removal of sediment in the future.	Refer Q2/O, S5/O & Q4/O	Refer Q2/O, S5/O & Q4/O
Q3/O	As part of the review of Council's SWMP continue to investigate catchment based stormwater quality improvement works and water sensitive urban design adoption opportunities to reduce sand/sediment and other contaminant loads reaching the creek.	High	FCC (MW)
Q3/4	Refer Q2/O, S5/O Q5/O regarding accumulation of contaminated sediment in the waterway.	Refer Q2/O, S5/O & Q5/0	Refer Q2/O, S5/O & Q5/0
Q3/5	As part of the design development of the new drain diversion to Beach Street, investigate measures to reduce the sediment and pollutant loads entering Kananook Creek. Refer to Q2/O and S5/O	High	MW
Q3/6	Investigate opportunities to improve stormwater quality in the catchment to reduce untreated stormwater discharging into Kananook Creek and Port Phillip Bay. Refer Q5/O.	High	MW FCC
Q4/O	Liaise with EPA to investigate revising the SEPP criteria for Kananook Creek to a saline system to allow appropriate criteria to be applied to the water quality of Kananook Creek.	High	MW EPA
Q4/5	Investigate opportunities to improve stormwater quality in the catchment. Refer Q5/O to reduce untreated stormwater discharging into Kananook Creek and Port Phillip Bay.	High	MW FCC
Q5/O	Investigate capture of pollutants and litter at source.	High	FCC
Q5/O	Continue to investigate stormwater quality treatment opportunities and WSUD in the catchments where possible. Commit to WSUD for all local government infrastructure projects where feasible.	High & Ongoing	FCC MW
Q5/O	Plan and implement cost effective systems that will significantly reduce litter and pollutants going into the waterways.	High	FCC MW
Q5/O	Ensure new development meets appropriate standards for stormwater quality through the development approvals process to reduce impacts of stormwater on Kananook Creek.	High & Ongoing	FCC
R1/O	Sensitively improve recreation facility provision along the Kananook Creek corridor to improve accessibility and compatible with the environmental values.	Refer Section 4	Refer Section 4
R1/1	Investigate the potential to construct an off-road trail along Eel Race Drain or Eel Race Road to connect the Kananook Creek trail to Eel Race Drain and Seaford Wetlands. Undertake an evaluation of the potential feasibility of the trail and its impact on the existing vegetation and habitat values prior to construction.	High	FCC (MW)
R1/2	Consider modifications to the Riviera Street flood control structure and/or provide signage to users of small watercraft to disembark at the canoe launch ramp provided and then re-enter the creek upstream of the structure at a safer more appropriate point.	High	MW
R1/3	Refer R2/O regarding upgrade of the surface of the Kananook Creek trail.	Refer R2/O	Refer R2/O
R1/4	Refer R2/O regarding upgrade of trail surface.	Refer R2/O	Refer R2/O

No.	Action	Priority	Respons-ibility
R1/5	Undertake a specific trail design investigation for this section of the trail reviewing the final alignment in the context of a crossing point over or under Mile Bridge.	High	FCC (DSE)
R1/6	Refer to S2/6 regarding maintaining access for boats.	Refer S2/6	Refer S2/6
R2/3	Upgrade of the open space area to address the following: • revegetate the riparian zone with indigenous vegetation, retaining views to the creek from the reserve; • upgrade the small non-motorised watercraft launching facility, integrated with revegetation works; • install paths to improve pedestrian access in the reserve and to the creek; • provide picnic and potential BBQ facilities designed to complement the natural creek character and meet flood plain requirements; • retain open grassed areas to allow for use during events and informal passive use; • develop integrated interpretive signage regarding the creek's values, access points and liaise with appropriate RAP regarding potential integration of Aboriginal archaeological and cultural heritage values of Kananook Creek corridor; • investigate potential re-establish stand of Swamp Paperbark in the area where one remnant tree remains; • plant indigenous overstorey trees to reduce the visual prominence of the community centre building whilst retaining some filtered views.	High	FCC RAP (AAV)
R2/5	Continue to secure open space corridor through this reach in accordance with LU4/5.	Refer LU4/5	Refer LU4/5
R2/6	Provide a public reserve and access along the eastern side integrating with future development and incorporating principles included in LU1/6.	High	FCC
R3/5	Investigate design for trail in conjunction with final size and alignment of Kananook Boulevard. There may be opportunities to reduce the width of Kananook Avenue to allow additional space for an off-road trail as part of the current transit city planning.	High	FCC (DPCP)
R3/6	Maximise the opportunity provided by the upgrade of Kananook Creek Boulevard to improve the visual amenity of the Long Island creek bank and surrounding open space. Future design for Long Island Reserve interface treatment to Kananook Creek corridor to include: • ensure safe off-road access between the bridge over the creek mouth along the western bank; • where possible, incorporate open grassed areas adjacent to the proposed creek wall to provide a usable soft edge treatment as a contrast to the hard urban edge on the eastern side; • integrate access between the Long Island Foreshore Reserve and the existing footbridge crossings over Kananook Creek; • create open safe lines of sight along paths and at key crossing points to encourage safe access for all; and incorporate indigenous species into the open space interface treatment design utilising predominantly overstorey and low vegetation to retain clear sight lines, where appropriate.	High & Ongoing	FCC
R4/O	Investigate the potential to establish facilities that improve the community use including seats, picnic facilities and play compatible with environmental values. Two locations for these upgrades include: • Seaford Community Centre in accordance with the Seaford Life Saving Club Precinct Masterplan (2004) • Riviera Street Reserve	Refer Section 4	Refer Section 4
R4/3	Continue to seek opportunities to increase the public reserve width for access to Brodie Street crossing. Refer to LU5/3.	Refer LU5/3	Refer LU5/3
R4/5	Address recreational boating use of the creek downstream of Beach Street, refer R6/O	Refer R6/O	Refer R6/O
R4/6	Address recreational boating use of the creek downstream of Wells Street, refer R6/O	Refer R6/O	Refer R6/O
R4/6	Improve navigability of Beach Street for canoes by actively managing silt to align with the development of Kananook Creek Boulevard.	High	MW
R5/O	• Long Island Reserve as part of the Kananook Creek Reserve, Long Island Environmental Management and Development Plan.	High	FCC
R6/O	Clarify responsibilities for water-based recreation in Kananook Creek and how these will be delivered.	High	MW PV FCC
R6/O	Lack of navigability due to sediment build up in the creek to be assisted by implementing S5/O and Q2/O.	High	Refer S5/O & Q2/O
R9/O	Council to conduct with the community a Visioning exercise for Kananook Creek to inform the revision of the Regional River Health Strategy to consider environmental, social and recreational aspects of the creek.	High	FCC
S1/O	Investigate means to improve the management of large algal blooms in Kananook Creek to improve the in-stream habitat values. This issue will potentially be addressed in D2/O.	High	MW

No.	Action	Priority	Respons-ibility
S1/3	Investigate implementation of an incentives and/or education program for private landholders with frontage to the creek. The program will aim to improve the management of the riparian zone and in-stream habitats on private land. Refer also to LU1/3 and V4/3.	High	FCC MW Land-holders
S1/4	Undertake an inventory of treatments and assets and investigate and report on the approvals for development along the western bank of the creek both for Melbourne Water and Council approvals. Seek removal and /or remediation of unapproved encroaching assets.	High	MW FCC
S1/5	Refer D2/5 and LU1/5 regarding private walling systems and jetties encroaching into the waterway.	Refer D2/5	Refer D2/5
S1/6	Investigate a walling system design that provides for retention of critical cross section, channel maintenance and improved visual character. Also refer to LU1/6 and LU2/6.	High	FCC MW
S2/O	In the short-term protect existing terrestrial fauna values by minimising further loss of indigenous vegetation in the waterway corridor, and revegetation with appropriate indigenous species where appropriate to strengthen the links. Refer to LU1/O and LU3/O. For medium-term action refer to S3/O.	High & Ongoing	FCC MW
S2/3	Undertake an inventory of treatments and assets and investigate and report on the approvals for development along the western bank of the creek both for Melbourne Water and Council approvals. Seek removal and /or remediation of unapproved encroaching assets.	High	MW FCC
S2/4	Investigate and implement an incentives and/or education program for private landholders with frontage to the creek. The program will aim to improve the management of the riparian zone, in-stream habitats and sediment control during construction on private land. Refer also to LU1/4, V2/4 and V7/4.	High	FCC (MW)
S4/O	Protect existing riparian vegetation from further loss, and where possible, increase the presence of riparian vegetation to improve the in-stream habitat values. Refer to LU1/O and LU3/O.	High & Ongoing	FCC MW
S5/O	Undertake an overall investigation into the environmental issues associated with sedimentation and feasibility of potential options to address the river health impacts of sediment build up.	High	MW FCC PV EPA
S2/5	Investigate implementation of an incentives and/or education program for private landholders with frontage to the creek. The program will aim to improve the management of the riparian zone, in-stream habitats and sediment control during construction on private land. Refer also to V5/5 and LU1/5.	High	FCC MW
S2/6	Council to continue dredging at the mouth in accordance with current arrangement with DSE to allow boat access between the boat ramp and the creek mouth. Refer to S5/O and R6/O.	Refer S5/O	Refer S5/O and R6/O
S3/2	Continue to support the need for public acquisition of remaining freehold titles upstream of Armstrongs Road on the western side of Kananook Creek in order to protect and restore the riparian vegetation and stream edge. Refer to LU1/2, LU3/2, LU4/2 and LU6/2.	Refer LU1/2, LU3/2, LU4/2 & LU6/2	Refer LU2/2, LU3/2, LU4/2 & LU6/2
S3/5	Investigate a walling system design for Kananook Creek that provides for retention of critical cross section, channel maintenance and improved visual character. Also refer to LU1/6 and LU2/6.	High	FCC MW
S5/O	Undertake an overall investigation into the environmental issues associated with sedimentation and the feasibility of potential options to address the river health impacts of sediment build up.	High	MW FCC PV, EPA
V1/3	Control the Kikuyu and Angled Onion adjacent to Armstrongs Road with appropriate control techniques, to prevent it spreading further into the remnant indigenous vegetation.	High	FCC
V1/4	Establish an integrated vegetation management program to protect and enhance the present values.	High	FCC (MW)
V1/5	Establish an integrated vegetation management program to protect and improve the existing values.	High	FCC (MW)
V1/6	In future plantings to both sides of the creek, investigate use of indigenous species to reflect the upstream habitat values of the creek corridor. Suitable species could include Coast Banksia and Manna Gum, where appropriate in the highly modified context. Refer to LU1/6.	High & Ongoing	FCC
V2/O	Undertake revegetation works in the gaps in the riparian zone to improve continuity along the Kananook Creek Corridor, along with weed control in the areas with existing indigenous vegetation. Refer to the Reach recommendations for locations of future weed control and revegetation. Refer to LU1/O and LU3/O for vegetation on adjoining freehold land.	Refer Section 4 for site specific actions.	Refer Section 4 for site specific actions.

No.	Action	Priority	Respons-ibility
V2/1	Investigate opportunities to revegetate the north and south sides of the channel along Eel Race Drain between Mornington Peninsula Freeway and Whatley Street footbridge, sympathetic to the function and purpose of the levee banks. Revegetate where possible, with modified Swamp Scrub EVC in line with the RRHS.	Refer S2/1	Refer S2/1
V2/3	Liaise with Railway authority to provide adequate ongoing management of this vegetation and control of weeds, particularly Gazania sp.	High	FCC Rail authority
V2/6	Ensure ongoing protection and recruitment of remnant Coast Banksia in Long Island Reserve to improve the natural values of this reserve.	High & Ongoing	FCC
V3/1	Remove the non-indigenous Me*laleuca parvistaminea* planted along the channel to contain further spread and investigate the potential to replace with *Melaleuca ericifolia*.	High	MW (C)
V3/3	Establish an integrated vegetation management program to protect and enhance the present values.	High	FCC MW
V3/4	Identify extent of impact of weeds including Desert Ash, Angled Onion, Ivy Groundsel, Rambling Dock and Dolichos Pea as the basis of developing an integrated weed management program.	High	FCC (MW)
V4/O	Refer Action LU1/O to address ongoing loss of Riparian vegetation to the creek on private land.	Refer LU1/O	Refer LU1/O
V4/3	Liaise with adjoining private landowners along the western bank of the Creek via incentives and/or education programs to encourage protection of remnant indigenous vegetation and appropriate revegetation to re-establish habitat corridor link. Refer to S1/3 and LU1/3	Refer S1/3 & LU1/3	Refer S1/3 and LU1/3
V4/4	Continue to monitor and target Bridal Creeper around the boundaries of the saline wetland areas to contain its spread.	High	FCC
V5/2	Investigate the potential to improve the condition of the riparian zone downstream of Riviera Street by providing maintenance access track to define the boundary between private and public land to prevent encroachment into public land. The track alignment will need to ensure it does not unduly damage existing indigenous vegetation in this reach.	High	FCC
V5/3	Identify the extent of impact of weeds in this reach, particularly English Ivy, Cape Ivy, Rambling Dock and Dolichos Pea, as the basis of developing an integrated weed management program.	High	FCC
V6/3	Assess fuel loads and remove or consolidate patches to reduce the bushfire threat, whilst retaining some areas for habitat value.	High	FCC (MW)
V6/4	Target control of weeds in public land near the boundary fence with residential properties adjoining the eastern boundary of the reserve to contain their spread into the reserve.	High	FCC
V7/4	Liaise with the adjoining residents on eastern boundary of the reserve via incentives and/or education programs to encourage control or replacement of weed species in their gardens to reduce the ongoing management issue in the reserve. Refer also to V2/4, S2/4 and LU1/4.	High	FCC Land-owners
V8/O	Undertake accurate weed mapping for all public land (in addition to recent RRR mapping on FCC Council land), in the Kananook Creek corridor in accordance with Reach Recommendations. Prioritise control of new and emergent weeds to minimise opportunity for them to spread further through the system. Develop a practical monitoring system to allow evaluation of the success of weed control techniques including biological controls and adjust where required.	High	FCC MW KCC
V8/3	Undertake control of Kikuyu adjacent to the railway car park which is spreading into adjoining vegetation. Investigate incorporating additional indigenous overstorey trees into the car park design.	High	FCC
V8/4	Assess fuel loads and remove or consolidate patches to reduce the bushfire threat, whilst retaining some areas for habitat value.	High	FCC
V9/3	Revegetate the riparian zone adjacent to Chapman Avenue once angled parking on the east side has been removed as part of the Structure Plan works at Seaford Village.	High	FCC
V10/O	Develop a Vegetation Implementation Plan that includes suitable species lists for revegetation in different parts of the waterway corridor. The Implementation Plan will need to address the issues identified in this Management Plan.	High	FCC MW
V10/3	Increase the presence of Coast Banksia with additional trees around the oval and car park area in RF Miles Reserve to improve the natural character, overall habitat values, and the shade and character of the reserve. Refer R4/3.	High	FCC
V10/4	Initially spray outer edges of Kikuyu, Tradescantia and other smothering groundlayer weed populations to contain further spread. Expand spraying to reduce total weed cover and eradicate over time where feasible. Follow up with revegetation as weeds are fully eradicated using appropriate EVC species.	High & Ongoing	MW (FCC)

5.2.2 Medium priority actions

No.	Action	Priority	Respons-ibility
D2/6	Investigate the need for increased cross sectional area and potential alternations to the cross section at the mouth for flood transmission. Refer to LU2/6.	Medium	MW
H2/O	In consultation with the BLCAC and BFL identify opportunities to integrate interpretation of the Aboriginal archaeological and cultural heritage values of the Kananook Creek corridor at the key visitor destination points identified for the site including: • Eel Race Drain in conjunction with Seaford Wetlands the school • Riviera Street Reserve • Seaford Township • Long Island Reserve Identify appropriate European historical information to interpret and include in the Signage Plan, including reference to the fishing and boating use of Kananook Creek refer R3/O and H3/6.	Medium	FCC BLCAC BFL (AAV) (MW)
H2/1	Refer to H2/O regarding provision of interpretive information regarding Aboriginal archaeological values of Eel Race Drain and the adjoining Seaford Wetlands.	Medium	FCC BLCAC BFL MW (AAV) (MW)
H3/6	Incorporate suitable information regarding European historical values into the future interpretive signage plan for the Creek - Refer to R3/O and H2/O	Medium	FCC
LU1/1	FCC and KCC to investigate potential measures to encourage landholders to plant and retain native trees on their properties to improve the environmental corridor values of Eel Race Drain between Mornington Peninsula Freeway and Whatley Street footbridge. Refer to Actions S2/1 and V1/1.	Medium	FCC KCC
LU2/1	• FCC to consider updating the SF8 requirements at the next opportunity to reinforce the association with Eel Race Drain and reinforce preferred vegetation controls and planting.	Medium	FCC
LU2/1	• FCC to provide an effective means to assess the visual impact of proposed single dwelling development and exempt ancillary buildings that are visible from Eel Race Road and Eel Race Drain.	Medium	FCC
LU5/2	Upgrade the reserve to exclude vehicle parking from the Riviera Street Drainage Reserve and improve its use as an open space link between the Seaford Foreshore Reserve and Kananook Creek (Refer to R4/2)	Medium	MW
LU7/2	Liaise with Railway authority and its contractors to improve land management practices.	Medium & Ongoing	FCC (Rail authority)
R2/O	Prepare a trail network plan which considers all-ability access and public safety in the context of being sensitive to environmental values. The trail network plan is to include: • options to remove/reduce steps along the path; • improve all-ability access in regards to trail surface; and • address personal safety concerns including review of the trail alignment and adjacent vegetation to allow longer sightlines down the trail to assist people make decisions regarding their personal safety.	Medium	FCC
R2/O	Determine the status of sections of the trail network i.e. 'shared use', 'walking only' or 'nature trail' and sign appropriately. The trail is to be maintained as a nature trail north of Station Street.	Medium	FCC
R2/4	Upgrade the entry to promote the values of Kananook Creek at this highly visible crossing. Consider the following in this upgrade: • establish open views into the trail; and • interpretative and directional signage developed as part of the Signage Plan for the creek (Refer R3/O)	Medium	FCC
R3/O	Prepare a Signage Plan for the Kananook Creek corridor which includes consideration of the following: • identify visible points at which to install directional, regulatory and interpretive signage; • identify appropriate scope of content to be included at each of the interpretive sign locations: • designs to be robust in a public setting to address vandalism and graffiti whilst being sensitive to the environmental and landscape values of the site; and • refer to H2/O for consideration of Aboriginal cultural heritage and European historical values.	Medium	FCC

No.	Action	Priority	Respons-ibility
R3/2	Develop a Concept Plan for Riviera Street Reserve to achieve the following: • improve the area around the small non-motorised watercraft launching ramp; • improve interface between the street and the reserve with improved vegetation management and vehicle control measures if required; • integrate the trail on the east side of the creek with the proposed watercraft launching area and park management/maintenance, along with access over creek, and access through to the Seaford Foreshore Reserve; • provide seating and picnic facilities; • undertake appropriate revegetation of the reserve to increase presence of indigenous vegetation along the bank, with some viewing locations; • develop integrated interpretive signage regarding the creek's values, access points and liaise with BLCAC and BFL regarding potential integration of Aboriginal archaeological and cultural heritage values of Kananook Creek corridor; and control Kikuyu in accordance with Action V5/2.	Medium	FCC
R5/O	Upgrade the visitor facilities associated with the canoe launching ramps where space permits. This includes parking, paths and picnic areas. There is space to upgrade the ramps with associated facilities at the following locations: • Seaford Community Centre as part of the Seaford Life Saving Club Masterplan (2004);	Medium	FCC
R6/O	Investigate long term options of navigability of small shallow-draft watercraft, including developing a long term maintenance plan and funding options for this maintenance.	Medium	FCC MW
S1/1	Investigate the provision of low benches for plant colonisation along the toe of the banks in Eel Race Drain from Mornington Peninsula Freeway downstream to Whatley Street Footbridge to improve in-stream habitat values of the engineered Eel Race Drain channel.	Medium	MW
S1/2	Investigate insertion of low banks and berms to allow colonisation by ephemeral macrophytes between Eel Race Road and the Riviera Street Flood Control Complex in line with the RRHS.	Medium	MW
S2/1	In addition to planting indigenous vegetation in adjoining private and public land (as per Action LU1/1 and V1/1), investigate opportunities to undertake revegetation of shrubs along both banks of Eel Race Drain as described in V2/1 to improve overall habitat values of this corridor including habitat connectivity and shading of the stream to improve in-stream habitat whilst not posing threat or risk to the function and purpose of the levee banks on both sides of Eel Race Drain in line with the RRHS. Refer to LU1/1.	Medium	MW (C)
S3/O	Prepare a habitat assessment for the terrestrial component of the Kananook Creek corridor including desktop review of existing information, conduct additional field survey work, and prepare management recommendations for the ongoing protection and improvement of terrestrial habitat values including any requirement for feral animal control. This should be undertaken prior to finalising revegetation priorities, as the habitat assessment will inform appropriate priorities.	Medium	FCC (MW)
V1/1	Increase the presence of indigenous overstorey vegetation where appropriate on adjoining public land given there are limited opportunities to plant into the levee banks. This could include Seaford Wetlands, Patterson River Secondary College and the Eel Race Road reserve. Refer also to LU1/1 and S2/1.	Medium	FCC KCC (MW)
V1/2	Develop an integrated weed management program in the Coastal Banksia Woodland, with priority control to emerging new weeds including Dolichos Pea, Cape Ivy and Rambling Dock.	Medium	FCC (MW)
V2/5	Identify extent of impact of weed invasion, particularly Mirror Bush and garden escapees, as the basis of developing an integrated weed management program. This should consider the following: • target woody weeds with drill/fill or cut/paint and remove from site when practical • control impact of climber weeds including Cape Ivy and Rambling Dock.	Medium	FCC (MW)
V3/O	Establish a detailed quadrat and floristic survey to provide a benchmark for long-term changes in the Kananook Creek corridor due to potential impacts from increased salinity. Monitor the site, and adjust and amend the species used in revegetation to suit the changing conditions.	Medium	FCC (MW)
V3/2	Assess fuel loads and remove or consolidate patches to reduce the bushfire threat, whilst retaining some areas for habitat value.	Medium	FCC (MW)
V3/5	Initially spray outer edges of Kikuyu, Tradescantia and other smothering ground-layer weed populations to contain further spread. Expand spraying to reduce total weed cover and eradicate over time where feasible. Weed eradication is to be followed by revegetation using appropriate EVC species.	Medium	FCC
V5/O	Investigate the cause of vegetation loss along the riparian zone, and aim to ensure suitable species are used in regeneration works on public land.	Medium	FCC (MW)
V5/4	Control Desert Ash near Mile Bridge as a priority followed by other woody weeds in the riparian zone.	Medium	MW FCC
V6/O	Remove the plantings of non-indigenous *Carpobrotus glaucescens* and replace with *Carpobrotus rossii*.	Medium	FCC

No.	Action	Priority	Respons-ibility
V6/2	Contain and control Kikuyu by initially spraying outer edges of populations to contain further spread into remnant vegetation. Where appropriate, expand presence of indigenous vegetation along Creek edge and continue to contain Kikuyu to open grassed area only. Refer to R3/2 for upgrade of Riviera Street Reserve.	Medium & Ongoing	FCC (MW)

5.2.3 Low priority actions

No.	Action	Priority	Respons-ibility
R2/2	Provide a public trail link through this Melbourne Water Riviera Street Drainage Reserve. This will establish a direct link between the Seaford Foreshore Reserve, Kananook Creek and residents to the east of Kananook Creek. Refer also to LU4/2 and V7/2.	Low	FCC (MW)
R3/3	Improve the interface between the oval at RF Miles Reserve and the walking trail by planting indigenous overstorey and ground layer vegetation. When upgrading pavilion, revise the layout of the club rooms to store the waste away from the creek. Refer also V10/3 for increased Coast Banksia planting.	Low	FCC
R5/O	• Riviera Street Reserve; and	Low	FCC
S2/2	Seek to rehabilitate the old course and floodplain wetland downstream of Riviera Street for habitat diversity through a staged program of vegetation enhancement.	Low	MW
V4/1	Map the extent of weed invasion and identify extent of impact as basis to developing an integrated weed management program for Eel Race Drain.	Low	FCC KCC (MW)
V7/2	Plant indigenous vegetation which does not compromise the drainage infrastructure in Riviera Street Drainage Reserve and improves the visual and habitat link between the Seaford Foreshore Reserve and Kananook Creek Reserve. Refer to R2/2 for other works in this reserve.	Low	MW (FCC)

5.2.4 Ongoing actions

5.2.4.1 High & Ongoing

No.	Action	Priority	Respons-ibility
D1/3	Ensure all future developments meet Melbourne Water requirements for developments in flood prone areas, such as between Seaford Road and Station Street. Refer also to LU2/O.	High and Ongoing	FCC MW
D1/4	Ensure future developments meet Melbourne Water requirements for developments in flood prone areas, such as between Station Street and Mile Bridge. Refer to LU3/4 and LU2/O.	High and Ongoing	FCC MW
LU2/O	Continue to use the LSIO to manage the floodplain to address potential impact of earthworks and structures along Kananook Creek.	High and Ongoing	FCC MW
LU1/6	Ensure the following principles are integrated into future TAFE to Bay Planning Scheme provisions: • public open space of adequate width to ensure pedestrian and all-ability access along the eastern frontage to Kananook Creek which is open and accessible to the public at all times; • reflect some of the cultural and environmental character of Kananook Creek in the detailing of the interface treatment; • adequate flood protection to be achieved; and • utilise indigenous plants in the landscape treatment in the public open space and on freehold land where applicable. Refer also to V1/6.	High and Ongoing	FCC (MW)
Q1/3	Investigate opportunities for potential sediment and other contaminant control in the catchment and ensure ongoing implementation of Council's SWMP and prevent further accumulation of contaminated sediment in Kananook Creek. Refer Q5/O.	High & Ongoing	FCC (MW)
Q2/O	Commit to WSUD for all local government infrastructure projects where feasible to reduce sediment build up in the stream.	High and Ongoing	FCC
Q2/O	Ensure new development meets appropriate standards for stormwater quality through the development approvals process to reduce impacts on in-stream habitat values.	High and Ongoing	FCC

No.	Action	Priority	Respons-ibility
Q3/4	Refer Q2/O, S5/O and Q5/O regarding accumulation of contaminated sediment in the waterway.	Refer Q2/O, S5/O & Q5/O	Refer Q2/O, S5/O & Q5/O
Q5/O	Continue to investigate stormwater quality treatment opportunities and WSUD in the catchments where possible. Commit to WSUD for all local government infrastructure projects where feasible.	High and Ongoing	FCC MW
Q5/O	Ensure new development meets appropriate standards for stormwater quality through the development approvals process to reduce impacts of stormwater on Kananook Creek.	High and Ongoing	FCC
R3/6	Maximise the opportunity provided by the upgrade of Kananook Creek Boulevard to improve the visual amenity of the Long Island creek bank and surrounding open space. Future design for Long Island Reserve interface treatment to Kananook Creek corridor to include: • ensure safe off-road access between the bridge over the creek mouth along the western bank; • where possible, incorporate open grassed areas adjacent to the proposed creek wall to provide a usable soft edge treatment as a contrast to the hard urban edge on the eastern side; • integrate access between the Long Island Foreshore Reserve and the existing footbridge crossings over Kananook Creek; • create open safe lines of sight along paths and at key crossing points to encourage safe access for all; and incorporate indigenous species into the open space interface treatment design utilising predominantly overstorey and low vegetation to retain clear sight lines, where appropriate.	High and Ongoing	FCC
S2/O	In the short-term protect existing terrestrial fauna values by minimising further loss of indigenous vegetation in the waterway corridor, and revegetation with appropriate indigenous species where appropriate to strengthen the links. Refer to LU1/O and LU3/O. For medium-term action refer to S3/O.	High & Ongoing	FCC MW
S4/O	Protect existing riparian vegetation from further loss, and where possible, increase the presence of riparian vegetation to improve the in-stream habitat values. Refer to LU1/O and LU3/O.	High & Ongoing	FCC MW
V1/6	In future plantings to both sides of the creek, investigate use of indigenous species to reflect the upstream habitat values of the creek corridor. Suitable species could include Coast Banksia and Manna Gum, where appropriate in the highly modified context. Refer to LU1/6.	High and Ongoing	FCC
V2/6	Ensure ongoing protection and recruitment of remnant Coast Banksia in Long Island Reserve to improve the natural values of this reserve.	High and Ongoing	FCC
V10/4	Initially spray outer edges of Kikuyu, Tradescantia and other smothering groundlayer weed populations to contain further spread. Expand spraying to reduce total weed cover and eradicate over time where feasible. Follow up with revegetation as weeds are fully eradicated using appropriate EVC species.	High & Ongoing	MW (FCC)

5.2.4.2 Medium & Ongoing

No.	Action	Priority	Respons-ibility
LU7/2	Liaise with Railway authority and its contractors to improve land management practices.	Medium & Ongoing	FCC (Rail authority)
V6/2	Contain and control Kikuyu by initially spraying outer edges of populations to contain further spread into remnant vegetation. Where appropriate, expand presence of indigenous vegetation along Creek edge and continue to contain Kikuyu to open grassed area only. Refer to R3/2 for upgrade of Riviera Street Reserve.	Medium & Ongoing	FCC (MW)

5.2.4.3 Ongoing

No.	Action	Priority	Respons-ibility
D1/2	Ensure new developments meet Melbourne Water requirements for developments in flood prone areas such as Riviera Street and Armstrongs Road. Refer also to LU2/O.	Ongoing	FCC MW
D4/O	Melbourne Water to continue the existing maintenance program to clear drain outlets where sediment build up causes flood risks.	Ongoing	MW
H1/O	Any future works in the Kananook Creek corridor that involve significant ground disturbance is likely to require a Cultural Heritage Management Plan to be prepared and approved by AAV prior to commencement of works under the current Aboriginal Heritage Act 2006. This applies to public and private land.	Ongoing	FCC MW Land-holders
H1/1	Prior to any future works that require disturbance to the ground in this location, prepare a Cultural Heritage Management Plan in accordance with H1/O.	Ongoing	Refer H1/O
H1/5	Continue to protect the white painted timber footbridge at Fiocchi Avenue as a reminder of the earlier use of the area as a holiday destination. Interpretation of this former earlier use to be provided through interpretive signage, refer to R3/O and clarify if the footbridge is a more recent structure to avoid confusion.	Ongoing	FCC
H1/6	Notify the relevant Registered Aboriginal Party prior to works commencing on site to give the opportunity for monitoring during the works, consistent with the recommendations in the Andrew Long & Associates Cultural Heritage Assessment (2005).	Ongoing	FCC RAP (AAV)
H2/6	In future redevelopment of the Frankston CAD and Long Island Reserve, clarify the origins of the footbridges (if they are retained) to avoid misinterpretation of the historical values.	Ongoing	FCC
LU2/6	Ensure there are adequate controls to ensure future development does not reduce the flood capacity of Kananook Creek.	Ongoing	FCC MW
LU3/O	Apply and enforce existing and future controls for approvals and maintenance of jetties, built structures and edge treatments to Kananook Creek in an effective and timely manner.	Ongoing	FCC
LU4/3	In future redevelopment in the business area of Seaford Village, landscape plans are to demonstrate protection of existing indigenous vegetation and utilising indigenous species in future landscaping and revegetation. This is to provide habitat continuity through this area. Mature exotic vegetation (not weed species) that contributes to the creek's landscape character should be retained. Refer to R1/3 and S1/3.	Ongoing	FCC
LU5/5	Integrate principles outlined in LU1/6 in new TAFE to Bay planning scheme provisions, including specific controls on the riparian and terrestrial vegetation.	Ongoing	FCC
LU5/5	For commercial areas not covered by the TAFE to Bay provisions, consider using the residential character planting guidelines to guide assessment of landscaping plans for commercial development applications. Retain mature exotic vegetation (not weed species) that contributes to the creek's landscape character.	Ongoing	FCC
LU6/2	Consider encroachment issues from private land into public land in any redevelopment application,	Ongoing	FCC
Q1/4	Investigate opportunities for potential litter control measures in the catchment and ensure ongoing implementation of Council's SWMP and address litter accumulation in the lower portion of the reach. Refer Q5/0.	Ongoing	FCC (MW)
Q1/5	Continue to investigate and implement at source litter control measures in the catchment to address litter accumulation in the reach.	Ongoing	FCC (MW)
Q2/O	Incorporate snag maintenance for litter in creek maintenance program where feasible and consistent with river health outcomes.	Ongoing	MW
Q2/3	Continue to monitor the Dissolved Oxygen levels to minimise potential impacts of the groundwater discharges on in-stream habitat values	Ongoing	MW
Q2/4	Continue to maintain the Overton Road Litter boom.	Ongoing	MW
Q4/4	Continue to monitor the dissolved oxygen levels to minimise impacts of groundwater discharges on in-stream habitat values.	Ongoing	MW
R1/3	The trail is to be maintained as a nature trail north of Station Street.	Ongoing	FCC
R2/1	Liaise with Patterson River Secondary College and Seaford North Primary School to seek their involvement in future revegetation works on the school grounds, Eel Race Drain and Seaford Wetlands.	Ongoing	FCC MW Schools (KCA) (FOESW) (MW)
R6/O	Whilst woody debris in the creek provides important in-stream habitat, Melbourne Water will actively manage woody debris to provide appropriate access for canoes.	Ongoing	MW
R7/O	Agencies will continue to provide support to Kananook Creek Association and other community groups in holding community educational events in the creek corridor including the Celebration Day.	Ongoing	FCC MW C

No.	Action	Priority	Respons-ibility
R8/O	Recreational fishing to continue in Kananook Creek where it is compatible with waterway health values described in the plan.	Ongoing	FCC PV (MW)
V1/O	Undertake regular formal reviews the outcome of works from the ongoing fire management program in the Kananook Creek Reserve A Fire Management Works Plan (FCC, 1998), and refine recommendations where required to integrate with ongoing conservation and vegetation management works in the corridor.	Ongoing	FCC
V2/2	Ensure ongoing protection of remnant vegetation and encourage recruitment of Coast Banksia where it is senescing.	Ongoing	FCC MW
V2/4	Liaise with adjoining private landowners on western side of creek via incentives and/or education programs to encourage protection of remnant indigenous vegetation and appropriate revegetation on private land to re-establish habitat corridor link. Refer also to V7/4, S2/4 and LU1/4.	Ongoing	FCC (MW)
V4/2	Liaise with adjoining residents via incentives and/or education programs to encourage protection of remnant indigenous vegetation and appropriate revegetation on private land along the western bank to re-establish habitat corridor link. Refer also to LU1/2.	Ongoing	FCC (MW)
V4/5	Continue to maintain the existing revegetation area between Fiocchi Avenue and Beach Street and extend over time.	Ongoing	FCC
V5/O	Provide support and supervision to the Kananook Creek Association and other community groups undertaking revegetation works on public land.	Ongoing	FCC
V5/5	Investigate implementation of an incentives and/or education program for private landholders to protect indigenous vegetation on their land and plant additional indigenous vegetation on their land to improve the environmental values of the waterway corridor. Refer to LU1/5 and S2/5.	Ongoing	FCC MW
V7/O	Progressively remove the non-indigenous Eucalyptus botryoides and replace with appropriate indigenous overstorey (refer to EVC templates for appropriate species for where removal occurs).	Ongoing	FCC
V7/3	Plant out select patches of Coast Banksia and other suitable tree species where appropriate to address dieback and tree decline.	Ongoing	FCC
V9/O	Discourage uncontrolled access through improved definition of paths, as recommended in R1/O, monitor, and selectively fence areas where trail improvements do not prevent unrestricted access.	Ongoing	FCC
V9/4	Plant out select patches of Coast Banksia and other suitable tree species where appropriate to address dieback and tree decline.	Ongoing	FCC

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DRAWINGS

The following drawings form part of the Kananook Creek Corridor Management Plan:

Existing Condition Plans

KCMP-01 Existing Conditions Plan Reach 1
KCMP-02 Existing Conditions Plan Reach 2
KCMP-03 Existing Conditions Plan Reach 3
KCMP-04 Existing Conditions Plan Reach 4
KCMP-05 Existing Conditions Plan Reach 5
KCMP-06 Existing Conditions Plan Reach 6

Existing Vegetation Communities Plans

KCMP-07 Vegetation Communities Plan Reach 1
KCMP-08 Vegetation Communities Plan Reach 2
KCMP-09 Vegetation Communities Plan Reach 3
KCMP-10 Vegetation Communities Plan Reach 4

Management Plans

KCMP-11 Management Plan Reach 1
KCMP-12 Management Plan Reach 2
KCMP-13 Management Plan Reach 3
KCMP-14 Management Plan Reach 4
KCMP-15 Management Plan Reach 5
KCMP-16 Management Plan Reach 6

Appendix A

Kananook Creek Corridor Management Plan Waterway Geomorphology, Flow Management, Water Quality and Habitat Issues, prepared by Aquatic Systems Management Pty Ltd, Feb 2007

Kananook Creek Corridor Management Plan

Waterway Geomorphology, Flows Management, Water Quality and Habitat Issues

Aquatic Systems Management Pty Ltd

February 2007
(Amended January 2008)

INDEX

INDEX....2
1. INTRODUCTION....3
2.0 BACKGROUND....3
2.0 HISTORICAL MANAGEMENT SETTINGS....5
3.0 CURRENT MANAGEMENT ARRANGEMENTS....7
4.0 REGIONAL RIVER HEALTH STRATEGY....9
5.0 FLOW MANAGEMENT....9
5.1 Flow Management Issues....12
6.0 GEOMORPHOLOGY....14
6.1 Geomorphology Issues....17
7.0 WATER QUALITY....18
7.1 Water Quality Issues....25
8.0 HABITATS....26
8.1 Habitat Issues....28
9.0 REACH ISSUES....29
9.1 Reach One - Eel Race Road to Mornington Peninsula Freeway....29
9.2 Reach Two - Eel Race Road to Station Street....31
9.3 Reach Three - Station Street to Seaford Road....35
9.4 Reach Four – Seaford Road to Mile Bridge....37
9.5 Reach Five – Mile Bridge to Wells Street....41
9.6 Reach Six – Wells Street to Creek Mouth....45
10.0 CONCLUSION....48
11.0 REFERENCES....49

1. INTRODUCTION

This report forms part of the process to review and establish a renewed Management Plan for the Kananook Creek Corridor. The report seeks to provide an overview of the technical background and management issues that are current and need to be actioned. This report overviews the current waterway geomorphology, flows management, water quality and habitat issues of Kananook Creek.

As no new or detailed investigation of issues was possible within the project scope all matters reviewed rely upon the currently available information.

2.0 BACKGROUND

Kananook Creek is a creek that has had its channel and valley form established through a number of processes over a long period of time. Essentially Kananook Creek as it is today is the result of many thousands of year's formation by forces of flows from the larger Dandenong and Eumemmerring Creek catchments and that of longshore action along the coast of Port Phillip Bay, which formed a series of parallel dunes along the seaward interface of the Carrum Carrum Swamp. The Carrum Carrum Swamp is part of a geological trough (refer Figure 1) that is bounded on the north side by a monoclinal fold near Beaumaris and on the south side by Selwyn's Fault near Frankston. (Sherbourne Hills 1951)

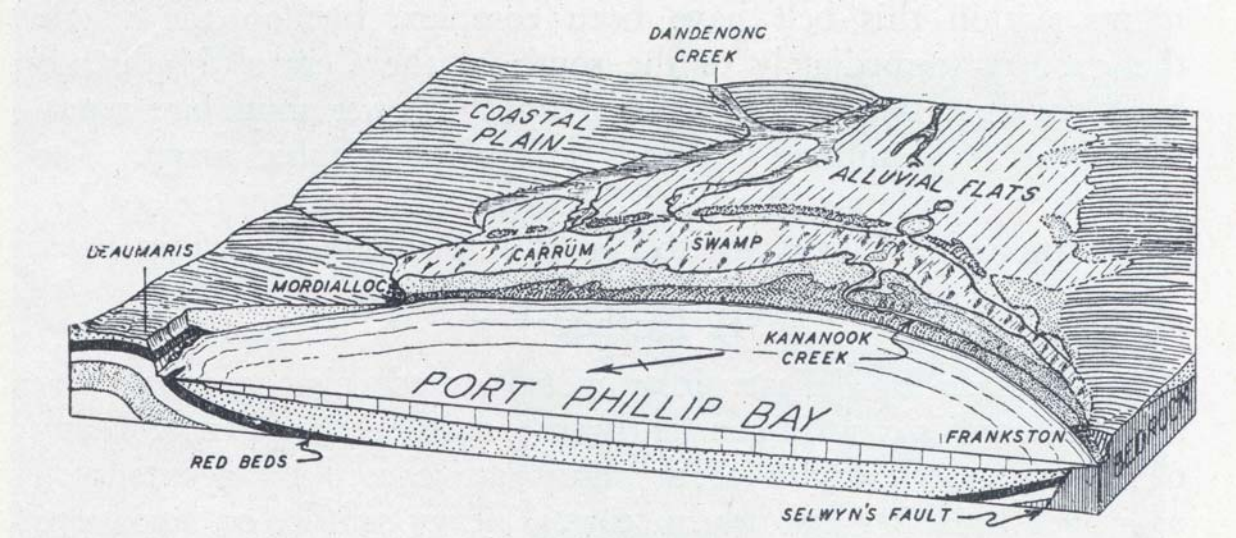

Fig. 209—Block diagram showing the structure of the district between Beaumaris and Frankston.

Figure 1 - Diagram of Carrum Lowlands Physiography (Sherbourne Hills 1951)

A significant portion of the Carrum Carrum Swamp was drowned following the end of the last Ice Age about 5000 – 7000 years ago. Dominant features of the

former coastal shore line from that period still exist in the Isles of Wannarkladdin which were the former coastal dune systems behind which were a series of inter-dunal lagoons. Following the subsequent retreat of the sea, due to drier and cooler conditions, the current coastal dune system was established and a newer set of inter-dunal lagoons was created, that filled with a mixture of eroded dunal sands and more recent alluvial deposits borne from the catchments of Dandenong, Eumemmerring and Boggy Creeks and other smaller creek systems to the north. Over a long period of time the seasonal flood inundation established a pattern of braided and anastomosing channels and fresh to brackish lagoons and wetlands that covered over 4,000 hectares. These wetlands were arranged in a series of cells with the remnants of Edithvale and Seaford Swamps being the remnants that are evident today. Extensive swamp lands existed where Patterson Lakes and Wannarkladdin Wetlands are today.

Before the subsidence of the lands to form Port Phillip Bay (Gregory 1912), the head of Kananook Creek exited through the alluvial deposits and floodplains near Carrum, through to a larger waterway system that discharged via the Port Phillip heads. After this occurred and the sea flooded the Bay, the newer dune systems developed to form what is known as the Long Beach today. The outlet of the Kananook Creek has shifted with the elongation of the dunes in a southwards manner over thousands of years, thus forming the primary coastal dune barrier that is part of the western bank of Kananook Creek today.

Kananook Creek extends over 7 km from Carrum to Frankston and is either a confined valley with dunes on both sides or has a small floodplain on one bank or the other, made from deposited silt and sand alluvial material. The outlet of the creek at Frankston changed positions and meandered up and down the coast near Frankston depending on the wave action and sand barrier formation. It was historically noted to be further south at the time of European discovery by Grimes in 1802 than it is today, where it has been fixed through structural formation of the mouth, coastal recovery and development on the foreshore. Further, the mouth would have been generally seasonally closed by a sand bar when flows from the catchments were very low in the summer period. There is significant evidence in the current channel form and contraction downstream of subcatchment inputs that the former channel size of the creek was larger than today, indicating that the channel maintenance flows of the mean annual flood and floods up to the 5 year ARI events were very large and probably maintained at a constant level for longer periods of time by the provision of a large natural flood storage pondage in the Carrum Carrum Swamp system. No flows synthesis has been done for the original creek condition as part of this study.

The changes to the creek occurred coincidently and subsequently as a result of the Patterson Cut in 1879 (McGuire 1980). This constructed opening in the dunal barrier at Carrum allowed the waters from the larger upper catchment and Carrum Carrum Swamp to rapidly drain from the swamp lands. Large floods in September 1880 saw the enlargement of the opening and channel of the Patterson Cut. The subsequent formation of the Carrum Trust and its successors saw more drainage and flood protection works including the development of the Eel Race Drain which together with a series of drains conveyed Boggy Creek and its catchments runoff to the former head of Kananook Creek at Eel Race Road, Carrum

The severance of the major catchments has had a large hydrologic impact and reduction in flow dynamics on the functioning of Kananook Creek.

2.0 HISTORICAL MANAGEMENT SETTINGS

Kananook Creek has undergone significant change following the severance of the freshwater flows derived from the larger upper catchments of Dandenong Creek. Within a few years of the creation of the Patterson Cut, the changes in flows to Kananook Creek were noted to be causing the closure of the mouth of the creek, with newspaper reports noting the issue in 1889 and 1890. In 1897 fish kills were also reported, this being due to a complex set of interactions including salt water intrusion, a closed estuary and poor exchange of the water due to the loss of oxygenated waters and finally the discharge of what is now known to be organically rich and high acid sulphate potential groundwaters to the creek. Similarly, the historical reports on water quality problems in 1909 and 1910 when the creek's poor condition was reported in the local paper as, "*a menace to health and progress and a foul smelling ditch or a slough of despond*". This is despite a relatively low population existing in the area and one that was unlikely to have a large highly connected sewage problem that came with more intense development later, after the wars, and contributed to poor water quality in the Creek. The deoxygenation of the creek was acute with many fish kills and the presence of black anaerobic conditions.

The first known creek rehabilitation works on Kananook Creek occurred in 1888, with the establishment of a timber weir and lock arrangement on the mouth to try and improve access and flushing following the reduction in flows due to the Patterson Cut.

Following the establishment of The Carrum Trust in 1889 under the Irrigation Act and its subsequent transformation into a range of bodies culminating in the

Carrum Drainage District in 1936, a range of activities that reinforced the changes in drainage patterns occurred. This included the extension of the Eel Rae Drain inland and the drainage of the Boggy Creek wetlands and floodplain (McGuire 1980).

The reported water quality problems continued with the first attempt at flushing occurring with installation of a pump on Seaford Pier in the 1920's to pump seawater to the creek. Whilst this facility apparently operated with some degree of success in lessening the anaerobic conditions of the creek, it fell into disrepair and was damaged in a storm during World War 2 and was removed.

Whilst other works were tackled in the Carrum Drainage District, it appears little further work was done on the problems of Kananook Creek until 1958, when a Parliamentary Works Committee of Enquiry made recommendations on the provision of a flood outlet at Seaford at what is now known as the Riviera Street Outlet Structure (McGuire 1980). In parallel with the building of this structure, Eel Race Drain was enlarged and the levees banks built that severed all but major flooding events from passing into Seaford Wetland and the former McLeod's Road Swamp where Patterson Lakes now exists.

Development along Kananook Creek and further inland in its connected catchments increased dramatically after World War 2, but with the whole area being unsewered. This led to discharges of septic and sullage effluent being discharged to the creek, with a corresponding dramatic decline in water quality with an exacerbated anaerobic state with a high organic load and high nutrients, let alone high bacterial counts. This persisted through the 1950's and into the late 1960's when the Frankston Sewage Authority was finally established. Whilst direct sewage discharges to the creek from individual properties progressively lowered in the 1970's, the treated secondary effluent discharge back into the creek via Rossiters Road Drain from Treatment Plant in Thompson's Road increased. This discharge maintained the high organic loads with high algal loads and anaerobic status of the creek due to the algal load death.

After much debate and requests for improvement to the creek condition, an extensive study was conducted in the late 1970's into the potential management solutions for the creek (Kerr et al 1979 ; Scholes 1980) This body of work was coincidental with a study into the tidal flushing issues of the highly eutrophic Patterson River estuary. Following the adoption of the Kananook Creek Rehabilitation Strategy (Kerr et al 1979) and as updated by Scholes (1980), a number of studies of the hydraulic regimes of Kananook Creek (Albicini et al 1982 Hinwood et al 1981, Hinwood et al 1983) were conducted. These all culminated in the establishment of the Kananook Creek Pump Station that started pumping sea water from Patterson Lakes into the head of the creek via Eel Race

Drain in February 1984. Pumping rates varied between 49 Ml/d (20 cusecs) and 98 Ml/d (40 cusecs) which was mixed with the natural catchment flows from Boggy Creek that averaged 10 Ml/d, plus the discharges of treated effluent from the Frankston Sewage Treatment Plant that at the peak averaged flows of 17 Ml/d.

Following the Pumping Station commissioning, the water quality of the creek improved with higher dissolved oxygen levels being attained. However, the creek adjustment to a more marine regime saw the changes in vegetation start with reductions in the Phragmites stands and also the presence of large blooms of *Enteromorpha* and other marine algae in early spring through to autumn.

3.0 CURRENT MANAGEMENT ARRANGEMENTS

Today the Kananook Creek Pump Station is maintained by Melbourne Water and pumping regimes have been maintained or slightly increased with the installation of a new pump of 110 Ml capacity to replace the older 98 Ml (40 cusec) pump.

Pumping is maximised over the whole year with stoppages only due to power supply cuts or brown-outs or for periods of pump station maintenance where the pipes and station are cleaned of barnacle growth. The current operating protocol provides for a maximum of 160 ML/day (with two pumps (the 40 and 20 cusec pumps) operating) over the late spring and summer period and for the new 110ML/day (40cusec) pump installed in 2007, operating as a single duty pump throughout the rest of the year. This is at slight variance to the original intent in which only 49 ML/day (20 cusecs) would be provided in the late autumn and winter period, increasing to (160 ML/day (60 cusecs) in the peak beach weather of the late spring and summer period (Scholes 1980). This arrangement was to ensure the best possible outcome for bacterial water quality parameters created by the discharge of treated sewage effluent to the creek. The current operation predominantly using the new 110ML/day pump, is flushing the creek and maintaining adequate dissolved oxygen profiles during the day, but is not necessarily having any substantial benefit to the creek from an ecological or water quality point of view. Low dissolved oxygen levels occur at night due to the high algal load and pumping may need to be maintained at a high rate to limit this diurnal oxygen sag.

The Riviera Street Flood Control Complex weirs and control systems have recently been refurbished to ensure the maintenance of the critical operation as a flood relief for large storm events. This also included the removal of the creek side submerged weir on the creek side and provision of a manually operated high

flow gate to replace the old drop log system if the upper catchment flows need to be isolated. The former operational settings resulted in early closure of the creek side opening, thus excluding almost all event flows from the upper creek from passing down the creek. With the new arrangements flexibility it is now possible to allow the small and moderate upper catchment flows down the creek until critical conditions of a larger upper catchment flood are incident on the creek. These flows will be important to channel maintenance. These larger flows must still be excluded from the creek as widespread flooding may result under these conditions.

The new management regime involves closure of the gate as required or directed by the Melbourne Water flood management teams' direction. Hence the current situation allows far more of the smaller and moderate flood events from the upper catchment can pass into Kananook Creek. Further, the back flooding of the creek that arises from the shorter and more intense events on the local creek catchments, can also pass back upstream into the Riviera Pondage and be allowed to pass to sea if the main bypass gate is opened.

On closure of the creek side gate approximately 2.0m^3/s passes over the structure in a 1 in 100 Year ARI event (K Boniface pers comm.). In large storm events with the creek gates closed to prevent downstream flooding, the split of flows is approximately 2m^3/s to the creek and 30 m^3/s to the bay via the culverts.

Current waterway maintenance along Kananook Creek has to be predominantly done from the shoreline with a regular patrol being conducted for litter in the lower half of the creek. The operation of a maintenance boat up the creek is also still undertaken when needed and to support the Kananook Creek Associations Clean Up day but is limited to periods of high tide. The maintenance boat is required less frequently now because the litter load to the creek has diminished with proactive litter control programs in the catchment. The litter boom at Overton Road is still operational and receives regular inspection and clean outs at least once per week.

Improvement activities have been conducted by Melbourne Water, including the provision of waters edge vegetation management and the establishment of co-operative revegetation activities with the Frankston City Council in the lower portions of the creek through the Melbourne Water "Corridors of Green" Grants Program.

Water quality monitoring is still conducted by Melbourne Water on a monthly basis at one site as well as more detailed snap shot reviews at multiple sites.

4.0 REGIONAL RIVER HEALTH STRATEGY

The Port Phillip and Westernport Regional River Health Strategy (2006) (RRHS) was prepared by Melbourne Water in conjunction with The Port Phillip and Westernport CMA. The RRHS provides a five year blueprint for Melbourne Water, the Port Phillip and Westernport Catchment Management Authority, Councils, community groups and environmental and industry associations to work together to improve the rivers and creeks across the region. The strategy is an important component of the wider Port Phillip and Westernport Regional Catchment Strategy, which sets the framework for the overall co-ordination of natural resource management in the region.

Kananook Creek is given a management unit (#39) within the RRHS within the Dandenong Creek catchment. The Kananook Creek management unit incorporates Boggy Creek, Kananook Creek, Eel Race Drain, Sweetwater Creek and Tamarisk Creek and thus comprises highly modified catchments, but also natural reserves and wetlands. The Kananook Creek management unit is accorded a high significance rating, largely due to the presence of Seaford Wetland and the fact the catchment also has a high social value. The current overall condition for the whole system is recorded as poor, due to very poor indices for flow and vegetation, poor water quality, moderate aquatic life and good habitat and stability ratings particularly for the modified streams within the unit. The overall condition target for Kananook Creek within the regional context is low and seeks to halt further decline in the condition with a particular focus on improvement of water quality. The key actions outlined for the first five years of the strategy is to implement the Ramsar Management Plan for Seaford wetlands and to also implement the Frankston City Councils Stormwater Management Plan. Another action of lower priority was to review the 1992 Kananook Creek Masterplan, which this project is now doing. The Kananook Creek Corridor Management Plan will also address the actions need to halt further decline in the condition of the creek and its values.

5.0 FLOW MANAGEMENT

Kananook Creek is a tidally influenced estuary subject to the tidal influences of Port Phillip Bay. Whilst Port Phillip Bay has a damped tidal amplitude due to the influences of Port Phillip Heads, there is still about 700 mm of amplitude under neap tide cycle and up to 1.2 m in spring tide cycle at the creek mouth. Higher tides can be experienced under king and storm tides.

As indicated in the Geomorphology discussion, the Kananook Creek mouth has historically been a barrier estuary with regular closures in the summer-autumn period when catchment flows were at their lowest. The sand bar barrier is well nourished by the dominant long shore action and sand draft from the north. Barrier breakout was historically consistent with the autumn rainfall break flows and probably remained open throughout the winter and spring rains, only closing in early to mid summer. The sand bar will readily reform as flows drop away although some water salt intrusion through the bar into the lower end of the creek is likely if the bar forms.

Flows down Kananook Creek probably never ceased historically during late summer and autumn, as there would have always been a small base flow from the larger catchment. Kananook Creek today has a far smaller catchment than at the time of European settlement. Today the catchment commanded by the creek is approximately 130 km^2 as distinctly different to 740km^2 prior to the Patterson Cut. The annual flood regime was critical to the provision of an annual flood flow that whilst damped by the large storage capacity in the Carrum Swamp, probably had an estimated average annual peak flow of in excess of 100 m^3/s down the creek. The 100 Year flow was probably far larger than this again. As indicated this flow was integral to providing the channel maintenance flows that maintained the large channel dimensions and created the recorded deep holes along the creek. The flow regime to the creek is vastly different today, with runoff derived from Boggy Creek and some minor drains off a porous sandy terrain that forms the headwaters of the catchment. Groundwater contributions to base flows in the Boggy Creek and local catchments are relatively small and are unlikely to have affected the hydrologic or environmental character of creek historically as no highly efficient drains existed to under drain the groundwaters and conduit them to the creek.

Today the flood flows are controlled by Riviera Street Flood Control Complex structure which under the new management regime is open to far more of the upper catchment flood events although once the creek side gate is closed for large events the structure will prevent all but 2m^3/s at 100 year ARI level passing down the creek. Importantly the early closure of the creek side opening prevented the majority of upper catchment event flows from passing down Kananook Creek. The 100 Year ARI flood of the upper catchments to Riviera Street is about 31.4m^3/s and lower down the creek at the mouth the flow is 33 m^3/s (GHD 1987). The flows that are needed for creek channel maintenance are those of a frequency of a 1 to 2 Year ARI, being approximately 10-12m^3/s.

Not withstanding the insertion of the Riviera Street Flood Control Complex diversion structure flood, the ability of Eel Race Drain and the outlet structure to transmit the 100 Year ARI flows is also limited and ponding will occur upstream

in Eel Race Drain and upstream of the Mornington Peninsula Freeway. As the levels rise, breakaway flows may also occur over the southern levee of Eel Race Drain at the north end of Seaford Wetland in extreme events, causing flooding and flood storage through the lower portion of Seaford Wetland.

Flooding along Kananook Creek is a historic fact and flood levels for the 100year ARI event are now set at 1.7 m AHD following a flood modelling review (GHD 1987). The flooding regime is due to the normal consequence of the high flows being detained in the creek due to the limited cross section of the mouth and low gradient of the creek and the usual coincidence of floods with higher sea levels and tidal influences. Some older developed areas with high value developments occur on lands below the 100 year flood level in Kananook Creek, resulting in flooding when high creek levels limit outfall drainage from these areas.

Melbourne Water is planning flood mitigation works for the Sandhurst Avenue and Lee Street Drains to protect the commercial precinct of Frankston from flooding. These works may lead to an increased sand load in the lower end of the creek due to the sandy nature of the catchment and transfer of sand load through the new drains. Detailed design is expected to commence in 2007/08 with construction occurring after detailed design and taking approximately 3 years. The transfer of the sand load will not have significant impact as the new drains simply divert the current loads from the catchments. However there may be disturbance to the creek when these high flow pipes are activated through the potential scouring of the sediments in the lower reach which may occur under flood flow conditions.

The current creek flow regime is reliant upon the following components of low flow;

- Runoff from the Boggy Creek catchment – subject to a seasonal flow due to the porous nature of the sandy catchment although runoff from impervious urban and industrial development areas has increased the rainfall runoff, particularly in summer. This catchment includes Carrum Downs, Wadsleys and Rossiters Road Drains which are essentially ephemeral.
- A small trickle flow derived from a diversion from lower Eumemmerring Creek to Wadsleys Drain to provide a small freshwater make up flow to Seaford Wetland.
- Groundwater intercepted by the deep main drains through the southern portion of the former Carrum Swamp – principally Weatherston, Bardia Avenue and Milne Avenue Drains.
- Very small amounts of freshwater derived from water mains leakage in the developed areas.

- The salt water flows pumped from Kananook Creek Pump Station - pumping capacity is variable and following a recent upgrade to the pumps a peak of about 164ML/day is achievable for the late spring and summer period. Whilst this station was originally sized in 1982 to address the combined impacts of oxygen demands exerted across the catchment and also that of reducing the residence times and oxygen problems in Patterson Lakes, the pumping capacity more than meets the need for dissolved oxygen supply today. Previously, dissolved oxygen demand arose from the treated sewage discharges from the former Frankston Sewage Treatment Plant which discharged to Rossiters Road Drain, plus that of the unsewered discharges in the catchments, the organically rich groundwater discharges and also the urban runoff impacts. Today there are no treated effluent discharges and the level of unsewered premises in the catchment is significantly less that previously. The levels of groundwater discharges have been traced and found to be widespread in the old swamp areas. However finite quantification of this problem is going to be hard to achieve.

From this review and having a mind to the changed circumstances of the loss of the historic larger catchment flows and also the flows to the creek from the former Frankston Sewage Treatment Plant, there is a need to investigate the following matters;

- Investigate options for and the feasibility of the establishment of a stronger seasonally variable low flow discharge of freshwater to the Creek (particularly in winter and early spring)
- Investigate mechanisms and operating procedures to increase the flood flow component to the creek from the upper catchment without jeopardising the flood management along Kananook Creek; and
- Investigate the need for improved flood overflow and floodplain storage management in Seaford Wetland.

These improvements to flow management regimes are needed for improved channel maintenance and ecological estuarine gradient conditions

5.1 Flow Management Issues

Whilst the more recent flow management has historically concentrated on the need to satisfy water quality and in particular dissolved oxygen demand and the impacts of a poorly exchanged estuary, the key issues for flow management today are as follows;

- Need to increase the channel maintenance flows across all seasons to reduce long term channel reduction. The lack of the large flows derived from the whole of the upper Dandenong and Boggy Creek catchment and in particular the flood flows down the creek in the winter spring period that would have provided larger flows, has been reduced dramatically. Hence the ability for the stream to maintain the large channel dimensions and scour the deep holes along the creek has been reduced significantly.
- The physical arrangements and operation procedure of the Riviera Street Flood Control Complex structure needs review such that the benefits from event flood flows arising from the Boggy Creek catchment are maximised to assist with channel maintenance in Kananook Creek.
- The base flows derived solely from the Kananook Creek Pump Station more than satisfy any algal bloom, oxygen demand derived from urban runoff and organically rich groundwater intrusion or any potential impacts of acid sulphate discharges, so as to maintain an acceptable dissolved oxygen regime over the critical summer and autumn period, if the pump station is operative.
- The Kananook Creek Pump Station was previously subject to fairly regular periods of loss of power due to local blackouts. In April 2007 Melbourne Water purchased a new 110ML (40-cusec) pump which now provides an additional alternate base summer flow. Since the new pump has been in operation, there have been no interruptions in pump operations.
- Loss of base flows due to pump station maintenance and or blackouts can have a deleterious effect with die off of the large algal blooms in the Creek or extreme diurnal oxygen sags.
- The saline base flow rate from pumping and that derived from the local catchments is insufficient to maintain the creek channel competence.
- The saline flows from pumping are affecting the vegetation along the creek, are impacting on nationally significant values of Seaford Wetland and also have removed any estuarine salinity gradient that would support an estuarine fish nursery.
- The increased saline flows with good nutrient availability have altered the ecology of the Creek such that large blooms of the saline alga – *Enteromorpha intestinalis* and other macro algal species can form nuisance proportions, plus the establishment of seagrass.
- Flood flows in the lower sub-catchments may impact on the lower estuary segments and in particular the need to provide new or augmented flood mitigation outfalls for the Frankston Commercial precinct may result in creek scouring.
- Floods derived from the upper part of the Boggy Creek catchments cause ponding to occur upstream of the Mornington Peninsula Freeway. The declared flood level in this area is 3.2 m AHD and there is about

3,700,000 m^3 of flood storage, generally on Melbourne Water Eastern Treatment Plant land. A strategy is in place to ensure this flood storage is retained.

- Break away flood flows into Seaford Wetland occur under major event conditions as the southern levee of Eel Race Drain may be overtopped in a 100 year ARI event as flow capacity of Eel Race Drain is limited to about $32m^3/s$. Further investigation is required to determine whether this overflow needs to be formally constructed. Refer the GHD/ASM Edithvale-Seaford Wetlands Review of Wetlands Operations (2006).

6.0 GEOMORPHOLOGY

Kananook Creek was formed as a parallel dunal estuarine creek following the combined impacts of the sinking of Port Phillip Bay between the Rowsley fault and Selwyn's fault in the late Pliocene period, plus the increase in sea heights over the last 5000 years ago that saw the former creek and river channels of the then Yarra River (and the Dandenong Creek) that flowed out at Port Phillip Heads drowned.

Kananook Creek was formed over many years by the combined forces of a waterway outflows from the Dandenong Creek catchment and that of the longshore or littoral drift forces that deposited sands and formed the long beach running from the Beaumaris Bluff through to Frankston. The Creek as it is known today sits between the old coastal dunal systems and that of the current coastal dune system. An ancient dunal system exists further inland along Wells Road.

The formation of such a large channel and development of the parallel sand dune system could only have occurred with the aid of a large flow regime driven by the $740Km^2$ catchment upstream and the large longshore action of the beach.

The catchments of Dandenong and Eumemmerring Creek formerly discharged in to the flat sunklands behind the new dunal systems in a vast floodplain now known as Carrum Swamp. This vast swamp formerly had its primary outlet via Kananook Creek and filled with the annual flood flows with these surging through between the dunal systems to maintain a relatively large channel morphology. The impact of the choke between the dunes and the flood storage enable the flows to be maintained at a relatively high rate for extended periods similar to how a retarding basin operates. As with many barrier estuaries, the mouth of the creek moved up and down the coastal area with accounts of it being both north and south of its current location.

Following colonisation of the Port Phillip district in the early to mid 1800's, the desire to drain the Carrum Swamp was strong to allow the use of the area for farming. In 1879, the Patterson River was cut and the flow regimes to Kananook Creek altered irrevocably. The flood flows that maintained the channel in its form were removed and the catchment draining to the creek was cut back to about 130 km^2. Many problems soon showed following the cessation of flows. As well as water quality problems siltation readily occurred.

The massive reduction in the annual flood flows resulted in the stronger closure pattern at the mouth as the flow magnitude required to attain sand barrier breakout flows were reduced significantly. Many attempts and various schemes of arrangement were employed over the last 100 years to try and maintain a navigable opening at the mouth. All have proved rather fruitless and dredging remains the sole successful method.

Flooding has always proved a problem due to the limited ability for the creek to transmit large peak flows. The Riviera Street Outfall (now known as the Riviera Street Flood Control Complex) was built by the State Rivers & Water Supply Commission in 1962 to alleviate flooding down the creek due to upper catchment flows that had always proved to be a problem in large events. Similarly the Eel Race Drain which was enlarged after the 1934 floods was again augmented and the levee banks increased in the 1950's and late 1970's.

Settlement and expansion of the district continued slowly up until after World War 2, when new residential areas such as the Pines Estate became the forerunner to a rapid expansion in the district. The majority of the area was poorly drained and many new drains were installed to connect the developing areas directly to the creek as a result of the need to drain and service new areas. This had the added impact of delivery of sand to the creek from land disturbance and urban runoff. The quantity of sediment produced from the roads through the area has been perhaps underestimated and it is now evident that there is a long term management problem to try and address (WBM 2002). Sediment from road runoff has been shown to contain high levels of heavy metals and other contaminants and is likely to cause a long term management problem in the creek unless tackled.

Prior to the imposition of EPA dredging protocols in the early 1990's, sediment deposits in the creek were cleared on a biannual basis through dredging at the mouths of the drains and also in the creek immediately upstream and downstream of the drain inlets. However the disposal of the dredged material proved to be problematic due to the high levels of salt. Further the disturbance to the creek sediments created significant water quality problems and eventually the

imposition of the EPA's dredging policy prevented further dredging along the creek. Today, the creek mouth at Frankston is the sole area allowed to be dredged.

The accumulations of silt and sands that started to accrete slowly after the cessation of flows in the late 1890's accelerated through the post 1940's and 1980's to the position today that the creek is starting to show definite signs of wanting to reduce its cross sectional area to that which could be maintained by the reduced flows. The process of channel reduction is relatively slow but still perceptible to anyone who has observed the creek over the last 30 years. Surveys conducted by the DVA and Melbourne Water of the creeks profile were taken in 1982 and again in 2002 with these showing gradual accretion in some areas but a more sustained accretion in areas downstream of the main drains. As channel competence flows have reduced significantly with time and the inevitable impact of a reduced channel size is being gradually realised. The rate of change and channel reduction is likely to be driven by a number of factors including wet and dry rainfall sequences and the rate of supply form the catchments. The change in the channel cross sectional area is a classic response to changes in flows similar to that observed downstream of reservoirs after their establishment.

This is a natural process and one that will be hard to overcome and given the ubiquitous nature of the sand generation across the catchment, it is now being accelerated. Based on the experience of stream channel reduction due to decreases in flows in other cases, the only apparent response is to try and increase the annual flood flows to try and maintain a modified channel size. It is unlikely that changes in the base flow pumping arrangements from the Kananook Creek Pump Station or potential increases from any low flow diversion of freshwater will change the channel morphology. It should be noted that the sediment erosion capability of the normal base flow and tidal cycles are fairly minimal and it requires the flood flows with higher heads and hence velocities to erode the material. This is particularly so in the reach upstream of Mile Bridge where the impact of tidal rise and fall is more damped.

Other potential options for sediment management, such as various forms of dredging and or repositioning of sediment are likely to be fraught with major issues with the management of toxicant release and need to satisfy EPA protocols. Given the long term scale of changes, it is unlikely that a morphology will be able to be established that allows for deep draft boating. The sediment management options need to be fully assessed in a more detailed review than can be conducted in this study.

The critical area of attention for sedimentation is downstream of Seaford Road through to the Mile Bridge and then to the mouth. It is recommended that an

overall investigation into the issues and processes associated with sedimentation be undertaken and also a feasibility study be undertaken of the potential options to address the impacts of sediment build up in Kananook Creek.

The other impacts on the creek morphology arise from the desire to wall the creek and increase development areas. Downstream of Beach Street, the creek was subjected to a concrete walling style in the 1970's by the Frankston City Council who is the recreational manager for the Crown lands in this area. The walling is showing serious signs of structural deterioration and will fail over the next few years. The replacement of the walling with a more structurally sound and visually appealing form will be a major capital expenditure for Council.

Some of the private properties abutting the lower part of the creek also have a range of walling or bank treatment types, some of which is structurally unsound. The issue of approvals for edge treatments will need to be reviewed and a revised set of guidelines established. Some of the conflict arises over a misunderstanding about the extent of private land ownership along the creek. Many people are unlikely to be aware that changes to the Water Act override private property rights in relation to Waterway bed and bank and vest these assets in the Crown.

Another recent practice is that of insertion of jetties over the creek with protrusions into the air space above the creek that is critical to flood flows. These jetties are likely to attract flood debris and may increase flood heights or cause damage. Some may have been installed without appropriate approvals and may need to be removed or modified.

The issue of maintenance of navigable entrance through the mouth is subject to a different series of process to that of catchment derived sediment. The long shore action and sand transfer along the beach is the primary casus of the formation of a series of sand bars and also the sand barrier at the mouth. This area is currently dredged by suction dredge under an arrangement between Frankston City Council and Parks Victoria. No matter what the outcomes of general sediment management is for the rest of the creek, the mouth barrier management will need to continue.

6.1 Geomorphology Issues

Arising from the above discussion there are many geomorphic issues to consider. The major issues are as follows;

- Review the flood flow management arrangements in Eel Race Drain and also the rehabilitated Riviera Street Flood Control Complex to allow higher floods from Boggy Creek to occur in the upper segment of the creek to aid the maintenance of the channel competence and morphology of the Creek.
- Review and secure the functions of the Boggy Creek floodplain and flow path management to ensure higher flood flows from increasing catchment development do not impact on the Creek or Seaford Wetland
- Review potential options to manage sediment for the key areas of the creek impacted by drainage inputs.
- Establish a long term morphology monitoring program through fixed survey sections and comprehensive survey of the reaches affected most by sedimentation.
- Review the walling structures downstream of Beach Street with a view to appropriate replacement or repair options.
- Maintain the existing dredging of the mouth sand bars to provide for navigation to the boat ramp.
- Review the edge treatments and jetty approvals for the private frontages along the creek to ensure that appropriate treatments templates and guidelines are put into place.

7.0 WATER QUALITY

The water quality in Kananook Creek has been the focus of considerable management attention, particularly over the last 30 years. As long ago as the end of the 1890's the creeks water quality has been held in contempt by the local residents. Following the disconnection of the large flows from the upper catchment of Dandenong Creek, the creeks character obviously changed. Reports of foul smelling water in the creek in those early days after diversion of the upper catchment flows indicate that, although there was little sewage loads being discharged to the creek as the area was very limited in development, the creek had a significant water quality problem. It is probable that the issue of discharges from the former swamp pore water and natural groundwater discharges may have contributed to deoxygenation and presence of anoxic conditions along the creek thus causing the black colour. This was a complex yet little understood phenomenon until relatively recent times.

As the catchment developed and more organic loads from septics and wastewater were discharged to the creek either through partially treated septic and sullage waters or as secondary treated effluent later on in the 1970's, the issue of the anaerobic state of the creek attracted strong notoriety and criticism. An extensive

body of research and management intervention led to the commissioning of the permanent Kananook Creek Pump Station in 1982. The body of research included a number of trial manipulations to appraise potential options to overcome the creeks parlous condition (Kerr et al 1978). One of those trials involved the diversion of waters from upstream into Seaford Wetland and insertion of a tidal barrier at Overton Road to limit the influence of tidal inflows. This meant that the creek had only limited freshwater flows and no tidal exchange. Under these conditions the influence of the organically rich groundwater discharges became very evident, far in excess of that predicted. This included the presence of acid sulphate waters that turned the whole of the upper creek turned bright orange and then progressively turned black as the anoxic conditions of long residence times prevailed.

This trial resulted in a solution being proposed and which was subsequently implemented. This was the pumping of sea water into the creek via Patterson Lakes and Eel Race Drain to satisfy the oxygen demand of all sources including that arising from the treated effluent from the Frankston Sewage Treatment Plant. The waters initially pumped from Patterson Lakes also contained diluted treated effluent from the Dandenong Sewage Treatment Plant and Cranbourne Sewage Treatment Plant that discharged to Dandenong Creek and Patterson River.

As mentioned the review in 1978 (Kerr et al 1978) recommended that as well as the permanent provision of pumping of sea water from Patterson Lakes, that the diversion of the low flows of Dandenong Creek to Mordialloc Creek would improve all estuaries (Scholes 1982).

Following the cessation of discharges of treated effluent from the Frankston Treatment Plant in 1989, the Kananook Creek water quality rapidly improved. The Dandenong Treatment Plant ceased discharge to the Dandenong Creek and Patterson River in 1994, followed by the cessation of discharge from the Cranbourne Sewage Treatment Plant to Eastern Contour Drain (and subsequently to Dandenong Creek) in 1996. These actions along with a significant program of wetland installation across the Dandenong Creek catchment has seen the progressive lowering of the nutrient levels in the creek system that inturn was pumped to Kananook Creek via Patterson Lakes.

Today the situation is that most of the Kananook Creek catchment has been sewered and industrial discharges and spills reduced markedly. The marinisation of Kananook Creek has been in place now for over 20 years and while the water quality has improved markedly over the historic situation, there are a number of problems starting to reveal themselves.

Water quality monitoring undertaken by Melbourne Water is conducted on through both monthly sampling and also more intensive snap shot monitoring programs which enable description of the dynamic conditions influencing the creeks environment over the seasons.

What is evident from these programs and in particular the most recent intensive snap shot monitoring program (Bourgues in prep), is that the pumping of seawater from Patterson Lakes is dominant and that the attainment of low turbidity and suspended solids, plus high dissolved oxygen concentrations are benefits of the pumping regimes. The nutrient levels of nitrogen and phosphorus are as could be expected with pumping of sea water and the creek water quality can be regarded as being eutrophic. What is evident is that there are generally eutrophic conditions sufficient to support algal blooms of *Enteromorpha intestinalis* and other algae in Patterson Lakes and this is also evident in Kananook Creek. Under the relatively shallow and warm conditions present in Eel Race Drain and Kananook Creek, *Enteromorpha intestinalis* blooms are able to sustain at nuisance proportions from early spring right through to mid autumn. Such large populations of algae exert a diurnal variation in the dissolved oxygen content, exhibited as low oxygen levels overnight whilst the algae respire.

The control of algal blooms of this type is a problem in many estuaries across the world. The problem is really apparent when the winter spring rains are low, nutrient levels are relatively high and the estuaries do not undergo the normal changes in salinity gradients, plus the turbidities in the estuaries become too low to limit light penetration into the water column and thus limit the primary production.

Large blooms of opportunistic green macro algae such as *Enteromorpha intestinalis* are of ecological concern in estuaries worldwide (Kamer et al,2004a). There are many factors that contribute to the establishment of the blooms including water column and sediment nutrient levels, salinity levels and also water temperatures and water column turbidity (Kamer et al, 2004., Martin et al 1999). One of the factors know to limit this type of bloom from establishing early in spring is the influence of higher turbidities from catchment flows (Cohen et al 2004, Kamer et al, 2004). The research into management of these blooms is outside of this study, but it is evident that the alga is opportunistic and the eutrophic conditions with Patterson Lakes and Kananook Creek are supportive of blooms conditions. From the research overseas, one of the factors that the situation at Kananook Creek may benefit from, would be a reconnection of the freshwater flows with higher turbidities in the critical early spring period.

The extent of algal bloom conditions is not only unsightly and causing fouling on the bed and all structures down the creek, it can be a major issue if the pump

station fails or is shut down for any significant period, resulting in very low dissolved oxygen levels through algal respiration and death with an associated large oxygen demand that may turn the creek anaerobic and odorous. This has been observed in the past, but fortunately due to the provision of new pumps at the Pumping Station and other upgrade works by Melbourne Water, the frequency of outages has reduced of late, thus maintaining a reasonably constant supply of oxygen to the water column thus offsetting the impact of diurnal oxygen sag.

The recent detection of higher levels of nutrients from the Wadsleys and Boggy Creek catchments will need further investigation, but only help to sustain the conditions supportive for bloom conditions. Further research into the blooms conditions may be warranted but management opportunities may be limited to changes in turbidity and salinity levels over the seasons through the use of variance in pumping rates and base flow diversions from Patterson River.

The water quality within Patterson River, as indicated by the Melbourne Water ambient monitoring results (MWC 2007), has continued to improve from that reported in the 1980's (Condina,1982), with further lowering of nutrient levels. It should be noted that recent increases in turbidity are attributed to the Eastlink project.

The overall improvement in the Dandenong Creek water quality can be attributed to a lot of work on sewer diversion and stormwater quality treatment in a number of wetlands installed across the catchment through the late 1990's. As one potential option, the Patterson River water quality is now of a quality that could be considered for diversion into the head of Kananook Creek via Wadsleys Drain. Up to 20 Ml/d may be available in low flow periods and potentially more in the winter spring period. These freshwater flows could be used to establish a mix of waters to provide for establishment of a seasonal salinity gradient down the length of Kananook Creek. The provision of this base flow over the year may also help offset the impacts arising from the loss of the pumping station due to power outages or maintenance shutdowns. A more detailed investigation of the full diversion options and feasibility will be needed but this is outside the scope of this current study. Alternative options to increase alternative seasonal freshwater flows into the Kananook Creek system should also be explored with a corresponding feasibility study into these options.

Marinisation of the water of the Kananook Creek is also showing other impacts along the creek environments. It has been noted that there has been an increase in salinity at Seaford Wetland with summer salinities in the wetland exceeding 25,000 us/cm. This has been attributed to the increase in the saline wedge under the wetland through the elevation of the salt water levels in Eel Race Drain

(Walker 1990, Hydrotechnology 1994). Another issue is the dieback of the former fresh- brackish water based plant communities along the upper parts of the creek system. A vegetation assessment undertaken for this Plan has identified this decline and one that appears to be accelerating with the likely changes in the vegetation potentially significant long term, affecting areas of ephemeral and moist riparian vegetation communities though increase in salinity gradient (Duggan 2006).

The discharge of urban stormwater through the system of drains connected to the creek has a series of associated issues. The understanding and characterisation of stormwater quality over the last 10 years has shown that stormwater is high in levels of organic material, settleable solids, oils, heavy metals, bacterial loads from native animal wastes and sewer overflows and litter. Based on the most recent monitoring, the total carbon and nutrient levels are generally high and as well there being increased levels of *Cr, Cu, Ni, Pb and Zn.* Thus Kananook Creek can be regarded as a Eutrophic waterway with urban runoff contamination (Bourges in Prep). A sediment survey which followed the water quality investigation has highlighted some very high levels of Zinc. Also organotins (dibutyl and tributyl tin compounds) have been detected in all sampled sites'(Bourges in prep)

Melbourne Water has previously undertaken the installation of some water quality treatment facilities in the catchments, but whilst opportunities to treat the loads are limited by the lack of available treatment sites, Melbourne Water will continue to explore options for stormwater quality improvement in the catchment. The lack of available large treatment sites means that stormwater quality treatment to an extent will have to rely on targeted use of Water Sensitive Urban Design (WSUD) techniques for major sites, roads and freeways.

During 2007 Melbourne Water undertook works to construct a litter trap, sediment basin, wetland and rain garden (bioretention basin) within the Melbourne Water Banyan retarding basin at Carrum Downs. The works have been constructed to improve the stormwater quality from the upstream catchment which eventually drains into Kananook Creek via Boggy Creek, and will remove approximately 1.1 tonnes of nitrogen annually.

Early in 2008, Melbourne Water will commence construction of another stormwater wetland to improve the quality of stormwater entering Kananook Creek at its junction with Eel Race Drain. The wetland will essentially be treating the Boggy Creek catchment. The works will include a sediment basin and two separate wetlands (on either side of the creek) to improve stormwater quality from the upstream Boggy Creek catchment to Kananook Creek and the Bay. This wetland system will remove approximately 5.6 tonnes of nitrogen

annually and whilst targeted to improving nitrogen levels in the Bay, this will also benefit the Creek.

Both of these projects form part of Melbourne Water's nitrogen reduction program which aims to reduce 100 tonnes of nitrogen annually (from existing development) from the stormwater system through the construction of regional stormwater quality works.

It should also be noted that it was a requirement that all road runoff from Eastlink be treated to Best Practice Environmental Management Guidelines prior to being discharged into the Melbourne Water drainage system. This has been implemented through Water Sensitive Urban Design (WSUD) construction techniques.

The use of WSUD options should continue to be considered for major sites, roads, developments and freeways across the Kananook Creek catchment.

Frankston City Council is continuing to implement the actions from its Stormwater Management Plan (WBM 2002). The key strategy actions were to be directed at the higher value Lower and Middle Kananook Creek catchments with non structural and structural programs. For further improvements in water quality a program of WSUD with all road upgrades and development, as well as tight controls on sediment during development, need to be implemented. Various inner city councils are investigating stormwater retrofit targets which should allow them to treat 2-5% of the catchment area annually as part of existing road upgrade and infrastructure programs. In particular many non structural programs have been initiated including improved construction site management through the planning scheme and also through building approvals. Improvements in the kerb side collections throughout the municipality plus concentration of high litter producing areas has resulted in a noticeably large reduction in litter observed in the creek. Many initiatives have implemented through the Frankston CAD with litter traps and provision of improved street furniture and engagement with the Commerce groups to manage waste production.

As indicated in the Geomorphology section, the loads of suspended solids from road runoff and general catchment disturbance of the easily disturbed sandy catchment is high and is impacting on the creek. These sediments and associated contaminants are transported to the creek via Council drains and there is a need for Council to continue its current site management program for sediment control. However the majority of the sediment is derived from non point sources such as roads, which is harder to control without wide scale adoption of Water Sensitive Urban Design. The gradual introduction of Water Sensitive Urban design techniques in reconstruction schemes will take a long time, but are

worthwhile. Further, significant contributions fro development sites and industries such as quarries are all contributing, particularly in the Boggy Creek catchment.

The fate of most of the solids and the dissolved or adsorbed contaminants is that once they are discharged to the Creek and come in contact with the saline environment, agglomeration and settling of flocculated material rapidly occurs, such that the creek sediments accumulate the contaminants. Observations of this process reveal the sediments laid in a sequence of vegetative material and sediment similar to a layer cake. This layering also seems to act to consolidate the sediment thus inhabiting the normal sediment erosion processes in a relatively low energy environment.

Due to the trapping of the organic litter load (which accounts for over 80% of the litter stream) the sediments are also subject to anaerobic reduction in the layers below the surface layer which is oxidised by the movement of oxygen rich flows from the pumped base flows. Any disturbance of the sediments is liable to turn the water column black with the release of significant concentrations of anoxic sulphide material. This anaerobic pore water is also likely to contain large concentrations of labile heavy metals and other contaminants. This character of the sediments makes it hard to remove sediment from the creek without impact.

With respect to litter incidence along the creek, there was a significant reduction in levels of anthropogenic sourced litter from the residential areas. This can be primarily attributed to the successful introduction of improved kerb side collection and recycling programs by Council over the lasts 5 years. Similar reductions can also be noted for the commercial areas following a strong program of litter trapping and waste management instituted after the completion of Councils Stormwater Management Plan (WBM 2002). Whilst a welcome overall reduction in anthropogenic litter accumulations is noted, occurrences of litter are still evident in the creek, particularly after rainfall events. This litter is generally sourced from wind blown sources, vehicles and building sites across the catchment. A review of Councils Stormwater Management Plan (WBM 2002) is currently underway and may identify new initiatives to further reduce the incidence of contaminants to the creek.

From other programs conducted elsewhere, it is known that source reduction programs are far more effective than the insertion of more in creek litter booms. The current litter boom at Overton Road which is managed and maintained by Melbourne Water still collects some litter items but these are a small number compared to the past, with the boom now collecting the floating algae and other vegetative material.

The last significant water quality issue that cannot be ignored is that of the organically rich and groundwater discharges with acid sulphate characteristics entering the creek. This issue is not immediately evident and is held in control by the flushing regime currently in place. This action is effective due to the establishment of a highly aerobic surface sediment layer on the bed of the creek and through dilution and oxidation of the organic inputs and discharges as they enter the creek. Significant lowering of the artificial pumped flows would likely reveal the issue again as it was in 1978. There are signs of the inputs along the creek particularly downstream of Bardia Avenue where the sediments have a dark brown grey character of elevated iron sulphide levels.

The quality of Kananook Creek is measured against the SEPP water quality criteria from the Waters of Victoria. These criteria appear to be based upon freshwater criteria and overlook the fact that the Creek system has been marinised. Hence the assessment of the current condition of the water quality of the creek is problematic.

7.1 Water Quality Issues

The water quality in Kananook Creek is likely to always remain problematic due to the significant impacts arising from the historic changes bought about through the loss of the large connected catchment and the subsequent development in the local catchment. Some of the issues are likely to remain intractable, but there are a number where some potential remediation options warrant further investigation. The key issues for consideration include the following;

- Investigate the opportunity and feasibility to attain an increase and constant input of freshwater to the head of the creek to reduce the impacts of marinisation upon the creek and Seaford Wetland.
- Investigate the benefits arising from the introduction of higher turbidity waters to the stream during the winter and spring period to reduce the incidence and extent of major marine algal blooms through lower light penetration
- Investigate options for implementation of management measures to reduce the duration and extent of the major algal blooms through introduction of seasonal salinity gradient in the Creek.
- Continue to monitor the oxygen profiles in the creek and seek to prevent significant diurnal sag arising from loss of flows or large algal blooms.
- Continue to seek improvement in the litter management strategy through the review of the Municipal Stormwater Management Plan and maintenance of the current litter capture systems and other Stormwater Management Plan actions.

- Continue and expand programs to limit stormwater problems at development sites through the implementation of Stormwater Management Plan actions.
- Investigate opportunities to treat stormwater runoff from areas with high levels of contamination such as collector roads and freeways (such as during road upgrades).
- Continue to look for stormwater quality treatment opportunities and Water Sensitive Urban Design systems in the catchments and precincts where possible. Commit to WSUD for all local government infrastructure projects. Set local targets for retrofitting existing urban areas with WSUD.
- Investigate environmentally sensitive and cost effective options to treat and remove contaminated sediments near main drain outfalls to the creek and dispose of the material in accordance with the EPA's waste management system.
- Consider the implementation of a periodically more intensive monitoring regime to inform on the dynamic water quality characteristics under the various diurnal and flow regimes.
- Investigate the appropriateness of the current SEPP water quality criteria.
- Continue to inform the constituents in the catchment of the impact of various activities upon the water quality of the creek

8.0 HABITATS

The aquatic habitats of the Kananook Creek have not been well studied since the introduction of the current pumping regime. A recent study of fish fauna showed that the creek attracts the normal estuarine species and a number of migratory species that seek to move into freshwaters (McGuckin 2006). As the system is marinised the operation of the creek as an estuary is compromised and the function as a nursery for species such as Yellow Eyed Mullet and Bream appears reduced from its potential level due to the lack of a salinity gradient along the length of the creek.

Other species found in the creek include Goby (Bridled and Tamar River), Small mouthed hardyhead and Flat headed gudgeons. The migratory species included, Eels, Galaxids, Tupong, with the latter trying to find its way up Wadsleys Drain as a freshwater habitat to breed. Other species noted in the McGuckin study (2006) included marine crustacea, crabs, barnacles and shrimp. Of interest was the finding of a number of Northern Pacific seastars in Eel Race Drain downstream of the pumping station in early 2007. This species is an invasive pest that has been detected in Port Phillip Bay since 1994. Northern Pacific seastars are known to have detrimental effects on native marine organisms,

mainly because they are voracious predators that eat a wide range of native animals. They can have a major impact on populations of native shellfish, which are important components of the marine food chain (DSE 2004)

An exciting find during the site inspections for this Plan was the location of a Water Rat (*Hydromys chrysogaster*) feeding table in the upper part of Kananook Creek indicating the presence of the species and it's feeding on a range of crustacea, molluscs and shell fish. This sighting needs confirmation with further investigation.

Kananook Creek has changed in many ways over the last decade following the establishment of the saltwater pumping and also as a result of more intensive development on many of the private frontages along the creek banks. In particular there has been a notable decline in the amount of fringing and overhanging vegetation that provide critical microclimate control and shading of the edges of the creek and also protective habitat for species against predation. Losses of the large bands of Phragmites have also been noted along with a significant decline in the Melaleuca bands along the creek (Duggan 2006). These two species provided significant components of the edge and verge habitats. A reduced edge flora is evident in many areas with either bare banks or some saline species now noted. One particular noted instream species that has established is that of seagrasses (either Zostera or Heterozostera). This was previously unrecorded in the creek (Duggan 2006).

A major issue with respect to the ecological diversity was the decline caused by the large algal bloom conditions at the time of site inspection for this study. *Enteromorpha Intestinalis* blooms totally dominated the waters along with Cladophora and Ulva species. This bloom physically smothered the substrates and water column such that many fish species would have trouble finding suitable niches in which to live. The likelihood of a large hatching of the biting saltwater midge is likely as it has a preferential habitat on the large masses of floating algae.

The Council managed Reserve along Kananook Creek is also an important regional resource with many animals and birds using the corridor. Whilst no recent or contemporary study has been conducted for species of significance there are regular sightings of some species. Of note is the regular presence of Nanking Night Heron along the creek and occasional sightings of Lewins Rail, Baillon's Crake and Australasian Bitterns (DSE 2001). The value of the reserve as a regional habitat resource is key to the retention of remnant values within the Frankston City Councils area. This study does not include a survey of the current values and it appears that a more thorough study may be warranted.

8.1 Habitat Issues

The habitat issues are related to the water quality management regime and also that of the changes in the physical environment. The key issues to be noted are as follows;

- Marinisation has resulted in a loss of an estuarine salinity gradient and hence the ecological diversity that would normally exist to sustain estuarine fish nurseries and other more diverse habitats and ecosystem.
- Marinisation is causing a slow die back of critical components of the estuarine vegetation that create habitats for many species.
- Loss of critical edge vegetation through development on private lands and marinisation is resulting in a loss of waters edge shading and protective habitats for many species
- The large algal bloom of predominantly *Enteromorpha intestinalis* is colonising the benthos and water column and physically precludes many species as well as providing a habitat for the biting saltwater midge.
- Importance of Kananook Creek as a regional fishery hatchery and resource requires integration with flow and water quality management to provide the seasonal habitats required.
- Investigation as to the extent and potential management options for the Northern pacific sea star
- Addition of Kananook Creek as a site to be surveyed as part of a broader Water Rat study for the region.
- The continued management of the Kananook Creek Reserve for regional significant fauna habitat values.

9.0 REACH ISSUES

9.1 Reach One - Eel Race Road to Mornington Peninsula Freeway

Reach One comprises the highly modified channel of Eel Race Drain. This channel is man made, trapezoidal in shape and has little variance in channel form or habitat complexity due to its primary function as a flood protection levee. A few older Melaleuca stands exist along the banks and some areas of Phragmites are colonising the edge. The water column is dominated by macroalgae and rapid dissolved oxygen decline may occur if the Patterson Lakes Pump Station fails which can lead to fish kills.

The addition of some low edge banks that allow colonisation of the engineered channel by fringing and shading plants would also provide for increased habitat diversity. These planted benches could be established without impact on the flood flow characteristics of Eel Race Drain.

Similarly, planting of the lower portions of the levee banks with fine rooted plants would also improve the streams habitat and visual presentation without impacting on the structural integrity of the levees. No planting in the upper 75% of the levees should be considered.

The sourcing of an alternate flow of freshwater should be investigated to lower the impacts of pumps station maintenance periods and or local power outages. This freshwater source could also provide for the establishment of a season salinity gradient down the creek supported by catchment flows from Boggy Creek and lower pumping rates from Patterson Lakes Pump Station. An investigation into the diversion mechanisms is required, but modern engineering solutions can provide for asset security of the levee banks and also potentially provide for fish passage for migratory species into the Dandenong and Eumemmerring Creek systems. The diversion of this flow is seen as critical to the long term health of Kananook Creek.

The health of Seaford Wetland could also be improved with the displacement of the salt wedge currently created under the wetland from the marinised Eel Race Drain and allow for diversion in increased low flow of freshwater into that system to potentially offset the salinity problem. The provision of a submerged wall across Eel race Drain may also be required to limit the salt wedge intrusion upstream of the Pump Station.

The water quality of Eel Race Drain is currently dominated by the Patterson Lakes pumping flows with high salinities due to the marine strength water and salinities are high. Nutrient levels are high enough in the flows from the upper catchments of Boggy Creek that have warranted the investigation of a water quality treatment wetland for catchments upstream of the Mornington Peninsula Freeway. Melbourne Water has been focused on nutrient reduction strategies to reducing the overall nutrient loads to the bay. Whilst loading reductions to the bay is the key driver of the investment strategy, water quality benefits accrue to the waterways downstream of the works. One wetland has been built in the Boggy Creek catchment by Melbourne Water in 2007, with works to construct a litter trap, sediment basin, wetland and rain garden (bioretention basin) within an existing Melbourne Water retarding basin at Banyan Reserve in Carrum Downs (please refer earlier Section 7.0).

Early in 2008, Melbourne Water will commence construction of another stormwater wetland upstream of the Mornington Peninsula Freeway near the junction of Boggy Creek with Eel Race Drain to further reduce contaminant loads. As well as benefiting the Bay these assets will also improve the quality of stormwater entering Kananook Creek.

Further, the presence of a high nutrient source in Wadsleys Drain needs to should be investigated.

The levee banks of Eel Race Drain provide flood protection to the surrounding developed areas. The northern levee is higher than the southern levee to ensure that Patterson Lakes has a high level of protection. Whilst the channel capacity of Eel Race Drain will carry the design flood flows for the 1 in 100 Year ARI event, higher flows above that return interval will side caste into Seaford Wetland. Seaford Wetland provides for extensive flood storage. As mentioned in Section 8.2 there may be a need to investigate the need for further flood protection at the Austin Road end of the wetland. A formal review and strengthening of the levees at the northern end of Seaford Wetland and provision of an armoured and controlled overflow point will also need investigation.

Key issues and actions for Reach 1

Flood management

- As flood management for Eel Race Drain involves side casting into the Seaford Wetland as a flood storage zone, investigate the flood storage function and any requirement for additional protection to properties along Austin Road for above design events and investigate the need for levee

bank augmentation along Eel Race Drain and provision of a structured controlled overflow point.

Flow management

- With the need to manage flows along the Creek there is a need for new and increased flow monitoring and level information required for the management of the recommended high and low flow management regime. This will require the investigation of requirements for pump station upgrades and or new provisions to enable the integration into the flow and level management system

Water quality

- As the marinisation of the reach from Kananook Creek Pump Station limits the establishment of an estuarine gradient, investigate the provision of a variable pump regime and also an alternate fresh water flow from the upstream sources to provide for a fresh brackish environment over the cooler seasons
- As part of the need to protect the Seaford Wetland from adverse salinity impacts, investigate the provision of a submerged weir in Eel Race Drain to limit salt wedge intrusion into the head of Eel Race Drain and Seaford Wetland
- The detection of high nutrient concentrations in tributary drains to Eel Race Drain require investigation as to source of high nutrient concentrations

Habitat

- The in stream habitat of the engineered channel of Eel Race Drain is low and needs improvement with the potential for the provision of low benches for plant colonisation along the toe of the banks

9.2 Reach Two - Eel Race Road to Station Street

The lower portion of this reach containing the natural section of the original creek alignment is perhaps the least disturbed of all the reaches along the creek. The upper portion immediately downstream and upstream of the Riviera Street control structure is highly modified and channelised. A change in the instream vegetation is particularly noticeable with the reduction of Phragmites stands over the last 15 years, this being attributed to the increase in salinity due to marine discharges and cessation of discharges from the former Frankston Sewage Treatment Plant (about 17 Ml/d).

The channel and valley geomorphology has had some minor alteration with the segment downstream of the Riviera Street control structure being dredged in the late 1980's. The former floodplain and ephemeral wetland is still present in this area and warrants rehabilitation. The provision of higher flows and fresher flows will aid this rehabilitation. The option of dredging this area of backwater out, to form an island is challenged by the issues of acids sulphate soil disposal and the loss of important habitat diversity along the creek. Further, the formation of an island is unlikely to provide significant refuge habitat as the main predators can swim to the island.

Recent refurbishment of the controls and gates at the Riviera Street Control structure has secured the operation for high flood diversion out to the Bay. However as discussed in the Flow Issues - Section 5, of this report there is a need to reappraise the diversion of the smaller flood flows away from the Creek. Critically the allowance of instantaneous flows of up to $12m^3/s$ (1040Ml/day) through the Riviera Street Flood Control Complex and a stage level of 1.2m AHD is reached in the creek downstream at Armstrongs Road before the creek side gate is closed at the control structure and the bay side gate opened. This flow equates to approximately a 1 in 2 Year ARI flow event.

The increases in flows will allow inundation of the flood runners and low levels wetlands along the creek and also create a head that will increase the discharges through the sedimented reaches downstream. Maximum benefit from the increases in upper catchment flow through the creek and increased scouring of the sediment will be realised if the discharge level can be maintained over a number of days and through a number of tidal cycles. An arrangement that uses the Riviera Pondage as a storage zone that could also provide another mechanism for flushing via discharges of pulses timed to coincide with the low tide could also be considered. This arrangement is unlikely to be as effective as a more prolonged discharge under higher flow conditions but is a worthy consideration. Flood protection should not be compromised as the local catchments will have drained from the creek by the time the upper catchment reaches the head of the creek. A series of safety controls will need to be installed to ensure that the high flow diversion to the Bay still actuates. This arrangement will need to be subject of a comprehensive investigation, but appears to be potentially the most viable option to overcoming some of the creeks issues.

Some non-motorised small watercraft attempt to navigate through the narrow creek side opening of the Riviera Street flood control complex, an activity which appears to be unsafe. A former old drop log post previously added to the navigation difficulty, however this was recently removed during upgrade of the structure. Further modifications could be considered to the structure in addition

signage could be used to inform users of small watercraft to disembark at the canoe launch ramps provided and then re-enter the creek upstream of the structure at a safer and more appropriate point.

Water quality in this reach is dominated by the impacts of the Kananook Creek Pump Station. Currently the lack of catchment flows and loss of the freshwater flows from the former sewage plant discharges result in a marine water quality being maintained over the year. The nutrient levels in this segment varies due to the influence of Boggy Creek flows from urban runoff and also some puzzling records of higher nutrient levels in Wadsleys Drain. This nutrient level is high enough to maintain a nuisance level of macro algae blooms in Reach 5. A key improvement to this area will be the provision of a permanent freshwater input from upstream and also the variance in the pumping arrangements from Patterson Lakes in late autumn, winter and early spring to provide a fresh brackish gradient in the upper estuary area in line with a more natural profile.

Habitat quality in the segment downstream of Riviera Street is relatively high with excellent east bank habitat complexity, plus some good elements along the west bank. Unfortunately, as with the other downstream reaches the quality of the west bank vegetation is under strong pressure due to land use changes. An indication of potential Water Rat habitat was also sighted in this area and warrants investigation as to confirm occupation and use of the area. Two feeding areas were sighted and this is an encouraging outcome.

Upstream of Riviera Street through to Eel Race Road the channel is highly modified and has a lower habitat complexity. Complexity could be improved through the insertion of some low in stream banks to allow ephemeral macrophytes to grow and thus increase the habitat diversity. This area is also heavily colonised by large accumulations and growths of macro algae and seagrass. Bream are known to use this reach and the maintenance of dissolved oxygen is critical to their survival.

The area upstream of Armstrong's Road is of good quality and warrants a protective stance. Some of the land parcels in the area were rationalised in the late 1970's around Ti Tree Grove, this providing some level of protection to elements of the creek frontage but other areas remain subject to ongoing disturbance and decline. Again the determination of a suitable mechanism for a higher degree of control through the Municipal Planning Scheme would be an important protective measure for this area.

Key issues and actions for Reach 2

Stability

- Prepare a rehabilitation plan for incremental rehabilitation of the old creek courses, wetlands and past dredging deposits in the reserve and floodplain downstream of Riviera Street.

Drainage and Flooding

- Some private developments on the western bank between Station Street and Eel race Road have altered levels or removed bank materials and require checking against the declared 1 in 100 year ARI levels.

- Investigate and review operation of the Riviera Control structure and adjust automated controls to allow passage of all flows up to $12m^3/s$ up to the stage level of 1.2m and or operations to allow pulses of flows to coincide with low tides.

Flow management

- Investigate requirements for gauging station upgrades to allow for integration into the flow and level management system for the new increased flow monitoring and level information required for the management of the recommended high flow management regime.

Water quality

- Investigate the provision of a variable pump regime and also fresh water flow to provide for a fresh brackish environment over the cooler seasons limits and the establishment of an estuary gradient along the creek to overcome the marinisation of the reach from Kananook Creek Pump Station

Habitat

- In stream habitat is high and needs protection from being compromised by developments – particularly on the western bank and requires a number of responses including
    - Instigation of an incentive and/or education program for private property owners to enhance instream habitats
    - Ensure that all development proposals have set back and habitat improvement conditions on the approvals

  - Seek to improve planning control mechanisms and development controls to assist the protection of natural values on both banks.

- Seek to improve the habitat complexity of the old course and wetland d/s of Riviera Street old course and floodplain wetland habitat d/s of Riviera Street with staged rehabilitation program

- Eel Race Drain upstream of Riviera Street Control structure is low in habitat diversity and requires the investigation of the insertion of low banks and berms to allow colonisation by ephemeral zone macrophytes

9.3 Reach Three - Station Street to Seaford Road

This reach has only a few large drains entering from urban catchments. Notwithstanding this there is still a reasonable level of connected catchments and sand sources. The only significant drain impacting in this reach is that of Weatherston Road Drain which connects to the Swamp Drain and subsequently to Seaford Wetland.

The management of the tidal back up and flood management of the Seaford Wetland require review to ensure functionality of this important system. The current arrangement of this system is vital to flood management and the changes to the drainage system over the last 20 Years warrants a review and is likely to include the need for the establishment of a flood wall at the Austin Road end of Seaford Wetland.

The rate of sedimentation in the creek is not significant in this reach and the stream form remains relatively unmodified except at crossing points where the inverts have been hardened. Except for the continuing decline in the west bank vegetation cover and associated erosion, the east bank habitat complexity is still relatively good despite decline in the overall condition of the riparian vegetation. As with the previous two reaches the long term decline in habitat on the west bank is worthy of intervention and assistance programs to achieve rehabilitation of the creek side habitats. Examples of this would be best achieved on public lands such as at Seaford in front of the Community Centre. A pattern of redevelopment is evident along this reach with some larger land holdings being subject to multiple tenement dwellings, with these seen to be adversely and incrementally changing the bank side conditions and vegetation.

The maintenance of the floodplain and also a buffer along the creek for habitat continuity will need to be managed through the town planning approval processes based on a consistent template. The revised flood heights are

nominated in the planning scheme overlays however the environmental values are only recognised in the planning scheme on public land along the waterway and not private land.

Flow and level gauging is an ongoing issue and the maintenance and potential upgrade of the Station Street Gauge Station may be considered as part of the options analysis for the recommended new flow management regime.

Key issues and actions for Reach 3

Stability

- As some newer private property bank treatments are encroaching into the waterway or are deteriorating and need replacement and may not have appropriate approvals, there is a need to undertake an inventory of treatments and assets that are noted to intrude into the creek, plus confirm the approvals for these developments along the western bank of the creek for both Frankston City Council and Melbourne Water approvals. Any unapproved works should be subject to either removal or remediation or repair of failing assets.
- Minor sedimentation is occurring within the reach at the outlets of the drains requiring the establishment of increases in the hydrological and hydraulic management changes to encourage scouring and sediment rearrangement for an improved channel profile

Drainage and Flooding

- Some private developments on the western bank have altered or removed bank materials and an audit is required to ensure all recent developments are above the declared 1 in 100 year ARI levels between Seaford Road and Station Street

- The Weatherston Road Drain and Seaford Swamp Drain System needs review for management of tidal back up and flooding, in particular capacity and operation performance and institute upgrades as required

Flow management

- A new and increased flow monitoring and level information will be required for the management of the recommended high flow regimes and may require an investigation into the requirements for gauging station upgrades and integration into the flow and level management system

Water quality

- Catchment sourced contaminated sediments accumulating in the waterway necessitates a review of the Frankston City Council Stormwater Management Plan and Melbourne Water sites for potential for additional and improved sediment control.

- High organic and acid sulphate groundwater discharges to the stream via the drainage system has impacts on the water quality in this reach and it will be important to ensure adequate flows of either fresh or fresh and marine water mix are provided to maintain adequate dissolved oxygen levels

Habitat

- In stream habitats are being compromised by developments particularly on the western bank and hence there is a need to
    - instigate an education and/or incentives program with private property owners who have frontages to Kananook Creek to enhance instream habitats
    - ensure that all development proposals have set back and habitat improvement conditions on the approvals
    - Seek to improve planning control mechanisms and development controls to assist the protection of values on both banks

9.4 Reach Four – Seaford Road to Mile Bridge

The reach between Seaford Road and Mile Bridge has the highest number of large urban drains (Melbourne Water and Frankston City Council) entering from the catchments to the east. The main drains include Bardia Avenue Drain including the Seaford Swamp Drain, Buna Ave Drain, Milne Ave Drain, Skye Road Drain, McCulloch Ave Drain, Jennings Outfall No2, and Overton Road Drain.

The fact that the entry of these drains coincides with the end of the active tidal intrusion limit and also the changes in stream hydrology has resulted in the transported sediments from the catchment accumulating within the creek channel. The stream channel is noticeably contracting in areas upstream and downstream of the drain outlets and sediments accreting in the bed and on the banks. The sediments consist predominantly of sands and silts and a range of contaminants derived from the urban run off from roads and developments, including

hydrocarbons, heavy metals and nutrients and animal faeces. This together with a significant organic load of leaf litter form layers of sediments in the creek which readily consolidate under the normally low velocity regime of the tidal and low gradient estuary condition.

It will be important to establish a long term geomorphic monitoring program to be able to assess the rate of channel change. Periodic measurements at a number of fixed survey sections and of the creek bathymetry throughout this whole reach will be important to understanding the rate of change and sediment increase over time.

The cessation of sediment removal from the creek following changes in EPA dredging protocols in 1992 has seen the ability to manage the sedimentation problem become almost intractable. No sediment has been able to be removed since 1992 due to the higher levels of contaminants. As a result the creek bed is exposed in areas under spring tide lows and navigability for shallow draft craft such canoes may be excluded under these conditions. It may not possible to guarantee long term full tidal cycle navigability along the whole creek unless either a flow regime is established or partial dredging or rearrangement of sediment occurs. Due to the anoxic conditions created under the disturbance of the sediments that dredging would create it is unlikely that an appropriate dredging option will be found. Therefore the option of seeking some changes in the flood hydraulics is important to creating conditions that will allow the formation of a new channel profile.

The potential for improvement in source control for sediment appears to be limited, but an appraisal of all opportunities should be sought as this is the most efficient mechanism of reducing continuing sediment impacts on the Creek in the long term.

Along with the sediment changes along this reach and lack of higher flows there is a loss of the flood channel and backwater or connected wetland inundation that will sustain these habitats. The cessation of upper catchment floods flows into the creek following the establishment of the Kananook Creek Pump Station appears to be having an impact on the habitat diversity as well. The increased seasonality of marine conditions along with loss of associated upper bank vegetation is resulting in some bank erosion and slumping. This is noticeable in remnant natural areas, but is more pronounced in areas that heave been redeveloped. The change in bank vegetation adjacent to some of the newer developments has been associated with a noticeable decline in bank side vegetation. This is seriously reducing the habitat complexity for these areas and an environmental significance overlay and other suitable planning or development controls must be instituted to arrest the decline in stream side

values. As with other reaches, the establishment of an education and/or incentives program through the western bank private properties would aid the retention and re-establishment of this critical vegetation.

With respect to water quality, this reach has the coincidental issues of poor tidal exchange, extended residence times, the presence of the large algal bloom problems and also the discharge of organically rich and acid sulphate groundwaters that are intercepted and transported to the creek via the drainage systems that intersect the groundwaters associated with the older swamp deposits inland. The lower dissolved oxygen levels may be experienced at times and as a result and waters may attain a darker colour at times. The increased flows over the summer and autumn periods will ensure that oxygen levels remain elevated during summer and autumn to prevent fish kills. The addition of a freshwater make up flow would also ensure that anoxic conditions do not occur in periods when the Kananook Pump Station may be offline, as lower dissolved oxygen levels during summer and autumn will increase the impact of any temporary reduction in flows on in-stream habitat values. Threats from oil spills in industrial catchments has reduced in recent times, and continued investigation into measures to reduce the impacts of urban stormwater run off including oils and other contaminants on Kananook Creek will be required.

The change to a seasonal estuary condition would assist the improvement of the creek as a fishery resource where fresher environments are required for many of the species. This reach would be particularly improved through this as the potential for nursery conditions is high.

The presence of litter throughout this reach has reduced significantly from the historical levels. This is due to the changes in litter management by Frankston City Council at point sources and also through an improved kerb side collection program. Whilst the changes are significant a continued search for improvements in source and near source is needed as litter is still being transported to the creek under storm conditions. The continuing maintenance of the Melbourne Water's Overton Road floating litter boom will aid the ongoing management of litter.

Key issues and actions for Reach 4

Stability

- As some private property bank treatments are encroaching into the waterway or are deteriorating and need replacement and may not have appropriate approvals, there is a need to undertake an audit of treatments and assets and investigate the approvals for developed along the western bank of the creek

for both Frankston City Council and Melbourne Water approvals, plus seek removal or remediation of unapproved encroaching structures or repair of failing assets.

- As sedimentation is occurring within the reach at and downstream of major drain outlets there is a need to appraise the sediment management options for the creek for any potential to;
    - maintain desired channel characteristics and to ;
    - institute hydraulic management changes to encourage scouring and sediment rearrangement for an improved channel profile

- As the stream is showing signs of sedimentation and cross sectional closure, but the rate of closure is hard to assess, there is a need to establish a fixed site network for geomorphic assessment based on regular surveys of controlled sections to monitor accretion levels over the long term

Drainage and Flooding

- As some private developments on the western bank have altered or removed bank materials, an audit is required to ensure that all recent developments are above the declared 1 in 100 year ARI levels between Mile Bridge and Seaford Road.

Water quality

- As litter accumulation is evident in the lower portion of the reach arising from the adjacent catchments, there is a need to seek further improvements to litter management through,
    - additional activities under the Frankston City Council Stormwater Management Plan,
    - maintenance of the current litter patrols and also
    - the continued maintenance of Melbourne Water's Overton Road litter boom
- Catchment sourced contaminated sediments are accumulating in the waterway necessitates a review of the Frankston City Council Stormwater Management Plan and Melbourne Water sites for potential for additional and improved sediment control.
- Organically rich and acid sulphate groundwater discharging to the stream via the drainage system has impacts on the water quality in this reach and it will be important to ensure adequate flows of either fresh or fresh and marine water mix are provided to maintain adequate dissolved oxygen levels

Habitat

- In stream habitats are being compromised by developments particularly on the western bank and hence there is a need to
    - Instigation of an incentives and/or education program for private property owners to enhance instream habitats
    - ensure that all development proposals have set back and habitat improvement conditions on the approvals
    - Seek to improve planning control mechanisms and development controls to assist the protection of values on both banks

9.5 Reach Five – Mile Bridge to Wells Street

The creek within this reach has two forms. The segment between Wells Street and Beach Street is concrete walled on the eastern side with the west bank being a mixture of private walling treatments and or natural batters. Similar to Reach 6, the walling on the east bank is likely to have a limited life but is the most recent section of walling undertaken and may have a slightly longer life span than that downstream. The condition and type western bank treatment includes a variety of log and timber jetties of various forms and state of repair. Some sites have random rubble fill and one site on the downstream side of the Beach Street Drain outfall has been subjected to an urgent repair intervention with large rock after flood damage in 2005. This style of treatment holds the erosion but is unlikely to be an acceptable form in the longer term.

With respect to the private frontages it is unclear as to whether Frankston City Council or Melbourne Water approval has been obtained for construction of the edge treatments and in particular the overhanging jetties that encroach into the waterway. Past practice was that new structures were not allowed to intrude into the waterway area and the more recent or newer structures seem not to comply with that standard. An audit should be made to see what approvals were given and further there is a need to establish a set of standards for structures such as jetties for the Creek. One of the reasons this may have occurred is a misunderstanding about the rights of landowners whose older titles appear to extend into the creek and a belief that development into the creek is within a landholders rights. This is not the case as the Water Act (1989) specifically overrides any private right over the bed and banks of the creek, let alone the need to obtain permission for any works in or over a waterway from Melbourne Water. These facts may need to be clearly explained in a Planning Overlay and/or accompanying explanatory pamphlet.

The discharge from Beach Street Drain delivers a significant source of catchment derived sediment and litter. The sediment is a large deposit fanning downstream of the drain. This accumulation is anticipated to continue due to limited opportunities in the catchment for sediment reduction, and dredging of this sediment for flooding reasons may potentially be required at some time in the future.

The EPA protocols on dredging make the management of sediment in this area make the maintenance of the channel profile difficult. It is likely that the sediment will be rated in the low to medium contamination range due to the influence of road runoff that contains many heavy metals. A review of the catchment and the Frankston City Council Stormwater Management Plan (WBM 2002) for additional source and near source sediment and litter controls should be undertaken identify opportunities to further limit the production of sediment and litter in the catchment. Melbourne Water will also continue to explore options for stormwater quality improvement in the catchment.

Upstream of Beach Street through to Mile Bridge, the Creek has a more natural profile although some bank encroachment is evident particularly on the west bank. As for the lower section of the reach landowners need to be appraised of the legal and town planning obligations with respect to works in or over a waterway. A common standard to creek edge developments and jetties is also required to guide future developments. The loss of habitat along the stream is another outcome of the incremental development along the western frontages in particular with loss of vegetation shading and habitat complexity. The on going intrusion will result in a decline of the creek values.

The channel shows signs of long term contraction with edge sediment infill and Phragmites colonisation. This process seems to be a long term response to the catchment changes and land development, plus the changes in hydrological conditions of the creek. Bank protection in this area has been enhanced on the east bank through the cooperative improvement of the riparian vegetation through an incentives program initiated and supported by Melbourne Water and undertaken by Frankston City Council (Corridors of Green). The involvement of the Kananook Creek Association and the community are important elements that will make this program a success. This improvement activity serves to support a slightly higher level of stream diversity through the provision of overhanging and fringing vegetation and shade. This is less on the western bank where development has encroached and the loss of vegetation and shade is impacting on the instream values. The gradual negotiation for the creation of an access path along the segment upstream of Fiocci Avenue will assist in the establishment of better habitat values. There is a need to monitor the long term channel profile

changes and a series of controlled sections for long term monitoring will be required.

Flooding is a potential impactor in this reach and it is noted that some developments have responded using flood walls to allow development into the floodplain. Whilst developments can seemingly meet the flood protection levels, it allows for no safety factor that may arise from a king tide or greater than 1 in 100 Year ARI event.

Water quality is affected by the discharges entering Kananook Creek from a number of Frankston City Council and Melbourne Water drains in Reach 3 that occur under both low and event flow. The maintenance of reasonable Dissolved Oxygen levels is assisted by the relatively good tidal exchange through this reach under both neap and spring tidal cycles. Observations under outgoing tide conditions show that the velocity at the final portion of the low spring tide in particular has a velocity that is contributing to maintenance of a deeper channel within the cross section with the size sorting of finer fractions midstream.

Key issues and actions for Reach 5

Stability

- As some of the newer private walling systems and jetties are encroaching into the waterway or are deteriorating and need replacement and may not have appropriate approvals, there is a need to undertake an audit of the approvals for more recent developments along the western bank of the creek for both Frankston City Council and Melbourne Water approvals and seek removal or remediation of unapproved encroaching and or repair of failing systems.

- Develop new guidelines for bank edge treatments and jetties for private frontages such that flooding conflicts and waterway encroachment is managed appropriately.

- As sedimentation is occurring within the reach at and downstream of Beach Street Drain, there is a need to appraise the sediment management options for the creek for any potential to;
    - to maintain desired channel characteristics and to ;
    - institute hydraulic management changes to encourage scouring and sediment rearrangement for an improved channel profile

- As the stream is showing signs of sedimentation and cross sectional closure, but the rate of closure is hard to assess, there is a need to establish a fixed site

network for geomorphic assessment based on regular surveys of controlled sections to monitor accretion levels over the long term.

Drainage and Flooding

- As some private developments on the western bank may not have been approved and may below the declared flood levels, there is a need to audit all recent developments to ensure that all developments are above the declared 1 in 100 year ARI levels between Wells and Beach Streets

- As a number of developments and jetties that encroach into the waterway channel have occurred along the western bank of this reach, potentially without approval and may impact on flood levels, there is a need to investigate all recent developments along the western bank for approvals and compliance with declared flood levels and impacts on flooding

Water quality

- As there is continued litter accumulation in the lower portion of the reach arising from the catchments, further improvements to litter management through the Frankston City Council Stormwater Management Plan and maintenance of current Melbourne Water litter patrols needs to be sought.

- Catchment sourced contaminated sediments are accumulating in the waterway which necessitates a review of the Frankston City Council Stormwater Management Plan and Melbourne Water sites for potential for additional and improved sediment control

Habitat

- In stream habitat for fish is being compromised by developments particularly on the western bank requires
    - Instigation of an incentives and/or education program for private property owners to enhance instream habitats
    - ensuring that all development proposals have set back and habitat improvement conditions on the approval
    - seek to improve or strengthen planning control mechanisms and development controls to assist the protection of values on both banks

9.6 Reach Six – Wells Street to Creek Mouth

This is the final reach of the creek before entering Port Phillip Bay and has been subject to the highest degree of modification over time. The whole reach has been is artificially deepened and widened and walled with concrete panel walling. The area is subject to motorised and non-motorised recreational watercraft use. The mouth is constrained by hard walling and is subject to continual closure by sand drift along the coast in line with a natural tendency of forming the mouth barrier. Maintenance of a navigable mouth requires regular dredging and opportunities for alternative treatments to reduce the frequency of dredging are limited. The EPA's current dredging protocol which allows maintenance of the bar and mouth to the boat ramp. This work is done in a co-operative management arrangement between Frankston City Council and Parks Victoria. No dredging of Kananook Creek is allowed or occurs upstream of the boat ramp.

Previous trials at different techniques for dredging of the creek have been conducted including a sand fluidisation trial. Generally the only successful technique has been with eduction dredging, however, the increase of flood flows from the upper catchment may help to decrease the frequency of dredging through provision of increased long term scouring and transport to the bay. Accretion of sediment discharged through the local and regional drains is evident, this being sourced from catchment wide presence of sand on the road system. A partial dredging of this section may be required and would be best undertaken as part of the need to reset the lower end as part of the Transit City project. Limited opportunities appear to exist in the immediate catchment to intercept or trap this material due to the widespread nature of production and the lack of opportunity for sites. Melbourne Water is investigating three sites for potential water quality management facility retrofit into existing retarding basins or in potential new sites as part of the flood management improvement for the Frankston CAD. The Frankston City Council in it its review of its Stormwater Management Plan should continue to seek to identify sites for sediment management at or near source. Experience shows that generally street sweeping has limited impact stormwater pollution control and on the management of fine sediment that is being transported (Walker and Wong 1999).

The major issue for this reach is the condition and structural integrity of the concrete walling system that was built by the Frankston City Council against the advice of the DVA in the 1970's. This asset is formed by the insertion of wall slabs into the sandy substrate without a base footing and with an anchored concrete ring beam at the top. Many failures were evident with ring beam and

anchor failures, corrosion of the reinforcement of the panels and movement of the panels. Replacement of the walling has been costed previously in the region of $1.5 M but is likely to be more costly today. This project is integral to the proposed redevelopment of the area as part of the Transit City Project. Future reestablishment of the walling will need to maintain the creek cross section and allow for regular dredging or desilting of the estuary. The development of a renewal program and the adoption of a long lasting and visually pleasing design warrant further investigation.

The projected changes to the drainage infrastructure in the area with augmentation of Beach Street drain and the provision of a new outfall drain to Playne Street to provide for a bypass of the Sandgate Avenue and Teachers College drains will need to be accommodated within the wall and walkway design. These drains are unlikely to have significant impact on the creek except for potential scouring of the sediments under high flow conditions.

Flooding within this reach is controlled by the cross sectional area of the creek outlet. The 1 in 100 Year ARI flood level is set at 1.8 M AHD but the actual height is dependant on the tide height. All floor levels in this reach are above the 1.8m AHD level. Options for increasing the cross sectional area at the mouth is limited but it is recommended that lowering of the upper bank levels near the mouth could be investigated.

The water quality in this segment is a reflection of the total catchment upstream and also the influences of the tidal flux. Water quality is generally clear but the influences of the large algal bloom and the presence of litter being sourced from the adjacent catchments detracts from a pleasant setting. The level of the litter problem has reduced significantly from past years through Council source control programs. Sedimentation along the waterway is evident with this consolidating and not being subjected to scouring under the normal low flow or tidal regimes.

The habitat values of this reach are fairly limited due to the highly structural nature of the channel form. The bed is mobile and whilst colonised in part by seagrass due to the marinisation, only limited fish habitat is available. A Spotted Goby was observed on the field tour for this project

Issues for Reach 6

Stability

- As the walling systems are deteriorating and need replacement, there is a need to investigate a walling system design that provides for retention of critical cross section and channel maintenance.

- As sedimentation is occurring within the reach at and downstream of Beach Street Drain, there is a need to appraise the sediment management options for the creek for any potential to;
    - to maintain desired channel characteristics and to ;
    - institute hydraulic management changes to encourage scouring and sediment rearrangement for an improved channel profile

- As the mouth is subject to continual closure through bar formation from long shore drift of sand, there is a need to maintain the current dredging regime and also investigate the potential to expand this operation further upstream.

Drainage and Flooding

- As flood protection works will result in augmentation of drains passing through the CAD to the creek and will transmit larger flows, there is a need to de-energise the flows at the creek and to ensure the drain outlets are integrated into the walling designs and hidden.

- As there is a potential need to increase the cross sectional area at the mouth for flood transmission purpose in the future, investigate the need for increased cross sectional area and potential alterations to the cross section at the mouth

Water quality

- As there is continued litter accumulation in the lower portion of the reach arising form the adjacent catchments, further improvements to litter management through the Frankston City Council Stormwater Management Plan and maintenance of current litter patrols needs to be sought.

- Catchment sourced contaminated sediments are accumulating in the waterway necessitates a review of the Council Stormwater Management Plan and Melbourne Water sites for potential for additional and improved sediment control.

10.0 CONCLUSION

This review of the flow management, geomorphology water quality and habitat issues for the back grounding of the preparation of the Kananook Creek Corridor Management Plan, has looked at the historical and contemporary issues associated with the creek.

The Issues and Actions paper is to inform the actions to be identified in the plan for follow up actions by the management agencies. The review is not exhaustive but identifies the key issues associated with the subject areas.

A dominant issue with the management of the creek is the need to try and restore some increased freshwater flows and flood flows to the head of the creek to offset some of the issues of water quality and flows arising from alienation of the creek from its former catchment. The impact on the trend to form a smaller creek is perhaps difficult given the degree of change and the inability to recover the former conditions due to the extensive changes and development in the catchment since the late 1880's. However, a range of potential actions exist and it is possible to attain an improved river health condition and environmental values for the creek as well as maintain the existing high social values.

Kananook Creek has attained a high set of social values and attracted vibrant support for its ongoing environmental improvement from the former parlous state that it was in during the 1970's. Many improvements have been made and further actions are possible. Whilst the improvement actions suggested in this report will not see the creek attain high natural values or significance due to the level of disturbances to processes and water quality, the Creek can none the less look forward to further incremental improvement in overall quality if the improvement actions suggested prove feasible. The creek will serve to remain an important social icon into the future.

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Appendix B

Overview of Vegetation Condition and Management Issues for Kananook Creek - Discussion Paper, prepared by Bushland Management Services, Jan 2007

OVERVIEW OF VEGETATION CONDITION AND MANAGEMENT ISSUES for KANANOOK CREEK

Discussion Paper

Prepared by Darcy Duggan.

Bushland Management Services

JANUARY 2007

CONTENTS

BACKGROUND....3

1. INTRODUCTION....3

2. SITE DESCRIPTION....3

2.1 Overview of Land Use and Associated Impacts....4

2.2 Site history....5

3. CURRENT STATUS AND CONDITION OF VEGETATION....6

3.1 Vegetation Quality Rating....7

3.2 Comparative changes in vegetation....8

4. MAJOR ISSUES AND THREATS....10

4.1 Weed Invasion....10

4.2 Revegetation works....11

4.3 Fire Management and fuel loads....11

5. SUMMARY OF KEY MANAGEMENT ACTIONS....12

Background

The primary purpose of this issues paper is to provide a brief overview of current conditions and management issues for the vegetation along the Kananook Creek Management Plan. This plan will provide both directions for future management of the creek, as well as form the basis of capital improvement works all which is directed at improving the long term sustainability of Kananook Creek. A number of previous reports and various studies undertaken for the creek have provided useful background information to this study.

1. Introduction

The Kananook Creek study area extends downstream from the Mornington Freeway overpass to the creek outlet in Frankston foreshore.

Kananook Creek features extensive areas of Reserves containing remnant vegetation totalling around 43 hectares, and forms a critical habitat corridor along its length. These areas are generally restricted to the east bank of the creek and comprise a mix of crown land and land owned by the Frankston City Council [FCC], and also includes a few parcels of land along the floodplain and managed by Melbourne Water [KCC 1996]. The two key agencies responsible for management of these areas are Melbourne Water- main part of stream to top of bank, and FCC for the remaining areas upslope. The creek is also bounded by significant tracts of private land this being along the majority of the west bank and also the east bank downstream of Mile Bridge.

Substantial works have been undertaken in recent years by the various agencies in association with members of the Kananook Creek Association [KCA] in undertaking woody weed management, revegetation, rubbish removal and construction of the Kananook Creek linear path.

The creek corridor has been identified as a site of high regional significance for its conservation values (Ecology Australia, 2006)

2. Site Description

Kananook Creek is located within the City of Frankston, and flows through predominantly residential properties with a small area of mixed commercial and residential zoned land located downstream near the Frankston city centre.

The northern section includes Eel Race Drain which is a constructed drain and has been substantially modified since the late 1890's. Boggy Creek and its tributaries is the primary source of freshwater runoff into the top end of Kananook Creek since the diversion of Patterson River in the late 1880's. The creek then flows due south for approximately 7.4 km between the current coastal dune of the Seaford Frankston foreshore and the secondary or former coastal dune system that runs parallel to the

east. These dunes are comprised of Quaternary siliceous and calcareous sands, and are variable throughout.

The creek valley is generally well formed with a floodplain of variable width with creek flats and small areas of swampy depressions. This valley form was created following the retreat of the sea and lowering of the floor of Port Phillip Bay between fault lines. The creek and valley form were created by the full catchment flows of the Dandenong Creek catchment. The diversion of Patterson River and post European settlement drainage activity has reduced stream flows leading to an increased accretion of sand along the stream bed and resulted in a reduction in cross section [water depth] of the creek.

The creek features a fairly contiguous corridor of remnant vegetation along the east bank, with smaller fragmented areas of remnant vegetation restricted to the west bank due to residential housing. Mature overhanging vegetation along the creek fringe is a distinguishing character of the upper reaches of the creek in particular, and is a critical habitat feature.

To facilitate the description of the creek and development of a future management program for this study, the creek has been divided into 6 [six] reaches extending from the top end of Eel Race Drain downstream to the creek mouth. The upper reaches of the creek feature significant areas of remnant vegetation with urban development generally restricted to the west side of the creek. Urban development begins to encroach onto the edge of the reserve along the east bank in the middle reaches. The vegetation within the lower reaches 1 and 2 are comparatively narrow and substantially disturbed due to associated impacts of private dwelling and urban development and feature only small and highly fragmented areas of remnant vegetation remain.

2.1 Overview of Land Use and Associated Impacts

The history of land use and associated modifications arising from initial clearing and settlement most notably along the west bank of the creek, has led to substantial loss and degradation of the original vegetation values. The overall extent and condition of remnant vegetation along the east is more substantial, but is highly variable in quality throughout. Riparian vegetation continuity rates moderately, due to numerous longitudinal discontinuity's [gaps] associated with road/rail crossings and is under high threat of weed infestation [60-80%].

Impacts have included:

- Significant changes in hydrology as a result of draining swamps and wetlands and associated land clearing. This has led to major modification of stream flow volumes, changes to seasonal quality and periodicity of environmental flows, erosion, sedimentation and associated changes in stream morphology

- Gross structural modification to vegetation and associated species loss due to clearing, past fire events and weed invasion; and

- Fragmentation of vegetation and increased isolation of flora and fauna leading to increased susceptibility to external disturbances and eventual local extinction.

Impacts associated with surrounding catchment land use are now readily reflected in both water quality and the overall nature and condition of remnant vegetation and allied wildlife habitat values.

2.2 Site history

Prior to discussion of the current vegetation condition, a brief overview of the site history is pertinent to understanding its present status and management needs. A more detailed discussion of associated changes to the catchment and allied hydrology is outlined in the issues paper prepared by ASM [Oct 2006].

At the time of European settlement, the lower reaches of the Kananook Creek that form part of this study would have originally functioned as a healthy estuary. This would have normally exhibited a gradient in water salinity levels with fresh/brackish water and associated vegetation communities dominant at the top end of the system, grading to increasing water salinity and salt tolerant vegetation at the lower end and entrance to the creek. These conditions would change seasonally with higher freshwater inputs expected during the winter/spring period.

Historically the creek has undergone two major phases of disturbance and modification.

- The first phase was a significant reduction in overall catchment area associated with clearing and diversion of stream flows due to excavation of the Patterson River Cut

- The second major phase was the establishment of a Pumping station along Eel Race Drain to pump “stagnant” seawater from Patterson Lakes into the creek.

The outcome of these changes has been a substantial increase in salinity levels in the upper reaches of the creek. This has negated the effects of freshwater in the upper part of the creek that would normally function as part of a healthy estuary.

As a consequence, the creek although still subject to tidal influences in the lower reaches, is no longer truly estuarine in nature with an associated salinity gradient from fresh/brackish in the upper sections through to marine at the mouth.

These changes to surface flows, levels and increased salinity have also had an impact on the local groundwater regime in the dual systems with increased salinity higher into the dunal profile and floodplain flats.

Given the significance of these environmental factors in determining the survival and distribution of plants, there is some evidence from the current survey of a shift in vegetation structure and species dominance as a consequence of changes in salinity levels within the upper reaches of the study site. These changes are likely to have medium-long term impacts on vegetation and habitat function of the creek.

3. Current status and condition of vegetation

Two previous vegetation surveys have been undertaken for the Kananook Creek. The first survey was by R. Hook [1977] who undertook a detailed study of the middle reaches of the creek from Reserve Road downstream to McCulloch Avenue. A more comprehensive survey from Eel Race Road downstream [but not including Eel Race drain] was carried out by Bruner and Courtney in 1999. This later survey recorded a total of 133 taxa of plants (81 indigenous, 52 exotics) throughout the upper and lower reaches of the Kananook Creek, not including marine species.

Two broad vegetation associations are evident based on the variable land form and site conditions present. Vegetation growing upslope on the old sand dune formations tends to be Woodland in character with a distinct assemblage of species, compared with vegetation along the creek flats and verge, which is generally thicker and shrubland in structure.

The overall classification of the EVC's present along the creek upstream of Overton Road is shown on the DSE Gippsland Plains Biomap for the region as Coast Banksia Woodland /Swamp Scrub mosaic [EVC 904]. The mosaic classification is in reference to the two major EVC's being consistently intermingled and difficult to separate out at the current scale of mapping. Coast Banksia Woodland is the dominant vegetation found upslope along the older dune formations and is multi age class, and varies considerably in structure and species composition, reflecting various aspects of the past history and disturbance of the site.

The predominant EVC downstream of Overton Road is shown as Swamp Scrub [EVC 53-61]. Both these EVC's are listed as endangered for the Melbourne- Port Philip catchment area and generally within the state.

These findings have been generally validated in the recent Vegetation Study for the City of Frankston [Ecology Australia 2006] which identified Coast Banksia Woodland /Swamp Scrub mosaic [EVC 904] as the dominant vegetation present.

The maps in the Ecology Australia 2006 report do not show areas of Swamp Scrub downstream of Overton Road. This may be due to the generally degraded and fragmented condition of existing remnant areas being considered too problematic to classify. The authors did however record the presence of two additional EVC' s along the creek, being [308] Aquatic Sedgeland and [842] Saline Aquatic Meadow. These were noted as present as small remnant areas but were not analysed in detail [Ecology Australia 2006].

It is clearly apparent from the recent survey undertaken of the creek for this study, that the current status and classification of the vegetation is more complex than previously documented. This is particularly evident along the lower slopes, creek flats and small swampy depression areas where subtle changes in moisture and salinity gradient, slope, substrate saturation, aspect and soil type are highly influential in affecting the dominant vegetation cover.

The current EVC classification is considered to be too simplistic and reflects the limitations of the original survey and the scale at which the survey data was mapped,

as well as the limited knowledge base of wetland typology [classification based on site features, vegetation structure and species composition] at the time.

In view of the recent review of wetland typology and reclassification of existing EVC's [Frood 2006], it is highly likely that other EVC's may be present, often as small remnant areas, distributed along the length of the creek.

This is especially the case for the middle and lower reaches of the creek where a range of halophytic [salt tolerant] species are predominant along the lower slopes and creek verge. Further evaluation of these areas is warranted in view of the apparent change in vegetation structure and species dominance associated with the senescence and relatively recent dieback of Melaleuca due possibly to changes in salinity. These sites would appear to be opening up in structure due to the dieback and collapse of Melaleuca and subsequent increase in dominance of halophytes within the understorey.

Whilst the scope this study did not include detailed analysis of the EVC's, it is likely that based on field observations, the following EVC's may be present or warrant reclassification.

Areas currently classified as Swamp Scrub, now have a predominance of halophytes present in the understorey and best fit the description for Estuarine Scrub [EVC 953]. Similarly small areas of Swamp Scrub on slightly drier more elevated sites and lacking in key character wetland species may in fact be better classified as Damp Melaleuca Scrub [EVC 948].

Other possible EVC's present are:

Estuarine Wetland [EVC 10]
Estuarine Reedbed [EVC 952]
Tall Marsh [EVC 821]

The vegetation maps prepared as part of this study must therefore be considered tentative pending further detailed field work to determine the status of remnant sites.

3.1 Vegetation Quality Rating

In relation to the overall quality and condition of the vegetation, weed invasion is widespread throughout and encompasses a range of smothering ground cover weeds notably introduced grasses and herbs such as Tradescantia, as well as various climbers Notable species include Cape Ivy and Bridal creeper which are frequently entwined within the native shrub canopy making management and control extremely problematic [Refer to Table for list of major weeds present].

In determining a vegetation quality rating, a number of features [criteria] such as structural and floristic integrity [intactness], degree of disturbance and weed invasion are assessed. Vegetation quality is then rated on a scale of 1-5 and is consistent with the system used in previous studies ie. Bruner and Courtney [1999]

The vegetation quality ratings used are as follows:

1. Vegetation structurally and floristically intact or almost so; weed invasions **minimal** or weeds absent; disturbance **minimal** or absent.

2. Vegetation structurally and floristically **substantially intact**; low levels of weed invasions; **low levels** of disturbance.

3. Vegetation **partially intact** structurally and/or floristically; **moderate** levels of weed invasion; woody vegetation intact and herbaceous vegetation greater than 50% cover; **moderate** levels of disturbance.

4. Vegetation comprised **of less than 50% cover** of indigenous species and/or with **much reduced** species richness; in the case of woody vegetation the upper strata may provide moderate to high cover but the field layer is substantially exotic *or* only scattered overstorey remnants but moderately dense understorey and/or field layer; **high** levels of disturbance

5. Vegetation is **grossly modified** with scattered to rare dominants of upper strata only persisting; **very high cover of weeds**; current or former levels of disturbance **high or very high**.

The general condition and quality rating of remnant vegetation is variable throughout the creek, reflecting a variable history of past disturbance and land use. The most degraded sections are the upstream section of reach 6 [upstream of footbridge] which features a constructed channel, and the two downstream reaches 1 and 2 within the Central Activity District of Frankston.

The existing vegetation along the lower reaches has been severely modified by past clearing and associated weed invasion, and is now dominated by introduced grasses, exotic trees and shrubs. Small isolated areas of remnant escarpment vegetation have survived in addition to older areas of native revegetation. These areas would generally rate at 5, but will tend to improve over time as areas of revegetation establish and improve the overall structural integrity of the vegetation.

The overall quality of vegetation found along the remaining upper and middle reaches of the creek is rated ar around 4, with some small areas of higher quality Estuarine wetland vegetation recorded in the middle reaches These sites would rate between 2-3 on the scale due to the increased level of intactness and generally low cover of weeds present

3.2 Comparative changes in vegetation

Whilst the time frame for this study prevented a detailed analysis of the original survey area studied by Rosemary Hook [1977], it is clearly apparent from preliminary field observations and analysis of maps and quadrat data collected by Hook, that a number of changes to vegetation have occurred over the time since that study.

Subject to further field survey and analysis, the following observations are made in relation to apparent changes to vegetation along the middle reaches of the creek.

1. Significant overall reduction in density and distribution of Phragmites within the middle reaches and along creek fringe and instream where it had originally formed dense beds. Possibly due to the increase in salinity and decrease in nutrient loads.

2. Apparent changes in Melaleuca cover and associated Swamp Scrub vegetation as evident in the variable age class of stands present. Some Melaleuca areas exhibit extensive root sucker recruitment, are a comparatively young age class and would appear to have substantially increased in cover. In contrast to other areas, the overall Melaleuca cover is now depleted due to senescence and death of parent plants and lack of recruitment. This is also possibly due to the changes in salinity regimes and changes in the groundwater

3. General decline in health and vigour of Coastal Banksia – evidence of dieback and likely senescence of older trees. The underlying causes are likely to be a complexity of factors relating to loss of primary dune vegetation and associated increased exposure to winds; lack of fire; alleopathic effects of weeds and adverse impact on chemical and biological status of soils and associated beneficial soil microflora and fauna; natural scencense,

4. A number of key halophytes were noted as present throughout the original survey site and are still evident onsite. It is not possible however to assess changes in dominance of these species, due to limited survey data and time available to interpret successional changes in vegetation and associated factors relating to shading from Melaleuca growth.

5. Overall reduction in a number of key woody weeds such as Boxthorn, Mirror Bush, Boneseed etc through some sections of the creek, reflecting past management efforts of the Council, KCA and other agencies.

6. Significant increase in the distribution and density of Bridal Creeper. Originally recorded by Hook as common but restricted to the northern part of the creek in low numbers, this weed has comprehensively invaded the creek environs and is in very high cover in places. This weed has the capacity to smother ground cover vegetation as well as climb into the shrub layer, and is by far the most serious weed species present.

4. Major issues and threats

4.1 Weed Invasion

In the course of fieldwork, weed invasion and the degradation it causes was consistently noted, and is by far the most significant threat to the survival of remnant vegetation and the long term biological values along the creek.

An assortment of environmental and noxious weeds have invaded throughout the creek vegetation and have largely replaced the native understorey. Key threat weeds include various introduced annual and perennial grasses and smothering ground covers eg Wandering Creeper *Tradescantia*. Notable grass weeds such as Buffalo grass *Stenotaphrum secundatum* and Kikuyu *Pennisetum clandestinum* are present but otherwise localized in occurrence and will require an active weed management strategy to contain and control spread and impact onsite. This strategy has been applied to date with some success by Melbourne Water in targeting the control of Sharp Rush *Juncus acutus*, an active invasive species along the creek edge.

A similar approach will also be required in dealing with a number of garden escapees which were also noted including Seaside Daisy *Gazania linearis* [eg widespread along edge of rail reserve], Freesia *Freesia leichtlini*, Stonecrop *Sedum* spp and Agapanthus *Agapanthus praecox*. These species are new emergent weeds and pose a significant long term threat to native vegetation due to their smothering growth habit and ability to prevent recruitment of native overstorey trees and shrubs.

Several climbing species such as Bridal Creeper *Myrsiphyllum asparagoides* and Cape Ivy *Delairea odorata* are common and widespread and have the capacity to invade into and smother the shrub canopy. Other serious creepers/climbers such as English Ivy *Hedera helix*, Climbing Groundsel *Senecio angulatus*, and Dolichos Pea *Dipogon lignosus* are also present but otherwise fairly localised in occurrence or in an early phase of development and spread. Recent fires have stimulated the growth of Dolichos Pea as noted near the footbridge – Seaford Reserve. Management of these species will be critical to contain further spread along the creek. This will be difficult and challenging in many instances however due to their intertwined growth with native shrubs.

The other major category of weeds present is a variety of woody shrub and small tree species. Substantial efforts have been made by Melbourne Water, local council and KCA members in removing many woody weed thickets from the creek environs particularly in the upper reaches, where various garden escapees including NZ Mirror Bush *Coprosma repens*, African Boxthorn *Lycium ferrocissimum* and Cotoneaster were formerly common and widespread. Whilst these species are still scattered throughout the creek [lower reaches in particular adjacent to private properties] these species pose less of an overall threat compared with the other categories referred to.

New emergent woody species noted as present in small populations or restricted distribution include Myrtle-leaf Milkwort *Polygala myrtifolia*, Sweet Pittosporum *Pittosporum undulatum*, Cape Wattle *Paraserianthes lophantha* [post fire

recruitment], Edible Fig *Ficus caria*, Prickly Pear *Opuntia* spp and Crack Willow *Salix fragilis?*[scattered along lower reaches of creek].

Ecology Australia [2006] listed the invasion of Coast/Sallow Wattle *Acacia longifolia* s.l. and Coast Teatree *Leptospermum laevigatum*, away from the coastal fringe as a particular concern.

Ongoing causes of weed invasion include:

• Removal of vegetation and dumping of garden clippings and associated urban litter This is especially evident in the lower-middle reaches where houses back directly onto the edge of the reserve, with several properties with weeds spreading over the fenceline into remnant bushland.

• Pest animals [particularly Blackbirds, Starlings, Indian Mynahs and foxes] which are primary vectors in the spread of many berry producing weed species.

4.2 Revegetation works

A range of revegetation works of variable age were noted throughout the creek reserve. These generally consist of small patch plantings of tree/shrub species along the Kananook Creek path with limited plantings near the creek

Earlier plantings undertaken by the former Board of Works comprise a mixture of non indigenous trees and succulent ground covers such as Pigface *Carpobrotus edulis*. One notable tree species planted is Mahogany Gum *Eucalyptus botrioides*. This species may behave as an environmental weed, and can readily hybridise with local Eucalypt species leading to "pollution" of the local gene pool.

Some doubts were raised as to the species and provenance of a native Pigface evident in several fairly recent revegetation sites. The form used is considerably more robust with strongly triangular leaves compared with the more distinctive local variety *Carpobrotus rossii,* and more readily fits the description for *Carpobrotus glaucescens* which is typically found on coastal areas of NSW and Qld.

Similar concerns were also raised as to the species of Melaleuca used in revegetation works along section of Eel Race [Reach1] which is clearly not the local form of Swamp Paperbark *Melaleuca ericifolia*. The potential environmental impact of this species as far as ability to naturalise and/or hybridise with the local form is unknown, and consideration should be made for their removal as a precaution.

4.3 Fire Management and fuel loads

Evidence of previous small wildfires was noted at several places along the creek. Fire management and fuel loads is a particularly sensitive public risk issue, with some middle reach areas especially vulnerable, due to the close proximity of houses adjacent to the reserve.

Fire is a natural part of the coastal vegetation, and is integral to the recruitment of many native species which otherwise senesce over time and die out. Many coastal species such as Coastal Tea tree tend to produce large quantities of dead branches and litter over time, which provides a ready fuel for fire. A proactive approach to fuel management will be essential to limit the risk to life and property associated with wild fire, whilst also trying to protect wildlife habitat values.

A review of access and water points is recommended as well as maintenance of fuel loads close to property boundaries. This should also include consideration of the need for the staged replacement of wooden paling fences with suitable non flammable materials.

5. Summary of key management actions

The following threats to riparian vegetation condition will need to be addressed as part of an integrated vegetation management program:

- Poor longitudinal continuity, restricting the biodiversity function of the riparian corridor.

  Improve linkage where feasible through targeted revegetation works to fill gaps and improve continuity and connectivity of vegetation corridor. Particular scope and opportunity to improve riparian vegetation along the west bank adjoining residential properties

- Weed infestation, reducing the quality and sustainability of native vegetation

  Weed management will aim to initially contain further spread of established and new emergent weeds, working then to control and reduce impact on native vegetation and where feasible eradicate species from the site over a realistic timeframe [5-10 years].

- Unrestricted access along sections of creek, causing disturbance to and degradation of vegetation structure and introduction of weeds

  Riparian vegetation management will include weed control and revegetation activities along natural reaches and in habitat ‘nodes’ in landscaped reaches as well as the exclusion of disturbing processes such as unrestricted public access and associated recreational activities that are combining and contributing to the degradation of native vegetation quality.

- Loss of creek edge vegetation and overhanging shading vegetation

  This is a key factor in retaining and rehabilitating the creeks fish nursery values, with particular attention to be paid to addressing the loss along the western shore and eastern shore near higher activity nodes.

- Possible long term impacts to vegetation due to increased marinisation of the creek system will need to be addressed in line with recommendations by AMS [Oct 2006] by increasing freshwater flows into the top end of the creek system.

  Recommend that a thorough detailed quadrat and floristic survey be conducted to provide a bench mark for the long term changes due to changes in hydrology and salinity.

Appendix C

Bird list for Kananook Creek Reserve

Extract from the following report:
Flora and Fauna Surveys of Kananook Creek Reserve by Hans Brunner and Bev Courtney, Nov 1999

2.3 Birds

2.3.1 Survey Methods

The bird list was compiled by direct observation, calls, identification of nests and presence of feathers. In addition, a comprehensive list was obtained from the publication *Kananook Creek Corridor*. The list was compiled by a local resident, Mrs Mary Reynolds, over a period of several years. Only one species was added, a newly arrived Crested Pigeon, which was observed near the railway lihe north of Armstrongs Road.

2.3.2 Results

Table 4. Birds recorded in the Kananook Creek Reserve

Common Name	Scientific Name
Pied Cormorant	Phalacrocorax varius
Little Pied Cormorant	Phalacrocorax melanoleucos
Black Cormorant	Phalacrocorax carbo
Little Black Cormorant	Phalacrocorax sulcirostris
White-faced Heron	Ardea novaehollandieae
Large Egret	Egretta alba
Royal Spoonbill	Platalea regia
Yellow Billed Spoonbill	Platalea flavipes
Chestnut Teal	Anas castanea
Black Duck	Anas superciliosa
Black Shouldered Kite	Elanus notatus
Australian Goshawk	Accipiter fasciatus
Nankeen Kestrel	Falco cenchroides
Little Falcon	Falco longipennis
Coot	Fulica atra
Dusky Moorhen	Gallinula tenebrosa
Silver Gull	Larus novaehollandieae
*Spotted Turtledove	Streptopelia chinensis
Crested Pigeon	Ocyphaps lophotes
Rainbow Lorikeet	Trichoglossus haematodus
Musk Lorikeet	Glossopsitta concinna
Eastern Rosella	Platycercus eximius
Horsefield's Bronze-Cuckoo	Chrysococcyx basalis
Shining Bronze Cuckoo	Chrysococcyx lucidus lucidus
Southern Boobook Owl	Ninix novaeseelandiae
Tawny Frogmouth	Podargus strigoides
Fork-tailed Swift	Apus pacificus
Azure Kingfisher	Ceyx azureus
Laughing Kookaburra	Dacelo gigas
Sacred Kingfisher	Halcyon sancta
Welcome Swallow	Hirundo neoxena
Black-faced Cuckoo-shrike	Coracina novaehollandiae
*Blackbird	Turdus merula
Song Thrush	Turdus philomelos
Scaly Thrush	Zoothera dauma
Eastern Yellow Robin	Eopsaltria australis
Crested Shrike-tit	Falcuneulus frontatus
Rufous Whistler	Pachycephala rufiventris
Golden Whistler	Pachycephala pectoralis
Grey Shrike-thrush	Colluricincla harmonica
Rufous Fantail	Rhipidura rufifrons
Willie Wagtail	Rhipidura leucophryx
Superb Blue Wren	Malurus cyaneus
Brown Thornbill	Acanthiza pusilla

Striated Thornbill	Acanthiza lineata
Little Wattlebird	Anthochaera chrysoptera
Red Wattlebird	Anthochaera carunculata
Spiny-cheeked Honeyeater	Acanthagenys rufogularis
White-naped Honeyeater	Melithreptus lunatus
New Holland Honeyeater	Phylidonyris novaehollandieae
Eastern Spinebill	Acanthorhynchus tenuirostris
Mistletoe Bird	Dicaeum hirundinaceum
Striated Pardelote	Pardalotus striatus
Silvereye	Zosterops lateralis
*House Sparrow	Passer domesticus
*Tree Sparrow	Passer montanus
Goldfinch	Carduelis carduelis
*Common Starling	Sturnus vulgaris
*Common Myna	Acridotheres tristis
Australian Magpie Lark	Grallina cyanoleuca
Grey Butcherbird	Cracticus torquatus
Australian Magpie	Gymnorhina tibicen
Australian Raven	Corvus coronoides

* denotes introduced species

Hon Lisa Neville MP
Minister for Environment, Climate Change and Water

8 Nicholson Street
East Melbourne, Victoria 3002
Telephone: 03 9637 9654
DX210098

Ref: MBR027593

Mr Anthony Moffat
Patterson Lakes Quiet Lakes Owners & Residents Inc
5 Gladesville Boulevard
PATTERSON LAKES VIC 3197

Dear Mr Moffat

BORE FLUSHING AT QUIET LAKES

I am writing to update you on my decision on bore flushing at Quiet Lakes.

I note that there has been a three year trial to test that the pumping would provide additional benefits to residents and that the independent report indicated that the pumping could be beneficial.

I would like to confirm Melbourne Waters communication with residents, that a user-pays approach needs to be considered in any additional use of the bore to manage blue-green algae levels.

I have asked Melbourne Water to continue to use the bore pump to top up the water levels in the lakes during summer, as has been the case since the lakes were developed. However any additional use of the bore pumps will need to be funded by the primary beneficiaries – in this case the residents of Quiet Lakes.

Yours sincerely

Hon Lisa Neville MP
Minister for Environment, Climate Change and Water

14/ 9 /2015

VICTORIA State Government

10 October 2013

To
Sonia Tallarida
Facilitator and Chair for the
Patterson Lakes Management Plan Steering Committee

Dear Sonia

Patterson Lakes Independent Review

Please find a response to your letter dated 3 September 2013 requesting advice from the Review Panel on the interpretation of Recommendations 2, 3, 4, 16, 19, 20 and 21. I apologise for the delay in responding as I have been away overseas. Please note that I circulated your letter and questions to the other former Review members.

I note that your letter seeks advice to assist the Patterson Lakes Management Plan Steering Committee (PLMPSC) to arrive at a common understanding to implement the above recommendations.

The work of the Review was on the basis of a Planning Panel. As such, the role and involvement of the Review members ceased upon submission of its final report. Similar to a Planning Panel, once a final report is submitted there is no further involvement of the report authors (Review members) on the matter. Consequently, I regret to advise you that myself and the other members, in their roles as members of the Review, are not in a position to provide further clarification of the report.

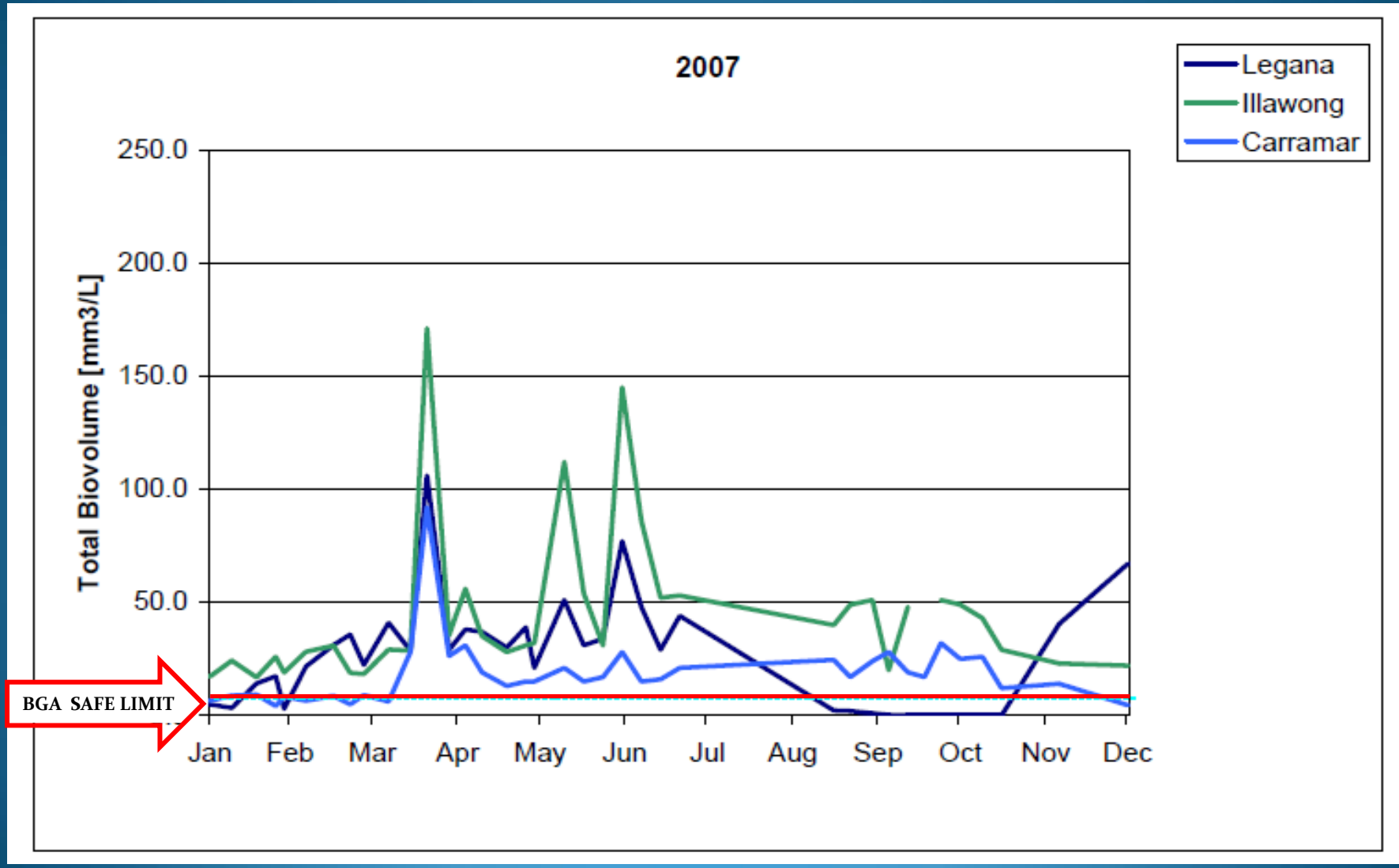
If there are differences or confusion regarding the interpretation of recommendations, I would suggest that they be accepted as to their meaning on face value and in plain English or to utilise the discussion contained within the body of the report to obtain an idea of what is meant by the recommendations. If the discussion contained in the report is not helpful in reaching a clear interpretation of the meaning of a recommendation, then I would suggest that the key action for PLMPSC is to work through the recommendations and issues in a collaborative manner and to reach a general consensus that allows the Committee to move forward to progress the recommendations and their intent as best as possible for the benefit of the Patterson Lakes Tidal Waterways and Quiet Lakes.

I hope the above is helpful.

Yours Sincerely

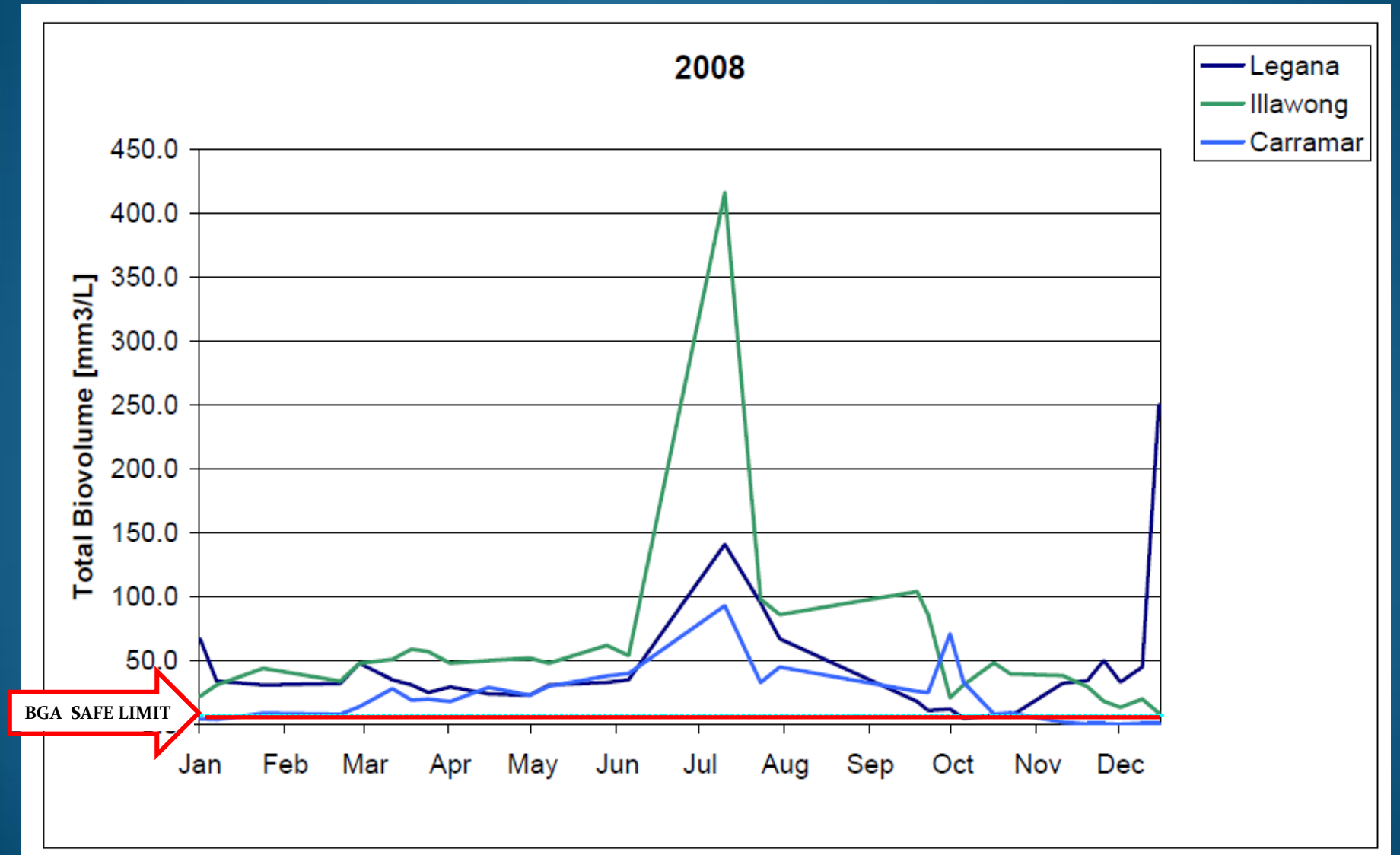
Chris Harty

Quiet Lakes BGA data - 2007



Quiet Lakes

BGA data - 2008



Quiet Lakes

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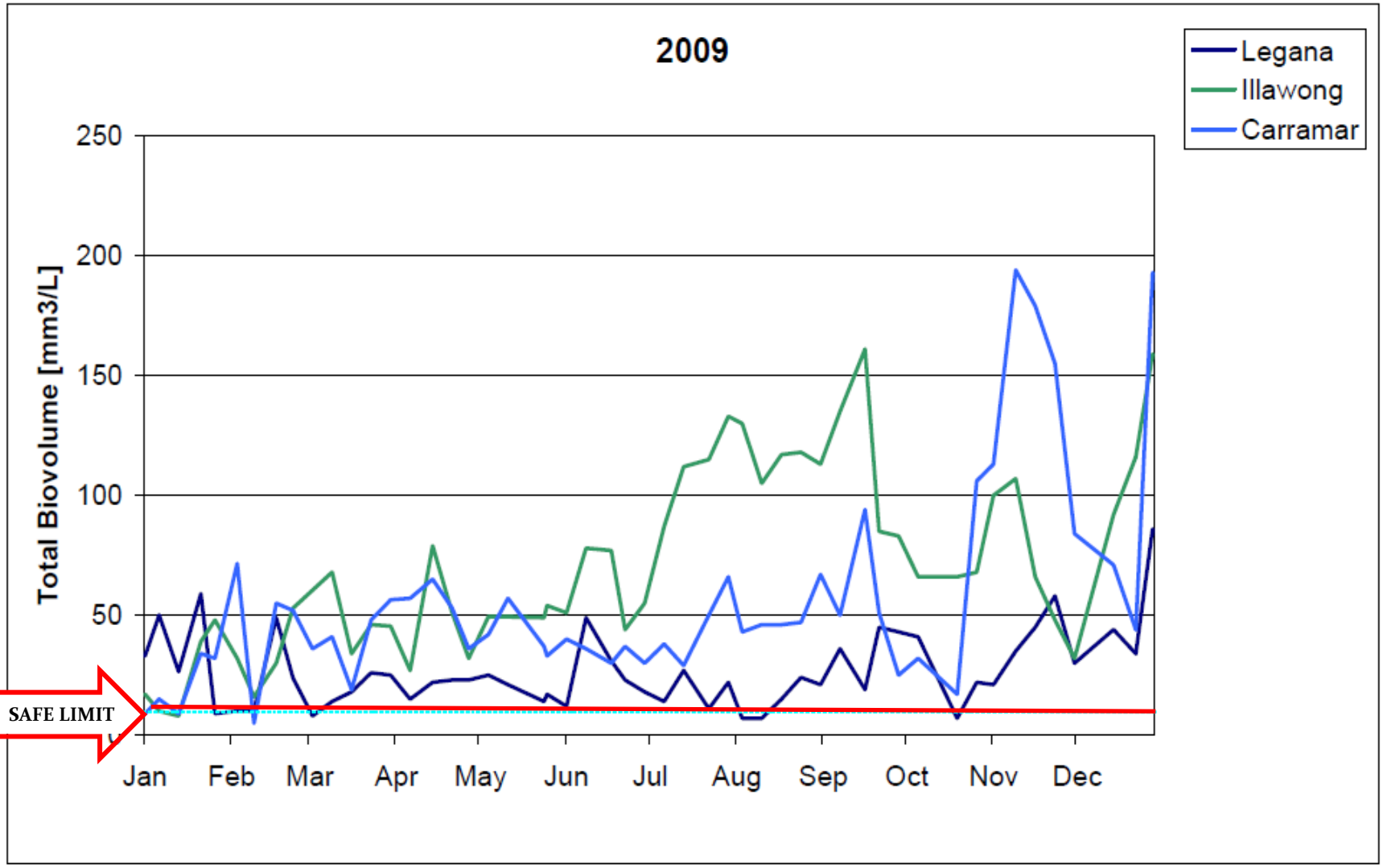

Quiet Lakes

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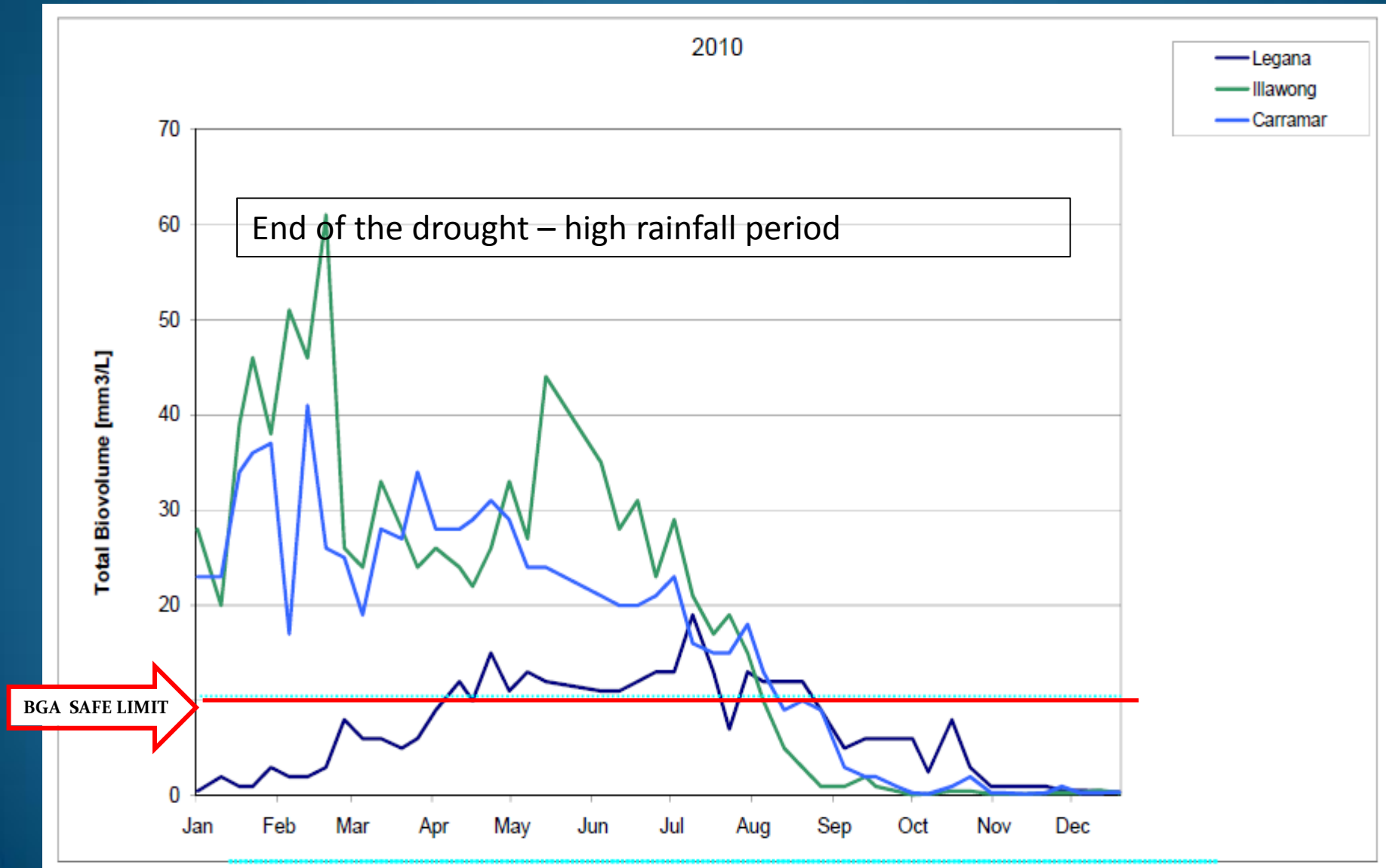
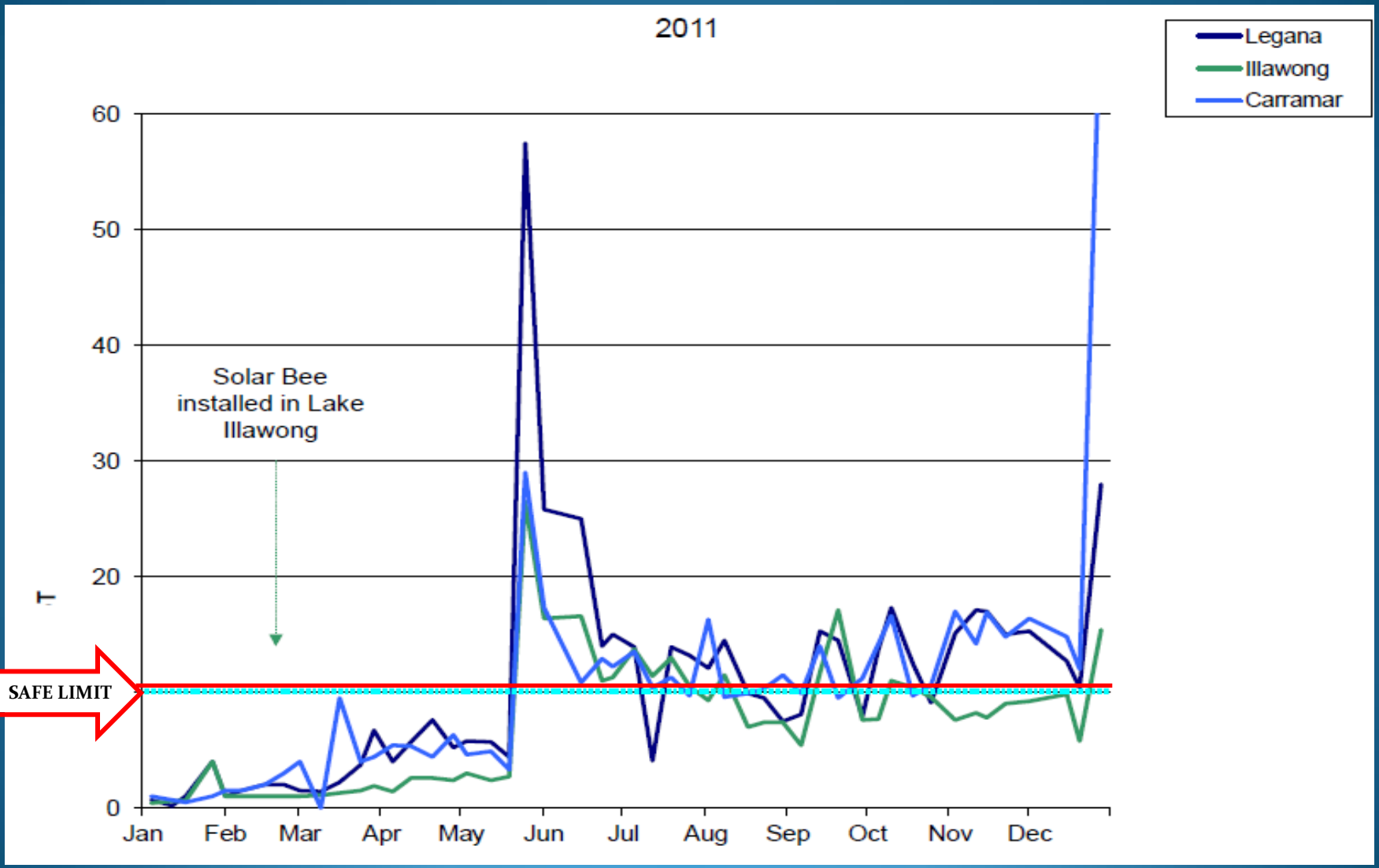
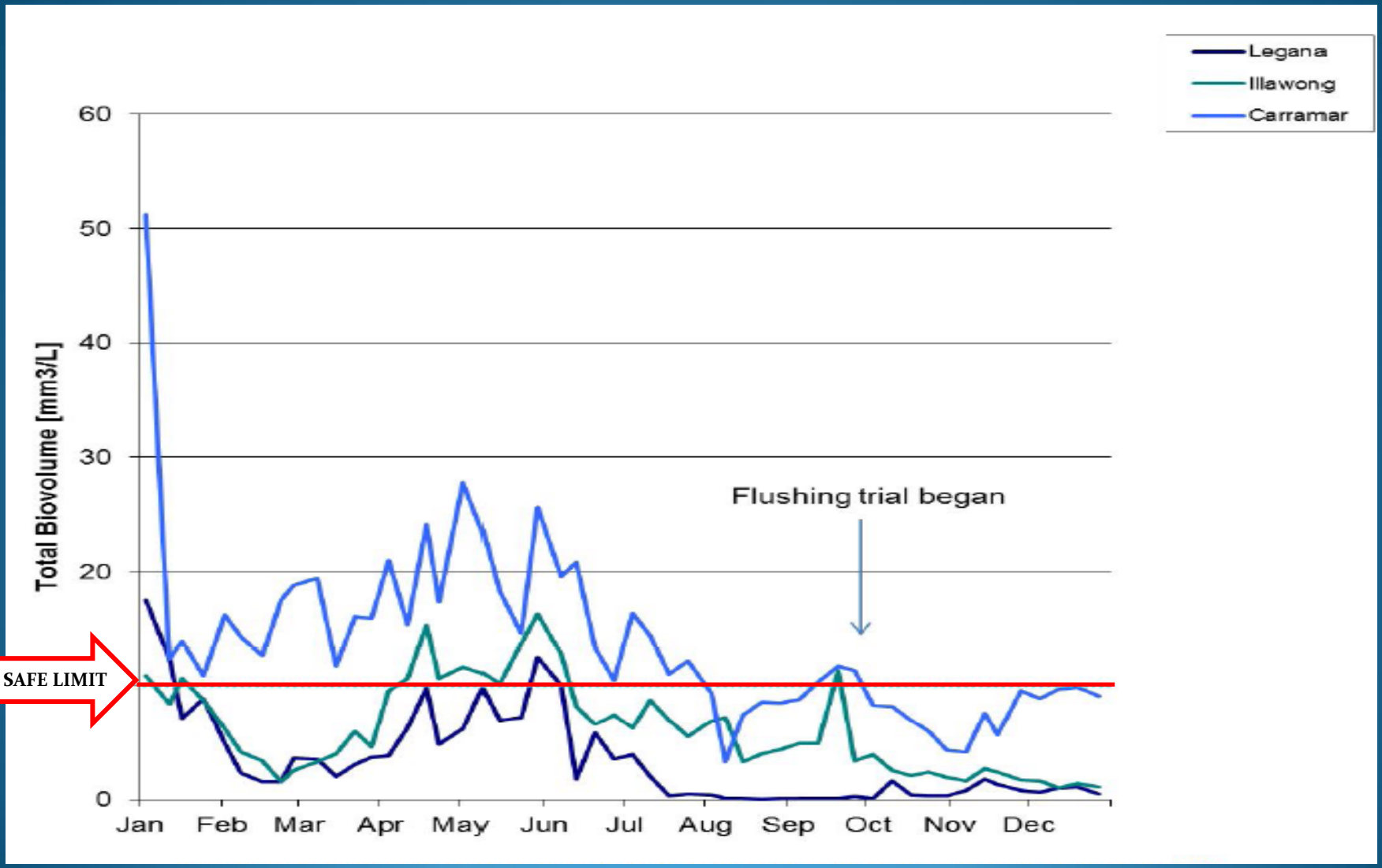


Quiet Lakes

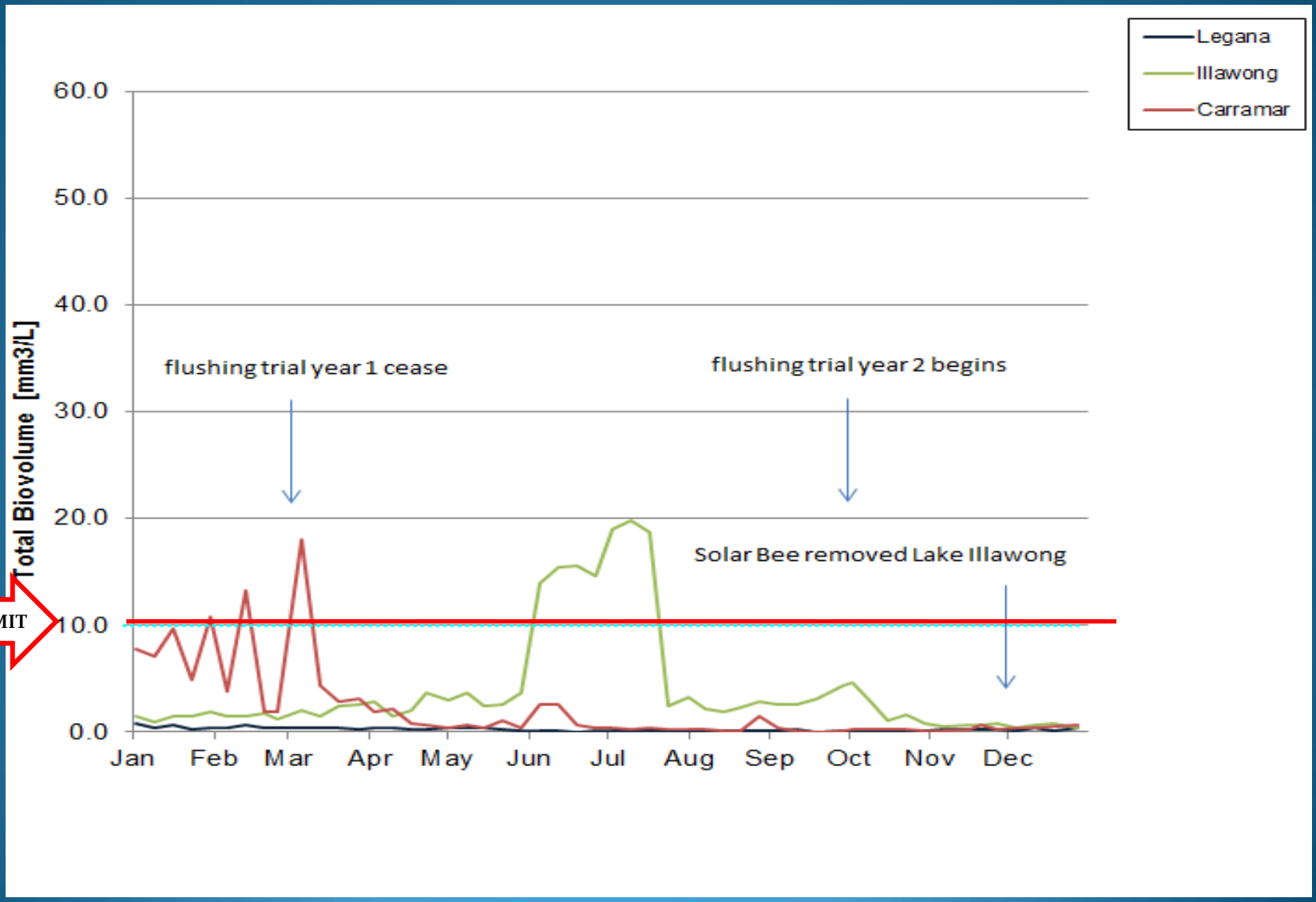
BGA data – 2011



Quiet Lakes BGA data 2012



Quiet Lakes
BGA data 2013



Quiet Lakes

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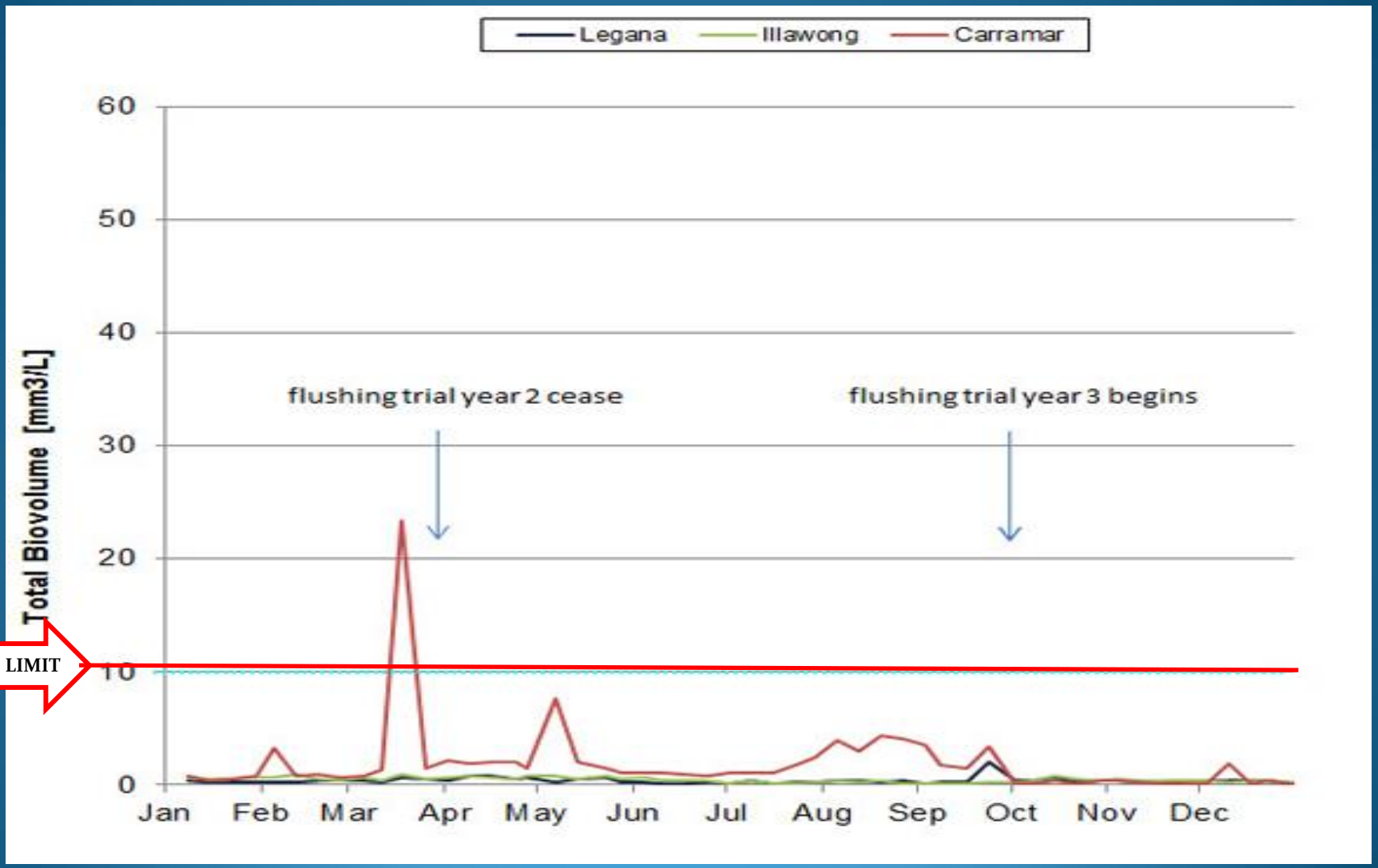

Quiet Lakes

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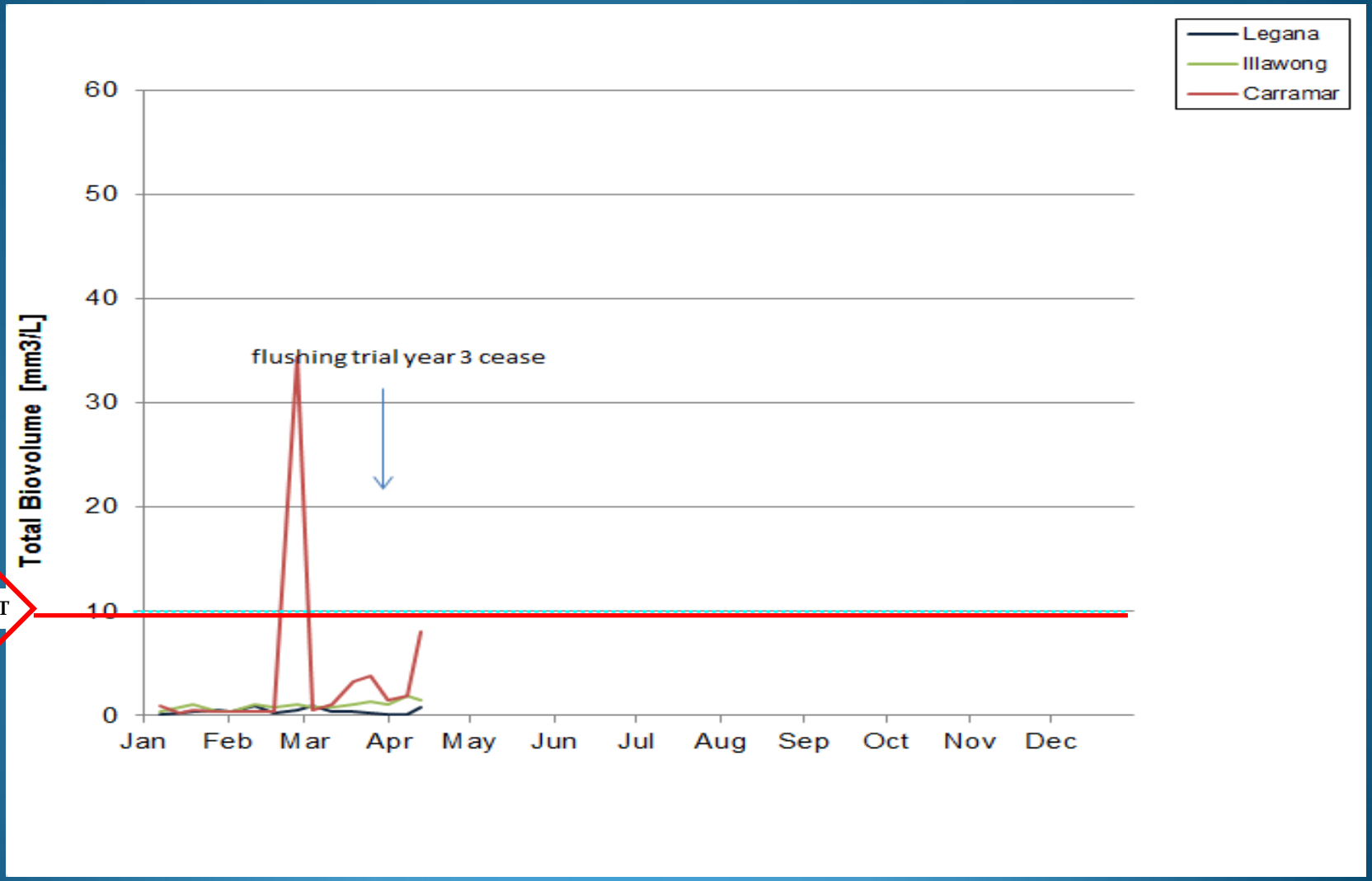

PATTERSON LAKES **QUIET LAKES** OWNERS & RESIDENTS INC.
Association #A0050282B

BALLOT RESPONSE

IMPORTANT MESSAGE FROM YOUR RESIDENTS' ASSOCIATION

The Patterson Lakes Quiet Lakes Owners' and Residents' Association (PLQLOR) advises Quiet Lakes residents to vote YES in Melbourne Water's ballot in favor of commencing the bore.

We do this reluctantly and with the promise that we will continue to fight to get this illegal charge removed.

We have come a long way in getting the Precept Rate abolished and fighting Melbourne Water to protect these lakes. If it wasn't for the actions of PLQLOR in fighting tooth and nail for your rights over the years, we would all now be paying Melbourne Water thousands of dollars a year in the Precept Rate.

Although Melbourne Water and our State Water Minister Lisa Neville refuse to protect public health, the PLQLOR is committed to saving these Quiet Lakes. We therefore urge residents to vote YES to fund the running of the bore.

As your community representative, the PLQLOR will continue the fight to compel Melbourne Water to honour the Independent Review's conclusion that Melbourne Water is responsible to fund and operate the bore to manage Blue Green Algae and keep these lakes SAFE.

The recent flyer (on colored paper) distributed to residents by an unnamed, anonymous person attempting to confuse residents and defame the PLQLOR is proof of the dirty politics being played in this issue.

The PLQLOR wants to keep the lakes safe and clean. While our fight with Melbourne Water is not over, we urge all residents to vote YES.

Please TICK THE YES BOX on Melbourne Water's ballot

For further information please contact:

Anthony Moffatt
President – PLQLOR Association
Mobile: 0423 065 751
Email: amoffatt@pfco.com.au

Louis Cali
Vice President – PLQLOR Association
Mobile: 0414 011 603
Email: louis_cali@yahoo.com

Save Patterson Lakes https://www.facebook.com/savepattersonlakes

minutes

Patterson Lakes Independent Review Steering Committee

DATE	2 September 2016
VENUE	City of Kingston Office, 1230 Nepean Hwy Cheltenham
ATTENDEES	Mayor Cr Tamsin Bearsley – City of Kingston Graeme Davis – Parks Victoria Anthony Moffatt – Community Representative (Quiet Lakes) Andrew Meehan – Community Representative (Tidal Waterways) David Jordan – Community Representative (via phone) Daniel Freer – City of Kingston Apologies John Woodland – Melbourne Water Ross Bleazby – Melbourne Water

MEETING OPENED: 12:10pm

Introductions

Cr Bearsely opened the meeting, thanked those in attendance and noted apologies from John Woodland and Ross Bleazby (Melbourne Water).

Graeme Davis provided an overview of Parks Victoria's responsibilities in relation to the Independent Review outcomes with respect to Parks Victoria's role and responsibilities against legislation and policy of the organisation. Graeme acknowledged the history of the site and Parks Victoria's role as water way manager, and its ability to be contracted when funded to undertake specific functions. Graeme outlined the Parks Victoria submission to the inquiry panel.

The committee discussed the potential for use of the Parks and Waterways charge being used to fund activities. Graeme believed that any consideration to use of the Parks and Waterways charge for activities requires assessment against Parks Victoria's funding deed.

Action: Graeme Davis to investigate the appropriateness of Parks and Waterways charge being used for Parks Victoria activities.

Andrew Meehan reiterated his understanding of Melbourne Water's position that they had agreed to be bound by the outcomes of the review, and that Melbourne Water had committed to pick up the responsibilities of Parks Victoria where they had not been taken up.

kingston.vic.gov.au
Cheltenham 1230 Nepean Highway **Chelsea** 1 Chelsea Road
1300 653 356 131 450 03 9581 4500 PO Box 1000, Mentone 3194 info@kingston.vic.gov.au cityofkingston kingstoncc

In addition Andrew requested that Kingston follow up the status of a previous allocation of $300,000 made by Melbourne Water for asset renewal work on the Quiet Lakes and Tidal Waterways infrastructure.

Action: Daniel Freer to seek confirmation from Melbourne Water on status of asset funding allocation ($300,000).

Sand Retrieval

Cr Bearsley provided an overview of a meeting held at the office of Sonia Kilkenny MP on 26th August 2016 (with representatives from Melbourne Water, Parks Victoria and Kingston) regarding the Patterson Lakes and Quiet Lakes assets. Specific discussion was held in regard to the requirement to undertake sand retrieval. Ms Kilkenny MP provided an undertaking that she would raise with the relevant Ministers the need for additional funding to be provided to Melbourne Water undertake this task on a regular basis.

Action: Melbourne Water to provide an update on discussions between Ms Kilkenny MP and Ministers Neville and D'Ambrosio regarding funding.

Water Quality

Cr Bearsley provided an outline of the Essential Services Commission findings for the implementation of the water quality requirements of the review. It was highlighted the importance of Melbourne Water to consult and involve residents as recommended by the Essential Services Commission.

Action: Melbourne Water to provide timeframe for water quality consultation

Action: Melbourne Water to confirm their commitment to meeting water quality as outlined in the independent review.

Quiet Lakes Maintenance additional charge

Cr Bearsley recognised and acknowledged the disappointment of the community representatives in the consultation process that Council is undertaking regarding the additional charge proposal.

Andrew Meehan suggested that the maintenance being currently undertaken is not being delivered at a high enough standard, particularly with regard to weed spraying.

Action: Council's contract manager Will Tangipo to raise contractor performance standards directly with Melbourne Water.

Anthony Moffatt suggested that residents are provided with schedule of works, this to be published on Council's website, notice boards, email lists to engage with residents to assist Council and Melbourne Water in contractor performance.

Anthony Moffatt sought clarification of the appendix attached to the survey circulated to residents.

Action: Daniel Freer to circulate detail on calculations for how maintenance charges.

Meeting closed 1:20pm