

INVESTIGATIONS FOR A MAJOR WATER MINING PROJECT AT PRINCES PARK, MELBOURNE



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ABSTRACT

A Feasibility Investigation has been carried out by City West Water and City of Melbourne, with the assistance of Earth Tech, to examine issues related to the implementation of a water mining project in the Carlton area of Melbourne to service the local parklands and other potential uses with recycled water. The investigation covered a wide spectrum of issues ranging from an assessment of demand for recycled water in the area to preparation of a Concept Design, including a Triple Bottom Line assessment, a risk analysis and an Environment Improvement Plan. The Investigation confirmed the feasibility of a Water Mining Project for the Princes Park Precinct and provided City West Water and City of Melbourne with the data required to facilitate internal and external planning and approval processes related to implementation of the Project.

KEY WORDS

Recycled water, water mining, sewage treatment, membrane process, Membrane Bioreactor, Triple Bottom Line, Environment Improvement Plan.

1.0 INTRODUCTION

Water recycling is being increasingly recognised as an important element in the sustainable management of Victoria's water resources. Several key initiatives have been promoted to increase recycling, including commitments to reduce potable water consumption in Melbourne by 15% and to recycle 20% of Melbourne's wastewater by 2010.

While the major water recycling projects in Melbourne focus on reusing effluent from the Western and Eastern Treatment Plants, the opportunities available in inner-city areas could not practically be serviced by recycled water from these remote Plants. Water mining has been identified as an alternative option to provide recycled water for these potential reuse sites. Water mining involves installation of localised treatment plants that extract wastewater from nearby sewers and treat it to an appropriate standard using appropriate treatment technologies.

City West Water and City of Melbourne are jointly considering a Water Mining project to supply recycled water to Princes Park and other nearby sites for uses where 'fit for purpose' recycled water can be substituted for potable water. The primary use of the recycled water will be for irrigation of areas managed by City of Melbourne, including Princes Park, Royal Park and Carlton Gardens. Other potential reuse sites include Melbourne Zoo and the Commonwealth Games Village.

This paper discusses outcomes from a feasibility investigation carried out to examine the issues related to the implementation of this project. The issues considered include recycled water demand, appropriate water quality and treatment systems, staged implementation, cost estimates and preparation of a concept design. As part of this investigation, a Triple Bottom Line assessment of the project has been carried out, using the framework proposed by the Department of Sustainability and Environment.

The investigation also included a risk analysis and an Environment Improvement Plan for the project.

2.0 DEMAND ASSESSMENT

Six demand scenarios have been investigated in the study, ranging from a project that provides recycled water to all the identified potential reuse sites (Scenario 1) to providing recycled water to Princes Park only (Scenario 6). Each scenario investigates the range of project costs as well as the impact on the capacity and size of the Water Mining Facility (WMF) required to provide the recycled water volume appropriate to each scenario. The details of the demand scenarios are furnished in Table 1 and the location of the reuse sites are shown in Appendix 1.

Table 1: *Alternative Demand Scenarios*

Sites	Description	Demand Scenarios					
		1	2	3	4	5	6
Sites 1-5	Royal Park North	✓	✓	✓	✓	✓	
Sites 6-7, 15	Royal Park Central	✓	✓	✓	✓	✓	
Sites 8-10	Royal Park South	✓	✓	✓	✓	✓	
Site 11	Native Gardens	✓					
Sites 12-13	Flemington Rd Ovals	✓					
Site 14	Royal Park West	✓					
Sites 16-18, 20	Princes Park North	✓	✓	✓	✓	✓	✓
Site 19	Optus Oval	✓	✓	✓	✓	✓	✓
Site 21-25	Princes Park South	✓	✓	✓	✓	✓	✓
Site 26-27	Carlton Gardens	✓	✓		✓		
Site 28	Royal Parade	✓					
Site 29	Flemington Road	✓					
Site 30	C.S.L	✓	✓	✓			
Site 31	Melbourne Zoo	✓	✓	✓			
Site 32	Melbourne University	✓	✓	✓			
Site 33	CGV	✓				✓	

3.0 SOURCE OF RECYCLED WATER

Investigation of sewers in the vicinity of Princes Park has shown that the North Yarra Main Sewer is the only sewer in the area that carries sufficient flow to supply the range of Demand Scenarios of the proposed water mining scheme. This Melbourne Water sewer runs at a depth of 45 m near the proposed location of the WMF (intersection of Cemetery Road West and Princes Park Drive) which makes the extraction of sewage difficult and expensive. This sewer is shallower near Flemington Road (being 25-30 m deep) which would make extraction from the sewer easier. However, the politically sensitive nature of the area and the associated planning issues and possible delays to the project would outweigh any benefits obtained from siting the WMF in this location. Therefore, it is proposed to construct the WMF within Princes Park itself, close to the intersection of Cemetery Road West and Princes Park Drive, which appears to be the least contentious site, and to extract sewage from a North Yarra Main Sewer manhole closer to Princes Park.

4.0 WATER MINING FACILITY

4.1 Treatment Process

Several treatment processes were considered for producing recycled water and a detailed analysis of the available treatment processes indicated that membrane based technologies offer the best solution, based primarily on the following factors:

- Competitive capital and operating costs
- The physical barrier to the passage of pathogens by the small size of membrane pores
- The reduced 'footprint' of membrane systems
- The ease of modular construction, facilitating the adoption of staged implementation.

The two membrane systems considered were:

- Membrane Bioreactor (MBR) – this combines biological treatment with ultrafiltration membrane separation and, followed by appropriate disinfection, will produce Class A recycled water – an MBR was used in the Domain Gardens and Albert Park Demonstration Water Mining trials
- Multiple Water Reuse (MWR) technologies – this comprises Microfiltration membrane filtration followed by Reverse Osmosis (MF+RO) – this recently patented process is currently being trialled at Flemington Racecourse.

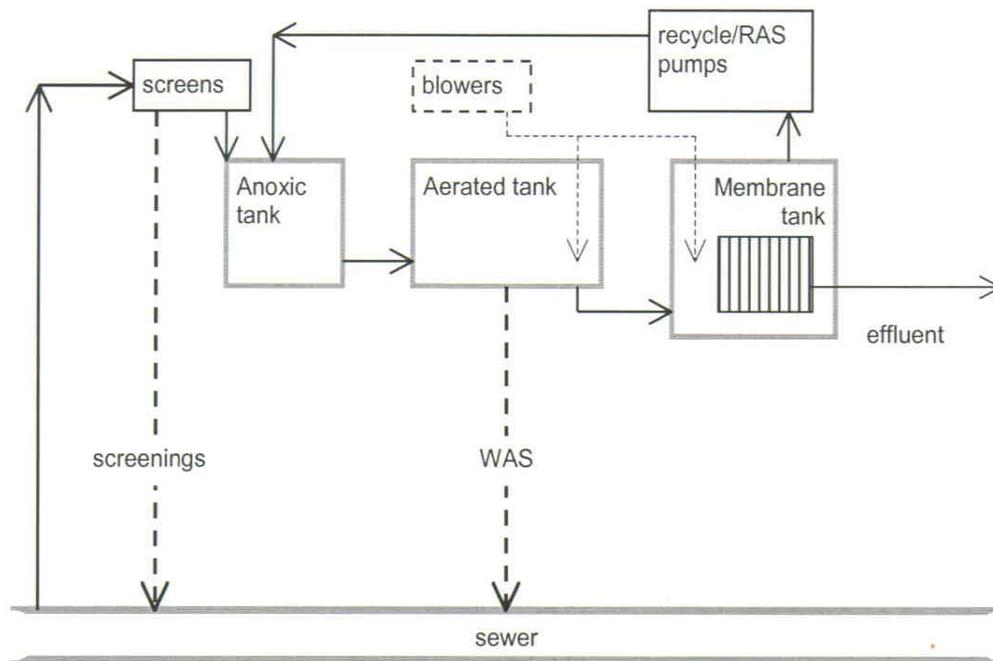
The MWR ranked first in the assessment of treatment options for the WMF. While MF+RO has been used for upgrading the quality of a secondary treated effluent (eg. Luggage Point, Brisbane), its performance when applied to raw sewage is not as well understood. There has been limited full-scale, commercial application of the MWR process, and there are issues that need to be clarified about the long-term operational aspects of this process. It is, therefore, proposed to proceed with the MBR process, which is a proven technology and is available from a number of international suppliers.

Two optional treatment enhancements were also considered:

- Reduction of nutrient (nitrogen and phosphorus) concentrations to avoid over-application when recycled water is used for irrigation, and
- Salinity reduction, using Reverse Osmosis (RO) – it is noted that RO will also further reduce nutrient concentrations and will also provide a significant barrier to the passage of pathogenic organisms.

The proposed treatment train is schematically represented in Figure 2. This treatment configuration will produce Class A+ recycled water – this is defined as equivalent to EPA Victoria's Class A standard with additional nutrient removal and RO treatment. This higher quality is favoured considering the sensitive nature of the project location and to minimise any negative community concerns or perceptions about issues such as water quality and public safety in relation to water mining.

Figure 2: *Simplified Schematic of Membrane Bioreactor (MBR) Option*



4.2 Treatment Plant Capacity

As the demand for recycled water at most of the potential reuse sites is for watering grass, the recycled water would need to be applied during evening/ night time to minimise losses from evaporation – a watering time of 9 hours (9:00pm to 6:00am) has been assumed for this investigation. Providing this volume of recycled water over this irrigation period would have a significant effect on the design capacity of the WMF, since the total daily irrigation requirement would have to be produced and supplied over these 9 hours. This would also be inefficient, as the WMF would lie idle for the rest of the day (or significantly ramped down, if supplying recycled water to the Zoo or CSL). An alternative option has, therefore, been investigated whereby storage tanks are provided at each reuse site, allowing the WMF to fill the tanks over a 24-hour period. The impact of this arrangement on the size of the WMF is demonstrated in Table 2 below.

Table 2: *Alternative WMF Capacities*

Demand Scenario	Daily Recycled Water Demand (kL/d)	Treatment Plant Capacity (ML/d)	
		On-site Storage 'Continuous Demand' (24 hr/d operation)	No Storage 'Instantaneous Demand' (9 hr/d operation)
1	7,080	7.1	14.2
2	5,920	5.9	11.1
3	5,170	5.2	9.1
4	4,140	4.1	11.1
5	3,380	3.4	9.0
6	1,790	1.8	4.8

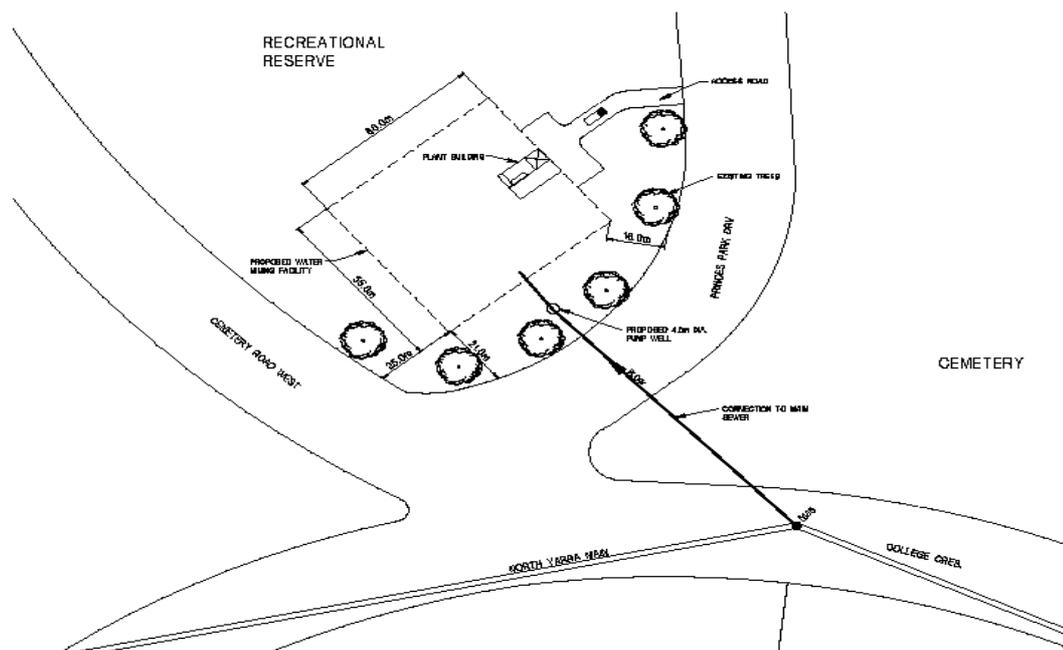
It is clear that it is not practical to supply recycled water ‘on demand’ to potential reuse sites. The negative impact on the Project is not only an economic one, but would also exacerbate the problem of siting a large wastewater treatment plant within the limited space available at Princes Park. It is, therefore, proposed to proceed with the option of storage tanks being provided at all reuse sites, subject to suitable tank locations being identified at each site.

4.3 Location and Layout

The recommended location of the WMF is at the southern extremity of Princes Park, adjacent to Cemetery Road West. It is proposed to maximise the extent of underground construction, with the aboveground part of the structure designed to be in the style of existing buildings at Princes Park.

Based on the use of membrane treatment technologies in the WMF, the plant footprint will vary between 3,300m², say 55m x 60m (Option 1), and 1,100m², say 55m x 20m (Option 6), using an MBR system. The proposed location and layout of the treatment plant is shown in Figure 3.

Figure 3: *Proposed Water Mining Facility*



5.0 PROJECT IMPLEMENTATION

The project seeks the maximum practical uptake of recycled water in the Princes Park precinct to improve its economic viability. However, there is a strong case for implementing this Water Mining project in stages. The benefits of this approach are:

- low initial capital cost;
- experience gained from operation of the first stage of the WMF would be incorporated into the design of further stages, improving the overall efficiency

- of the plant;
- a smaller first-stage project scope may be more conducive towards gaining initial public acceptance; and
- the risk of environmental impact is lower with a smaller plant – this presents a conservative approach towards achieving the ultimate capacity of the plant.

The proposed implementation plan is given below.

- Stage 1 (Year 1) : Use of recycled water for irrigation of Princes Park only (Demand Scenario 6).
- Stage 2 (Year 2-3) : Extension to Royal Park. (Demand Scenario 5)
- Stage 3 (Year 4-5) : Extension to all other sites (Demand Scenario 1).

This staged project implementation will allow a gradual augmentation of the recycled water distribution system and will require an initial 1.8 ML/d WMF, increased in stages to 3.4 ML/d, then to 7.1 ML/d.

6.0 TBL ANALYSIS

A Triple Bottom Line Assessment was carried out to examine and discuss the benefits and impacts of a Water Mining project at the Princes Park precinct. The analysis was undertaken in a Workshop attended by representatives of City West Water, City of Melbourne and Earth Tech. The Workshop was conducted using the framework proposed in the “Draft Guidelines for Planning and Reporting Recycled Water Programs” prepared by the Department of Sustainability and Environment.

At the outset of the Workshop, it was agreed that, while elements of the Draft Guidelines were to be utilised, as described in this Section of the Report, some “tailoring” of the process described in the Draft Guidelines was required since:

- The Workshop was considering a specific project, i.e. Water Mining to service areas in the Princes Park precinct, rather than comparing a number of alternative projects in a Recycled Water Program
- While a number of alternative Demand Scenarios have been identified, this Feasibility Investigation should not limit the scale of implementing Water Mining across the study area. While a Water Mining project could be implemented in stages, City West Water and City of Melbourne are seeking to encourage the widest possible adoption of water recycling in this area.

It was, therefore, agreed that the primary objective of this Appraisal was to examine and discuss the benefits and impacts of a Water Mining project at the Princes Park precinct, compared to a base case comprising continued use of mains water for irrigation and other non-potable demands by potential users of recycled water in the precinct and continued discharge of sewage in the North Yarra Main to the Western Treatment Plant.

The Workshop agreed to adopt the “standard” set of seven key criteria proposed in the Draft Guidelines. These criteria are listed below:

- Impact on the environment

- Impact on water resources
- Impact on regional development
- Impact on social factors
- Direct project cost
- Impact on other business costs
- Risk outcome

The Workshop considered the meaning and significance of each of these criteria by reviewing the factors presented in Chart 6 in Annexure 1 of the Draft Guidelines .

The first task was to select the criterion that was considered to be the most important with respect to the Princes Park Water Mining proposal. The Workshop participants deliberated privately on the merits of the criteria and then nominated their choice. After a period of discussion and negotiation, it was agreed that the most important criterion was the “Impact on Social Factors”.

The Workshop then followed the Draft Guidelines methodology to assign weights and scores to the key criteria. The assessment process resulted in an overall positive score, indicating that the proposed Water Mining project at Princes Park is considered to be a more favourable outcome on a TBL basis than maintaining the “status quo” of the adopted base case.

7.0 CONCLUSIONS

There is significant potential demand for recycled water in the Princes Park area and implementation of a water mining facility to supply these demands is technically feasible.

An initial TBL analysis carried out as part of this feasibility study also indicated that the proposed project will have a favourable outcome. The Investigation has provided City West Water and City of Melbourne with the data required to facilitate internal and external planning and approval processes related to implementation of the Project.

Figure 4: Potential Reuse Sites

