Key Issue:
2 – Reservoir Impoundment

Climate Zone:
As: Temperate

Subjects:
- Management of environmental and social effect

Effects:
- Maintenance of the streamflows and water quality
- Protection of vegetation and wildlife habitat
- Consideration of social and recreational effect

Project Name: Sugarloaf Reservoir Project
Country: Australia

Implementing Party & Period
- Project: Melbourne and Metropolitan Board of Works(MMBW)
Melbourne Water Corporation
1974 -
- Good Practice: Melbourne and Metropolitan Board of Works(MMBW)
Melbourne Water Corporation
1974 -

Key Words:
Streamflow, Water Quality, Vegetation and Wildlife Habitat, Social and Recreational Effects

Abstract:
In the sugarloaf reservoir project, environmental and social factors remained a major consideration in the development of the engineering design and during construction, including consultation with non-government environmental groups. These consultations resulted in some important modifications to the engineering designs. The construction imposed strict environmental protection measures.

1. Outline of the Project

Following two periods of drought in 1967/68 and 1972/73, the Government of the State of Victoria, Australia, directed the Melbourne and Metropolitan Board of Works (MMBW) to implement the following major works to improve the security of metropolitan Melbourne's water supply against future droughts: construction of the Yarra Brae Dam forming a limited storage on the Yarra River near Melbourne, and the construction of the Sugarloaf Reservoir as a larger off-river storage at a higher elevation to be supplied by pumping from the Yarra Brae Dam;

The development was required by the State Government to be subject to satisfactory environmental

studies, which included social and recreational impacts as well. These were carried out by multi-disciplinary teams from the MMBW and other Government departments. Public participation was invited by the issue of information brochures, and public meetings were held and written submissions invited to receive comments.

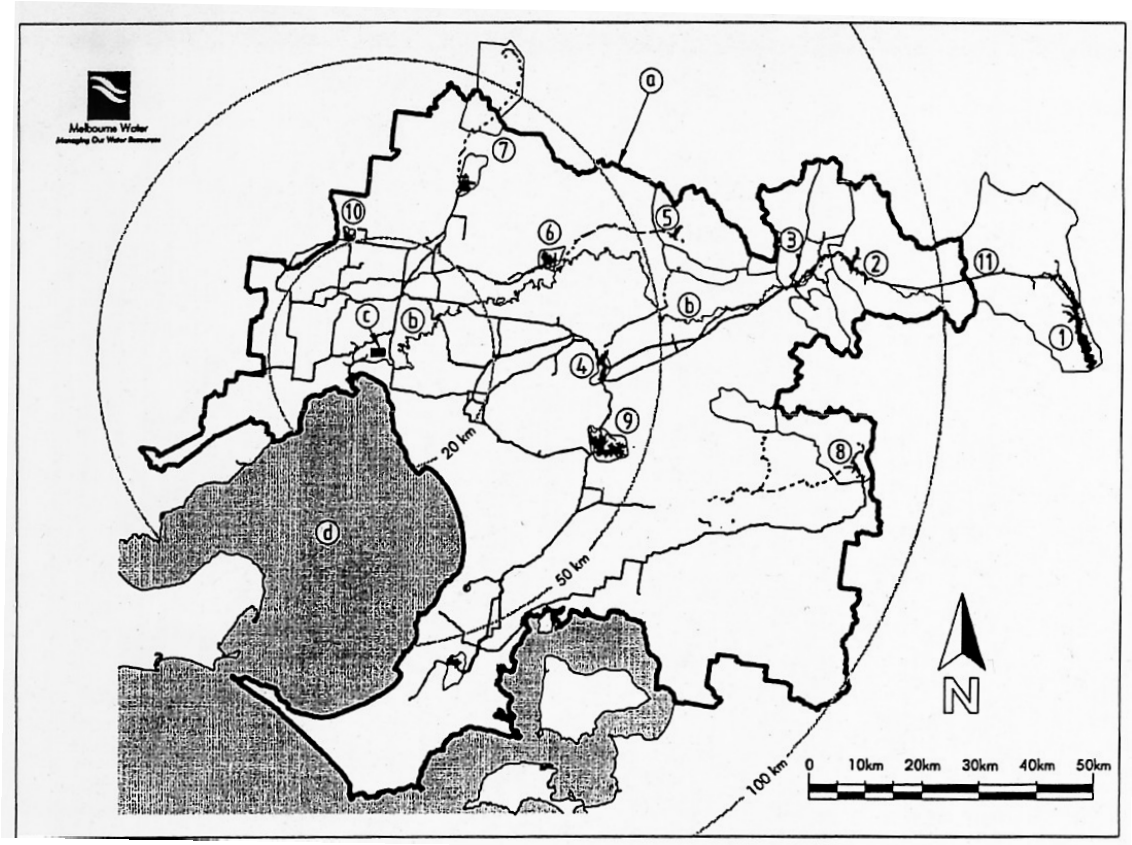
The studies led to the deletion of the Yarra Brae Dam, which it was assessed would lead to significant environmental and social disbenefits, so that the final project comprised only the Sugarloaf Reservoir supplied by pumping directly from the Yarra River.

2. Features of the Project Area

The City of Melbourne is the capital of the State of Victoria located at the south-eastern corner of the continent of Australia, on the lower reaches of the Yarra River.

In 1970/71, when the Sugarloaf Reservoir projects was being planned, the population in the Board's supply area was about 2.3 million and the per capita demand about 385 litres per day; currently (1999/2000) the population served in an enlarged supply area is about 3.1 million and the per capita demand about 440 litres per day.

Water demand in the Melbourne metropolitan area is higher in summer than in winter, particularly due to domestic garden watering in the summer, whilst streamflows are lower in the summer, so seasonal storage is required. In addition, there is a need to provide for inter-annual storage because of the occasional occurrence of droughts when rainfall is low for successive years. Until the 1980's these storages (see Fig. 1) had been provided in uninhabited catchments, including a major storage, the Upper Yarra Reservoir, on the Yarra River.



(1) Thomson Reservoir
(2) Upper Yarra Reservoir
(3) O'Shanassey Reservoir
(4) Silvan Reservoir
(5) Maroondah Reservoir
(6) Sugarloaf Reservoir
(7) Yan Yean and Tourorong Reservoir
(8) Tarago Reservoir
(9) Cardinia Reservoir
(10) Greenvale Reservoir
(11) Thomsom-Yarra Tunnel

(a) MWC Water Supply Boundary
(b) Yarra River
(c) Melbourne Central Business Disitrict
(d) Port Phillip Bay
___ Major water conveyance line

Fig.1: Melbourne Water Supply System

3. Major Impacts

The main issues resulting from the studies of the Yarra Brae-Sugarloaf Project concerned:

(1) streamflow and water quality
(2) vegetation and wildlife habitat
(3) social and recreational effects.

The proposed average abstraction of about 100,000 megalitres per annum amounted to some 17 percent of the river's average flow, estimated to be 590,000 magalitres per day near the Yarra Brae Dam site. Although the proposed rate of abstraction was considered to have only a marginal effect on the quality of the water downstream of the Yarra Brae Dam during normal flows, there was concern that the effect might be significant when river flows were low, especially as some untreated sewage discharges were known to exist downstream of the dam. To counter this, the scheme as proposed made provision for releases to be made, either from the Yarra Brae or Sugarloaf storage, to maintain a minimum flow of 245 Ml/day in the Yarra River immediately downstream of the Yarra Brae dam.

The likelihood of stratification in both the Yarra Brae and Sugarloaf Reservoirs was uncertain, so the study recommended that at each dam provision should be made to draw water off from the most suitable level. The possibility of artificial mixing was also suggested. Although eutrophication was considered to be likely due to high nutrient levels in the Yarra River water. It was expected that the water treatment process could be designed to deal with any taste and odour problems.

The reservoir formed by the Yarra Brae Dam, would extend some 20 kilometres back along the Yarra Valley and inundate some 790 hectares of land predominantly in private ownership, utilised mainly for grazing. Approximately 30% of this area was in its natural tree-covered state, mainly riparian forest. Immediately upstream of the dam the reservoir would drown a steep-sided valley forming much of the "white water" sections of the river. Further upstream the valley widens and the reservoir would be relatively shallow. The loss of the riparian forest would result in a significant loss of habitat for certain species of indigenous wildlife. The inundation of some swamp areas and old river meanders areas in the upper reaches of the reservoir would reduce the habitat for wading and shallow bottom feeding birds, but the reservoir would provide more habitat for certain species of fish.

The Sugarloaf Reservoir would inundate one-third of the riparian vegetation in its catchment and 10 percent of the best class of wildlife habitat. However, this would still leave potential for re-establishment of an increased area of that habitat in the catchment. It was estimated that gressland in the catchment would revert to forest and scrub in 10 to 15 years.

Significantly, there were no endangered species of fauna or flora in either the Yarra Brae or Sugarloaf Reservoir areas.

The social and recreational impacts of the Yarra Brae Dam were very significant. The inundated area plus a "buffer strip" approximately 100 metres wide, which would also have to be acquired, would have displaced residents from 39 dwellings and partially affected the land of several more, including pastoral properties in private ownership. The river and its environs were generally regarded as an attractive recreation area for Melbourne. The "white water" reaches of the river were used by canoeists. As would be expected, there was adverse public comment on the loss of this land and the loss of amenity that would result from the exclusion of the public from the affected reach of the river and its environs.

By comparison, of the social and recreational effects of the Sugarloaf Reservoir were far less severe as there were only a few permanent inhabitants. The study recommended that all public access to the

catchment be prohibited, in accordance with MMBW practice in its other water supply catchments.

4. Mitigation Measures

As a direct result of the submissions received, the study team gave consideration to alternative proposals. On the basis of costs, yields and environmental factors, these alternatives were narrowed down to:

(1) a scheme requiring both the Sugarloaf Reservoir and Yarra Brae Dan with the addition of the small upstream weir to maintain water levels in a shallow area (Fig. 2); and,
(2) a scheme which eliminated the Yarra Brae Dam altogether and provided only a small weir some 20 km upstream, from which water would be pumped to Sugarloaf Reservoir (Fig. 3).

The latter scheme would provide an increment of water suppy of about 73,000 megalitres per annum, compared with an increment of about 100,000 megalitres per annum from the former scheme, but its estimated capital cost was only 75 per cent of the capital cost of the former scheme. The unit cost of the incremental water supply from the latter scheme, which eliminated the Yarra Brae Dam altogether, was therefore only marginally greater.

Having regard to these considerations and the adverse social and recreational impacts which would be caused by the Yarra Brae Dam, the Victorian State Government decided in November 1974 to adopt the alternative scheme eliminating Yarra Brae Dam.

Although the project plan adopted as a result of the environmental study eliminated many of the features considered to be environmentally or socially unacceptable, especially the Yarra Brae Dam, these objectives were kept very much in mind in the detailed design and construction of the project. Some specific features of the project which were designed or modified to avoid or reduce environmental concerns included Fig. 3):

(1) eliminating the proposed weir on the Yarra River, which would interfere with canoeing, prevent the passage of fish, and result in sediment accumulation, by proving, with the aid of a hydraulic model test, that pumping could be satisfactorily carried out without the weir;

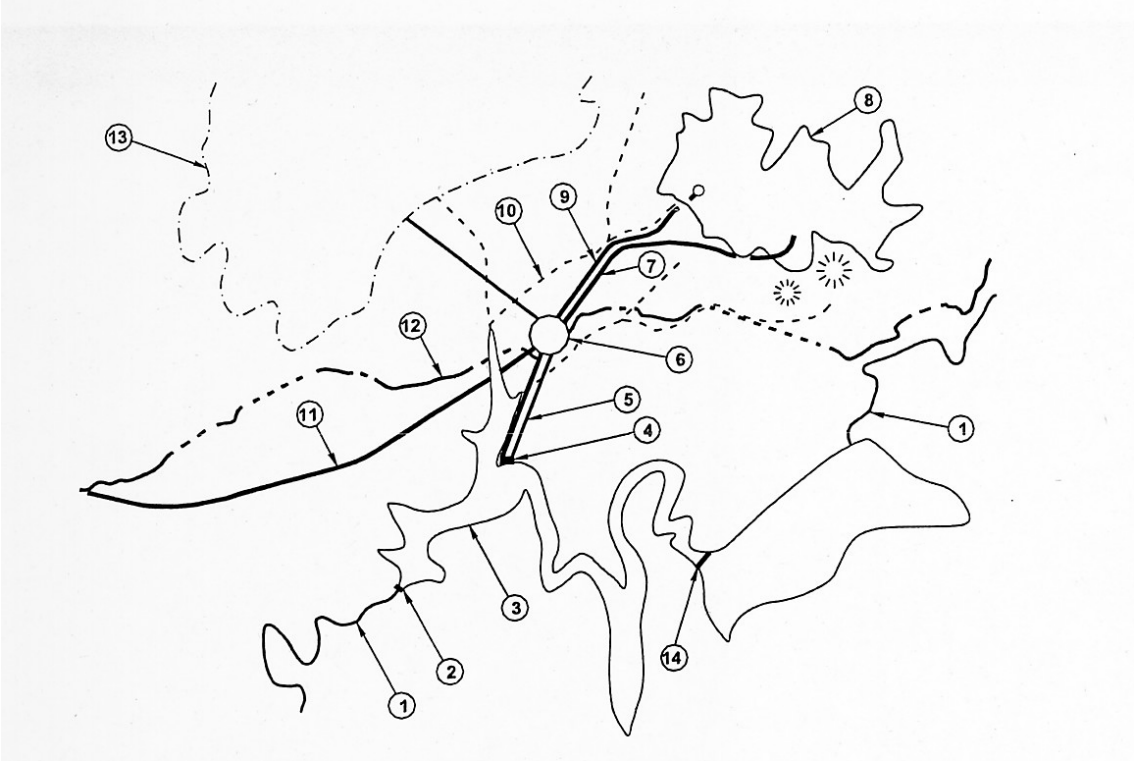
(2) replacing the pumping main conveying water from the Yarra River toSugarloaf Reservoir, initially proposed as a surface pipeline up a steep ridge on a visually intrusive pipertrack from which frees would have to be cleared, by a tunnel through the ridge which would result in greater capital costs but lower operating costs, so that life-cycle costs were similar;

(3) locating the quarry for the dam embankments within the area to be inundated, as recommended in the Environmental Study Report, and designing the dam to accommodate the proportions of weathered and unweathered rockfill that would be obtained; and

(4) providing the water outlet from the reservoir to the treatment plant with a “roller shutter” which would enable water to be drawn off from any level in the reservoir as recommended in the Environmental Study Report.

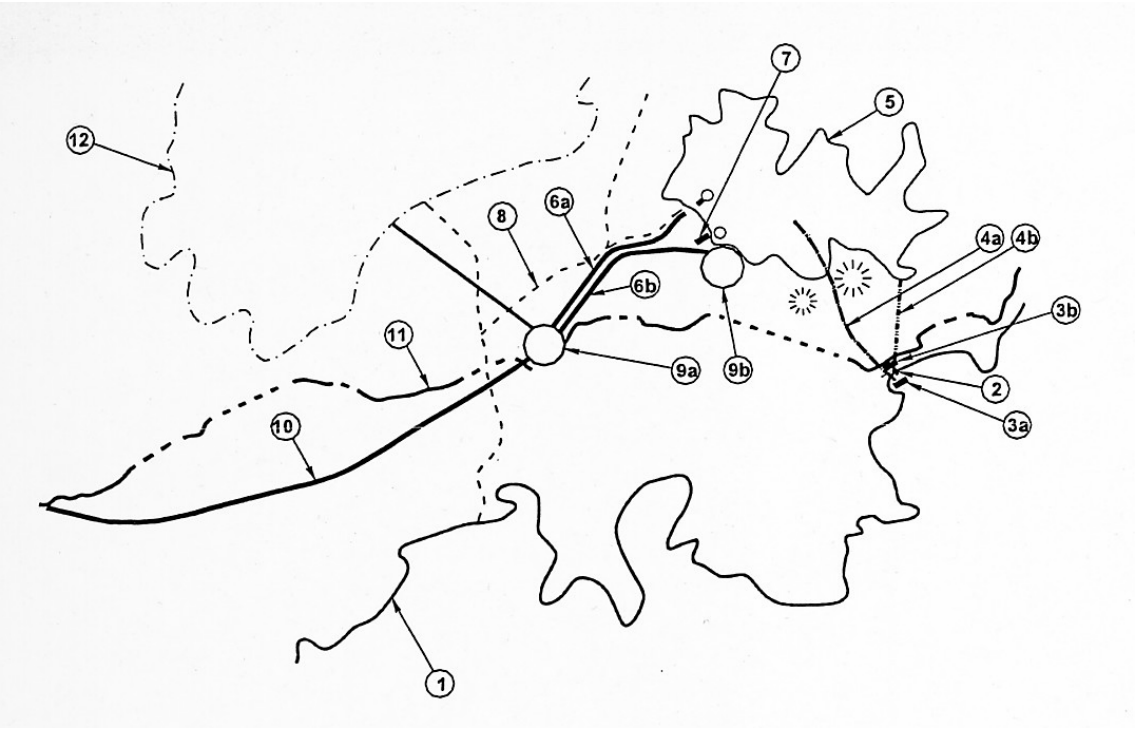
The specifications for construction of the works included a section on environmental care and protection, which required the construction agencies to comply with special requirements to protect the environment. In addition, and perhaps more importantly, construction agencies were required to follow general guidelines on environmental care and protection which were included in the specifications, and referred to as the “Engineer-in-Chief’s Directive”, which gave the objective and broad principles and

responsibilities to be followed, as well as prescriptions.



(1) Yarra River
(2) Yarra Brae Dam
(3) Yarra Brae Reservoir
(4) Pumping station
(5) Rising main
(6) Treatment plant
(7) Reservoir inlet main
(8) Sugerloaf Reservoir
(9) Reservoir outlet main
(10) Sugarloaf Creek
(11) Outlet main to supply
(12) Maroondah Aqueduct
(13) Possible Future Watoson's Creek Reservoir
(14) Weir (modified scheme only)

Fig.2: Yarra Brae-Sugarloaf Project Initial and Modified Environmental Study Schematic Layout



(1) Yarra River
(2) Weir(deleted in final scheme)
(3a) Pumping station(study)
(3b) Pumping station(final)
(4a) Reservoir inlet main(study)
(4b) Reservoir inlet tunnel(final)
(5) Sugarloaf Reservoir
(6a) Reservoir outlet main(study)
(6b) Reservoir outlet main(final)
(7) Reservoir pumping station(final)
(8) Sugarloaf Creek
(9a) Water treatment plant(study)
(9b) Water treatment(final)
(10) Outlet main to city
(11) Marooondah Aquaduct
(12) Possible Future Watson's Creek Reservoir

Fig.3: Sugarloaf Reservoir Project Alternative Environmental Study and Final Schematic Layouts

5. Results of the Mitigation Measures

5.1 Streamflows

In the 18 years from 1981 to 1998 when the Sugarloaf project was in full operation, the average flow in the Yarra River at Warrandyte, a few kilometers downstream of the original Yarra Brae Dam site, would have been about 492,000 megalitres per annum, if allowance is made for abstractions made to Sugarloaf Reservoir. Average abstraction to Sugarloaf Reservoir during the same period was 37,500 megalitres per annum compared with a planned maximum abstraction of about 73,000 megalitres per annum. This is less than 8 per cent of the present estimate of average river flow, whilst the planned abstraction was 17 per cent of average river flow as then estimated.

As recommended in the Environmental Study Report, provisions were made in the design of the project to release water from Sugarloaf Reservoir into the Yarra River to maintain a minimum flow of 245 Ml/day near the original Yarra Brae Dam site in times of drought, in order to assure satisfactory water quality. In practice, an alternative approach has been adopted based on monitoring of the flow in the Yarra River at Warrandyte, as well as an upstream station in the river below the Upper Yarra Dam and tributaries which are normally diverted to supply. Firstly, abstraction to Sugarloaf Reservoir is stopped if the flow at Warrandyte would otherwise fall below 245 Ml/day. Secondly, diversions to supply from tributaries of the Yarra River further upstream are stopped if the flow at the upstream station would otherwise fall below 98 Ml/day. In addition, minimum environmental flows are released at all times from all the storage dams and diversion weirs upstream of the abstraction point to Sugarloaf Reservoir. These and other measures have resulted in significantly higher minimum river flows in a recent drought than previously observed in droughts of similar severity. Water quality in the river is expected to continue to improve, especially as there has been a significant reduction in untreated sewage discharges into the river since the Environmental Study was carried out.

5.2 Reservoir Water Quality

Since the Sugarloaf Reservoir has been in operation, an air bubbling system has been in operation, at a well chosen point in the reservoir, particularly to remove manganese and iron compounds in the stored water by oxidation. This has caused sufficient mixing to avoid significant stratification so that there is very little difference in water quality over the whole operating depth range in the reservoir. There has been no indication of eutrophication taking place and it is not expected as long as aeration is commenced as required.

5.3 Vegetation and Habitat

In the inundated part of the catchment, natural revegetation is taking place very slowly in previously fertilised grassland. Although a 1.8 m high exclusion fence surrounds the catchment, indigenous mammals are seen within it. The reservoir was stocked with redfin but this has not continued, and fishing with organic bait is no longer permitted to minimise water quality concerns. “European” carp have developed naturally in the reservoir although not as yet to damaging populations.

5.4 Public Access to the Sugarloaf Reservoir Catchment Area.

Although the Environmental Study Report recommended that public access to the Sugarloaf Reservoir catchment should be prohibited even though the water is fully treated, two areas above the reservoir full supply level were developed as public picnic areas, from which all drainage was diverted out of the catchment. These areas are provided with toilets, potable water supply and berbecues. In addition,

following a study conducted by Melbourne University, sailing is now permitted under the control of a sailing club, and fishing is permitted off the bank of the reservoir at designated areas. These public access facilities are currently under review for water quality reasons.

6. Reasons for Success

The use of the project developer's own staff to carry out such studies has been questioned in recent years as leading to bias in favour of the project. The Melbourne and Metropolitan Board of Works (MMBW) had no option but to adopt this course as there were very few independent external resources available in Melbourne at that time. The absence of bias in the study was largely due to the professionalism of the staff, and MMBW's (and the State Government's) commitment to environmental and social equity. The commitment was demonstrated by the State Government's willingness to adopt a modified Sugarloaf Reservoir project which was not as productive nor quite as economic as the original Yarra Brae-Sugarloaf scheme.

The inclusion of engineers in the environmental study team proved to be of merit, as it enabled appropriate solutions to environmental problems to be developed during the study rather than leave them as unresolved issues as often happens.

The development of the projects without major public controversy has shown the essential need to involve the public in the early planning stages of a project. It is also important to provide the public with full information about the proposals, adequate facilities and study time, and the opportunity to ask for further information and dialogue with the study teams. Whilst fully considered preliminary plans of the projects are required to form the basis of public consultation provision must be made for changes to these plants during and as a result of public comments, even quite major ones as occurred with the Sugarloaf Reservoir project.

Consideration of environmental issues during the implementation stages of the projects was ensured both by the informal encouragement to all those involved to observe the sprit of environmental care, and the setting up of Environmental Committees during the design and construction stages, as well as by prescription in the construction contracts. With regard to the latter the issue of guidelines, rather than only legalistic specifications, were found to be beneficial.

Monitoring of environmental concerns identified in the environmental studies is being carried out during the operation of the schemes, but these have been modified where necessary to fulfil the intent rather than the strict requirement of the study reports, eg. with respect to the maintenance of minimum flows in the Yarra River.

