Urban waterway restoration: Daylighting Dandenong Creek

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Key Points

- Urban waterways have suffered from altered hydrology, water quality degradation, channelisation and piping.
- Efforts are now being made to improve the ecological condition and amenity of urban waterways through a range of activities including stormwater management, channel works and daylighting.
- Re-creation of natural waterway features represents just one part of urban waterway restoration, and is often constrained by adjacent land use and the need to still provide flood protection.
- However, catchment based activities to help mitigate hydrological and water quality impacts are required in order to achieve effective urban waterway restoration.

Abstract

Dandenong Creek, in the eastern suburbs of Melbourne, is a highly modified urban waterway with varying sections of natural stream, constructed earthen channel, concrete lined channel and underground pipe. Melbourne Water, in partnership with the Environment Protection Authority and local councils and community groups is undertaking a program of works to improve the aesthetics and environmental health of a section of the creek between Bayswater and Wantirna through the Enhancing Our Dandenong Creek (EODC) project. This involves re-engaging the creek with parts of its floodplain and daylighting an 800 m length of creek that was piped in the 1960s when major urbanisation was taking place. This paper discusses the design process for the daylighting of Dandenong Creek.

The design process involved a staged approach whereby cultural and ecological studies were undertaken upfront in conjunction with geotechnical and contaminated land studies. These studies aimed to determine the limitations for recovery of this reach of creek while identifying key design criteria for the re-constructed waterway. Once these criteria were determined, a proposed alignment and conceptual design features were presented to stakeholders for consideration.

There are limitations on the restoration potential for the waterway, however the works will provide localised ecological improvements, improved amenity and reduce risk to further degradation in downstream reaches, and once achieved, will represent one of the first examples of daylighting an urban waterway in Australia.

Keywords

Urban waterway restoration, daylighting, waterway design processes

Introduction

Urban development has a profound impact on the ecology of waterways, mainly due to increased catchment imperviousness and consequent impacts on stream hydrology (Walsh et al. 2005). Conventional urban stormwater drainage systems have been designed to efficiently pipe rainfall runoff to the nearest waterway, increasing the frequency and volume of peak flow events (Burns et al. 2012). Waterways have also been channelised and piped to further improve hydraulic conveyance and minimize flooding impacts. Conventional stormwater drainage design is now being challenged and efforts are being made to restore urban waterway health. This paper discusses the design process for restoration of a reach of Dandenong Creek, near Bayswater in the eastern suburbs of Melbourne, specifically the daylighting of an 800 m section of piped creek (Figure 1).

Dandenong Creek is a highly modified urban waterway with varying sections of natural stream, constructed earthen channel, concrete lined channel and underground pipe. Melbourne Water, in partnership with the Environment Protection Authority and local councils and community groups is undertaking a program of works to improve the aesthetics and environmental health of a section of the creek between Bayswater and Wantirna through the Enhancing Our Dandenong Creek (EODC) project. This involves re-engaging the creek with parts of its floodplain and daylighting a section of creek that was piped in the 1960s when major urbanisation was taking place.

The project aims to improve the natural amenity of the creek, maintain or increase flow capacity, create a more natural planform, and improve riparian and instream habitat and general creek health. The design for daylighting Dandenong Creek was a staged process that involved a review of background information (historical channel features, ecological values and cultural heritage), on-site investigations (geotechnical, contaminated land, flora and fauna and cultural heritage site assessments) and hydraulic analysis to identify values and threats/risks that would influence constructability of the new channel. The outcomes of these assessments informed the development of a concept design and constructability report. Following stakeholder feedback, a functional design and costing was then completed.

Figure 1. Dandenong Creek study reach

Historical Channel Features

Pre-development drawings of Dandenong Creek indicate it was characterised by a sinuous planform featuring a shallow low-flow channel 3-7 m wide and 0.5-1.2 m deep within a narrow, 25-35 m wide floodplain (Figure 2).

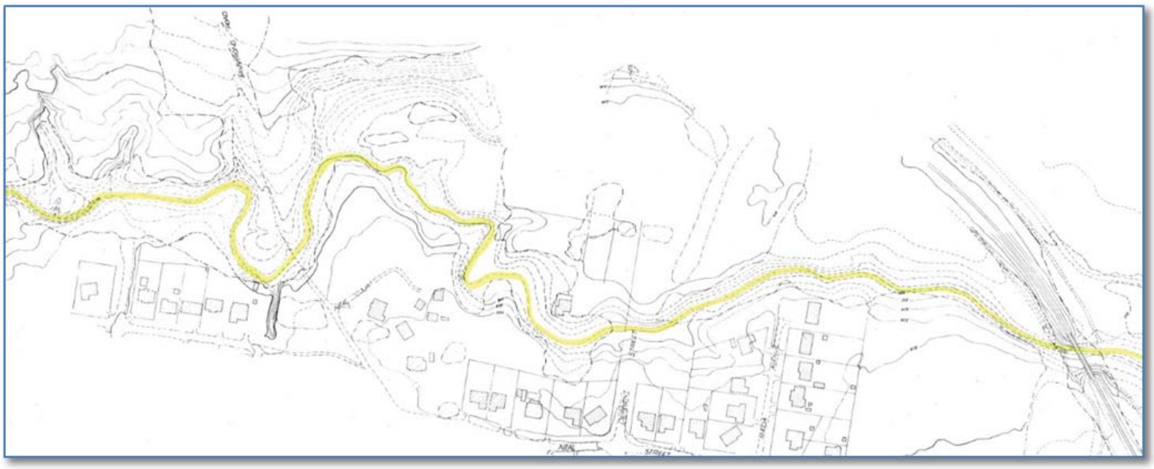

Figure 2. Plan of Dandenong Creek at the project site prior to channelization and piping in the 1960s (from Dandenong Valley Authority, 1966).

The creek was de-snagged, channelised and in some sections piped in the late 1960s. This was to improve the hydraulic capacity of the creek and reduce flood risk to newly developed suburbs. In the study area, the creek consists of a low flow pipe overlaid by a broad grassed trapezoidal channel for conveying high flows (Figure 3). The resulting channel is shorter and steeper (Table 1), and with lower roughness, which efficiently passes flows downstream.

In designing a new channel for this reach it was important to look at the pre-channelisation geometry and identify opportunities to replicate these features, while recognising that site constraints such as public open space, land use, and stormwater drains limited the opportunity to return the channel to its original course. Also, an increase in peak flows due to catchment urbanisation means the new channel needs to be able to convey a larger flow volume than the original channel geometry would allow without causing flooding.

Figure 3. Dandenong Creek showing the existing low-flow pipe outlet and grassed high-flow channel

Table 1. Current and natural channel characteristics

Parameter	Current channel	Natural creek (pre-1960)
Channel length	802 m	1042 m
Floodplain / valley length	740 m	740 m
Sinuosity	1.08	1.41
Bed grade	0.33%	0.26%
Low flow carrier	1050 / 1200 mm RC pipe, 780 m long	Trapezoidal channel (6 m wide, 0.8 m deep)

Existing values of the reach

A review of flora and fauna databases and survey reports identified the potential for the presence of a number of threatened flora and fauna species and ecological communities in the study area that if present would need to be considered in the design and construction of the new channel. Site assessments revealed that due to the historical levels of disturbance, current values are restricted to a few locations adjacent to the creek corridor and comprise small patches of remnant native vegetation associated with mature overstorey trees (Swamp gum, Manna gum, and the rare Yarra gum) that are present on what would have been the original course of the creek. The location of these trees and associated understory vegetation were incorporated into the proposed alignment of the new channel.

There is limited ecological value within the piped section of the creek itself, however, downstream of the piped section the creek comprises an open, albeit modified, channel that comprises shallow pool habitat separated by rock grade-control structures. No fish surveys have been conducted in this part of the system, however, it is probable that the creek supports common native fish like Short-finned eel and Common galaxias. Removing the piped section will benefit these species by improving fish passage between downstream and upstream reaches. Furthermore, during site inspections, long-neck turtles and a number of common frog species were recorded, and it is also possible that the creek environments support Rikali (native water rat); all of which would benefit from the daylighting. Habitat needs, including provision for fish passage, deep and shallow water depths and slackwater areas, are important design features for the new channel to maximise habitat value for a range of aquatic fauna.

Constraints to Restoration

A number of geotechnical and contaminated land investigations were completed in order to understand potential constraints on how the new waterway might be constructed. Investigations revealed potential soil stability issues for batter slope construction, heavy metal contamination of excavated material and high levels of leachable zinc in the soil surrounding the pipe which could contaminate surface waters downstream of the reach.

More significantly, adjacent land use and the need to maintain flood conveyance means that 1) the new channel cannot follow the original channel alignment and 2) cannot re-create the original channel dimensions, which would be too small to convey the increased volume of stormwater runoff due to urbanization and increased catchment imperviousness.

Design Features

In progressing the design for the new channel constraints were addressed through identification of an alignment predominantly within the existing channelised alignment, yet following the original meander pattern where possible, and adoption of a channel geometry that balanced the need to generate low shear stresses in order to revegetate the new channel yet maintaining hydraulic conveyance to prevent an increase in flood levels.

To maximise the potential for ecological improvement, the channel alignment incorporated existing native vegetation in to the new riparian zone and included improved fish passage and a range of deep and shallow aquatic habitats for fauna such as fish, frogs, turtles and rikali.

The following describes in more detail aspects of these required design features.

Channel Form

A two-stage channel configuration comprising a low flow channel and higher flow terrace, was adopted for the reconstruction of the creek (Figure 4), replicating the natural creek characteristics, and also other developed sections of Dandenong Creek that have remained an open channel. A two-stage configuration has the benefit of maintaining necessary scour velocities during low or normal flow conditions, reducing the potential for stagnation, yet maintaining hydraulic capacity for larger flow events.

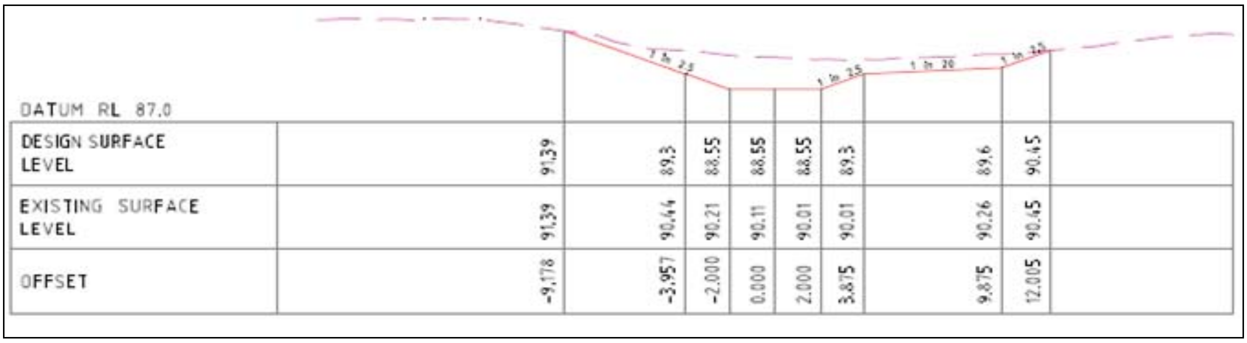

Figure 4. Example cross-section.

Due to the encroachment of residential development on the southern side of the site, there is a limit in the amount of construction room available and also on the number of meander bends that can be incorporated into the design. Hence, two rock chutes are included in the design to help control bed gradient.

Hydraulic Analysis

Hydraulic design criteria and parameters were developed with reference to recommended design limits for in-channel stream power, velocity and shear stress associated with the 1 in 2 year annual exceedence probability (AEP) (DSE 2007). An important factor when considering the 1:2 year AEP is that it is likely this event will be exceeded prior to the establishment of revegetation. In constructing new waterways there is a major risk of erosion, particularly on outside bends prior to vegetation establishment. Hydraulic modelling revealed that high velocity and shear stresses were likely on some outside bends. Hence erosion protection in the form of rock riprap, and in some locations, bed-armouring will be needed.

Hydraulic analysis was also used to show that the new channel would not result in increases flooding for a range of recurrence events. In fact, flood levels are significantly reduced in the vicinity of the new channel due to an overall increase in channel capacity compared with the current pipe (see Figure 5 for relative change in flood levels for the 1% AEP).

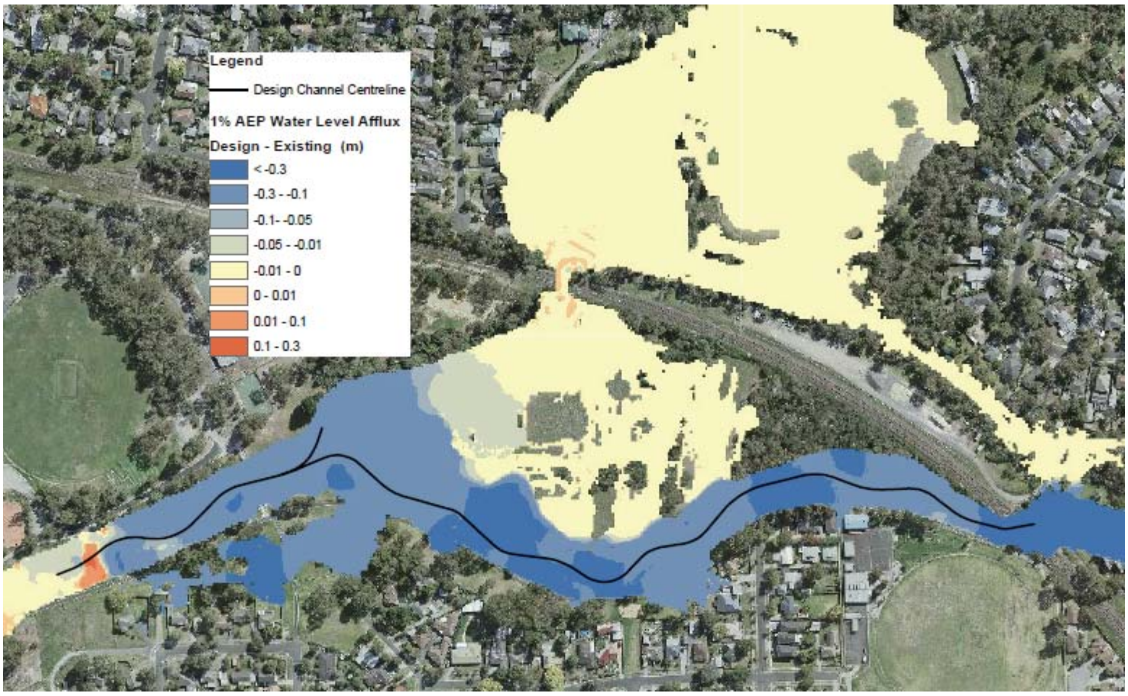

Figure 5. Change in 1% AEP water level between the current piped situation and proposed new channel.

Ecology

Design features were included to provide for vegetation and habitat retention and improvement opportunities, including:

- habitat features like rock chutes, deep pools, shallow riffles and benches;
- a range of habitats with varying exposure to inundation to facilitate the return of riparian and swamp understorey vegetation (predominantly sedges, rushes) that is currently absent from the creek;
- protection of Yarra Gums by constructing an alignment that utilises them to shade the creek and avoids disturbance to their root zones;
- revegetation with indigenous (preferably local provenance) species including trees, shrubs and groundcover species such as sedges, shrubs and native grasses and herbs; and
- implementation of an appropriate weed control program prior to construction to reduce the occurrence of weeds in the topsoil.

However, substantial improvement in the overall ecological health of Dandenong Creek is unlikely to be achieved until catchment based activities are adopted that address the hydrological and water quality impacts associated with urbanisation, namely catchment imperviousness and stormwater runoff (Figure 6).

Figure 6. Stormwater input to urban waterways represents a major challenge to waterway restoration.

Design consultation

Throughout the design process, consultation was held with Melbourne Water, local councils and community groups. Stakeholders were provided with opportunity to provide input through on-site meetings and review of design products such as alignment and landscape plans (see Figure 7).

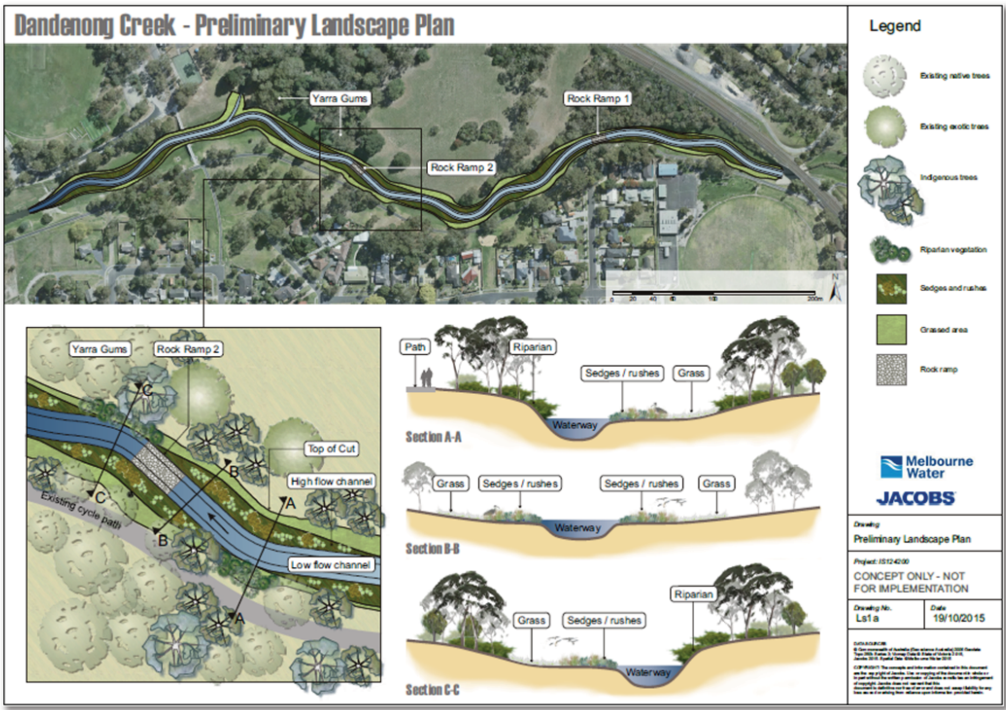

Figure 7. Preliminary landscape plan.

Conclusions

Urban waterway design requires a range of issues to be considered including site constraints, geotechnical requirements and contaminated land assessment. The design for Dandenong Creek was able to address these issues and provide a stable waterway with characteristics of a natural waterway that incorporate existing ecological and social values, hence achieving the project aim of improving local aesthetics and amenity.

However, the ability to achieve substantial ecological and water quality improvements in Dandenong Creek is limited by the effect that urbanisation has had on hydrology, particularly an increased frequency of high flows. Catchment based activities to help mitigate hydrological and water quality impacts are required to augment the physical waterway improvement if effective urban waterway restoration is to be achieved.

Acknowledgments

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