water e-journal
Online Journal of the Australian Water Association
ISSN 2206-1991
Volume 1 No 4 2016
http://dx.doi.org/10.21139/wej.2016.039

USING MARKET BASED INSTRUMENTS TO DELIVER COST-EFFECTIVE STORMWATER MANAGEMENT OUTCOMES

HOW MELBOURNE WATER, SOUTH EAST WATER AND KNOX CITY COUNCIL WORKED TOGETHER TO ACHIEVE STORMWATER QUALITY AND FLOW OBJECTIVES FOR DOBSONS CREEK

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ABSTRACT

This paper summarises the results of a stormwater disconnection market-based instrument (MBI) pilot, an outcome-based tender for installing rainwater tanks on homes in Dobsons Creek.

The MBI will disconnect 6,500 square metres of roof area on private homes from the stormwater system that drains into Dobsons Creek. Disconnection will benefit the Creek by reducing untreated stormwater runoff by around 2.2 million litres on average each year.

The Dobsons Creek pilot shows carefully designed and market tested MBIs have potential to be an important part of the waterway and catchment management toolbox.

The pilot suggests that waterway objectives in the Dobsons Creek catchment can be most effectively achieved with a mix of works on public and private land. It also shows that MBIs have the potential to deliver more cost effective outcomes compared to other funding mechanisms.

INTRODUCTION

Urbanisation, urban density and population growth are increasing hard surface areas and stormwater runoff across Melbourne. Conventional drainage of urban stormwater runoff degrades streams and rivers by increasing the frequency and magnitude of storm flows, delivering polluted water to streams after any rain, and by contributing to reduced base flows by reducing infiltration into soils (Walsh et al. 2016). The net effect is a substantial increase in the volume (and decrease in quality) of water running to streams (Walsh et al. 2012).

As part of delivering its waterway and drainage obligations, Melbourne Water works with the 38 Councils in its operating area to deliver on-ground stormwater treatment works. Historically, Melbourne Water has focussed on delivering stormwater treatment works together with Council on Council land, and on land owned or operated by Melbourne Water.

More recently, Melbourne Water has been working with homes and businesses in Melbourne to deliver stormwater treatment at the lot scale. There are several reasons for pursuing this type of strategy of varying importance among catchments:

1. Runoff from household and commercial roofs and other impervious area has to be disconnected to achieve stormwater flow and quality targets.
2. There is limited public land available for stormwater works. Public sites may not be suitable to stormwater treatment works for technical or community safety or preference reasons.
3. Stormwater treatment at the lot scale may be a more prudent, cost effective and efficient means of Melbourne Water achieving its stormwater objectives.

4. Councils may have limited capacity to operate and maintain public stormwater treatment assets. Locating stormwater treatment works on private land may provide Melbourne Water with opportunities to operate and maintain these assets in cooperation with the landowners.

This paper reports the results of a market-based instrument (MBI) pilot, an outcome based tender, for installing rainwater tanks on homes in Dobsons Creek. The creek runs through the peri-urban community of The Basin, which is located 31 kilometres east of the Melbourne CBD, at the foot of the Dandenong Ranges.

Melbourne Water, South East Water and Knox City Council (KCC) have been working together to achieve KCC's stormwater quality and flow objectives for Dobsons Creek. To achieve KCC's target of reducing direct connected impervious (DCI) area in Dobsons Creek catchment to less than 1% by 2020, disconnection needs to occur on public and private land.

Melbourne Water has worked with Knox to deliver stormwater treatment works on public land, and with South East Water to deliver stormwater treatment works at the household scale with property owners.

In Stage 1 of the project, property owners in the upper Dobsons Creek catchment were offered standardised stormwater treatment systems (tanks plumbed for internal use) free of charge. Stage 1 of the project delivered effective works on around 20% of eligible properties.

In Stage 2, due to the traditionally low uptake of community participation in environmental projects, Melbourne Water wanted to test the potential for the Dobsons project to increase the prudency, efficiency and effectiveness of its program delivery by implementing an outcome-based tender approach.

The objectives of this MBI pilot were to:

- Test an alternative approach to allocating project funding to property owners for stormwater management outcomes
- Increase the level of knowledge and understanding among Melbourne Water staff on alternative models for delivering projects
- Present the advantages and disadvantages of the tender-based approach in relation to the direct funding (free of charge) approach
- Identify when MBI outcome tender based approaches are suitable for waterway management.

Melbourne Water, Knox City Council, South East Water worked with Marsden Jacob Associates and the University of Melbourne to design and implement the MBI pilot.

APPROACH

MBI Approach and Why We Chose It

We delivered Stage 2 of 'Tanks for Helping Your Creek' with a single round, multi-unit, sealed bid, budget-constrained, discriminatory price auction, with an undisclosed reserve price.

In this type of auction households submit a single best and final offer towards the costs of installing rainwater tanks in their home. The bids are due by a closing date. When making their bids, home owners were aware that: Melbourne Water had a limited budget; that they were in an auction market with other households in the Basin also competing to have tanks installed; that if they bid below Melbourne Water's minimum acceptable bid (the reserve price) they would not win at the auction; and that they could miss out on having a tank installed if they were outbid by other households taking part in the auction.

Some of the key design features of the auction were that it was:

A single round auction.
Auctions can be run as a single bidding round or in multiple rounds. We chose a single round as it was easier to implement, and involved lower administration costs for Melbourne Water.

Moreover, it was not clear from the auction design literature and previous experience that a multiple round auction would deliver efficiency gains. There is strong evidence that bidders learn in auctions over time (Rolfe & Windle, 2008).

This learning can be good if bidders build up a greater understanding over time of what they are willing to accept for providing the environmental service. The flip side of this is that learning can result in bidders behaving more strategically to capture rents and/or learn about the buyer's valuation of the ecological good.

Multi-unit.
MBIs for conservation outcomes are called 'multi-unit auctions of a heterogeneous item'. What this means is that Melbourne Water is purchasing multiple units of different actions (rainwater tank specifications, roof areas, and stormwater connectivity to Dobsons Creek) that lead to a targeted environmental benefit outcome.

Discriminatory price.
In a discriminatory price auction each bidder submits a bid stating the price they are willing to receive per unit of a good, and the number of units they are willing to sell at that price. The lowest bid is selected first, followed by the second lowest bid and so on until the target is achieved or the budget is exhausted. In a discriminatory price auction each successful bidder receives the value of their bid.

Sealed bid.
Sealed bidding refers to a situation where bidders submit bids that are not revealed to other auction participants. Evidence shows that sealed bidding in discriminatory price auctions can increase competition between auction participants.

Budget-constrained.
Auctions can be conducted either with a fixed budget (which is the norm) or, alternatively, with a fixed target.

In a budget constrained auction the agency accepts bids based on their benefits to bid ratios until a predetermined fixed budget is exhausted.

In the target-constrained auction the agency predetermines the size of the conservation scheme and accepts bids until the target is achieved. In this case, the budget needed to fill the target is not known until the auction is completed.

Undisclosed reserve price. In our auction the reserve price was a minimum amount that Melbourne Water wanted households to pay towards having rainwater tanks installed.

We used an undisclosed reserve price to create a minimum price floor. By not knowing the reserve, households were encouraged not to shade their bids (i.e. underbid). Evidence suggests that not disclosing the reserve price results in auction participants bidding closer to their real willingness to pay.

Implementation

'Tanks' Stage 2 used a simple and low cost tendering approach, building on lessons learned, approaches and tools developed for the 'Tanks for Helping Our Creek' Stage 1 program, the Little Stringybark Creek rainwater tank tenders run by Melbourne University (Bos and Brown, 2015), and international and Australian best-practice MBI design principles.

Stage 2 was supported by a low-cost direct marketing campaign involving letter drops, phone calls and door knocks. The MBI delivery model was established using a minimal viable product model (Lean Start Up methodology) to test four key project hypotheses:

- people still wanted tanks in homes (even after Stage 1 was complete)
- people were prepared to pay for tanks (even after Stage 1 offered tanks at no cost)
- payment would be made over phone using credit card or periodic payment
- people would make meaningful bids ($500+ per household).

Live market testing demonstrated:

- people still wanted tanks in homes (those who already had tanks wanted more)
- people were prepared to pay for tanks and cited numerous benefits to owning tanks
- people offered to pay via credit card over the phone
- highest single recorded bid was $1,000.

Priority areas for the tender were properties connected to the stormwater drainage system upstream of reaches being monitored for ecological response (Zones 1, 2, Fig. 1). Zone 3 was not a priority as it was largely disconnected by a large bio-retention system (Wicks, Fig. 1).

All households within priority zones 1 and 2 were eligible to participate, including households that already had rainwater tanks (including those from Stage 1).

Households could have one or more of a 2,000, 3,000 and/or 4,500 litre rainwater tank installed on their property. Rainwater tanks were plumbed into the home with associated site preparation, pump and switching systems, leaf eaters and electrical work. Slimline tanks were offered. Uses for the rainwater were garden irrigation, laundry and toilet.

The MBI pilot used an innovative outcome-based approach that prioritised tender bids based on an Environmental Benefit Index (EBI) for Dobsons Creek. EBI was calculated based on changes in flow-frequency, volume-reduction, and water quality resulting from the tank, standardised to 100 m2 (complete disconnection of 100 m2 of impervious surface = 1 EB: Walsh et al. 2015).

Bids received from homeowners were assessed based on a '$ per EB' measure. The $/EB measure was the net cost to Melbourne Water per EB gained by disconnecting roof area from the house. The net $/EB was calculated as the cost of installing the tank minus the household contribution, divided by the number of EB that disconnection would achieve.

The information needed to calculate the $/EB was estimated for each household by a licensed tradesperson during a pre-bid site visit. The tradesperson estimated the roof catchment area and agreed on the tank and plumbing setup with the owner. Following the site visit the tradesperson estimated the cost of tank installation. The tank setup and costing information, along with the roof catchment area information was used to estimate the maximum achievable environmental benefit (EB) score for the house.

Households were then sent an information pack about the 'Tanks' program including details of the offer. The offer identified that Melbourne Water was running an auction; that there were limited funds; and that Melbourne Water had a minimum reserve price. Households were told how much rainwater their tank would capture on average, and how much they would save on their annual water bill each year on average from their tank setup. Households were also told the full cost of installing the tank. Households used the offer pack information to submit a bid by the auction close date. Bids received from homeowners were assessed based on the $/EB measure discussed above.

The reserve price was set by comparing the $/EB for household stormwater disconnection with the lifecycle cost of current and future projects that disconnect stormwater using works on public land in the Basin. These lifecycle costings were based on findings from the Little Stringybark Creek project (Bos and Brown 2015) and costs provided by KCC.

Homeowners who made successful bids entered into a memorandum of understanding with Melbourne Water.

Under the terms and conditions and MoU the households who are having tanks installed:

- Agree to maintain, at their own cost, all equipment installed as part of the Stormwater Fund, including any accessories required for the daily operation of that equipment in accordance with the design requirements.
- Agree to ensure that the equipment and the captured stormwater is used appropriately and responsibly
- Will allow Melbourne Water to conduct an annual check of the tank for the first four years of operation to ensure that the installed system is operating properly. At these visits Melbourne Water can recommend maintenance works, but the homeowner will be responsible for undertaking the work.

The monitoring and evaluation plan of the tender will be run in two parts. The objective of this plan is to ensure that the Dobsons MBI is delivering expected outcomes, and also to check how the auction and tank installation performed.

The first part of the evaluation is a post-implementation review. The post-implementation review is done about three months after the rainwater tanks are installed. It evaluates participants' satisfaction levels with the auction and tank installation process.

The second part of the evaluation should be run for two to three years into the program, focussing on landholder compliance with the contracts; whether there are measurable reductions in pollution loads; and whether these are in line with modelled expectations, after accounting for exogenous factors.

Table 1: Dobsons Creek disconnection summary for 'Tanks' Stage 1 and 2 and Knox Public Works

Priority	Total	1	2	3
Location		Upstream DBS4	Downstream of Wicks Reserve and upstream of DBS8	Upstream of Wicks Reserve, Disconnected catchment
Total area (ha)				
Total impervious area (ha)	12.2	6.2	1.1	4.9
Road area (ha)	3.6	1.5	0.7	1.4
Paved area (ha)	2	1.1	0.1	0.8
Roof area (ha)	6.6	3.6	0.3	2.7
Properties (no)	428	229	38	161
Knox public works				
Total impervious area disconnected (ha)	0.8	0.1	0.7	-
Environmental benefit (EB)	695	249	446	-
Average cost per impervious area disconnected (sqm)	$154	$270	$141	$ -
Average cost per EB	$1,723	$869	$2,199	$ -
Stage Two Outcomes				
Total impervious area disconnected (ha)	0.7	0.6	0.1	-
Properties treated	33	31	2	-
Environmental benefit (EB)	64	59	5	-
Water provided by rainwater tanks to the home in an average year (kL)	2,200	2,037	163	-
Roof area treatment efficiency %	96%	96%	99%	-
Average cost per impervious area disconnected (sqm)	$45.5	$45.5	$48.5	$ -
Net average cost per impervious area disconnected (sqm): net of household payment	$42.6	$42.5	$46.5	$ -
Net average cost per EB: net of hh payment	$4,768	$4,652	$6,127	$ -

RESULTS

Participation

Half of wall households who were contacted and who were 'in the market' for a rainwater tank accepted the site visit.

Bids were received from 53 of the 63 households that received site visits. Of these 53 households, bids were accepted for 39 properties that represented value for money for Melbourne Water, based on cost effectiveness comparison with the cost of delivering stormwater disconnection on public land in the Basin. Subsequent to having their bids accepted, six households withdrew from the program due to changed circumstances.

Auction Outcomes

Outcomes for 'Tanks' Stage 2 and Dobsons Creek public works are shown in Table 1. Key results from the Dobsons Creek 'Tank's Stage 2 and the program overall are:

- **Stage 2 of the 'Tanks' program disconnected 0.7 ha of impervious roof area from the stormwater system that runs into Dobsons Creek at an average cost to Melbourne Water of $45 per square metre.** This builds on the 1.8 ha of roof area that was successfully disconnected in 'Tanks' Stage 1 at a cost of $67 per square metre, and the 0.8 hectares of impervious area disconnected with public works at a cost of $154 per square metre.
- **The average capital cost per unit of EB for the 'Tanks' Stage 2 is in the order of $4,750, net of the household contribution.** Comparison EB figures are not available for Tanks Stage 1. Based on a comparison of the disconnection areas and costs, we would expect that Stage 1 EBs would have averaged around $6,500 capital cost per EB. The average capital cost per unit of EB for public works is $1,725 per EB. The average EB dollar capital cost in real terms is in the order of $1,850 per EB.
- **The EB maximising investment in stormwater works with a limited budget combines public and private works.** Fig. 2 shows that after the Wicks public project (Fig. 1), the average dollar cost of public and private works of the asset lifecycle is comparable, and that the optimal investment given a limited budget is a combination of public and lot scale works (assuming these assets all perform as intended and deliver their estimated maximum EB).
- **Households placed meaningful bids and paid meaningful amounts.** Households' average winning bid was $622, with a $100-$1,000 bid spread.
- **The rainwater tanks installed by Melbourne Water in Stage 2 will capture about 2.2 million litres of roof runoff in an average year.** This water will be used for flushing toilets, watering gardens, and in washing machines. Households will save around $200 a year in water bills, on average, by substituting rainwater for mains water. All tanks include a dripper hose that will slowly release water into an adjacent garden or grass area to reduce overspilling risk.
- **All households have agreed to maintain the rainwater tanks to achieve their stormwater quality outcomes.** This includes allowing monitoring of the tanks in the three years after installation to ensure that the rainwater tank is operating as a stream protection asset.

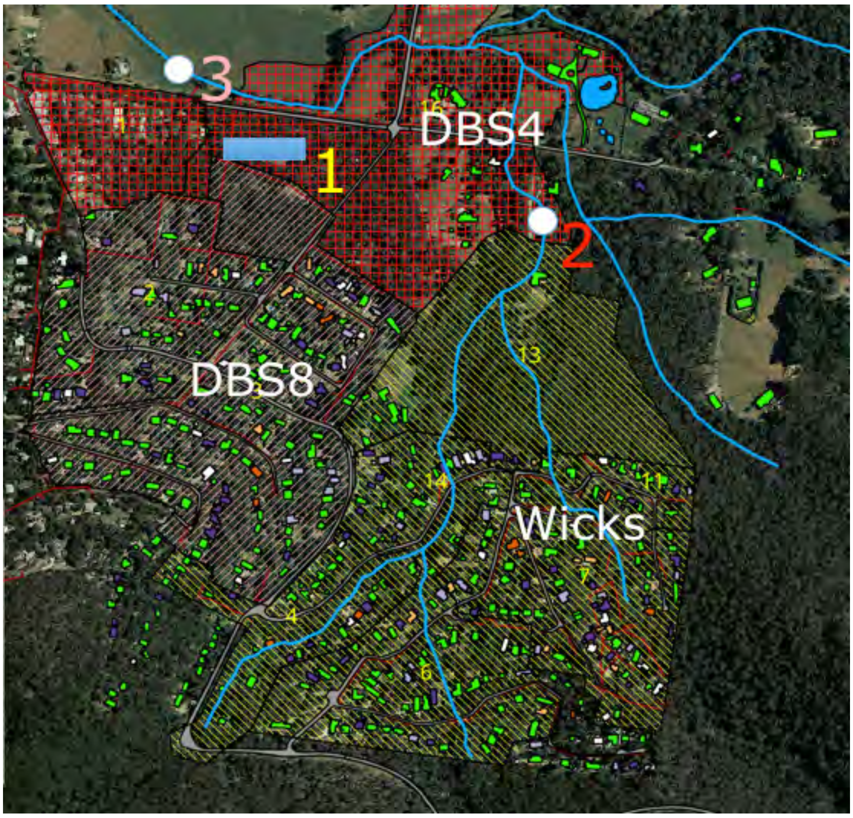

Figure 1: Dobsons Creek catchment boundaries and priority areas
Priority areas 1 = upstream of DBS4 monitoring station; 2 = Downstream of DBS4 and Wicks and upstream of DBS8; 3 = "Unconnected" sub catchments

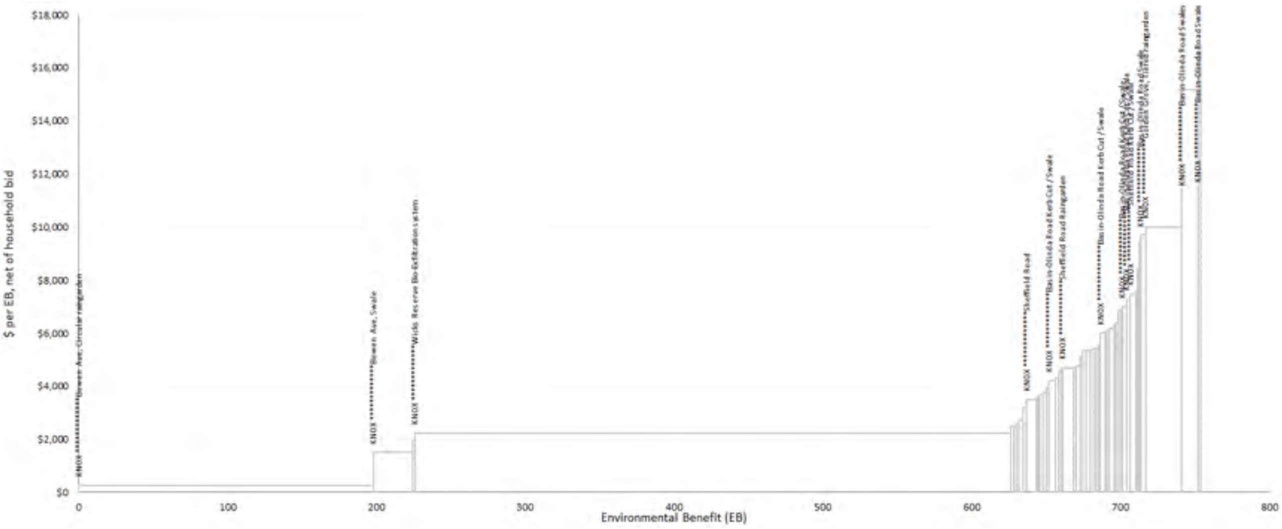

Figure 2: Marginal Cost Curve for Dobsons Creek Public Works and 'Tanks' Stage 2 – lifecycle cost incurred by Knox City Council and Melbourne Water (labels with ***** are public works)**

DISCUSSION

The 'Tanks for Helping Your Creek' Stage 2 MBI pilot builds on experience and lessons developed through the Little Stringybark Creek MBI pilots (Bos and Brown, 2015, Walsh et al. 2015).

The pilot makes Melbourne Water an international leader in using MBIs to deliver urban stormwater outcomes. Other than the Little Stringybark Creek MBIs and a procurement auction for stormwater retention that was implemented in the urban Shepherd Creek Watershed in Cincinnati, Ohio (Thurston et al. 2008) we are not aware of any other similar MBI pilots in urban catchments anywhere else in the world.

The following are primary lessons from the Dobsons Creek MBI pilot:

- MBIs are potentially an important part of the waterway and catchment management toolbox of interventions to achieve waterway and drainage objectives. This is demonstrated by the Dobsons Creek pilot – Melbourne Water and Knox City Council cannot achieve the DCI objectives by developing public works alone. Moreover, the Dobsons Creek pilot suggests that Melbourne Water can achieve well-targeted outcomes potentially more cost effectively with an MBI than with a grant scheme.
- Time must be taken up front to test and design the MBI including understanding customer benefits, marketing, customer engagement channels and methods of transaction. Taking an adaptive approach to improve the process is crucial to project success.
- Managers should be considering MBIs to manage stormwater impacts on catchments and waterways in combination with public works and other actions when one or more of the following are present:
  - Where stormwater runoff from household and commercial roofs and other impervious areas has to be disconnected to achieve stormwater flow and quality targets
  - Where there is limited public land available for stormwater works, or public land has a high developable land value
  - Where there are more than 20 households which can be involved that do not have rainwater tanks, where roof area makes a significant contribution to stormwater drainage, and stormwater systems are connected to waterways that managers want to protect, maintain or enhance
  - Where a council has limited capacity to operate and maintain public stormwater treatment assets. Locating stormwater treatment works on private land may provide managers with opportunities to operate and maintain these assets in cooperation with the landowner.
- Keep it simple. The evidence from this project and the Little Stringybark Creek project highlights that there is a trade-off between auction and auction delivery complexity, participation rates and the efficiency of bids received (Bos, Walsh, & Fletcher, 2013).

In short, while more complicated auction designs should in principle deliver more efficient pricing outcomes (i.e. people will bid closer to what they are actually willing to pay rather than trying to 'game' the auction), the downside trade-off is that participation in stormwater auctions appears to trail off if the auction design is too complex.

- On balance, keeping auction processes simple should result in more households participating, which should open up more opportunities for cost effective EBs to be identified. Keeping it simple can involve using some core, simple and readily transferable design and implementation elements that should be part of all MBIs, irrespective of the number of potential market participants, whether the issue is diffuse or point-source, and the environmental outcomes they are targeting.
- Delivery and engagement is important. The process from engaging households to get an expression of interest, through site assessment, bid receipt and evaluation, to notification of outcomes, contracting, payment and installation must be tight. If there are lags between the auction and notification and receipt of payment then people will drop out because the momentum of being involved wanes over time. Whenever possible, the payment mechanism should be via automated payment to minimise administration costs from setting up the payment plans.

ACKNOWLEDGMENT

CJW is supported by Melbourne Water through the Melbourne Waterway Research-Practice Partnership.

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He led the award-winning Cooperative Research Centre for Freshwater Ecology project, 'Urbanisation and the Ecological Function of Streams', which demonstrated that the most likely cause of the sad state of Melbourne's creeks and rivers is urban stormwater runoff.

He has also been involved in the Centre for Water Sensitive Cities through team leadership roles.

Leon Harvey is a water industry professional specialising in water strategy, planning and market innovation. Over his career Leon has developed expertise in managing stakeholder groups and multi-agency projects.

His passion for the environment has seen him manage portfolios of work covering capacity building in local government, community engagement, capital works for waterway health, development of regional strategic plans, science-based pilot projects and integrated water management plans for Melbourne's multi-billion dollar inner urban redevelopment.

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