Harsha Sapdhare PhD Research Information Sheet

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Leaky Well Devices and Kerbside Inlets for Stormwater Interception in Urban Streets

WSUD and Green Infrastructure

WSUD techniques have received significant attention over the last two decades, due to their potential contribution to developing resilient cities with cost effective green infrastructure. Beatty and Heckman (1981) reported that restricted watering, nutrient deficiency, poor soil, vandalism and physical injury are common reasons for destruction and deterioration of urban tree growth. Harvested through WSUD devices, urban stormwater can provide a fit-for-purpose water source to enhance tree growth (Denman 2006).

Trees and other vegetation can play a significant role in the urban hydrological cycle (Stovin *et al.* 2008); it can improve the infiltration rate of urban soil and increase groundwater recharge (Bartens *et al.* 2008), as well as reducing runoff (Ely and Pitman 2014). Some councils irrigate street trees for the first few years after planting, but they then become dependent on rainfall and infiltration of stormwater to provide the required water and nutrients for growth and survival (Dong *et al.* 2016). This study investigates the effectiveness of leaky well, an infiltration device that is designed to restore soil moisture and provide passive irrigation to street trees.

More specifically, this study investigates the performance of leaky wells when connected to a TREENET Inlet as a means of collecting stormwater. The TREENET Inlet system is an emerging WSUD tool which harvests road runoff from residential streets and arterial roads to irrigate street trees. By intercepting the 'first flush' of stormwater, TREENET Inlets remove pollutants near their source. TREENET Inlets are installed in the kerb; they connect to an infiltration pit or 'leaky well' which detains the water until it soaks into the soil in the road verge.

Case study – Eynesbury Avenue Kingswood, South Australia

In this study, 28 TREENET Inlets coupled to leaky wells (Fig 1) were installed in suburban Kingswood, located in the City of Mitcham local government area in South Australia. The leaky wells were comprised of four different backfill media (quartz gravel, sandy loam, water treatment solids (SPACE), and the site's natural silty clay). The performanc eof inlets filled with different media types have been assessed to investigate their performance with respect to water quality improvement. A series of experiments were performed in the field and in the

Fig 1: TREENET inlet with leaky well

laboratory, to investigate the potential of the TREENET Inlet and leaky well combinations to assist with managing water quality and water quantity. Life cycle cost and cost-benefits analyses were also conducted. Shown in Figure 2, the research components aimed to:

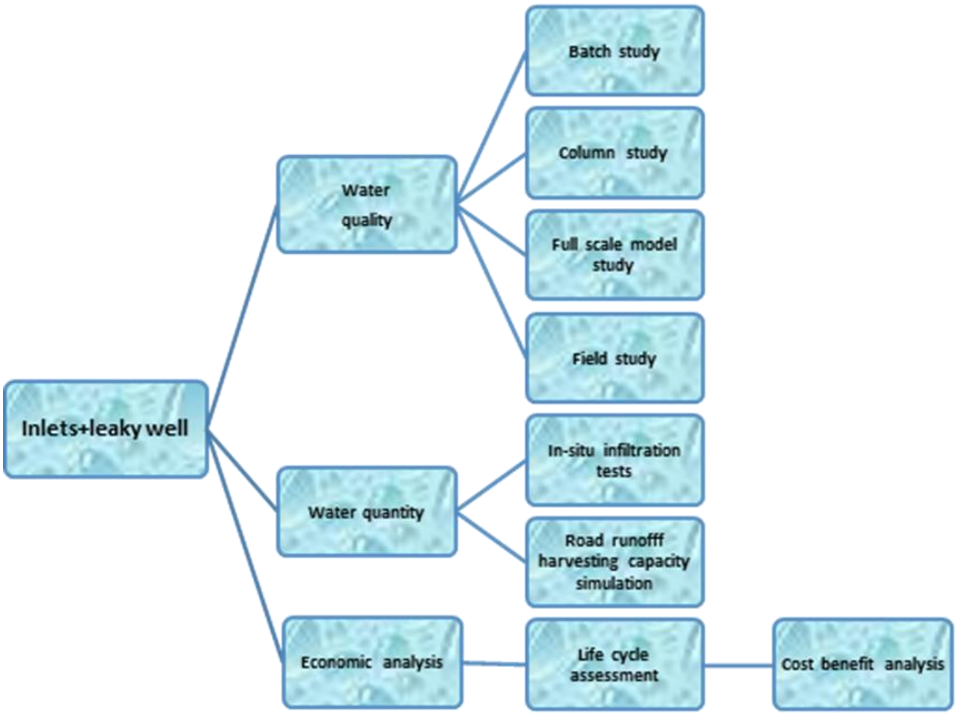

Figure 2. Research study flowchart chart

- quantify the treatment capability of the four media. The batch study (ASTM 2008), column study (Hatt *et al.* 2007) and full-scale model (Davis *et al.* 2001) study was conducted in the laboratory.
- test *in-situ* hydraulic performance by the constant head method (Asleson *et al.* 2009; Hatt and Le Coustumer 2008; Michigan 2000) to compare the infiltration capacity of the four different backfill media in the leaky wells and to investigate whether the infiltration rate change with time.
- test the rate of inflow into the TREENET Inlet at different kerb gradients, using grades of 0 to 5 % and flow rates of 0.5 to 5 L/s
- support a life cycle assessment of the leaky well device and backfill media using accede techniques (ISO 14040), (Flynn and Traver 2013; Taylor 2003; Wang *et al.* 2013).
- support a cost-benefit analysis based on physical quantifications, discounting, net present value (NPV) test and sensitivity analysis (Hanley and Spash 1993).

The installation of TREENET Inlets in Eynesbury Avenue was undertaken as part of a 'kerbing renewal' capital works project by the City of Mitcham. Installation cost was approximately $1000 per installation, which was higher than the usual cost because:

- the contractor was at the time unfamiliar with the TREENET Inlet installation procedure
- excavation proceeded slowly to ensure that dimensions accurately represented the specification and were consistent across all sites (four leaky wells were installed per day)
- four different backfill materials were required, requiring collection from multiple sites
- a hydrovac system was used to ensure utilities and underground assets were not damaged

More recently construction costs of approximately $500 per unit have resulted from modification of the inlet design and the construction process, although the major cost remains dependent on the scale of the leaky well and the method of excavation. TREENET Inlet maintenance is minimal, with street sweeping carried out every six weeks as per the council's schedule. Sediment has been removed from the bottom of the leaky wells after 3.5 years, but this was undertaken for research purposes only - investigations by the City of Mitcham have determined that sediment removal has not been necessary to maintain performance during a five year lifespan at other sites.

This research is focussed on the cost and benefits of the TREENET Inlets to the local council where they are installed, however there may be positive and negative externalities which affect down-stream councils which should also be investigated. It is also suggested that tree root growth should be investigated in urban streets in different soil types and in relation to different tree species. The current research will provide information regarding water quality and quantity benefits of TREENET Inlets and the first full life-cycle assessment of the device. It is anticipated that this information will further inform leaky-well design to optimise performance and cost effectiveness.

The results will be original and reported via Ph.D. thesis in 2018, with a view to subsequent publications in international journals.