Swale servicing an industrial yard.

Quality solutions for small systems

Cameron Mars puts the focus on small-scale stormwater treatment options – and asks if they are as good as they could be

The treatment of stormwater run-off is a prescribed requirement for many small developments within New Zealand cities. However, questions need to be asked as to whether the correct treatment technologies are always being employed.

Should we be looking at greener solutions and are councils requiring water quality issues associated with such developments to be adequately addressed? Many small residential, commercial or industrial developments do not have the luxury of being serviced by downstream treatment facilities, nor do they have large available land areas within which treatment facilities can be sited. It is these smaller developments that are the focus of this article.

Generally, larger subdivisions are required to adopt a treatment train approach involving primary (pollutant trap), secondary and potentially tertiary treatment. In contrast, smaller developments usually have the option of utilising primary pollutant traps or filter devices as the only means of treatment and such systems are generally accepted and approved by councils I have had experience with.

However, it could be argued that primary treatment, as the only means, is not acceptable (for new developments) and that more stringent measures should be enforced. It could also be argued that this can be achieved at minimal additional cost to the developer by using sound engineering design judgement at the start of the project and making the best use of landscaping.

Multiple stormwater treatment technologies are available to the design engineer such as “natural” or “green” systems that rely on plant and soil removal mechanisms, proprietary “off-the-shelf” devices utilising gravitational settling or cartridge filtration and proprietary package plant bio-filtration systems.

Selection of a treatment technology will, to a large extent, be determined by factors such as site constraints, land use, land availability, maintenance requirements and capital expenditure (to name but a few).

However, too often the treatment outcome of each device is overlooked. Given that many developments fall

under various council global consents, little in the way of an assessment of environmental effects is required. While some councils are enforcing treatment, there appears to be little to no incentive to install devices with potentially high treatment outcomes, resulting in the installation of devices (at some sites) that only provide the bare minimum or even lesser contaminant removal.

Ease or effectiveness?

On the whole, the realm of stormwater treatment falls within the civil and environmental engineering professions. However, suppliers, developers, drainlayers, structural engineers and architects can also make recommendations and do have opinions. Of these professions, how many have the science or technology backgrounds to define the nature of potential contaminants, the treatment mechanism and the likely treatment outcome?

Therefore, is there not a tendency amongst some professions to design or select treatment systems based on ease of installation (eg, package systems) and hydraulic requirements, rather than the actual treatment effectiveness?

The installation of proprietary (filter cartridge or gravity settling) primary treatment systems is common – due to their design simplicity, small size, perceived cost, ease of installation, hydraulic performance or simply due to familiarisation (past experience) with a certain device. When comparing the varying proprietary filters available and their treatment outcomes, it is not a case of comparing apples with apples because many use different media, have differing design/operating principles and hydraulic requirements.

Whilst manufacturers' literature generally states high TSS removal, often around the 80 percent realm, very rarely are Biochemical Oxygen Demand (BOD), pH, pathogen, nutrient and heavy metal efficiencies stated. Field evaluation studies from within New Zealand and overseas suggest a less simplistic picture when considering proprietary device removal efficiencies, with treatment outcomes being dependent on site rainfall and contaminant loadings, with removal rates ranging from negative (contaminant export) values up to 80 percent (usually less) for TSS, depending on device selection and the design sizing. Some devices have poor to no copper or zinc removal, whilst others provide "acceptable" removal ranges.

While off-the-shelf primary treatment devices are an easy option for many sites, they must be installed with sound engineering knowledge and judgement based on the known rainfall patterns, land use and expected contaminant concentrations. It could be questioned whether this due diligence is lacking in many instances.

Secondary considerations

That said, this article is not against the use of proprietary devices. They are an important part of the treatment train – but consideration does need to be given to their standalone benefit and whether secondary treatment should also be employed within new developments. The exception to this would be existing, already developed, inner city sites and roading infrastructure, from a time before treatment was a requirement. The proprietary devices are a good retrofit and will remove gross pollutants and potentially some heavy metals which, in a nutshell, is better than no treatment. However, when considering new developments should not more be expected (with the changing environmental times) and could a combination of proprietary systems and/or "green" landscaped treatment technologies provide a higher level of contaminant removal, without utilising excessive land area?

Design, build and operational capital expenditure is an interesting factor and often misleading. While proprietary devices are marketed as being cost effective, this is a point that could be debated (not in this article, however). When considering "green" systems, rain gardens are generally considered to be at the higher end of the cost scale, given they can be around $1000 per square metre. However, when the fact that around 10 percent of a development area is usually set aside for landscaping is taken into account, the effective rain garden detention capacity coupled with a reduction and lag in post-development peak flow rates (effectively reducing detention requirements), the capital expenditure becomes less inhibitive as well as providing a visually pleasing amenity.

The green edge

The treatment outcome of rain gardens and other such systems needs to be considered; a well designed and constructed rain garden will provide not only solids removal but also a reduction in BOD, heavy metals, nutrients, pathogens and pH stabilisation, within a sustainable system in which plant uptake is also a factor.

Rain garden servicing a residential unit development.

Many of the "green" treatment solutions utilising plant and soil removal mechanisms have flexible design constraints that can be adjusted to match hydraulic requirements and can reduce the need for piped reticulation.

Another advantage with "green" systems is that they can alleviate the issues around varying flow and contaminant concentrations that are prohibitive for some proprietary devices, thereby operating as standalone systems or alongside a pollutant trap or cartridge filter. Rain gardens are designed with a standing water volume, effectively storing variable inflows on the surface prior to infiltration and unless poorly designed or maintained, will restrict contaminant export.

Swales as a standalone feature can incorporate bio-retention, with an adequately designed outlet and planting to reduce contaminant export, or swales can be designed in tandem with a proprietary device allowing for primary treatment or polishing prior to discharge. Only swales and rain gardens have been discussed, however small vegetated soakage basins and many other engineered solutions are also viable options.

The maintenance factor

Whilst the selection of a treatment device (or devices) is an important consideration, so is the maintenance requirement. Without ongoing maintenance, treatment outcomes may be significantly impaired and contaminant export could result in higher loadings discharging from a system. This is an area in which I believe far more council input is required.

Two options are available; either (1) council maintains the treatment systems and passes the cost on to the site proprietor; or (2) the proprietor is responsible for maintenance. Many councils have opted for the second approach; however, enforcement of maintenance is necessary and it is in this realm that councils are yet to provide assistance or take responsibility.

Councils could have a register of treatment devices and could notify proprietors when maintenance is due and request notification from an accredited supplier or maintenance provider that the work is complete.

To date, this has been ignored by many councils and considered cost prohibitive both in time and manpower. However, there is little point in installing treatment systems if they are not maintained. Such systems could even potentially have an adverse effect on the environment they were originally designed to protect (periodic high discharge loadings due to contaminant export).

Some proprietary suppliers are aware of this issue and are including a short-term maintenance package within their cost estimates. However, this is not solving the longer-term issue. If maintenance is a foreseeable concern, green systems could be the more viable option, as swales tend to be mowed and litter picked up with little cost, whereas rain gardens require care of vegetation and removal of litter. However, low maintenance hardy plant species can be used.

Green landscaped stormwater treatment devices are visible and therefore more likely to be maintained. Furthermore, poor or no maintenance will eventually lead to treatment system failure; this will generally be visibly evident within green systems, while, in contrast, underground contained proprietary devices will allow inflows to bypass.

Overall, many councils are taking steps to ensure cleaner waterways via the treatment of stormwater discharges from small development sites. However, the approach needs to be clearer and firmer with regards to acceptable treatment standards and should incorporate more "green" bio-filtration systems working alone or in tandem with proprietary pollutant traps and cartridge filter devices, rather than the latter being used as the sole device.

Suppliers are providing package plant bio-filtration technologies, which appear to be good systems incorporating plant and soils attenuation and require limited land availability. However, these systems, as with all others, also have the issue of maintenance, and this is an issue that will be ongoing unless councils stop placing the emphasis solely on the developer or proprietor and take some responsibility.

The engineering community needs to take responsibility for providing adequate treatment designs and this requires a collaborative approach between the civil and environmental professions to ensure acceptable treatment outcomes are provided within a realistic design and civil engineered platform.

Councils also need to provide a clear and firm guideline or standard for minimum expectation. Within New Zealand, there are well designed and functioning stormwater treatment systems which are a credit to the engineering community and the associated developers. But not all treatment systems achieve the same high standard. **WNZ**