Why the best designed stormwater treatment systems can fail –
How to stop Council from inheriting a lemon.

NOTE: Before reading the following paper, the author would like to advise that:

The following paper has been created to be educational. It points out many areas in which oversights and errors can lead to Councils not getting what they expect.

Papers such as this are acknowledged to be more valuable than ones that espouse a series of successes. By noting elements of failure or problems within our imperfect stormwater systems, it is hoped that Councils (who inherit most of them) will know where the pitfalls lie, and be able to minimize the problems they inherit.

The only way to advise Councils, and the industry, of common problems that exist, are to bring them to light, in published papers such as this.

This paper was not written to point blame at any one section of the industry.

This paper was not written to target specific companies, Councils, products or contractors. It was written to demonstrate common areas in which we can all learn.

All sections of the industry can improve the way they do business, and the results they achieve. No-one is perfect, and various examples prove this is true.

The information presented in the paper is factual .

The author hopes you gain knowledge, and are able to "*learn from the mistakes of others*". Mistakes cost money and usually lead to an environmental impact. If just one person (after reading this paper) stops, thinks, and checks what is going on, and prevents a preventable mistake, ….. then there has been value in this paper.

The author wishes everyone success in their stormwater ventures, and hopes the information contained in this paper helps them to achieve it.

Why the best designed stormwater treatment systems can fail – How to stop Council from inheriting a lemon.

By Murray Powell BE, MBA – General Manager, Optimal Stormwater

Most Metropolitan Councils in Australia have between 20 and 200 structural stormwater treatment devices. When you add wetlands, bioswales, rain gardens, detention basins, etc, this figure could even double. And if you added all the devices and works that are on private lands, the number of individual assets suppose to be protecting our environment can become an impressively large number.

But the reality is that a large number of these stormwater treatment systems are failing.

Some of the time its due to a lack of maintenance funds at Council, and this is a huge issue for many Councils, but in between the design phase and the maintenance phase, there is a process with more holes than swiss cheese.

This paper highlights and addresses the issues facing Councils and developers, during the design, approval, installation, commissioning and handover process.

Different Councils have attempted to deal with this problematic period in different ways, and with differing levels of success. But there are some common pitfalls that all Councils should be wary of, if they are to avoid lemons.

A number of issues will be covered in this paper, of which some include:

- devices not being handed over;
- devices being substituted by contractors without Council's approval;
- Council not getting enough say in the design of the solution;
- the problem with private certifiers;
- DCPs only covering structural elements;
- maintenance staff not being involved in the design of assets they will inherit;
- bonds and their value;
- below average installation;
- poor or non-existent Works-As-Executed drawings;
- lack of maintenance whilst in developer ownership;
- the handover process;
- developers being responsible for builders;
- auditing/inspection;
- cleaning contractors; and
- retaining capacity within Council to address these issues appropriately.

With a large focus at conferences on design requirements, new WSUD solutions, modelling outcomes, new products and solutions, it is worth remembering that the treatment train or treatment chain is only as strong as its weakest link. And that link might not be structural, it could be, and commonly is, in the developer maintenance or handover of a stormwater treatment solution. This paper will provide a checklist of issues for Councils to consider in their future DCPs and when accepting future stormwater solutions.

1 Introduction

When engineers and designers are selecting a type or design of treatment for urban stormwater they usually rely on the claimed or reported performance.

These performance outcomes are likely put into tools like MUSIC to design a final performance outcome. This is compared against Council stipulated targets, and the design is fine tuned until the computer model outputs meet the stipulated targets. The theory of this is fine, and there is no better way to design, and no better approval process. However, Council should be aware of all the pitfalls as to why the results on the ground don't always meet the modelling outcomes.

There are potential problems in every step of the process that actually starts well before design, and ends long after the solution is operational. For stormwater managers to get solutions that are (a) effective, (b) reliable and (c) cost effective to maintain, they need to be aware of these pitfalls, and avoid as many as they can.

The author has had experience in both State Government and Local Government. He also has experience within the private sector, with suppliers, consultants, installation contractors and cleaning contractors. Because of this, it is possible to understand the stormwater treatment process from each stakeholder's viewpoint, and then point out why things go wrong and how things can be done better.

2 Policy Problems

Most Councils have Development Control Plans (DCPs), that detail the requirements for a new development to proceed. Stormwater treatment requirements are usually a percentage removal of certain pollutants, or no nett impact. This is a good start, but the author believes these should be more comprehensive and more flexible.

2.1 Capital Works Only

The first problem with these requirements is that they usually only relate to the capital works. There is either no requirement (or a very weak requirement) for devices to be maintained during the development/construction phase.

Sometimes this requirement is in the "conditions of consent" for the construction certification, which is good, but does it need to be in the DCP as well, to get the message across. Or are financial drivers a better way to get results?

Without adequate maintenance, bioswales and wetlands become overloaded in months rather than decades. It can lead to GPTs becoming full in weeks not months, but then bypassing for years until the final handover to Council.

The way to overcome this problem is to include:

- a requirement for monitoring;
- a requirement for cleaning;
- a bond to cover the cost of cleaning the device, and cleaning up of any bypassed pollution, that is equal to, or greater than the value of the solution; and

- The right for Council to organize the cleaning of devices, and backcharge the developer/contractor or take the money from their bond.

Some developers/contractors do the right thing, but in the experience of the author, they are unfortunately the minority. Most see GPTs, pit traps, or bioswales as items they had to have to get approval, and unless forced to clean them, their first cleaning is commonly the day before they get handed over to Council. It is doubly important to remember, that during the construction and building phase, there is usually double (or more) pollution load coming from the catchment, so it should be doubly important to focus on environmental protection at this time but too often there is no focus at all.

The *South East Queensland Construction and Establishment guidelines* (by Water by Design) provide some positive direction in this area, and are a good reference. Likewise, some Councils in NSW have good policies in place, and should be looked to for guidance and assistance.

2.2 The Problem with Private Certifiers

The reasoning behind the existence and use of private certifiers is valid. It can speed up development approval, and take some of the load off Councils.

Private Certifiers are engaged by developers. Consultants are paid to find the cheapest capital cost solution that Council will accept. It is the job of the private certifier to check everything against Council's policies and requirements, as they were "written".

The long term maintenance requirements – method, frequency, cost, only get considered to the extent they have to be, which depends on how the policy is worded, if it contains a reference to long term maintenance at all.

So the problem with private certifiers is that they are working for themselves, not Council, and they are effectively doing the work of Council, but employed by the developer. The author can cite multiple times that Council have not been impressed with the solutions accepted by Private Certifiers. There is no simple answer to how this could be done better, and of course every Private Certifier is different.

3 Design

3.1 Designing on Desire

It has come to light on three recent projects, that consultants doing designs for Councils, have been "designing on desire". Council states they desire, this and that, and this and that, and, and, and….. But at no stage does the consultant say "that's not a good idea".

If Council selects or desires a device that is undersized or oversized, it should be the designer that advises Council of this and discusses the appropriateness of their selection and possible alternatives.

If a designer just agrees to include everything that Council wants, it can result in a solution that is either going to be of very low cost effectiveness, or unaffordable, or both.

Designers need to produce the best design possible within any given financial constraints of Council. "Don't design a Rolls Royce, if Council can only afford a Commodore". (Besides, do you know how much it costs to service a Rolls Royce?) Designs should reflect Council's limitations in capital cost and seek to minimize any ongoing maintenance commitment from Council.

The scale of the solution needs to match the task and the maintenance regime needs to match with Council's current cleaning programs and resources to achieve a Win-Win outcome. If designs are not financially realistic, they waste the time of the designer, Council employees, and any contractors tendering on the project.

The realistic situation is that almost every stormwater solution proposed is a compromise between performance, hydraulics, capital cost and ongoing costs. Its great for Councils to have desires, but its up to the designers to explain the compromise process, and ensure financial reality of all solutions designed.

3.2 Who Designed This?

It is common for a consultant to be engaged to do the design for a new subdivision or development. It will be done in such a way as to meet Council's policies, and therefore get approval.

In reality it's hard to put everything into a policy or code. There is just so much to be considered to achieve a high performance solution which has low maintenance.

Council's don't want "one of everything". This is a maintenance nightmare. Councils are better off nominating a limited choice of devices which are consistent with their existing maintenance programs, so the developer can still get a competitive price, and Council are going to get a device they are happy with. (Some Councils already do this through the pre-DA lodgement process)

It is common for devices to be chosen based on performance, which is actually a combination of functionality and volume of flow treated. It is uncommon for maintenance to be one of the key factors in the decision, it is even less common for the more expensive devices with lower long term maintenance to be chosen, because this disadvantages the developer (and they are paying the consultant). It is virtually unheard of for the designer of the solution to contact the Council maintenance department, and seek their advice as to what sort of devices they prefer and have the equipment to clean.

It is common therefore to design a solution that is focused on minimizing the capital and installation cost to the developer.

It is up to Council to establish clearcut codes if they wish to have an input into the devices they will inherit.

The way to overcome this is to obtain input into the stormwater codes from the Council Maintenance section, (and any cleaning contractors they engage) regarding the performance, ease of cleaning, cost effectiveness, etc of devices and solutions they already have. Councils should be able to nominate devices they will accept and ones they won't accept, without fear of legal threats from proprietors.

Councils, not consultants should ideally be selecting the type of device (within reason). The sizing should be based on both validated performance and Life Cycle Costs, with a considerable focus on maintenance (this should be agreed with the designer). It should then be the consultant's job to design it into the project. So when someone asks "Who chose this?" the answer should be Council.

3.3 Designing for Failure

There is a common oversight in many designs. They are designed on the assumption that they will be correctly operated and adequately maintained.

Ideally Councils should assume:

- No maintenance
- plant death
- weeds in vegetated systems and algae in wetlands
- power failure and/or mechanical failure
- blockages
- vandalism

Triggers for failure can be budget cuts leading to low maintenance, administrative delays, large storms which impact the device performance, too much work for cleaning contractors, poor soils, wrong fertilizer, or the most annoying element vandalism.

When a solution fails it should have two consequences if possible:

- It should be obvious. Council or a cleaner (or in some cases the public) should be able to readily tell that it's not working
- It should fail "safe". So even though the solution/device has failed, it has not increased the risk to public safety or private property.

3.4 Over designed and under designed

In some cases, consultants are overly conservative in designing based on performance, flow or objectives from Council. These designs may be unrealistic or very cost prohibitive to achieve. This can leave some heavy ongoing maintenance burdens on Council. On one project the author was involved with, due to site constraints, it was going to cost almost twice the amount to go from 42% TN removal to 45% TN removal (based on modelling). It is the opinion of the author that Council should weigh up the cost and long term benefit, if this sort of scenario arises, and be flexible. It may be more realistic to spend a lesser amount and get a greater (environmental) return at another location.

Likewise, under specifying designs based on unverified performance claims or lack of requirements from Council, can also leave Council with less than ideal solutions. Some devices state a treatable flowrate based on water without pollution. Designers using this flowrate in MUSIC consequently overestimate the pollution removal of that particular device. And maintenance seems to be forgotten altogether during the modelling phase.

It's a good idea for Council to check that the solution proposed is sized correctly based on performance, flow volume not flowrate, and most importantly pollution storage volume which governs maintenance frequency and cost.

It is recommended for Councils to set the bar high, but be prepared to be flexible and compromise where there is a logical justification to do so. Put common sense and experience at the top of your decision making tree.

3.5 Design Checks

Design reviews on major projects, where an independent third party is engaged to review the design is a good idea. No-one is perfect, and the reviewer might just pick up problems that the designer couldn't see. As a designer, you sometimes get "too close" to the work, and quite obvious things get overlooked. It could be a typo or something like the equipment being too large to fit through the door on the building it's going in.

Getting another expert to provide a "sanity check" on the design is generally a cost effective way to guarantee the project outcomes. It is common to do this on an hourly basis, with an agreed upper limit, so it does not need to be costly. The reviewer should be identifying problems, not fixing them. Fixing them is the job of the designer, so responsibility for the full design remains with them.

Whilst nobody likes to hear that their design could be improved, this process reduces the risk for Council, and should also reduce the number of complications. Whilst not really cost beneficial on small projects, once projects get over $1M, it's an option Councils may choose consider.

3.6 WSUD …is there an issue with the definition?

Most Councils have policies requiring WSUD on all new projects. This is great, but there are still some individuals that think the definition of WSUD means raingardens and bio-swales, often with an emphasis on "soft" engineering design.

WSUD is more than just raingardens, bio-swales and wetlands. It includes all types of quality, quantity and sustainability works, including GPTs and media filters, stormwater harvesting, and flood mitigation. A raingarden on every corner is likely to be quite costly for the actual benefit it potentially produces. So the cost effectiveness of "WSUD elements" should also be taken into account when designers and Council maintenance staff are agreeing on which WSUD elements are best suited to their municipalities in the long term.

WSUD is essentially the evolution of stormwater management, that includes a greater focus on integration and sustainability. WSUD does not mean soft engineering. That is only one component.

4 Implementation

4.1 Making Installation Contractors Accountable

Most installation contractors have the same objective: get the work done as fast as possible and as low cost as possible, so they make the most profit possible. Their job is to make money. They don't see their job as protecting the environment.

As such, it can be common to find pipes cut to join to a GPT with exposed reo sticking out and rusting away.

Joins between existing infrastructure and new infrastructure have been a common area to take short cuts in. Joins with gaps, holes, exposed reo, no benching, and generally really rough work, are more common than not, and because it is generally underground and out of view, it often goes unnoticed. To inspect the work before handover, ideally a confined spaces entry is required, and any treatment device should be pumped down to a dry state, so all surfaces and joins can be inspected, and the device can be confirmed to be in good condition, and empty of pollution. This also allows inspection of the upstream and downstream lines, as well as behind screens and in diversion chambers.

For solutions like raingardens and bio-infiltration systems, there is less concrete but plenty of areas that contractors can cut corners, such as cheap media, insufficient media, and sub surface drainage lines full of dirt. But unlike a GPT, they are harder to inspect once completed, so more vigilance is required at every stage of the installation.

Once it's all installed it's almost impossible to check and confirm if it was done right. It is for this reason that "hold points" should be built into every installation, so the designer or Council can confirm the installation was in accordance with the design.

In the *South East Queensland Construction and Establishment guidelines*, (by Water by Design), a process is described that goes a long way to addressing this.

4.2 Getting what you approved

Most Councils will have projects where they approved one solution but something else was installed. It comes from the developer or installation contractor deciding that something else was "*equivalent*".

Put simply, those with a conflict of interest (developers and contractors) should never be allowed to make the decision as to whether something is equivalent or not. This should always fall to either the designer or the Local Council.

And if the Council or the designer has not approved the equivalent solution, then the contractor should be made fully aware of the implications that the solution will need to be removed and the approved solution installed.

4.3 Who's responsible?

Once core infrastructure is installed, and the lots get sold on a new subdivision, the builders move in. This phase of an urban development seems to produce many times the pollution compared to the other phases.

But who is responsible when the GPT or bioswale is full in one storm. Is it the developer who is the current owner, or the builder with no sediment and erosion controls, who just lost 2 tonne of topsoil down a drain?

This is actually simple. It is the developer who owns and operates the GPT or bioswale who is responsible for it.

In a way, the developer is just out of luck, because he becomes responsible for the failure of others. Council could assist them with some education or prosecution of the builders, but the responsibility is clear.

5 Handover

5.1 Devices not being handed over

One of the best ways to inherit a lemon, is to find out 3 years after it was installed, that the device actually exists. Or learning, once the garden keeps flooding, that it's actually a raingarden that is blocked and should have been maintained.

Good handovers can be rare. This is where Council is actually presented (at completion of the solution) with:

- a complete set of Works-As-Executed Drawings, and
- an Operation & Maintenance Manual customised for the assets being handed over.

If Council is going to own it, and operate it, this is absolutely basic, but unless Council requires Works-As-Executed drawings (not design drawings), they won't have an accurate record of what's in the ground. And whilst most proprietary devices have generic O&M Manuals, these may or may not be sufficient (especially when customised elements of the solution exist).

5.2 Capacity building…. And retention within Councils

The knowledge of what's in the ground, how it works, its design features and intentions, its normal operating state, its normal monitoring, normal cleaning, annual cleaning, and any servicing requirements need to be known.

But because people don't stay in one job all their life, unless all this information is documented, and stored in a logical way for future reference it seems to get lost.

Councils need to ensure that when their knowledgeable, trained, experienced staff move on (and their capacity is lost), their replacement can easily pick up all the information on all their stormwater treatment solutions. Storing everything electronically is obviously preferable, but this may mean scanning old documents and drawings, to make sure all information on all assets is held in a logical, secure manner.

Many Councils are now developing GIS systems which map their road and drainage assets with cross references to record keeping systems and plans of the assets.

5.3 Monitoring, Regular Cleans & Annual Cleans

The first thing to note is that solutions don't monitor themselves. It is up to Council to monitor solutions, or engage someone to do it for them.

It is then up to Councils to do the "Regular Maintenance" of solutions or engage someone to do it for them.

Then annually it is then up to Councils to do the "Annual Maintenance" of solutions or engage someone to do it for them.

When budgets and programs are all done annually, it stands to reason that the absolute longest any device or solution should go without monitoring is 1 year.

Wetlands, or bio-retention basins, or porous paving, or other solutions that might have a theoretical cleaning frequency of less than once per year, still need to be on the program, or they tend to get forgotten. Once a solution is left off the cleaning program, it doesn't get budgeted for, so even if someone picks up the error at a later date, there is insufficient funding to do anything about it.

Having a good database of every device and solution is critical to its ongoing operation, maintenance and success. The use of an experienced consultant to audit everything and create this database is money well spent. The use of cleaning contractors that understand the differences between a regular clean and an annual clean, is also recommended. If the cleaning contractors know what's required to keep devices and solutions working at their peak, the asset owner will get a more reliable environmental outcome. Engaging the lowest cost cleaning contractors that may not have sufficient experience, or don't have the right equipment for the job often won't achieve acceptable outcomes.

Let's just say that as all stormwater assets are not alike, all cleaning contractors are not alike. Find a good cleaning contractor and stick with them if possible. Changing cleaning contractors every year reduces the chance of gaining from the "capacity and experience" they gain with every clean.

6 Conclusions

- Councils sometimes don't get enough say in the design of the solutions they will inherit. Get more involved, they will be your assets.
- There are pros and cons with private certifiers.
- Make sure designs are realistic regarding capital cost, and realistic regarding the ongoing operational commitment required from Council.
- DCPs traditionally only cover physical elements. Ensure their operation and maintenance is included too.
- Maintenance staff should be involved in the design of the assets they will inherit.
- Get bonds in place of appropriate value, because contractors have different objectives to Council.

- Ensure all devices get handed over and ensure work as executed drawings and operations and maintenance manuals are provided.
- Check or audit devices to avoid them being swapped out by contractors.
- Council or the designer should decide what's an equivalent product, not contractors.
- Be aware of below average quality installation, and check for it.
- Lack of maintenance whilst in developer ownership is a huge problem. Determine a way to fix this for the future.
- Understand the handover process, from builder to Council DA engineers, to the Stormwater Asset Database, to the maintenance contractor.
- Ensure developers know they are responsible for any builders, and for cleaning of their devices.
- On-going Auditing/inspection, is an excellent tool to minimize your lemons.
- Cleaning contractors are not all the same, find a good one and try to stick with them if possible.
- Retain capacity within Council to address these issues. If nobody is looking after the stormwater solutions, you'll have a lemon orchard.

If Council is able to heed the lessons contained in this paper, they are more likely to achieve superior environmental outcomes, and maximise their cleaning dollar. There are plenty of lemons in existence that are not protecting our environment as they should be. These assets should be indentified and rectified. We don't need any more lemons, so hopefully the advice above will assist Councils to get a few more apples instead of lemons in the future.