Stormwater Management in the Industrial Environment

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Abstract

The importance of stormwater management for industrial sites is recognised worldwide, as the contaminants present in discharged stormwater is typically higher than other landuses. The enforcement of it by regional councils varies throughout NZ, but the ARC specifically addresses this issue through rules in the Proposed Auckland Regional Plan: Air, Land and Water (PARP:ALW).

Industrial site stormwater management is best dealt with through a combination of site management, spill contingency and appropriate treatment methods. Every-day housekeeping practices can provide significant benefits to stormwater quality. Spill contingency is paramount in areas where spills are more likely. Appropriate on-site treatment devices are required for industries listed in the PARP:ALW. Thoughtful site design and the application of low impact urban design principles can also contribute significantly, and in a cost effective manner, to the improvement of stormwater quality.

However, it is critical that what is written into site environmental management plans accurately reflects the actual site management capability, and that site design engineers understand the critical consenting and stormwater quality requirements when designing the site.

This paper primarily uses examples from the ITP consent process for the new Lion Nathan beverage facility in Manukau City to illustrate these key aspects. Good collaboration between the stormwater team and the site designers has proven to be worthwhile in achieving sustainable infrastructure for Lion while satisfying the required environmental outcomes. Examples include appropriate use of bunding and isolating valves, development of a wetland for the contaminant prone areas, and the mutual benefit of a financial contribution to MCC for use of an existing facility for stormwater treatment.

1 Background

Stormwater discharges from urban land uses can cause adverse effects on the freshwater and marine receiving environments into which they discharge. From physical changes in streams due to hydrological impacts, through to deposition of contaminants into ecosystems or groundwater, the effects can be significant. The impacts have historically been more easily seen in heavily industrialised countries, where large rivers have been severely impacted. By comparison, New Zealand's streams and harbours appear relatively clean. But ecological monitoring shows that many areas are already affected, particularly in urban environments.

Contaminants such as zinc and copper accumulate in the freshwater and estuarine sediments, and are bio-available to benthic organisms, such as mud worms and crabs, cockles and pipis. These metals, in their soluble form can be ingested by these benthic organisms, as well as by muscles and oysters. Ecological studies have shown that these organisms are affected by these heavy metals, and are not found in locations with high concentrations. In addition to the obvious environmental effect of loss of biodiversity, once ingested by these aquatic animals, these metals have entered the food chain.

It is important that we work to improve the quality of our stormwater discharges to ensure that our harbours and waterways are available for the country's future needs. This paper outlines both planning mechanisms and engineering tools and techniques which, together, can achieve positive environmental outcomes and sustainable stormwater infrastructure.

2 Contaminants in stormwater

It is widely accepted that stormwater derived from urban surfaces carries contaminants into the receiving environment. These contaminants have

been characterised over the years through monitoring studies, many of which have been instigated or paid for by regional councils. The contaminants identified as being of concern for urban stormwater treatment programmes in New Zealand are sediment, hydrocarbons, zinc and copper. In Auckland, the ARC has developed a spreadsheet contaminant load model, (CLM) (ARC, May 2006) which is used for catchment management planning purposes. The data used in the model is derived from a suite of monitoring studies that have been carried out in the Auckland Region. The following is an extract of data taken from that model.

	Total Suspended Sediment*	Zinc*	Copper*	Total pertoleum hydrocarbons*
Roads - < 1000 vehicles per day	4	0.021	0.007	0.11
Roads – 1000-5000 vehicles per day	30	0.107	0.0349	0.54
Roads – 5000-20000 vehicles per day	15	0.537	0.1744	2.68
Residential paved surfaces	20	0.070	0.010	Not in CLM
Industrial paved surfaces	50	0.100	0.130	Not in CLM

*loads given in grams of material per square metre per year

The contaminant load model allows for other land uses, grasslands, construction earthworks sites and upper catchment forest, bush and pasture, which are not included here. The data shows that industrial paved surfaces contribute a relatively high loading of sediments, a zinc loading comparable to that of a road with 1,000-5,000 vehicles per day, and a copper loading comparable to a road carrying 5,000-20,000 vehicles per day.

In addition to concerns about the environmental effects of the contaminants listed in the CLM, industrial sites are of concern due to their potential for a wider range of contaminants. For example a metal processing site, where items are chrome electroplated, will have several different chemical mixes for the process. These could include sodium hydroxide for cleaning prior to electroplating, acids to prepare the metal surface for the adhesion of the final metal, and metal acid baths for the final electroplating. Food manufacturing plants require cleaning solutions to comply with health regulations for cleaning of manufacturing equipment, and for a large producer, this would be used in significant quantities. These chemicals are usually delivered to site in plastic mini tanks, which are then forklifted to a storage location. While hazardous substances legislation sets requirements for handling and storage, there is a risk of spill in the use and storage of these chemicals. The spills clearly have human health and well-being risks, but also pose significant ecological risks if released to the fresh or marine water environment downstream.

3 Legislative requirements

Section 15 of the Resource Management Act sets the scene for the control over the discharge of contaminants into the environment.

Section 15 (1) No person may discharge any—

- *(a) contaminant or water into water; or*
- *(b) contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water; or*
- *(c) contaminant from any industrial or trade premises into air; or*
- *(d) contaminant from any industrial or trade premises onto or into land—*

unless the discharge is expressly allowed by a national environmental standard or other regulations, a rule in a regional plan as well as a rule in a proposed regional plan for the same region (if there is one), or a resource consent.

Regional councils have used a variety of approaches to deal with this through the regional plan mechanism.

The Environment Canterbury Natural Resources Regional Plan (NRRP), has three rules relating to the discharge of stormwater containing contaminants. These are Water Quality Rules WQL5, 6 and 7. WQL5 is for the discharge of stormwater to land, WQL6 is for the discharge to rivers or lakes, and WQL7 is for the discharge either to land or water in a stormwater management area. Both WQL5 and WQL6 are permitted activities, with significant conditions required to be met. WQL7 is a controlled activity, also with a suite of conditions to be met.

ORC has three rules for the discharge of stormwater. Rule 12.4.1.1 is for the discharge of stormwater from a reticulated system, and Rule 12.2.1.2 is for the discharge of stormwater from a road. Both of these are permitted activities, provided that they comply with the stated conditions.

ARC has taken a "belts and braces" approach. They have chosen to differentiate between consents related to general urban stormwater and industrial and trade premises on the basis of the above data, and have set up an entire set of rules for a consent, known as the ITP consent – Industrial and Trade Process consent. The permitted activity rules, 5.5.14 and 5.5.15, permit the use of land, rather than the discharge of stormwater or contaminants. The controlled (5.5.17) and discretionary (5.5.19) activity rules are for the discharge of stormwater. They all have significant conditions attached which must be complied with in order to fulfill the requirements.

The ITP rules set up three categories of site – a high risk category which requires consent, a moderate risk category which does not require consent and a low risk category, which is defined by default of not being either of the others. The categories are defined according to the activity area, in Schedule 3 of the PARP:ALW, which lists all activities which require consideration.

4 Managing stormwater discharges

Given that contaminants entrained in stormwater have an effect on the ecology of the streams, estuaries and harbours, and knowing that industrial sites provide a greater opportunity for contaminants to enter the environment, a more rigorous approach is sensible. The legislative framework of the RMA supports such an approach.

There are three key components of the accepted approach to management of stormwater on industrial sites: emergency spill procedures; environmental management plans; and treatment devices.

Emergency Spill Plans

Due to the quantities of chemicals typically stored on industrial sites, the event of a spill can lead to significant environmental consequences. It only takes one spill to kill an entire stream – and then years for it to rehabilitate. Therefore, an emergency spill plan is imperative.

The ideal spill plan is one page, states a simple procedure for dealing with the spill, and provides essential emergency contact information – for the emergency response services, for the regional council and for a contact person for the company. The emergency spill plan should be posted on notice boards around a site, wherever there is product capable of spilling and entering the stormwater system.

While human health must always be paramount, containment of the spilled substance should be the first priority. A basic spill procedure should include instructions for staying safe, stopping the source, containing the spill, personnel to be notified, and clean up and disposal instructions.

Environmental Management Plans

Good site housekeeping goes a long way towards reducing the contaminant load from an industrial site. The use of an environmental management plan, often linked to a wider company environmental management system, is a key tool for setting up operating procedures and site practices.

This management approach is recognised worldwide as being an important aspect of environmental

responsibility – far better to prevent than to have to clean up afterwards.

A management plan tailored to an individual site will be based on the results of a site audit, and will document the following key items: Identification of contaminant sources and management methods; Standard Operating Procedures; Roles and Responsibilities for key staff; Training and Awareness; Monitoring and Maintenance; Review of the Plan; Records.

The introduction of an environmental management plan to an existing site can make a significant difference, even where site restrictions limit the construction of a treatment device. The process of writing the management plan can identify simple solutions to storage or work behaviours, and effecting a change to these can make real differences to the discharge of contaminants.

Treatment Devices

The development of treatment devices provides an opportunity for innovation – for the benefit of both the client and the environment.

There are several design guidelines available in NZ which provide ideas and guidance for the choice of stormwater treatment devices. The most widely used are the ARC's TP10, Christchurch City Council Waterways, Wetlands and Drainage Guide, and the WERF On-Site Stormwater Management Guide. However, these guidelines are based on treatment for general urban runoff, and not specifically for industrial applications.

Preferred treatment devices for industrial applications include wetlands or ponds, raingardens, or sand filters. There are proprietary devices in the market place, which might be useful depending on the individual contaminant load.

A key issue for industrial landowners is the footprint area of a chosen device. Loss of land to a device such as a wetland or raingarden is often considered too expensive. However, these types of vegetated devices are proving to be the best for treating industrial contaminants.

Raising the Bar - LIUDD Principles for Site Design

While emergency spill procedures, environmental management plans and treatment devices are all well recognised ways for dealing with the management of stormwater on industrial sites, better environmental outcomes can be maximised by the use of collaboration across the design team with the application of low impact urban design principles.

Low impact or water sensitive design has been used for many years for stormwater management. It is a significant concept in Australia, where the capture and re-use of stormwater is highly desirable. It is widely used in the developed world for improvement of the water quality of stormwater discharges. Primary ideas include the reduction of impervious surfaces, the choice of materials at source to reduce impacts (eg inert roofing materials or green roofs), separation of contaminated from uncontaminated stormwater, attenuation of excess stormwater to reduce peak flows, through to the use of vegetated devices which provide habitat even while they provide a treatment function.

The low impact urban design and development (LIUDD) research programme led by Landcare Research, NZ, from 2003 – 2009 advocates the use of LIUDD. This implies the integration of low impact stormwater objectives with those of urban design. (Landcare 2009). NZ planners will have had updates of this work as it progressed, as have stormwater engineers at the annual NZ Water Stormwater Conference.

Low impact urban design principles are most often associated with residential subdivision. Ideas such as using cluster housing and providing bigger and better community open space; the use of green corridors for ecological enhancement as well as cycle or walkway linkages through an urban environment; re-use of stormwater and treatment devices and the aim of improving the urban living environment.

Many of the benefits that can be gained in the residential environment can be gained in the industrial environment also. Industrial and commercial sites have high percentages of imperviousness. Many district plans require landscaping only as a street frontage feature, with the remainder of the site being completely covered.

The high cost of industrial land is a driver in this equation. While the reduction in imperviousness is not realistic, there are other aspects that can be applied usefully.

With the development of the new brewery site for Lion Nathan at East Tamaki, the opportunity was available to for integration across the disciplines, which also led to the achievement of sustainable stormwater outcomes. Early collaboration between the architects, landscape architects, stormwater and process engineers on Lion's Project Century led to an on-going relationship which enabled LID principles to be included on the site. A sound relationship between Lion and MCC also provided room for alternative approaches to the stormwater financial contributions.

Amongst a suite of consents required for the site was the ARC's ITP consent. Stormwater treatment was required. Discussion between Beca and Thresher, landscape architects, led to the integration of the stormwater treatment into a landscape story – reading the site from left to right, the water flows through a raingarden, along an industrial style channel, and into the wetland. Plant types have been incorporated to achieve the visual lines required by the client, and to provide an interesting approach to the site.

While impervious surface cannot be reduced, careful attention to site design means that separation of contaminant sources has been achieved wherever possible. In some cases, this has been by roofing, and in others, by variations on bunding and drainage to trade waste. Disposal of stormwater to trade waste is not an acceptable practice. The can crushing plant, which operates infrequently, is sited outside, and the ground area on which it sits is drained to a trade waste drain. This area has been minimised to meet trade waste requirements, but has allowed for the ARC's water quality volume to be collected. The footprint area associated with the delivery of bulk cleaning products (eg caustic soda) – in very significant quantities – is bunded, and permanently drained to trade waste. Trucks will need to park inside the bunding to achieve hose connections for delivery. Other process areas are bunded, with isolating valves for connection to either trade waste or stormwater, depending on the operation status of the equipment.

An important part of overall site management is that these source control aspects are documented in the environmental management plan, with a record of the appropriate standard operating procedures. In turn, the operation and maintenance of these stormwater features is then required in terms of the consent.

Another feature of the stormwater management outcome for Project Century was the use of the existing stormwater pond at the south end of the site for stormwater quality purposes. Land uses on the southern part of the site are principally associated with truck movements, and loading of product to containers for trucking off-site. As there is low risk of spill in this area, the use of an existing facility was considered appropriate. An agreement with MCC enabled this, and MCC are currently upgrading the pond to a wetland, capable of treating stormwater from the wider catchment. In our efforts to provide stormwater treatment for Auckland's water bodies, a realistic approach to minimising the number and type of facilities is an important consideration in the achievement of sustainable infrastructure. Although not strictly a low impact design consideration, the maintenance requirements for a multitude of stormwater devices is significant. Any opportunity for minimising the maintenance workload while maximising urban design objectives must be realised.

Conclusions

Stormwater management is important on industrial sites due to the potential range and quantity of contaminants which could reach the stormwater receiving environments. Standard methods for management, such as environmental management plans, spill procedures and treatment devices provide a sound approach.

However, the integration of LIUDD principles into the site design process, by good collaboration across the design team, can provide better environmental outcomes – both for the receiving water habitats and for the urban environment. It provides an opportunity for innovation both in the site design and in the use of stormwater treatment devices. The Lion Nathan brewery development in East Tamaki is an example of good collaboration across a large multi disciplinary project, and has achieved a sustainable stormwater solution.

While there are large areas of industrial activity in NZ which require attention for cleaning up, it is predicted that newly zoned land will be required for industrial and commercial purposes. These greenfields industrial areas should be designed in accordance with low impact and sound urban design principles and objectives, teamed with innovative engineering techniques. This collaboration across the disciplines will provide a sound approach to the protection and enhancement of our freshwater and marine environments.

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