

HAWKE'S BAY WATERWAY GUIDELINES

⊕ INDUSTRIAL STORMWATER DESIGN



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Hawke's Bay Waterway Guidelines

Industrial Stormwater Design

Prepared by:
Earl Shaver, Aqua Terra International Ltd

Reviewed by:
Gary Clode, Manager - Engineering

Acknowledgement

This document for the Hawke's Bay Region is based primarily on the "Stormwater Management Guidelines for the Hawke's Bay Region" for stormwater processes that remove contaminants. The listing of industries, contaminants generated and appropriate stormwater management practices is based on a table done by Campbell Sturrock with assistance from Mike Timperley and Earl Shaver. Earl Shaver has expanded the treatment options in the Table.

Note

This document is a living document and may be reviewed from time to time as industry standards change and best practice evolves. Please contact Hawke's Bay Regional Council to ensure the latest version is used.

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Contents

1	Introduction	1
2	Source Control and Housekeeping	2
	2.1 Importance of having site plans	2
	2.1.1 Stormwater pipes, their inlets and outlets	3
	2.1.2 Outdoor areas	3
	2.1.3 Stormwater and wastewater systems	3
	2.2 Housekeeping	4
3	Industries, Contaminants and Treatment Practices	7
4	Stormwater treatment practices	13
	4.1 Stormwater Management Ponds	13
	4.2 Constructed wetlands	14
	4.3 Sand and Sand/Peat Filters	14
	4.4 Rain gardens	15
	4.5 Infiltration practices	16
	4.6 Swales and filter strips	17
	4.7 Oil and water separators	17
	4.8 Oxidation	18
5	Conclusion	19

1 Introduction

Industrial sites are potentially significant sources of contamination to receiving systems. Their impact can be disproportional to their size as they may have significant storage of chemicals, have operations that involve a variety of chemicals and drainage systems that quickly convey the contaminants to receiving systems. Receiving systems are discussed in some detail in the 'Stormwater Management Guidelines for the Hawke's Bay Region' and each of the receiving environments mentioned could be encountered on or near an industrial site. Those receiving environments discussed in the Stormwater Guidelines include:

- Streams and rivers,
- Ground,
- Estuaries,
- Harbours,
- Open coasts, and
- Lakes

Industrial sites also must continually guard against spillage of chemicals and protect storage areas from coming into contact with stormwater and must develop and implement operational plans that are risk based to prevent adverse impacts to receiving systems. This guideline provides a brief discussion of a number of issues related to the establishment and operation of an industrial activity.

This guideline will provide a discussion of the following items:

- Source control and site housekeeping,
- Industries, contaminants of concern and appropriate treatment practices, and
- Stormwater treatment for contaminant reduction.

Each of these items is a significant element in developing an effective site management plan and the elements need to be done in conjunction with one another to minimise adverse impacts to receiving systems.

Example of a Waste Bin Leaking Paint into the Stormwater Drainage System



2 Source Control and Housekeeping

Initial consideration has to be given to source control and preventing discharge of contaminants in the first place. This can only be done when there is a good understanding of site operations, areas potentially draining contaminants and the site drainage system. These items can be considered if there is an up-to-date site plan.

2.1 Importance of having site plans

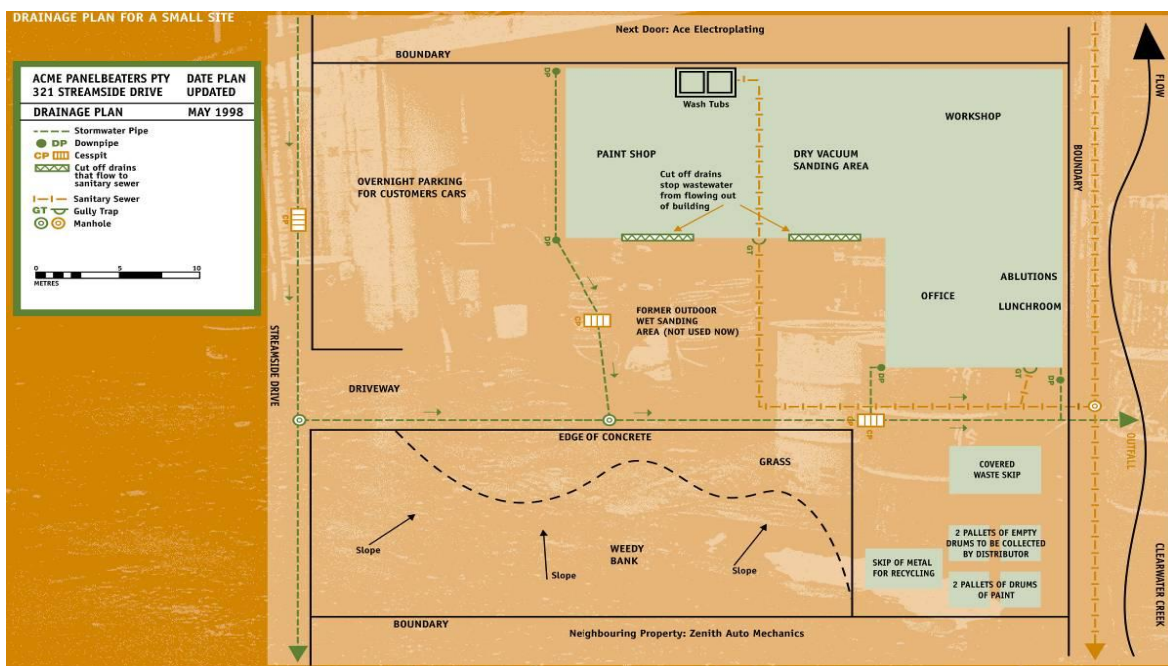
A site plan has to be available that shows the following:

- Buildings,
- All outdoor areas,
- Site boundaries and adjacent land use, and
- Stormwater and wastewater systems.

Figure 2-1 shows a typical site plan for an industrial site.

When considering the drainage plan, the following elements need to be considered as part of the drainage system.

Figure 2-1
Typical Industrial Site Showing Various Site Elements



- Stormwater pipes, their inlets and outlets,
- Any open drains,
- Direction of stormwater flows and overland flowpaths,
- Low points on the site,
- Areas where runoff leaves the site (ground or surface water),
- Stormwater management practices, and
- Any evidence of a cross-connection between the stormwater and wastewater system.

2.1.1 Stormwater pipes, their inlets and outlets

The site drainage system will outfall into one of three systems:

- A council reticulation system that will eventually outfall into a stream, lake, ground, estuary, harbour or open coast environment,
- A soak hole or general soakage into the ground, or
- A stream, estuary, lake, harbour or open coast environment.

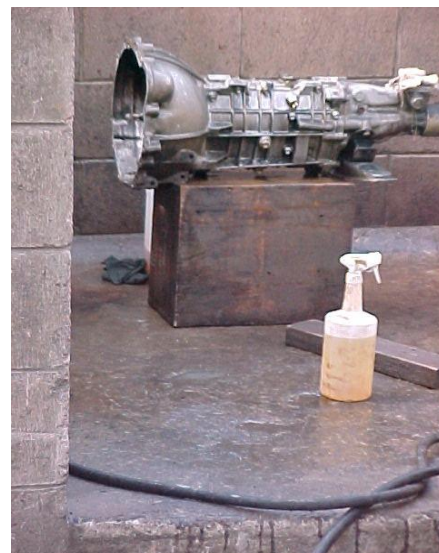
It is important to know what the eventual receiving system is in order to determine the potential impact of contaminants to that system.

2.1.2 Outdoor areas

Spills and leaks from outdoor activities can easily get into the stormwater system. It is important to know where these activities drain to in the event of a spill. Examples of outdoor activities include:

- Loading and unloading areas,
- Decanting areas,
- Refueling and lubricating areas,
- Washdown areas, or
- Permanent or temporary areas for storage of materials.

Example of Degreasing Where the Runoff Could Enter the Stormwater Systems



2.1.3 Stormwater and wastewater systems

Stormwater systems are those that accept surface runoff related to rainfall, while wastewater systems can include the following elements:

- Sanitary or trade waste sewers,
- Gully traps,
- Internal floor drains,
- Manholes, or
- Trade waste connections.

It is important to recognise that stormwater systems should not be used for wastewater disposal. Cross-connections are a major source of contaminant entry into stormwater systems.

Cross-connections can be a problem, especially for older sites where waste pipes are connected to the stormwater system. These can include:

- Boiler blowdown waters,
- Compressor condensates,
- Cooling water,
- Sewage,
- Trade wastes, and
- Wash waters.

If cross-connections are found, the issue should be discussed with the local council and disconnect the cross-connection as soon as possible by connecting the waste pipe to the sanitary sewer.

2.2 Housekeeping

Inspections can reveal housekeeping problems and any of the following items indicate the need for improved site housekeeping:

- Stains or corrosion of any surface, including along concrete heading towards grates or around grates,
- Marks on or near any stormwater grate or stormwater cesspit or materials in the indicating that anything other than clean rain water has gotten into them,
- Stormwater grates that are blocked with solids like grass, plastic or litter,
- Puddles, discolouration, oil or grease or chemicals on the ground,
- Leaking or corroded equipment, valves, seals, containers or lines,
- Areas where absorbent materials (kitty litter, sawdust) have been used to clean up a spill but not properly removed,
- Outdoor bunds where stormwater valves have been left open or are not securely locked,
- Litter or waste thrown behind buildings, over fences, onto foreshore or river banks,
- Containers that are stored in the open that could contain residues, show signs of corrosion or leaks or torn bags,
- Leaks, overflows or spills from tanks, valves, pumps or drip trays,
- Containers unsafely stacked on top of each other or
- Containers that are not clearly labeled or not labeled at all.

Example of Staining that Indicates Discharge of Contaminants into the Stormwater System



Washdown areas are another source of contaminant discharge to receiving systems. Issues related to washdown areas can include the following:

- Washdown areas being routinely cleaned after washing to ensure that contaminants removed by the washing operation do not enter the stormwater system,
- Equipment being routinely maintained so that they do not produce excessive contaminants when washing is done, and
- Washdown is done in designated areas.

Loading, unloading, material handling and decanting areas are another source of contaminant generation and potential discharge. These areas need to be considered for contaminant generation with examples being the following:

- Spills caused by decanting liquids. This issue can be reduced by using funnels, drip trays, buckets or other devices to catch liquids,
- Checking drip trays routinely to ensure that they do not become overly full,
- Filling and transferring materials procedures, and
- Checking valves, pumps, flanges, seals, pipe connection points for bulk tanker deliveries for leakage.

Storage of Funnels that Minimise Spillage During Liquid Transfer



Storage areas are another area that needs to be considered for contaminant generation. These can include:

- Raw materials/supply stores,
- Dangerous goods stores,
- Finished goods stores,
- Other materials such as cleaning agents, detergents or weed killers.
- Metal drums and vessels, or
- Containers or bags.

Bunded areas are areas where substantial quantities of chemicals are stored and have a protective bund around the storage area to capture chemicals in the event of a sudden rupture or leak releasing the chemicals. Bunds need to be sized appropriately (normally 110% of tanks storage volume) and routinely inspected with the inspection including the following:

- Valves,
- Locks or other controls on valves,
- Stains or leaks inside and around the bunds,
- Crash barriers, and
- Pipework across roofs to prevent leakage into the stormwater drainage system.

Refuelling, vehicle maintenance and oil storage areas are also potential sources of contaminant generation and potential discharge to stormwater systems. Contamination potential can be reduced through the following activities:

- Regularly cleaning around pumps, refuelling areas,
- Lubrication materials, vehicle maintenance and oil storage being checked and cleaned as needed,
- Checking and maintaining shut-off valves,
- Routine maintenance of company vehicles to prevent leaks,
- Proper storage of waste oil and routine removal of the waste oil from the site, and
- Radiator fluids disposed of as a trade waste.

A Bunded Refuelling Tank



Finally, underground and above ground storage tanks need to be carefully considered for the following:

- Tank labelling to show contents,
- Procedures for filling tanks to minimise risk of overfill, drips or spills,
- Inspection and maintenance of equipment, and
- Volume indicators that can be checked to ensure there is no leakage.

All of these activities constitute source control on industrial sites. While they may provide significant reductions in contaminant generation, they will not normally be adequate for effective site control. There will normally be a need for a stormwater management treatment system as an overlay.

The combination of source control in conjunction with implementation of stormwater quality treatment will provide the best outcome from a contaminant capture perspective.

3 Industries, Contaminants and Treatment Practices

The following table 3-1 provides a detailed listing of industries, the contaminants that they generate, the likelihood that those contaminants will be released into the environment and the types of stormwater practices that can be used to reduce the level of a given contaminant from being discharged.

**Table 3-1
Industrial Activities, their Description, Contaminants of Concern, Likelihood of Release and Treatment Practices**

Industrial Activity	Description of Trade	Contaminants of Concern	Likelihood of Release	Treatment Processes
Wood or paper product storage, manufacturing or fabrication	Treated timber storage	Cu, Cr, As, TSS	High	Settling, sand/peat filter
Wood or paper product storage, manufacturing or fabrication	Timber treatment	Cu, Cr, As, Sn, TSS, Oil and Grease, pesticides	High	Sand/peat filter
Transport and related activities	Boat or ship construction, repair or maintenance	Cu, Zn, TSS, Oil and Grease	High	Settling, oil/water separator, sand/peat/carbon filter
Research or defence	Naval and air force defence activities	Metals, pesticides, oil and grease	High	Settling, oil/water separator, sand/peat/carbon filter
Recycling, recovery, reuse or disposal	Metals (crushing, grinding, sorting or storage)	Oil and grease, TSS, Zn, Cu, Pb, Cd, Cr	High	Oil/water separator, sand/peat/carbon filter
Recycling, recovery, reuse or disposal	Automotive dismantling	Oil and grease, TSS, particulate metals, Zn, Cu, Pb, Cd, Cr	High	Coarse settling, oil/water separator, sand/peat/carbon filter
Metal processing, metallurgical works or metal finishing	Processing of metals (smelting, casting)	Metals (Al, Pb, Zn, Cu, Fe), TSS, pH	High	Sand/peat/carbon filter
Metal processing, metallurgical works or metal finishing	Metal plating, anodising or polishing	Metals (Zn, Cu, Cr, Ni, Ag), pH, Cyanide	High	Peat filter
Transport and related activities	Marinas	TSS, Zn, Cu	Medium	Peat filter
Sewage treatment and handling	Sewage treatment plants	TSS, BOD, NO ₃ +NO ₂ , NH ₃ , Pathogens	High	Settling, wetlands, disinfection
Sewage treatment and handling	Sewage solids storage	TSS, BOD, NO ₃ +NO ₂ , NH ₃ , Pathogens	Low	Settling, wetlands, disinfection
Rubber industries	Synthetic rubber manufacturing	Zn, TSS, organics	Medium	Wetlands
Recycling, recovery, reuse or disposal	Tyres	Zn, TSS	High	Sand/peat/carbon filter
Recycling, recovery, reuse or disposal	Chemical containers cleaning, reconditioning or recycling	Metals, COD, NO ₃ + NO ₂	Medium	GPT screen, coarse settling, oil/water separator, oxidation sand/peat/carbon filter
Recycling, recovery, reuse or disposal	Waste transfer stations	GPs, TSS, COD, Metals, Oil & Grease, residual organic compounds	Medium	GPT screen, coarse settling, oil/water separator, oxidation, sand/peat/carbon filter
Recycling, recovery, reuse or disposal	Hazardous materials storage or treatment	TSS, COD, Metals, Oil and Grease, organics	Medium	Sand/peat/carbon filter

Recycling, recovery, reuse or disposal	Non-metal recycling (composting, glass, paper or paper board)	TSS, COD, NO ₃ + NO ₂ , pathogens	High	Wetlands + oxidation
Recycling, recovery, reuse or disposal	Crushing, grinding or separation works (other than sand, gravel, rock or mineral - e.g. slag, road base, demolition material)	TSS, pH, Zn	High	Sand/peat filter, wetlands
Recycling, recovery, reuse or disposal	Landfills	Metals, TSS, BOD, NO ₃ +NO ₂ , NH ₃ , organics	Low	Coarse settling, oil/water separator, oxidation, sand/peat/carbon filter
Recycling, recovery, reuse or disposal	Chemicals	Fe, Al, pH, NO ₃ +NO ₂ , metals, organics	Low	Sand/peat/carbon filter
Recycling, recovery, reuse or disposal	Batteries	Pb, pH	Low	Sand/peat filter, carbonate filter
Product storage or handling centres	Bulk chemicals	AL, Fe, Zn, NO ₃ +NO ₂	Medium	Sand/peat/carbon filter
Petroleum or coal product manufacturing	Coal products	TSS, AL, Fe, pH	Medium	Settling, wetlands
Non-metallic mineral product manufacturing	Cement, lime, plaster and concrete products	TSS, Fe, pH, Oil and Grease	High	Settling, wetlands
Non-metallic mineral product manufacturing	Concrete batching plants (ready mixed concrete)	TSS (lime), pH	High	Settling, wetlands
Motor vehicle services facilities	Mechanical servicing of motor vehicles	Oil and grease, metals	High	Sand/peat/carbon filter
Motor vehicle services facilities	Service stations	Oil and grease, PAH, BTEX, TSS	High	Oil/water separator, sand filter, oxidation
Metal processing, metallurgical works or metal finishing	Refinement of ores	TSS, metals	Medium	Settlement, wetland
Metal processing, metallurgical works or metal finishing	Metal blasting or coating (excluding spray painting)	Zn, other metals, TSS	High	Sand/peat filter
Electronics	Circuit board manufacturing (excluding assembly only)	Metals (Zn, Cu, Cr, Ni), pH, organics	Medium	Sand/peat filter
Commercial livestock processing centres	Tanneries and Felmongeries	BOD, oil and grease, sulfides, Cr, N	High	Oil/water separator, oxidation, peat filter
Chemical and associated product manufacturing	Fungicides, herbicides, pesticides, timber preservatives and related products	COD, pH, As, Cu, Cr, Pesticides	Medium	Sand/peat/carbon filter

	Batteries	Pb, pH	Medium	Sand/peat filter, carbonate filter
Chemical and associated product manufacturing	Batteries		Medium	
Chemical and associated product manufacturing	Paint, pigment, inks and dyes	Al, Zn, Fe, COD, organics	Medium	Sand/peat/carbon filter
Chemical and associated product manufacturing	Acids, alkalis or heavy metals	PH, TSS, metals	Medium	Sand/peat/carbon filter, carbonate filter
Transport and related activities	Railway workshops or refuelling depots	Oil and grease, TSS, COD, Zn	Medium	Settlement, sand/peat filter
Transport and related activities	Road freight transport depot (bulk chemical)	Oil and grease, TSS, COD, Zn, organics	Medium	Sand/peat/carbon filter, oxidation
Transport and related activities	Truck refuelling facilities (non-service station)	TPH, PAH	Medium	Sand/peat filter
Transport and related activities	Shipping container reconditioning	Oil and grease, TSS, COD	Medium	Oil/water separator, Settlement
Rubber industries	Tyre manufacturing or retreading	Zn, TSS, organics	Medium	Sand/peat filter
Recycling, recovery, reuse or disposal	Oil, petroleum hydrocarbon wastes	Oil and grease, PAH, BTEX	Medium	Oil/water separator, sand/carbon filter
Recycling, recovery, reuse or disposal	Sewage solids treatment or storage facilities	TSS, BOD, NO ₃ +NO ₂ , Pathogen	Medium	Retention, oxidation
Product storage or handling centres	Bulk hydrocarbons (non-service stations)	Oil and grease, PAH, BTEX	Medium	oil/water separator, sand/peat/carbon filter
Power	Gas, coal or liquid power generation	Oil and grease, Zn, TSS	Medium	oil/water separator, wetlands
Power	Electrical substations	Oil and grease	medium	Sand filter
Petroleum or coal product manufacturing	Bitumen/asphalt premix or hot mix	TSS, Zn, TPH	Medium	oil/water separator, Sand/carbon filter
Animal feedstuffs	Pet food manufacture	BOD	Medium	Sand/peat filter, swales
Agriculture support industries	Inorganic fertiliser manufacture, storage or handling	COD, TSS, Pb, Fe, Zn, P	Medium	Sand/peat filter, high plant surface area and soil organics
Wood or paper product storage, manufacturing or fabrication	Log storage yards (outside of forested areas)	TSS, COD, NO ₃ +NO ₂	High	Wetlands
Chemical and associated product manufacturing	Synthetic resins	TPH, pH, Zn	Low	Sand/peat filter
Chemical and associated product manufacturing	Solvents	TPH	Low	Sand filter
Chemical and associated product manufacturing	Explosives and pyrotechnics	Metals (Pb, Zn), VOC's	Low	Sand/peat/carbon filter

Wood or paper product storage, manufacturing or fabrication	Particle board or other wood panel manufacturing	TSS, COD, NO ₃ +NO ₂ , oil and grease	Medium	GPT, Settling, sand filter
Wood or paper product storage, manufacturing or fabrication	Pulp, paper or paper board manufacturing	TSS, COD, NO ₃ +NO ₂ , oil and grease, Zn	Medium	Wetlands, oil/water separator
Wood or paper product storage, manufacturing or fabrication	Plywood or veneer manufacturing	TSS, COD, NO ₃ +NO ₂ , organics	Medium	Wetlands
Transport and related activities	Shipping, loading/unloading	Oil and grease, TSS, COD	Medium	Oil/water separator, sand/peat filter
Transport and related activities	helports	Oil and grease, TSS, COD		Oil/water separator, sand/peat filter
Transport and related activities	Toad freight transport depot (non-chemical) with mechanical servicing	Oil and grease, TSS, metals	High	Oil/water separator, sand/peat filter
Petroleum or coal product manufacturing	Petroleum refining	Oil and grease, PAH, BTEX	Medium	Oil/water separator, sand/carbon filter
Petroleum or coal product manufacturing	Petroleum hydrocarbon, oil or grease manufacturing	Oil and grease, PAH, BTEX	Low	Oil/water separator, sand/carbon filter
Non-metallic mineral product manufacturing	Glass	Oil and grease, BOD, TSS	Medium	Oil/water separator, sand/peat filter
Metal product manufacturing	Sheet and structural metal products	Fe, Al, Zn	Medium	Sand/peat filter
Machinery or equipment manufacturing	Other machinery or equipment	Oil and grease, Fe, Al, Zn	Medium	Sand/peat filter
Machinery or equipment manufacturing	Industrial machinery or equipment	Oil and grease, Fe, Al, Zn	Medium	Sand/peat filter
Food or beverage manufacturing or handling	Vineyards or wine manufacturing	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Processed dairy foods manufacturing	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Oil or fat product manufacturing or handling	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Meat and meat product manufacture (including fish)	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Processed dairy foods handling	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Other foodstuffs handling	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area

Food or beverage manufacturing or handling	Meat product handling (including fish)	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Beverages or malt product handling	BOD, TSS, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Bakery product handling	BOD, TSS, oil and grease	Medium	Oil/water separator, high plant activity and surface area
Commercial livestock processing industries	Slaughter	BOD, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Commercial livestock processing industries	Manufacture, store or handle products derived from animal slaughter (gelatin, fertiliser or meat products)	BOD, oil and grease, N	Medium	Oil/water separator, high plant activity and surface area
Commercial livestock processing industries	Scouring or carbonising greasy wool or fleeces	BOD, oil and grease, N	Medium	Oil/water separator, oxidation
Commercial livestock processing industries	Rendering or fat extraction	BOD, oil and grease	Medium	Oil/water separator, oxidation
Chemical and associated product manufacturing	Other chemical products (plastic manufacturing)	pH, TSS, Zn, N	Low	Sand/peat filter
Chemical and associated product manufacturing	Polishes, adhesives or sealants	BTEX, pH, Zn	Low	Sand/peat/carbon filter
Chemical and associated product manufacturing	Medicinal, pharmaceutical or veterinary products	COD, As, Cd, Cr, Phenol	Low	Sand/peat/carbon filter
Chemical and associated product manufacturing	Industrial gas	N, pH, TSS	Low	Sand filter
Animal feedstuffs	Stock food manufacture storage or handling	BOD, TSS	Medium	Swale/high plant surface area and soil organics
Transport and related activities	Bus depots	Cu, Zn, TSS, TPH, PAH	Low	Sand/peat/carbon filter
Transport and related activities	Commercial airports	Oil and grease, TSS, COD	Low	Settling, oil/water separator, sand/peat/carbon filter
Machinery or equipment manufacturing	Motor vehicles or parts	Oil and grease, Fe, Al, Zn	Low	Sand filter
Food or beverage manufacturing or handling	Other foodstuffs manufacturing	BOD, TSS, oil and grease, N	Low	Oil/water separator, high plant activity and surface area
Food or beverage manufacturing or handling	Flour mill or cereal foods	BOD, TSS, oil and grease, N	Low	Oil/water separator, high plant activity and surface area
Chemical and associated product manufacturing	Cosmetics, toiletry, soap and other detergents	Zn, N	Low	oil/water separator, oxidation, peat filter

BTEX is an acronym standing for benzene, Toluene, ethylbenzene, xylenes that are volatile organic compounds (VOCs) found in petroleum products
Carbon filters are effective at removing sediment and VOCs

There may be variations to each of the categories listed in Table 3-1 and consideration needs to be given to Table 3-2 for the contaminant removal processes that are listed.

Table 3-2 Summary of Contaminant Removal Mechanisms		
Mechanism	Contaminants Affected	Removal Promoted By
Physical sedimentation	Solids, BOD, pathogens, particulate COD, P, N, metals, synthetic organics	Low turbulence
Filtration	Same as sedimentation	Fine, dense herbaceous plants, constructed filters
Soil incorporation	All	Medium-fine texture
Chemical precipitation	Dissolved P, metals	High alkalinity
Adsorption	Dissolved P, metals, synthetic organics	High soil Al, Fe, high soil organics, neutral pH
Ion exchange	Dissolved metals	High soil cation exchange capacity
Oxidation	COD, petroleum hydrocarbons, synthetic organics	Aerobic conditions
Photolysis	Same as oxidation	High light
Volatilisation	Volatile petroleum hydrocarbons and synthetic organics	High temperature and air movement
Biological microbial decomposition	BOD, COD, petroleum hydrocarbons, synthetic organics	High plant surface area and soil organics
Plant uptake and metabolism	P, N, metals	High plant activity and surface area
Natural die-off	Pathogens	Plant excretions
Nitrification	NH ₃ -N	Dissolved oxygen > 2mg/l, low toxicants, temperature > 5-7°C, neutral pH
Denitrification	NO ₃ +NO ₂ -N	Anaerobic, low toxicants, temperature > 15°C

4 Stormwater treatment practices

It may provide some value to have a brief discussion of stormwater management practices relating to their appropriateness in providing water quality treatment for industrial sites. These practices are all listed in the ‘Stormwater Management Guidelines for the Hawke’s Bay Region’ and most of them are appropriate for treating industrial sites.

The use of infiltration practices as a water quality treatment practice is discouraged on industrial sites. The ground is itself a receiving system and contaminants may migrate to groundwater and be discharged into another receiving system (stream, estuary, harbour, open coast, lake). Where infiltration of stormwater runoff is anticipated, treatment should be provided prior to the infiltration practice to prevent migration of contaminants to groundwater.

In addition, there is no discussion of proprietary products for treatment of industrial sites. The consideration of these practices has to be done in accordance with Section 10 of the ‘Stormwater Management Guidelines for the Hawke’s Bay Region’ to ensure that the proprietary product is suitable for a specific contaminant reduction. The Hawke’s Bay Regional Council should be contacted for information on these practices.

The following discussion relates to a number of practices in the ‘Stormwater Management Guidelines for the Hawke’s Bay Region’. A practice not included is green roofs as they are not normally used for site treatment.

4.1 Stormwater Management Ponds

Basic water quality function processes

Stormwater management ponds, having primary focus for stormwater quality, normally have a permanent pool of water. These ponds can, through their normal storage of water or in conjunction with extended detention, provide water quality treatment.

The primary contaminant removal mechanism of all pond systems is settling or sedimentation. They can be effective at removal of suspended solids (50% – 90%) and have lesser effectiveness for removal of metals, whose removal is primarily through attachment to sediments that may be captured in ponds.



4.2 Constructed wetlands

Basic water quality function processes

Wetlands can provide the same sedimentation benefits of deeper ponds but they also provide additional treatment through mechanisms that do not exist in deeper ponds. Those mechanisms include the following:

- Biological degradation, sedimentation, microbial uptake of organic material
- Adsorption, volatilisation, photosynthesis, and biotic/abiotic degradation of organic contaminants
- Sedimentation, filtration of suspended solids
- Sedimentation, nitrification/denitrification, microbial uptake, plant uptake, volatilisation for nitrogen removal
- Sedimentation, filtration, adsorption, plant and microbial uptake for phosphorus removal
- Natural die-off, sedimentation, filtration, predation, UV degradation, adsorption for pathogens
- Sedimentation, adsorption, plant uptake for heavy metal reduction



The accumulation of organic matter from dead plant material also promotes contaminant removal. High-density wetland vegetation is likely to achieve higher treatment efficiency than lower density because the larger surface contact area supports more microorganisms that mediate contaminant removal processes.

4.3 Sand and Sand/Peat Filters

Basic water quality function processes

Sand filters reduce contaminants by a variety of chemical, physical and biological processes. In some cases the contaminants are transformed (decomposition, decay) and in other cases they simply accumulate in the filter media. The removal processes include:

- Sedimentation
- Adsorption
- Volatilisation
- Filtration
- Biological processes



While sand is a fairly sterile media, other processes do occur related to the capture of contaminants such as oil and grease, which form an organic biofilm that facilitates removal of metals. This is more of a by-product of system performance rather than a design one.

Sand/peat filters or sand/peat/carbon filters operate similarly to sand filters although sand/peat filters, by addition of peat, use the peat due to its organic content to remove soluble metals through adhesion of the metals to the organic particles. The use of carbon is of value for removal of organics as chemical absorption takes place as carbon is activated by a positive charge and attracts negatively charged contaminants. Carbon is not effective at removal on dissolved inorganic compounds. In terms of industrial sites, wherever dissolved metals are contaminants of concern, peat will probably be used in a 50:50 blend to facilitate removal of the metals. When activated carbon is used as a media, the proportion should be 45:45:10 with 10% being activated carbon.

4.4 Rain gardens

Basic water quality function processes

Rain gardens include the same contaminant removal mechanisms that sand filters do but also include additional processes that can further improve water quality performance. Topsoil can be very effective in removing heavy metals through organic complexing. Soil bacteria can metabolise oil, grease, and petrol and plants uptake, transpire, accumulate and detoxify metals and many other toxic compounds.



Rain gardens have lower permeability rates than do sand filters due to the blending of topsoil into the sand. As such they would require a greater surface area than do sand filters so their selection in lieu of sand filters should be based on the need to reduce soluble metals as a primary consideration. If they are not present or hydrocarbons are the primary contaminant of concern then sand filters could be used.

4.5 Infiltration practices

Basic water quality function processes

Infiltration practices direct stormwater runoff away from surface runoff paths and into the underlying soil. This is very different from using practices that have underdrains, which then would be considered as subsurface detention practices. Most infiltration practices used in the Auckland Region are in reality detention practices due to having underdrains on the clay soils that are so prevalent around the Region. Where surface runoff systems (ponds, wetland, filters, etc.) direct water to streams or estuaries, infiltration practices direct the runoff to groundwater. They comprise a suite of practices including trenches, dry wells and permeable pavement.

The use of infiltration practices on industrial sites should be restricted or at least considered with caution. Infiltration practices are sensitive to clogging and run the risk of transporting contaminants to groundwater.

From a water quality perspective the following specific processes alter the quality of infiltrating water during ponding and subsurface travel:

- Filtration
- Adsorption
- Biodegradation
- Growth of micro-organisms
- Chemical oxidation and reduction
- Chemical precipitation and dilution
- Volatilisation
- Photochemical reactions



Soils vary in their ability to filter and adsorb and a greater discussion of their processes is probably beyond what is desired here.

4.6 Swales and filter strips

Basic water quality function processes

Contaminant removal depends on the residence time of water through the swale or filter strip and the depth of water relative to the height of vegetation. Good contact with vegetation and soil is required to promote the operation of the various mechanisms that capture and transform contaminants, so spreading flow in minimal depth over a wide area is best.

The passage of stormwater through vegetated swales and filter strips utilises a number of physical, chemical and biological processes to remove stormwater contaminants. Those factors include the following:

- Reduction of flow speed by vegetation to improve settlement
- Filtration by dense vegetation
- The rough nature of the soil/vegetation interface which improves retention of settled material and reduces resuspension
- Some infiltration of runoff depending on soil conditions
- Contact between stormwater contaminant and the abundant organic matter in swales which can result in adsorption
- Existence of micro-organisms which degrade organic contaminants
- Uptake of contaminants by plants



Although the 'Stormwater Management Guidelines for the Hawke's Bay Region recommends a flow residence time of 9 minutes, significant water quality benefits can be gained by smaller residence times. Metals reductions can be significant even with shorter residence times although TSS reductions will be somewhat less.

4.7 Oil and water separators

Basic water quality function processes

Oil and water separators are applicable to treat stormwater runoff from areas where hydrocarbon products are handled or where small spills routinely fall on paved surfaces exposed to rain. They are not usually applicable for general urban runoff, because by the time the oil reaches the device it has emulsified or coated sediment in the runoff and is too difficult to separate.



Oil and water separators have significant benefits for spill containment. Spills enter the separator and mix with the water. Then the oil in the spill will rise to the surface. All separators should hold the 2500 litres of oil that is the industry standard. Grease and oil will be present as oil droplets of different sizes or as a surface slick.

Oil products have a specific gravity that is lighter than water. The actual specific gravity depends on water temperature and the density of the oil. Oil and water separators use the fact that oil entering the separator will rise to the surface of the water and be prevented from exiting by the presence of baffles. The use of oil specific gravity of 0.9 is considered appropriate for general use as diesel has a specific gravity of 0.85, kerosene of 0.79 and gasoline has a specific gravity of 0.77.

4.8 Oxidation

While not discussed as a practice in the 'Stormwater Management Guidelines for the Hawke's Bay Region', oxidation is mentioned as a treatment practice for some industrial contaminants.

Oxidation is the interaction between oxygen molecules and all of the various substances that they interact with. It involves the loss of at least one electron when two or more substances interact. From an industrial contaminant perspective, oxidation is the assurance of an aerobic environment for promotion of contaminant reduction. This can be done mechanically or by ensuring that anaerobic conditions do not develop.

Where oxidation is listed as a treatment process, wetlands should not be used. Wetlands may become anaerobic over the summer months, which will reduce potential to deal with certain contaminant conditions.

5 Conclusion

Implementation of source control for all industrial sites is a responsibility that all industries in the Region should accept. Source control is good business as chemicals used in the industrial operation can cause contamination if they are discharged off site. Reducing contaminant discharge results in less wastage of chemicals, which has benefits in terms of reduced purchase of chemicals. Having leaky pipes costs money, as chemicals are lost.

Source control can be as simple as recycling materials, such as the following:

- Oil,
- Solvents,
- Aluminium, steel and other metals,
- Glass,
- Cardboard, or
- Newspaper and office paper.



Industries listed in Table 3-1 that have a high likelihood of release should have an aggressive source control programme to reduce contaminant discharge. A number of these high potential contaminant release industries may have to implement stormwater treatment to provide adequate site control, but source control is absolutely essential if aquatic receiving systems are to remain healthy.