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Water quality study of the Muchea livestock truck wash

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Resource management technical report 420

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Summary

Across Australia there is a lack of information on the quality of the water discharged from facilities that are used to wash livestock trucks. This water quality scoping study partially fills that information gap and provides a starting point for future planning, design and construction of livestock truck washes.

The study was undertaken in 2011–12 at the Western Australian Muchea Livestock Centre, and aimed to gain insights into water quality associated with the truck wash facility at that site. These insights can help to inform the planning for further construction of truck wash facilities throughout the state, and whether disposing wastewater to Water Corporation's sewerage system could be part of a new facility. We examined water quality at primary points of the wastewater treatment system to understand the impact of each part of the system and determine the most appropriate site for detailed temporal monitoring. This was followed by a two-day sampling program at one point in the treatment system. We concluded that the minimum infrastructure requirements to satisfy Water Corporation's maximum allowable limits for disposal to the sewerage system include sieve bend screens (Hunter screens), an anaerobic or settling pond, and a holding pond to ensure sufficient safety margins if sewer disposal was ever delayed.

We recommend that further consideration is given to estimating the capital and operational costs of a truck wash facility that meets these minimum requirements, compared to a closed system that retains all wastewater on-site, or other systems that recover nutrients from high-value products. We also recommend that a sampling program be conducted across all truck washes in WA to gain insight into possible geographical variations and the wider applicability of this study's findings.

1 Introduction

State government border protection and biosecurity regulations stipulate that all trucks carrying livestock that enter Western Australia (WA) from other states must be washed down at a truck wash facility. And, although there is no regulatory requirement to wash trucks for movements within WA, industry recognises the benefits of such washing — abattoirs and other purchasers will downgrade prices for poorly presented, dirty livestock — and it is routinely done. But, there is a lack of information on the quality of the water discharged from these truck wash facilities.

During 2011–12, the Department of Agriculture and Food (now Department of Primary Industries and Regional Development), supported by the Western Australian Meat Industry Authority, undertook a water quality scoping study to provide preliminary insights into water quality at primary points along the wastewater treatment system at the Muchea Livestock Centre (MLC) Truck Wash. We:

- assessed the water quality concentrations and loads against the Water Corporation's maximum acceptable limits (MALs) at primary points along the treatment system to provide a basic assessment of the minimum treatment required before discharge into Water Corporation's sewerage system
- estimated the volumes of water exiting the truck washdown bay — existing sewerage treatment sites have limited capacities for treating wastewater
- estimated the use of truck wash facilities by drivers and whether this influences water quality characteristics
- estimated the cost of disposing wastewater to the sewerage system.

Based on these insights, we considered expected water quality outcomes if a new truck wash was built, and the potential for discharging the wastewater into Water Corporation's sewerage system, or retaining the wastewater on-site. These insights provide a starting point for future planning, design and construction of livestock truck washes.

2 Background

For biosecurity and animal welfare reasons, DPIRD encourages owners to wash down their livestock carriers (trucks). The Livestock and Rural Transport Association of Western Australia generally supports this position and has lobbied for improved washdown facilities over the last decade.

WA has 11 major truck wash facilities. Eight are owned by local governments and the other three are owned by the state government — these are the MLC, which is a saleyard, and two quarantine washes, one at Kununurra and one at Kalgoorlie. Truck washing also occurs at other non-government facilities.

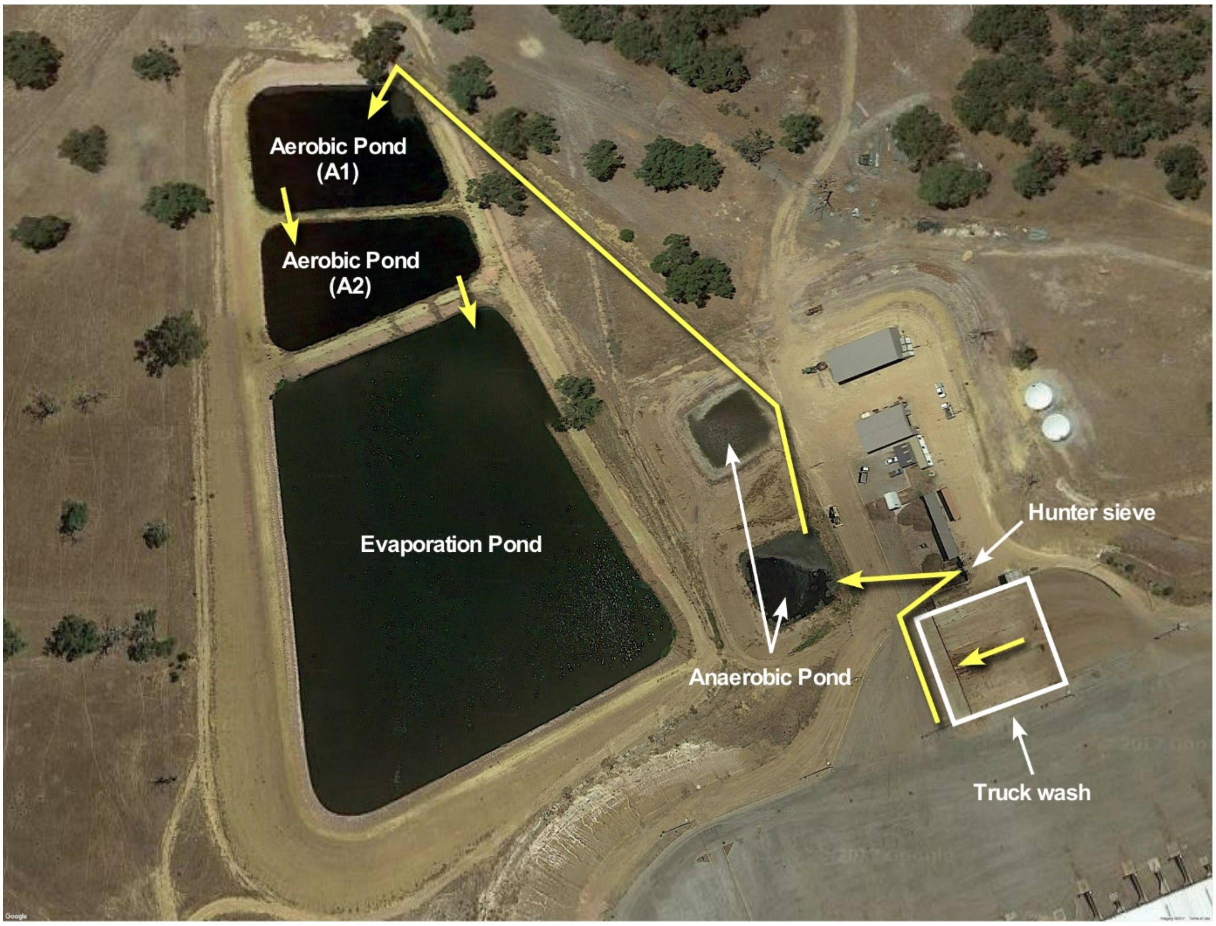
Although the number of truck wash facilities has increased in the past 10 years, there has been no statewide strategy. Local governments are responsible for most of these facilities, resulting in varying standards and questionable environmental impacts. Local governments are now very cautious about taking on the responsibility for these facilities, and their environmental impacts, and there is a risk that access to such facilities will decrease with time.

A strategically located network of public access truck wash facilities is needed across WA to provide suitably equipped areas for washing down livestock carriers. The current network is deficient, with some areas of the state — for example, the southern metropolitan region — having no access to a truck wash facility, and others having facilities that do not comply with environmental standards.

Further information about the effectiveness of on-site effluent processing facilities is required to guide the construction and operation of truck washes where they are lacking. This study reports on findings that will assist DPIRD and the Department of Water and Environmental Regulation for consideration of water quality issues related to the regional truck wash facilities.

3 Site details

The wastewater treatment system for the MLC Truck Wash is a closed system, which does not discharge off-site or to the sewerage system — it uses evaporation to ensure no off-site discharge (Figure 3.1).



Note: The yellow arrows show the direction of wastewater flow from the truck wash area.

Photo: Google Earth (2017)

Figure 3.1 Layout of the wastewater treatment system at the MLC Truck Wash, with the truck wash area, the sieve bend screens (Hunter sieve), two anaerobic settling ponds, two aerobic ponds (A1, A2), and an evaporation pond

The wastewater generated from washing livestock trucks is captured on-site by a grated concrete channel at the lower end of the truck washdown bay (Figure 3.2). The captured wastewater then flows to a trafficable sump and on to sieve bend screens where coarse solids are separated from the liquid (Figure 3.3). If washdown flow rates are high or if a pump fails, an overflow outlet in the trafficable sump directs the wastewater directly into one of two anaerobic settling ponds.

Collected solids are sold as a soil enhancer. Under normal conditions, the liquid passing through the sieve bend screen flows into one of two anaerobic ponds (Figure 3.4). These anaerobic ponds are used alternately; the first pond was in operation during this scoping study.

The water from the anaerobic pond then flows through a concrete pipe to the first aerobic pond (A1) by gravity (Figure 3.5). Overflow from A1 flows by gravity through a pipe into the second aerobic pond (A2), and then flows into the evaporation pond (Figure 3.6).

Figure 3.2 Livestock trailers being prepared for washing in the truck washdown bay. Wastewater grate and sump are at the lower left

Figure 3.3 Sieve bend screens (Hunter sieves) remove most of the larger solid waste from the water

Figure 3.4 Anaerobic settling pond

Figure 3.5 Outlet from the anaerobic settling pond to the first aerobic pond (A1)

Figure 3.6 Aerobic ponds A1 and A2, with the evaporation ponds in the background

4 Methods

We undertook two water quality sampling programs at the MLC Truck Wash facility. The first explored the spatial variation of water quality as wastewater travelled through the treatment system. Once the spatial variation in water quality was established, we conducted a temporal sampling program at a suitable site identified in the first sampling program.

4.1 Sample sites

We identified primary and readily accessible components of the wastewater treatment system as sample sites. These sample sites allowed us to assess water quality through the treatment system, and the points where water quality may satisfy Water Corporation's industrial waste criteria for MALs.

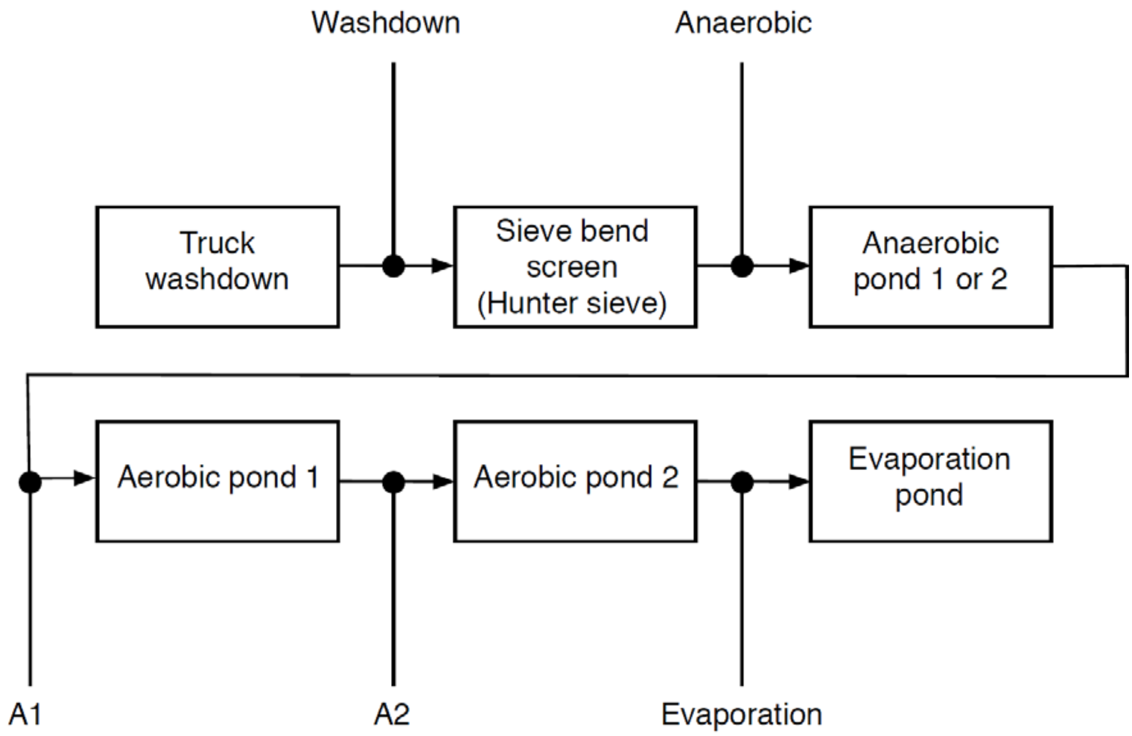


Figure 4.1 Primary components of the truck wash's wastewater storage and treatment system and sample sites

4.2 Spatial sampling

The aim of the first sampling program was to determine the quality of the water at primary locations along the MLC Truck Wash wastewater treatment system, and at which points the Water Corporation's MALs were satisfied. We conducted the sampling in November 2011.

We took grab samples at the entry points to the ponds to sample the flow from the previous component, as well as the washdown sample which is downstream of the truck washdown (Figure 4.1).

Representative samples were collected at each sample site, and subsamples were put into sampling bottles provided by the WA ChemCentre. Samples were analysed for total chemical composition (Appendix A), so filtration was not required. The samples were then assessed against the MALs.

No trucks were being washed when the samples were taken. We washed off the residual waste on the truck wash pad to allow a sample at the first sample site (Washdown). The sieve bend screen was manually operated to provide flow for sampling at the inlet to the anaerobic pond. All other sample sites were flowing sufficiently to allow a grab sample to be collected, and the manual operation was representative of automatic operation as shown by the flow at all sample sites.

We collected samples at each of these sites (Figure 4.1):

- Washdown: Wastewater from the lower end of the bays where the stock crates are washed flows through a grated concrete channel and into a sump (Figure 4.2). The sample was collected as the wastewater exited the grated concrete channel, immediately before the sump. This sample represents truck wash wastewater.
- Anaerobic: The wastewater flows through a sieve bend screen, which removes larger solids, and into an anaerobic settling pond. A sample was collected at the inlet of the anaerobic pond (Figure 4.3) and represents wastewater after it has passed through a sieve bend screen and with larger solids removed.
- A1: This sample was collected at the inlet to the first aerobic pond and represents wastewater exiting the anaerobic pond.
- A2: This sample was collected at the inlet to the second aerobic pond and represents wastewater exiting the first aerobic pond.
- Evaporation: This sample was collected at the inlet to the evaporation pond and represents wastewater exiting the second aerobic pond.

Figure 4.2 Grab sample collection at the exit of the truck wash channel

Figure 4.3 Grab sample collection at the entrance to the anaerobic settling pond

4.3 Temporal sampling

The sampling for spatial variation (Section 4.2) represents a single point in time. Temporal sampling was conducted in January 2012 to determine how water quality varied over a two-day period. After reviewing the spatial sample data, we positioned an automatic sampler (Figure 4.4) to sample from an inspection hole immediately before the inlet of the first aerobic pond (A1). A subset of the complete analyses was carried on the samples based on the review of the complete analysis (Appendix A). A rating curve was developed for the inlet pipe by measuring flow from the pipe at different heights. This rating curve was programmed into the sampler, and a flow-based sampling program was used to collect a sample every 12 500 litres (L). The automatic sampler was set to operate until all sampling bottles were filled; two bottles per sample were filled. The autosampler started in the morning of 30 January 2012, with the last sample collected at 10pm that day. It was restarted in the morning of 31 January 2012, with the last sample collected at 11pm. The base of the sampler was loaded with ice to ensure samples were adequately preserved during the collection phase. Every second sample was decanted into appropriate bottles and sent to the ChemCentre for analysis. The reduced suite of analytes was selected following guidance from Water Corporation (Appendix A).

Figure 4.4 Autosampler set-up in front of aerobic pond A1

4.4 Flow measurements

At the truck washdown bay, the site manager measured flow from an unrestricted hose and a restricted hose (a hose with a restrictive nozzle) on several occasions. Flow measurements were determined at each sample site using a stop watch and a 9L bucket.

4.5 Truck usage information

To determine the average daily volume of trucks using the truck washdown facility, Avdata (the suppliers of the water monitoring system) records were used. Information provided by Avdata included the time each truck wash station was used (minutes), time started and finished, and the Avdata tag number. When calculating time usage from the records, if an Avdata tag number followed in time to the next time slot for the one tag, it was assumed to be one truck. The data used in calculating truck usage was from September and October 2011.

4.6 Maximum acceptable limits and cost for discharge to sewer

The Water Corporation has MALs, or acceptance criteria, for various physical and chemical components of trade waste that are allowed to be discharged into the sewerage system. Trade wastes are discharges from commercial operations rather than routine domestic effluent discharge. Such commercial operations discharge materials that are higher in volume or are problematic for a wastewater treatment facility. The MALs are documented on Water Corporation's website:

https://www.watercorporation.com.au/Help-and-advice/Trade-waste/Permits-and-charges/Trade-waste-permits/Acceptance-criteria-for-trade-waste.

MALs are typically expressed as a concentration, or sometimes as an upper maximum acceptable limit; these can differ for specific wastewater treatment plants. We used the values of the maximum limits of the Woodman Point Wastewater Treatment Plant (WWTP) as a benchmark for comparing the MLC wastewater.

The costs of discharging the various analytes to Water Corporation treatment facilities were obtained from Water Corporation's Trade Waste Charges web page:

https://www.watercorporation.com.au/Help-and-advice/Trade-waste/Permits-and-charges/Trade-waste-charges.

Costs vary according to the analyte's classification (low, medium, high, very high), with cost estimates being based on the analytes listed in the current Trade Waste Charges table and their volumes. Unlisted analytes were not included in the cost calculations, nor were Water Corporation charges for annual permits, establishment, monitoring or any other charges. The costing is intended to assess how changes in water quality at primary points in the MLC wastewater treatment system are reflected in the costs.

To determine the daily load measurement required for some MALs and for cost estimates, each analyte concentration was multiplied by the median flow rate (assumed to be 1 litre per second [L/s] from Avdata records and preliminary on-site flow measurements) per day equivalent (Appendix B).

5 Results and discussion

5.1 Spatial sampling

5.1.1 Analyte concentrations

Total suspended solids (TSS) include particulate material in the water that cannot pass through a 1.2 micrometre (µm) glass microfibre (grade GF/C filter). Wastewater directly flowing from the truck wash was more than the MAL concentration of 1500 milligrams per litre (mg/L) for TSS (Table 5.1), and largely comprised livestock excrement and soil/dust collected from road travel. The TSS concentration was reduced by 400mg/L after passing through the sieve bend screen, which removes the larger solids, such as animal manure; however, this TSS concentration was still above the MAL when it entered the anaerobic pond. The largest reduction in TSS concentration occurred after water had passed through the anaerobic pond, and the TSS concentration was reduced to below the MAL. This is most likely attributed to the residence time of the water in the anaerobic pond, allowing solids and other contaminants to settle. The anaerobic ponds, while small in surface area, are deeper than the aerobic ponds. Further reduction in TSS concentration was seen as water flowed through aerobic ponds A1 and A2 into the evaporation pond.

The pH of the water at all sample sites was within the acceptable range for depositing wastewater into Water Corporation sewerage systems, with all samples having a pH between 7 and 8.5 (Table 5.1).

Total dissolved solids (TDS) is the measure of all inorganic and organic material that is dissolved in the water (that is, material that can pass through a 1.2µm filter). A large component of TDS are salts such as magnesium and calcium. The TDS concentration was well below the MAL at all sample sites (Table 5.1). A slight increase in TDS concentration was seen in the water as it passed through each pond. This is most likely due to the effect of evapoconcentration of salts.

Chloride was below the MAL (Table 5.1). A slight increase in concentration occurred between the truck wash and the evaporation pond, which is most likely due to evapoconcentration of chloride.

Biochemical oxygen demand (BOD) is a measure of how much oxygen is required by the available microorganisms within the water to break down the readily available organic matter into simpler forms. The BOD concentration was below the MAL at all sample sites (Table 5.1). The reduction in BOD in the aerobic ponds suggests that much of the organic matter has settled out in the anaerobic pond and the demand by microorganisms for oxygen for processing food is reduced.

Similar to BOD, the chemical oxygen demand (COD) measures how much oxygen is required to decompose organic matter and oxidise inorganic chemicals such as ammonia and nitrite. The COD concentration was below the MAL at all sample sites (Table 5.1). The highest demand for oxygen was in the anaerobic pond, and reflects much of the material settling in this pond.

Table 5.1 Total concentrations of analytes at sample sites compared to the maximum acceptable limits (MAL)

Analyte	MAL (mg/L)	Sample site				
		Washdown	Anaerobic	A1	A2	Evaporation
Total suspended solids	1500	4300*	3900*	660	600	220
pH	6–10	7.8	8.2	7.2	7.7	8.2
Total dissolved solids	20 000	760	1100	1200	1200	1400
Chloride	15 000	102	142	194	217	271
Biochemical oxygen demand	3000	420	440	89	59	35
Chemical oxygen demand	6000	990	1500	1200	810	760
Benzene	0.08	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	1.3	0.0034	0.0042	<0.001	<0.001	<0.001
Ethylbenzene	1	<0.001	<0.001	<0.001	<0.001	<0.001
Xylene	1.4	<0.002	<0.002	<0.002	<0.002	<0.002
Total petroleum hydrocarbon	30	4.9	4.5	0.26	<0.25	<0.25
Sum of sulfate, sulfite, thiosulfate	600	72.3	93.4	29	27.2	28.6
Sulfide	5	<0.01	0.01	0.01	<0.01	<0.01
Aluminium	100	200*	140*	6	2	2
Ammonia	200	5	10	110	78	46
Arsenic	5	0.05	<0.05	<0.05	<0.05	<0.05
Boron	0	0.35*	0.40*	0.24*	0.23*	0.27*
Cadmium	5	0.005	0.004	<0.002	<0.002	<0.002
Chromium	10	0.81	0.65	0.04	0.02	0.02
Copper	5	0.29	0.22	0.04	0.02	0.02
Iron	100	270*	240*	29	17	14
Lead	10	0.11	0.08	<0.02	<0.02	<0.02
Mercury	0.05	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Molybdenum	10	0.02	0.02	<0.02	<0.02	<0.02
Nickel	10	0.14	0.11	0.02	0.01	0.02
Selenium	5	<0.05	0.12	<0.05	<0.05	<0.05
Silver	5	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc	10	2.30	2.30	0.33	0.17	0.18

* Analyte concentration exceeded the MAL.

Note: All analyte concentrations are shown in mg/L.

Benzene, toluene, ethylbenzene, xylene (BTEX) are some organic compounds found in petroleum derivatives (among others). They have the potential to contaminate soil and water, and are toxic and carcinogenic. All BTEX group compounds were below the MAL limit and all were reported as below detectable limits in the aerobic ponds (Table 5.1). Total petroleum hydrocarbons (TPH) is a measure of a large variety of hydrocarbons present in the environment. The TPH was below the MAL (Table 5.1). The TPH present in the washdown and anaerobic pond is most likely residual from vehicles and exhaust fumes. Much of this was settled out or consumed in the anaerobic pond and TPHs were not detectable after the first aerobic pond.

Sulfate was below the MAL at all sample sites, even though it was slightly increased in the wastewater entering the anaerobic pond (Table 5.1). Sulfide was not detected at three of the sample sites (Table 5.1), with very small concentrations of sulfide observed at the anaerobic and A1 sites, which indicates the expected reducing conditions of the anaerobic pond; however, these sulfide concentrations were well below the MAL.

The MAL for aluminium in wastewater entering the sewage system is 100mg/L and aluminium in water coming straight off the trucks being washed was 100mg/L more than the MAL (Table 5.1). After the water passed through the sieve bend screen, aluminium was reduced by 60mg/L to 140mg/L, though still exceeding the MAL. Once it passed through the anaerobic pond and entered the first aerobic pond (A1), the concentration fell below 20mg/L. This indicates that the aluminium is settling out in the anaerobic pond, which would be accelerated by the pH of that pond contributing to precipitation.

Nutrients, such as the nitrogen in ammonia, provide ‘food’ for algal blooms downstream of effluent discharges from animal waste facilities. Excessive nutrients in a wastewater system can place stress on the treatment system, decreasing its efficiency to treat the water. Ammonia was within the MAL at all sample sites along the treatment system; however, it increased after the wastewater exited the anaerobic pond (Table 5.1). This indicates the system was working where nitrogen containing organic material, such as sheep faeces, was degrading and generating ammonia in the anaerobic pond. Ammonia is the stable form of nitrogen under reducing conditions, as would be expected from an anaerobic pond. The MLC wastewater treatment system is designed to first break down the organic forms of nitrogen into ammonia in the anaerobic pond and then to subject the ammonia to aerobic conditions to allow this ammonia to be converted to nitrogen gas and enter that atmosphere, resulting in a lower total nitrogen load flowing out of the system. Some of the nitrogen will also be retained in the ponds as sludge which will be removed during maintenance.

Boron concentration was reduced after passing through the anaerobic pond (settling out); however, the concentration increased in the evaporation pond (Table 5.1), possibly due to evapoconcentration. The MAL for boron is taken on a case-by-case basis depending on the treatment plant, and exceeded the MAL for boron used at Woodman Point WWTP at every sampling location in the system.

Iron concentration at the washdown and the sieve bend screen was higher than the MAL (Table 5.1). Much of the iron settled out in the anaerobic pond, and after the wastewater left the anaerobic pond, the iron concentration was below the MAL. The high concentrations of iron at the washdown and sieve bend screen sample sites may be from soil that has accumulated on the feet of animals and from gravel roads during transport being washed from trucks.

All other trace elements were below their respective MALs (Table 5.1).

5.1.2 Analyte loads

The TSS exceeded the daily load MAL for the washdown and anaerobic sample sites (Table 5.2). The TDS, BOD, COD, phosphorus and total Kjeldahl nitrogen (TKN) were all well below the daily load MAL at each site.

Table 5.2 Estimated daily load of selected analytes at each sample site compared to the daily maximum acceptable limits (MAL) for the Woodman Point Wastewater Treatment Plant

Analyte	MAL (kg)	Sample site				
		Washdown	Anaerobic	A1	A2	Evaporation
Total suspended solids	300	363.8*	329.9*	55.8	50.8	18.6
Total dissolved solids	450	64.3	93.1	101.5	101.5	118.4
Biochemical oxygen demand	300	35.5	37.2	7.5	5.0	3.0
Chemical oxygen demand	400	83.8	126.9	101.5	68.5	64.3
Phosphorus	10	1.9	2.6	3.0	2.5	2.5
Total Kjeldahl nitrogen	50	9.3	12.7	16.1	10.2	6.9

* Analyte load exceeded the MAL.

Notes:

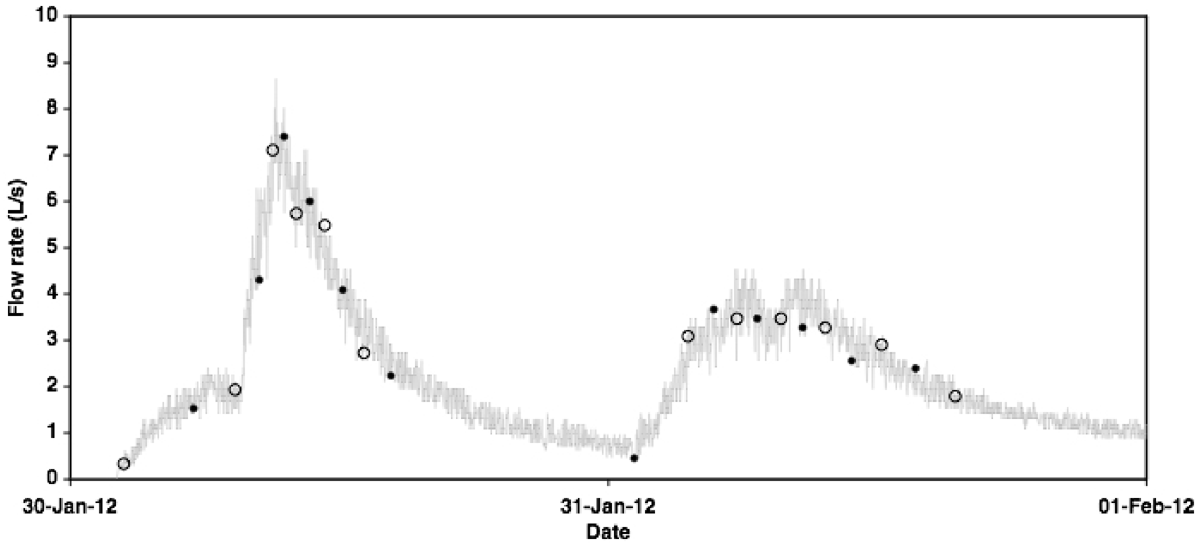
1. Daily load was based on sample concentration and 1L/s flow rate.
2. All analyte loads are shown in kilograms.

5.2 Temporal sampling

5.2.1 Analyte concentrations

Analysis of grab sample data suggests that the minimum infrastructure requirements to achieve the MAL set by Water Corporation could be achieved with a sieve bend screen and an anaerobic settling pond. The infrastructure chosen depends on whether concentration, load or both are used to satisfy the MAL requirements. Small-scale temporal monitoring at sample site A1 provided further insights into water quality during periods when stock crates were being cleaned.

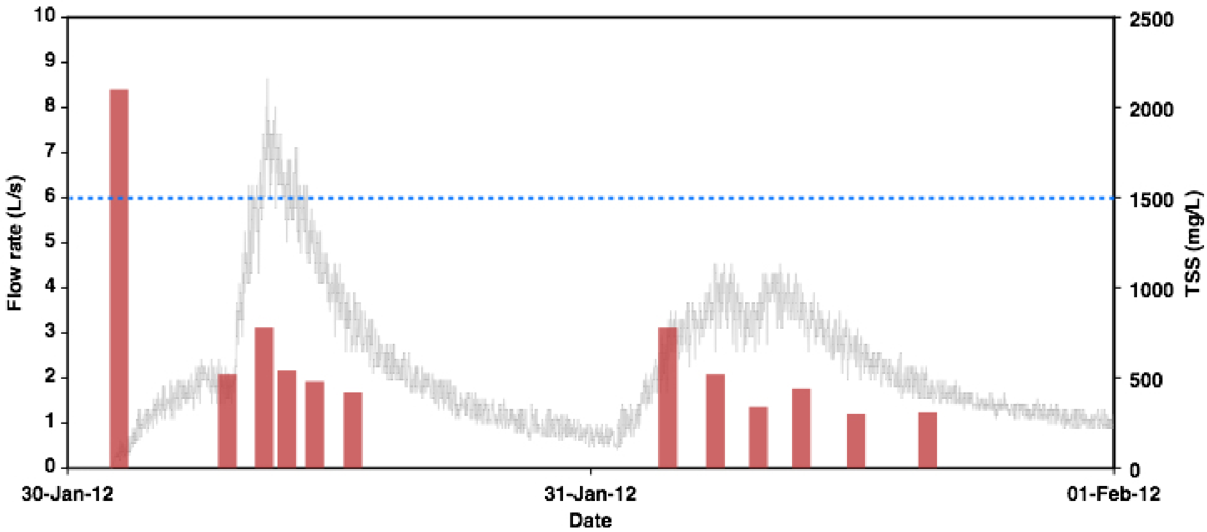
Figure 5.1 shows the variation in discharge at the sample sites. When more stock crates were being washed, discharge increased and the time between samples reduced to match the autosampler's program. About 375 000L of wastewater was measured at sample site A1 over the 48-hour sampling period, with a flow weighted discharge of 2.15L/s. Figure 5.2 to Figure 5.7 show the estimated contaminant loading we calculated on the basis of an assumed flow rate of 1L/s. Doubling these loading estimates on the basis of flow measurements made over the 48-hour sampling period (2.15L/s) maintained the daily loads below the MAL requirements in most cases. Those that did not satisfy the daily load MAL requirements are thought to be due, in part, to sediment disturbance when the sampling equipment was installed, rather than operation of the facility.



Note: Closed circles = samples taken; open circles = samples that were analysed.

Figure 5.1 Hydrograph of flow from the autosampling program at sample site A1 and the collected samples

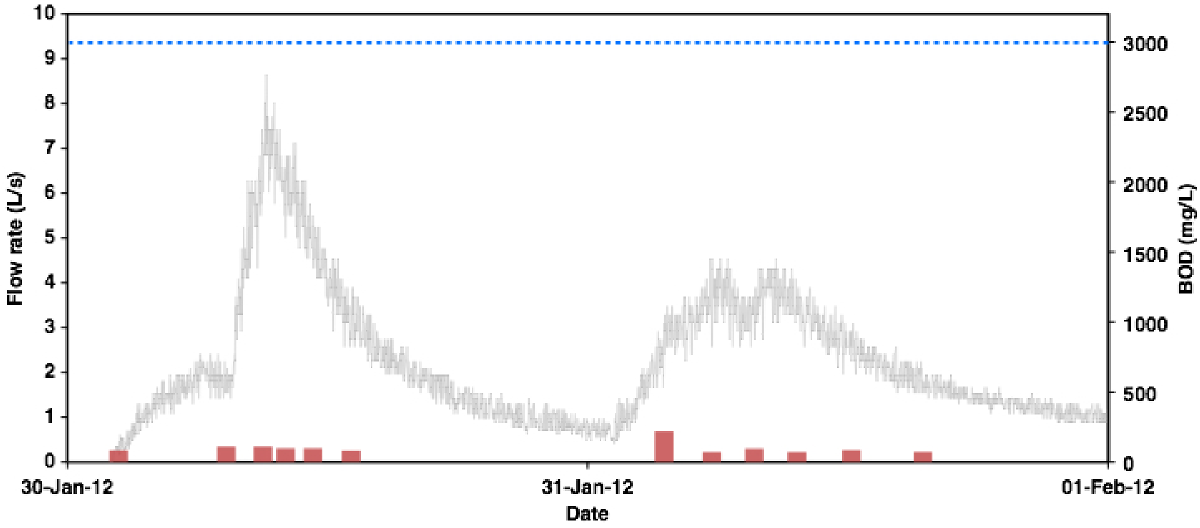
TSS concentration over the two-day sampling period was mostly constant over time, except for the first sample taken on the first day (Figure 5.2). The increase may be due to sediment disturbance during set-up of the autosampler intake pipe before starting the sampling program. All remaining samples were below the MAL and were similar to the grab sample taken at the same location.



Note: Red bars = TSS; grey trace = flow; blue dashed line = MAL

Figure 5.2 Concentration of total suspended solids (TSS) over time at sample site A1 compared to flow and the maximum acceptable limit (MAL; 1500mg/L)

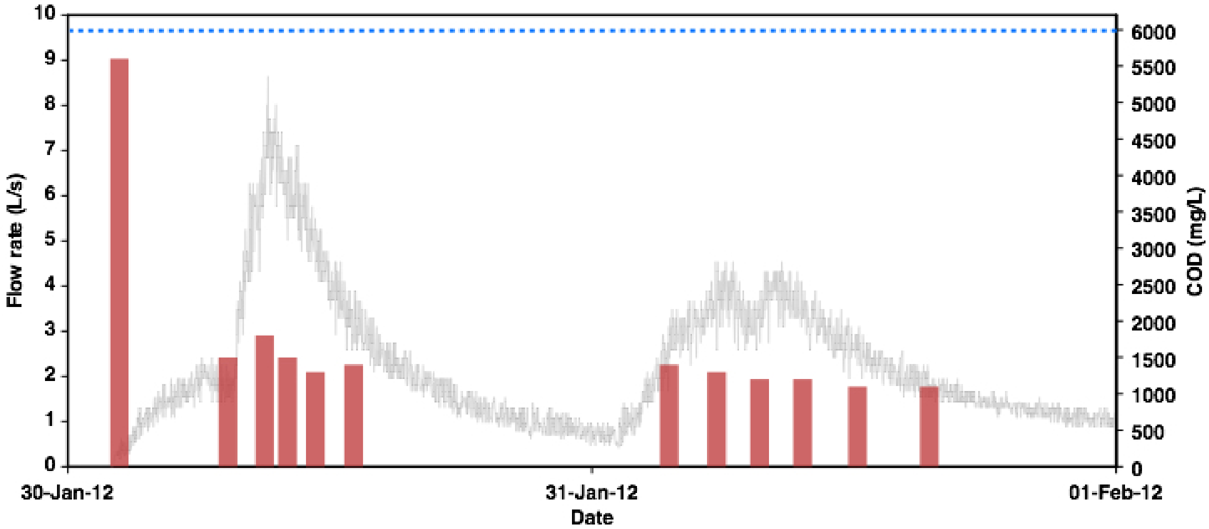
The BOD concentration for all the samples was below the MAL, with a slight increase seen at the start of the second day of sampling (Figure 5.3).



Note: Red bars = BOD; grey trace = flow; blue dashed line = MAL

Figure 5.3 Concentration of biochemical oxygen demand (BOD) over time at sample site A1 compared to flow and the maximum acceptable limit (MAL, 3000mg/L)

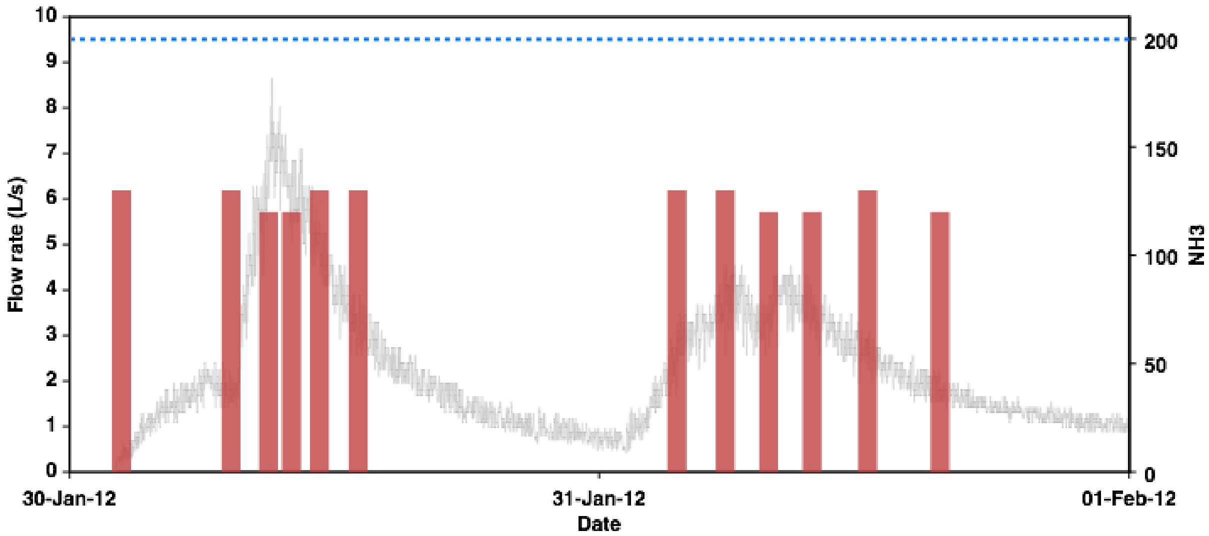
Similar to TSS, a spike was seen in the COD concentration at the start of the sampling program (Figure 5.4). This is most likely due to some initial disturbance of sediment in the pipe; however, it is still below the MAL. Most samples had a concentration similar to the grab sample.



Note: Red bars = COD; grey trace = flow; blue dashed line = MAL

Figure 5.4 Concentration of chemical oxygen demand (COD) over time at sample site A1 compared to flow and the maximum acceptable limit (MAL; 6000mg/L)

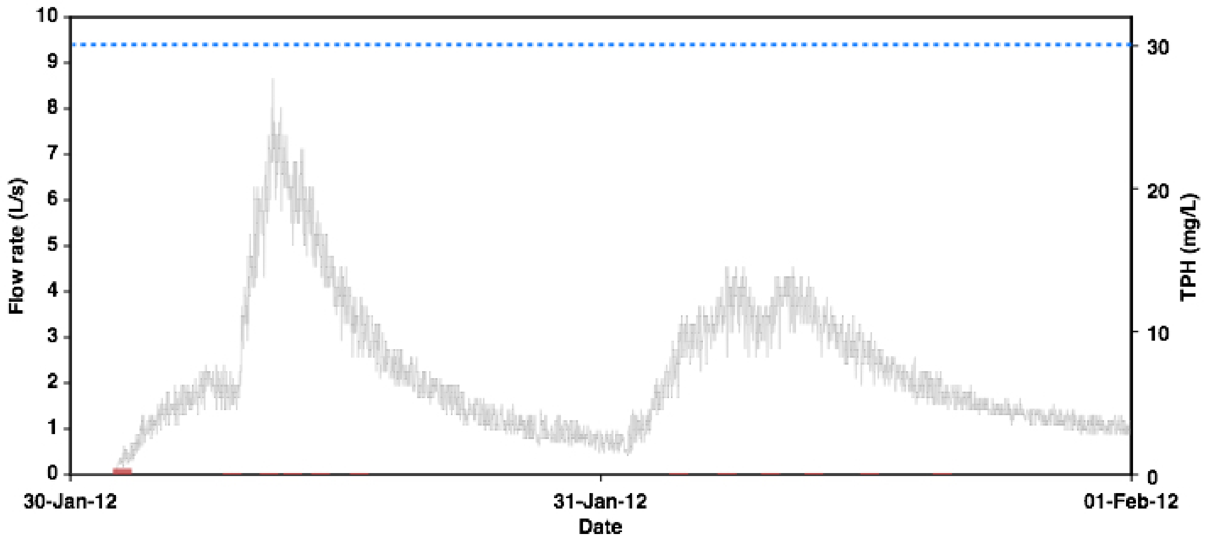
Ammonia concentration was below the MAL over the sampling period, but was slightly higher than the grab sample concentration (Figure 5.5).



Note: Red bars = NH_3; grey trace = flow; blue dashed line = MAL

Figure 5.5 Concentration of ammonia (NH_3) over time at sample site A1 compared to flow and the maximum acceptable limit (MAL; 200mg/L)

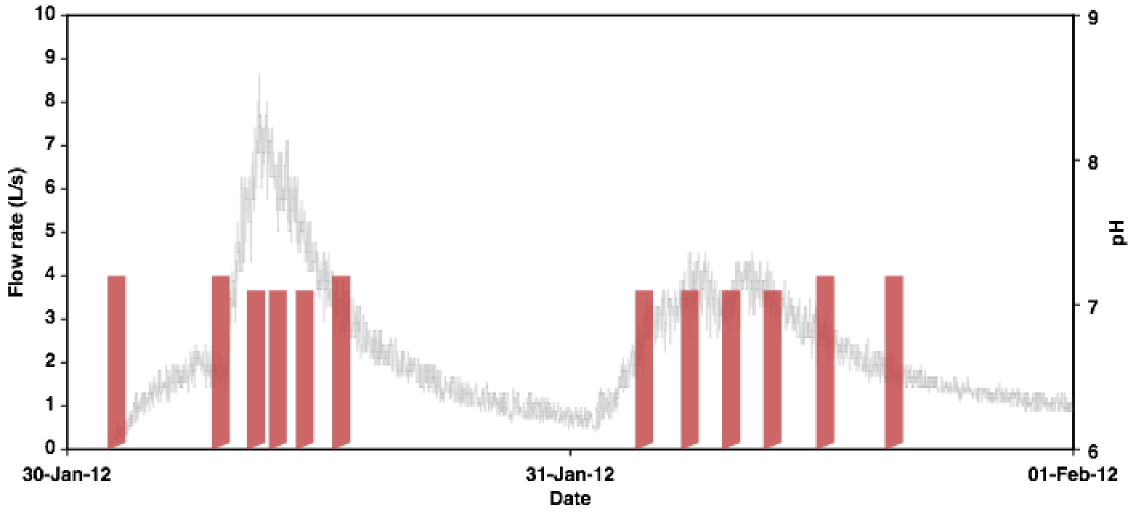
The TPH concentrations were below the MAL, and remained low over the sampling period (Figure 5.6).



Note: Red bars = TPH; grey trace = flow; blue dashed line = MAL

Figure 5.6 Concentration of total petroleum hydrocarbon (TPH) over time at sample site A1 compared to flow and the maximum acceptable limit (MAL; 30mg/L)

The pH of the water over the two-day sampling period varied little and remained between 7 and 7.5 (Figure 5.7). The samples collected by the automatic sampler reflected the water quality of the grab sample taken the previous November at the same sample site.



Notes:

1. Red bars = pH; grey trace = flow
2. Right-hand y-axis range shows the acceptable pH for depositing into Water Corporation sewerage systems.

Figure 5.7 pH over time at sample site A1 compared to flow

5.2.2 Analyte loads

The calculated daily load for TSS, BOD, COD, phosphorus and TKN was below the MAL for a flow rate of 1L/s, except for COD on one occasion (Table 5.3). Increasing the flow rate to 2.15L/s exceeded the daily load MAL for COD and TSS on one occasion, and for TKN on most occasions.

Table 5.3 Calculated daily load compared to daily maximum limit for the Woodman Point Wastewater Treatment Plant

	Analyte				
Date & time	**Total suspended solids**	**Biochemical oxygen demand**	**Chemical oxygen demand**	**Phosphorus**	**Total Kjeldahl nitrogen**
Daily load MAL (kg)	300	300	400	10	50
30/01/2012 10:21	177.7	7.1	473.8*	3.6	17.8
30/01/2012 15:19	44.0	9.3	126.9	3.4	16.9
30/01/2012 17:00	66.0	9.3	152.3	3.4	16.1
30/01/2012 18:03	45.7	8.3	126.9	3.1	16.1
30/01/2012 19:19	40.6	8.3	110.0	3.1	16.1
30/01/2012 21:04	35.5	6.9	118.4	3.2	16.1
31/01/2012 11:31	66.0	18.6	118.4	3.4	16.9
31/01/2012 13:42	44.0	6.0	110.0	3.1	16.1
31/01/2012 15:40	28.8	8.1	101.5	3.1	16.1

(continued)

Table 5.3 continued

Date & time	Analyte				
	Total suspended solids	Biochemical oxygen demand	Chemical oxygen demand	Phosphorus	Total Kjeldahl nitrogen
31/01/2012 17:38	37.2	6.0	101.5	3.0	15.2
31/01/2012 20:09	25.4	7.3	93.1	3.0	15.2
31/01/2012 23:26	26.2	6.1	93.1	3.0	14.4

* Analyte load exceeded the maximum acceptable limit.

Notes:

1. Daily load was based on sample concentration and 1L/s flow rate.
2. All analyte loads are shown in kilograms.

5.3 Flow measurements and truck usage information

Typical flow rates at each sample site through the MLC wastewater treatment system, when measured, were about 1L/s (Table 5.4).

During September and October 2011, on average, six trucks used the truck wash for 1 hour and 45 minutes each per day. About 106 000 to 150 000L of water was used per day (17 000–26 000L per truck), which equates to 1.75L/s assuming 24-hour usage of the facility, or 3.5L/s assuming 12-hour usage of the facility. This is within the typical flow rate of a washdown hose (Table 5.4).

Table 5.4 Measured flow rate at each sample site

Sample site	Measured flow rate (L/s)
Truck wash hose	2.8–4.2
Truck wash	1
Anaerobic	1
A1	1
A2	1.5
Evaporation	1

5.4 Cost classification

The cost classifications that follow are estimates based on an assumed 1L/s flow rate — they need to be adjusted for other flow estimates based on the analyte concentrations at various points in the MLC wastewater treatment system and Water Corporation’s quality–quantity charges. For example, the values should be approximately doubled if the measured flow rate of 2.15L/s at sample site A1 over the 48-hour monitoring period is used. This is only an approximation because changes in load of any analyte may place it in a different cost class, where differential costs may change by a factor that is different than the change in flow. Actual costs based on load calculations will need to be made dependent on flow estimates from longer-term monitoring.

Table 5.5 shows that for most analytes the classification is low or medium, and it improves as water flows through the MLC wastewater treatment system. As a result, total daily costs for disposal decrease as water quality improves. Costs decrease by as much as 78% by the time wastewater enters the evaporation pond, or by as little as 6% when wastewater enters the anaerobic pond.

The largest decrease in cost was seen from wastewater sampled at the truck wash bay compared to the wastewater that has passed through the anaerobic pond (sample site A1). Subsequent smaller decreases in cost are seen from sample site A1 to site A2, and from site A2 to site Evaporation. If the plan was to discharge to the sewerage system, then the biggest saving would be after the anaerobic pond. However, replacing the aerobic pond with a holding pond would provide a safety mechanism if disposal needed to be held for any reason and would also provide for some of the cost savings of the aerobic system.

Table 5.5 Classification of analytes at the sample sites and the estimated cost that could be charged by Water Corporation for discharging into the sewerage system

	Sample site				
Analyte	**Washdown**	**Anaerobic**	**A1**	**A2**	**Evaporation**
Arsenic	Medium	Medium	Medium	Medium	Medium
Biochemical oxygen demand	Low	Low	Low	Low	Low
Cadmium	Low	Low	Low	Low	Low
Chromium	Medium	Medium	Medium	Low	Low
Copper	Low	Low	Low	Low	Low
Lead	Low	Low	Low	Low	Low
Mercury	Low	Low	Low	Low	Low
Molybdenum	Medium	Medium	Low	Low	Low
Nickel	Medium	Medium	Low	Low	Low
Nitrogen (total Kjeldahl)	Flat rate	Flat rate	Flat rate	Flat rate	Flat rate
Oil and grease	Low	Low	Low	Low	Low
Phosphorus	Flat rate	Flat rate	Flat rate	Flat rate	Flat rate
Selenium	Medium	Medium	Medium	Medium	Medium
Silver	Low	Low	Low	Low	Low
Sulfate, sulfite	Low	Low	Low	Low	Low
Total dissolved solids	Low	Low	Low	Low	Low
Total suspended solids	Low	Low	Low	Low	Low
Zinc	Medium	Medium	Low	Low	Low
Quality–quantity charges ($/d)	673	623	128	106	46
Volume charges ($/d)	124	124	124	124	124
Total ($/d)	797	747	252	230	170

Note: The classification indicates the concentration or load cost level that would be applied by Water Corporation according to quality–quantity charges based on 1L/s flow rate.

6 Conclusion

Wastewater exiting truck wash bays could not be discharged into Water Corporation’s sewerage system because the TSS and iron are more than the MAL set by Water Corporation. Similarly, wastewater that has passed through a sieve bend screen still has TSS and iron concentrations that exceed the MAL.

Wastewater exiting the anaerobic settling pond was below the MAL for all the analytes, except boron, which is considered by Water Corporation on a case-by-case basis. Many of the solids, metals and nutrients settle out of the water by travelling through a sieve bend screen and anaerobic pond.

Small increases in TDS, boron and chloride through the system appear to be due to evapoconcentration. All other analytes tend to show reductions as wastewater travels through the system; these reductions would also help reduce ongoing disposal costs.

Over a two-month period (September and October 2011), an average of six trucks used the MLC Truck Wash for 1 hour and 45 minutes each per day. Between 106 000 and 150 000L of water was used per day (17 000–26 000L per truck). The temporal sampling program showed that the concentrations of the analytes measured at sample site A1 varied little, suggesting that wastewater passing through the anaerobic pond via the sieve bend screen and into aerobic pond A1 should not exceed the MAL under normal daily operations.

The minimum infrastructure required to satisfy disposal into Water Corporation’s sewerage system would comprise sieve bend screens and an anaerobic settling pond. A holding pond would likely be required as a safety mechanism if disposal to the sewerage system needed to be withheld for any reason. This minimum infrastructure would also provide the greatest cost reduction in Water Corporation charges associated with disposing of analyte concentrations and loads.

7 Recommendations

- The minimum infrastructure required to satisfy Water Corporation's MALs comprises sieve bend screens, an anaerobic settling pond and a holding pond.
- Grab samples are taken at each other WA truck wash facility for water quality analysis, along with an infrastructure audit and estimates of water use. A comparative analysis of water chemistry would help determine applicability of the results from this scoping study to other facilities.
- Install a pulse meter on the Avdata system at the MLC facility. This would allow a more accurate estimate of water use at this facility, and thus more accurately estimate costs for wastewater discharge into Water Corporation's sewerage system.
- Undertake a full costing (for example, over 5 to 10 years) to compare on-site collection and remediation of wastewater (that is, a closed system similar to the MLC facility) to on-site collection of wastewater (including sieve bend screens, anaerobic pond and a holding pond) and disposal into Water Corporation's sewerage system. Full costs would include land purchase costs, construction costs for dams/ponds, ongoing charges associated with disposing wastewater into the sewerage system, and infrastructure costs associated with nutrient recovery systems.
- Extend the study at the MLC facility over winter. This study was done in summer, over a short time period — an assessment over winter is needed to determine the impact of increased flow caused by rainfall entering the wastewater treatment system either by run-off from the bays or by directly falling onto the ponds. Although rainfall will result in dilution, the reduced residence time may limit opportunities for biological processing and polishing of the effluent. The increase in volume from rainfall would also increase the cost if discharged to Water Corporation's sewerage system.

Appendix A Sample analysis suites

Sample analysis suite for the spatial grab sample program

Total suspended solids	Sulfate, sulphite, thiosulphate	Nitrate + nitrite
pH	Sulfide	Total Kjeldahl nitrogen
Total dissolved solids	Aluminium	Total nitrogen
Chloride	Ammonia	Total phosphorus
Biochemical oxygen demand	Arsenic	Electrical conductivity
Chemical oxygen demand	Boron	
Benzene (B)	Cadmium	
Toluene (T)	Chromium	
Ethylbenzene (E)	Copper	
Xylene (X)	Iron	
Total BTEX	Lead	
Oil and grease	Mercury	
Total petroleum hydrocarbons (TPH)	Molybdenum	
• TPH C6–C9	Nickel	
• TPH C10–C14	Selenium	
• TPH C15–C28	Silver	
• TPH C29–C36	Zinc	

Sample analysis suite for the temporal autosampling program

Ammonia	Total phosphorus
Biochemical oxygen demand	Total suspended solids
Chemical oxygen demand	Total petroleum hydrocarbons (TPH)
Electrical conductivity	• TPH C6–C9
Nitrate + nitrite	• TPH C10–C14
pH	• TPH C15–C28
Total Kjeldahl nitrogen	• TPH C29–C36

Appendix B Daily load calculations

To calculate the daily load measure for each analyte required for either MAL or costing estimations, we used the following calculation:

The median time (in minutes) of use for a truck was multiplied by 60 to obtain seconds:

$105 \times 60 = 6300s$

The median flow rate (L/s) from the hose was multiplied by the time in seconds of truck use to provide the litres per truck used:

$6300s \times 2.8L/s = 17\ 640L$

The litres per truck used was multiplied by the median trucks per day to give the total litres used per day:

$17\ 640 \times 6 = 105\ 840L$ (or about 106 000L per day)

To calculate an equivalent discharge rate (EDR) over 24 hours for the multiplication of concentrations for daily load values, the 106 000L was divided by the seconds in a day:

$106\ 000 / 86\ 400 = 1.23L/s$

The 1.23L/s over 24 hours a day is equivalent to six trucks washing at 2.8L/s for 1 hour and 45 minutes each per day.

The analyte concentration (mg/L) was multiplied by the EDR and the time in seconds in a 24-hour day to give kilograms per day (kg/d):

For example: Iron at $240mg/L \times 1L/s \times 86\ 400s = 20.7kg/d$

Shortened forms

Short form	Long form
µm	micrometre
A1, A2	aerobic ponds
BOD	biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, xylene compounds
COD	chemical oxygen demand
d	day
DPIRD	Department of Primary Industries and Regional Development
kg	kilogram
L	litre
MAL	maximum acceptable limit
mg	milligram
MLC	Muchea Livestock Centre
pH	measure of acidity or basicity of a solution
s	second (time)
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TPH	total petroleum hydrocarbon
TSS	total suspended solids
WA	Western Australia
WWTP	wastewater treatment plant