SLUDGE, THE CURRENT PROBLEM OR WHERE DID MY BUDGET GO?

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ABSTRACT

Sludge management costs have increased considerably as a result of upgrades to the liquid stream in both water and wastewater treatment plants. These have also been impacted by increases in haulage and landfill acceptance costs. This paper discusses some of the issues involved with developing a coherent, cost effective and sustainable sludge management strategy.

These issues include the lack of information on sludge quantity and quality, as most if not all monitoring is on the liquid stream. There is also a lack of clarity as to the applicability of the Biosolids Guidelines to non-standard land application options. Also, this paper will address the (in)ability of the Guidelines to address the risks perceived by stakeholders associated with biosolids application to land, especially the commercial and social barriers. There are considerable costs involved with demonstrating compliance with the Biosolids Guidelines, especially the monitoring provisions.

These issues and how they have impacted on various projects that the author has been involved with over the past 15 years will be discussed along with some innovative solutions.

KEYWORDS

Sludge, Biosolids Guidelines, Monitoring, Options Assessment, Parameters

1 INTRODUCTION

Since 1990, significant expenditure has occurred on New Zealand's wastewater and water infrastructure through upgrades to treatment plants. The wastewater upgrades are primarily due to the implementation of the Resource Management Act, and the required reduction in environmental effects from the liquid stream discharges stemming from community expectations. The water upgrades resulted from the requirements of the New Zealand Drinking Water Standards.

These upgrades have resulted in the required improvement to the quality of the final liquid stream from both forms of treatment plant. However, this has also resulted in a significant increase in the quantity of sludge which is produced, as material that has been removed from the liquid stream to improve its quality is now typically directed into the solid waste matter (ie sludge).

This is generally the case with a very few exceptions. One such exception is the upgraded Hastings Wastewater Treatment Plant (WWTP), where the upgrade has resulted in a significant improvement in discharged effluent coupled with (currently) no sludge production that requires separate treatment and disposal. However, this is the exception to the general rule that improved treatment leads to more sludge, and often sludge which is more difficult to handle.

Also, many of these treatment plants are processing increased quantities of water or sewage associated with increasing population served, with many plants having significant planned increases in catchment populations over the next 20 to 30 years. Therefore, the step increase in sludge production from a change in process will be compounded by increasing sludge production due to population increase.

Often the selection of treatment processes for the liquid stream upgrade is based on assuming that any sludge produced would be mechanically dewatered and sent to the local landfill. This would generally have been based on the rates for haulage and landfill acceptance as applied at the time of the upgrade. However, given rising fuel prices, haulage rates can be expected to increase at a greater rate than normal inflation, and there have been significant changes in landfills in New Zealand over the past 20 years, which have affected landfilling costs.

The 2006/7 National Landfill Census (MfE, 2007) indicated that there were 327 landfills in 1995, 115 landfills operating in New Zealand in 2002, and 60 landfills operating in 2006/7. This reduction has largely been a result of the closure of old style "tips" which were located close to population centres but had minimal environmental controls in place. The remaining landfills are more strategically located on a regional or sub-regional basis, generally away from population centres.

This reduction in the number of landfills has resulted in an increase in the travel distances associated with transporting sludge and/or biosolids from the treatment plants to the landfills, as the local landfills have been replaced with "regional" landfills, which are located away from population centres. These landfills are often operated by commercial entities rather than councils, who can choose whether to accept the sludge and the rate at which to charge such acceptance.

The landfill census notes that there has been a significant improvement in all aspects of landfill design and operation including stormwater, leachate and landfill gas management, dealing with hazardous waste and controlling access to the site. These improvements in design, construction and operation have resulted in a rising cost of acceptance of waste at landfills to reflect the increasing investment required to establish the air space within the landfill.

From 2012, the Emissions Trading Scheme will require that all landfills pay a surcharge to reflect their emissions of landfill gas. It has been estimated that this could add $20 to $30 per tonne for the aaceptance of waste at a landfill.

Therefore, the actual costs faced by the asset managers responsible for the treatment plants now that the upgrades have been completed may be significantly higher than those predicted at the time of the options assessment for the upgrade. Even for plants which have not been upgraded the change in the availability of landfills will have significantly affected their costs for sludge disposal at a landfill.

It is noted that a number of WWTPs have attempted to establish beneficial use routes for their biosolids. However, three composting plants failed to establish sufficient uptake of their product and have closed, namely, Wellington, Rotorua and Paengaroa and their biosolids now goes to landfill. This indicates the problems inherent in establishing land application routes in New Zealand.

Another source of sludge that requires management is oxidation pond sludge, or sludge which has been maturing in sludge lagoons that is periodically removed. With the advent of many then new community oxidation ponds in the 1970s and 1980s, many of these oxidation ponds have now accumulated significant quantities of sludge.

This sludge has not needed management on an annual basis and hence has not been a recurring annual cost on the budget. However, a number of such facilities now require removal of the sludge to allow for the continued operation of the pond or lagoon. Dependent upon the method used, the removal, dewatering and disposal of this sludge can represent a significant cost. As an example, desludging the oxidation ponds in Cromwell, mechanical dewatering of the sludge and its disposal in Victoria Flats Landfill is estimated to cost $3 million. This represents a significant cost to a small community.

Therefore, MWH have worked with a number of District and City Councils to determine the most appropriate solution for the management of their sludge. In this paper, I have selected four treatment plants to illustrate the issues discussed. These include two large wastewater treatment plants in Tauranga, a smaller wastewater treatment plant that serves Invercargill, and a small water treatment plant that serves Waikouaiti, a satellite plant within Dunedin City.

The first section of this paper describes these treatment plants, including the sludge management regime and an indication of the quantity and quality of the sludge produced, and any issues identified with determining these aspects. Subsequent sections highlight some of the techniques we have used, the issues that have arisen in identifying sustainable and affordable solutions and an innovative solution to sludge dewatering which we are currently trialing. The paper will also highlight that there is also a lack of clarity as to the applicability of the Biosolids Guidelines to non-standard land application options. Also, this paper will address the (in)ability of the Guidelines to address the risks perceived by stakeholders associated with biosolids application to land, especially the commercial and social barriers. The paper will also demonstrate the considerable costs involved with demonstrating compliance with the Biosolids Guidelines, especially the monitoring provisions.

2 REFERENCED TREATMENT PLANTS

2.1 TE MAUNGA AND CHAPEL STREET WASTEWATER TREATMENT PLANTS

In 2007, MWH assisted Tauranga City Council with the development of a Biosolids Management Plan for the two WWTPs in Tauranga, namely:

- Chapel Street WWTP, which treats wastewater from the west and south sides of the Tauranga Harbour. The liquid treatment process includes fine screening and grit removal, primary treatment, contact stabilisation, and UV disinfection,

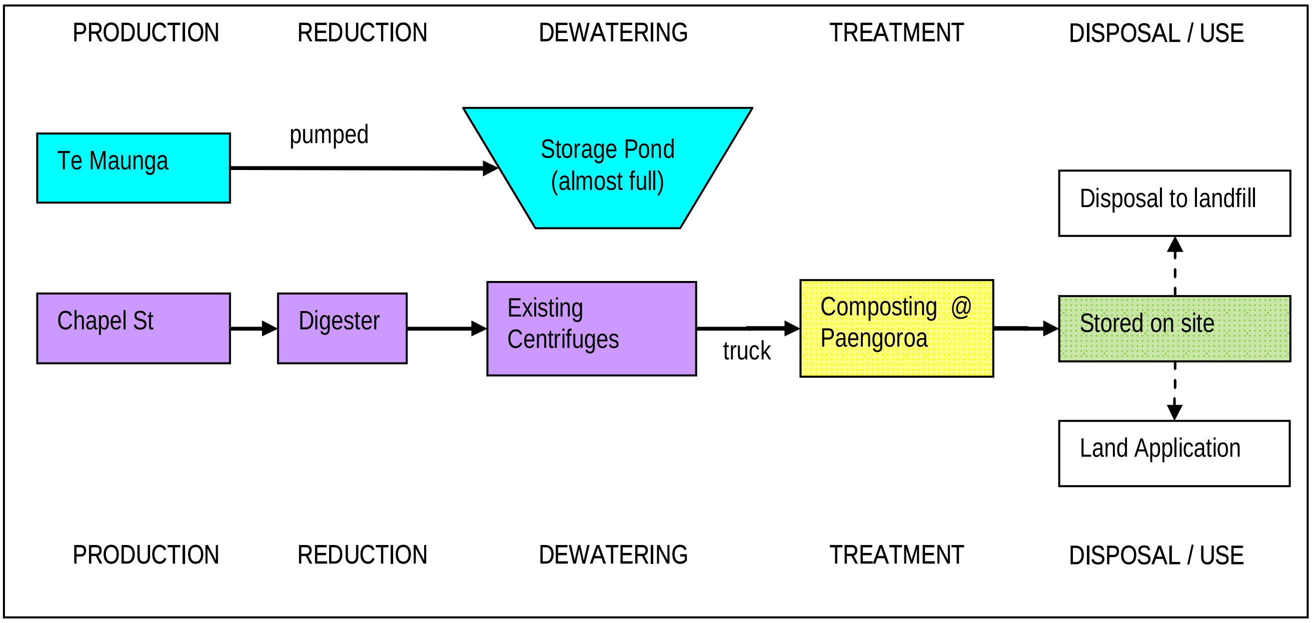
- Te Maunga WWTP, which currently treats wastewater from the Mount Maunganui and Papamoa area. The liquid treatment process includes fine screening and grit removal, modified ludzack ettinger (MLE) based activated sludge treatment, followed by polishing ponds and wetlands.

The treated wastewater from Chapel Street is transferred to Te Maunga, where the flows are combined after passing through wetlands and discharged through an ocean outfall located off the Papamoa beach area.

In 2007, the Chapel Street WWTP treated the wastewater from roughly two thirds of the City's population. However, the proposed Southern pipeline will divert a proportion of the flow away from the Chapel Street WWTP to the Te Maunga WWTP. The flow to the Chapel Street WWTP will be capped at 20 MLD (ADWF), with the remainder of the flow being diverted to Te Maunga WWTP, such that it will treat about twice as much flow as Chapel Street by 2050 given the expected population increases in Tauranga over the next 40 years.

Figure 1 summarises the existing sludge management activities at the two wastewater treatment plants at the time of the development of the Biosolids Management Plan.

Figure 1: Sludge Management Route in 2007 at Taranga WWTPs



At Chapel Street, sludge from the primary and secondary treatment processes was blended, prior to anaerobic digestion via a mesophilic (38°C) process reducing the mass of volatile solids by approximately 40% and then dewatered using centrifuges. The digestion process produced stabilisation grade B biosolids.

The dewatered Chapel Street sludge was transported 45km by truck to the composting facility at the privately owned and operated Compost Suppliers Ltd at Paengaroa. The compost was stored on site.

At Te Maunga, waste activated sludge (WAS) was discharged directly to a sludge lagoon.

The sludge lagoon was de-sludged in 2002/2003. The sludge was removed from the lagoon and dewatered prior to disposal into shallow pits excavated into the capping layer of the closed landfill site near the WWTP. At the time of the Biosolids Management Plan which was undertaken in 2007/8, it was expected that the lagoon would require further desludging by late 2009. This has now been completed and the sludge is now being removed in 5 year cycles to maintain the available volume in the lagoon.

There were no planned changes to the liquid wastewater treatment processes at either WWTP, which would influence the quantity of the sludge produced, apart from the growth in population. Therefore, it was assumed that the quantity of sludge produced from the liquid stream will increase in proportion to the contributing population.

The quantity of sludge produced from the Chapel Street WWTP was determined from the mass of sludge fed to the centrifuges as the total suspended solids (TSS) concentration in the digesters was reasonably constant and did not fluctuate to the same degree as the solids concentration from the primary sedimentation tanks.

The measured raw sludge feed volume to the digesters was about 200 m^3/d. Based on the measured daily flow and the TSS concentrations in the digesters, the mass load to the centrifuges was about 2,640 kg/d. Assuming a solids recovery of 91 % in the centrifuge, the dry mass load to composting was about 2,400 kg/d. This was similar to the average daily dry solids load of 2,300 kg/d for 2007 as calculated from the wet sludge (weigh bridge) and dewatered sludge concentration. There would be less variation expected in the measurements associated with the derivation using the digester, and hence this quantity was used.-

This illustrates the need for using a variety of methods to estimate sludge quantities dependent upon the data available. Direct monitoring of the quantity of sludge was not undertaken at any of the treatment plants that we have been involved with, even the large plants. An estimate had to be made on the basis of information from the liquid stream. For all plants, we estimated the quantities from all available data sources in order to ground truth the estimates to increase reliability of the estimates.

The bioreactor at Te Maunga WWTP acted as the primary storage vessel with a stable suspended solids concentration, thus the waste activated sludge (WAS) can be pumped directly from the bioreactor, providing a consistent feed to the sludge lagoon or the thickening/dewatering process. The lagoons are now used to stabilise the sludge and to allow dewatering to achieve 20%DS, which is then accepted at the landfill as discussed in the later section of this paper.

The quantity of WAS drawn off was based on bioreactor volume and solids retention time (SRT) and was independent of population equivalent. Hence the WAS average daily flow was fixed at 1,710m^3/day. The mixed liquor suspended solids will increase as the population increases. The 2002 sludge quantities were derived during the design process as 2,060 kg DS/day. This was pro-rated in accordance with the population to provide the sludge estimates throughout the assessment period.

There were no planned changes to the liquid wastewater treatment processes at either WWTP, which would influence the quality of the sludge produced. Therefore, it was assumed that the quality of the sludge would remain relatively unchanged. It was understood that some growth in industry was planned within the catchment but it was expected that this would be controlled to ensure that it does not change the quality of the sludge in terms of its metals and synthetic organic concentrations.

There was minimal information available on the quality of the Te Maunga and Chapel Street sludges and the Paengaroa compost, which was still operational in 2007/8. However, indicatively, both the Te Maunga WWTP and the Chapel St WWTP would produce grade "b" biosolids, and would require combination with diluent material to produce grade "a" biosolids. The Paengaroa compost complied with the grade "a" limits for metals, but exceeded the post 2012 dieldrin limit from the Biosolids Guidelines.

It is noted that greenwaste which is used as diluents for the sludge or biosolids can contain its own contaminants which may render it unsuitable as a diluent.

2.2 CLIFTON WASTEWATER TREATMENT PLANT

In 2009, we assisted Invercargill City Council with developing a potential land application site for biosolids from their Clifton WWTP at the Awarua Industrial Area. The biosolids was from sludge that had been produced over a considerable period at the Clifton Wastewater Treatment Plant (WWTP). The sludge was processed through digesters, lagooning and dewatering to produce biosolids. The sludge management activities were:

- The sludge had been digested for approximately 20 days to stabilise and reduce volatile solids
- The digested sludge had been held in lagoons for about five years to reduce pathogenic organisms, during which time a considerable amount of the water drained away. The solids content had increased during this time from 3% to 20%. By this time, the sludge is sufficiently stablised to be termed biosolids.
- Biosolids were excavated from the lagoons and windrowed for about 13 months at a nearby site at the time of the investigation. This process further reduced the volume of the biosolids by removing water, such that the solids content increased from 20% to 30% or above.
- The biosolids would be excavated from the windrows at Station Road (adjacent to the WWTP) and transported to the Awarua site for land application.

The biosolids had previously been applied to the closed landfill in Invercargill. They were placed on top of the cap to provide a growing medium for native plantings established on the site, and were not incorporated into the soil. The plants are reported to have thrived.

At the time of our project, there were 10,000 m^3 of biosolids in the windrows at the Station Road site, which had sufficiently matured for application to the Awarua site. Some of these biosolids had been applied at the Sandy Point site, which was allowed under a separate resource consent. That consent allows the biosolids to be spread at a depth of between 35mm to 55mm. The biosolids was not incorporated into the soil but applied to the surface to avoid disturbance of the relatively shallow top soil, which lies over sand.

The annual biosolids production after lagooning and windrowing from the Clifton WWTP was estimated as between 1,460 m^3 and 1,890 m^3 dependent upon the dry solids of the biosolids. On an ongoing basis, this is the quantity of biosolids which would need to be removed each year from the lagoons to the windrows and then applied to land to ensure that the lagoons and the windrows were available for processing the ongoing sludge production from the WWTP.

The biosolids had been extensively stabilised due to the digestion process followed by their prolonged holding in the sludge lagoons. Due to this treatment, they would be classified as Grade B under the Biosolids Guidelines. This means that the biosolids have been treated such that pathogens and vector attractant parameters have been reduced to acceptable low levels to minimise the risks to public health, and application to land is acceptable subject to controls on the extent of public access and some other activities.

Three biosolids samples were collected from different locations around the lagoon that were excavated in November 2006 and analysed for the parameters required by the Biosolids Guidelines. The results were generally consistent, as would be expected given that the sludge in the lagoon would be reasonably mixed prior to settlement.

The biosolids were 35% to 39% organic carbon and 2.6% nitrogen. Given the treatment that the biosolids had received, this nitrogen would be largely in the form of organic nitrogen. The biosolids also contained 0.6% total phosphorus, some of which will be in the form of phosphate.

The biosolids were 'Grade b'. There were a number of parameters which did not exceed the soil ceiling limit given in the Biosolids Guideline, indicating that for these parameters the biosolids has very low levels of contamination. The parameters which did not comply with the current limits for 'Grade a' biosolids were mercury, zinc, dieldrin and total dioxin. Copper and cadmium exceeded the lower limits for 'Grade a' which only apply from 2012, and the Ministry for the Environment (MfE) working party recommended not be implemented, but they did comply with the up to 2012 'Grade a' limits.

The biosolids are indicated as being 'Grade Bb'. Therefore, the biosolids are suitable for application to land subject to controls which ensure that potential effects are minimised. Our project was to develop a method of applying biosolids at a greater depth of application to improve its economic feasibility as a management route. This is discussed later in the paper.

2.3 WAIKOUAITI WATER TREATMENT PLANT

In late 2009, MWH started assisting Dunedin City Council (DCC) with determining alternatives for the management of the sludge produced from the Waikouaiti Water Treatment Plant (WTP). In 2009, the plant was upgraded from a direct filtration plant to a microfiltration membrane plant. This resulted in a significant increase in the quantity of material removed from the liquid stream and hence the quantity of sludge produced.

At Waikouaiti WTP, there are three waste streams which discharge into the lagoon. These are:

- Alum waste from the backpulse which is directed to a tube settler
- maintenance clean waste
- recovery clean waste.

The sludge handling facilities were not upgraded as part of the upgrade of the WTP. All waste streams discharge to a series of lagoons (three in series) which act as natural sedimentation basins. The waste settles well in the lagoons to produce a clear supernatant which flows from one lagoon to the next by gravity until it reaches the final lagoon where the water is discharged (via a gravity sewer) to the Waikouaiti River upstream of the plant.

The sludge settled in the lagoons is a brown gelatinous material. Over time, the lagoons fill up with sludge. When the sludge has built up to such an extent that settling is no longer effective, and the quality of the supernatant may be compromised, the lagoons are emptied.

The lagoons were emptied in 2007 at a cost of around $44,000. This was the first time the lagoons had been emptied since 1991. The sludge was mixed with sawdust and taken to the DCC landfill at Green Island. The sludge was classified as a special waste, which incurred an increased disposal charge in comparison to normal waste.

Since the upgrade there has been a significant increase in the volume of sludge being produced. In 2009, a sucker truck was brought in to remove the sludge from the top pond and dispose of the sludge and water removed at the Musselburgh pumping station which connects to the Tahuna (main Dunedin City) wastewater treatment plant. The cost of this was around $15,000 and DCC expected that the lagoon will need to be emptied twice a year at the current rate of sludge production.

The sludge produced at the Waikouaiti plant comes from the removal of a combination of the turbidity and colour in the raw water and the coagulant that is added to the water plus any water that is removed along with them.

Ideally the weight of dry solids in the sludge would be calculated from actual plant data on the suspended solids content of the waste stream entering the pond. However, the discharge pipes from the tube settler and the neutralisation tank do not combine before the discharge to the sludge lagoons. Therefore, there is no location at which the combined flow to the lagoon can be measured directly.

The annual quantity of sludge produced by the WTP is 9,000 kg DS/year based on an industry standard formula which takes into account turbidity and coagulant dose. This relates to the annual average flow to treatment of 1,700 m^3/day.

This quantity is expected to increase in proportion to the population served, which is expected to be 7% from 2001 to 2021. This equates to an annual increase of 0.35%, which was applied to the quantity of sludge produced. Therefore, by the end of the assessment period in 2040, the annual sludge production would be 10,000 kg DS/year and the annual average flow to treatment would be 1,890 m^3/day.

This assumes that the quality of the stream from which the water is taken does not significantly change. If the stream becomes more turbid, then the quantity of sludge that will need to be removed will increase.

The maximum capacity of delivered water which can be supplied by the current WTP is 3,000 m^3/day. Therefore, the sludge management systems that were assessed were designed to cope with the associated quantity of waste water and sludge for a potentially prolonged period while this maximum supply is maintained.

3 ASSESSMENT OF OPTIONS

3.1 DEVELOPMENT OF FEASIBLE ROUTES AND COST MODEL

For both the Tauranga WWTPs and the Waikouaiti WTP we undertaook a review of the options available for the management of the sludge/biosolids produced from the plants to enable the development of sludge management strategies or plans for the plants.

Before options are developed for the sludge management strategies, a summary of the relevant information which would influence the feasibility of options is undertaken. These typically included:

- National and Regional planning context, this establishes whether the sludge or biosolids requires a consent for processing or land application,and whether existing consents or rules apply which would influence the potential options.
- Characterisation of the contributing wastewater / water treatment plants and existing sludge management activities including the quantity and quality of sludge produced, as described in the previous section. This includes projections of sludge quantities over the assessment period selected, generally 30 years.
- Availability of bulking material / diluent which can be used as part of the selected option, such as sawdust or green waste. For some Councils, there is limited availability to these materials
- Land availability both for the application of biosolids to land but also land availabiilty around the treatment plant for any recommended unit processes that may be required for the recommended strategy.
- Any beneficial use options which are currently available or may be present in the future within sufficient geographical reach of the plant. These will be dependent upon the treatment of the biosolids.

The various treatment and disposal/use options relevant to the individual treatment plant are reviewed and then potentially feasible complete management routes, including both treatment and disposal, are developed for the selected options. These routes identify all the elements required for the implementation of the route, so that all aspects of the route can be evaluated and included in the cost model.

For each route, the same starting point within the treatment plant must be used to ensure comparability of results. For the Waikouaiti WTP, the starting point for the route was the tube settler for the back pulse or the discharge from the membrane plant for the other discharges.

It is important at this stage to ensure that sufficient options are included to provide adequate comparison data, but that the number of routes is kept to a reasonable minimum to avoid information overload. For example, Figure 2 summarises the routes that were devised for the Waikouaiti WTP. Note that there were paired routes where either the treatment or the disposal was the same to allow comparison between alternative options.

Figure 2: Feasible Sludge Management Routes for Waikouaiti WTP

Option	Treatment	Storage	Transfer	Disposal
1	Settlement in existing lagoons	In existing lagoons	Sucker truck	Tahuna WWTP
2	Settlement in existing lagoons	In existing lagoons	Slurry tanker	Sprayed on land adjacent to WTP owned by DCC
3	Dewater by plate press	Skips	Hook truck or similar	Green Island Landfill
4	Dewater by plate press	Storage on concrete pad	Truck	Cleanfill
5	Dewater by plate press	Storage on concrete pad	Bobcat into truck	Applied using quad bike & trailer to DCC forest land
6	Dewater by containerised plate press	Skips	Hook truck	Green Island Landfill
7	Dewater by non-biodegradable geobag	Concrete pad with drainage	Truck	Green Island Landfill
8	Dewater by biodegradable geobag	Concrete pad with drainage	Bobcat into truck	Applied using quad bike & trailer to DCC forest land
9	Dewater using reed beds	Reed beds	Excavator into truck	Applied using quad bike & trailer to DCC forest land

For each potentially feasible route, a spreadsheet cost model was developed which included the costs attributable to that route from the discharge from the Waikouaiti membrane filtration plant to the final point of disposal or use, including any required after care requirements. The costs used in the model were the costs at the time of the assessment, and were estimates based on concept design, received budgets, or current rates.

The analysis was to determine the difference in the sum of the NPV costs over the defined modeling period, which is typically 30 years. The NPV sum was split into the capital costs, the operating costs and the transport and disposal costs. The model did not include all costs incurred in the management of sludge, but the items which change according to the route which was being modelled.

For the Waikouaiti WTP model, the components that were included in the model are:

- Administration and management, which was assumed to be 2% of the total costs for that year. This represented the costs involved with managing the whole process, rather than specific design fees

- Dewatering which included the existing settling lagoons, plate press dewatering, geobag dewatering and reed bed dewatering. The costs included were the capital costs of the establishment of the different dewatering options, the subsequent replacement of end of life mechanical and electrical equipment, and the operating and maintenance costs associated with each of the process routes

- Storage. For the plate press routes, the storage of the sludge was either in skips or in concrete storage areas. The other routes did not require separate storage of sludge. The cost involved with each of the storage options included the capital cost of constructing the storage areas, and the associated operating and maintenance costs

- Application to land, which was either liquid application to the land adjacent to the WTP, or solid application to nearby forest land owned by the council. The costs for both applications included the estimated costs of consenting the land to receive the sludge, and the required metals content analyses. The costs specific to the two application types include:

    - Liquid application: the value of the land, the capital and replacement cost of the slurry tanker and the associated operating and maintenance costs, and the hiring of the tractor

    - Solid application: the capital and replacement costs of the spreading equipment and the associated operating and maintenance costs

- Disposal to the Tahuna Wastewater Treatment Plant. The costs included transfer to the plant and the trade waste discharge fee

- Disposal in landfill. The costs included the cost of transfer to the landfill, and the gate charge at the landfill.

- Disposal in cleanfill. The costs included the cost of transfer to the cleanfill, and the gate acceptance charge at the cleanfill.

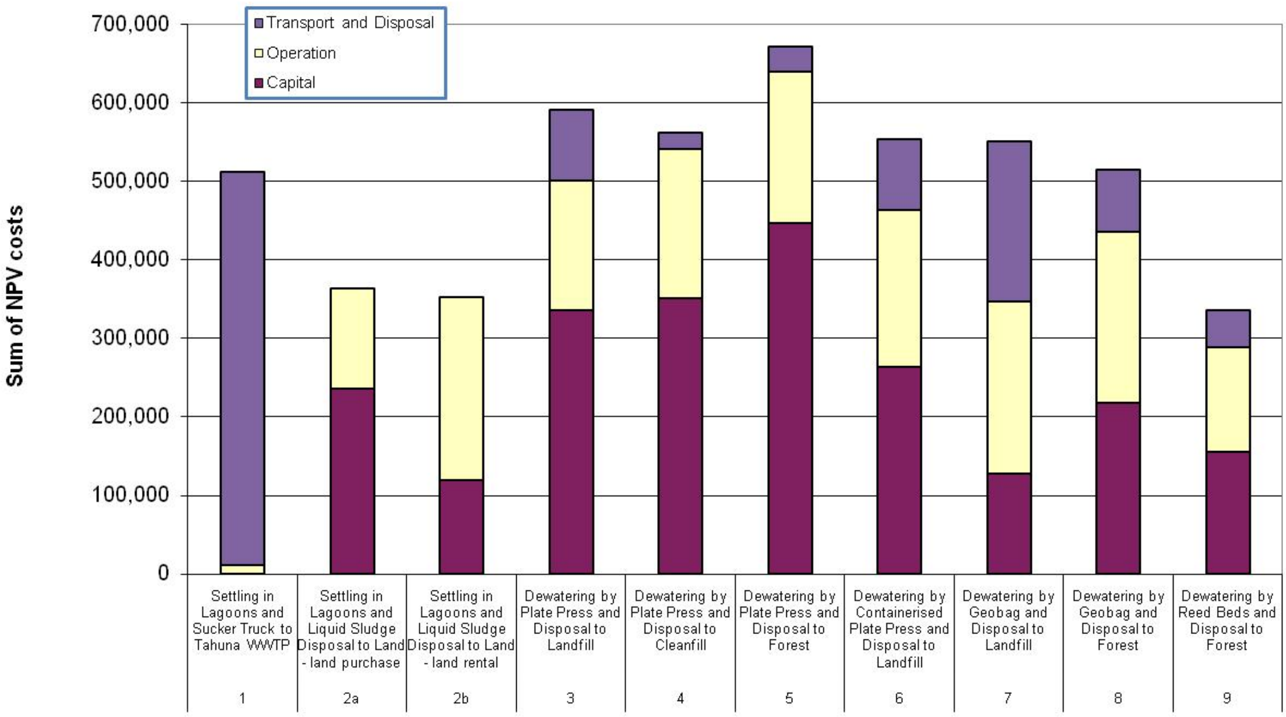
These components were similar to the models for sludge management routes that we have developed for other treatment plants.

The model was developed such that rates or factors that were common to all routes referenced the same cell such that sensitivity analysis on these rates or factors could be performed easily. This enabled the use of the model in workshops to illustrate the sensitivity of the costs.

3.2 RESULTS OF ASSESSMENT

The typical results generated from this analysis are shown in Figures 3, 4 and 5, which show the results of the cost modeling for the Waikouaiti WTP. The capital, operating and transport and disposal components of the total NPV costs are shown for each of the routes in Figure 3.

Figure 3 Sum of the NPV of the costs for each of the Routes using Base Case Assumptions for Waikouaiti WTP



The lowest cost route was the dewatering by reed beds with disposal to forest. However, this was the option with the most uncertainty as further investigations and trials were required to confirm the design parameters and whether suitable reeds could be found for New Zealand. Also, resource consents would be required.

The next lowest cost route was the settling in the existing lagoons and the application of liquid sludge to the section adjacent to the WTP. The overall NPV cost was similar for both sub-options for this option which varied according to who owns the land. This route had considerable uncertainty regarding the availability and cost of the land, the potential impact on the productivity of the land and whether consent can be gained for the application of sludge to the land.

For the disposal routes to forest, the lowest overall cost options were those associated with dewatering using reed beds, then geobags and then a sludge (dewatering) plate press. This was also the progression of increasing certainty with the costs and associated results of the processes.

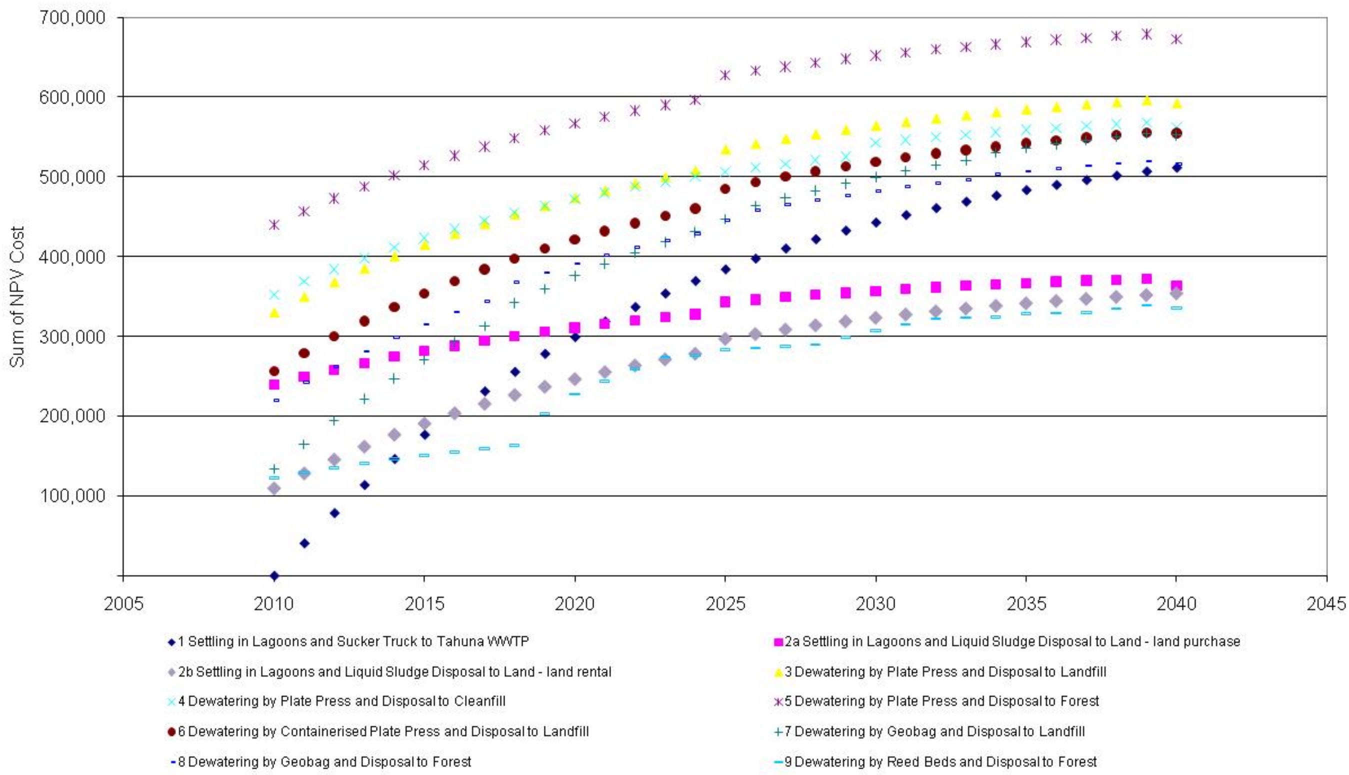
This illustrates the need to understand the underlying assumptions and uncertainties associated with the development of the costs when interpreting the results of the analysis. Whilst some of these uncertainties were incorporated by the different contingencies rates used for the various routes, this underlying uncertainty cannot be wholly quantified, and needs to addressed in the qualitative evaluation of the routes.

An important consideration, especially when attempting to understand the results of the model in terms of Council's available budgets, is the staging of when costs will be incurred. This can be readily generated from the model as shown in Figure 4, which shows the manner in which the NPV costs increase over the model period.

The difference in costs in the first year of the model reflects the degree of capital cost that would be incurred in implementing a route. The route based on the existing system had no initial start cost but within 5 years was exceeding the NPV costs of the next cheapest option. It shows the increase in costs at year 15, when the electrical and mechanical components of the routes would need to be replaced.

The small decrease in NPV costs at the end of the model period (2040) for some of the routes reflected the residual value of the civil components of the routes for which an asset life of 70 years was assumed. The residual value can be significant for options with considerable initial capital expenditure such as solar or thermal drying.

Figure 4: Cumulative NPV Cost over Model Period for each of the Routes using Base Case Assumptions



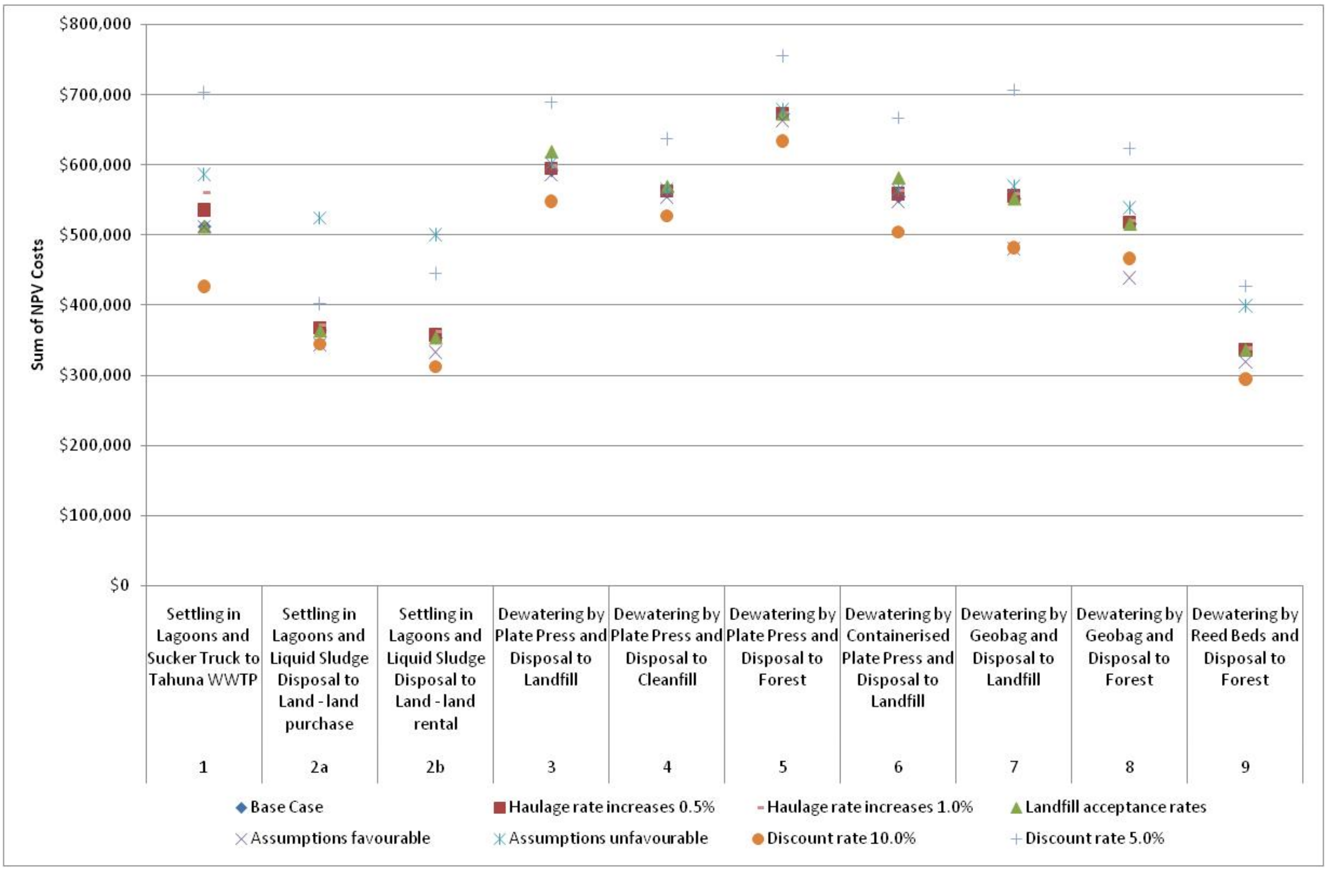
There are a number of sensitivities in the model which impact upon the relative costs of the routes. As identified earlier, the cost model was set up so that an assessment of the effects of these sensitivities can be readily performed. The resultant variability in the sum of the NPV of the total costs for the Waikouaiti WTP are shown in Figure 5.

The sensitivity factor which had the most significant influence on the overall NPV costs was the discount factor. This was common to all the assessments which we have performed using this model. The discount rate is an accounting tool, and can be set at whatever rate is considered appropriate for the situation. It reflects the relative importance of money spent now versus money spent in the future. The rate of 8% was used for the base rate, and the impact of changing this to 5% and 10% was investigated. This affects the impact of ongoing costs, in particular delayed capital costs or large operating or transport and disposal costs on the NPV. The variation in discount rate caused the largest variation in total NPV of all the sensitivity factors. However, the cost relativity between the various routes remained the same.

The impact on the costs of increases in the rate for transfer was modelled for a year by year increase in both haulage and fuel costs of 0.5% and 1%. Most options were not significantly affected by this sensitivity except for the haulage to Tahuna WWTP, where the sludge was transferred at very low % dry solids and hence a large quantity of water was being transported.

There were a number of assumptions which are inherent in the cost estimates. These were varied to reflect both the possible unfavourable end and the possible favourable end of these assumptions. The plate press routes were reasonably insensitive to these variations in assumptions, reflecting the low level of uncertainty relating to this treatment option. However, these variations in assumptions made a significant difference to the costs of the other routes, although the relationship between the costs of the routes remained generally the same.

Figure 5: Variability in the Sum of the NPV of the costs for each of the Routes



As a result of our assessment, DCC decided to conduct trials of the reed beds to determine if they can be implemented in New Zealand. These trials are ongoing and are discussed further later in this paper.

A similar assessment was performed for Tauranga City Council for the Te Maunga and Chapel Street WWTPs. This project demonstrated some of the inherent difficulties in cost modeling of biosolids routes especially those which involve the private commercial entities.

The project investigated whether the implementation of CANNIBAL® would be beneficial at Te Maunga WWTP amongst other options. This process reduces the amount of sludge that is produced from the liquid treatment stream rather than a sludge treatment process.

The reduction in the sludge produced is accomplished through an interchange recycle flow between the aerobic activated sludge process and a sidestream interchange bioreactor. The process is a patented technology supplied by Siemens Water Technologies.

The process separates the sludge produced by the WWTP into biological material and trash, inerts and sand. At Te Maunga WWTP, sludge was continuously produced which was made up of all these elements. With the CANNIBAL® system, trash, inerts and sand would be separated from the solids stream on a continuous basis, and there would be regular purges to remove biological material from the system, which would require further processing to become biosolids.

The quantity of biological material that is produced depends upon the yield which can vary from 0.1 to 0.3 kg TSS per kg BOD removed in the aeration basin. This yield is dependent upon the settleability of the sludge. To model the effect of the implementation of CANNIBAL® at Te Maunga WWTP, a solids yield of 0.2 kg TSS per kg BOD from the CANNIBAL® system was used.

This resulted in the predicted quantities of sludge reducing from 2,700 kg DS/day in 2011 to 970 kg DS/day of biosolids and 800 kg DS/day of trash, inerts and sand with CANNIBAL®. This would be a significant reduction in the quantity of material that required disposal or use and would produce a cleaner biosolids which may be more suitable for beneficial use.

Given the results of the assessment performed, the implementation of CANNIBAL at Te Maunga was cost neutral in terms of the total NPV of the entire system. Its incorporation made the route more robust to changes in factors which are outside the Council's control.

Whilst some decisions could be made as a result of the assessment, the specific biosolids management processes could not be definitively selected. Therefore, a Biosolids Management Plan was proposed which provided a process through which the actual physical processes could be selected and gradually implemented over a number of years, possibly with stages timed to coincide with the natural replacement dates for existing equipment after some initial investment for required units at the start.

As part of the implementation of this Plan, proposals were requested for all parties to disposal of the biosolids from both plants. A proposal was received for transfer and disposal of biosolids dewatered in 20%DS to the Hampden Downs Landfill at a rate of $98/tonne. The rate for landfill acceptance which was used for the cost modeling was $150/tonne based on quoted rates from other landfills. The transfer costs were additional to this modeled rate.

The low rate effectively halted any significant capital investment in alternative management routes, particularly those involving significant initial capital cost such as the CANNIBAL® system. However, given that it was a commercial decision by a private company, there is no guarantee that it will be available on renewal of the contract.

This highlights the need to ensure that councils provide the opportunity for commercial entities to offer alternatives in sludge treatment /biosolids disposal which could provide significant cost savings. Also that flexibility is required in any Plan, such that it can be adapted on an ongoing basis dependent upon the options that are available to a Council. From discussions with some commercial operators, regional consolidation may allow private investment into alternatives that include beneficial use, but individual council scale solutions generally do not allow for this.

4 REVIEW OF THE BIOSOLIDS GUIDELINES

4.1 INTRODUCTION

It is understood that the NZ Biosolids Guidelines (NZWWA, 2003) will be reviewed shortly. A number of issues with the current Biosolids Guidelines were identified during our projects. These issues are identified in this section of the paper. It should also be noted that a recent review by the Australian and New Zealand Biosolids partnership has identified a number of areas that should be considered further in the New Zealand review.

4.2 RESIDUAL RISKS

The current Biosolid Guidelines is an extensive document, which requires careful reading to understand the philosophy and also the extensive detail. The Guidelines do not currently provide definitive, clear statements on methods which will result in levels of risks that are considered to be acceptable. This leaves some doubt from the current Guidelines on the residual risks involved in the land application of biosolids and renders gaining acceptance of land application more difficult.

A stream lined document which discusses the methods for compliance with the various levels of restriction and indicates that if these are adopted then risks are considered minimal would assist with gaining public and regulatory acceptance. The current document discusses the risks but does not categorically indicate that these are addressed by the control methods proposed.

4.3 APPLICABILITY

Currently, the Biosolids Guidelines primarily focus on biosolids which are produced on a continuous basis and are applied annually to the same area. This is implied by the commentary on the potential build up of contaminants in the soil as postulated in the Guidelines, resulting from biosolids application.

The discussion in Section 6.3 of the Biosolids Guidelines indicated that biosolids should be applied at a nitrogen limited agronomic rate of 200 kgN/ha/year, which will limit the potential build up of contaminants in the soil and hence leaching through to groundwater. It recommends that soil should be monitored on a regular basis through the period of application to determine when the soil is approaching the soil limits and hence further application at the site should discontinue.

This would appear to exclude a wide range of biosolids, such as that produced from oxidation ponds (if suitably treated or held) or from sludge lagoons, or other long term sludge treatment methods. Typically sludge from these sources requires disposal on an infrequent basis . Their application to land would be a one off application, rather than a continuing annual application. In order to make the land application of these types of biosolids economically feasible, its application at rates greater than 200 kgN/ha/year would generally be required.

The project which we undertook with Invercargill City Council (ICC) sought to address this and is discussed later in the paper. It would be useful if the Biosolids Guidelines could provide advice on such one-off applications. This may require trials such as those we proposed for ICC.

An accepted national position on the relevance of the limits given in the Biosolids Guidelines to water sludge, rather than wastewater biosolids, would be useful. Given the different organic composition of the water sludge as compared to wastewater, it would be useful if guidance could be provided at a national level on the applicability of the Guidelines, rather than individual councils having to determine this and have this interpretation accepted by the relevant authorities. This could enable the land application of water sludge. This would be made more relevant if aluminium were included in the parameters which are addressed, although this should recognize the form of aluminium in water sludge.

4.4 PARAMETERS

The parameters which are controlled by the Biosolids Guidelines are metals and organic contaminants, specifically, organochlorine pesticides (OCP), polychlorinated biphenyls (PCBs) and dioxins. The reasons for selecting these parameters for control are not specifically provided in the Biosolids Guidelines.

OCPs were heavily used but their use has effectively ceased since mid 1970s. Therefore, the presence of OCPs in sewage sludge will be a legacy of past land uses. From the analyses that have been performed for the biosolids projects that we have been involved with, generally OCP are detected in the sewage sludge. The concentrations generally exceed the grade a limit but comply with the grade b. None of the monitoring results that we have seen has exceeded the Grade b limits and hence been rendered sludge for this parameter.

Similar to OCPs, the use and storage of PCBs in New Zealand has been banned with few exceptions, and therefore the presence of PCBs in sewage sludge would again be from legacy issues. In the monitoring that we have seen, the PCB concentrations have complied with the Grade a limit.

Dioxins are a group of chemicals which are present in many reservoirs in New Zealand and hence there is potential for its redistribution back into the environment from these sources as well as from ongoing burning sources. However, Section 2.2.3 of Volume 2 of the Biosolids Guidelines indicates that "*studies have found that background levels of dioxins and PCBs in New Zealand are generally low relative to other countries.*". For the biosolids analyses that we are aware, the dioxin concentrations have exceeded Grade a limit but complied with Grade b.

Analysis for these three organic parameters is expensive. To ensure that comparison can be made with the limits in the Biosolids Guidelines analysis needs to be undertaken at trace rather than screening level, which is even more expensive. The current rates for OCP and PCB analysis in solids from the 2011 Hills Laboratory Catalogue are

$230 and $220 per sample respectively. The only laboratory in New Zealand which provides analysis for dioxin is AsureQuality Limited. The cost per sample for dioxin analysis in 2009 was $1,861.50.

The cost for the metals suite that is required is $74 excl GST. Therefore, analysis of a single biosolids or soil sample for all the required parameters is approximately $2,400. This represents a significant cost to any project which is considering land application of biosolids, especially when multiplied by the required number of samples.

It would appear, from the analyses that we are aware of, that typically biosolids are grade b for OCP, PCB and dioxin. Bare also rendered grade b by the concentrations of some metals, typically copper, and zinc. A study could be undertaken which compiles the available information on biosolids concentrations and hence determines the "typical" biosolids concentrations. This would be especially useful for small WWTPs with minimal industrial sources. Provided they had no specific risk factors for these parameters, it could be assumed that their biosolids were grade b. This could be used in place of actual monitoring for these very expensive parameters.

During the project for Tauranga City Council, we determined the expected costs of the required monitoring programme associated with land disposal of their biosolids. This involved both testing of the biosolids and the soil to comply with the recommendations of the Biosolids Guidelines. It was assumed that an area of 500 ha was available for land application, based on an application rate of 200 kgTN/ha/year, and receiving approximately 80% of the biosolids expected to be produced in 2012. This proportion would reduce as the quantity of biosolids increases with increasing population.

Table 1 summarises the monitoring required and the associated analysis costs. This does not include the cost of collecting the samples. Biosolids Guidelines indicates that soil sampling should include the collection of 10 samples per hectare and then the samples should be composited into a single sample analysis. It is unclear whether the compositing referred to is all samples for each hectare or all samples for the application area.

Given that 500ha were required for the Tauranga biosolids, this constituted 5,000 samples. Compositing this number of samples together is not feasible. Therefore, we assumed the level of compositing given in Table 1. If it were assumed that the collection of each sample would take 15 minutes, the sampling effort involved with collecting the samples equates to 1250 hours or just over 30 weeks (based on an 8 hour by 5 day week). This would also constitute a major cost and logistical exercise.

Table 1: Estimated Costs of Monitoring for Land Application of Tauranga WWTPs' biosolids (as at 2009).

Aspect of Monitoring	**Scope of Monitoring**	**Estimated Analytical Cost**
Biosolids: Product Verification Phase	Over a three month period: 15 samples for stabilization parameters, 12 samples for metals and OCP and PCB and 1 sample for dioxin analysis	$28,000 (one off)
Biosolids Routine sampling phase	In each year: 52 samples for stabilization parameters, 26 samples for metals, 6 samples for OCP and PCB and 1 sample for dioxin analysis	$15,000 (each year)
Soil	1 composite sample for analysis for every 10 hectares (100 samples in each composite) prior to application and then every 5 years, We assumed the same parameters as the routine biosolids monitoring for contaminants, and dioxin analysis performed on one composite samples per 100 hectares (1,000 samples in each composite), no stabilisation monitoring required	$39,000 (every 5 years)

It is recognized that the Tauranga WWTPs are two of the larger biosolids producers in the country. However, these costs would not cover their whole biosolids production. These costs, reduced on a pro-rata basis for the soil aspect, would be incurred by any other Council attempting to implement a land application route and it represents a considerable cost, which given the basis for the analysis for these parameter may not be justified.

5 APPLICATION RATES

The Biosolids Guidelines recommends that biosolids be applied to land in accordance with the nitrogen agronomic rate of 200 kgN/ha/year. It is noted that in a number of locations around the country the leaching of nitrogen from applied sources to soil into groundwater is a considerable concern. However, for other sources of nitrogen, it is generally present as ammonia or nitrate being the more immediately available and for nitrate mobile forms of nitrogen. In well stabilised biosolids, the nitrogen will be present predominantly as organic nitrogen.

The process of converting the organic nitrogen to nitrate, involves it first being converted into ammonia and then into nitrate by the various micro-organisms in the soil structure. It should be noted that not all the organic nitrogen will be converted. Some will be retained in the organic material in the soil and will not be available to the plants or to become “leachable” nitrogen.

This conversion process is why biosolids is a slow release fertiliser, as compared to commercial fertiliser where the nitrogen is applied as ammonia or nitrate and hence is immediately available. The rate at which this conversion process occurs is unknown, and is dependent upon site specific factors such as temperature, aeration of the soil, and the nature of the micro-organisms that live in the soil.

Organic nitrogen and ammonia in the biosolids will be held within the soil matrix, dependent upon the nature of the soil. After conversion to nitrate, the nitrogen will be available for uptake into plants but could potentially leach down through the soil into the groundwater.

The Biosolids Guidelines do indicate that in some situations, the N loading could be expressed as an average enabling larger loads to be applied at less frequent intervals. It also indicates that only 10% of the nitrogen in the biosolids would be converted into available forms each year.

Any phosphorus not present in the form of phosphate would need to be converted before it would be available to plants. Generally, phosphorus is relatively immobile, and would not be expected to leach into groundwater in significant quantities.

Therefore, a better understanding of the degree to which nitrogen is actually released from the biosolids and soil matrix would assist in knowing the potential effects of increasing the application rate, which is needed to increase the economic feasibility of land application particularly for one off applications.

The investigations that we undertook for the Invercargill City Council (ICC) were to provide greater clarity around this issue. ICC had rezoned an area in Awarua for industrial development. As part of this development, the ICC were to establish areas of native planting and manage these areas and stormwater conveyance areas. There was an opportunity for the ICC to beneficially use the biosolids produced from the Clifton WWTP within the industrial area to enhance the growth of the native plantings.

The native plantings were to be performed on a staged basis which would allow trials to be conducted of the amount of biosolids that could be applied in one event to the soil, assuming mixing with a specific depth of soil, such that the soil contaminant limits in the Biosolids Guidelines are not exceeded after mixing of the biosolids with the soil. These depths of biosolids ranged from 90 mm to 370 mm which equated to total nitrogen loads of 5,500 kgN/ha to 22,000 kgN/ha for a single event.

If it is assumed that the biosolids release their nitrogen content over a ten year period, and that the release is relatively constant over this period, and it is assumed that all the nitrogen is released (rather than some nitrogen remaining bound in the organic structure of the mixed soil and biosolids) the equivalent annual nitrogen load to those given above would be between 550 kg N/ha/year and 2,200 kg N/ha/year, which is between 3 and 11 times higher than the nitrogen application rate nominated in the Biosolids Guidelines for annual application to pasture of

200 kg N/ha/year. The smallest depth of biosolids is within the envelope of typical nitrogen loading rates for land where animals would be excluded (600 kgN/ha/year from the Environment Waikato rules).

This approach relies on the nitrogen and phosphorus being released slowly from the biosolids over a period of many years, and hence not being released in a single large dump soon after application. Whilst this slow release is expected to happen, the proportion of the various forms of nitrogen in the biosolids is unknown and the rate of conversion of the organic nitrogen into nitrate is unknown.

Therefore, the application of a large quantity of biosolids involved the risk of a load of nitrogen being discharged into the groundwater and moving away from the application site. Also, the practicality of achieving adequate mixing of the biosolids with the soil, as well as the subsequent suitability of the land for trafficking or other activity when a layer of biosolids has been applied, were unknown. It was expected to be problematic for the deeper depths, given operational experience at the landfill.

In order to address these concerns, trial applications of biosolids were proposed which would have been monitored to determine the extent of any potential effects resulting from the elevated application rate and also to develop the physical application methodology.

These trials would be undertaken in the buffer planting strips that are planned around the site. The biosolids would provide beneficial nutrients for the plantings and hence should enhance the growth of the plants, as is understood to have occurred for plantings at the closed landfill with the same biosolids.

The trials were planned to involve the following:

- The biosolids would be applied at various application rates from 100mm to 400mm depth as practicable. As a conservative approach, the initial trials would be undertaken at the lower application depths. Once the monitoring of the initial trials confirmed that it is appropriate, the application depth would be increased for subsequent trials but would remain within the requirements of the soil contaminant limits

- Soil and groundwater quality would be monitored to determine the effects from the trial and appropriate rates of application for other areas around the Site

The sampling that had already been undertaken of the biosolids in the lagoon that had been excavated for windrowing, was believed to be sufficiently representative of the quality of the biosolids. Soil sampling would be undertaken before application to verify the background levels. After sufficient consolidation of the soil has occurred, sampling should be repeated to verify that the soil contaminant limits have been complied with. Given that there would be no further application of biosolids, then further testing of the soils after this confirmation has been performed would not be considered necessary.

For each application area, the direction of groundwater flow would be determined, and an appropriate number of upstream and downstream monitoring bores established to monitor the potential plume from the site. For the first two years, groundwater would be monitored on a quarterly basis for the forms of nitrogen and phosphorus and on an annual basis for the metal and organochlorine compounds identified in the Biosolids Guidelines.

Dependent upon the results of the sampling, it was expected that the frequency of sampling could reduce to an annual basis and it was expected that, within 10 years of the initial application, monitoring of the groundwater will no longer be required as the biosolids will have released most of its available nutrients by this time.

During the planning process, Fonterra released their amended approach to accepting biosolids on dairy grazing land. This was expected to influence other dairy companies, which were accepting milk from dairy farms on the site. The position was effective from 1 June 2010. With respect to biosolids, land to which biosolids has been applied will no longer be acceptable for the grazing of lactating dairy cows. Any dry stock (ie cows not producing milk) fed feed that has been grown with stabilised sludge must not be fed the material for 30 days before start of lactation that may supply Fonterra.

Therefore, any application of biosolids to land would render the land unacceptable for use in the grazing of dairy cows or the production of feed for lactating dairy cows supplying Fonterra. There was no time limit on this prohibition.

Before the application for resource consent was lodged the property department of ICC decided that it did not wish to have biosolids applied within the Awarua site. This was to ensure that any potential industries that could locate in the Industrial area would not be compromised by the presence of biosolids at the site. This was a purely commercial decision, but was made to protect the considerable investment that ICC had made in zoning the industrial area.

This indicates the problems that can be encountered when attempting to find sites to which biosolids can be applied. This is especially the case given that land which is suitable for biosolids application would also be suitable for dairy grazing or other cross sensitive uses and hence would have to compete with these other potentially more economically beneficial uses.

6 REED BED TRAILS

As discussed earlier in this paper, the outcome of the assessment of options for the Waikouaiti WTP was that dewatering by reed beds be further investigated as the option needs to be trialled to determine how effective it would be on sludge produced by the membrane filtration process at Waikouaiti.

The option was considered advantageous and worthy of further investigation given its relatively low capital cost and its very low operating cost, including no electricity requirement, as no pumping is required. The option represented a potential sustainable solution for the dewatering of the sludge.

The purpose of the trial is to determine:

- Whether appropriate plants can be identified which will survive the conditions to which they will be exposed under dewatering reed bed conditions. The reeds which were used in the trials carried out for the Hanningfield WTP in the UK are pest species in NZ and hence cannot be used.
- The percentage dry solids that can be achieved from dewatering of membrane reject water from the Waikouaiti WTP using reed beds
- The required dimensions of the reed bed (area, loading, number of basins operations etc.) for a full scale plant
- The quality of filtrate water from the reed bed system to determine if it meets discharge consent conditions.

The plants being trialed are *Shoenoplectus tabernaemontani* (Lake club rush), *Baumea articulate* (Stout jointed sedge) and *Carex Secta* which may be suitable based on the following selection criteria:

- Tolerant of permanent submergence up to 300mm
- Robust / aggressive
- Evergreen (as opposed to deciduous, shouldn't die back in winter).

Each type of reed is trialed in its own bed, with a plant rate of 4 plants / m^2 i.e. 16 plants of one type per bed (standard rate as advised by Titoki Nursery Ltd and consistent with the plant rate at the Hanningfield WTP trial).

The trial was commissioned in February 2011. The initial phase of the trial has focused on determining which species of plant is able to survive and grow in the conditions. The initial loading rate during this period is considerably less than the intended fully developed beds, as the plants are still growing to full size. *Shoenoplectus tabernaemontani* has not grown as well as the other two species and we are currently considering whether to replace it with another species. Over the forthcoming summer, we will gradually increase the loading rate to the design rate.

It is expected that the results of the trial will be available in the next few years.

7 CONCLUSIONS

Sludge management costs continue to be a significant and increasing cost. As discussed in this paper, these costs will only increase and we would expect this to occur at a faster rate than standard inflation.

This paper has described methods for identifying various options for treatment and disposal or use of biosolids/sludge, and a number of issues that need to be addressed when performing assessments of these options.

When estimating sludge quantities, you need to use a variety of methods dependent upon the data available. Direct monitoring of the quantity of sludge was not undertaken at any of the treatment plants that we have been involved with, even the large plants. An estimate had to be made on the basis of information from the liquid stream. For all plants, we estimated the quantities from all available data sources in order to ground truth the estimates to increase reliability of the estimates.

The various treatment and disposal/use options relevant to the individual treatment plant need to be identified and then potentially feasible complete management routes, including both treatment and disposal, developed for the selected options. These routes should identify all the elements required for the implementation of the route, so that all aspects of the route can be evaluated and included in the cost model.

For each route, the same starting point within the treatment plant must be used to ensure comparability of results. It is important to ensure that sufficient options are included to provide adequate comparison data, but that the number of routes is kept to a reasonable minimum to avoid information overload.

It is important to understand the underlying assumptions and uncertainties associated with the development of the costs when interpreting the results of the analysis. Whilst some of these uncertainties were incorporated by the different contingencies rates used for the various routes, this underlying uncertainty cannot be wholly quantified, and needs to addressed in the qualitative evaluation of the routes.

There are a number of sensitivities in any model which impact upon the relative costs of the routes. The cost model should be set up so that an assessment of the effects of these sensitivities can be readily performed.

It is important for councils to provide an opportunity for commercial entities to offer alternatives in sludge treatment /biosolids disposal which could provide significant cost savings. Also flexibility is required in any Plan, such that it can be adapted on an ongoing basis dependent upon the options that are available to a Council. From discussions with some commercial operators, regional consolidation may allow private investment into alternatives that include beneficial use, but individual council scale solutions generally do not allow for this.

The forthcoming review of the Biosolids Guidelines is noted. A number of issues that could usefully be addressed to facilitate land application of biosolids are identified in the paper.

A clearer definition of the methods for ensuring an acceptable level of risk for land application would be useful. This should definitively state that resultant risks are considered acceptable, which could facilitate general acceptance and clarity of the guidelines. Currently, the guidelines discuss the risks at length but do not provide clear direction on whether these risks can be adequately addressed.

Typically biosolids for these parameters are grade b for OCP, PCB and dioxin. The biosolids are also rendered grade b by the concentrations of some metals, typically copper, and zinc. A study could be undertaken which compiled the available information on biosolids concentrations and hence determine the “typical” biosolids concentrations. This would be especially useful for small WWTPs with minimal industrial sources, which provided they had no specific risk factors forthese parameters, could assume that there biosolids are grade b. This could be used in place of actual monitoring for these very expensive parameters.

The monitoring requirements for both the biosolids themselves and the soil should be reviewed. The current recommendation in the Biosolids Guidelines results in significant costs, which reduces the acceptability of land application.

A definition of the applicability the limits in the biosolids guidelines to water sludge would be useful. Also, an explanation would be useful of the applicability and the method of application of the Biosolids Guidelines to one off applications of biosolids, such as that from desludging of oxidation ponds. This should address the risk of nitrogen leaching from application of nitrogen loads which exceed the agronomic rates in terms of total nitrogen, but may not significant in terms of “leachable” nitrogen.

The current Fonterra position with regards to biosolids application is that any application of biosolids to land would render the land unacceptable for use in the grazing of dairy cows or the production of feed for lactating dairy cows supplying Fonterra.

Further to the Fonterra position, it is noted that the property department of ICC decided that it did not wish to have biosolids applied within the Awarua industrial site. This was to ensure that any potential industries that could locate in the Industrial area would not be compromised by the presence of biosolids at the site. This was a purely commercial decision, but was made to protect the considerable investment that Council had made in consenting the industrial area.

These two instances indicate the problems that can be encountered when attempting to find sites to which biosolids can be applied. Especially given that land which is suitable for biosolids application would also be suitable for dairy grazing or other cross sensitive uses and hence would have to compete with these other potentially more economically beneficial uses.

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