THE VALUE OF BIOSOLIDS IN NEW ZEALAND – AN INDUSTRY ASSESSMENT

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ABSTRACT

New Zealand's municipal water industry spends an estimated $40M per year to dispose of or beneficially reuse biosolids. New narratives of zero-waste, circular economy, nutrient cycle, and resource recovery are changing the way politicians, the public, and us as an industry think about waste and resources. This paper assesses the biosolids sector to identify ways of reducing cost, and capturing the value of biosolids in terms of:

- nutrient cycle including chemical fertiliser vs organic nutrients;
- carbon footprint;
- soil enhancement by returning moisture and organic carbon;
- land, quarry or mine rehabilitation; and
- zero-waste.

The paper characterises biosolids production, disposal and reuse across New Zealand and discusses the drivers and frameworks that result in different regional end-use or disposal solutions. Critical success factors of successful beneficial reuse initiatives are identified. The challenges of pathogens, metals and emerging contaminants are discussed. The strengths and weaknesses of the industry are presented and recommendations are made. The regulatory framework, end markets, cultural and social aspects are also discussed. Nutrient markets and economics, and the role our industry can play in this are assessed.

A discussion on industry challenges and opportunities with some recommendations is presented with the goal to find more sustainable and resilient outcomes that capture the value of biosolids and reframes the problem to one that sees product and value.

KEYWORDS

Biosolids, biosolids reuse, resource recovery, waste, landfill, fertiliser, organic soil conditioner, circular economy

1. INTRODUCTION

16 wastewater utilities representing 23 of the largest Wastewater Treatment Plants (WWTPs) across New Zealand were surveyed in 2019 to understand the treatment, volumes and end fate of sludge and biosolids in the country. This paper presents the findings and trends identified through the survey as well as the findings from international experience. Questions of value and cost, successes, challenges and changing drivers, are discussed.

Biosolids are examined through three lenses: the water utility, the waste sector and nutrient markets. From a water utility lens, the industry produces more than 300,000 wet tonnes of biosolids per year, with an annual processing and end-fate cost of $40M excluding cost of capital. From a waste sector lens, 35% of NZs biosolids go to “Class A” landfills, making up an estimated 3% of all waste going to these landfills. Central government and many councils have set targets for a zero waste future by 2050 or sooner.

From a farmer lens, carbon rich organic fertiliser options can be more attractive than chemical fertiliser for a range of reasons. Biosolids can provide an ideal alternative and more utilities are finding land application options for managing biosolids.

So is the New Zealand water industry optimising the value of biosolids? What are the drivers for current practice? What does good practice look like and do we need to change? If so how do we drive for change? This paper looks at how to improve sustainable outcomes and provide a roadmap for nutrient recovery.

DEFINITIONS

Biosolids – a municipal wastewater sludge that has been stabilised or treated to comply with land application guidelines. Class A and B biosolids are defined as per the WaterNZ and Ministry for the Environment Guidelines for the Safe Application of Biosolids to Land (2003).

Sludge – the unstabilised organic solids from wastewater treatment processes.

2. SURVEY

2.1 SURVEY METHODOLOGY

16 utilities servicing towns and cities with populations greater than 25,000 people were sent a questionnaire including the following parameters:

- primary stabilisation process;
- secondary treatment;
- biosolids production in wet tonnes;
- dewatered solids content; and
- operational cost for processing and maintenance.

All data requested was consistent with the regular ANZBP[1] industry survey across New Zealand and Australia, except that cost and population estimates were also included. Cost comprises of all operational and maintenance costs downstream of the primary or secondary clarifier. It includes the operating, maintenance and laboratory costs for equipment, as well as materials and energy for:

- thickening pre digesters (including chemicals);
- digesters;
- dewatering (including chemicals);
- drying;
- pumping;
- trucking;
- monitoring; and
- disposal gate fee.

The survey asked for operational costs only and excludes the cost of capital in real estate, plant and consents. To provide consistency, the costs were set to start at the collection of sludge (primary and/or secondary) through to the final placement or economic transaction to a third party. Costs start at collection since every process step that follows aims at capturing value or reducing cost for final product end fate. In other words, once collected or disposed of from a clarifier, the sludge has finished its useful life. Costs downstream are incurred to create a product that has a lower disposal cost or a higher sale value, whether that be by volume reduction or reducing odour for instance.

The utilities included in the survey are:

1. Whangarei District Council
2. Watercare Services Limited
3. Tauranga City Council
4. Hamilton City Council
5. Taupo District Council
6. Rotorua District Council
7. New Plymouth District Council
8. Horowhenua District Council

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[1] Australia New Zealand Biosolids Partnership

9. Palmerston North City Council
10. Wellington Water
11. Nelson City Council
12. Christchurch City Council
13. Selwyn District Council
14. Dunedin City Council
15. Queenstown District Council
16. Invercargill City Council

All utilities responded to the survey. Timaru, Greymouth, Napier, Hastings and Gisborne were excluded from the results on the basis that they did not have activated sludge processes, or no separate discharge for sludge.

It is recognised that data is collected and interpreted in different ways, especially when more than twenty individual organizations provided information through the survey. Each utility has different methods and detail in the data they hold. Generally the large specific costs such as chemicals and transportation are readily accessible. Maintenance or power costs however are often applied across the wastewater treatment plant rather than on a process unit basis. Additionally some process units such as digesters have major maintenance every seven or more years and some utilities make no direct allowance to annualise these costs. Those differences in data collection were not an issue for the survey however, as the purpose is not to make definitive statements about finite costs or volumes but rather to provide a means of understanding trends and comparisons.

The end-fate options are categorised as resource recovery (land, agricultural land, forestry, landfill cover and quarry rehabilitation) and waste (landfill and on-site storage).

2.2 Survey findings

The survey found that the 300,000 wet tonnes of sludge or biosolids produced in New Zealand typically have a dry solids content of 18%. Of this, 225,000 wet tonnes have no further dewatering or treatment, while four facilities follow the first dewatering step with thermal drying to above 90% dry solids.

BIOSOLIDS PROCESS CORRELATION TO END-FATE

The processing and end fates are presented in the Sankey Diagram below. The challenge for the water industry is to process dry tonnes of feed sludge. The diagram therefore presents the data with this metric. It is important to note that where digestion is used, dry solids content reduces by 40-60% so the dry tonnes of the end product will be different to the feed sludge. The most common metric used by the waste and resource recovery industry is wet tonnes of the end product. Wet tonnes of the end product are a function of the dry tonnes in the end product (impacted by digestion), and the water content of the end product (ie dewatering or drying).

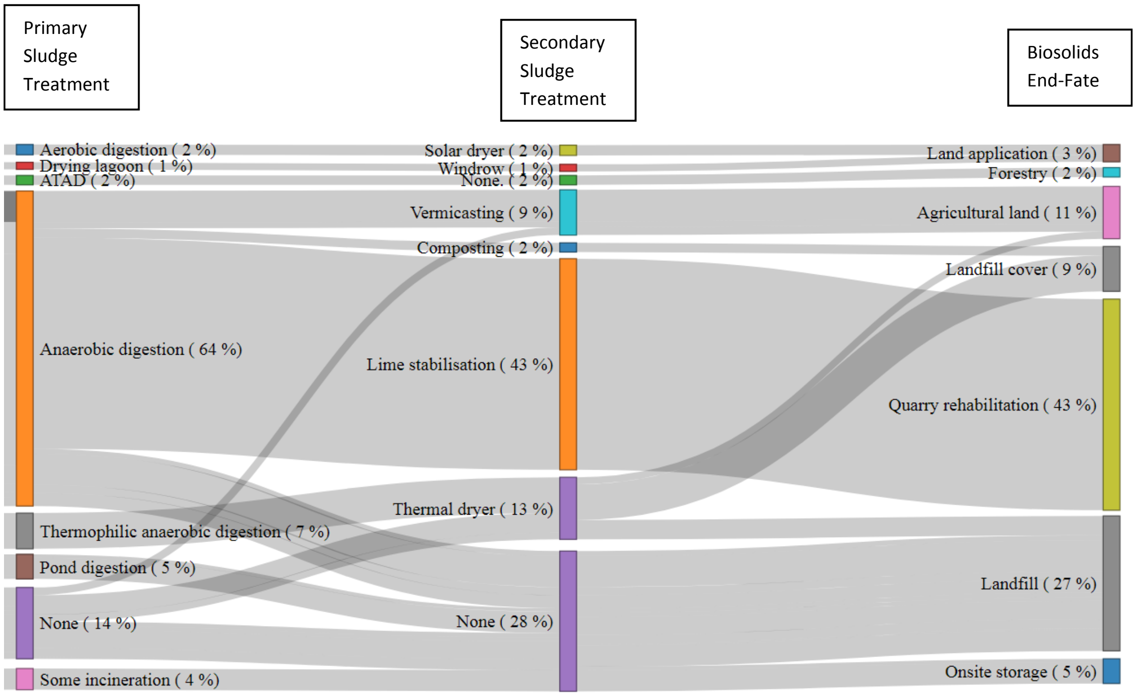

Figure 1 : Sankey Diagram showing feed sludge percentage (dry solids) of surveyed utilities by treatment processes and end-fates.

The diagram shows that in the New Zealand context:

- there is no obvious correlation between digestion method, including “no digestion”; and end use;
- resource recovery only occurs at sites with secondary sludge treatment, with the only exception being the forestry application from Nelson at Rabbit Island where ATAD provides Class A stabilisation.

The three sites that vermicast biosolids for agricultural application to land are Taupo, Rotorua and Hamilton. It is noted that Tokoroa also vermicasts however it was excluded from the survey because the population does not meet the 25,000 people threshold. Vermicast requires a high carbon feed source. It is therefore practiced only in the Central North Island where high forestry and pulp and paper by-products are readily available. One thermal drying facility produces a fertiliser product for sale (New Plymouth). Selwyn and Christchurch dry their product to produce a Class A product for resource recovery, while Wellington (Seaview) dries their product to reduce bulk for transport and landfill costs in the absence of a viable beneficial use at present.

The end-fates presented as dry solids of the end product (ie after processing) are presented below:

End Fate	**End product percentage (dry solids) for surveyed WWTPs**	**Classification**
Land Application	3.0%	Resource Recovery
Forestry	1.7%	
Agricultural Land	11.7%	
Landfill Cover	7.0%	
Quarry Rehabilitation	36.9%	
Landfill	34.7%	Waste
Onsite Storage	4.9%	

Table 1: End product percentage (dry solids) of surveyed utilities by end-fate

This table shows that almost 60% of New Zealand's biosolids are used as resource recovery.

BIOSOLIDS ECONOMICS

The survey found that New Zealand spends more than $40M per year in operational costs alone to treat and manage biosolids. These costs generally comprise of:

- a product development cost such as the processing at the WWTP;
- a transportation cost; and
- a gate transaction, either a fee (eg at a landfill) or a revenue (eg New Plymouth's BioBoost™)

Transportation cost and the gate transaction are a direct result of the product development cost. For example, the transportation cost and landfill fee paid by Watercare for Rosedale WWTP's biosolids are directly proportional to the investment in product development affecting volume (dewatering, digestion) and quality (digestion – the landfill does not accept undigested sludge because of odour). Similarly, the rate paid by Wellington Water to landfill is directly proportional to volume and quality, both achieved by thermal drying. The revenue generated by New Plymouth for its Bioboost™ product is achievable only thanks to product development quality and volume coming from the thermal drying process.

The unit chosen for analysis was the cost per feed sludge dry solids ($/tDS where tDS is tonnes of dry solids).

Two WWTPs are excluded from the cost analysis because they do not process their sludge and have long-term on-site pond storage. They therefore do not incur any costs.

The data is presented in Figure 2 below:

Figure 2: Unit cost to process biosolids by digestion method ($/tDS feed sludge)

The first finding is that all utilities incur a significant net cost regardless of a value of the end product. This is consistent with international experience. This is also consistent with processing of other organic resources such as food and garden waste. Composting and digestion facilities charge a gate fee for receiving the organic product both in New Zealand and internationally. This is because the marketing and distribution cost of selling the end product is typically offsetting the revenue from sales, and therefore the processing cost needs to be recovered “at the gate”.

The second finding is that a clear difference in processing cost was found for facilities with digestion compared to those without digestion. Where digestion is used, the operational costs were on average $270 per tonne of dry solids processed less than at facilities without digestion. This excludes the capital cost of digestion.

Digestion provides three key benefits:

- the opportunity to capture methane and generate electricity;
- a reduction in volume by 40-60% as dry solids are volatilised; and
- increased options for the end product as it is stabilised and therefore meets broader odour reduction and vector attraction requirements.

The break-even cost for a digester is dependent on the economics of methane capture and the reduced volume translating to lower cost of transport and disposal. The cost structures for these variables range from country to country, and within New Zealand from region to region. In New

Zealand, unlike Australia, the USA and the UK, the cost of power is typically low and there are no incentive payments from government for generating on-site electricity. Additionally, our landfill levy is low by comparison, at $10 per tonne vs. $NZ100 in parts of Australia and $NZ140 in the UK. Therefore, the payback for volume reduction and energy capture is significantly different.

The capital cost for digesters obviously needs to be considered for a full economic Net Present Value assessment. Some high level estimates for the construction of a concrete digester with mixing and full integration to plant costs $2,000 per cubic meter of capacity. One tonne of dry solids per day (or 365 tDS/year) load equates to 400m3 of capacity. Therefore a capital investment of $80,000 is required which at a cost of finance of 6% translates to $132 per tonne per day.

Digestion often results in methane production which is captured and used for energy at the WWTP, and in some instances where there is a surplus in energy can result in revenue from exports to the grid. As a rule of thumb, in New Zealand the cost of generating the energy is off-set by the cost of maintenance of the engines, gas scrubbers, and supporting infrastructure.

The cost to process a unit of feed sludge was plotted against the size of WWTP (based on feed sludge in per day) to assess if there is a correlation between scale and cost. Interestingly, only a weak correlation was found (see Figure 3).

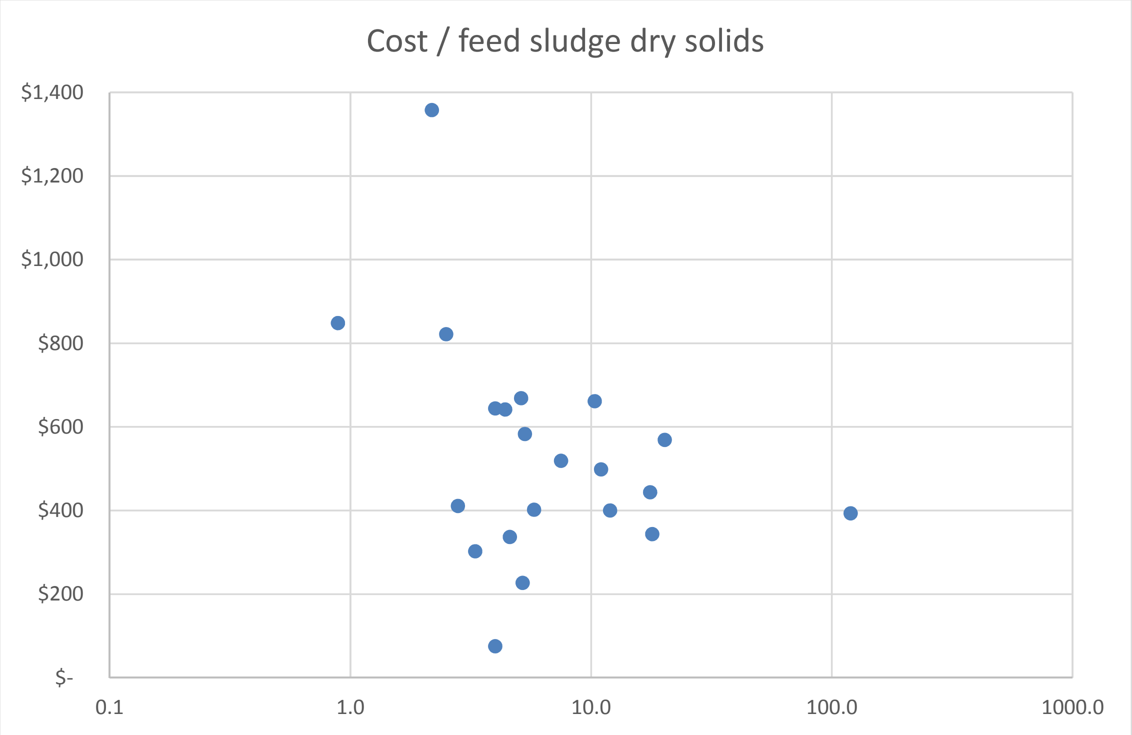

Figure 3: Unit cost of biosolids processing to WWTP size ($/tDS feed)

One WWTP has substantially higher costs than all others at $1357 per dry tonne feed sludge. The reason for this is believed to be high transportation and landfill costs. The other outlier is the facility with a unit cost of $75. This facility has storage and land available to passively pond digest for up to 20 years and windrow for 5 years, with final application to nearby land owned by the Council.

2.3 Some industry examples

ROSEDALE WWTP

Rosedale WWTP in Auckland's North Shore digests and dewaters its sludge to capture methane, reduce volume to lower haulage and landfill costs, and create a stabilised product that will be accepted at a range of landfills. This in turn ensures price competition on the landfill gate fee. The following operational and maintenance costs are incurred:

- thickening (Gravity Belt Thickeners) including polymer;
- digesting, methane collection and cogeneration engine maintenance;
- revenue from electricity produced is neutral, off-set by cost of maintenance;
- dewatering (centrifuges) including polymer;
- laboratory costs;
- control systems and pumping;
- collection contract costs (including landfill gate fee and landfill levy).

Construction of a thermal hydrolysis plant has commenced which will provide a pasteurised biosolids product with the goal of achieving a biosolids product suitable for land application.

TAUPO WWTP

Taupo WWTP collects sludges from around the district. Sludge is digested, dewatered and vermicast prior to land application to grow lucerne feedcrops for livestock. Each process activity ensures a reduced volume of a stabilised product ready to be taken to their own farm for verimcasting and safe (Class A) and economic to apply to land as a rich source of nutrients and carbon. The following operational and maintenance costs are incurred:

- thickening (Gravity Belt Thickeners) including polymer;
- digesting;
- dewatering (centrifuges) including polymer;
- laboratory costs;
- control systems and pumping;
- haulage costs;
- vermicasting.

The biosolids application is undertaken adjacent to land that has been irrigated with the WWTP effluent for the past 20 years, so there is public and Iwi understanding of land application. Feilding is currently planning a similar approach with composting as opposed to vermicasting.

LOWER NORTH ISLAND PROJECT

Seven lower North Island Councils are collaborating in a three year project to develop a biosolids strategy. The strategy is partly funded by the Ministry for the Environment Waste Minimisation Fund and co-ordinated by Lowe Environmental Impact. Partners include the Institute of Environmental Science and Research Ltd and Massey University. The approach has allowed Councils to fund a strategy that may not have been affordable if each had undertaken their own independent approach. The strategy:

- collects and consolidates biosolids data across the region;
- identifies opportunities for efficiency of regulatory processes and operational activities like desludging and dewatering;
- identifies tangata whenua and community consultation considerations;
- undertakes field trials of beneficial reuse options; and
- develops and assesses scenarios or options for implementation.

3. PRODUCTS AND MARKETS – CURRENT AND FUTURE

3.1 International outlook

Application to land is the end fate of 16% of New Zealand biosolids (tDS end product). By contrast, the United Kingdom and Australia apply 80% of biosolids to land, while the USA apply 50% to land. Many European countries also have high land application, while others are focused on incineration (often because of scarcity of land – for example the Netherlands and Switzerland). Most countries or states either have significantly higher landfill levies than New Zealand or they have a complete ban on biosolids and organic waste going to landfill.

It is the author's anecdotal experience from the UK, USA, and Australia that:

- application to land of stabilised biosolids (Class B without secondary treatment) makes up about half of land application programmes in the UK and USA;
- secondary treatment is practiced to provide greater security to the end markets by lifting pathogen protection from Class B to Class A, reducing odour and improving handling;
- utilities in the USA have recently started to focus on their sludge or biosolids processing as product production which shifts the operations paradigm from a compliance focus, to a market security and customer satisfaction focus;
- utilities in Australia tend to have a single market for their product, while in the USA the trend is for a utility to have two or more products and end-fates to provide medium term resilience;
- vermicasting is unique to NZ;
- application of biosolids to parks, road berms and home gardens is common practice in the USA for Class A product; and
- co-composting with green waste is common practice globally where land application is employed.

Composting creates a final blended product generally more compelling to some end users with typically reduced metal concentrations. It also beneficially utilises another waste product. It is however dependent on real estate and green-waste feed-stock.

3.2 Changing drivers and opportunities

BIOSOLIDS QUALITY

Biosolids quality has changed significantly over the past 20 years. Many utilities have reported a reduction in heavy metals due to improved trade waste management and the off-shoring of industry such as metal platers. For example Mangere WWTP's average zinc concentration has halved from 1000 mg/kg by dry weight in 2008 to 500 mg/kg in 2018, and cadmium has reduced from 2 mg/kg to 1 mg/kg. Advanced treatment has progressed across New Zealand, increasing the Class A stabilised biosolids being produced through composting, vermicasting, or thermal processes. Works have commenced at the Rosedale WWTP for a thermal hydrolysis facility which will provide a Class A product.

BIOSOLIDS GUIDELINES

The current guidelines "Guidelines for the Safe Application of Biosolids to Land" (2003) are being updated. The update is currently in draft form "Guidelines for Beneficial Reuse of Organic Materials on Productive Land". It is anticipated that these guidelines will be finalised over the next 12 months. The primary suggested change for biosolids is changes in metal limits for Class A biosolids as follows :

Parameter	2003 Guidelines Limit		Proposed Limit as per current Draft Guidelines for Beneficial Use of Organic Materials on Productive Land
	Valid 2003 through to 2012	Current, valid since 2013	
Arsenic	20	20	30
Cadmium	3	1	10
Chromium	600	600	1500
Copper	300	100	1250
Lead	300	300	300
Mercury	2	1	7.5
Nickel	60	60	135
Zinc	600	300	1500

Table 2: New Zealand Guideline Metal Limits (all units mg/kg dry weight)

DECISION MAKING

Utilities are introducing new drivers to their decision making including zero carbon, zero waste and sustainability reporting. For example, Auckland Council now requires climate change impact statements to be included in all council committee reports. The implications for biosolids producers, the wastewater utilities, are complex: energy used in production, methane emissions, energy generated in production and carbon sequestration in soil.

LANDFILLS AND WASTE

Central government is expected to undertake consultation on the waste levy in October 2019. This may result in a cost increase for any biosolids taken to landfill. In the longer term, there is a possibility that the government will follow other governments and ban biosolids from landfills. New

Zealand's waste sector is developing a greater understanding of processing and end fates of organic wastes.

NUTRIENT MARKETS

There is some growing concern about the impact of using chemical fertiliser as opposed to organically rich alternatives. This could change the dynamic and create opportunities for biosolids application to land. Biosolids are inherently rich in nutrients and carbon. Pathogens, metals and emerging contaminants need to comply with relevant standards and guidelines for beneficial reuse to be possible. Much has been published in this field and it is not the intent of this paper to go into the detail.

The biggest challenge for biosolids is inventory management - the inevitable daily production of sludge and finding a place to put it. The biosolids industry is effectively a high volume-low value industry which means that inventory management and transportation logistics have a significant influence. It also means that decisions are driven by the daily security of supply for end placement. Landfills inherently provide a relatively high level of security, while soil markets are seasonal and therefore require inventory storage.

SHIFT TO "PRODUCT" PARADIGM

A key shift is needed from a "compliance" paradigm focused on the minimum requirements to a "product quality" paradigm focused on customer needs. Parameters that can be influenced by the product producer include moisture content, odour, pathogens and chemical quality. These are influenced by dewatering or drying, stabilisation, pasteurisation and tradewaste management. In addition blending of soil or other organic products can significantly enhance product appeal.

SECTOR COLABORATION

There is an opportunity for the waste and water utility sectors to work more closely together, building on the following strengths:

- water industry knowledge of processing of organic wastes (it is our core business);
- water industry real estate and asset base for processing organic wastes (including consents);
- waste and resource recovery industry knowledge of land application of organic wastes (for example compost);
- nutrient market knowledge of soil, land holdings, seasons, site constraints, distribution and spreading logistics

LANDFILL ACCEPTANCE

Legislation across Continental Europe and Ireland, many States in the USA and some States in Australia do not allow biosolids to be landfilled. This essentially results in either incineration or beneficial reuse through land application. If New Zealand bans biosolids and organic wastes in general from going to landfill, this will significantly limit the options for utilities. Perhaps more importantly it changes the resilience profile as a significant "fall-back option" will no longer be available.

CARBON ACCOUNTING

The future of biosolids will be influenced by carbon accounting, the Emissions Trading Scheme (ETS) and the current Draft Climate Change Response (Zero Carbon) Bill. Biosolids have the ability to help sequester significant amounts of carbon into the soil. Their footprint is also subject to transportation emissions and process emissions. In addition, they have the potential to provide energy from methane production during anaerobic digestion processes. All of these aspects mean that more assessment is required as to how biosolids and carbon are accounted for.

3.3 Nutrient products and biosolids

429,000 tonnes of nitrogen were applied to New Zealand in 2015 ("Nitrogen and Phosphorus in Fertilisers", Stats NZ, 2019). By way of comparison, Watercare produces 140,000 wet tonnes of biosolids per year in Auckland, at an estimated 6% nitrogen and 18-20% dry solids. Our total nitrogen production is therefore 140,000 x 0.06 x 0.19 = 1600 tonnes. Watercare produces 0.4% of New Zealand's nitrogen market.

Almost all of the urea demand is met by farmer owned co-operatives of the chemical fertiliser industry. Desktop research shows that the price of a metric tonne of urea at 46% nitrogen has been between $600 and $700 during 2019. It should be noted that the farmer co-operatives pay a rebate to their shareholders. Composters also contributor to soil nutrient markets. Other products available include organic products form dairy sheds, dairy factories and chicken factories.

Stuff[2] reported that average cost for fertiliser application to farmland in NZ is $200 to $300per hectare. This is consistent with a bottom up assessment for chemical fertiliser costs of $292 per hectare to spread[3]. By way of comparison, the cost to apply biosolids to land is estimated at $233 per hectare. This is based on post-production and post-transportation cost of biosolids. Spreading cost can range from $5 to $18 per tonne. This wide variation is due to the local geography and distance of travel from stockpiles. If an assumed $15 per wet tonne cost is applied and an application of 17 tonne per hectare, total cost amounts to $255 per hectare. Alternatively at $2200 per day for an operator, spreader, loader, water cart and assuming a productivity rate of 20 tonne per hour at 8 hours amounts to $233 per hectare[4].

Biosolids provides nitrogen in plant-available and bound forms. It therefore acts as a slow release fertiliser with significantly lower nitrogen leaching compared to urea. In addition, biosolids provides a significant amount of carbon to the soil, allowing the soils to rebuild organic content with many well documented benefits including improved microbiological activity, improved moisture holding capacity, and reduced erosion. Another benefit of biosolids is that it provides carbon sequestration into the soil.

The proven options for biosolids end-fate are categorised as those options that are common international practice with a mature body of industry knowledge on safe, compliant and economic application. These include landfill disposal, soil nutrient products, land rehabilitation and

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[2] Stuff website : https://www.stuff.co.nz/business/farming/107560267/farmers-are-paying-too-much-for-fertiliser-soil-scientist (3 October 2018)

[3] based on 200kgN/ha, $650/T urea @46%N, $15/T delivery haulage and $6.50/ha cost to spread

[4] $2200 / 160T x 17 T/ha = $233 / ha

incineration. Developing options are categorised as end-fates that have not been adopted at sustained scale by utilities but have future potential subject to further research and development. These options include the conversion into biochar by low temperature anoxic pyrolysis, conversion into crude oil by hydrothermal liquefaction, and creating construction additives like concrete and asphalt. These options have limited short or medium-term potential at commercial scale for NZ, and are presently in a research and development phase.

Utilities will need to undertake their own business-case assessment on the most desirable option. In the interests of brevity this paper focuses on the soil nutrient product option on the following basis:

- The **developing options** do not currently provide certainty for future scenarios, they are currently being researched by organizations such as Melbourne Water (hydrothermal liquefaction), South East Water (biochar in Victoria, Australia), and building materials (Thames Water, UK and RMIT, Victoria, Australia).
- **Landfill** is not consistent with New Zealand government and local government policy for a zero waste future. Policy signals a rethink on what (if any) waste should go to landfill. Global trends are to ban biosolids going to landfill or to impose waste levies of up to $140 per tonne.
- **Incineration** is a specialist topic on its own accord. While practiced at small scale by Dunedin City Council, it has the following complexities to address: air quality scrubbing, air discharge consents, a unique and different layer of public involvement not familiar to the water industry, high vertical stack requirements, a significant capital investment with a risk of non-compliance moth-balling the facility, and limited NZ experience.
- **Rehabilitation** of soil quality is broadly covered in the discussion regarding soil nutrient products. Rehabilitation in the form of re-contouring the landscape of a mine or a quarry, as per Puketutu Island from the Mangere WWTP, is a unique bespoke undertaking requiring a specific case-by-case assessment. Here too there may be a requirement for a significant capital investment by way of consents, groundwater monitoring, liners and leachate management.

Soil nutrient products are the focus as an option in this paper for the significant body of knowledge spanning back almost a century. This focus does not mean that other options are not valid for assessment as each utility will have its own unique situation.

4. CONCLUSION

New Zealand manages over 300,000 tonnes of biosolids per year at an operational cost of more than $40M per year. A survey of New Zealand sludge and biosolids management found that:

- Three industries provide important input to biosolids use or disposal, namely the wastewater industry, the waste and resource recovery industry, and nutrient markets
- 35% of biosolids are placed directly into Category A Landfills, this makes up an estimated 3% of total waste to Category A Landfills. These statistics could significantly shift up or down over the next five years depending on what action individual utilities and we as an industry take

- The Government and many Councils have zero waste policy goals beyond 2040. Biosolids is a relatively easy landfill waste to transition to a resource
- Almost 60% of biosolids are beneficially reused (12 out of 17 utilities surveyed):
    - seven utilities directly apply biosolids to land as a fertiliser or compost product. This makes up 17% of biosolids compared to Australia who applies 80% of their biosolids to land, and the USA applies 50%. The NZ product is treated by either thermal or solar drying, windrow stabilisation, vermicasting, or ATAD
    - Mangere WWTP in Auckland produces 37% of New Zealand's biosolids, which are used beneficially in quarry rehabilitation and landform restoration.
    - two utilities produce biosolids which are used for landfill cover
- Beneficial reuse pathways include a secondary sludge treatment process such as thermal drying, composting or lime addition:
    - A number of utilities are actively developing biosolids-to-land pathways, all of these include secondary treatment processes such as windrowing, composting, and thermal hydrolysis
    - There is surprisingly plentiful body of knowledge for land application of biosolids as practiced by Invercargill, Nelson, Selwyn, New Plymouth, Rotorua, Taupo, and Hamilton
    - Where effluent irrigation programme is currently in place a biosolids to land programmes can leverage from public and Iwi understanding of the benefits
    - The agriculture industry is looking for organic carbon rich alternatives to chemical fertilisers,
- There are opportunities for the water sector to work more closely with the waste and resource recovery sector, as well as the nutrient sector, and central government
    - Carbon footprint and the potential for biosolids to sequester carbon into the soil will become more important in the future
    - The landfill levy is currently being reviewed by the Ministry for the Environment
    - Several utilities are accessing the waste minimisation fund to develop biosolids reuse strategies
- The water industry can benefit in a shift in operational philosophy from a compliance focus to a product development focus. This will require partnerships with end users, some of whom have been resistant to change and continue to import and apply offshore nutrients to land.

ACKNOWLEDGEMENTS

The author wishes to thank Roseline Klein, Nathaniel Wilson and Shane Morgan of Watercare and Jim Bradley of Stantec for their technical support and for reviewing this paper. The author also thanks the ANZBP for collaborating with the collection of the survey data and all the utilities who participated in the survey for their time and information.