Selwyn District Council
Pines Long Term Sludge Handling Options

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1 Introduction

1.1 Background

The Pines Wastewater treatment Plant (WWTP) was constructed in 2007 to serve a design Population Equivalent (PE) of 6,000 from the town of Rolleston. The area is experiencing significant growth, and the catchment which Pines currently serves is expected to expand, to the extent that the WWTP is projected to treat wastewater flows from a population of 28,000PE by 2016, and nearly 50,000PE by 2041.

A separate study has been carried out outlining the preferred liquid stream treatment process for the expansion, which is herewith referred to as Pines Stage II. This report considers the sludge and biosolids handling options for dealing with the projected increase in population.

1.2 Scope

The purpose of this short report is to:

(1) Report on the grading of biosolids produced
(2) Identify a preferred end (biosolids) disposal route
(3) Evaluate the sludge treatment options and identify a preferred solution

It is important to note that the end disposal route will largely determine the level of sludge treatment required on site. Consequently, discussion of disposal routes precedes that of on-site treatment processes. Where the report makes reference to “sludge”, the it is referring to non-dewatered material. This material is typically around 1.5% dried solids (DS) if not thickened, but may increase to around 6% if well thickened in a mechanical process. By contrast, “biosolids” refers to “…sewage sludges or sewage sludges mixed with other materials that have been treated and /or stabilised to the extent that they are able to be safely and beneficially applied to land"[1].

2 Current Sludge Management Practice

Waste activated sludge (WAS) from the WWTP process is currently fed to a 125 m^3 storage tank. The tank was originally designed to aerate and store the sludge before feeding the partially digested sludge to a centrifuge dewatering unit, prior to disposal off site (at approximately 20% DS). However, the centrifuge was not installed at the time as it was considered not cost effective. Consequently, the current practice is that the storage tank contents are tankered off-site once a week to an off-site thickening and dewatering facility. Only three quarters of the tank is emptied, which causes a gradual sludge build up in the tank. Subsequently, there is a substantial risk of foaming and bulking of the WAS when it is aerated. This has resulted in the tank overflowing on several occasions and, as a result, the aerator in the tank has been switched off.

The current practice is far from ideal. Not only does it result in poorer solids reduction and thickening prior to sludge removal, but the anaerobic conditions create an offensive odour around the WAS tank. While this has not been noticeable at the site boundary (as required by the consent), it was noted by members of the public visiting the plant during an Open Day on 8 November 2008.

The existing practice cannot continue through to the next stage of the Pines development. Not only will the odour become more pronounced, but the costs of tankering what has become anaerobically digested sludge, will be very high. This is a very uneconomic and unsustainable method of dealing with the solids, which will be exacerbated by the growth of the catchment.

The proposed short term proposal (ie for coping with waste sludge from the existing plant) is to install two 30 m^3 PVC tanks adjacent to the WAS tank as storage for the sludge. This will allow the existing WAS tank to be used as an aerobic digester and thickening unit, reducing tankering costs and odour. This proposal is outlined in the 'Short Term Sludge Handling Report' document.

3 Legislation Governing Sludge Disposal Methods

Central government policy includes the New Zealand Waste Strategy. One of the targets of the New Zealand Waste Strategy is that by December 2007, more than 95% of sewage sludge currently disposed to landfill would be composted, beneficially re-used or appropriately treated to minimise the release of methane and leachate into the environment.

The Resource Management Act (RMA) provides the legal basis for activities regarding wastewater treatment in New Zealand. However, there are currently two sets of guidelines regarding the application of sludge or biosolids to land. These are:

(1) "Public health guidelines for the safe use of sewage effluent and sewage sludge on land", Department of Health (DoH), 1992; and
(2) "Guidelines for the safe application of biosolids to land in New Zealand", New Zealand Water and Waste Association (NZWWA) and the Ministry for the Environment (MfE), 2003.

The underlying principles of the NZWWA guidelines include the following:

- That biosolids can and should be used beneficially
- Protection of public health

[1] "Guidelines for the Safe Application of Biosolids to land in New Zealand", NZWWA, 2003.

- Consistency with the RMA
- Biosolids management framework needs to be flexible and enabling
- Consistency with central government policy
- Appropriate risk management
- A precautionary approach

In the NZWWA guidelines, biosolids are divided into different grades based on stabilisation (A or B) and chemical composition (a or b).

Grades

Stabilisation (e.g A): A high-quality biosolid 'A' is one in which pathogens and vector-attracting compounds, such as volatile solids, have been substantially reduced or removed. To achieve stabilisation grade B, the biosolids need to meet a lesser degree of stabilisation plus one of the vector attracting compound (VAR) requirements for grade A. [2]

Contaminant (e.g. a): To achieve contaminant grade 'a' the concentration of all the contaminants within the biosolids must be at or below the level indicated in Table 4.2. A biosolid has to be classified as chemical contaminant grade b even if only one contaminant falls within that category. If any contaminant concentration is above the limit given for grade b, then the product is to be considered a sludge rather than a biosolid and the sludge has to be treated, or blended with another substance, in order to become a biosolid, or disposed of.[3]

If a biosolid achieves grade Aa, the guidelines propose that application to land should be a permitted unrestricted activity, not requiring consent. Disposal of grades Ab, Ba or Bb biosolids to land are considered a discretionary activity subject to regional plans, and require resource consent. In addition to the above requirements for grade B biosolids, a storage period of up to 12 months is required if the material is to be re-used on land.

4 Criteria for Options Assessment

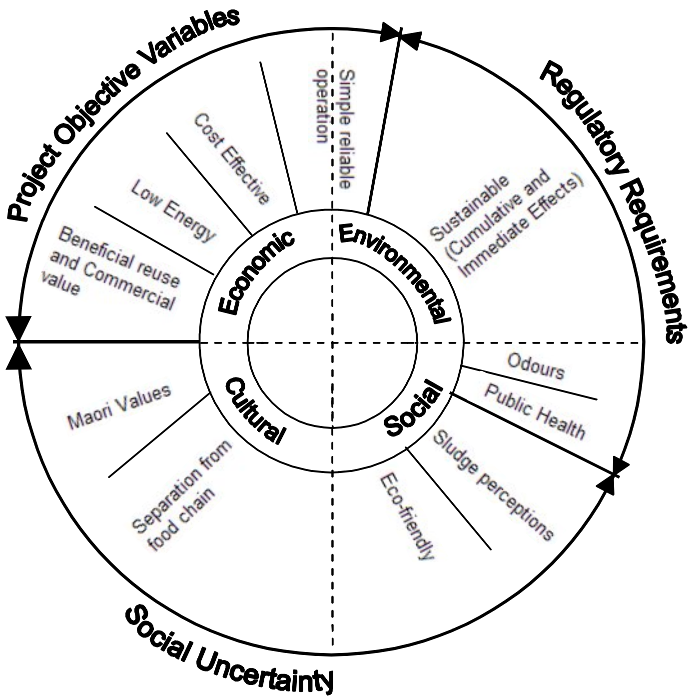
To compare and evaluate the sludge treatment and end disposal options, each has been assessed against four well beings. These are: (1) Economic, (2) Environmental, (3) Social, and (4) Cultural.

As part of SDC's drive towards sustainability, each of these well beings is considered when assessing the impact of any activity. A full report on the sustainability of wastewater operations is currently available as the draft report "Pines II WWTP Sustainability Assessment and Alignment" (MWH, 2008).

In determining the preferred sludge management option, the following diagram, incorporating the four well beings at the centre, has been used.

[2] Section 4.3.1 and Table 4.1 of Guidelines for the Safe Application of Biosolids to Land in New Zealand
[3] Section 4.3.2 and Table 4.2 of Guidelines for the Safe Application of Biosolids to Land in New Zealand

Drivers Determining Sludge Management Options



The three priorities identified for the comparison of options are:

(1) simple and reliable operation
(2) cost effective
(3) Beneficial re-use and commercial value.

The fact that beneficial re-use is considered a priority drives the need to achieve a grade Aa or Ba biosolid. It should be noted that as the industrial component for Rolleston and the surrounding area is small, there is likely to be few metal contaminants, so a grade Aa or Ba biosolid is wholly achievable. Furthermore, any new industry that emerges in the future will be subject to ta Trade Waste bylaw and will be required to resduce metal content if above a specified amount. Consequently, the need to produce at least a grade B quality biosolid means that the sludge treatment and handling must be geared towards this goal.

5 Sludge Disposal Options

5.1 Options Considered

There are a number of methods for the disposal or re-use of biosolids. The four routes considered in this report are:

(1) On land disposal (on-site) of non - dewatered sludge
(2) Beneficial use on land or industry
(3) Incineration
(4) Landfill

Each has been assessed against the four well beings shown in Section 4, with details provided below.

5.1.1 On land disposal (on-site) of non-dewatered sludge

This option proposes spraying sewage sludge over forested land at 2% DS. For example, the current Pines WWTP has area available between the centre pivot irrigators which could be planted with pine trees, and sludge could be sprayed in this area. This would be the most cost effective means of disposal as no new treatment processes (apart from aerobic digestion) would be required on site, and it would remove the need to tanker the sludge away from site. However, the high nitrogen content of the digested sludge requires a significant land area for disposal (approximately 84 ha for 12,000 pe). Furthermore the current consent only allows land application of sludge that meets Grade Aa standard. This is unlikely to change so both significant treatment and a resource consent would be required.

The land area required for sludge application is large and significantly reduces the overall capacity of the wastewater treatment and disposal system that can be situated on the site. Therefore, the use of sludge disposal to land @ 2%DS, if resource consent can be acquired, is only a short term solution, and not feasible in the long term.

5.1.2 Beneficial Use of Biosolids on Land or for Industry (Grade Aa or Ba)

Sludge and biosolids require a certain level of treatment to ensure it is sufficiently stabilised for land application without public health risk. Some of these treatment methods can provide environmental and economic benefits in the form of power or heat generation.

Dewatering and treating sludge to a biosolids standard for beneficial re-use is only a sustainable and practical option if there is an industry or market for the product. Some possible uses for the product are given below:

On Land: As a fertilizer or soil conditioner.

Reuse on land has issues with public health, environmental capacity and perception. The long term capacity for land application is based on a cumulative level of contaminants, determining the overall length of time the operation can be maintained. Public health issues relating to pathogens and metals should not be an issue as long as appropriate treatment and application is provided. However, there is little knowledge about the impact of micro-pollutants such as endocrine disrupters.

In Industry: Biosolids can be utilised in chemical and biochemical processes to produce biogas or bio-oil. The latter of these two processes is similar to the conversion of algae to bio-crude.

5.1.3 Incineration

Incineration greatly reduces the volume of material for disposal. The process consists of thermal drying of the sludge, destroying all of the biological material, followed by combustion in the presence of excess oxygen, to produce a residual inert ash. The residual product can be disposed of to landfill or used in construction materials such as concrete, roading underlay or bricks. Heat generated from the process can also be captured and re-used.

However, incineration is high in both capital and operating costs, often ruling it out as a feasible option. There is also generally strong public opposition as a requirement for a flue stack makes the treatment process visually prominent (flue gas treatment and dehydration is required). Furthermore, GHG emissions are emitted as a result of the incineration process.

Common opinion is that incineration and other thermic oxidation methods rate poorly for energy and GHG emissions, however studies have shown that they rate well comparative to other treatment and disposal options for both counts[4].

5.1.4 Landfill (any grade)

Disposal to landfill is a relatively straightforward operation. The sludge is dewatered, then transported by truck to landfill. It is likely that landfill at Kate Valley, approximately 1 ½ hours drive from Rolleston, would receive the biosolids.

There is a move both nationally and globally to move away from land-filling of sludge. It is considered an unsustainable approach to sludge disposal as the transportation and disposal costs are expensive, the sludge will emit GHG from the landfill, and it simply does not make the most of a nutrient rich material.

Although much of the GHG emissions can be captured at landfills with good Landfill Gas (LFG) recovery systems, and considerable consideration goes into design of leachate containment and collection, New Zealand is an earthquake prone nation, and during a strong earthquake there is significant risk of damage to the leachate containment systems.

Landfilling is also in direct deviation with the 2002 Waste Strategy and 2008 Waste Minimisation Act which aim to reduce the amount of solids going to landfill.

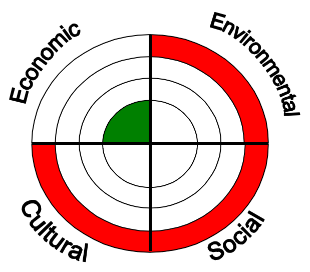
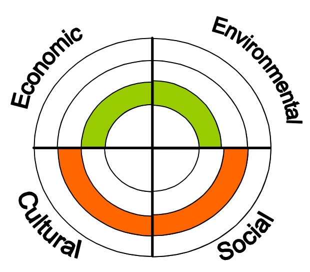
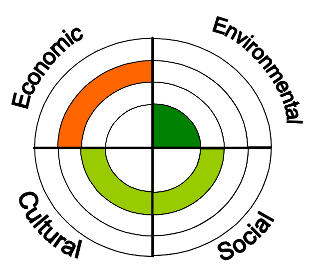
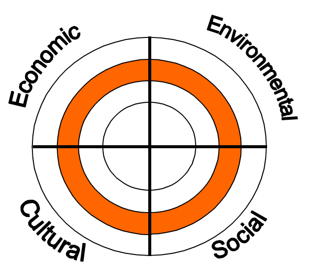
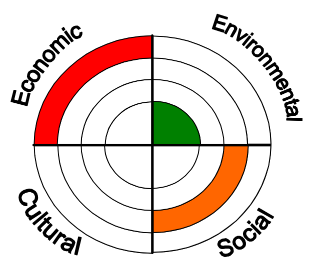
[4] Houillon, G. and Jolliet, O. (2005) Life cycle assessment of processes for the treatment of wastewater urban sludge: energy and global warming analysis, *Journal of Cleaner Productions*, **13**:287-299
Haug, R. T., Lewis, F.M., and Brady, P. (2004) Combustion and land application: can both be beneficial?, Water Environment Federation Technical Exhibition and Conference 2004.

5.2 Assessment of Sludge Disposal Options

Table 1 presents an assessment of the disposal options against the four well beings, with an explanation of this grading system given below.

KEY		
Four Wellbeing Ratings		
Very positive	***H***	***High impact***
Positive	***M***	***Medium impact***
Neutral (or perceived as either +ve or -ve)	***0***	***Neutral impact***
Negative	***N***	***Negative impact***

Table 1. Assessment of disposal options.

		
On land disposal of sludge (Grade Ba)	Beneficial Re-use (Grade Ba)	Beneficial Re-use (Grade Aa)
		
Incineration (Grade Ba)	Landfill (ungraded)	

Based on the above assessment, beneficial re-use on land (or in industry) at either a Grade Aa or Ba biosolid quality is the Best Practical Option (BPO).

6 Sludge Treatment Options

6.1 Options Considered

Table 2 below summarises the predicted amount of sludge which will be produced at the WWTP which will require treatment.

Table 2: Sludge volumes against population growth

	Year		
	2017	2031	2041
PE	28,000	41,500	47,774
Sludge Volume @ 2% DS (m^3/d)	72	107	123
Dewatered Sludge @ ~20% DS (m^3/d)	7.2	10.7	12.3

To achieve the biosolids quality necessary for beneficial re-use (either Aa or Ba), the options considered for sludge treatment are:

(1) Aerobic Digestion (AD) followed by centrifuge dewatering
(2) As (1) but with solar drying after the centrifuge
(3) Centrifuge dewatering followed by composting
(4) Aerobic Digestion followed by drying beds
(5) Aerobic digestion followed by geobags

A brief description of each process is given below.

- Aerobic digestion — Bacterial reduction and stabilisation of sludge in an aerobic environment. This will achieve a grade B biosolid
- Centrifuge — A mechanical equipment process of dewatering the sludge. There is no stabilisation or solids destruction, and can achieve a dewatered product of between 15-35% DS
- Composting — Aerobic composting of sludge with bulking material such as wood chips at a ratio of approximately 1:1. Requires a reliable bulking agent source but is of sufficient quality for general public use.
- Solar Drying halls — Large "greenhouse" halls using solar radiation to dry sludge and a mechanical robot to turn sludge. Stabilisation and dewatering up to 80% DS and above achievable.
- Drying Beds — Large areadivided into beds (typically around 50m long and 15m wide) where digested sludge is pumped and drying is induced naturally. The process is assisted by regular turnover by the operator.
- Geobags — Large geotextile bags fed with digested sludge, and as the sludge filters through, the bag retains the solids. Most often used as a one-off solution, such as de-sludging a lagoon.

The details, advantages and disadvantages of the above options can be found in Table 3. Based on the assessment, the preferred option is drying beds followed by beneficial re-use.

Table 3: Sludge Treatment Options Evaluation

Process	%DS achieved	Expected Dewatered Volume by 2041 (m^3/day)	Biosolids Grade	Disposal Method	CAPEX	OPEX	Advantages	Disadvantages
WAS[5] → AD[6] → Centrifuge	18-20	12.3	Ungraded (Ba)	Beneficial reuse	medium	medium	• Relatively simple process.	• Re-use of solids will be restricted (need consent) – may struggle to find suitable disposal area
				Landfill	medium	high	• Relatively simple process. • Certain disposal route	• Disposal to landfill a high ongoing cost. • Possible opposition form those on trucking route
WAS → AD → Centrifuge → solar drying	80	3.1	Ba (Aa?)	Beneficial reuse	high	Low/medium	• Large reduction in biosolids volume. • Aa grade not yet proven, but unrestricted use likely	• Solar 'greenhouse' takes up large area. • High initial cost
				landfill	high	medium/high	• Certain disposal route	• As above, but with additional cost of trucking to landfill.
WAS → Centrifuge → composting	-	-	Aa	Beneficial reuse	high	low	• Unrestricted use final product. • Excellent for plant growth. • Low disposal cost if public acceptance.	• Availability of bulking material (likely woodchips, green waste not suitable) • May struggle to get public uptake of compost. • Risk of odour issues
WAS → AD → Drying beds	30 - 40	6.2 – 9.3	Ba	Beneficial reuse	low	Low/medium	• Very simple. • Cheap process. • Easy to operate. • No chemicals required • Very effective over summer months	• Drying beds use large land area. • Risk of odour. • Likely public opposition. • Need Consent for reuse.
				landfill	low	medium	• Certain disposal route	• As above, but with high cost of trucking to landfill
WAS → AD → Geobags	~ 20	12.3	Ba	Beneficial reuse	medium	high	• Easy operation. • Low capital cost.	• DS content not certain & not a common method. • Large area required. • Geobags are not a sustainable process
				landfill	medium	Very high	• Certain disposal route	• As above, but with ongoing trucking costs

[5] WAS – Waste Activated Sludge - the solid material that is removed from the treatment process
[6] AD – Aerobic Digestion

7 Staging Strategy

Figure 2 below illustrates the proposed staging strategy for the long term sludge handling management.

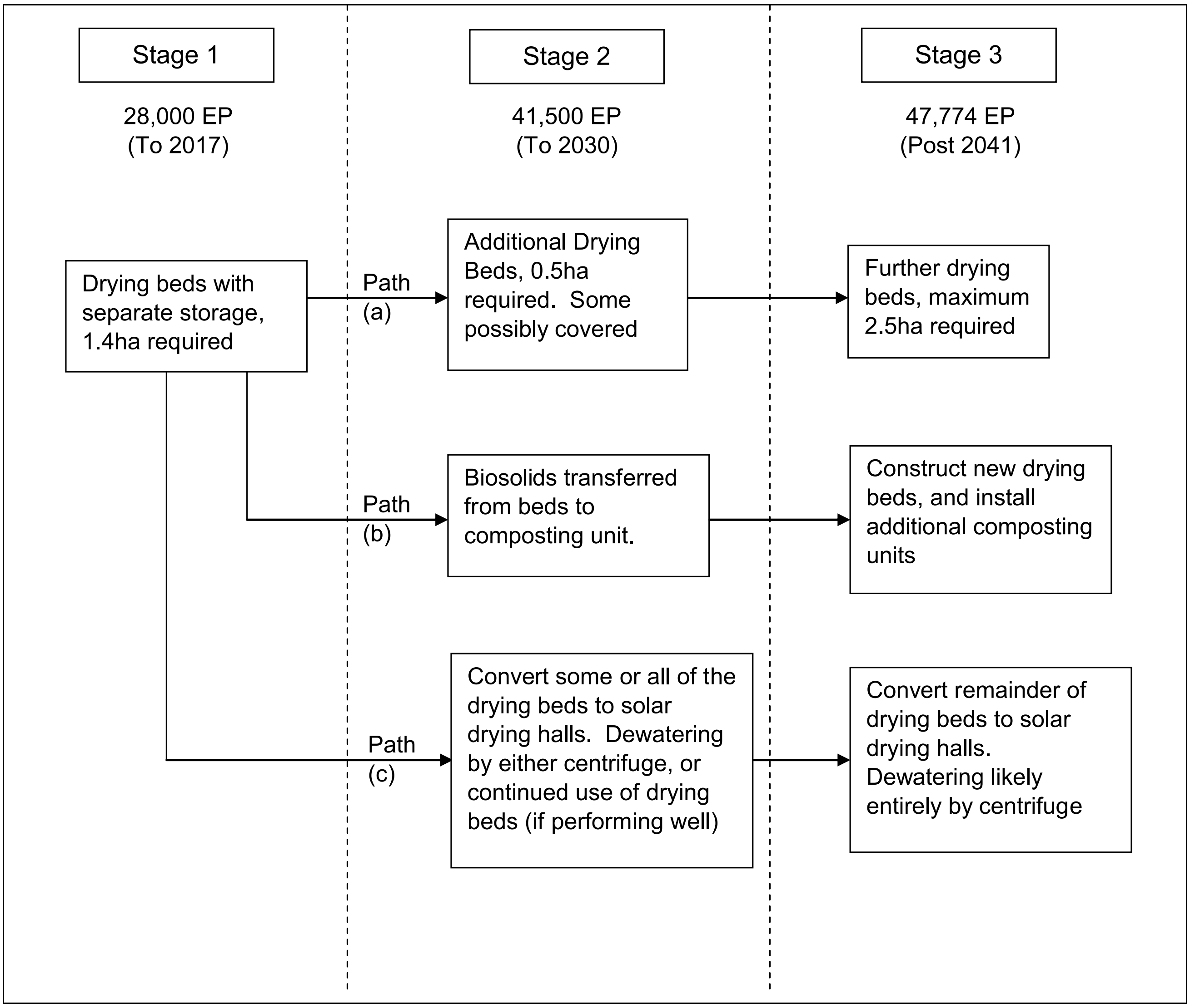


Figure 2: Long Term Sludge Staging Strategy

Stage 1

Figure 2 above shows that 1.4ha of total drying bed area would be required for a population of 28,000EP.

The opportunity exists to reduce the ultimate land take required by covering some of the beds to allow better dewatering over winter. Initially the beds would be left uncovered so that the performance could be fully assessed.

The beds would be fed with aerobically digested sludge, so that volatile content of the sludge is sufficiently reduced to create a grade Ba material. This will also substantially reduce any odour risk. It is estimated that the sludge would be fed at a dried solids content of 2%, with the drying beds capable of producing a 30-40% DS material within a fortnight.

Drying would be assisted by the Operator towing an auger behind a tractor to keep the sludge well aerated. Once the sludge is dried, a front end loader would be used to transfer the material to a covered storage area on site where it would be stored for 12 months. It is envisaged that this would be carried out every one to two weeks. Following the storage period the sludge will be available for soil incorporation or applied to fodder crops, orchards, or non-edible crops.

To protect the risk of biosolids dust blowing off the tops of the drying beds, it is proposed that trees be planted around the beds to minimise the airborne transfer of biosolids 'dust'.

The design population of 28,000EP is expected to be reached by 2017. There are several opportunities to develop dewatering after this point, as highlighted by paths (a), (b) and (c) in Figure 2. These are described in more detail below.

Stages 2 & 3

Path (a) – Add more drying beds

This option simply allows for the construction of more drying beds at the site, with continued production of Class Ba biosolids. This would require an additional 0.5ha of drying beds to be constructed at 2013, with a further 0.6ha of beds to be built at 2028.

Path (b) – Install composting units

This option proposes the installation of composting units to further process the sludge. The existing drying beds would be retained, with the requirement for additional beds to be based on their performance over the previous years.

A separate composting area would be provided at the site. The main benefit of this arrangement is that Grade Aa biosolid would be produced, removing the need for consent and allowing unrestricted use. From an environmental perspective, composting can be viewed as a very positive method of treating the biosolids. As a product that is high in nutrients and minerals, it is expected that there would be high demand for the compost, and that some of the costs in producing it could be recovered by selling the product. However, if there is no demand for the compost, the cost of running the plant will be higher as the product may need to be given away.

Composting requires the correct mix of carbonaceous material and dry matter. In other words, sufficient green waste (such as grass clippings) and bulking material (sawdust, or recycled, shredded paper) would need to be sourced. Bulking product may prove to be the most problematic material to source.

With this option, it may prove that the required bulking product will be most problematic to source. As a note, the composting operation at the SDC operated transfer station on Burnham School Road currently struggles to find good quality bulking material.

Path (c) – Convert some or all of the drying beds to solar drying halls

This option proposes covering some of the drying beds in a “greenhouse”, and installing a roving aerator to continually turn the sludge over. Effectively, the drying beds would be converted to ‘solar’ drying beds, with the possibility that a grade Aa biosolid is achievable. At the very least, the quantity of biosolid to be disposed would be significantly reduced. Odour is unlikely to occur with the solar drying beds as the aerating ‘robot’ maintains aerobic conditions amongst the solids.

At a population of 47,774, the area required for solar drying beds is estimated to be approximately 0.7ha, and it is likely that the existing drying beds (at 1.9ha in area) could continue to be used as the primary method of dewatering.

Beyond a population of 28,000 PE it is likely that centrifuges would be utilised as the main method of dewatering.

8 Recommendation

Based on the analysis to date, aerobic digestion of the waste sludge followed by 1.5ha of drying beds, located behind the existing WWTP, and on site storage of the thickened sludge for 12 months has been established as the preferred method of sludge handling.

It is further recommended that a staged approach is taken with respect to the drying beds for future populations. This is considered prudent for the following reasons:

(1) A large land are is required and, by staging, it removes the risk of constructing a large drying area for a population which may not materialise
(2) If they are not working as well as intended, it allows the opportunity for changing to either solar drying beds, or to include for composting