Slaughter Waste Composting Demonstration Trial – OMRR Compost Quality Assessment

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1 INTRODUCTION

This report contains the results of monitoring of a slaughter waste compost demonstration trial undertaken at Kuiper Ranch in Lower Nicola, B.C., and of testing conducted of the finished compost. This report has been prepared to complete the requirements of the Ministry of Environment approval issued for the project in May 2006.

In May 2006, with funding from the Investment Agriculture Foundation of B.C., a slaughter waste composting demonstration project was initiated at the Kuiper Ranch in Lower Nicola, B.C. The objective of the project was to demonstrate a low-tech but effective composting method for mixed slaughter waste. The technique used was the passively aerated static pile system, based on a process developed by the Cornell Waste Management Institute in New York State. It was intended to produce Class B compost that could be used on farm as a fertilizer for crop land.

A field day and composting seminar were held in conjunction with the project.

The project was undertaken under an Approval from the B.C. Ministry of Environment (Approval no. AR-18132 – Mino Kuiper). The slaughter waste compost pile was built on May 27, 2006 at the Kuiper Ranch in Lower Nicola B.C. Slaughter waste was sourced from Kam Lake View Meats in Kamloops and consisted of mixed slaughter waste from beef animals under 30 months of age with SRM waste removed. The waste, made up of heads, feet, rumen tissue and contents, fat, trimmings, small bones and some liquid was frozen at the slaughter plant until the day of pile building when it was hauled to the site in 45 gallon drums. Wood waste was sourced from Aspen Planers in Merritt. It consisted of wood chips and bark of variable particle size with some particles being at least 5 cm in length to provide the required particle size for bulking agent. Aged feedlot bedding was also used in the trial and was obtained from Kuiper Ranch. It consisted of wood shaving bedding from livestock pens that was soiled with urine and feces. It had aged for approximately one year.

2 CONSTRUCTION OF THE COMPOST PILE

The compost pile was built on a base layer of 60 cm of wood waste on top of two layers of heavy plastic. The base of the pile measured 11 m long by 3.6 m wide. The site was graded so that any leachate or runoff from the pile would flow into the plastic-lined leachate collection ditch built alongside the pile. The first layer of slaughter waste was placed on top of the wood waste base in a layer approximately 45 cm deep and 1.5 m wide. The waste was then covered with a 30 cm layer of either wood waste (Pile A) or feedlot bedding (Pile B) and a second layer of slaughter waste was put on top of this. The pile was then capped with 45 to 60 cm of either wood waste or feedlot bedding. Three temperature probes were installed into each side of the pile and the probes were linked to a Hobo data logger. A total of 18-45 gallon drums of slaughter waste were used in the making of the pile and approximately 30 cubic metres of wood waste. Less than 10 cubic metres of feedlot bedding were used in the pile.

3 COMPOST MONITORING

The compost pile was built in two halves. The western half of the pile (capped with wood waste) is identified as Pile A while the eastern half (capped with aged feedlot bedding) was identified as Pile B although the halves were contiguous. The objective of this was to compare wood waste with feedlot bedding as bulking agent for the compost.

3.1 Temperature data collection

The Hobo data logger collected temperature data from each half of the pile every 4 hours throughout the day. There were 3 temperature probes in each half of the pile plus one probe that recorded ambient air temperature. In addition, as a back up, for the first month manual temperature measurements were made with a composting thermometer. A rain gauge was installed beside the pile to monitor area rainfall during the first months of composting. Visual monitoring was done periodically to observe any bird or animal impact on the pile's integrity. Odour and leachate monitoring were also done periodically. Monitoring of the pile ceased in mid-September 2006 when the temperature probes were removed.

3.2 Pile size

The pile shrank approximately 30 cm in height during the first month and a further 30 cm in the following three months.

3.3 Odour and pests

There was a very faint odour from Pile A after the pile was built and throughout the first month of composting but no discernible odour from Pile B. It seemed that the odour from Pile A was rising with convective air from inside the pile and exiting through pathways created by the plastic tubes that surrounded the temperature probes that were inserted into the top of the pile. There was some bird activity on Pile A during the first two weeks of composting, possibly due to the odour, but the birds were not able to penetrate the capping layer. There was no bird activity around Pile B. No other pest problems were observed during the active composting phase. An electric fence with a solar battery was installed on the site and worked very well to keep out four-legged pests. There was no evidence of wildlife or livestock disturbing the pile during the active composting period.

3.4 Compost internal temperature

Graphs of pile internal temperatures are found at the end of the report. One week after the pile was constructed, its internal temperature had reached 52 – 68°C. Throughout the second week of composting (approx. June 4-10) the temperature in the interior of both halves of the pile hovered around 70°C (160°F), with the feedlot bedding covered pile averaging 72°C and the wood waste pile averaging 67°C. During the three months of temperature monitoring, significant variation was observed in temperatures at different locations in the pile, with probes inserted to 1.3 m (4 feet) generally registering much higher temperatures than those inserted to 1 m (3 feet) only.

Pile A (wood waste capped pile): Temperature in this pile reached a maximum of 68°C on day 9 of composting. At the end of the second week, the temperature gradually began to decline and had declined to 50°C by June 21, mid-way through the 4th week of composting. By the end of July after 8 weeks of composting, the temperatures in this pile had dropped below 50°C. On September 11 when the temperature probes were removed, the internal temperature ranged from 29 to 37°C.

Pile B (feedlot bedding capped pile): Maximum temperature in this pile of 72°C was reached on day 10 of composting. The temperatures in this pile remained high through 12 weeks of composting, declining only slightly to between 50°C and 60°C from the maximum temperatures observed during weeks two and three. Temperatures in this pile began to drop below 50°C after 14 weeks of composting. On September 11 when the probes were removed, the temperatures within this pile ranged from 36°C to 55°C. In terms of enhancing the breakdown of the slaughter wastes through biological activity, this feedstock was more successful, probably due to the manure present in the bedding which provided an ongoing source of nutrients and readily available carbon to the microbes in the pile.

3.5 Leachate

No leachate from the pile was observed at any time during the 3 months that the pile was monitored. There were several heavy rainfall events during the summer and although there was rainwater in the leachate collection ditch, there was no evidence that liquid had leached through the pile during rain events.

3.6 Decomposition of slaughter waste

On September 22, the pile was pulled apart to see how well material had broken down. All soft tissue had disappeared. A small amount of hair remained on bones which otherwise were bare. The composted material was dark brown in colour and looked like a mix of wood waste and well rotted organic matter. The inside of the pile was dry and it appeared that composting had slowed significantly. There was a very faint, not unpleasant, musty odour inside the pile.

4 COMPOST CHARACTERISTICS

Composting of slaughter waste in B.C. is regulated by the Organic Matter Recycling Regulation (OMRR). The following section outlines how the OMRR's process and quality requirements were met.

The slaughter waste compost at Kuiper Ranch was sampled on October 23, 2008. The pile was opened using a backhoe and samples were collected randomly from inside the pile. Two composite samples were collected, one from each side of the pile, for nutrient and trace element analysis. Each sample was made up of 8 subsamples. Seven discrete samples were collected for pathogen analysis. Samples were placed in a cooler with ice packs, and transported immediately to Caro Environmental in Kelowna for pathogen determination. The composite samples were kept cool until they were shipped by courier to Bodycote Labs in Edmonton for determination of nutrients, trace elements and compost quality.

4.1 Organic Matter Recycling Regulation (OMRR) process and quality requirements

The passively aerated static pile system used to compost the slaughter waste complies with the OMRR Class B compost process requirements. The pile was designed to enhance convective air flow through the pile as it heated.

Time and temperature requirements: To meet pathogen destruction requirements for Class B compost, OMRR requires that the internal pile temperature is raised to 40 °C or higher and maintained for 5 days, during which, for 4 hours, the temperature must exceed 55°C. To meet vector attraction reduction requirements, OMRR requires that compost achieve a temperature of 40°C for 14 days, and that the average temperature of the pile is higher than 45°C during the two week period.

Charts of the temperatures in the two piles for the first 8 weeks of composting are found at the end of the report. The temperature in Pile A (wood waste capped) remained above 55°C for the period June 2 to June 11 inclusive, a total of 9 days, and above 40°C for 28 days, from May 31 to June 28. The temperature in Pile B (feedlot pack capped) remained above 55°C for the period June 5 to 27 inclusive, a total of 22 days. Both treatments easily met OMRR pathogen destruction time and temperature requirements and vector attraction reduction requirements.

C:N ratio: the final C:N ratio of the woodwaste capped compost pile was 24:1, while the C:N of the feedlot capped pile was 34:1. This complies with the OMRR C:N requirement for finished Class A compost of 15:1 to 35:1. If Class B compost is to be surface applied, it must meet this standard. If it is incorporated within 6 hours of application, it is not required to meet this standard.

4.2 Fecal coliform levels

Seven discrete samples were collected from the whole compost pile for determination of fecal coliform concentration in October 2008. The total volume of compost produced was less than 1000 dry tonnes, so one set of samples was the OMRR requirement. The geometric mean of the samples was 103.14 MPN per gram of compost dry matter (Table 2). The compost meets Class B pathogen limits (less than 2,000,000 MPN per gram dry matter).

4.3 Trace elements

The trace element concentration of the finished compost is found in Table 2. Standards for Class B compost from the OMRR are found in Table 2 as well for comparison. The concentrations of all trace elements meet OMRR limits for Class B compost.

4.4 Macronutrient Value

Table 1 lists the nutrient concentration of the slaughter waste compost and other required parameters. There are no OMRR quality standards for these parameters.

Nitrogen: the compost made solely with wood waste and slaughter waste (Pile A) contained 0.48% total nitrogen (dry weight basis) or approximately 4.8 kg of nitrogen per dry tonne of material. The compost made with feedlot bedding contained 1.11% total nitrogen, or 11 kg per tonne of dry compost. The woodwaste compost contained 58.7 ppm of ammonia-N and 150 ppm of nitrate-N, while the feedlot based compost contained 16.7 ppm of ammonia-N and 230 ppm of nitrate-N. Less than 5% of the total nitrogen is in inorganic, plant available forms. It is estimated that less than 25% of the organic nitrogen in the compost will be plant-available in the year of application.

Phosphorus: the feedlot-based compost contained 1940 ppm total phosphorus, or approximately 1.9 kg per tonne of dry material. About 30% of the phosphorus is in plant-available forms. The woodwaste-based compost contained 1190 ppm total phosphorus, or 1.2 kg per tonne of dry material. Of this, 13% is in plant available forms.

Potassium: there were similar differences in potassium content between the two composts. The feedlot waste-based compost contained 9740 ppm of total potassium, or 9.7 kg per tonne of compost, and of that, 60% was found in plant available forms. The woodwaste-based compost contained 3540 ppm of total potassium, or 3.5 kg per tonne of dry material and about 50% of that was in plant available forms.

The compost is also a good source of other macro and micro nutrients. It has a pH near neutral and electrical conductivity is moderate. There are no concerns with the quality of the compost as a fertilizer for forage crops. The feedlot bedding-based compost is considerably higher in nutrients than the compost amended only with woodwaste.

4.5 Foreign matter content

As there was no inert material in the compost feedstock, it is expected that the foreign matter content of the finished compost will be lower than 1% as required by OMRR.

4.6 Bone residue management

Bones decompose more slowly than other constituents of slaughter waste during composting. This results in compost that is ‘finished’ except for the presence of bones. This can be handled in several ways. Bones can be ground before being composted which will increase their rate of decomposition. Bones can be screened out after composting, and re-incorporated into a new batch of compost. Finally, finished compost (with bones) can be used as up to half of the bulking agent for a new batch of slaughter waste compost. All of these management methods allow the bones additional time to decompose. A final disposal option is to screen bones out of finished compost and allow them to decompose in a remote area of the property (provided that all soft tissue and hair has decomposed). Because bones contain primarily calcium and phosphorus, both of which enhance the quality of compost, allowing them to decompose in the compost is the preferred disposal option.

5 END USE OF COMPOST

Mr. Kuiper originally intended to land apply the compost as a fertilizer for a crop of forage. However, he has decided to add it to an existing pile of composted feedlot manure on his property to allow further breakdown of the bones. Eventually the compost will be land applied.

As there was no SRM in the slaughter waste used for the project and the compost has met all OMRR composting process and quality requirements, it can be land applied provided that the rate is agronomic as described below, and that required buffers are adhered to.

6 APPLICATION RATE

Composts have relatively low levels of nutrients and a very small portion of the nutrients are in plant-available forms. Nutrient release from compost is typically very slow due to this. Because of this, composts are typically applied at higher application rates than manures or other high nutrient residuals. For the purposes of providing a rationale for an application rate, the appropriate application rate of the compost to provide sufficient nitrogen for a new seeding of forage grass on a typical forage field in the southern interior has been included here, even though Mr. Kuiper has not identified an area to apply the compost.

The calculations to determine the appropriate application rate for the slaughter waste compost are provided in Table 3.

It is expected that the compost will be applied to a field growing a crop of forage grasses for hay production, and that the site will have low to moderate fertility as is typical of hay fields in the southern Interior on beef cattle ranches. The recommended application rate of this slaughter waste compost on a typical hay field in the southern interior is 104 dry tonnes per hectare (194 wet tonnes per hectare). This is based on providing sufficient plant-available nitrogen to meet crop requirements for two years, plus a soil fertility top up because hay fields are typically deficient in nitrogen (225 kg plant-available N).

The total amount of finished compost from the demonstration trial is expected to be 18 wet tonnes. This will fertilize less than one hectare of Mr. Kuiper's land.

7 SITE ASSESSMENT, BUFFERS

Because Mr. Kuiper has not identified an application site at this time, no site assessment or soil sampling was done to determine background conditions on the site. When Mr. Kuiper land applies the compost, it is expected that he will adhere to the minimum setbacks from surface water and wells (30 m) and roads (20 m) and apply on a site where the groundwater is greater than 1 m from the surface of the soil.

Table 1. Nutrients and quality parameters in Kuiper slaughter waste compost

	Units	Kuiper slaughter waste compost	
		Slaughter waste: feedlot bedding	**Slaughter waste: woodwaste**
Quality parameters			
Moisture	%	57.6	35.4
Electrical conductivity (EC)	dS/m	1.62	0.56
pH (1:2 soil: water)	pH units	7.1	7.7
Total organic carbon	%	37.8	13.5
C:N ratio		34:1	28:1
Organic matter	%	71.3	24.1
Sodium absorption ratio		4.77	1.83
Nutrients (total or plant available as indicated)			
Nitrogen (TKN)	%	1.11	0.48
Plant-available N:			
Ammonia-N	mg/kg	16.7	58.7
Nitrate-N	mg/kg	230	150
Phosphorus (strong acid soluble)	mg/kg	1940	1190
Phosphorus (Bray P1)	mg/kg	570	160
Potassium (strong acid soluble)	mg/kg	9740	3540
Potassium (ammonium acetate)	mg/kg	6000	1700
Nutrients (total)			
Calcium	%	1.026	1.168
Magnesium	%	0.386	0.544
Sodium	%	0.226	0.096
Sulphur	mg/ kg	1356.05	684.55
Boron	mg/ kg	8.4	3.15

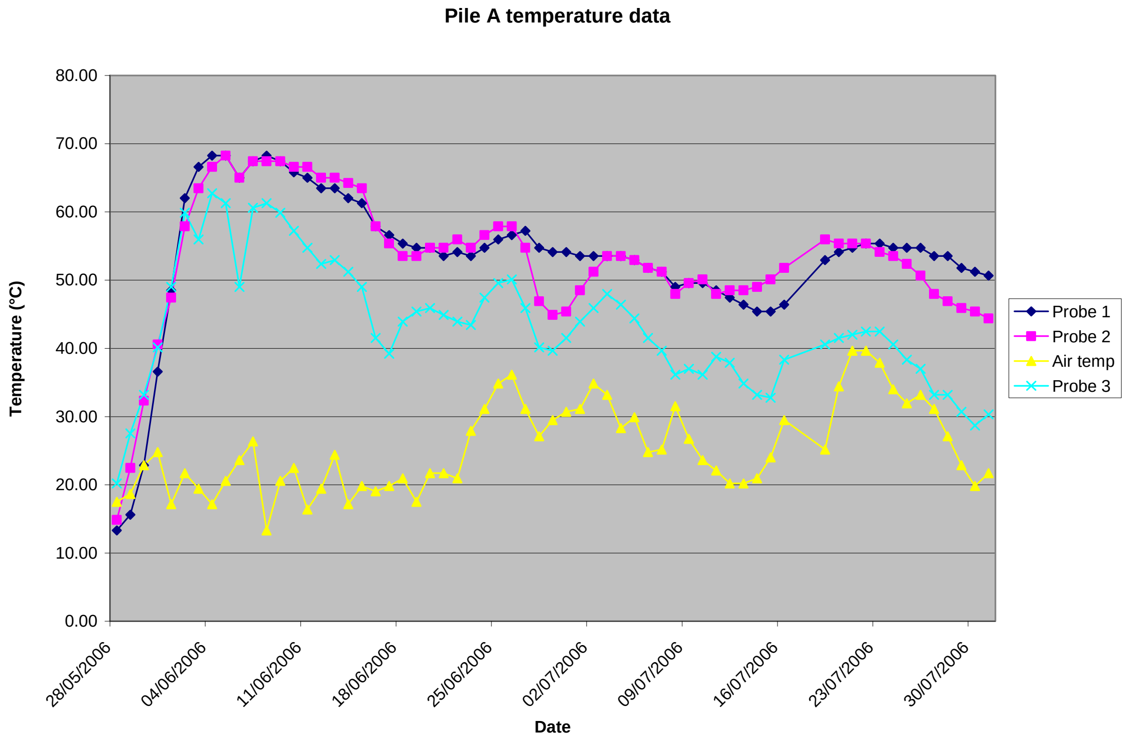
Note: there are no OMRR standards for these parameters in Class B compost.

Table 2. Concentration of trace elements and fecal coliforms in Kuiper slaughter waste compost.

	Units	Kuiper slaughter waste compost		OMRR Class B compost standards
		Slaughter waste: feedlot bedding	Slaughter waste: woodwaste	
CSR Trace elements (strong acid digestible)				
Arsenic	mg/ kg	1.3	3.4	75
Cadmium	mg/kg	0.17	0.14	20
Chromium	mg/kg	10.5	26.4	1060
Cobalt	mg/kg	3.1	9.1	150
Copper	mg/kg	17	41	2200
Lead	mg/kg	1.3	3.1	500
Mercury	mg/kg	0.01	0.01	15
Molybdenum	mg/kg	<1	<1	20
Nickel	mg/kg	7.4	16.2	180
Selenium	mg/kg	<0.3	<0.3	14
Zinc	mg/kg	60	65	1850
Bacteriology				
Fecal coliform (geometric mean of 7 samples)	MPN/g	103.14		2,000,000

Table 3: Application rate determination for slaughter waste compost at Kuiper Ranch

Parameter	Background information	Calculations
Crop information	Year of compost application: 1 cut of forage, total dry matter yield of 4 tonnes/ha Year following application: new stand of grass/legume – low N requirement - very low fertility site (no fertilization for 5 yrs)	***Nitrogen (N) requirement*** **Year 1**: 100 kg N/ha **Year 2**: 115 kg N/ha **Low fertility site top-up**: 50kg N/ha (subtract N release from grass/ legume ploughdown: 40 kg/ha) **Total: 225 kg N/ha**
Compost nitrogen availability information	- total N 0.8 % (dry basis) or 8 kg/dry tonne - inorganic N 0.03% or 0.3 kg/dry tonne - organic N approx. 25% available in app'n year - inorganic N approx. 20% loss during application	***N available from compost*** **Organic N:** 7.7 kg/tonne * 0.25 = 1.9 kg/tonne **Inorganic N:** 0.3 kg/tonne * 0.8 = 0.24 kg/tonne **Total available N:** **1.9 + 0.24 = 2.15 kg/dry tonne**
Application rate of compost to provide N requirement (dry basis)	Crop N requirement /N provided by compost	225 kg N/ha / 2.15 kg N/dry tonne = 104 **dry tonnes/ha**
Application rate of compost (wet basis)	Average total solids content of compost = 53.5% dry matter	104/ 0.535 = 194 **wet tonnes/ha**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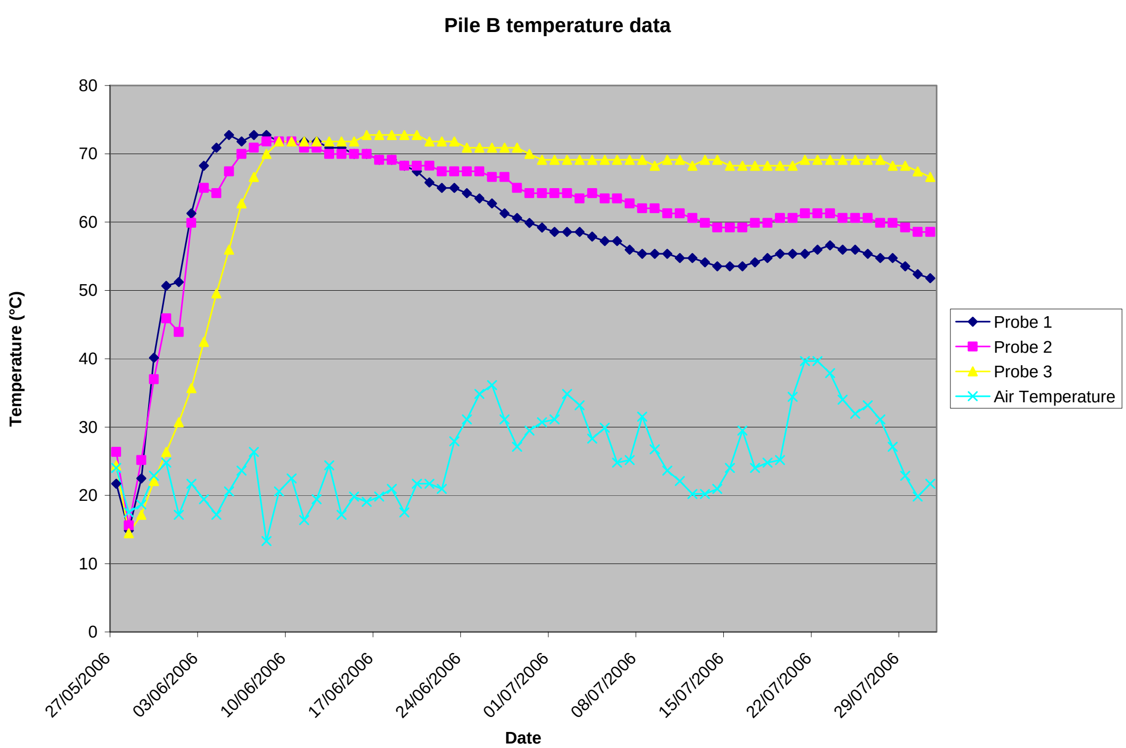
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Probe 1
Probe 2
Probe 3
Air Temperature