APRIL 2010

City of Kodiak

Biosolids Composting Pilot Test

FINAL SUMMARY REPORT AND TECHNICAL MEMORANDUMS

Final

Biosolids Composting Pilot Test

Summary Report and Technical Memorandums

Prepared for

City of Kodiak

April 2010

CH2MHILL
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Anchorage, AK 99503

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Contents

City of Kodiak Biosolids Composting Pilot Program Summary Report

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PREPARED BY: Cory Hinds/CH2M HILL
Scott Gamble/CH2M HILL

DATE: April 30, 2010

1 Background

The City of Kodiak (City) and CH2M HILL initiated a Biosolids Composting Pilot Program at the Kodiak wastewater treatment facility (WWTF) during summer 2009. The pilot program purpose was to prove biosolids composting efficiency with locally provided wood chips, forced aeration, and reusable aboveground piping in Kodiak's coastal climate. The pilot program also intended to demonstrate that suitable odor controls and processing capacity could be achieved with this composting method.

Secondary pilot program goals were to collect baseline data that would be required if the City develops a permanent composting facility, including data about:

- Wood chip type and volume requirements
- Sufficient temperature to achieve pathogen kill
- Aeration rates to manage moisture and temperatures
- Weather protection
- Mixing equipment capabilities
- Operating costs

The Alaska Department of Environmental Conservation (ADEC) and the U.S. Environmental Protection Agency (EPA) require that the compost meet strict criteria and achieve low pathogens and metals concentrations to allow unrestricted end use applications such as to lawn and gardens, construction projects, land reclamation projects, and ball fields. Current regulations state that compost pile temperature must be maintained at 55 degrees Celsius (°C) (130 degrees Fahrenheit [°F]) or higher for 3 consecutive days to reduce pathogen densities to below detectable limits for salmonella and fecal coliform. In addition, temperatures must be maintained higher than 40°C (104°F) for 14 consecutive days, with an average temperature higher than 45°C (113°F) to reduce the potential for spreading infectious disease through vectors such as flies. The compost must also be below acceptable metals concentrations.

2 Aerated Static Pile Composting Pilot Arrangement

The pilot program was conducted using a portable composting system designed by CH2M HILL. The C:N LITE Portable Composting System is a variation of the aerated static pile composting method. The C:N LITE system facilitates composting by using either positive aeration or negative aeration with an odor control system. During the Kodiak pilot program, the composting system was operated in negative aeration mode, meaning that air was pulled through the compost pile and discharged through a biofilter. A centrifugal blower and engineered pipe manifold network was used to move air through the compost piles. Aeration piping was designed to drain to a low point for condensate collection. Exhibit 1 illustrates the system. Compost pile points 1 through 6 and biofilter points A through D indicate temperature monitoring and moisture sampling locations. Exhibit 2 shows the site preparation and aeration piping. Exhibit 3 shows the final assembled compost pile.

EXHIBIT 1
Biofilter and Compost Pile Layout in Kodiak, Alaska

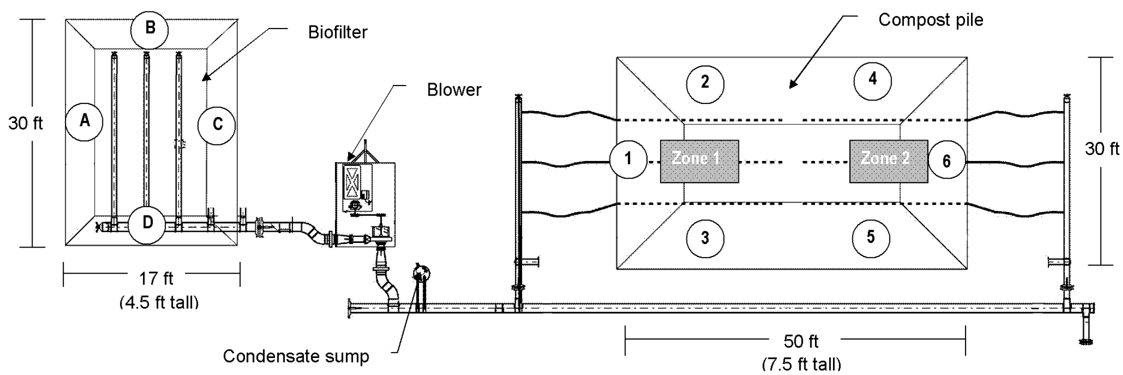


EXHIBIT 2
Compost Aeration Piping

EXHIBIT 3
Compost Pile at Start of Summer 2009

3 Pilot Program Activities and Results Summary

3.1 Site Preparation

Site preparation occurred from approximately March 1 through June 5, 2009, and consisted of removing two existing light poles; importing, placing, and grading soil fill; and constructing berms around the pad to prevent stormwater runoff. A temporary fence was erected around the site to control access.

3.2 Equipment Assembly

Equipment assembly occurred June 9 through 12, 2009. The following work was accomplished:

- Connecting the aeration piping
- Installing valves
- Installing the condensate sump and pump
- Setting up and testing the blower

In addition, the site was trenched to accommodate the drainage of condensate to a low point where the condensate would be collected in a sump. Excavation of approximately 5 feet was completed for the condensate sump. Collected condensate was pumped to the WWTF headworks.

Exhibit 2 is a photograph of the aeration piping.

3.3 Preparation of Amendments

The primary amendment used was wood received from various local wood sources in Kodiak. The majority of the wood came from brush clearing operations by Kodiak Electric Association. The City collected and transported the wood to the Public Works Department yard for processing/ chipping. Wood chips were produced at Public Works with a rented chipper and transported to the WWTF. Attachment 1, Table 3, shows wood chip particle sizes.

3.4 Biosolids and Wood Chips Mixing and Compost Pile Construction

Based on biosolids and wood chips moisture content, a mix ratio of approximately 1 part biosolids to 5.5 parts wood chips was formed into a compost pile in mid-June 2009. Exhibit 1 shows constructed compost pile dimensions. An approximately 6-inch wood chip layer was used as a base layer and approximately 12 inches of wood chips were added to the top and sides to provide insulation around the perimeter. Exhibit 4 summarizes pilot program biosolids and wood chip volumes.

Mixing was accomplished using front-end loaders.

3.5 Biofilter Construction

The biofilter was constructed with clean wood chips. It was located next to the compost pile to treat the discharge air to control compost pile odors.

EXHIBIT 4
Biosolids and Wood Chip Approximate Pilot Program Volumes

	Volume (cubic yards)	
Layer	**Biosolids**	**Wood Chips**
Compost mix	30	165
Base layer	N/A	50
Cover layer	N/A	70
Biofilter	N/A	75
Total	**30**	**360**

N/A = not applicable

3.6 Active Composting Phase

The mixture was actively composted and aerated for approximately 5 weeks. The compost pile was then deconstructed and reformed to ensure that all materials were exposed to the same high pile core temperatures experienced to meet regulatory requirements. During the active composting period, the pile temperature and moisture content was monitored, and the airflow was adjusted as needed to maintain moisture content within the optimal range of 55 percent to 65 percent. Because high temperatures drove moisture out of the pile, moisture was added to the compost pile during the active composting phase using garden sprinklers. In late June and early July, 14,300 gallons of water was added to the compost pile and biofilter to achieve the desired moisture content. Optimal moisture content was confirmed by onsite testing.

After the pile had been reformed, the material was actively composted for an additional 6 weeks, through early September. By this time, the majority of the energy in the material had been consumed, and the pile began the maturation phase of composting. Samples from the compost pile were tested for stability/maturity. Airflow adjustments and temperature measurements were made during September and early October to ensure that the active composting phase was completed.

EXHIBIT 5
Compost Pile Covered for Winter

No runoff or leachate was observed during the pilot program. With the exception of odors generated during initial mixing, odors were controlled by the biofilter.

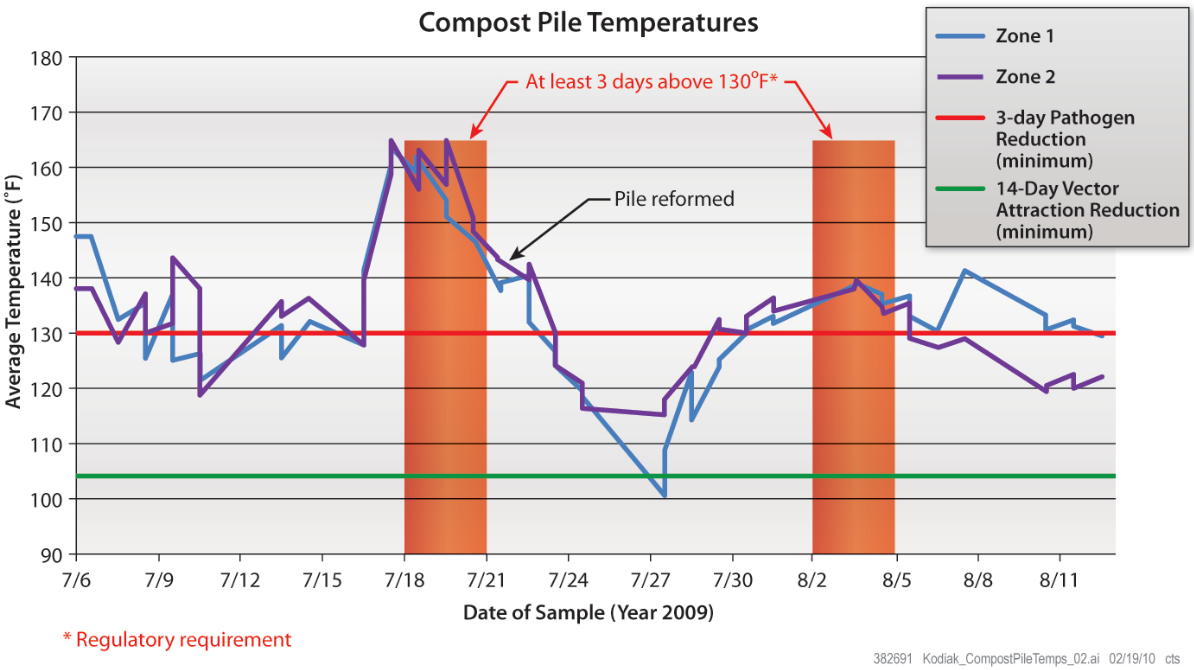
3.7 Curing/Maturation Phase

Once the active composting phase completion was confirmed by laboratory stability analyses, the composting aeration system was turned off and the pile was covered with a tarp to protect it from rainfall during the winter months. Exhibit 5 shows the covered compost pile. The compost will mature over the winter months; it will be screened in spring or summer 2010. The City will use the compost in various test applications.

3.8 Compost Monitoring Results

During the 11-week active composting process, the materials were exposed to temperatures exceeding 130ºF for more days than the 3 consecutive days required by regulation. In addition, temperatures were maintained higher than 104ºF for at least 14 consecutive days, with an average temperature higher than 113ºF to reduce the potential for spreading infectious disease through vectors such as flies. Average temperatures in the compost pile and the biofilter are shown in Exhibit 6.

EXHIBIT 6
Kodiak Compost Pile Temperatures



3.9 Compost Product Testing

Following active composting phase completion, City personnel took a composite sample from several composting pile locations on October 27. An unscreened sample was sent to Soil Control Laboratories in California for analysis. The sample was screened in the laboratory and analyzed for pathogens, metals, nutrients, maturity, and agronomic parameters. The compost age at this point was approximately 128 days. The sample was received and handled in accordance with the U.S. Composting Council's Test Methods for the Examination of Composting and Compost (TMECC) procedures. Exhibit 7 summarizes the lab results. Complete results are in Attachment 2.

3.10 Pathogen Reduction Testing

The compost was analyzed for fecal coliform and salmonella, which are used as pathogen contamination indicators. Measured levels were well below regulatory thresholds, as shown in Exhibit 7. These measurements confirmed that the temperatures achieved during the pilot program were sufficient to reduce pathogens.

EXHIBIT 7
Kodiak Compost Pathogen Results

Pathogens	Results	Unit	EPA Limit
Fecal Coliform	12	MPN/g	< 1000 MPN/g
Salmonella	< 3	MPN/4g	< 3 MPN/4g

EPA = U.S. Environmental Protection Agency
g = gram
MPN = most probable number

3.11 Metals Testing

Fourteen different metals were analyzed, including arsenic, cadmium, chromium, and mercury. As shown in Exhibit 8, all test result levels were below the limits specified in EPA regulations published in Title 40, Section 503, of the *Code of Federal Regulations* (40 CFR 503). These results were expected, given the relative lack of industrial sources and businesses on Kodiak Island.

EXHIBIT 8
Kodiak Compost Metals Results

Metal	Test Result[a]	EPA Limit
Aluminum	2200	--
Arsenic	< 1.0	41
Cadmium	< 1.0	39
Chromium	12	1200
Cobalt	2.5	--
Copper	63	1500
Iron	5800	--
Lead	100	300
Manganese	440	--
Mercury	< 1.0	17
Molybdenum	1.0	75
Nickel	11	420
Selenium	1.0	36
Zinc	120	2800

Note: All results are dry weight in milligrams per kilogram.
[a]<1.0 result was less than the detection limit of 1.0.
EPA = U.S. Environmental Protection Agency

3.12 Maturity Testing

Samples were tested for maturity using respirometry and germination tests. These tests are required to accurately gauge compost sample maturity. The respirometry test was used to determine the compost organochemical condition by measuring the amount of carbon dioxide given off by the microbes in a sample under controlled conditions. A germination test was used to evaluate the possible occurrence of harmful effects on plants by comparing the emergence and vigor of cucumber seeds grown in the prepared compost sample against those grown in a standard soil sample. Since the active compost phase had just been completed, and the maturation phase had just begun, it was not expected that the sample would be fully mature. However, the analysis indicated that the material was mature, with 100 percent growth and emergence in the germination test and a very low carbon dioxide respiration rate.

3.13 Agronomic Testing

Approximately two dozen specific tests were conducted to measure the agronomic value of the compost sample. The tests included nutrients, organic matter, pH, and electrical conductivity. The analysis showed that the compost had high organic-matter content and low salt and lime content, all of which indicate good compost characteristics. The ratio of nitrogen (N), phosphorus (P), and potassium (K), or NPK ratio, was measured at 1.1-0.4-0.2. Nutrient levels were slightly lower than expected for compost produced from biosolids. However, compost is typically used to amend and improve soil structure rather than as a nutrient source.

4 Answers to Specific Pilot Program Questions

The pilot program's secondary goals were to collect baseline data that would be required to develop a permanent facility. Exhibit 9 summarizes the informational and design goals of the pilot program and the conclusions that were reached.

EXHIBIT 9
Answers to Pilot Program Study Questions

Study Question	Answer
What is the best feedstock recipe for biosolids?	The ratio used in this pilot study was 5.5 parts woodchips to 1 part biosolids. The long-term ratio may be closer to 3 parts woodchips to 1 part biosolids due to recycle of oversized wood chips.
What is the minimum aeration time to achieve pathogen kill and odor control?	The pilot program confirmed that 3 consecutive days at temperatures above 130º F was sufficient for pathogen kill. Odors were controlled once the compost pile was constructed.
What is the best aeration rate in standard cubic feet per minute (scfm) per cubic yard and in hours per day to accelerate the process and manage moisture?	The 15-horsepower motor and blower used for this pilot program were more than sufficient for the size of this compost pile. Means to adjust the blower speed would be required for a full-scale operation.
What sort of weather protection is required to operate year-round?	Results from this study are inconclusive. Kodiak experienced an unusually dry summer during the pilot program, and water had to be added to the compost pile. Kodiak also experienced an unusually wet fall. It is recommended that a full-scale system should be under roof or indoors to better control moisture.

EXHIBIT 9
Answers to Pilot Program Study Questions

Study Question	Answer
What sort of mixing equipment is necessary to optimize the process?	Mixing can be accomplished using a variety of equipment. The City of Kodiak used two front-end loaders to mix the piles, with acceptable results. Odors and containment of the mixture should be considered in initial setup and transport.
What is the capital and operating cost at this scale?	Capital costs: $66,000 Operating costs: $50,000 (Attachment 3 provides a detailed cost accounting.)

5 Lessons Learned

Exhibit 10 summarizes lessons learned during this pilot study.

EXHIBIT 10
Lessons Learned During Kodiak Composting Pilot Program

Item	Description
Public opinion	Odors during mixing generated negative press. It would be best to locate the composting in a more remote location. In addition, public education will be required to reduce stigma associated with biosolids.
Startup	The time required to reach desired pile temperatures was longer than expected.
Moisture control	Be prepared to add moisture. There was no compost pile runoff during the dry summer of 2009. However, heavy rains in the fall of 2009 prevented drying of compost for screening. Moisture control is very important in the composting process.
Air flow	There is a need to be able to modify airflow rate, such as by using a variable frequency drive blower. Alternately, a bypass valve can be used.
Temperature control	Consider a thicker layer of wood chip insulation so that outer zones reach minimum temperature for pathogen kill, or be prepared to turn the pile inside out.

6 Conclusions and Recommendations

This pilot test demonstrated that high-quality compost, defined as exceeding EPA regulatory requirements for a Class A biosolids product and suitable for unrestricted use, can be produced using the aerated static pile method in Kodiak's coastal environment. Wood chip supply and processing, site preparation, and initial setup required a significant effort, but once the compost pile had been constructed, the day-to-day monitoring requirements were minimal (1 to 2 person-hours per day).

After some early complaints from neighbors during the initial mixing process and transport from the mixing area to the composting site, odors were successfully controlled using the wood chip cover and biofilter. Overall, as indicated in favorable articles in the *Kodiak Daily*

Mirror (February 20, 2008; July 15, 2009; and December 9, 2009; Attachment 4), the community of Kodiak appears to be supportive of the pilot program.

No runoff was observed during the active composting phase. However, it is acknowledged that the summer of 2009 was unusually dry. Water was added to maintain optimal moisture content. During wetter weather, the compost pile may require tarping to control runoff if operations are not covered or enclosed in a building. Careful management of moisture is recommended at curing phase completion so that the compost stays dry enough for screening. During this pilot program, screening the finished compost was postponed until spring because of higher moisture content caused by rains in late September.

To evaluate the feasibility of managing Kodiak's biosolids through a full-scale composting operation, we recommend study of amendment requirements, end use, and capital and operational costs. These three topics are the subject of future technical memorandums by CH2M HILL.

Attachment 1
Wood Chip Particle Size Requirements

Amendment Requirements for Composting Pilot Test

TO: Mark Kozak, City of Kodiak

COPIES: Howard Weston, City of Kodiak

FROM: Cory Hinds

DATE: September 12, 2008

PROJECT NUMBER: 370587

Table 1 shows mass and volume requirements for amendment for the pilot test.

Table 1. Mass and Volume Requirements for Compost Pilot Test Amendments

	Mass (tons)	Chipped Volume (cubic yards)	Loose Volume* (cubic yards)
Minimum	160	400	1,600
Maximum	400	1,000	4,000

* Numbers in this column represent estimated volume of brush/branches

Acceptable and not acceptable compost amendments are shown in Table 2.

Table 2. Acceptable and Not Acceptable Amendments

Acceptable Amendments	**Not Acceptable**
• Tree branches	• Treated wood
• Stumps	• Painted or oiled wood
• Clean lumber, plywood and particle board	• Plastic laminated products
• Pre-chipped wood	• Grass clippings
• Cardboard	• Sod
• Leaves & needles*	• Dirt

* Leaves and needles must be less than ¼ of the amendment mix.

Specification for grinding of the woody material is shown in Table 3.

Table 3. Particle Size Requirements for Compost Amendment

Particle Size	**Minimum Percent (by weight)**	**Maximum Percent (by weight)**
Less than 0.5 inch	-	25%
0.5 – 1.0 inch	40%	-
1.0 – 4 inch	20%	-
Over 4 inch	-	5%

Attachment 2
Laboratory Test Results

ANALYTICAL CHEMISTS and BACTERIOLOGISTS
Approved by State of California
SOIL CONTROL LAB
42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188
www.compostlab.com

Account #: 9100821-1/1-6156
Group: Oct.09 E #7
Reporting Date: November 11, 2009

City of Kodiak
2853 Spruce Cape Road
Kodiak, AK 99615
Attn: Harry M. Heiberg

Date Received: 28 Oct. 09
Sample Identification: Kodiak Compost
Sample ID #: 9100821 - 1/1

Nutrients	Dry wt.	As Rcvd.	units
Total Nitrogen:	1.1	0.34	%
Ammonia (NH_4-N):	240	78	mg/kg
Nitrate (NO_3-N):	0.95	0.31	mg/kg
Org. Nitrogen (Org.-N):	1.1	0.35	%
Phosphorus (as P_2O_5):	0.40	0.13	%
Phosphorus (P):	1700	560	mg/kg
Potassium (as K_2O):	0.20	0.065	%
Potassium (K):	1700	540	mg/kg
Calcium (Ca):	0.47	0.15	%
Magnesium (Mg):	0.15	0.047	%
Sulfate (SO_4-S):	5.3	1.7	mg/kg
Boron (Total B):	5.9	1.9	mg/kg
Moisture:	0	68.0	%
Sodium (Na):	0.014	0.0046	%
Chloride (Cl):	0.0068	0.0022	%
pH Value:	NA	6.35	unit
Bulk Density :	12	38	lb/cu ft
Carbonates ($CaCO_3$):	3.5	1.1	lb/ton
Conductivity (EC5):	0.58	0.19	mmhos/cm
Organic Matter:	88.4	28.3	%
Organic Carbon:	45.0	14.0	%
Ash:	11.6	3.7	%
C/N Ratio	42	42	ratio
AgIndex	> 10	> 10	ratio

Stability Indicator:		Biologically
CO2 Evolution	Respirometery	Available C
mg CO_2-C/g OM/day	0.2	0.9
mg CO_2-C/g TS/day	0.20	0.77
Stability Rating	*very stable*	*very stable*

Maturity Indicator: Cucumber Bioassay		
Compost:Vermiculite(v:v)	1:1	1:3
Emergence (%)	100	100
Seedling Vigor (%)	100	100
Description of Plants	*healthy*	*healthy*

Pathogens	Results	Units	Rating
Fecal Coliform	12	MPN/g	*pass*
Salmonella	< 3	MPN/4g	*pass*

Date Tested: 28 Oct. 09

Inerts	% by weight
Plastic	< 0.5
Glass	< 0.5
Metal	< 0.5
Sharps	ND

Metals	Dry wt.	EPA Limit	units
Aluminum (Al)	2200	-	mg/kg
Arsenic (As):	< 1.0	41	mg/kg
Cadmium (Cd):	< 1.0	39	mg/kg
Chromium (Cr):	12	1200	mg/kg
Cobolt (Co)	2.5	-	mg/kg
Copper (Cu):	63	1500	mg/kg
Iron (Fe):	5800	-	mg/kg
Lead (Pb):	100	300	mg/kg
Manganese (Mn):	440	-	mg/kg
Mercury (Hg):	< 1.0	17	mg/kg
Molybdenum (Mo):	1.0	75	mg/kg
Nickel (Ni):	11	420	mg/kg
Selenium (Se):	< 1.0	36	mg/kg
Zinc (Zn):	120	2800	mg/kg

Size & Volume Distribution			
MM	% by weight	% by volume	BD g/cc
> 50	0.0	0.0	0.00
25 to 50	0.0	0.0	0.00
16 to 25	10.0	8.4	0.27
9.5 to 16	23.5	25.2	0.21
6.3 to 9.5	32.0	33.6	0.22
4.0 to 6.3	12.8	11.2	0.26
2.0 to 4.0	14.1	14.0	0.23
< 2.0	7.6	7.6	0.23

Bulk Density Description:<.35 Light Materials, .35-.60 medium weight materials, >.60 Heavy Materials

Analyst: Assaf Sadeh

*Sample was received and handled in accordance with TMECC procedures.

Account No.: 9100821 - 1/1 - 6156
Group: Oct.09 E No. 7

Date Received: 28 Oct. 09
Sample i.d.: Kodiak Compost
Sample I.d. No.: 1/1 9100821

INTERPRETATION:

Is Your Compost Stable?

Respiration Rate — Biodegradation Rate of Your Pile
0.2 mg CO2-C/ g OM/day
+
< Stable >|< Moderately Stable >|< Unstable >|< High For Mulch

Biologically Available Carbon (BAC) — Optimum Degradation Rate
0.9 mg CO2-C/ g OM/day
+++
< Stable >|< Moderately Stable >|< Unstable >|< High For Mulch

Is Your Compost Mature?

AmmoniaN/NitrateN ratio
250 Ratio
++
VeryMature>|< Mature >|< Immature

Ammonia N ppm
240 mg/kg dry wt.
+++++++++++++++++++++++++++
VeryMature>|< Mature >|< Immature

Nitrate N ppm
0.95 mg/kg dry wt.
+
< Immature >|< Mature

pH value
6.35 units
++
< Immature >|< Mature >|< Immature

Cucumber Emergence
100.0 percent
+++
< Immature >|< Mature

Is Your Compost Safe Regarding Health?

Fecal Coliform
< 1000 MPN/g dry wt.
+++++++
< Safe >|< High Fecal Coliform

Salmonella
Less than 3 /4g dry wt.
+++++++
<Safe (none detected) >|< High Salmonella Count(> 3 per 4 grams)

Metals US EPA 503
Pass dry wt.
+++++++++
<All Metals Pass >|< One or more Metals Fail

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)
1.7 Percent dry wt.
+++++++++++++
<Low >|< Average >|< High Nutrient Content

AgIndex (Nutrients / Sodium and Chloride Salts) — ((N+P2O5+K2O) / (Na + Cl))
15 Ratio
+++
Na & Cl >|< Nutrient and Sodium and Chloride Provider >|< Nutrient Provider

Plant Available Nitrogen (PAN) — Estimated release for first season
2 lbs/ton wet wt.
+++++++++
Low Nitrogen Provider>|< Average Nitrogen Provider >|<High Nitrogen Provider

C/N Ratio
42 Ratio
++
< Nitrogen Release >|< N-Neutral >|< N-Demand>|< High Nitrogen Demand

Soluble Available Nutrients & Salts (EC5 w/w dw)
0.58 mmhos/cm dry wt.
+++
SloRelease>|< Average Nutrient Release Rate >|<High Available Nutrients

Lime Content (CaCO3)
3.5 Lbs/ton dry wt.
+++++++++++++
< Low >|< Medium >|< High Lime Content (as CaCO3)

What are the physical properties of your compost?

Percent Ash
11.6 Percent dry wt.
+++++++++
< High Organic Matter >|< Average >|< High Ash Content

Sieve Size % > 6.3 MM (0.25")
65.4 Percent dry wt.
++
All Uses >|< Size May Restrict Uses for Potting mix and Golf Courses

Account No.:		Date Received	28 Oct. 09	
9100821 - 1/1 - 6156		Sample i.d.	Kodiak Compost	
Group:	Oct.09 E No. 7	Sample I.d. No.	1/1	9100821

INTERPRETATION:

Is Your Compost Stable?

Respiration Rate

0.2 Low: Good for all uses mg CO_2-C/g OM/day

The respiration rate is a measurement of the biodegradation rate of the organic matter in the sample (as received). The respiration rate is determined by measuring the rate at which CO_2 is released under optimized moisture and temperature conditions.

Biologically Available Carbon

1 Low: Good for all uses mg CO_2-C/g OM/day

Biologically Available Carbon (BAC) is a measurement of the rate at which CO_2 is released under optimized moisture, temperature, porosity, nutrients, pH and microbial conditions. If both the RR and the BAC test values are close to the same value, the pile is optimized for composting. If both values are high the compost pile just needs more time. If both values are low the compost has stabilized and should be moved to curing. BAC test values that are higher than RR indicate that the compost pile has stalled. This could be due to anaerobic conditions, lack of available nitrogen due to excessive air converting ammonia to the unavailable nitrate from lack of nitrogen or other nutrients due to poor choice of feedstock, pH value out of range, or microbes rendered non-active.

Is Your Compost Mature?

AmmoniaN:NitrateN ratio	250	immature
Ammonia N ppm	240	mature
Nitrate N ppm	0.95	immature
pH value	6.35	immature

Composting to stabilize carbon can occur at such a rapid rate that sometimes phytotoxins remain in the compost and must be neutralized before using in high concentrations or in high-end uses. This step is called curing. Typically ammonia is in excess with the break-down of organic materials resulting in an increase in pH. This combination results in a loss of volatile ammonia (it smells). Once this toxic ammonia has been reduced and the pH drops, the microbes convert the ammonia to nitrates. A low ammonia + high nitrate score is indicative of a mature compost, however there are many exceptions. For example, a compost with a low pH (<7) will retain ammonia, while a compost with high lime content can lose ammonia before the organic fraction becomes stable. Composts must first be stable before curing indicators apply.

Cucumber Bioassay

100.0 Percent

Cucumbers are chosen for this test because they are salt tolerant and very sensitive to ammonia and organic acid toxicity. Therefore, we can germinate seeds in high concentrations of compost to measure phytotoxic effects without soluble salts being the limiting factor. Values above 80% for both percent emergence and vigor are indicative of a well-cured compost. Exceptions include very high salts that affect the cucumbers, excessive concentrations of nitrates and other nutrients that will be in range when formulated to make a growing media. In addition to testing a 1:1 compost: vermiculite blend, we also test a diluted 1:4 blend to indicate a more sensitive toxicity level.

Is Your Compost Safe Regarding Health?

Fecal Coliform

< 1000 / g dry wt.

Fecal coliforms can survive in both aerobic and anaerobic conditions and is common in all initial compost piles. Most human pathogens occur from fecal matter and all fecal matter is loaded in fecal coliforms. Therefore fecal coliforms are used as an indicator to determine if the chosen method for pathogen reduction (heat for compost) has met the requirements of sufficient temperature, time and mixing. If the fecal coliforms are reduced to below 1000 per gram dry wt. it is assumed all others pathogens are eliminated. Potential problems are that fecal coliform can regrow during the curing phase or during shipping. This is because the conditions are now more favorable for growth than during the composting process.

Salmonella Bacteria

Less than 3 3 / 4g dry wt.

Salmonella is not only another indicator organism but also a toxic microbe. It has been used in the case of biosolids industry to determine adequate pathogen reduction.

Metals

Pass

The ten heavy metals listed in the EPA 503 regulations are chosen to determine if compost can be applied to ag land and handled without toxic effects. Most high concentrations of heavy metals are derived from woodwaste feedstock such as chrome-arsenic treated or lead painted demolition wood. Biosolids are rarely a problem.

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P_2O_5+K_2O)

1.7 low nutrient content

This value is the sum of the primary nutrients Nitrogen, Phosphorus and Potassium. Reported units are consistent with those found on fertilizer formulations. A sum greater than 5 is indicative of a compost with high nutrient content, and best used to supply nutrients to a receiving soil. A sum below 2 indicates low nutrient content, and is best-used to improve soil structure via the addition of organic matter. Most compost falls between 2 and 5.

Account No.:		Date Received	28 Oct. 09	
9100821 - 1/1 - 6156		Sample i.d.	Kodiak Compost	
Group:	Oct.09 E No. 7	Sample I.d. No.	1/1	9100821

INTERPRETATION:

AgIndex (Nutrients/Na+Cl)

15 High nutrient ratio Composts with low AgIndex values have high concentrations of sodium and/or chloride compared to nutrients. Repeated use of a compost with a low AgIndex (< 2) may result in sodium and/or chloride acting as the limiting factor compared to nutrients, governing application rates. These composts may be used on well-draining soils and/or with salt-tolerant plants. Additional nutrients form another source may be needed if the application rate is limited by sodium or chloride. If the AgIndex is above 10, nutrients optimal for plant growth will be available without concern of sodium and/or chloride toxicity. Composts with an AgIndex of above 10 are good for increasing nutrient levels for all soils. Most composts score between 2 and 10. Concentrations of nutrients, sodium, and chloride in the receiving soil should be considered when determining compost application rates. The AgIndex is a product of feedstock quality. Feedstock from dairy manure, marine waste, industrial wastes, and halophytic plants are likely to produce a finished compost with a low AgIndex.

Plant Available Nitrogen (lbs/ton)

2 Low N Provider Plant Available Nitrogen (PAN) is calculated by estimating the release rate of Nitrogen from the organic fraction of the compost. This estimate is based on information gathered from the BAC test and measured ammonia and nitrate values. Despite the PAN value of the compost, additional sources of Nitrogen may be needed during he growing season to off-set the Nitrogen demand of the microbes present in the compost. With ample nutrients these microbes can further breakdown organic matter in the compost and release bound Nitrogen. Nitrogen demand based on a high C/N ratio is not considered in the PAN calculation because additional Nitrogen should always be supplemented to the receiving soil when composts with a high C/N ratio are applied.

C/N Ratio

42 Indicates immaturity As a guiding principal, a C/N ratio below 14 indicates maturity and above 14 indicates immaturity, however, there are many exceptions. Large woodchips (>6.3mm), bark, and redwood are slow to breakdown and therefore can result in a relatively stable product while the C/N ratio value is high. Additionally, some composts with chicken manure and/or green grass feedstocks can start with a C/N ratio below 15 and are very unstable. A C/N ratio below 10 supplies Nitrogen, while a ratio above 20 can deplete Nitrogen from the soil. The rate at which Nitrogen will be released or used by the microbes is indicated by the respiration rate (BAC). If the respiration rate is too high the transfer of Nitrogen will not be controlable.

Soluble Nutrients & Salts (EC5 w/w dw - mmhos/cm)

0.58 Low salts This value refers to all soluble ions including nutrients, sodium, chloride and some soluble organic compounds. The concentration of salts will change due to the release of salts from the organic matter as it degrades, volatilization of ammonia, decomposition of soluble organics, and conversion of molecular structure. High salts + high AgIndex is indicative of a compost high in readily available nutrients. The application rate of these composts should be limited by the optimum nutrient value based on soil analysis of the receiving soil. High Salts + low AgIndex is indicative of a compost low in nutrients with high concentrations of sodium and/or chloride. Limit the application rate according to the toxicity level of thesodium and/or chloride. Low salts indicates that the compost can be applied without risking salt toxicity, is likely a good source of organic matter, and that nutrients will release slowly over time.

Lime Content (lbs. per ton)

3.5 Low lime content Compost high in lime or carbonates are often those produced from chicken manure (layers) ash materials, and lime products. These are excellent products to use on a receiving soil where lime has been recommended by soil analysis to raise the pH. Composts with a high lime content should be closely considered for pH requirements when formulating potting mixes.

Physical Properties

Percent Ash

11.6 Low ash content Ash is the non-organic fraction of a compost. Most composts contain approximately 50% ash (dry weight basis). Compost can be high in ash content for many reasons including: excess minerilzation(old compost), contamination with soil base material during turning, poor quality feedstock, and soil or mineral products added. Finding the source and reducing high ash content is often the fastest means to increasing nutrient quality of a compost.

Particle Size % > 6.3 MM (0.25")

65.4 May restrict use Large particles may restrict use for potting soils, golf course topdressings, seed-starter mixes, and where a fine size distribution is required. Composts with large particles can still be used as excellent additions to field soils, shrub mixes and mulches.

Particle Size Distribution

Each size fraction is measured by weight, volume and bulk density. These results are particularly relevent with decisions to screen or not, and if screening, which size screen to use. The bulk density indicates if the fraction screened is made of light weight organic material or heavy mineral material. Removing large mineral material can greatly improve compost quality by increasing nutrient and organic concentrations.

Appendix:			
		Estimated available nutrients for use when calculating application rates	
Plant Available Nitrogen (PAN) calculations:			lbs/ton
PAN = (X * (organic N)) + ((NH4-N) + (NO3-N))			
X value =	If BAC < 2 then X = 0.1	Plant Available Nitrogen (PAN)	2.4
	If BAC =2.1 to 5 then X = 0.2	Ammonia (NH4-N)	0.16
	If BAC =5.1 to 10 then X = 0.3	Nitrate (NO3-N)	0.00
	If BAC > 10 then X = 0.4	Available Phosphorus (P2O5*0.64)	1.6
Note: If C/N ratio > 15 additional N should be applied.		Available Potassium (K2O)	1.3

Attachment 3
Pilot Program Costs

Capital Costs

Item	Hours	Labor Rate	Amount
Purchase unit from CH2M HILL	n/a		10000
Compost trailer shipping	n/a		8000
Blower bearings and freight	n/a		800
Gauges and thermometers	n/a		300
Misc. piping, bolts, clamps,etc.	n/a		600
Electrical labor	n/a		3000
WWTP labor - site preparation	387	40	15467
Public works labor - site preparation	206	40	8220
Tarps	n/a		4905
Equipment	--		
Loaders	66	54	3564
Trackhoe	89	42	3738
Backhoes	14	38	532
Dumptrucks	162	41	6642
Pickup truck	66	6	396
Total			**$ 66,164**

Operations and Maintenance Costs

Item	Hours	Rate	Amount
Operator oversight	100	60	6000
Recordkeeping (Administrative Assista	40	30	1200
WWTP labor	193	40	7733
Public works labor - chipping	617	40	24660
Sawmill	n/a		1000
Chipper rental	n/a		8500
Compost resting	n/a		500
Total			**$ 49,593**
Grand Total			**$ 115,757**

n/a = not applicable
WWTP = wastewater treatment plant

Attachment 4
Newspaper Articles on Composting Pilot Program

City to examine sludge disposal

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Officials consider composting for additional solid waste management

Article published on Wednesday, Feb 20th, 2008

By MISTY MAYNARD
Mirror Writer

The City of Kodiak will have about three years to determine how to dispose of sludge from the wastewater treatment plant, under an agreement between the city and the Kodiak Island Borough.

During a joint work session Tuesday evening, the City Council and Borough Assembly heard an update on the situation.

City Manager Linda Freed said the borough has agreed to continue taking the current volume of sludge for about three years, which gives the city time to complete a sludge disposal study. The borough first informed the city of its limited ability to handle the sludge in February 2007.

Sludge is basically treated sewage waste. Between 250,000 and 400,000 pounds of sludge are hauled to the landfill each month. Besides the difficulty of having little available disposal space, the handling characteristics of the sludge also pose a problem.

Disposal possibilities include shipping the sludge off-island or composting.

The study will be completed by CH2MHill and will outline all options for sludge disposal.

Composting

Even if composting is not the ideal solution for dealing with the sludge, it could provide a solution for solid waste management for the borough.

The Solid Waste Advisory Board also met Tuesday and heard a presentation on composting by Roland Shanks, environmental specialist with Rural Community Assistance Corp.

Assembly member Chris Lynch was at the SWAB meeting and spoke of the possibility of composting waste in Kodiak during the joint work session.

“What they presented is definitely viable,” Lynch said. “It was a good presentation.”

Some concerns for composting in Kodiak included the space it would take for the operation, weather conditions and cost.

Shanks’ presentation included photos of a composting operation in a city in Arizona. While most people think of the desert when they think of Arizona, the city’s location results in a climate similar to Kodiak’s.

“Composting is basically a natural process,” Shanks explained in his presentation. It is a method to turn garbage into soil.

Shanks said by recycling and composting, a city can reduce the amount of waste going into a landfill by up to 70 percent. One example of this kind of success is San Francisco.

The reduction will extend the life of the landfill, so costly expansions or a new landfill are not needed as frequently. Shanks said one Alaska community put in a new landfill that cost about $1 million per acre — and that doesn’t include maintenance costs for the next 20 to 30 years.

Maintenance of the landfill will also cost less, because the waste that produces methane and leachate will have been removed, making the landfill less toxic.

The system in Arizona Shanks used as an example is about three times what Kodiak would likely need, he said. The size of the system would depend not on current need, but would be based on 15- or 20-year projections.

“You don’t build it for today’s problems,” he said. “You build it to deal with the problems you’ll have 15 to 20 years from now.”

Composting is a controlled operation to ensure the product is safe for use in a garden or for other means.

Composting generates its own heat through the regulation of water, air and other factors. It takes several weeks to turn the trash into soil.

The end product can be sold, and Shanks said the Arizona operation has more demand than what it can supply.

Other Alaska cities also compost, including Anchorage, which sells much of its product.

A composting study would have to be done to determine the size of the system needed, as well as cost, Shanks said.

Even if a composting system were approved soon, it would take three to four years to build. One person attending the seminar asked if the time lapse might result in the borough getting dated technology, and if something new and better may become available before then. Shanks said that is unlikely.

Mirror writer Misty Maynard can be reached via e-mail at mmaynard@kodiakdailymirror.com.

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Composting well

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Article published on Wednesday, Jul 15th, 2009
By DEREK CLARKSTON
Mirror Writer

As supervisor of Kodiak's Water and Wastewater Treatment Plant, Harry Heiberg often gets asked about the plant's pilot project — composting biosolids.

No matter what he is doing, he always stops and answers every question.

"This is kind of exciting," Heiberg said, Tuesday morning. "It is an interesting alternative."

"When I go to Safeway or the post office, people ask, 'How can I get some of this compost?"'

The answer will be answered at the end of the summer.

The biosolids compost has been cooking for four weeks. Today, treatment plant operators will remix the compost.

Nearing the second of three phases, treatment plant workers check the temperature twice daily and so far they like what they see.

"We want to maintain 55 degrees Celsius (131 degrees) for three straight days, and that qualifies as a class A biosolid," Heiberg said.

The compost pile peaked at around 150 degrees and generally hovers around 131 degrees.

"If we can maintain the temperatures, we are going to screen all the wood chips out and end up with a compost," Heiberg said.

At that point, the compost is sent out to be tested and if it passes, the material will be available to the public.

There are still several questions Heiberg needs answered before he decides if composting is a suitable alternative to get rid of Kodiak's biosolids:

Does the community want this? Does Kodiak have enough wood chips to continually make compost? Or will the program be cost effective?

"We don't really know until it is all done," Heiberg said.

The project is progressing satisfactorily.

"I was expecting more of an odor," Heiberg said. "Except for the day we started, it has really been pleasant."

Heiberg said the small amount of odor coming from the compost outside of the plant is an earthy musty smell, according to a compost odor wheel chart.

Due to lack of rain, Heiberg's crew has had to water the compost pile to raise the moisture level.

Heiberg predicts the pilot program will produce a dumptruck-size load of compost. If the compost turns out usable, people can sign up to receive a portion of the compost by contacting the Kodiak Water and Wastewater Treatment Plant.

Mirror writer Derek Clarkston can be reached via e-mail at sports@kodiakdailymirror.com.

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Biosolids Composting Amendment Requirements

PREPARED FOR: Mark Kozak, City of Kodiak

PREPARED BY: CH2M HILL

DATE: April 30, 2010

1 Introduction

During summer 2009, a Biosolids Composting Pilot Program was conducted at the City of Kodiak (City) wastewater treatment facility (WWTF) using dewatered biosolids mixed with wood chips. This pilot program demonstrated that high-quality compost, defined as exceeding U.S. Environmental Protection Agency testing requirements and suitable for unrestricted use, can be produced using the aerated static pile method in Kodiak's coastal environment. Therefore, CH2M HILL recommended that the feasibility of operating a full-scale biosolids composting operation be further evaluated, such as studying amendment requirements, potential end uses, and cost.

This is the first of three technical memorandums evaluating the potential use of this composting method for the long-term management of biosolids from the WWTF. This memorandum estimates wood chip requirements for a full-scale operation and evaluates whether that volume is available in Kodiak. The second memorandum evaluates whether all the compost could be used in Kodiak and potential end uses of the full-scale compost product. The third provides a cost estimate for development of a full-scale biosolids composting operation.

For this memorandum, data from the Pilot Program and other CH2M HILL composting operations were used to estimate the volume of wood chips required for full-scale operation. That volume was then compared to the volumes of wood and other suitable amendments available in Kodiak.

2 Pilot Program Results

Exhibit 1 summarizes the volumes of biosolids and wood chips used in the Pilot Program.

EXHIBIT 1
Summary of Wood Chip and Biosolids Usage for Pilot Program

Wood chips	360 cubic yards[a]
Biosolids	30 cubic yards

[a] Includes chips for compost mix, base layer, cover layer, and biofilter

The results from the Pilot Program indicated that a mix ratio of approximately 5.5 parts wood chips to 1 part biosolids would be required to support an aerated static pile composting operation. As demonstrated in this pilot program, a significant volume of additional wood chips are required for the initial construction of the base layer, cover layer, and biofilter. In ongoing composting operations, the volume of required wood chips can be reduced by reuse of oversized chips captured during the screening process.

3 Estimated Full-scale Amendment Requirements

Based on results from similar composting operations, it is estimated that approximately 50 percent to 65 percent of the oversized wood chips could be captured during the screening process and recycled into the next batch of compost. Given this recycle rate, the estimated wood chip requirements for full-scale annual operation is summarized in Exhibit 2.

EXHIBIT 2
Summary of Annual Wood Chip Requirements for Full-scale Operation

New wood chips	3,800-3,900 cubic yards[a]
Biosolids	2,600 cubic yards
Volumetric mix ratio	3.2:1

[a]Range depends on quality and moisture content of wood chips available.

4 Available Wood and Other Amendments in Kodiak

For the pilot program, wood waste from Kodiak was used to demonstrate how the chipping and composting would actually work with local feedstock. An advertisement for clean, scrap wood was placed in the local newspaper. There were only a few responses, generating a small amount of wood. However, the local power company, Kodiak Electric Association, was doing work nearby and was able to contribute a substantial amount of wood (brush and small limbs) for the project. A chipper was rented, and it took 3 weeks of work to produce the 340 cubic yards of chips used in the project. Sources of wood used for the Pilot Program are shown in Exhibit 3.

EXHIBIT 3
Sources of Wood Chips Used for Pilot Program

Source	Wood Chip Volume (cubic yards)
Kodiak Electric Association	280
U.S. Coast Guard	60
Individuals responding to newspaper ad	20

There is not a known sustainable supply of wood on Kodiak Island that could be a source for compost amendments. It was found that the City Parks and Recreation Department, Alaska State Division of Parks and Outdoor Recreation (State Parks), and local contractors would not be good sources. The City and State Parks have limited trees, and construction produces too little scrap wood, in pieces that may not be suitable for sorting.

Tree stumps would provide a wood source if proper equipment (a tub grinder) were available. A tub grinder could process tree stumps and also branches larger than 12 inches that a wood chipper cannot accept.

Because all available pallets are used for shipping out seafood, pallets are not an available wood source. The U.S. Coast Guard (USCG) may be a source of wood. USCG has 3 miles of fenceline that is cleared regularly.

Another source of bulking agent is scrap cardboard. Recycled cardboard is readily available in Kodiak. Based on CH2M HILL experience, it is estimated that cardboard could be used for up to 30 percent of the total amendment requirement without affecting operations. In other words, up to one-third of the new wood chip requirement could be displaced by shredded cardboard. Special machinery may be required to shred the cardboard. Vertical batch mixers such as the Supreme mixer evaluated as part of the capital cost analysis may be able to be used to grind cardboard sufficiently for use.

Potential volumes of available bulking materials on an annual basis are shown in Exhibit 4. The last row of the table contains an estimated volume for wood chips that could become available if a wood-chipping operation being developed by Peter Olsen of Kodiak Wood Fuels is successful. In a telephone conversation with CH2M HILL February 18, 2010, Mr. Olsen said he is working on a wood-chipping operation for use in USCG wood boilers and estimated that the operation could provide the City with the required volume of chips. The wood source would be logging operations on Afognak Island.

EXHIBIT 4.
Estimated Annual Volume of Wood Chips and Other Amendments Available in Kodiak

Amendment	Volume (cubic yards)
Wood chips from brush and miscellaneous clean wood waste[a]	1,680
Wood chips from stumps[b]	280
Cardboard[c]	600
Subtotal	**2,280**
Wood chips from Kodiak Wood Fuels[d]	4,000

[a]Estimate includes wood generated by City of Kodiak, Kodiak Electric Association, and the public (assume four times the volume generated for the Biosolids Composting Pilot Program); and wood from USCG fence line clearing (assume 1 cubic yard/50 feet of fence line and total of 3 miles of fence line).
[b]Assumes 1 acre of clearing per year, with 70 stumps per acre and 4 cubic yards per stump, including some of the trunk. This source would require purchase and operation of a tub grinder.
[c]Assumes that Kodiak could capture approximately 30,000 pounds of cardboard per month. This is the approximate volume that Threshold Recycling Services currently processes, primarily mixed paper and cardboard (Bell & Associates, *Final Solid Waste Management Plan,* August 2008). Assumes a density of cardboard of 600 pounds per cubic yard.
[d]Initial indications are that the size of wood chips that might become available from Kodiak Wood Fuels would be close to the size needed for composting of Kodiak wastewater treatment facility biosolids. If this chipping operation is successful, then it is assumed that this volume could be provided.

If the wood chips from Kodiak Wood Fuels become available, then this source could supply the entire need for composting and could be a long-term source for the City. If wood chips from Kodiak Wood Fuels are not available, then the City could provide only about 50 percent of the amendments required for a full-scale composting project.

The addition of a supplemental amendment such as shredded rubber tires could displace up to one-third of the bulking agent supply. This practice has been used at the City of Windsor, Ontario, aerated static pile composting operation in the 1980s and 1990s and is currently practiced by the City of Davenport, Iowa, to offset the amount of wood chips that must be purchased. Screening to recycle tires back into the composting process ensures recovery of nearly 100 percent of the shredded tires.

5 Summary

The Kodiak pilot test provided the data on amendment requirements for the composting operation. Our analysis showed that, without purchase and operation of specialized equipment (tub grinder and cardboard shredder), the City will not be able to supply the required amendment to sustain a full-scale compost operation. Even if a tub grinder and cardboard shredder are purchased, CH2M HILL estimates that only 50 percent of amendment could be supplied in Kodiak. However, if the Kodiak Wood Fuels chipping operation is successful, then it is very possible that this source could provide the required volume of wood chips for a full-scale composting operation. The use of supplemental and fully recyclable bulking agents such as shredded rubber tires may be needed to provide enough bulking agent to meet the needs of the operation at full scale.

6 References

Peter Olsen/Kodiak Wood Fuels. 2010. Personal communication with Cory Hinds/CH2M HILL. February 18.

Biosolids experiment a success

Article published on Wednesday, Dec 09th, 2009
By SAM FRIEDMAN
Mirror Writer

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Enter sewage, exit water and create soil. That's the goal in an experiment recently conducted at the Kodiak Water and Wastewater Treatment Plant.

Lab tests released this week by Soil Control Lab show the experiment was a success. What was once toilet paper and human waste is now soil. Tests confirm the soil is sufficiently low in heavy metals and other potential toxins. It can now be used to grow flowers and vegetables.

The material used to make the soil would usually end up at the Kodiak Borough Landfill.

But the current load of soil is only an experiment to see if biosolids — the technical term for the main solid byproduct of sewage treatment — can be turned into dirt. The load of soil, composed of a week's worth of biosolids, will probably produce only a couple of dump truck loads of soil in the coming spring when workers will screen out the woodchips used in the composting process.

After some number crunching and evaluation of public opinion the city will make decisions regarding the expansion of the project.

"We now want to find out if this is something the community wants," plant supervisor Hap Heiberg said. "When I see people at Safeway they've been very supportive, and want to know how they can get compost."

Heiberg said options for disposal of biosolids from the treatment plant include continuing to take them to the borough landfill, burning them, hauling them off island or composting. The city must now weigh the options.

Setting up the pilot compost project cost about $100,000. Compositing all of Kodiak's biosolids would be considerably more expensive, and require finding enough wood chips to continually compost biosolids.

"Woody materials are going to be the biggest obstacle to the project," said Kodiak Public Works director Mark Kozak.

The current compost project produces soil by mixing the biosolids with woodchips. Buying enough woodchips to bring the project to scale might be prohibitive. Cardboard is a cheaper alternative, but would take additional research.

Expanding the compost project also would require a new site. The treatment plant property on Spruce Cape Road is too small and too close to homes.

"If this was Kansas and there was lots of land, it wouldn't be a big deal," Heiberg said. "But in Kodiak, large pieces of flat land are hard to find."

Composting also wouldn't completely cut the landfill out of the process. A small percentage of corn, eggshells and sticks filtered out in the process would have to be thrown away.

The treatment plant currently throws away about 3.5 million pounds of biosolids each year. Heiberg said that's about the equivalent of a football field stacked 18 inches high. The plant also takes biosolids off the Coast Guard Base.

Biosolids that emerge from the present treatment press are brown, smelly pieces of paper composed of 80 percent water. Most of the germs from the waste have already been killed by lye treatments.

Water treatment of sewage in Kodiak only began in 1978. When Heiberg first arrived, sewage was pumped directly into the ocean.

"I remember I got off of the ferry, and down by the harbor there were pipes with toilet paper coming out of them," he said. "So all of this has been since I got here."

He said Kodiak is now ahead of most Alaska communities in its water treatment because it invested in a secondary water treatment system. Most Alaska communities, including Anchorage, only send wastewater through a primary system.

To be placed on a list of people interested in receiving compost from the wastewater plant, e-mail Heiberg at hheiberg@city.kodiak.ak.us or call 486-8076.

Mirror writer Sam Friedman can be reached via e-mail at sfriedman@kodiakdailymirror.com.

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[d]Initial indications are that the size of wood chips that might become available from Kodiak Wood Fuels would be close to the size needed for composting of Kodiak wastewater treatment facility biosolids. If this chipping operation is successful, then it is assumed that this volume could be provided.

If the wood chips from Kodiak Wood Fuels become available, then this source could supply the entire need for composting and could be a long-term source for the City. If wood chips from Kodiak Wood Fuels are not available, then the City could provide only about 50 percent of the amendments required for a full-scale composting project.

The addition of a supplemental amendment such as shredded rubber tires could displace up to one-third of the bulking agent supply. This practice has been used at the City of Windsor, Ontario, aerated static pile composting operation in the 1980s and 1990s and is currently practiced by the City of Davenport, Iowa, to offset the amount of wood chips that must be purchased. Screening to recycle tires back into the composting process ensures recovery of nearly 100 percent of the shredded tires.

5 Summary

The Kodiak pilot test provided the data on amendment requirements for the composting operation. Our analysis showed that, without purchase and operation of specialized equipment (tub grinder and cardboard shredder), the City will not be able to supply the required amendment to sustain a full-scale compost operation. Even if a tub grinder and cardboard shredder are purchased, CH2M HILL estimates that only 50 percent of amendment could be supplied in Kodiak. However, if the Kodiak Wood Fuels chipping operation is successful, then it is very possible that this source could provide the required volume of wood chips for a full-scale composting operation. The use of supplemental and fully recyclable bulking agents such as shredded rubber tires may be needed to provide enough bulking agent to meet the needs of the operation at full scale.

6 References

Peter Olsen/Kodiak Wood Fuels. 2010. Personal communication with Cory Hinds/CH2M HILL. February 18.

End Use of Compost in Kodiak

PREPARED FOR: Mark Kozak, City of Kodiak

PREPARED BY: CH2M HILL

DATE: April 30, 2010

1 Introduction

During summer 2009, a field-scale Biosolids Composting Pilot Program was conducted at the City of Kodiak (City) wastewater treatment facility (WWTF) using dewatered biosolids mixed with wood chips. This pilot program demonstrated that high-quality compost, defined as exceeding U.S. Environmental Protection Agency testing requirements and suitable for unrestricted use, can be produced using the aerated static pile method in Kodiak's coastal environment. Therefore, CH2M HILL recommended that the feasibility of operating a full-scale biosolids composting operation be further evaluated, such as studying amendment requirements, potential end uses, and cost.

The second in a series of three, this technical memorandum focuses on evaluating the potential end uses of the full-scale compost product. The first estimates the volume of wood chips required as an amendment for a full-scale operation and its availability in Kodiak. The third provides a cost estimate for development of a full-scale biosolids composting operation.

The estimated annual, full-scale finished biosolids compost volume is approximately 2,100 cubic yards. This volume is based on an estimated annual volume of 2,600 cubic yards of biosolids to be composted. It is assumed that 50 to 65 percent of the bulking agent is recycled by screening through a 3/8-inch size screen, thereby maximizing the amount of bulking agent that is recycled into the composting process and minimizing the amount of compost that is produced.

CH2M HILL retained the services of Ron Alexander (R. Alexander Associates, Inc.), one of the nation's most experienced compost marketing consultants, to research potential markets for Kodiak's compost. Mr. Alexander reviewed the Kodiak pilot program compost data and conducted research by telephone with support from CH2M HILL. His analyses and recommendations were reviewed by CH2M HILL and are incorporated in the remainder of this memorandum.

2 Pilot Program Product Quality Results and Benefits of Compost for Kodiak

The compost-quality results for the compost product are provided in Exhibit 1. Overall, the compost is considered high-quality. It possesses moderate nutrient and high organic matter contents, is very stable and mature, and is ready for use. The pH and electrical conductivity values are also within acceptable levels allowed for usage in a variety of horticultural and agricultural applications. The carbon-to-nitrogen (C:N) ratio of the compost is considered somewhat high for soil incorporation uses initially, but should reduce with aging. The compost product was also analyzed for heavy metals and pathogens and met U.S. Environmental Protection Agency standards in Title 40, Section 503, of the *Code of Federal Regulations* for Class A biosolids material, suitable for distribution and marketing. Neither Mr. Alexander nor CH2M HILL has any concerns about unrestricted use of this product. The use of this compost product would improve the low pH and organic matter content of soils that exist on Kodiak Island (Owen, 2009, personal communication, and Johns, 2010, personal communication).

EXHIBIT 1
Pilot Program Compost Quality Results

Characteristic	Unit	Result
Total nitrogen	%, wet weight	0.34
Total phosphorus	%, wet weight	0.13
Total potassium	%, wet weight	0.065
Calcium	%, wet weight	0.15
Magnesium	%, wet weight	0.047
Bulk density	pounds per cubic foot	38
pH value	units	6.35
Electrical conductivity	dS/m, dry weight	0.58
Organic matter	%, dry weight	88.4
C:N ratio	Ratio	42
Moisture	%, wet weight	68
Stability	mg CO_2-C/g OM/day	0.2
Maturity – emergence/vigor	%	100%/100%

C:N = carbon-to-nitrogen
dS/m = deciSiemens per meter
mg CO_2-C/g OM/day = milligrams of carbon dioxide per gram of organic matter per day

3 Business Demographic Research

A desktop study of regional businesses and population demographics data was conducted using the Power Business 10.0 business list (2009 update) to better understand the potential compost markets on Kodiak Island. The business demographics data that were reviewed helped to provide an estimate of the potential number and types of businesses that may use compost on the island.

Generally, horticultural businesses are the highest-paying users of compost, after retail and residential end users. Regions such as Kodiak that have relatively low population densities also have lower numbers of horticultural businesses. However, other, large-volume (but lower-value) markets for compost do exist (for example, farmers, land reclamation) in more rural settings where more extensive agricultural activity can occur.

Exhibit 2 lists business types throughout North America that are known to be large users of compost and identifies the numbers of such businesses that are present on Kodiak Island and in nearby Anchorage and the Kenai Peninsula. As shown, Kodiak Island and the Kenai Peninsula have a small number of professional, horticultural-type businesses; therefore, these markets may not support significant usage of compost. The number of landscapers is significantly larger in Anchorage than on Kodiak Island or the Kenai Peninsula, and compost markets may be stronger there.

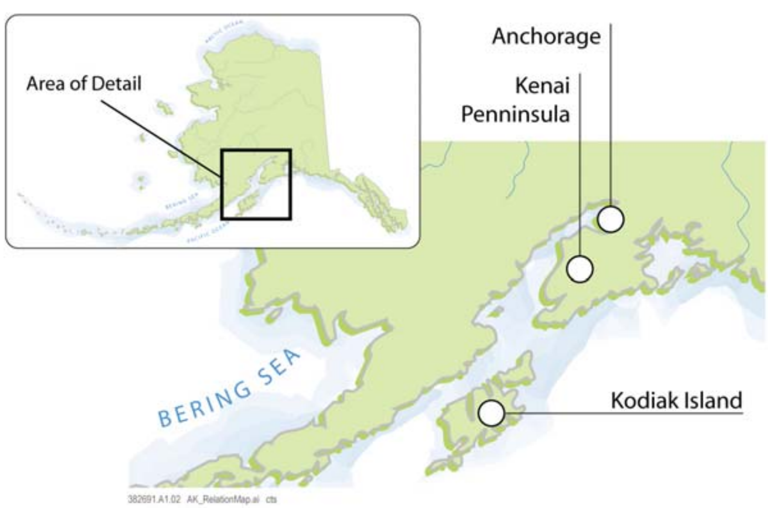
EXHIBIT 2
Demographics of Professional End Users of Compost at and near Kodiak

Area	Farmers	Landscapers	Retail/ Wholesale Nurseries[a]	Golf Courses		Landscape/ Equipment Suppliers	Bulk Materials		Garden Centers
				Private	Public		Topsoil	Mulches	
Anchorage	0	106	1	1	7	9	19	2	11
Kenai Peninsula	0	14	0	0	5	1	9	0	1
Kodiak Island	1	1	0	0	1	0	0	0	3
Total	**1**	**121**	**1**	**1**	**13**	**10**	**28**	**2**	**15**

[a]This category includes retail and wholesale nurseries. Retail nurseries are often also called garden centers

The locations of Kodiak, Anchorage, and the Kenai Peninsula in relation to each other are shown in Figure 1.

FIGURE 1
Location Map



4 Northwest Biosolids Compost Sales Research

Biosolids composters in the northwestern regions of Canada and the U.S. were contacted by telephone to better understand the potential end use markets for compost made from biosolids. Exhibit 3 illustrates that a variety of paying markets exist for biosolids compost in those regions and that there is a high level of success in market development. The table also illustrates that the common markets being developed in the more populated regions are landscapers, soil blenders, golf courses, and residential end users. Lower-quality compost, such as commercial-grade or compost produced for use in rural agricultural and land reclamation markets where compost is used in soil incorporation, soil blending, and erosion control. These trends may translate to Kodiak Island.

EXHIBIT 3
Northwestern Composters Market Concentration

Organization/Location	Primary Markets
EKO Systems - Lewiston, Idaho	Soil blenders, nurseries, landscapers, golf courses, Idaho Department of Transportation
EKO Systems - Missoula, Montana	Soil blenders, nurseries, landscapers, golf courses, land reclamation, Montana Department of Transportation, and bags to mass merchandisers
City of Santa Rosa - Santa Rosa, California	Landscapers, vineyards, municipal/government usage, residents
King County Wastewater Treatment Division / GroCo Products - Seattle, Washington	Forestry, agriculture, retail, landscapers
Roseburn Ranches Ltd./ ECO AG - High River, Alberta, Canada	Agriculture, land reclamation
Bowden Institute - Innisfail, Alberta, local farmer	Internal pasture and agricultural land use
City of Fort McMurray - Fort McMurray, Alberta, Canada	Local residents, landscapers
City of Medicine Hat - Medicine Hat, Alberta, Canada	Land reclamation
City of Edmonton - Edmonton, Alberta, Canada	City Parks Department, erosion control, landscapers, topsoil blenders, agriculture
City of Ketchikan, Alaska	Landfill cover (internal use only)
Utility Services of Alaska, Fairbanks, Alaska	Local residents, landscapers
City of Port Angeles, Washington	Local residents, landscapers

5 Market Research

Sixteen potential end users in Kodiak were contacted by telephone to better understand the existing demand or usage of compost. Of those 16 entities, only 4 companies currently use or sell compost. This result is not surprising because no compost is produced on the island, except compost that a given company may produce and reuse. However, the majority of the other 12 companies do use or sell soil products in both bulk and bagged form.

Those companies that sell retail emphasized the importance of packaging the compost product. Both Strawberry Fields Garden Center and Anchor Point Greenhouses stated that they would consider being involved in packaging the product.

Several professional and government end users, such as Kodiak Lawn Care, Bear Valley Golf Course, the City Parks and Recreation Department, and Kodiak Support Services

(U.S. Coast Guard) also showed interest in the product. The Alaska Department of Transportation (ADOT&PF) was interested in receiving more information since it uses mulch for erosion control on the mainland.

The market for sale of compost to the Kodiak community is unknown, but the success of the Utility Services of Alaska in Fairbanks, where biosolids compost has been sold to the public for over 5 years, is an indication that there would be some interest. Several individuals mentioned the stigma that exists with biosolids composting and suggested that public perception would have to be managed for marketing to be successful.

Peter Olsen of Kodiak Wood Fuels mentioned the possibility of using compost to improve regrowth of harvestable trees (Olsen, 2010, personal communication). Land application of lower-quality compost product may be the low-cost disposal option.

Another potential end use may be use in the final cover at the Kodiak Island Borough (KIB) Landfill. The landfill currently uses crushed rock for daily cover, but is anticipated to reach capacity in approximately 5 years and will be covered and closed. The top layer of the final cover is considered the vegetative layer and must be capable of supporting growth of native vegetation. Use of compost or compost-amended topsoil would help to establish and maintain vegetation in the final cover.

6 Conclusions and Recommendations

The Biosolids Composting Pilot Program demonstrated that a high-quality compost can be produced from Kodiak WWTF biosolids. However, it may be difficult to market the entire volume of the compost immediately if a full-scale facility is constructed and brought online at full capacity. Although poor soils exist on Kodiak Island that would greatly benefit from the addition of compost in a variety of uses, the development of markets would be better served by phasing in development of the facility. This strategy would allow for markets to be developed over a longer period and would give the City adequate time to educate the marketplace about compost usage and biosolids to improve public perception. In addition, lower-quality, high-volume compost uses like landfill final cover, and possible land application for forestry projects should be targeted to sustain the operation while other markets for higher quality compost are being developed.

The City will need to promote its compost to all horticultural businesses on Kodiak Island. In addition, because of its rural location, the City will need to be creative in market development efforts and promote the compost to other Alaska cities and towns as well as local residents. Large, local land managers such as the City Parks and Recreation Department, ADOT&PF, forestry operators, KIB (which manages the landfill), and Kodiak Support Services should also be approached. Application methods that can be marketed include soil incorporation soil blending, topdressing, soil remediation, and erosion control. Finally, if the full-scale composting operation is to move forward, a more in-depth evaluation of markets should be conducted that would include sale quantity estimates for various business types and the general public, evaluation of the potential for sales off the island, and the possibility of bagging the product for sale.

7 References

Olsen, Peter/Kodiak Wood Fuels. 2010. Personal communication with Cory Hinds/CH2M HILL. February 18.

Owen, Marion/Master Gardener in Kodiak. 2009. Personal communication with Ron Alexander/ R. Alexander Associates, Inc. December 15.

Johns, Tom/University of Alaska Fairbanks Cooperative Extension Service Land Resource Agent. 2010. Personal communication with Cory Hinds/CH2M HILL. February 23.

Kodiak Biosolids Composting Facility Conceptual Design and Cost Estimate

PREPARED FOR: Mark Kozak, City of Kodiak

PREPARED BY: Scott Gamble/EDM
Todd Williams/RIC

DATE: April 30, 2010

1 Introduction

During summer 2009, a field-scale Biosolids Composting Pilot Program was conducted at the City of Kodiak (City) wastewater treatment facility (WWTF) using dewatered biosolids mixed with wood chips. This pilot program demonstrated that high-quality compost, defined as exceeding U.S. Environmental Protection Agency testing requirements and suitable for unrestricted use, can be produced using the aerated static pile (ASP) method in Kodiak's coastal environment. Therefore, CH2M HILL recommended that the feasibility of operating a full-scale biosolids composting operation be further evaluated, such as studying amendment requirements, potential end uses, and cost.

The third in a series of three, this technical memorandum provides an initial level of design detail and construction cost estimates. The first estimates the volume of wood chips required as an amendment for a full-scale operation and its availability in Kodiak. The second evaluates whether all the compost could be used in Kodiak and potential end uses of the full-scale compost product.

2 Functional Requirements and Design Criteria

The following sections outline the functional requirements and design criteria that have guided the conceptual design of the proposed composting facility. These have been developed based on regulatory requirements, best management practices, results of the Pilot Program, and discussions and correspondence with City personnel.

2.1 Facility Location

The availability of land on which a composting facility could be sited in and around the City is limited. Three potential locations were identified by the City: two City-owned properties and the Kodiak Landfill operated by the Kodiak Island Borough (KIB).

The three sites were visually inspected by CH2M HILL personnel in June 2009. One City-owned site was determined to be too close to residential development and was not considered further. The KIB landfill site was also eliminated because of future landfill development and jurisdictional issues.

The remaining site, at Gibson Cove, which is located on the western end of the City, as shown in Exhibit 1, was found to be well suited to hosting a composting facility. The area is currently used for industrial activities and has appropriate utility services. It is well removed from residential development and other sensitive receptors, is well graded, and is, for the most part, free of brush and trees.

Based on the field review and discussions with City personnel, the Gibson Cove site was tentatively selected as a host property and was used as the basis for this conceptual design.

2.2 Feedstock Quantities and Characteristics

The composting facility is expected to accept and process all the undigested biosolids from the WWTP: approximately 7 dry tons per week at current generation rates.
The biosolids currently are dewatered at the WWTP using a belt filter press. Characteristics of the dewatered biosolids cake were obtained from WWTP records, analysis of a representative sample by the University of Alaska Fairbanks, and published literature. The key characteristics of the feedstock are summarized in Exhibit 2.

EXHIBIT 1
Feedstock Characteristics

Parameter	Value
Percent solids	17%[a]
Percent nitrogen	4.6%[b]
Percent carbon	41.2%[b]
Carbon-to-nitrogen ratio	~9:1[b]
Bulk density	1,650 pounds per cubic yard[b]
Volatile solids	75%[c]

[a]City of Kodiak wastewater treatment facility
[b]Laboratory analysis of biosolids sample by University of Alaska Fairbanks
[c]Assumed value

It is reasonable to assume that biosolids quantities will increase as a result of population growth. However, given the expected growth rate for the City and the quantities of biosolids requiring treatment, it is expected that increases over the 10- to 15-year horizon will be minor and can be handled operationally within the composting facility.

2.3 Facility Capacity

The WWTP generates 7 dry tons or 41 wet tons of dewatered biosolids weekly. Monthly variations in biosolids quantities are minimal; therefore, a peaking factor has not been assumed for this conceptual design.

It is necessary to add a dry amendment material to adjust moisture content of biosolids downward into the desired range for composting. Amendments are also required in order to provide structure and porosity to the composting mixture, thereby improving the movement of air through it. The quantities of these amendments must be accounted for in the facility's design capacity.

2.4 Design Life

A minimum design life of 20 years is recommended for the major components of the facility, including buildings.

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Exhibit 1
Site Location

Secondary components, including mobile equipment and some mechanical pre- and post-processing equipment, would have shorter lifespans and require replacement during the 20-year period. For example, mobile equipment used in composting facilities can be expected to have a lifespan of 5 to 10 years, depending of the number of hours per week during which it is utilized.

2.5 Corrosion Protection

Experience at composting facilities during the past 10 years has demonstrated the corrosive nature of the process off-gasses, and, to a lesser extent, of feedstocks and leachates. When organic waste processing is conducted within enclosed buildings, the impacts on building components can be catastrophic. However, recent experience with improved continuous-aeration systems has shown a very high capture of process off-gases, which significantly reduces the impact of process emissions on building structures. Therefore, all buildings and major equipment that come into contact with the off-gasses from the composting process or other corrosive environments at the proposed facility should be designed and constructed using suitable materials or protective coatings to minimize corrosion.

2.6 Worker Health and Safety

Health and safety measures such as the use of equipment guards, appropriate sight lines, and prevention/control of steam clouds (that could affect visibility) should be incorporated into the design to prevent injuries and downtime due to incidents.

Indoor air quality within the facility and the potential for exposure of staff to elevated levels of air contaminants (for example, ammonia, and carbon monoxide), dusts, and bioaerosols are critical considerations. Although the design of building air handling systems at composting facilities should not be based solely on the number of building air changes per hour, this measure does provide a convenient means of defining general ventilation requirements. Typically, composting facilities are designed with six or more air changes per hour, and ventilation systems are supplemented with emission source capture systems around certain unit processes.

2.7 Odor Management

Odorous emissions are a byproduct of the biological degradation process that occurs during the composting process. However, at a properly designed and operated facility, these emissions should not be excessive or become a nuisance, either onsite or at neighboring properties. Collection and management of odorous air streams are critical to the success of a composting facility.

With the use of enclosures comes the need for appropriately designed heating, ventilation, and air conditioning (HVAC) systems. A ventilation airflow rate of six air changes per hour or greater, combined with source capture of emissions from specific processing equipment, is the standard used in the industry for organic waste receiving and processing buildings.

At larger facilities, individual processing areas within the facility can be segregated with walls to prevent transfer of large volumes of airflow and migration of odors and dust between them. Building air is also reused as process air to reduce the overall amount of air that requires subsequent treatment.

In outdoor operating areas, the degree of odor control is more limited relative to enclosed operating areas. Odor control in outdoor areas is achieved primarily through good operating practices. However, basic design features should also be incorporated into outdoor operations, including:

- Working surfaces should be sloped to promote drainage and prevent standing water, which can become an odor source and attract vectors. Grades of up to 2 percent are typical, and minimum grades are often specified in state regulations or guidelines.
- Working surfaces should be designed to provide all-weather access for site equipment and to resist rutting and settlement, which can lead to standing water.

2.8 Product Quality Requirements

The quantities and proposed uses of the final product(s) produced by the composting facility should be reflected in the facility's design to ensure that suitable allowances are made for post-processing operations and equipment and storage space.

Based on the types and characteristics of the feedstock that be accepted at this proposed composting facility, it is expected that a uniform, high-quality compost product meeting state requirements for pathogen and trace element content can be produced consistently. Provided that a "clean" source of amendment material is used (for example, brush and land-clearing debris), this product can also be expected to have little to no foreign contamination (for example, plastic or glass).

In light of the intended uses of the compost, it will be necessary to produce a final product that is fully stabilized. Stability is a measure of the stage of decomposition of the organic material and is measured by reheating tests or carbon dioxide respirometry. The stability requirements outlined in Exhibit 3 have been adopted and used to guide the conceptual design of the proposed composting facility.

EXHIBIT 3
Product Stability Criteria

Stability Criteria	Method	Criteria
Reheat	TMECC 5.08-D	<10°C
Carbon dioxide respiration	TMECC 5.08-B	<4 mg CO_2/g OM/day

°C = degrees Celsius
mg CO_2/g OM/day = milligrams of carbon dioxide per gram of organic matter per day

2.9 Finished Product Storage

Finished compost must be stored in a manner that preserves the product's quality (for example, prevents weed propagation and pathogen reintroduction). This generally means that product stockpiles are stored on prepared surfaces and are kept free of vegetation (for example, from windblown seeds) and litter. There also must be sufficient space to store the compost that accumulates during months when product shipments are low (winter).

A storage capacity large enough to accommodate the volume of product produced in 4 to 6 months is expected to be necessary at a facility in Kodiak. Because of high levels of precipitation, it is recommended that product be stored under some form of roof structure to prevent it from becoming saturated.

2.10 Geotechnical Conditions

Subsurface conditions are reported to be unsuitable in their current condition to support a building. Therefore, it was assumed that 6 feet of unsuitable soils would be excavated and replaced with select fill below proposed structures. For the conceptual design, it was assumed that typical slab-on-grade and strip-footing construction will be suitable and that piles are not required.

3 Conceptual Design

Conceptual sizing and layout of the proposed composting facility was completed based on the design capacity and functional requirements outlined in this technical memorandum. Plans showing the location and conceptual layout of the proposed facility are provided in Exhibits 4 and 5. The key design features of the proposed facility are described in the following sections.

3.1 Composting Process and Equipment

The Kodiak facility would be designed based on the use of ASP composting within five discrete, cast-in-place concrete "bunkers." The 12-foot-high back and side walls of each bunker would allow for piles with vertical sides and for better utilization of space. Each bunker would be sized to hold 1 week's worth of biosolids and associated amendment mixture.

Compost in each bunker would be negatively aerated on a continuous basis using in-floor aeration piping. All five bunkers would be connected to a single variable frequency drive (VFD) controlled aeration fan. Aeration rates in each bunker would be controlled manually by varying the aeration fan speed (by the VFD) and manually opening and closing dampers in the aeration piping network, based on manual temperature measurements taken daily in the composting piles.

To further assist with odor and nuisance control, the ASP compost system would be completely enclosed within a building.

The proposed design would provide a total of 6 weeks of enclosed and aerated composting. After the initial 3 weeks of composting in one of the three primary compost process bunkers, material would be transferred to one of the two secondary compost bunkers for an additional 3 weeks of composting. The transfer process would serve to remix the materials and the secondary compost process would help to further stabilize the material, reduce odors, and enhance drying of the material.

Following this two-stage, active composting period, the materials would be stabilized, and the potential for causing odors and nuisance conditions would be significantly reduced. The compost would then be screened, using a small, 3/8-inch screen, to recover bulking agent so that it can be reused in the compost process. The screened compost would be transferred to an outdoor, unaerated storage area using a wheeled front end loader. The storage area would be covered by a wooden roof structure with side walls to provide protection from rain and snow. An asphalt pad would be provided to allow ease of unloading and to protect the product from contamination.

Exhibit 6 is a conceptual process diagram for the proposed facility. The diagram shows an initial mixing stage prior to composting, and screening following the ASP composting stage to recover amendments for reuse.

Preliminary mix calculations were completed to determine the overall volume of material (feedstock plus amendments) to be processed. This information is necessary for determining the size of composting and material handling equipment.

An important consideration for the design and sizing of a composting facility is the requirement for feedstock amendments. One or more amendments are added to the primary feedstock to adjust the solids content into the desired range and to provide structure and porosity to the mixture to improve the movement of air.

It is also a normal practice in composting facilities to recycle a portion of the oversized material screened from the compost back into the initial feedstock mix. This practice reduces the overall need for fresh amendment—in this case—new woodchips. The amount of oversized material recycled back into the mixture depends on a number of factors, including particle size, moisture of incoming feedstocks, and amount of non-organic materials present in the oversized materials.

Mix calculations were developed based on a target moisture content of 60 percent. The materials balance for the weekly amount of biosolids is shown in Exhibit 6.

3.2 Feedstock/Amendment Receiving and Storage

Because of the potential for odors, the proposed facility incorporates a completely enclosed receiving and storage bay for biosolids. Biosolids would be unloaded into the storage bay through a single overhead door. The storage bay would be accessed internally from the opposite end, allowing for a “first-in, first-out” processing of material. This approach prevents older feedstocks from being covered by new receipts and accumulating for longer periods.

The receiving and storage bay would be designed to provide 1 week’s worth of dewatered biosolids cake storage. This design allows receipt of material at the facility to continue in the event that processing is disrupted (for example, by equipment malfunction or process upsets). The inclusion of storage capacity also allows receiving and processing activities to be decoupled, which provides for operational flexibility.

Building components (for example, HVAC ducting, light fixtures, electrical cables, and conduits) would be situated in a manner and a location that do not interfere with the unloading of delivery vehicles and the use of mobile equipment within in the building. A minimum interior vertical clearance of 24 feet would be provided.

3.3 Mixing

Batch mixing would be used to ensure a homogeneous blend of biosolids and amendments and to ensure distribution of moisture. No shredding or pre-screening of feedstocks or amendments would be provided.

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Exhibit 4
Site Layout

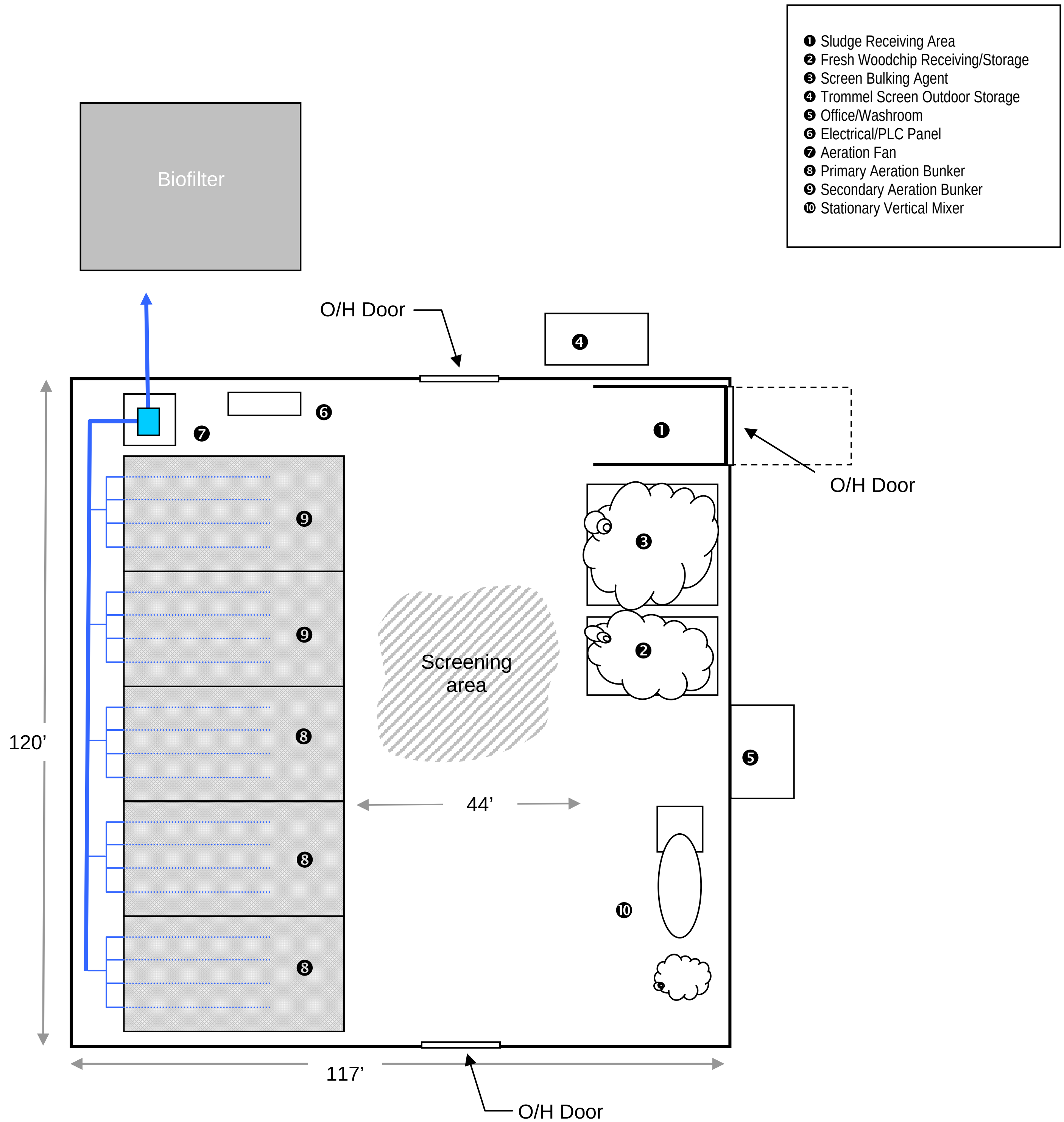

Exhibit 5
Internal Building Layout

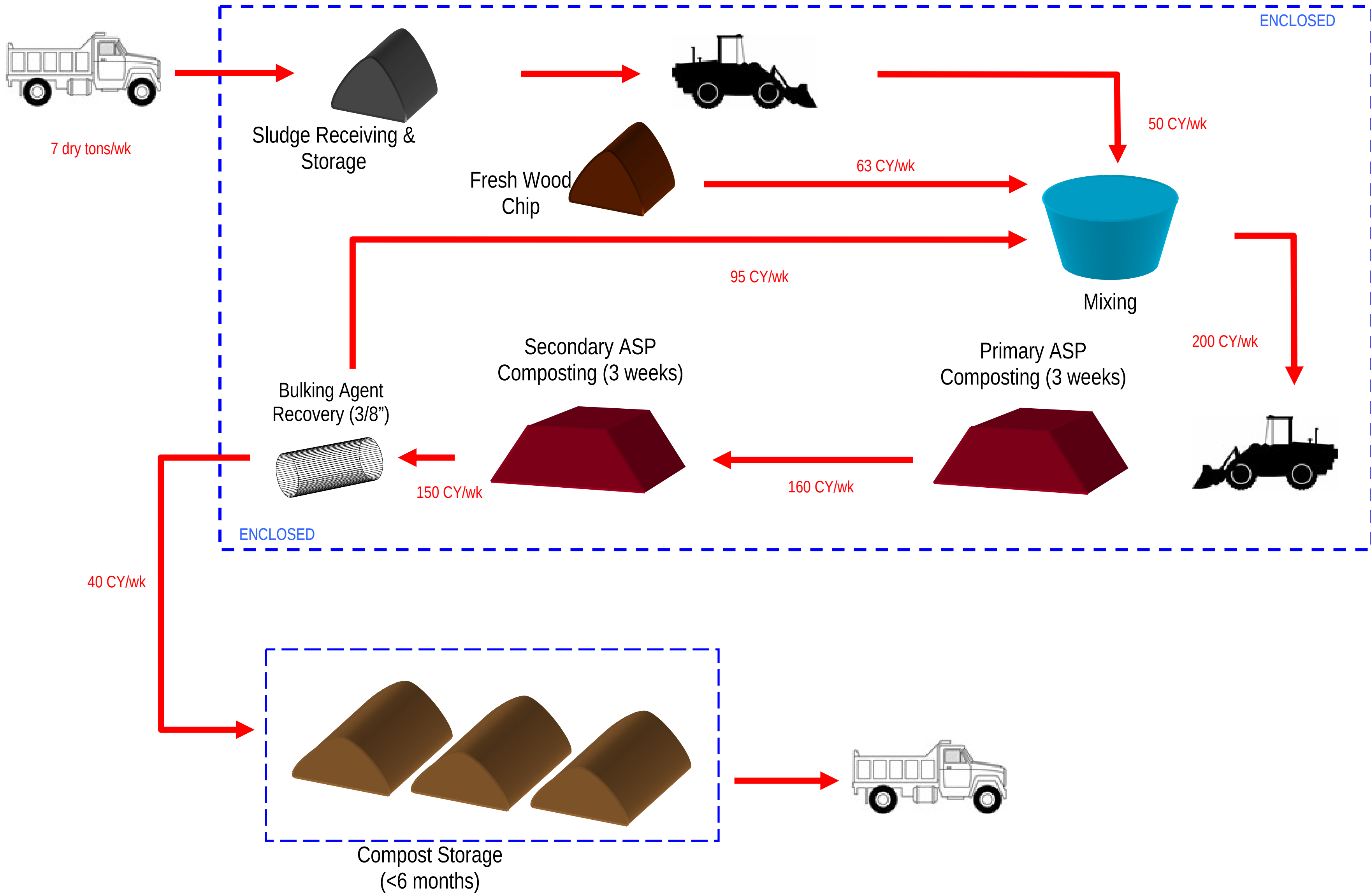

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Exhibit 6
Composting Process Flow Diagram

A wheel loader would be used to load feedstocks and amendments into a vertical auger mixer unit. The ratio of feedstocks and amendments in each batch would be based on the amounts needed to achieve optimal mix conditions: approximately 3.2 volumes of bulking agent to 1 volume of biosolids cake at the design condition. Mixing would occur within the building to allow operation in all weather conditions.

3.4 Screening/Amendment Recovery

Following composting in the ASP system, the stabilized compost would be screened to recover amendments for reuse in the composting process. Screening would also remove any oversized compost particles that may not have been fully stabilized and could lead to odors in the curing area.

Screening would be done using a small, diesel-driven, portable trommel screen equipped with 3/8-inch screens. The screening would be done indoors, with the oversized amendment materials being discharged directly into a stockpile adjacent to the biosolids receiving/storage bay.

When screening is completed, the trommel would be towed and stored outdoors.

3.5 Compost Storage

After the biosolids have been composted in the ASP composting system and screened to recover amendments for reuse, the material would require an additional 2 to 4 weeks of storage for further stabilization for high-end use markets. The conceptual design, therefore, includes an unaerated storage area. Materials would be transferred from the composting building to the storage area following screening, using a wheel loader. The storage area would be covered by a wooden roof structure erected over an asphalt pad and side walls to provide protection from rain and snow.

3.6 Compost Building Odor Control and Ventilation System

Studies at numerous ASP composting facilities have shown that the vast majority (>90 percent) of odors are generated during the active composting and curing stages. The Kodiak design provides a primary composting period for 21 days and a secondary curing period for 21 days, with continuous negative aeration from these piles. Studies at other ASP facilities have shown that by providing continuous negative aeration, greater than 95 percent of pile odors can be captured. The composting-process off-gas from the compost piles at the proposed facility would be collected and treated through an aboveground biofiltration system to remove odors.

Localized odors from biosolids receiving and mixing operations would exist, but such odors typically are not present in sufficient quantity or duration to create offsite nuisance conditions. At the proposed facility in Kodiak, biosolids received would be mixed and placed into the compost pile within 24 hours of receipt, where negative aeration would be used to capture and treat biosolids odors. This approach allows for minimizing the size of odor control handling ductwork, fans, and treatment systems, thereby minimizing capital and operation and maintenance (O&M) costs. The building air would be ventilated to atmosphere by the use of multiple blast fans in the ceiling of the structure. These fans would provide the needed ventilation rate of 6 air changes per hour within the structure. Higher air exchange rates up to 12 air changes per hour would be provided during periods when employees are accessing the building.

3.7 Odor Control Systems

Treatment of odorous air through biofiltration is the industry standard, and its success has been proven in applications around the world. An additional level of treatment can be achieved by using enclosed, "engineered" biofilters with synthetic media. However, the types of feedstocks processed and location of the proposed composting facility do not warrant this additional investment.

The biofilter at the proposed facility would consist of "traditional" design consisting of a 6-foot-deep layer of coarse wood chip overlying a concrete aeration floor. Perforated, high-density polyethylene aeration pipes would be embedded in the concrete floor to provide distribution of the process air.

The biofilter would be designed with two distinct cells, each with a capacity of 50 percent of the required total. This design allows for one cell to be taken offline (for media changes), while still providing 50 percent of the required treatment capacity. Each cell would be designed with an empty bed residence time (EBRT) of 60 seconds and would be approximately 20 feet by 40 feet. A surface irrigation system would be provided to maintain the media moisture content at the desired level.

3.8 Building Design

Two building options were evaluated for the Kodiak compost facility. The first is a standard, pre-engineered metal building with a 24-foot clear height. The internal structural steel components (for example, columns, cross-members, and roof purlins) in this building would require coating with a high-performance coating system, and periodic maintenance would be required.

The second building type considered is anodized-aluminum-framed building with tensioned polyurethane or similar fabric outer covering. These building components prevent corrosion, so painting and maintenance is minimized.

With both types of buildings, heating and building insulation would not be provided, but interior lighting would be. Exterior building walls in certain areas of both buildings (for example, areas where feedstocks, amendments, and compost are handled and stockpiled) would be designed to double as "push walls." In these areas, the building's concrete foundation wall would be constructed to a height of 4 feet, with reinforced masonry block walls extending to 12 feet.

Interior floors in both buildings would be constructed of reinforced concrete with 8-inch thickness. The compost bays would include an aeration pipe and grate system to allow aeration of the compost mass without surface piping that protrudes above the slab. Floor surfaces would be level and have a surface hardener applied.

3.9 Leachate Management

With an enclosed receiving, mixing, and composting operation, no surface water leachates would be produced.

Condensate from the compost aeration piping and biofilter piping would be collected in a leachate sump, from which it would be pumped and discharged to the sanitary sewer system.

3.10 Stormwater Management

Stormwater that has come in contact with feedstocks or has been contaminated by run-off from receiving, composting, and curing areas can be high in biochemical oxygen demand (BOD), suspended solids, and/or nutrients.

Enclosing the biosolids receiving and composting operations at the proposed facility would significantly reduce the potential for stormwater contact and eliminate the need for stormwater detention infrastructure.

Stormwater from non-operating areas outside the facility would be diverted around or away from the facility through ditches, swales, berms, or other conveyance methods. Similarly, drainage from building roofs would be controlled/diverted so that it does not enter or impede access to processing areas and buildings.

All drainage controls and conveyances would be designed such that the potential for erosion and sediment transport is minimized. Use of filter berms, bioswales, and erosion blankets constructed from compost would be incorporated into drainage controls as necessary.

3.11 Site Utilities

Potable water and natural gas service are not anticipated as being necessary at the composting facility. Potable water requirements for hand-washing can be met by using a small holding tank. Hot water requirements, and heating needs in the office area, can be met using electrical appliances.

Electrical service would also be required for the operation of the aeration system and ventilation fans. A three-phase service is anticipated, but the actual load requirements would be determined during the project's design stage.

It is not anticipated that telephone/data service would be necessary at the site. However, if remote process monitoring and alarm notification is desired, appropriate services would have to be provided.

3.12 External Working Surfaces and Roadways

Working surfaces and drive lanes in the sites outdoor areas would be designed to meet the expected wear and tear from site equipment, including wheel loaders and trucks. Although concrete and asphalt are the most desirable working surfaces, their capital costs are prohibitive. Therefore, the working surfaces would be based on the use of gravel.

3.13 Mobile Equipment Requirements

The conceptual design of the composting facility has been developed to minimize the level of automation and the need for specialized equipment. A list of mobile equipment required to support the composting operation is provided in Exhibit 7.

EXHIBIT 7
Mobile Equipment Requirements

Equipment Type	Quantity
Wheel loader (Cat 938 or equivalent)	1
Vertical auger mixing unit (Supreme 500 or equivalent)	1
Portable trommel for screening (MCB 412 or equivalent)	1

3.14 Staffing Requirements

It is anticipated that the required level of production at the composting facility can be maintained with a 3-day-per-week operating schedule. However, with the facility being remote from the WWTF, it is assumed that one additional full-time operator position is required to operate and maintain the facility. Exhibit 8 depicts the operating schedule.

EXHIBIT 8
Operating Schedule

Day	Activity
Monday	Emptying and transferring material between compost bunkers; screening
Tuesday	Dewatering at WWTP, and transferring biosolids to compost facility
Wednesday	Mixing biosolids/amendments and building composting pile
Thursday	Dewatering at WWTP, and transferring biosolids to compost facility
Friday	Mixing biosolids/amendments and finishing construction of composting pile

4 Facility Construction Cost Estimates

Two order-of-magnitude construction cost estimates were developed for the conceptual facility design, based on regional unit rates for construction costs as well as discussions with technology vendors and support equipment requirements for similarly sized facilities. Option A was developed using a pre-engineered metal building design, and Option B was developed using an aluminum-framed aluminum building design. Exhibits 9 and 10 summarize capital and equipment cost estimates, respectively.

5 Facility Operation and Maintenance Cost Estimate

Based on a weekly throughput of 7 dry tons per week of biosolids cake at 17 percent total solids, an estimate of O&M costs was developed. Exhibit 11 summarizes these estimated costs. A rate of $0.17 per kilowatt-hour was assumed for electricity, with $4 per gallon for diesel fuel. Labor rates using the City's prevailing rates for an operator assigned during 60 percent of his/her time to the composting operation were assumed. A cost of $20 per cubic yard for wood chips was also assumed for 100 percent of the bulking agent needs at the facility. This cost assumes barging from Anchorage. Maintenance costs for the mixer, front end loader, and screen were assumed based on percentage of capital equipment costs. The estimated impacts of revenue from compost sales at $12 per cubic yard are provided for comparison to a no-revenue option.

Exhibit 9 - OPTION A - Pre-Engineered Building ASP CAPITAL COST ESTIMATE				
2600 Cubic Yards per Year of Biosolids Cake Capacity				
SITE PREPARATION	**QUANTITY**	**UNIT**	**UNIT COST**	**TOTAL COST**
Site Work	1	LS	$ 7,500.00	$ 7,500.00
Earthwork	1	LS	$ 148,000.00	$ 148,000.00
Site Restoration/Security	1	LS	$ 20,500.00	$ 20,500.00
SITE PREPARATION TOTAL	**1**	**LS**	**$ 176,000.00**	**$ 176,000**
COMPOST PRE-ENGINEERED BUILDING				
Building Pad	1	LS	$ 127,860.00	$ 127,860.00
Building, 24' Clear Height	1	LS	$ 1,001,140.00	$ 1,001,140.00
Compost Bunkers and Pushwalls	1	LS	$ 207,720.00	$ 207,720.00
Office Building	1	LS	$ 30,000.00	$ 30,000.00
Access Ramps (3 @ 16 X 22)	1	LS	$ 9,720.00	$ 9,720.00
COMPOST BUILDING TOTAL	**1**	**LS**	**$ 1,376,440.00**	**$ 1,376,440**
COMPOSTING AERATION SYSTEM				
Compost & Biofilter Piping	1	LS	$ 58,290.00	$ 58,290.00
Biofilter Pad 44' x 44'	1	LS	$ 25,665.00	$ 25,665.00
Process Equipment	1	LS	$ 116,222.08	$ 116,222.08
Condensate Drainage	1	LS	$ 31,250.00	$ 31,250.00
COMPOSTING OPERATIONS AREA TOTAL	**1**	**LS**	**$ 231,427.08**	**$ 231,427**
COMPOST STORAGE SHED				
Building, Wood Truss Roof	1	LS	$ 113,500.00	$ 113,500.00
LIGHT ASPHALT Pavement	1	LS	$ 16,312.50	$ 16,312.50
COMPOST STORAGE AREA TOTAL	**1**	**LS**	**$ 129,812.50**	**$ 129,813**
MOBILE EQUIPMENT				
MOBILE EQUIPMENT	1	LS	$ 410,000.00	$ 410,000.00
MOBILE EQUIPMENT TOTALS	**1**	**LS**	**$ 410,000.00**	**$ 410,000**
Pre-Engineered Building ASP OPTION CONSTRUCTION TOTAL				**$ 1,913,680**
Contractor G&A			12.00%	$ 229,680
Contractor Home Office Support			2.00%	$ 38,280
Contractor Field Management			8.00%	$ 153,120
Contractor Fee			5.00%	$ 116,754
Project Bond			3.00%	$ 73,555
Contingency			20.00%	$ 505,078
Engineering			10.00%	$ 303,047
Construction Services			20.00%	$ 598,437
Owner Admin			5.00%	$ 143,867
Pre-Engineered Building ASP OPTION PROJECT TOTAL				**$ 4,486,000**

Mobile equipment is assumed to be separately procured by the City.

The enclosed Engineer's Estimate is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at its issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M HILL is not responsible for any variance from this estimate or actual prices and conditions obtained.
CH2M HILL is not responsible for the validity or accuracy of results due to data or inputs that have been changed from this original file without CH2M HILL knowledge or consent.

Exhibit 10 - OPTION B - Aluminum Framed STRUCTURE ASP CAPITAL COST ESTIMATE						
2600 Cubic Yards per Year of Biosolids Cake Capacity						
SITE PREPARATION	**QUANTITY**	**UNIT**	**UNIT COST**		**TOTAL COST**	
Site Work	1	LS	$	7,500.00	$	7,500.00
Earthwork	1	LS	$	148,000.00	$	148,000.00
Site Restoration/Security	1	LS	$	20,500.00	$	20,500.00
SITE PREPARATION TOTAL	**1**	**LS**	**$**	**176,000.00**	**$**	**176,000**
COMPOST PRE-SPRUNG BUILDING						
Building Pad	1	LS	$	127,860.00	$	127,860.00
Sprung Structure, 24' Clear Height	1	LS	$	453,580.00	$	453,580.00
Compost Bunkers and Pushwalls	1	LS	$	207,720.00	$	207,720.00
Office Building	1	LS	$	30,000.00	$	30,000.00
Access Ramps (3 @ 16 X 22)	1	LS	$	9,720.00	$	9,720.00
COMPOST PRE-SPRUNG BUILDING	**1**	**LS**	**$**	**828,880.00**	**$**	**828,880**
COMPOSTING AERATION SYSTEM						
Compost & Biofilter Piping	1	LS	$	58,290.00	$	58,290.00
Biofilter Pad 44' x 44'	1	LS	$	25,665.00	$	25,665.00
Process Equipment	1	LS	$	116,222.08	$	116,222.08
Condensate Drainage	1	LS	$	31,250.00	$	31,250.00
COMPOSTING OPERATIONS AREA TOTAL	**1**	**LS**	**$**	**231,427.08**	**$**	**231,427**
COMPOST STORAGE SHED						
Building, Wood Truss Roof	1	LS	$	113,500.00	$	113,500.00
LIGHT ASPHALT Pavement	1	LS	$	16,312.50	$	16,312.50
COMPOST STORAGE AREA TOTAL	**1**	**LS**	**$**	**129,812.50**	**$**	**129,813**
MOBILE EQUIPMENT						
MOBILE EQUIPMENT	1	LS	$	410,000.00	$	410,000.00
MOBILE EQUIPMENT TOTALS	**1**	**LS**	**$**	**410,000.00**	**$**	**410,000**
Aluminum Framed ASP OPTION CONSTRUCTION TOTAL					**$**	**1,366,120**
Contractor G&A				12.00%	$	163,934
Contractor Home Office Support				2.00%	$	27,322
Contractor Field Management				8.00%	$	109,290
Contractor Fee				5.00%	$	83,333
Project Bond				3.00%	$	52,500
Contingency				20.00%	$	360,500
Engineering				10.00%	$	216,300
Construction Services				20.00%	$	427,135
Owner Admin				5.00%	$	102,685
Aluminum Framed ASP OPTION PROJECT TOTAL					**$**	**3,320,000**

Mobile Equipment is assumed to be separately procured by the City

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EXHIBIT 11

Estimated Operation and Maintenance Costs

Item	Cost ($)
Annual wet tons biosolids cake = 2,150	
O&M Expenses	
Mixing	6,026
Front end loaders maintenance and repair	2,636
Diesel consumption all equipment	11,000
Electrical consumption all equipment	22,000
Screening	1,777
Staff	83,200
General repair and replacement	4,629
Bulking agent	65,520
Total O&M Expenses	**196,787**
Unit O&M cost per ton processed	**91.53**
Revenues from product sales	(25,584)
O&M cost after product sales	171,203
Unit O&M Cost Per Wet Ton After Product Sales	**79.63**

O&M = operation and maintenance