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1.   Introduction

This report addresses the "Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills," contained in Subpart WWW to 40 CFR Part 60, (referred to as the NSPS regulations) promulgated on March 12, 1996 by the United States Environmental Protection Agency (EPA) and the applicability of these requirements to the Cider Lake Landfill.

2.   Facility Historical Overview

The Cinder Lake Landfill (CLL) is located approximately 8 miles northeast of Flagstaff, Arizona (Figure 1) on land leased form the United States Forest Service (USFS). CLL is operated by the City of Flagstaff (City). The initial permit for landfill operations at the site was issued by the USFS (Permit No. 53) on December 10, 1963. Based on information from the City, municipal solid waste (MSW) landfilling began in 1965 in an area from which cinders were excavated for off-site uses.

Subsequent revisions to the land lease occurred in 1975, 1979, 1981 and 1986. The site boundary has existed in its current configuration since 1986 (Figure 2). It should be noted however that the City is in the process of acquiring additional land from the USFS for an extensive expansion adjacent to and east of the existing landfill.

2.1   Applicability of NSPS Regulations

NSPS regulations require landfills with design capacity of greater than 2,500,000 megagrams (Mg, also referred to as metric tons) to calculate NMOC emission rates to determine if the 50 Mg/year limit has been reached.   Since CLL has existed in its current configuration since 1986, it is considered to be an existing landfill and according to the NSPS regulations, CLL is subject to the schedule and requirements specified in the Emission Guidelines (EG) adopted by the State of Arizona which mirror the Federal regulation.

In 1993 Woodward-Clyde developed a closure design for the existing landfill and estimated the remaining capacity of the Cinder Lake Landfill at approximately 2.9 million cubic yards (air space). Assuming a 1200 pound/cubic yard in-place MSW density, approximately 1.58 million Mg of additional MSW can be landfilled on the current footprint. This is in addition to the landfill material in place. Therefore, an estimation of in-place tonnage is necessary to determine if the existing landfill exceeds the 2.5 million Mg design capacity threshold.

3.   Design Capacity of the Existing Landfill

3.1   Methodology

Files provided by the City were reviewed to evaluate the quantity of MSW disposed at CLL since its opening. The documents reviewed included:

- Summary of file and document information prepared by City staff

- Records of tonnage received at the landfill since 1985 (when the scale was installed)

- Various memos, letters, correspondences and documents related to landfill leases, design and operations dated between 1969 and 1991

- Slides illustrating landfill operations dated 1982, 1984 and 1987

- Site development plot plans dated May 1976, January 1980, July 1986 and July 1988

- Land lease survey plots dated October 1963, December 1975, January 1979 and February 1986.

A chronology of events related to the development of CLL is summarized in Table 1. This information was compiled in order to develop estimates related to the in-place MSW tonnage in CLL. Additionally, City of Flagstaff and Coconino County population data for the period between 1960 and 1996 were collected in order to evaluate general historic per capita disposal rates.

3.2   Historical Development and Operations of the Cinder Lake Landfill

The 1963 lease area for the CLL is shown on Figure 3. Based on the records reviewed, it appears that the for the first two years the site was used as a borrow source for cinders. MSW landfilling likely began in 1965. Additions to the leased area occurred in 1975, 1979, 1981 and 1986 as shown on Figures 4, 5, 6 and 7 respectfully.

From 1965 to the mid-1980s a dragline was used to excavate soil from trenches. The trenches were then filled with MSW. Trenches ranged from 60 to 80 feet in width and were approximately 25 to 35 feet deep. MSW was dumped into the trenches with only minor compaction. In the early 1980's City engineers estimated in-place MSW density of 500 pounds/cubic yard at CLL. One of the site development plans reviewed show the configuration of trenches on portion of the site, including an area that was filled between September 21, 1975 and May 4, 1976. The annualized MSW tonnage for this area assuming 30-foot deep trenches and a MSW density of 500 pounds/cubic year is 20,833 tons/year.

In 1985 a compactor was purchased and in 1990/91 a scrapper and D-8 were purchased to replace the dragline operation. At that point, trenching was discontinued and the landfill operation became a cut and cover operation. A 1,000 pound/cubic yard MSW density was estimated by landfill operations personnel. Beginning in fiscal year (FY) 1985/86 the City collected and compiled MSW tonnage data for CLL.

3.3   Estimating In-Place Tonnage

Actual tonnage data is only available from 1985. However as indicated above, site files contain information that allows an engineering estimate of annual tonnage for one other time period; 1975/76. This data is presented in the Documented Disposal Rate column on Table 2. Pre-1985 tonnage were estimated using three general strategies. The data points were plotted using an

XY scatter pattern and a linear regression/trend line was generated for the XY scatter pattern (see Figure 8). The slope of the trend line was then used to calculate pre-1985 estimated annual tonnages. These values are shown on Table 2. Using this approach, the in-place tonnage at the end of FY 1995/96 is estimated at 2,613,271 tons.

A second strategy for estimating in-place tonnage starts with a conservative assumption that 1975/76 tonnage of 20,833 tons also represents annual tonnage for the ten previous years. Tonnage from 1975 to 1985 was then increased linearly, along the trendline, using the equation shown on Figure 9. Actual tonnage data was used for 1985 to 1996. Using this approach, the in-place tonnage at the end of FY 1995/96 is estimated at 2,275,870 tons.

A third approach to estimating in-place tonnage uses population data and a per capita waste disposal rate to estimate 1965 to 1985 disposal tonnage. Figure 10 illustrates that the per capita disposal rate at CLL increased at a faster rate than the population of the City. This is likely due to both a general increase in the per capita waste generation rate seen throughout the United States during this period and the fact that four other county disposal sites closed during this period. The tons/year per capita rate estimated is shown on Table 2. It should be noted that these number are artificially high in that the disposal rate for CLL reflect waste from both the City and the portions of the county served by CLL while the population numbers reflect only the City's population. Data points showing the annual disposal rate versus population are shown on Figure 11. A linear trend line was generated (see Figure 11) providing an equation that represents the relationship between population and waste disposal rates. Annual tonnage rates based on this per capita tonnage trendline are shown on Table 2. Using this approach, the in-place tonnage at the end of FY 1995/96 is estimated at 2,530,529 tons.

The average of the result of the three approaches is 2,473,223 tons and this number is used as the estimated in-place tonnage for NSPS-related analysis. Average annual and in-place tonnages are shown on Table 2. The in-place MSW at the end of FY 1995/96 is estimated to be 2,243,670 Mg.

The average annual acceptance rate since 1965 is 72,376 Mg/per year (79,780 tons/year).

3.4   Design Capacity

The design capacity of CLL can be calculated by adding the estimated in-place tonnage to the available tonnage capacity of the existing landfill. As described above, the estimate remaining capacity in 1993 was 1.58 million Mg. The estimated in-place tonnage at the end of fiscal year 1992/93 was 1.89 Mg. Therefore, the total design capacity of CLL is estimated to be 3.47 million Mg. Since this capacity exceeds the 2.5 million Mg threshold, a calculation of the NMOC emission rate is required by 40 CFR Part 60 § 60.752(b).

4.   NMOC Emission Rate Calculations

4.1   Tier 1

In the NSPS regulations, the EPA established Tier 1 default values to calculate whether the NMOC concentration is above the threshold level for control requirements of 50 Mg/yr. The values used are 0.05 per year for k (methane generation rate constant, year^{-1}), 170 cubic meters per megagram for L_O (methane generation potential, cubic meters per megagram solid waste), and 4,000 parts per million by volume as hexane for the C_{NMOC}.

The default values for Tier 1 analysis were used in the equation specified for landfills with an unknown annual acceptance rate shown on Table 3. The results indicate an emission rate of 279.1 Mg/yr.

Based on information from the US EPA, since the average rainfall in the area of the Cinder Lake Landfill area is approximately 17.3 inches, the site qualifies as an arid region and a k value of 0.02 may be used instead of the default. Table 4 shows that the estimated emission rate using the arid region k value is 163.7 Mg/yr.

As indicated by the EPA in the NSPS Final Rule, the Tier 1 default values of k, Lo, and C_{NMOC} tend to overstate NMOC emission rates for most landfills, and are intended to be used to indicate the need to install a collection and control system or perform a more detailed Tier 2 analysis. Since the default value of 4,000 parts per million by volume as hexane for the C_{NMOC} is considered conservatively high for landfills in general, and especially landfill in the southwest, a Tier 2 analysis was conducted to obtain site-specific C_{NMOC} data.

4.2   Tier 2

Tier 2 sampling was conducted at CLL between May 6 and May 10, 1997. Tier 2 regulations require landfill owner or operator to determine the NMOC concentration by installing at least two sample probes per hectare of landfill surface that has retained waste for at least 2 years, with a maximum of 50 samples. The sample probes should be located to avoid known areas of nondegradable solid waste.   Since the area of CLL where waste has been in place is approximately 110 acres (44.5 hectares), 50 samples were collected.

4.2.1   Sampling Methodology

Tier 2 sampling was conducted by staff from Woodward-Clyde and PCR Laboratory Field Services (PCR).   A sampling plan with a grid pattern was developed for the sampling. Long stakes were place at various locations on the landfill and were used as reference points to identify the approximate sampling locations. Samples were collected using a Geoprobe™ direct-push sampling probe as an alternative sampling methodology to prescriptive sampling techniques (pilot probe and auger procedures). This alternative sampling methodology was approved by both the EPA and the Arizona Department of Environmental Quality in February 1997.

Once the probe was in place at each location, a sample was extracted and screened using field screening instruments (e.g. combustible gas analyzer) to verify that landfill gas was being extracted. Upon verification that landfill gas was encountered at each location, a sample was collected in the SUMMA canister. Samples from 5 probes were composited into 6-liter stainless steel SUMMA canisters with equal volumes taken from each sample probe in accordance with the regulations. All samples were collected at a depth of 6 feet. Figure 12 shows the location of the samples collected for each canister. The canisters were delivered to Performance Analytical Inc. (Arizona Department of Health Services License AZ0550) under chain of custody and were analyzed using Method 25C as described in the NSPS regulations. Copies of the field sampling logs, chain of custody forms and analytical results are provided in Appendix A.

4.2.2 Analytical Results

The compiled analytical results and field data are shown on Table 5. The analytical results for the duplicate, field blank and method blanks are all within acceptable laboratory quality assurance/control parameters. The NMOC concentrations (ppm as hexane) range from a low of 60 ppm to a high of 260 ppm. Canister 163 had the lowest concentration of NMOC. However, this sample exceeded both the 20% nitrogen limit specified in the NSPS regulations and the 2% oxygen limit provided as guidance from the US EPA. The results from this sample were considered invalid and were not included in the calculation for determining the average C_{NMOC}. The remaining samples were used to calculate the average C_{NMOC} of 629.3 ppm as shown on Table 5.

It should be noted that though canisters 26 and 266 also exceeded the 20% nitrogen limit, since these samples contained less that 2% oxygen, these samples were considered acceptable based on guidance from Foston Curtis at US EPA headquarters. For comparison purposes, the average C_{NMOC} was calculated excluding these samples. The resulting C_{NMOC} was 620.3 ppm.

4.3   Calculated NMOC Emission Rate

The C_{NMOC} value of 629.3 ppm was used in the equation for estimating NMOC emissions in arid regions (see Table 6). As shown on Table 6, the calculated NMOC emission rate is 25.8 Mg/year. For comparison purposes, the estimated NMOC emissions were also calculated using the prescribed default k value of 0.05. The resulting emissions estimate was 43.9 Mg/year.

Based on these results, a landfill gas collection system is not required at this time. The emission estimates will be recalculated on an annual basis and Tier 2 sampling will be conducted in 2002 (5 years) as required by the NSPS regulations.

4.3.1 Future Emission Projections

Estimates of future NMOC emissions were calculated using EPA's Landfill Air Emissions Estimation Model (version 1). It should be noted that this future estimate contains a level of inaccuracy because the annual acceptance rates are not available for most of the landfill's operating life. The annual acceptance rate extrapolations shown in Table 2 were used as input

for the model for this estimate. The results, shown on Table 7 and displayed graphically on Figure 13 indicate that a maximum estimated emission rate of 41.1 Mg/year will occur in 2005.

5.   Summary

Historical files from the City of Flagstaff were reviewed to estimate the design capacity for the Cinder Lake Landfill. The design capacity is estimated to be 3.47 million Mg. This design capacity exceeds the 2.5 million Mg capacity in the NSPS regulations (40 CFR § 60.752b), requiring an NMOC emission estimate.

A Tier 1 NMOC emissions evaluation was conducted using default values, and the results indicated a NMOC emission rate of 279.1 Mg/year. Based on discussions with the US EPA, the Tier 1 evaluation was also conducted using the modified k value for arid regions (0.02) and the resulting NMOC emissions estimate was 163.7 Mg/year. Since the estimated Tier 1 emission rates exceed the 50 Mg/year regulatory threshold, a Tier 2 emissions rate evaluation was conducted.

Tier 2 sampling consisted of collecting landfill gas samples from 50 locations at CLL. These samples were analyzed for NMOC, nitrogen and oxygen. The resulting average $C_{(NMOC)}$ was 629.3 ppm. This $C_{(NMOC)}$ value was used to replace the default value of 4000 ppm $C_{(NMOC)}$ in recalculating the estimated NMOC emission rate from the site. The resulting NMOC emission rate is 25.8 Mg/year. Since this value is below the 50 Mg/year threshold, a landfill gas collection system is not required at this time. The NMOC emission rate is required to be recalculated annually and Tier 2 sampling will need to be conducted again in 2002 (5 years).

Appendix A

- Field Sampling Logs

- Chain of Custody Forms

- Analytical Results