SOIL AND AIR MONITORING IN THE VICINITY OF A MUNICIPAL SOLID WASTE INCINERATOR. PART II: AIR MONITORING

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1. Introduction: The Columbus Municipal Waste-to-Energy (Columbus WTE) facility in Columbus, Ohio, began operation in June, 1983 and ceased operation in December, 1994. The facility is equipped with 6 boilers, 3 stacks, and utilizes hot-side electrostatic precipitators (ESP). The incinerator processed an average of 1600 metric tons of solid waste per day during its operation. A stack test taken in 1992 indicated that the emission rate of dioxin toxic equivalents (TEQs) from the incinerator was $3.12*10^{-5}$ g TEQ/sec[1], which translates to an annual emission of 984 g TEQ. Process modifications were undertaken in 1994 to reduce the flow volume of gas and the concentration of dioxin in the gas. A stack test taken after these modifications were completed[2] indicated that the annual release of TEQs was reduced to 267 g/yr. To put these emission estimates in perspective, they are comparable to the 560-1100 g TEQ/yr estimated to be emitted annually from all sources in England[3], 659-850 g TEQ/yr in Belgium[4], and 67-926 g TEQ/yr in West Germany[5]. This was the largest single source identified in the literature, and because of the this, the expectation is that there would be a strong potential to detect source impacts to soil and ambient air. This paper presents air monitoring results and a companion paper[6] presents soil monitoring results for sampling in the vicinity of the Columbus WTE.

2. Background: Figure 1 shows the location of 22 soil sample points surrounding the incinerator. Also shown in Figure 1 are the location of air monitoring stations which were part of a study of ambient air quality study done by the Ohio Environmental Protection Agency (OEPA).[7,8] Three additional soil samples were taken 28 miles away in a rural setting which was a site selected in the air monitoring study as a "background" site[7].

The prevailing wind direction was from southwest to northeast. The northeast was expected to be the quadrant most impacted by emissions from the Columbus WTE, and this explains the higher density of soil and air sampling in this direction from the incinerator. In general, the objective of both the air and soil sampling discussed in this paper is to obtain information on air and soil concentrations in areas expected to be most impacted by emissions from the Columbus WTE, as well as other locations in the city of Columbus and a background

setting.

The air monitoring studies are described in OEPA[7,8]. Six monitors were in the city of Columbus between 1.6 and 4.0 km (1-2.5 miles) from the site, mostly in the downwind direction but one in the upwind direction. A seventh sampler was located 28 miles upwind at the same location as the background soil sample. Samples were taken in March and April, 1994, while the incinerator was operating, and in June of 1995, when the Columbus WTE was shut down. General Metal Works model PS-1 high volume samplers were used to collect 48-hr samples. Concentrations were, therefore, total concentrations (vapor + particle phases).

3. Results: Congener profiles shown in Figures 2 through 4 describe the fraction of the total concentration which can be attributed to each of the congeners. For consistency, all y-axes display fractions to 0.15, with higher fractions indicated when needed. *It should be understood that the "total" concentration, as used throughout this paper, is simply the sum of the 17 toxic congener concentrations; it is not the sum of the congener group concentrations, as others have defined "total".*

Figure 2 shows congener concentration profiles of the stack emission test in 1994[2] (2a) compared to air monitoring which occurred in 1994[7] (2b,c,d). Six samples (5 in Columbus and the background sample) were taken on March 15-17, 1994, which corresponds to the precise time that the stack emission test was occurring, Mar. 16-18, 1994. Six more air samples were taken in April, 1994. The seven samples taken 1995[7] (six in Columbus and one background sample) occurred after the incinerator shut down. Figure 3 shows the average congener profiles of the highest 2 (3a) and lowest 2 (3b) air concentrations found in the 1995 air samplings. Figure 4 shows the congener concentration profiles of the four clusters of soil samples: the "on-site", "off-site", "urban", and "background". These clusters were described in the companion paper to this one.[6]

From Figures 2-4, the following is observed:

1. Air concentrations were higher in 1994 when the Columbus WTE was operating as compared to 1995 when it had shut down, as evidenced by: a) higher average urban concentrations - the average TEQ concentrations for the March and April, 1994 samplings were 0.067 (n=6) and 0.118 pg TEQ/m^3 (n=6), respectively, in the city of Columbus, compared to 0.049 pg TEQ/m^3 (n=7) found in June, 1995, b) the 1995 "high" air concentrations are lower than in the 1994 "high" air concentrations: 0.09 pg TEQ/m^3 (2.4 pg total/m^3; n=2) in 1995 versus 0.26 pg TEQ/m^3 (5.3 pg total/m^3; n=2).

2. As seen in Figure 2, the average congener profile of the two "high" air concentrations (Figure 2b) is very similar to the stack test which occurred in 1994 (2a). These similarities include: a) four predominant congeners - 1234678-HpCDD, OCDD, 1234678-HpCDF, and OCDF, which contribute 10% or more of the total concentration, b) similar contributions from the two most predominant congeners: above 30% for OCDD and around 20% for 1234678-HpCDF, and c) contributions less than 5% for other individual congeners. These two highest air samplers were found in the downwind direction from the Columbus WTE. Samplers located in the least predominant wind direction from the Columbus WTE during the 1994 sampling measured the two lowest air concentrations. The average air concentrations of these two "low" locations, as well as the profiles (3c), are very similar to the average background air concentration and profile (3d).

3. The two highest air concentrations in 1995 were not in the predominant downwind direction from the Columbus WTE. However, the 1995 high congener profile (Figure 3a) is fairly similar to the 1994 high congener profile (Figure 2b): a) high peaks at the four congeners mentioned above with OCDD at greater than 30%, and b) contributions less than 5% from

congeners other than these four.

4. In contrast to this congener profile pattern of "high" air concentrations, the "low" air profiles in the city of Columbus (Figure 2c from 1994 and Figure 3b from 1995) and the background air profile (Figure 2d) are dominated by OCDD, with contributions above 60%, with, relatively speaking, secondary peaks from 1234678-HpCDD, 1234678-HpCDF, and OCDF. All other congeners in this low profile contribute generally less than 2% to the total concentration.

5. Perhaps most significant is that the Columbus urban (not including the on-site cluster) and rural soil has a profile that better matches this latter "low" air profile rather than the "high" profile. Except for the "on-site" profile (Figure 4a), the other three profiles (Figures 4b,c,d) are dominated by OCDD, with contributions of 81% to total concentration, with secondary contributions from the three other congeners just mentioned for the low air concentrations. All other congeners in the soil profile contribute less than 1% to the total concentrations.

4. Discussion: The Columbus WTE had a measurable impact to air quality as indicated by the analyses above: the similarity between the 1994 stack test and the 1994 high air concentrations, the fact that the 1994 high air concentrations were found in the downwind direction from the Columbus WTE, and the fact that there were lower air concentrations taken in 1995 as compared to 1994. Interestingly, "high" air concentrations taken in 1995 after the Columbus WTE ceased operation appear to have a similar profile as the "high" air concentrations in 1994. This suggests that there are other sources impacting air quality in the city of Columbus. Of particular note, the urban soil, despite being near a major dioxin source, the Columbus WTE, and possibly other sources in the city of Columbus, appears to have a profile similar to the low air concentrations measured in this study. One might have expected, instead, a soil profile similar to a "high" air concentration profile.

References

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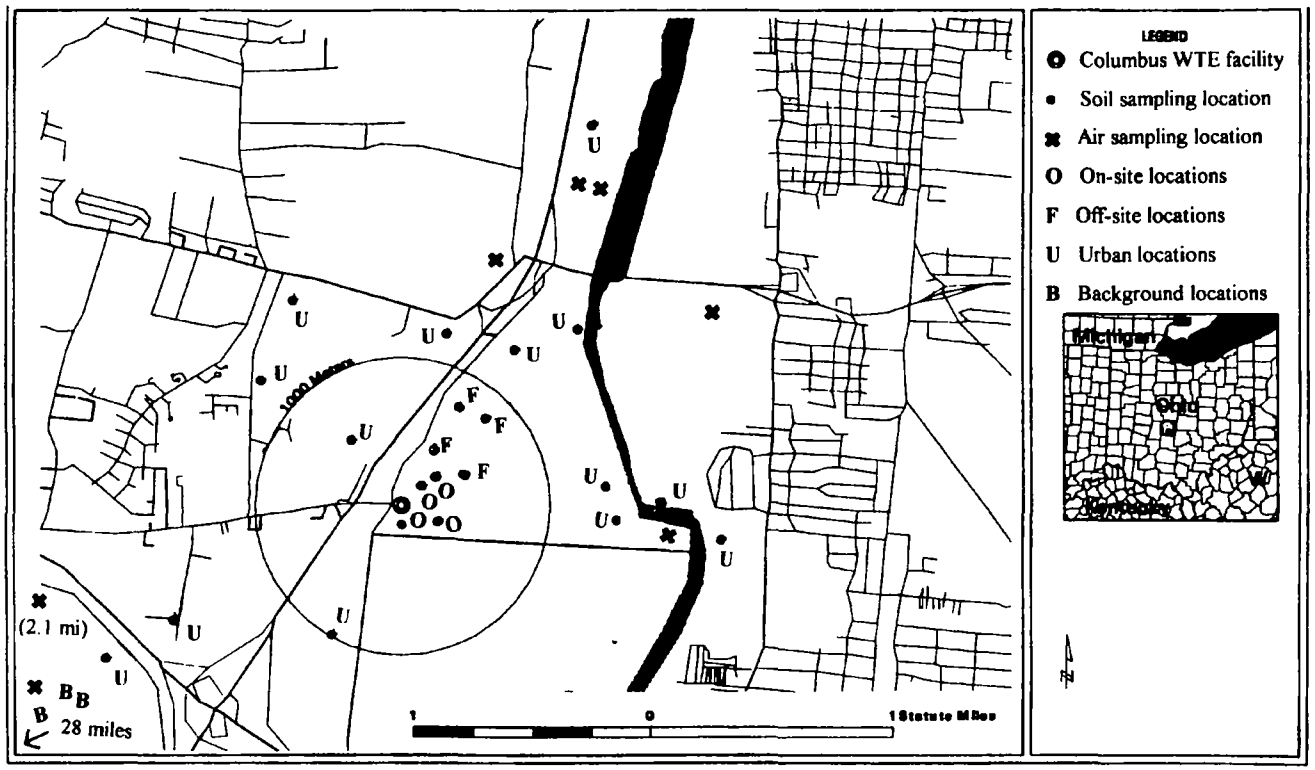
Figure 1. Columbus WTE site including soil sampling and air sampling sites.



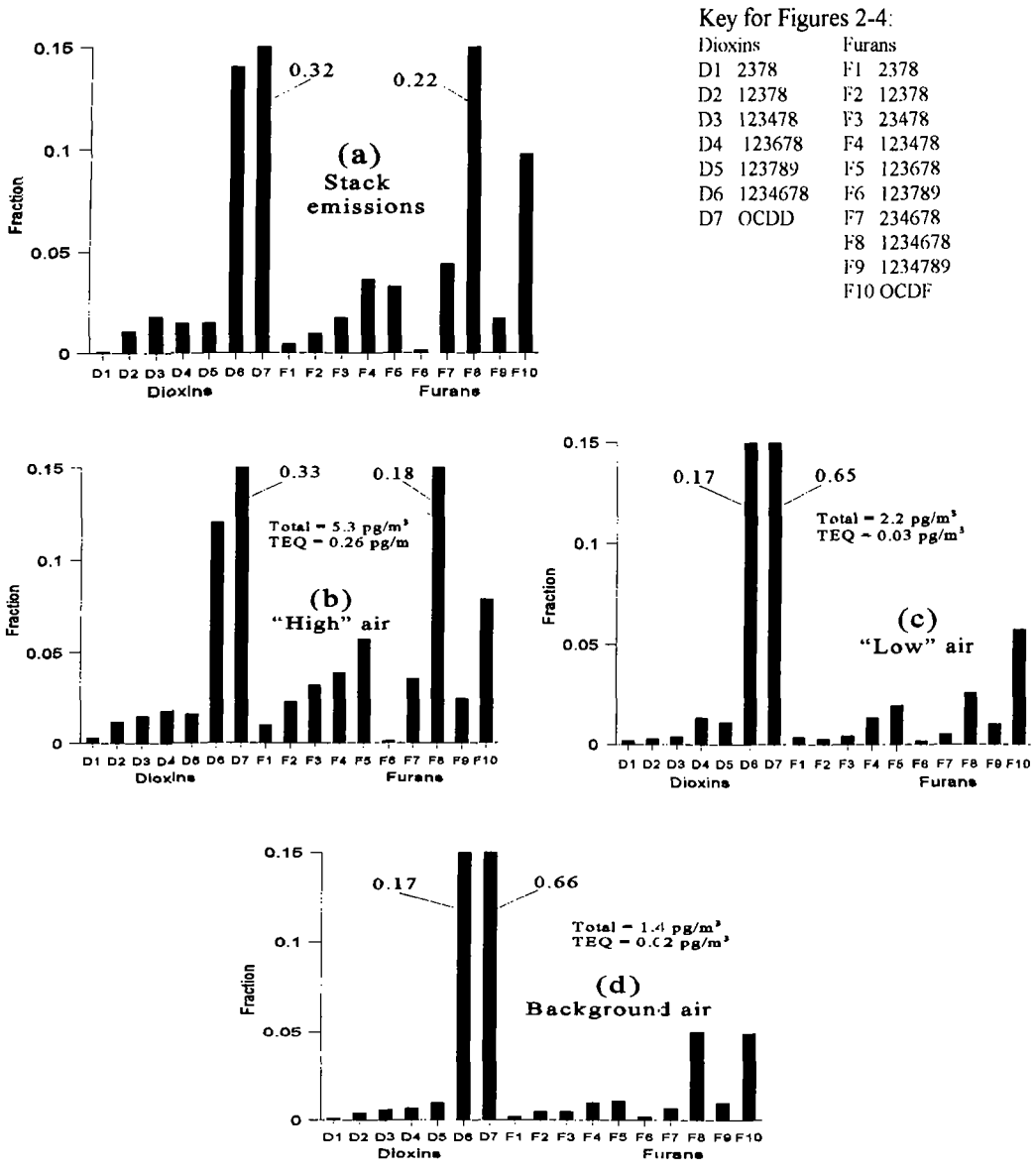


Figure 2. Congener profiles for (a) stack emissions from the 1994 stack emission test[2] (b) the highest air concentrations measured in the ambient air sampling in 1994[7], (c) the lowest air concentrations measured in the ambient air sampling in 1994[7], and (d) the background air sampling[7,8] (Note: "total" is defined as the sum of the concentrations of the 17 toxic congeners).

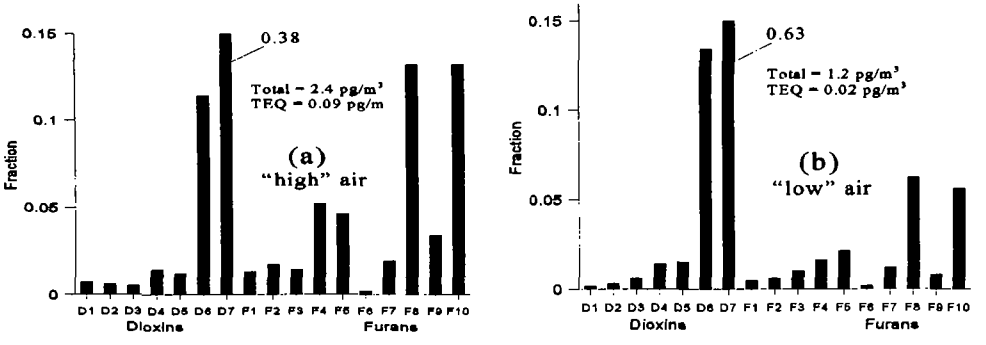


Figure 3. Congener profiles for (a) the highest two air concentrations taken in the 1995 ambient air monitoring study[7] after the Columbus WTE had closed, and (b) the lowest two air concentrations taken in the 1995 ambient air monitoring study[8] (note: "Total" is defined as the sum of the concentrations of the 17 congeners).

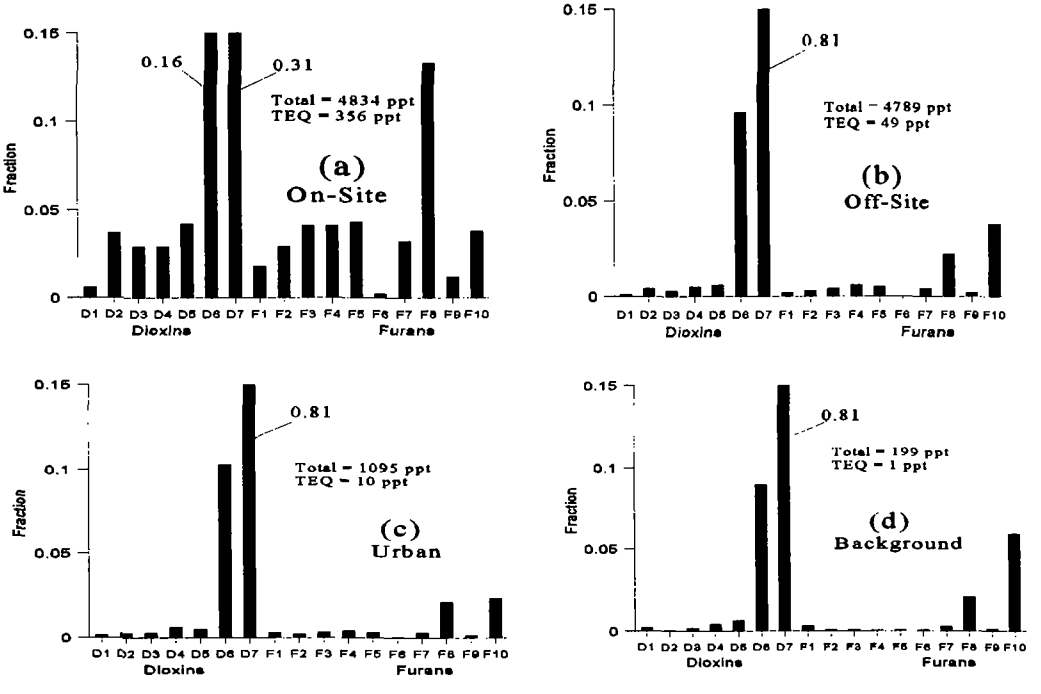


Figure 4. Congener profiles for soil sampling for (a) the "on-site" cluster , (b) the "off-site" cluster, (c) the "urban" cluster, and (d) the "background" cluster (note: "Total" is defined as the sum of the 17 congener concentrations. See the companion paper to this one[6] for more detail on the soil sampling.)