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Division of Republic Waste Services of Ohio
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June 4, 2007

Robert Hodanbosi, P.E.
Chief, Division of Air Pollution Control
Ohio Environmental Protection Agency
Lazarus Government Center
P.O. Box 1049
Columbus, OH 43216-1049

Re: Countywide Recycling & Disposal Facility Air Model
Toward Order 5.A of March 28, 2007 Directors Findings and Orders

Dear Mr. Hodanbosi:

As requested by the Agency in Bryan Zima's letter of March 28, 2007 to Jason Perdion (Baker & Hostetler) and clarified in your letter of May 15, 2007 to Todd Hamilton (Countywide), our consultant Lawhon & Associates performed air dispersion modeling to identify expected locations of maximum impact from the landfill. The purpose of the air modeling is to provide information for the selection of one or two locations to serve as "fixed" monitoring sites to evaluate potential exposures to the surrounding community.

In all scenarios, the maximum modeled impact occurred at or near the property boundary of the landfill. For all scenarios except one, the maximum modeled impact occurs on the eastern boundary of the landfill in what is currently a wildlife area. There are no human receptors in the area of maximum modeled impact. In fact, the modeling shows only slight potential impact to any area with residences.

Based on the results of the modeling, we suggest placing one monitoring station near Deuber Avenue to the east of the landfill to provide a monitoring location downwind of the prevailing westerly winds, and upwind of some residences.

We would appreciate the opportunity to discuss the results of the air model and the subsequent selection of the "fixed"" monitoring location with your staff at their earliest convenience.

Sincerely,

Tim Vandersall, P.E.
General Manager

Cc: Jason Perdion, Esquire, Baker & Hostetler LLP
Bryan Zima, Esquire, Ohio EPA Legal
Ed Gortner, OEPA, Central Office
Bill Skowronski, OEPA-NEDO
Kirk Norris, SCHD
Dan Aleman, CHD
Todd Hamilton, CWRDF
Jason Perdion, B&H
Michael Beaudoin, Earth Tech

Countywide Recycling & Disposal Facility
Air Dispersion Modeling

June 4, 2007

To Fulfill the Requirements Set Forth in Order 5.A. of the Ohio EPA Director's Findings and Orders Dated March 28, 2007

Republic Services of Ohio II, LLC
Countywide Recycling & Disposal Facility
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Introduction

Air dispersion modeling was performed at the Countywide Recycling & Disposal Facility located north of Bolivar, Ohio in Stark County. The purpose of the modeling was to provide information on the locations of expected maximum concentrations due to air emissions from the facility. This information will be used in selecting one or more monitoring sites. This modeling analysis was done to fulfill requirements set forth in Order 5.A. of the Ohio EPA Director's Findings and Orders dated March 28, 2007.

This report presents the technical approach that was followed in performing the required air dispersion modeling as well as the modeling results. The report is organized into sections that describe the model used, the location of the site being modeled, source parameters, Good Engineering Practice (GEP) stack height/building downwash considerations, modeling scenarios, terrain data, meteorological data, receptor locations, and results. Figures are located at the end of the document. In figures showing receptor locations or modeling results, the numbers along the left side and bottom are Universal Transverse Mercator (UTM) coordinates.

Modeling was done following the procedural policies of USEPA (USEPA 2005a) and Ohio EPA (Ohio EPA 2003). With some exceptions, the modeling was done as described in the modeling protocol (Lawhon, 2007) that was approved by Ohio EPA in a letter from Robert Hodanbosi, P.E., Chief of the Division of Air Pollution Control to Todd Hamilton, P.E., General Manager of Countywide RDF (Hodanbosi, 2007). Exceptions to the protocol methodology were made in response to Ohio EPA comments (Hodanbosi, 2007) and to correct errors or eliminate computational problems. All methodology changes are clearly noted throughout the report in text boxes labeled Protocol Exception. Modeling input and output files for this project will be supplied on compact disc.

Model Selection

Modeling was done using AERMOD (07026), which is the model currently recommended by USEPA and Ohio EPA for regulatory use (USEPA 2005a). AERMOD is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources, including point, area, and volume sources (USEPA 2004a, 2006a). The Lakes Environmental software package ISC-AERMOD View (version 5.6.0) was used to prepare the AERMOD input files and process output data for presentation. Current versions of the USEPA AERMAP and AERMET programs were used to process some of the input files for AERMOD. The use of these programs is discussed below in sections describing terrain and meteorological data.

AERMOD was run in its default, regulatory mode to compute ground-level air concentrations. Deposition was not considered.

Location

As shown on Figure 1, the facility is a landfill located just east of Interstate 77 and approximately 2 km north of Bolivar, Ohio. Terrain in the area around the landfill is hilly. Much of the surrounding land is undeveloped farmland with small forested areas scattered within, and the remainder is primarily residential. Several residences are located nearby. As shown in Figure 1, the area within 3 km of the site is predominantly rural for modeling purposes.

Source Description

The facility is a municipal solid waste landfill. The entire landfill is approximately 258 acres, but the modeling addresses 88 acres of the older permitted section and 38 acres of the expansion section where the odor-causing chemical reaction is believed to be taking place. Thus, the model addresses a total of 126 acres of the 258 landfill. An aerial map of the site showing property lines and the landfill area is shown on Figure 2. The landfill area is divided into cells as shown on Figure 3. Landfill cells 1 through 6A constitute the original landfill area. Cells 7 and 8A have been used more recently, and the remainder of the cells will be used in the future. In addition to the landfill cells, seven flares are used to burn off landfill gas from the gas collection system. Of these seven, three are used as backup flares and only

Protocol Exception

The list of flares to be modeled was modified to reflect information from Republic Services that flare #3 is no longer operated and that flares #2 and #5 do not operate unless other flares fail. Thus, only the four flares that normally operate were modeled. These changes are reflected on Table 1 and Figure 3.

and come on line in case other flares fail or undergo maintenance. For this study, only the four flares that are routinely operated were modeled. All the modeled sources are listed in Table 1 and shown on Figure 3.

In Table 1, landfill cells are designated as the source type AREAPOLY, which is the AERMOD designation for an area source that is non-rectangular. Both area sources were modeled with release heights set to zero and with initial vertical dispersion parameters also equal to zero.

Table 1. Summary of modeled sources

Source ID	Description	Source Type
SCEN1	Affected Area: Cells 1, 3, 4A, 4B, and 6A	AREAPOLY
SCEN2	Cells 1, 2, 3, 4A, 4B, 5A, 5B, 5C, 5D, 6A, and 7	AREAPOLY
FLARE1	Flare Station #1	POINT (flare)
FLARE4	Flare Station #4	POINT (flare)
FLARE6	Flare Station #6	POINT (flare)
FLARE7	Flare Station #7	POINT (flare)

Protocol Exception

Individual cells shown in the protocol were replaced with combined area sources in response to comments from Ohio EPA (Hodanbosi, 2007).

As noted in Table 1, the flares are modeled as point sources. Because flares have open flames instead of a typical stack exhaust, "equivalent" point source parameters were assumed or computed for modeling purposes using the following procedure (Ohio EPA, 2003):

1. Compute the equivalent release height from

$$\text{Height}_{\text{equiv.}} = \text{Height}_{\text{actual}} + 0.944(Q)^{0.478} \quad (1)$$

Where the heights are in units of meters and Q is the heat release rate in MMBtu/hour.

2. Assume temperature of 1273 K.

3. Assume exit velocity of 20 m/s.

4. Compute the equivalent diameter in units of meters from

$$\text{Diameter}_{\text{equiv.}} = 0.1755(Q)^{0.5} \quad (2)$$

Values for Q were computed from flare design flow rates using the following equation:

$$Q = \text{Flow} \times \text{HV} \times 60 / 1{,}000{,}000 \quad (3)$$

Where Flow = design flow rate through flare in units of standard cubic feet per minute (scfm)

HV = heat content in units of Btu/scf of landfill gas, taken as 200 Btu/scf based on the average measured values for January through March, 2007.

The constants convert units from Btu/min to MMBtu/hr.

Substituting the value for HV and simplifying yields

$$Q = 0.012 \times \text{Flow} \quad (4)$$

Values for modeling parameters for the flares are listed in Table 2.

Table 2. Flare specifications used for modeling.

Source ID	Flow (scfm)	Q (MMBtu/hr)	$Height_{actual}$ (m)	$Height_{equiv}$ (m)	Velocity (m/s)	Temperature (K)	$Diameter_{equiv}$ (m)
FLARE1	3,000	36.0	10.1	15.29	20.0	1273	1.05
FLARE4	3,014	36.2	13.1	18.30	20.0	1273	1.06
FLARE6	2,100	25.2	10.2	14.57	20.0	1273	0.88
FLARE7	3,014	36.2	13.1	18.30	20.0	1273	1.06

Good Engineering Practice (GEP) Stack Height/Building Downwash

No buildings are located near enough to the flares to need to be included in the modeling. Therefore, GEP stack height and building downwash are not important in this study.

Modeling Scenarios

As specified in Zima (2007), the following three source scenarios were modeled: (1) Cells 1 through 6A, (2) the entire landfill area, and (3) the flares. For all scenarios, both 24-hour and annual averaging times were modeled. Sources and emission rates modeled in each scenario are described below.

Scenario 1 (Affected Area)

In this scenario, landfill Cells 1, 3, 4A, 4B, and 6A were modeled as a single area source. A surrogate emission rate of 1 millionth of a gram/second/square meter (10^{-6} g/s/m^2) were used for all sources.

Scenario 2 (Cells 1-7)

In this scenario, landfill cells 1, 2, 3, 4A, 4B, 5A, 5B, 5C, 5D, 6A, and 7 were modeled as a single area source. As in Scenario 1, the source was modeled using a surrogate emission rate of 10^{-6} g/s/m^2.

Scenario 3 (Flares)

In this scenario, only the flares listed in Table 2 were included in the modeling. As directed in Zima (2007), each flare was modeled using a surrogate emission rate of 1 g/s.

Protocol Exception

- The definitions of which landfill cells to include in Scenarios 1 and 2 and how they were to be modeled (individual cells vs. all cells grouped into a single area source) were changed from the protocol in response to Ohio EPA comments (Hodanbosi, 2007).
- The surrogate emission rate used in modeling area sources was reduced from the 1 g/s/m^2 proposed in the protocol and suggested in Ohio EPA comments to (10^{-6} g/s/m^2 in order to prevent numerical format errors in the output files and to produce output concentrations in a more convenient numerical range for plotting purposes.

Meteorological Data

National Weather Service (NWS) meteorological data for the years 1986 through 1990 were used in the modeling analysis. These are the most recent five years of data available on the USEPA's SCRAM internet site. Surface data for the Akron/Canton Airport (station 14895) and upper air data for the Pittsburgh Airport (station 94823) were obtained from the internet site http://www.webmet.com/ and processed for use in AERMOD using the preprocessing program AERMET (06341) (USEPA 2004b, 2006b).

In using AERMET to prepare the meteorological data for AERMOD, three surface characteristics must be provided as inputs, the surface roughness (z_o), the Albedo (r), and the Bowen ratio (B_o). In this case, values for all three parameters were selected based on an urban setting around the Akron/Canton airport where meteorological data were obtained.

AERMET allows the values of micrometeorological parameters to vary seasonally or monthly and by wind direction sector. For this project, values were adjusted seasonally, but not by wind direction. The values used in processing meteorological data

Protocol Exception

The approach to defining micrometeorological parameters that was proposed in the protocol was changed in response to a comment from Ohio EPA (Hodanbosi, 2007). Specifically, all values are defined for the area around the meteorological station rather than the site, and no wind sectors were used in defining the parameters.

for this project are shown in Table 3.

A wind rose diagram is given in Figure 4 showing the frequencies of wind speeds and directions over the 5-year period 1986 through 1990. As shown, the wind blows predominantly toward the northeast.

Table 3. Meteorological parameter values.

Season	Albedo, r	Bowen Ratio, B_o	Surface Roughness, z_o (m)
Winter	0.35	1.5	0.5
Spring	0.14	1.0	1.0
Summer	0.16	2.0	1.3
Autumn	0.18	2.0	0.8

Note: Values of r, z_o, and B_o are based on an urban land use around the Akron-Canton Regional Airport. B_o values are for average wetness conditions. All values are taken from USEPA (2004b).

Receptors

Receptors were placed at the locations of nearby residences and in grids around the landfill at intervals sufficient to find the 24-hour and annual points of maximum concentration for each scenario. Receptors were placed every 50 feet along the property line as shown on Figure 5. A 500-meter grid was placed around the property to a distance of 16 km (Figure 6), and a 100-meter grid was positioned to cover the nearest 1 km around the property line (Figure 7).

Protocol Exception

- A 500-meter receptor grid to a distance of 16 km (approximately one mile) was added in response to a comment from Ohio EPA (Hodanbosi, 2007).
- The receptor spacing around the property line was changed from 100 meters to 50 meters in response to Ohio EPA comments.

Initial modeling was done using the property line, 100-meter, and 1-km receptor grids. Then, 10-meter grids were added to further refine the locations of the maximum concentrations. One 10-meter grid was defined to the east of the property line that covered a distance of approximately 500 meters around the maximum receptors for the different scenarios and averaging times. This grid is shown on Figure 8. For one combination of scenario, averaging time, and year, the maximum concentration occurred to the west instead of to the east. For that combination, another similar 10-meter grid was added to the west of the property line to a distance of 500 meters. The western 10-meter grid is shown on Figure 9.

Terrain Data

Digital terrain data files were obtained from the internet site (http://data.geocomm.com/catalog/US/61070/807/group4-3.html). These 24-Minute Digital Elevation Model (DEM) files were processed using the program SDTS2DEM (Version 0.018, April 29, 2002), a utility program by Mr. Sol Katz, available on the internet at http://data.geocomm.com/dem/sdts2dem.html. Receptor elevations and terrain height scales needed for AERMOD were determined from the DEM files using the terrain preprocessor program AERMAP (06341) (USEPA 2004c, 2006c). In order to cover the same 2 mile by 2 mile area over which receptors were placed, DEM files were obtained and used for the following USGS quadrants: Bolivar, Canton East, Canton West, Dellroy, Dover, Malvern, Massilon, Mineral City, Navarre, Robertsville, Strasburg, and Waynesburg.

Results

As discussed above, the model was set to generate concentrations at all receptors for two averaging times (24-hour and annual) and three scenarios. The desired results of this modeling study were locations of maximum impact rather than predicted concentration values. Because of this, surrogate emission rates were used in the modeling. Concentration values are shown on the results figures discussed below, but these values are only useful in comparing the relative concentrations of different locations within a single scenario. Comparisons of the concentration impact of one scenario versus another are not valid, nor are comparisons with any concentration standard, toxicity limit, or odor threshold.

Separate mode runs were made for each of five years of meteorological data. Each year's results are tabulated for all scenarios and averaging times in Table 4 with the year producing the highest maximum concentration highlighted. As

shown, 1986 meteorological data produced the highest concentrations for all scenarios except the annual averaging time for the flares scenario (Scenario 3). For that combination, the 1990 meteorological data set yielded the highest concentrations.

Table 4. Maximum modeling results for each year, averaging time, and scenario.

Scenario	Averaging Time	Year	Concentration	UTM Coordinates (m) x	y
1 (Affected Area)	24 hours	1986	2.5	464361.25	4502902.50
1 (Affected Area)	24 hours	1987	2.15	464379.81	4502857.50
1 (Affected Area)	24 hours	1988	1.82	464361.25	4502902.50
1 (Affected Area)	24 hours	1989	1.76	464379.81	4502857.50
1 (Affected Area)	24 hours	1990	2.09	464379.81	4502857.50
1 (Affected Area)	Annual	1986	0.45	464379.81	4502857.50
1 (Affected Area)	Annual	1987	0.42	464379.81	4502857.50
1 (Affected Area)	Annual	1988	0.43	464379.81	4502857.50
1 (Affected Area)	Annual	1989	0.36	464379.81	4502857.50
1 (Affected Area)	Annual	1990	0.40	464361.25	4502902.50
2 (Cells 1-7)	24 hours	1986	4.11	464416.94	4502767.50
2 (Cells 1-7)	24 hours	1987	3.70	464435.50	4502722.50
2 (Cells 1-7)	24 hours	1988	3.95	464420	4502760
2 (Cells 1-7)	24 hours	1989	3.29	463294.34	4503112.50
2 (Cells 1-7)	24 hours	1990	3.69	464420	4502760
2 (Cells 1-7)	Annual	1986	1.02	464420	4502760
2 (Cells 1-7)	Annual	1987	0.92	464420	4502760
2 (Cells 1-7)	Annual	1988	0.98	464420	4502760
2 (Cells 1-7)	Annual	1989	0.82	464420	4502760
2 (Cells 1-7)	Annual	1990	0.93	464420	4502760
3 (Flares)	24 hours	1986	14.5	464530	4502510
3 (Flares)	24 hours	1987	13.3	464550	4502460
3 (Flares)	24 hours	1988	13.0	464520	4502520
3 (Flares)	24 hours	1989	11.8	464491.16	4502587.50
3 (Flares)	24 hours	1990	11.2	464550	4502470
3 (Flares)	Annual	1986	2.11	464510	4502600
3 (Flares)	Annual	1987	2.00	464530	4502570
3 (Flares)	Annual	1988	2.21	464520	4502560
3 (Flares)	Annual	1989	1.98	464510	4502570
3 (Flares)	Annual	1990	2.26	464480	4502620

In all combinations of scenario, year, and averaging time, maximum concentrations occurred at or very near the property line. In all but one case, the maximum concentration was on the eastern side of the landfill. The exception occurred in 1989 when the maximum 24-hour concentration for Scenario 2 occurred to the west of the property line. As a result, an additional model run was done for that year with a 10-meter receptor grid located to the west of the property as discussed above and shown on Figure 9. To save execution time, the western 10-meter grid was not modeled in any other run.

Modeling results for the years yielding the maximum concentrations for each scenario are presented graphically in this report as concentration isopleths overlaid on an aerial photo. Isopleths are lines of constant concentration that were generated by the ISC-AERMOD View software from the receptor locations and concentrations predicted by AERMOD. They provide a visual representation of how concentrations predicted by the model vary spatially. Bands between the isopleth lines are shaded in different colors to show at a glance where similar concentrations occur. In this report, the red areas denote areas with concentrations above approximately 75 percent of the maximum concentration found anywhere.

The concentration value of the lowest isopleth was set at approximately 10 percent of the maximum concentration. Areas that are not colored are either inside the property line where no concentrations were computed or are beyond the lowest isopleth line and have concentrations of less than about 10 percent of the maximum.

For Scenario 1 (Impacted Area), 24-hour concentration isopleths for the year 1986 are shown on Figure 10. Figure 11 shows a close-up view of the maximum impact area with predicted concentrations posted at each receptor location. Similarly, annual concentration isopleths for 1986 are shown on Figure 12, with a close-up view of the maximum concentration area shown on Figure 13. As shown, the locations of the maximum concentrations for both averaging times for this scenario occur in the same vicinity just east of the property line. In addition, a close-up view of the residential area to the northeast of the plant is shown in Figure 14 (maximum 24-hour averages) and Figure 15 (annual averages). In both figures, concentration values are posted by the receptors to show how concentrations vary spatially in this region.

For Scenario 2 (Cells 1-7), 24-hour concentration isopleths for the year 1986 are shown on Figure 16. Figure 17 shows a close-up view of the maximum impact area with predicted concentrations posted at each receptor location. Similarly, annual concentration isopleths for 1986 are shown on Figure 18, with a close-up view of the maximum concentration area shown on Figure 19. As shown, the locations of the maximum concentrations for both averaging times for this scenario occur in the same vicinity just east of the property line. In 1989, maximum 24-hour results occurred west of the plant. However, as shown in Table 4, the 1989 maximum was lower than the maximum concentration predicted to the east in 1986. Thus, only the 1986 data are presented graphically. In addition, a close-up view of the residential area to the northeast of the plant is shown in Figure 20 (maximum 24-hour averages) and Figure 21 (annual averages). In both figures, concentration values are posted by the receptors to show how concentrations vary spatially in this region.

For Scenario 3 (Flares), 24-hour concentration isopleths for the year 1986 are shown on Figure 22. Figure 23 shows a close-up view of the maximum impact area with predicted concentrations posted at each receptor location. Similarly, annual concentration isopleths for 1990 are shown on Figure 24, with a close-up view of the maximum concentration area shown on Figure 25. As shown, the locations of the maximum concentrations for both averaging times for this scenario occur in the same vicinity as each other just east of the property line. In addition, a close-up view of the residential area to the northeast of the plant is shown in Figure 26 (maximum 24-hour averages) and Figure 27 (annual averages). In both figures, concentration values are posted by the receptors to show how concentrations vary spatially in this region.

In summary, the area showing the maximum concentration varies somewhat by scenario and averaging time, but all occur at or near the eastern edge of the property. The maximum impact area of the two landfill scenarios is very similar, and the maximum impact area for the flares scenario is just south of the maximum impact area for the landfill scenarios. The residential area to the northeast of the plant is not in the maximum impact area for any scenario or averaging time. Concentrations in this area range from less than 10 percent to approximately 25 percent of the highest concentrations found in the maximum impact areas, depending on scenario and averaging time.

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Lawhon & Associates (2007) *Countywide Recycling & Disposal Facility Modeling Protocol,* May 8.

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USEPA (2004a) *Users Guide for the AMS/EPA Regulatory Model - AERMOD*, EPA-454/B-03-001, September.

USEPA (2004b) *Users Guide for the AERMOD Meteorological Preprocessor (AERMET)*, EPA-454/B-03-002, November.

USEPA (2004c) *Users Guide for the AERMOD Terrain Preprocessor (AERMAP)*, EPA-454/B-03-003, October.

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USEPA (2006c) *Addendum: Users Guide for the AERMOD Terrain Preprocessor (AERMAP)*, EPA-454/B-03-003, December.

Zima, Bryan (2007) Letter from Ohio EPA to Jason Perdion, Baker & Hostetler, LLP, March 28.

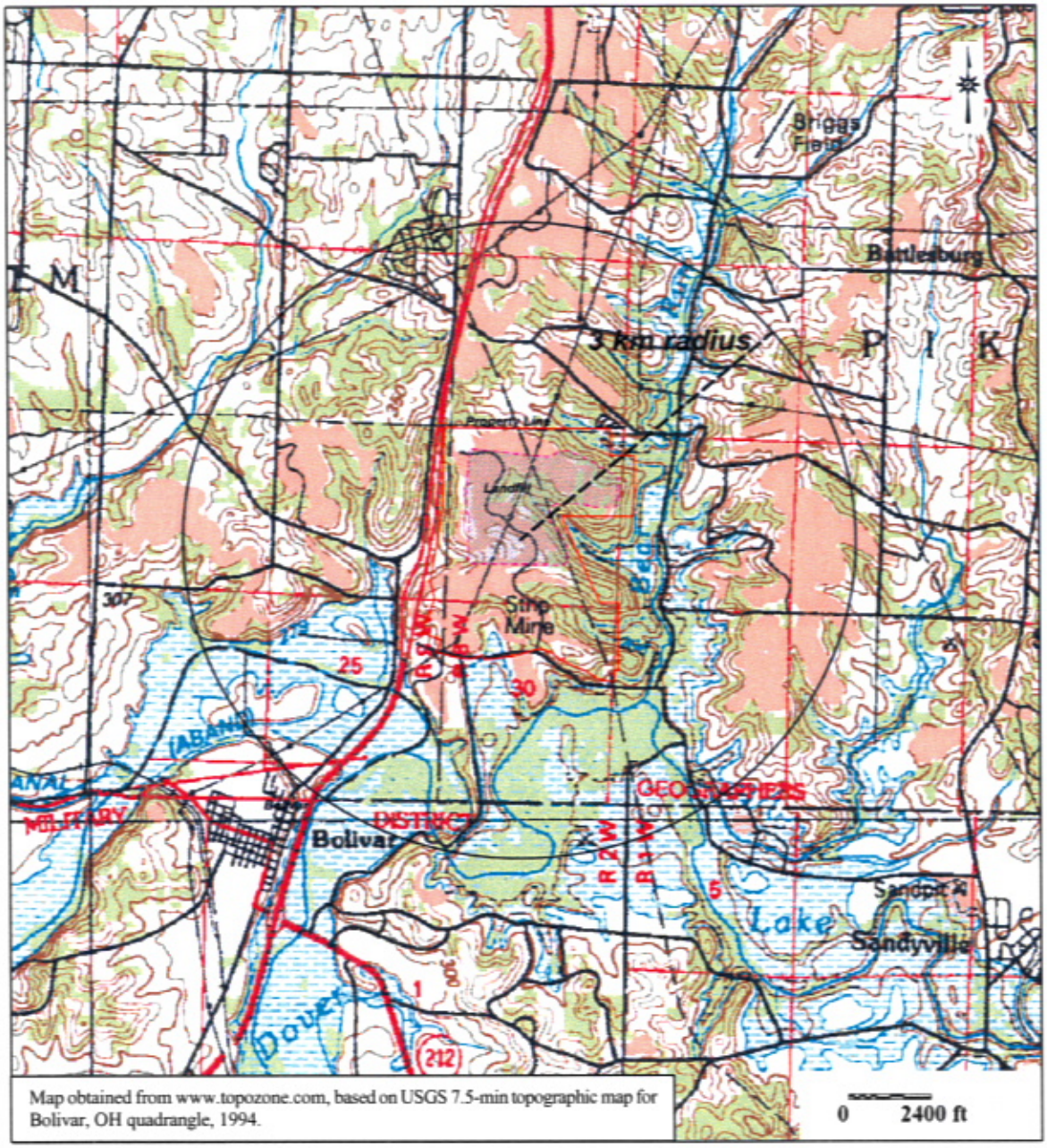

Figure 1. USGS topographic map showing location of Countywide Facility with 3-km circle.

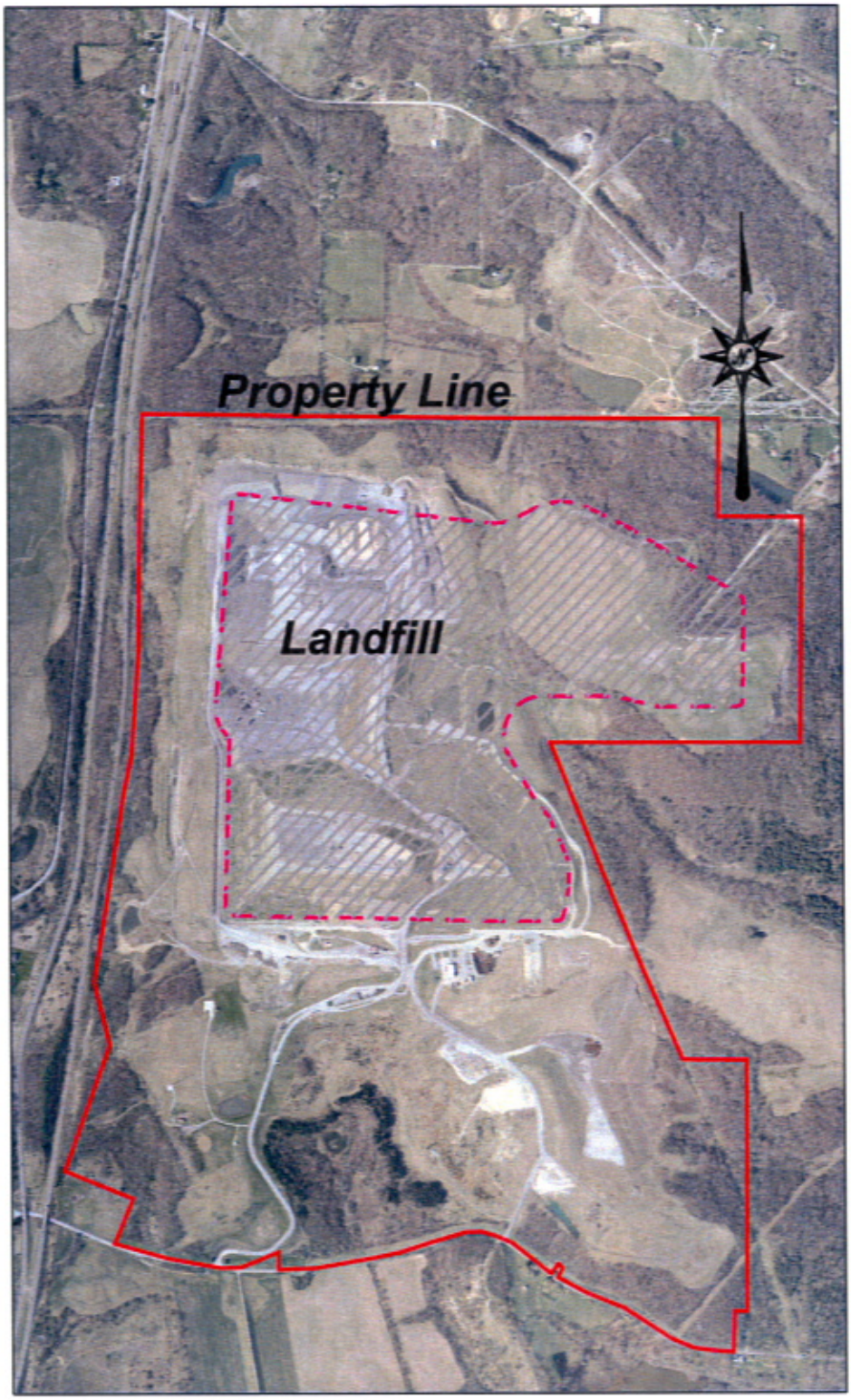

Figure 2. Aerial Map showing property line of the Countywide Facility.

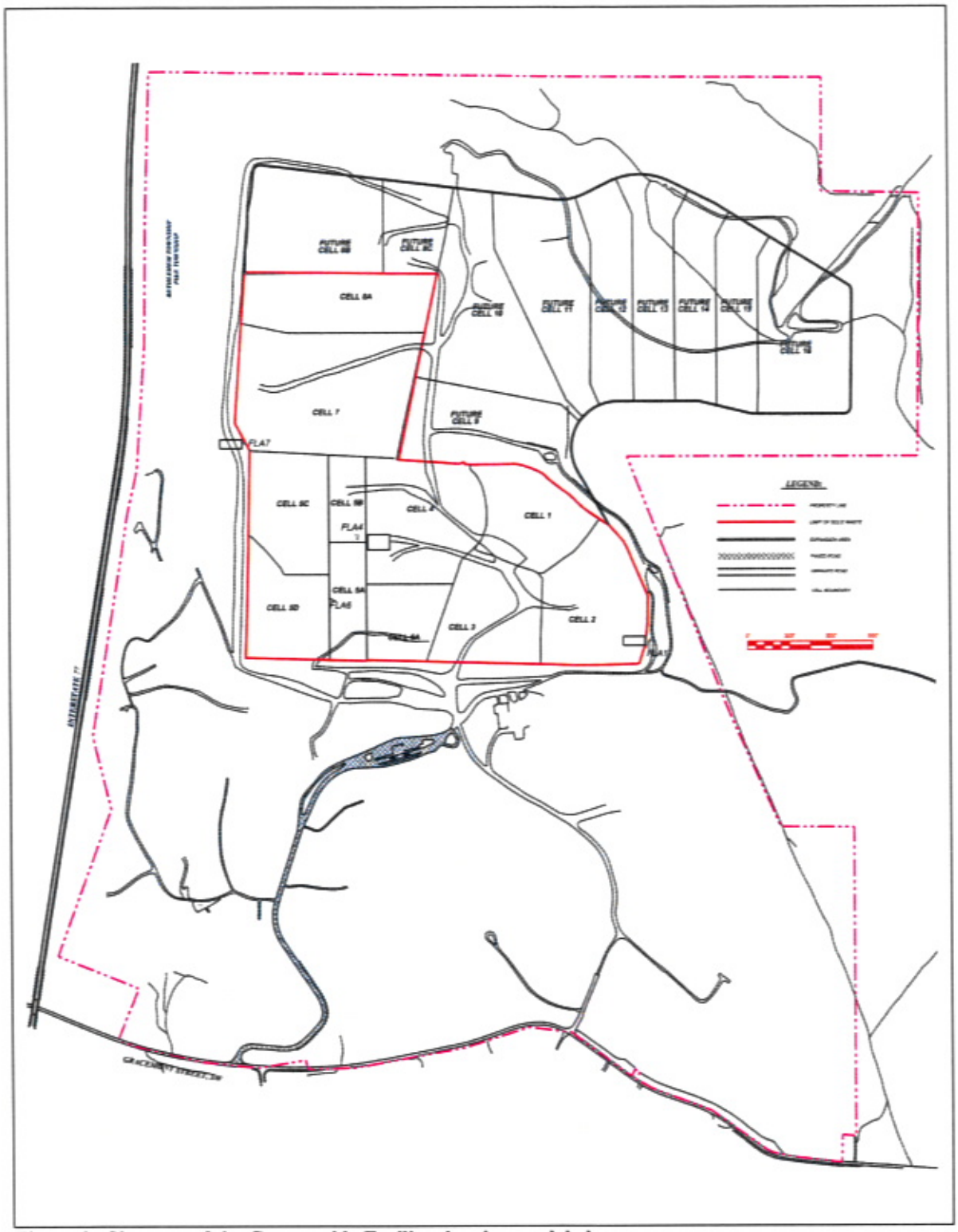

Figure 3. Site map of the Countywide Facility showing modeled sources.

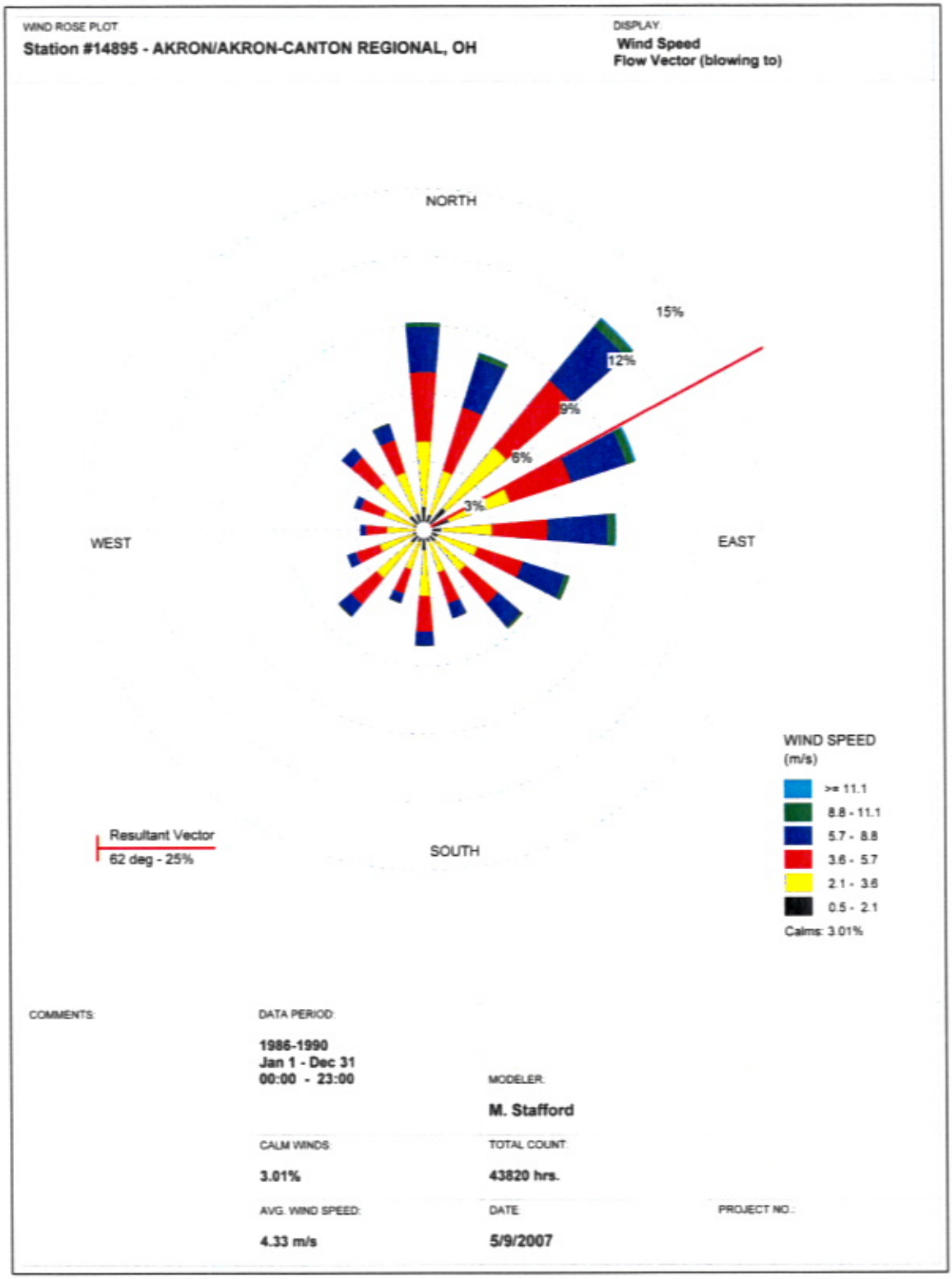

Figure 4. Wind Rose for Akron-Canton Airport.

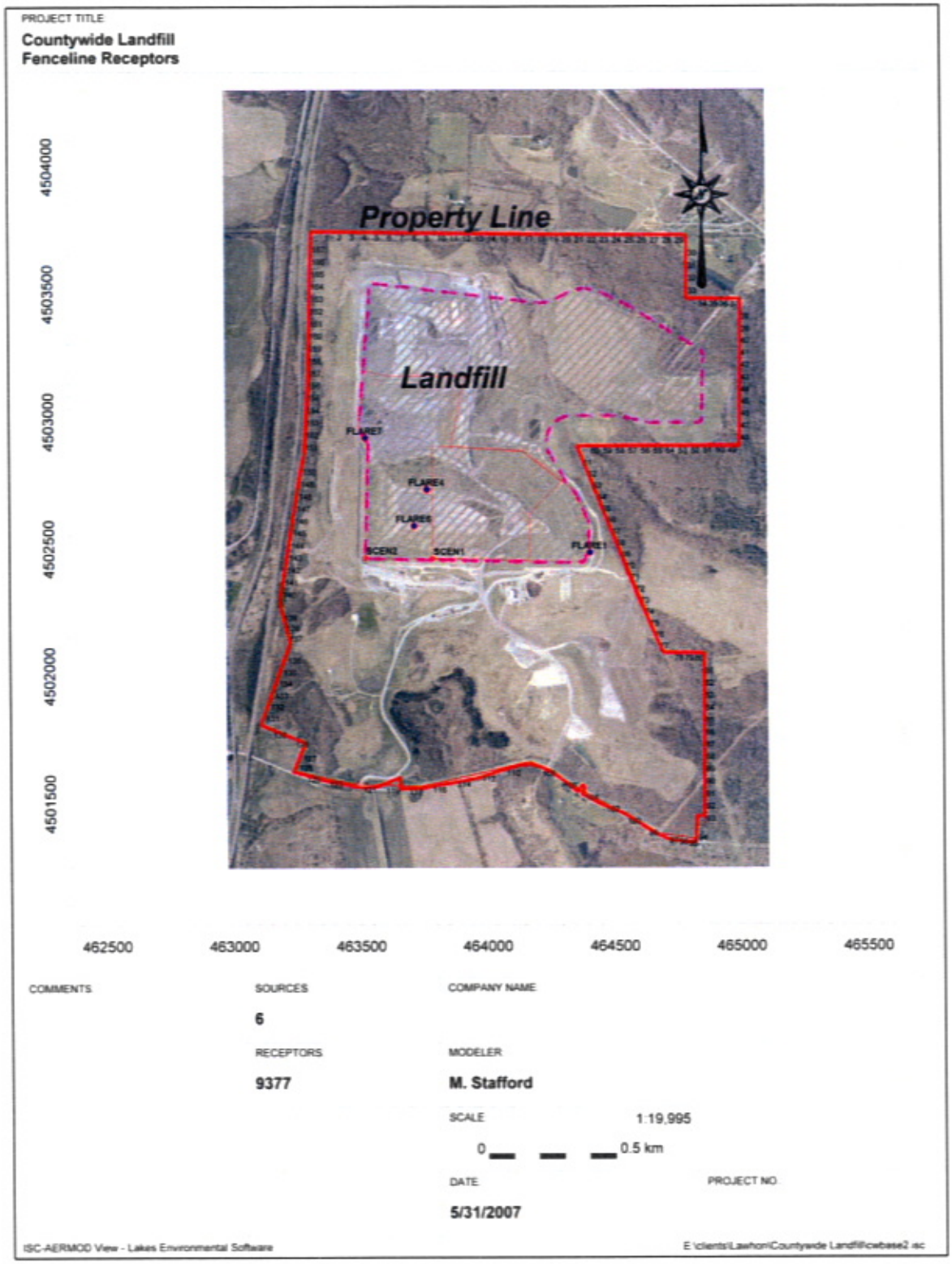

Figure 5. Fenceline (50-m) receptor grid.

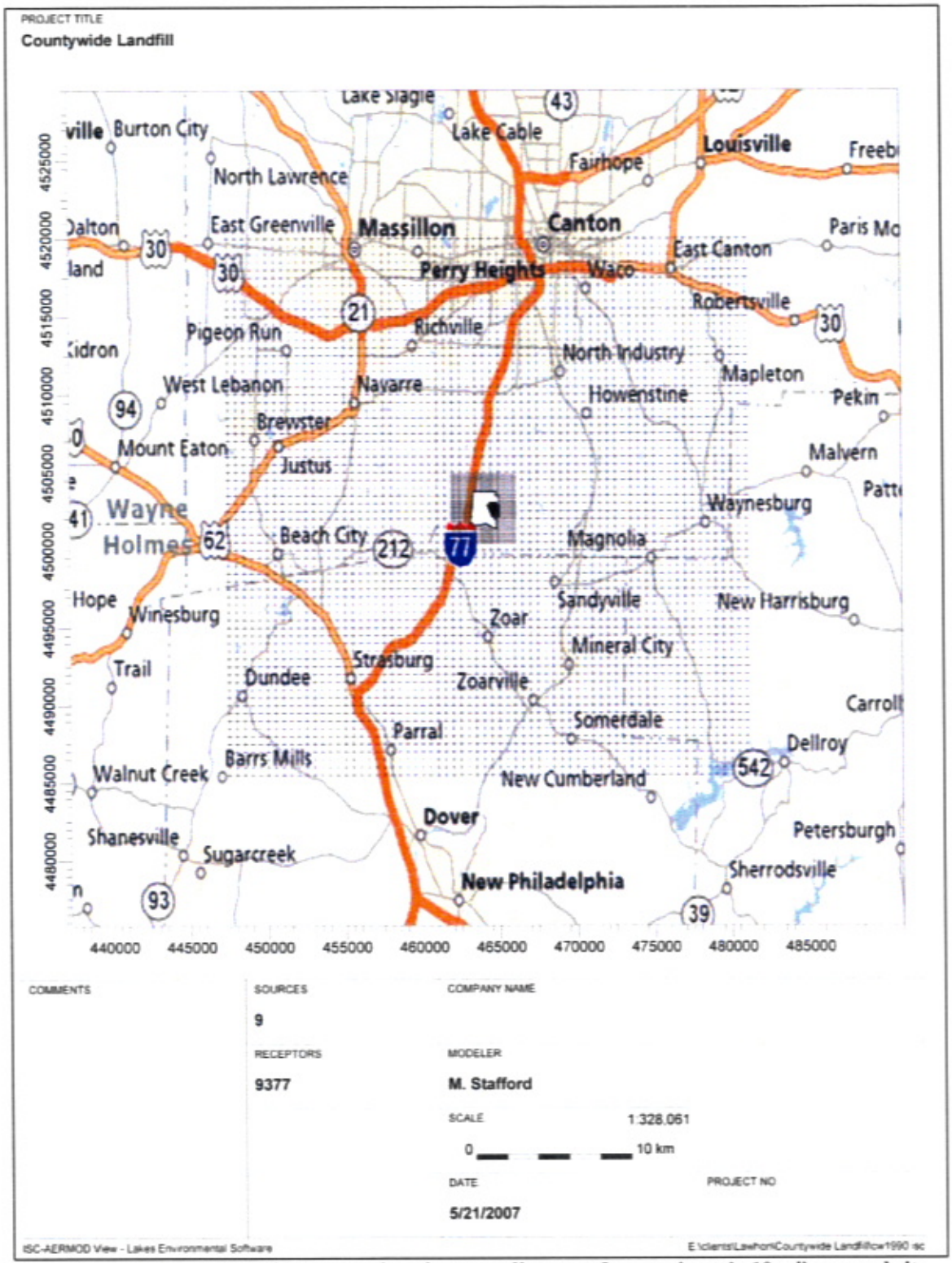

Figure 6. Coarse (500-meter) grid receptor locations to a distance of approximately 10 mile around site.

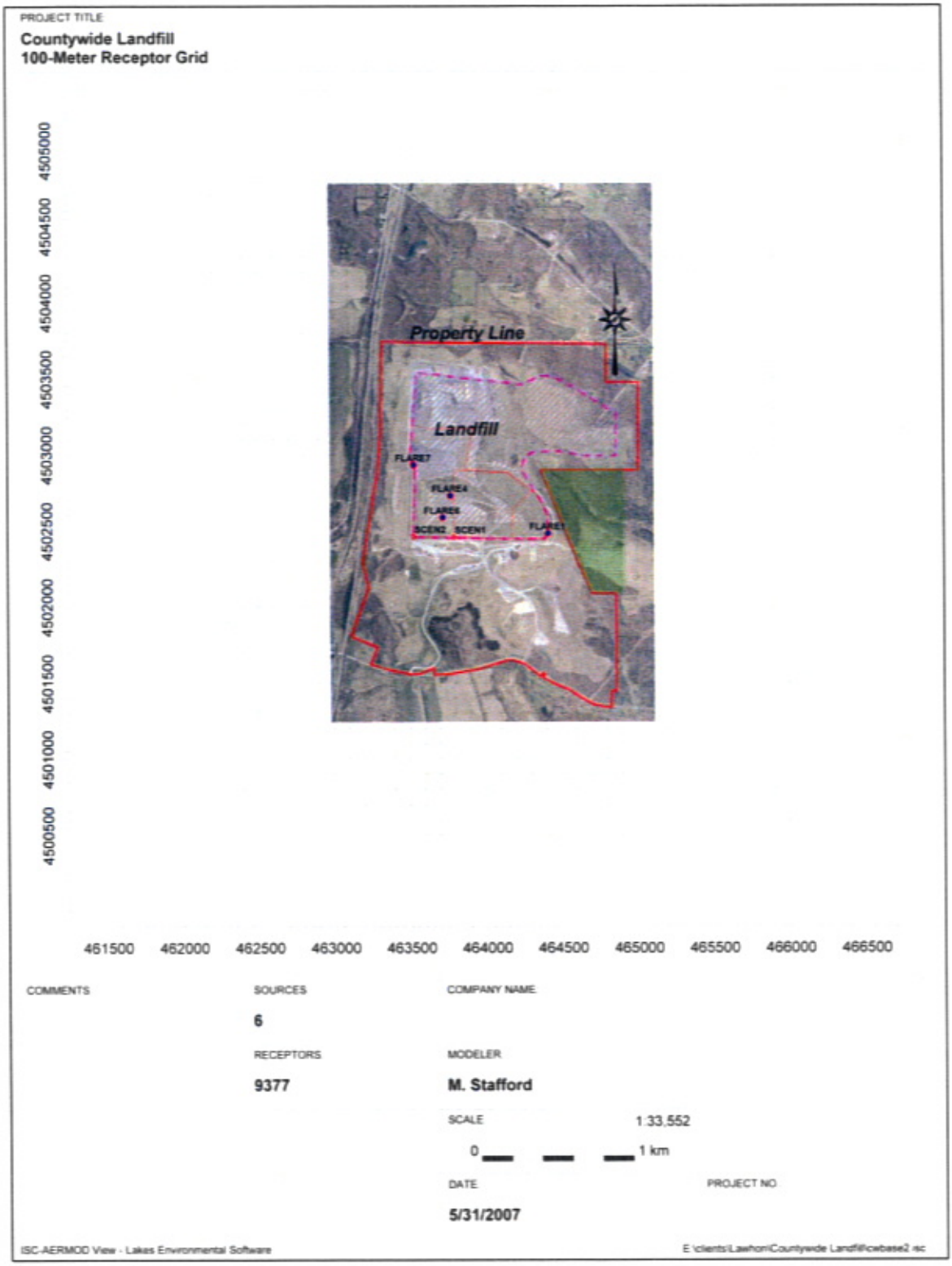

Figure 7. Medium (100-m) receptor grid to a distance of approximately 1 km from site.

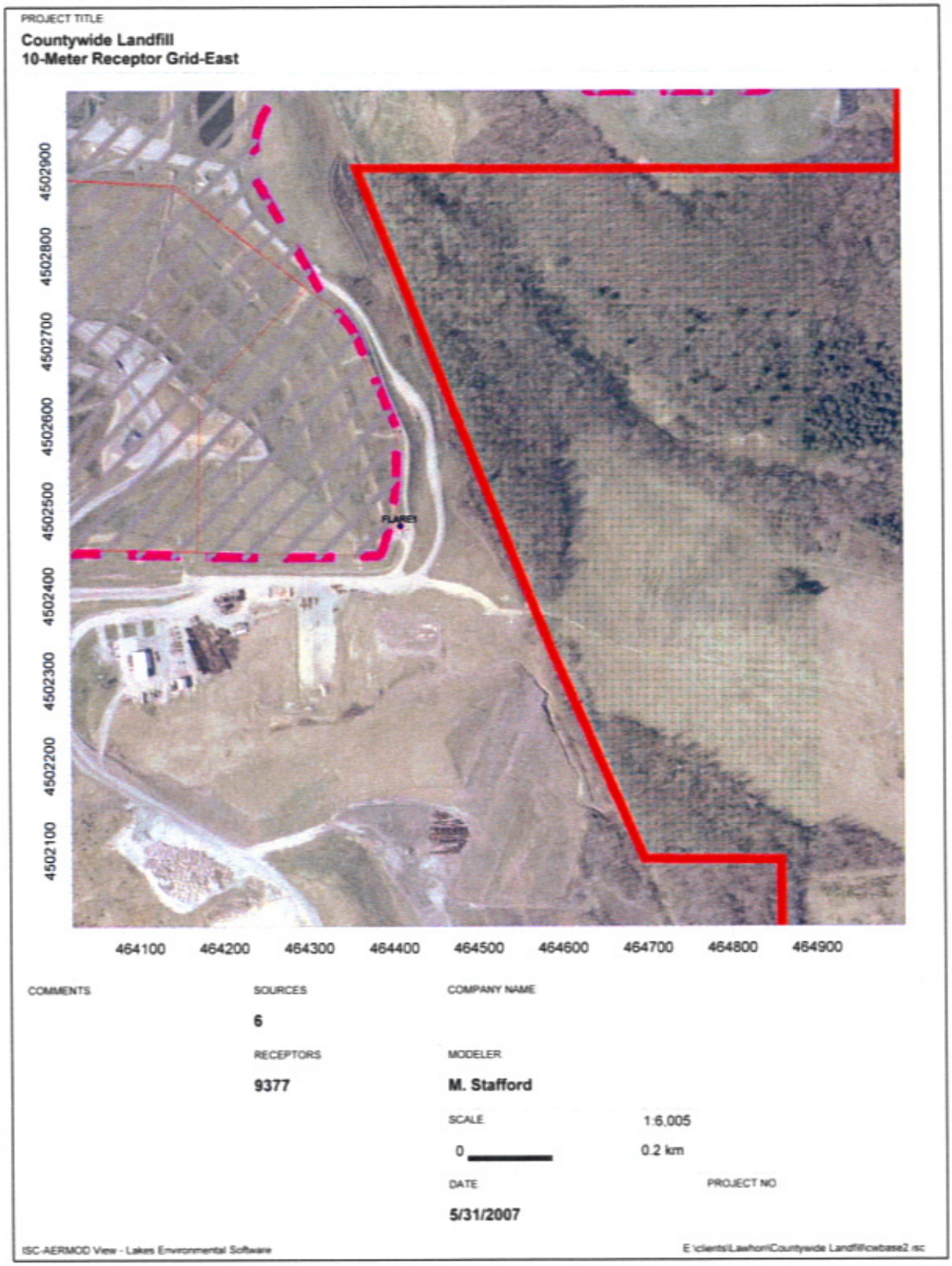

Figure 8. Fine (10-m) receptor grid used to locate eastern point of maximum concentration.

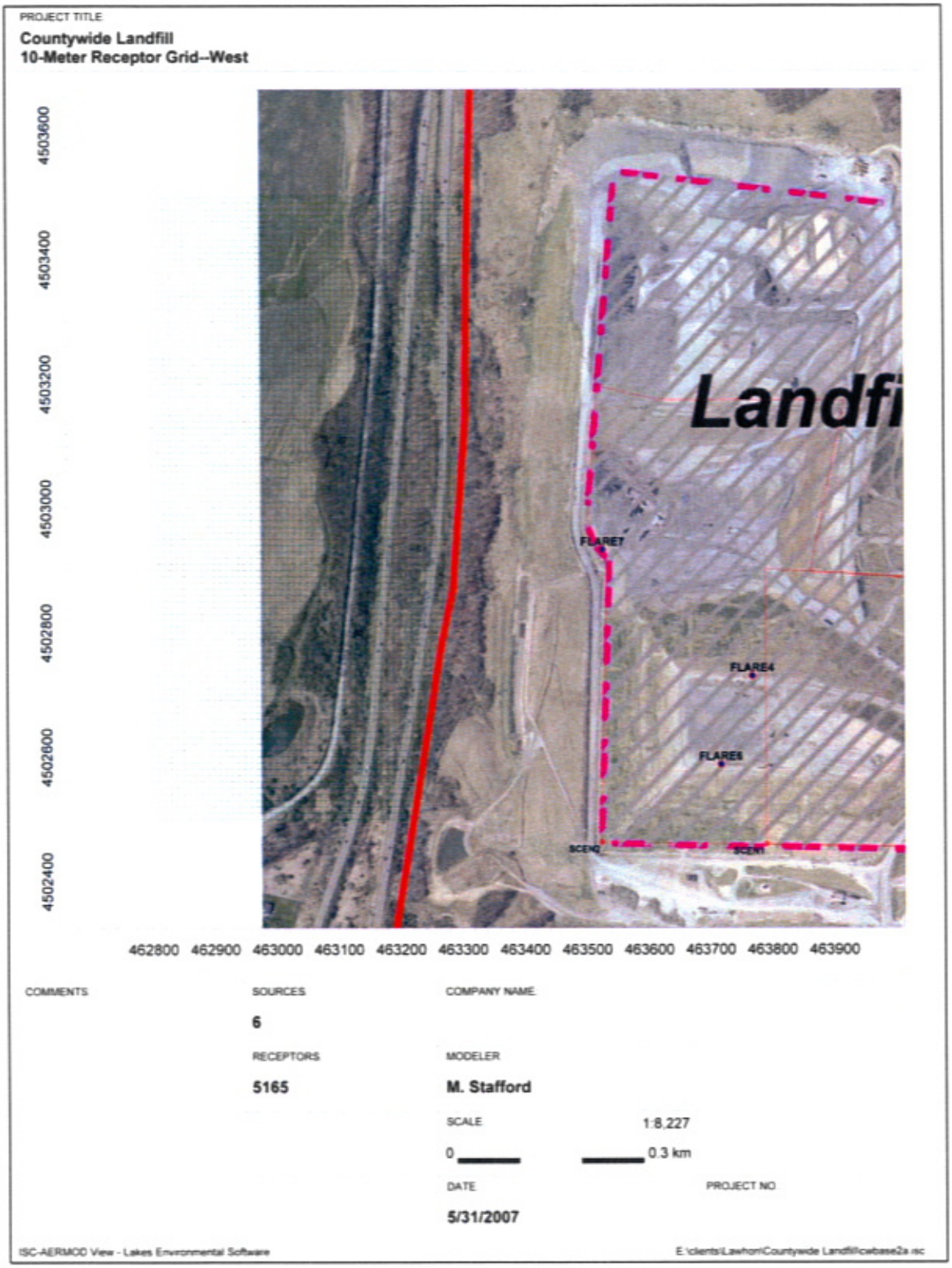

Figure 9. Fine (10-m) receptor grid used to locate western point of maximum concentration.

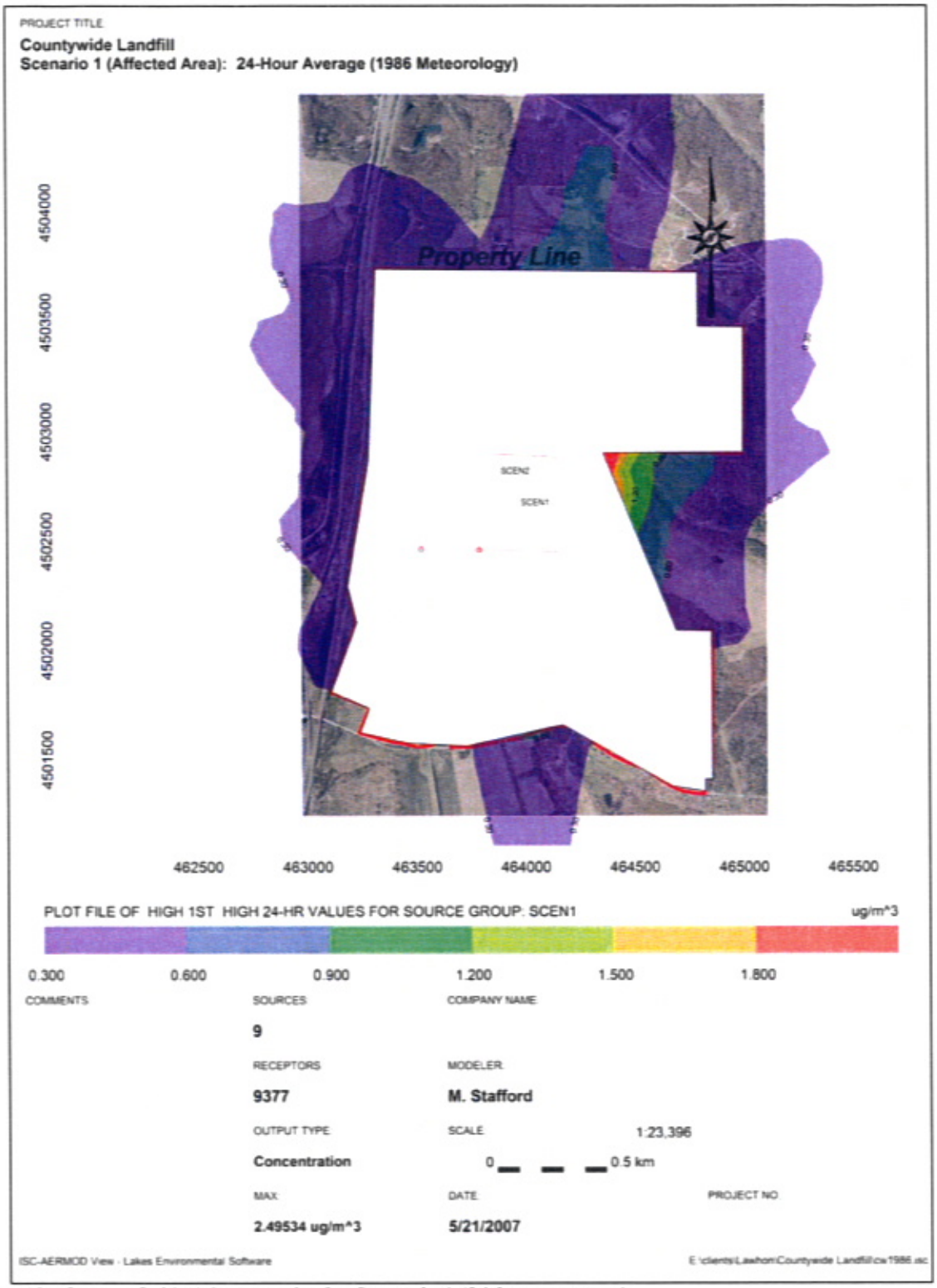

Figure 10. Coarse Grid (1-km) results for Scenario 1 (24-hour average).

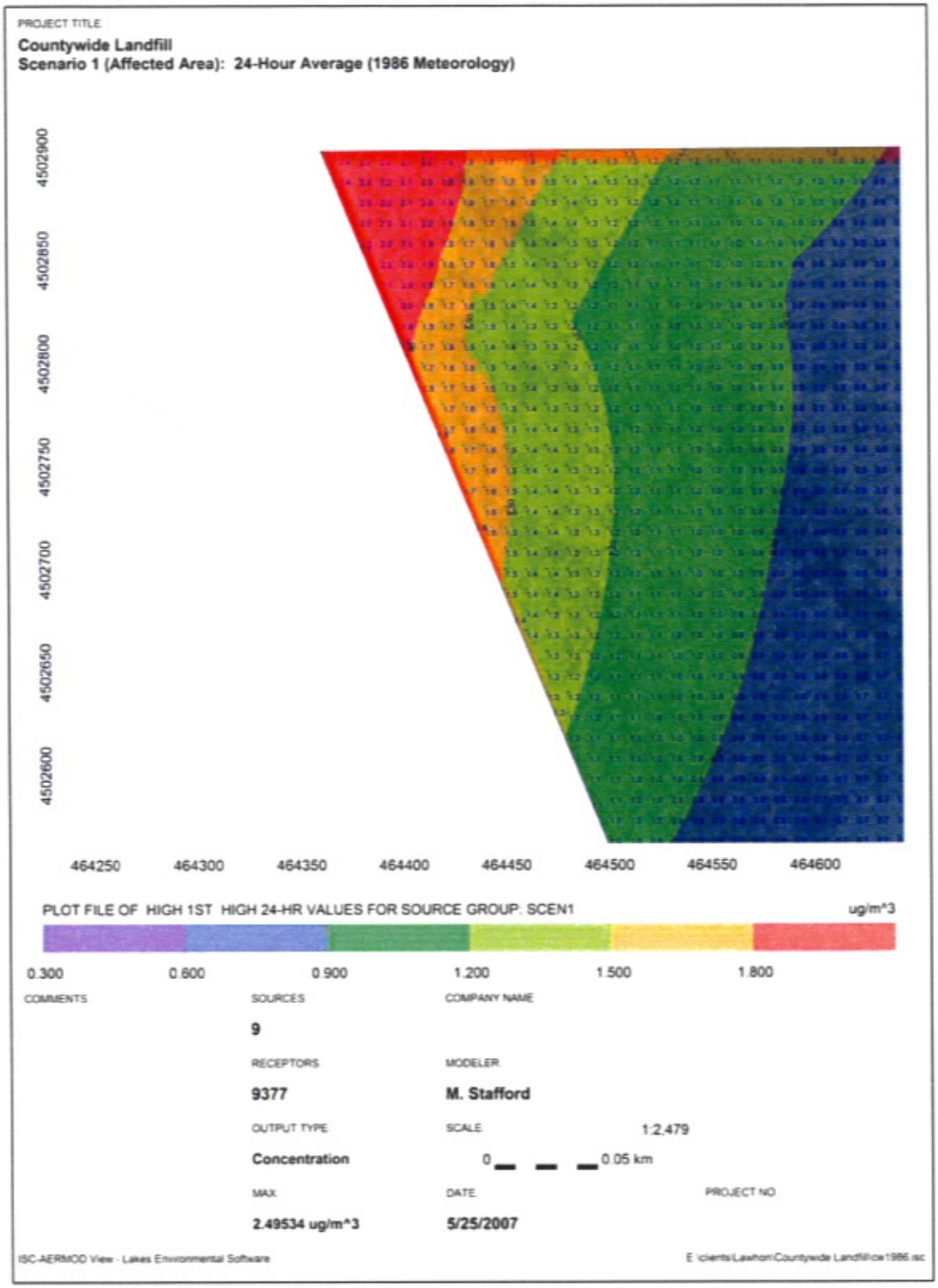

Figure 11. Fine Grid (10-m) results for Scenario 1 (24-hour average).

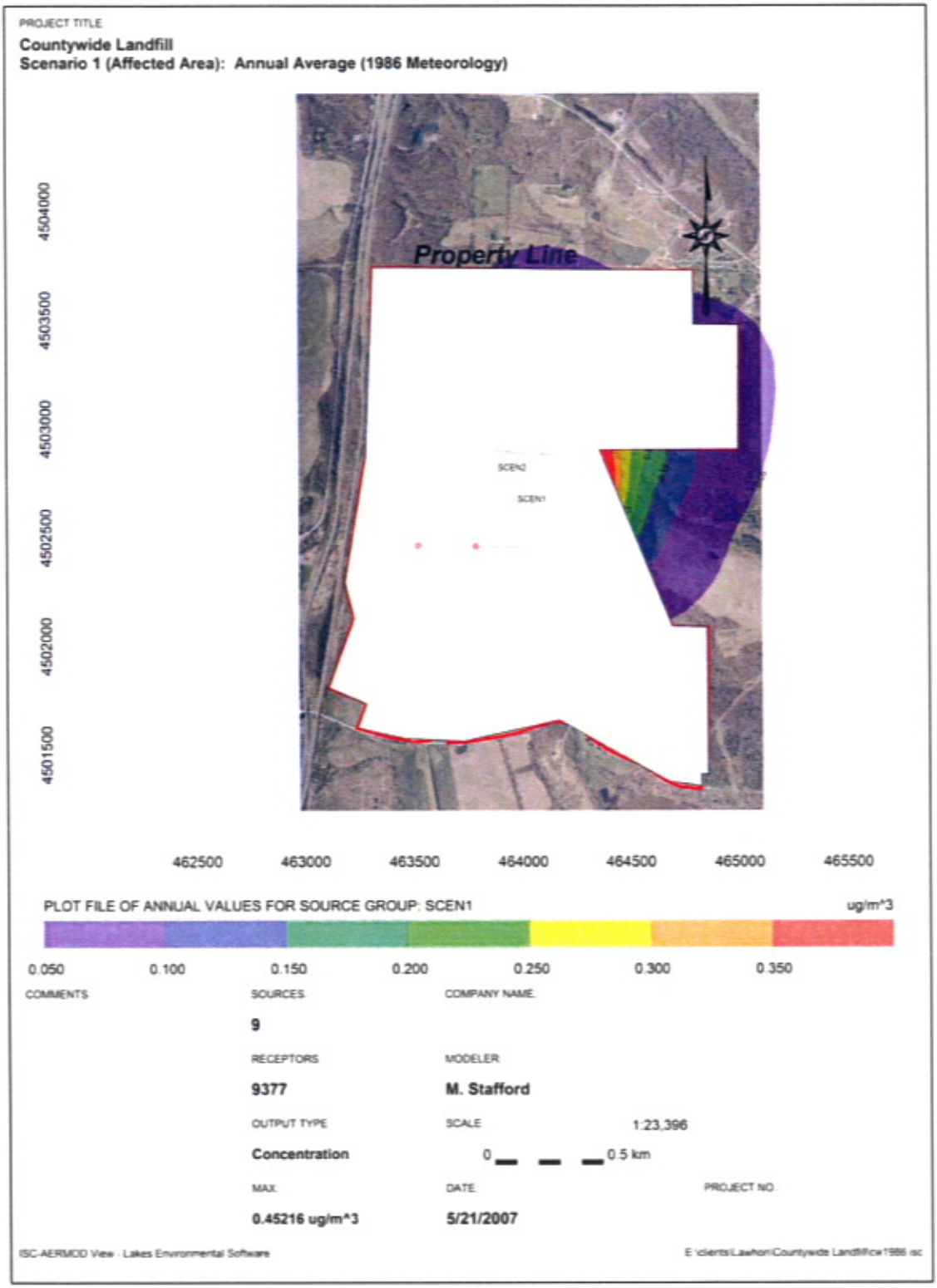

Figure 12. Coarse Grid (1-km) results for Scenario 1 (annual average).

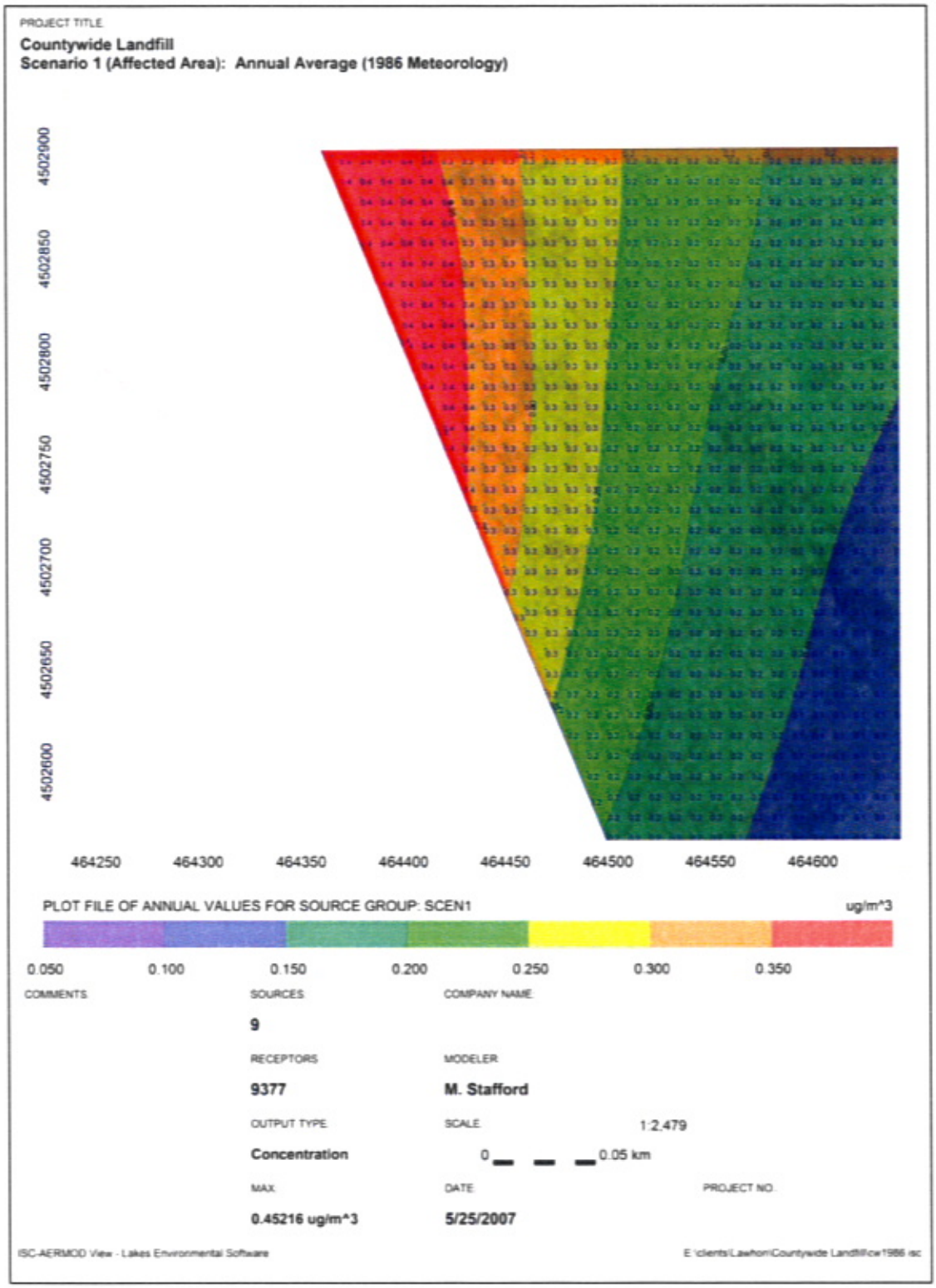

Figure 13. Fine Grid (10-m) results for Scenario 1 (annual average).

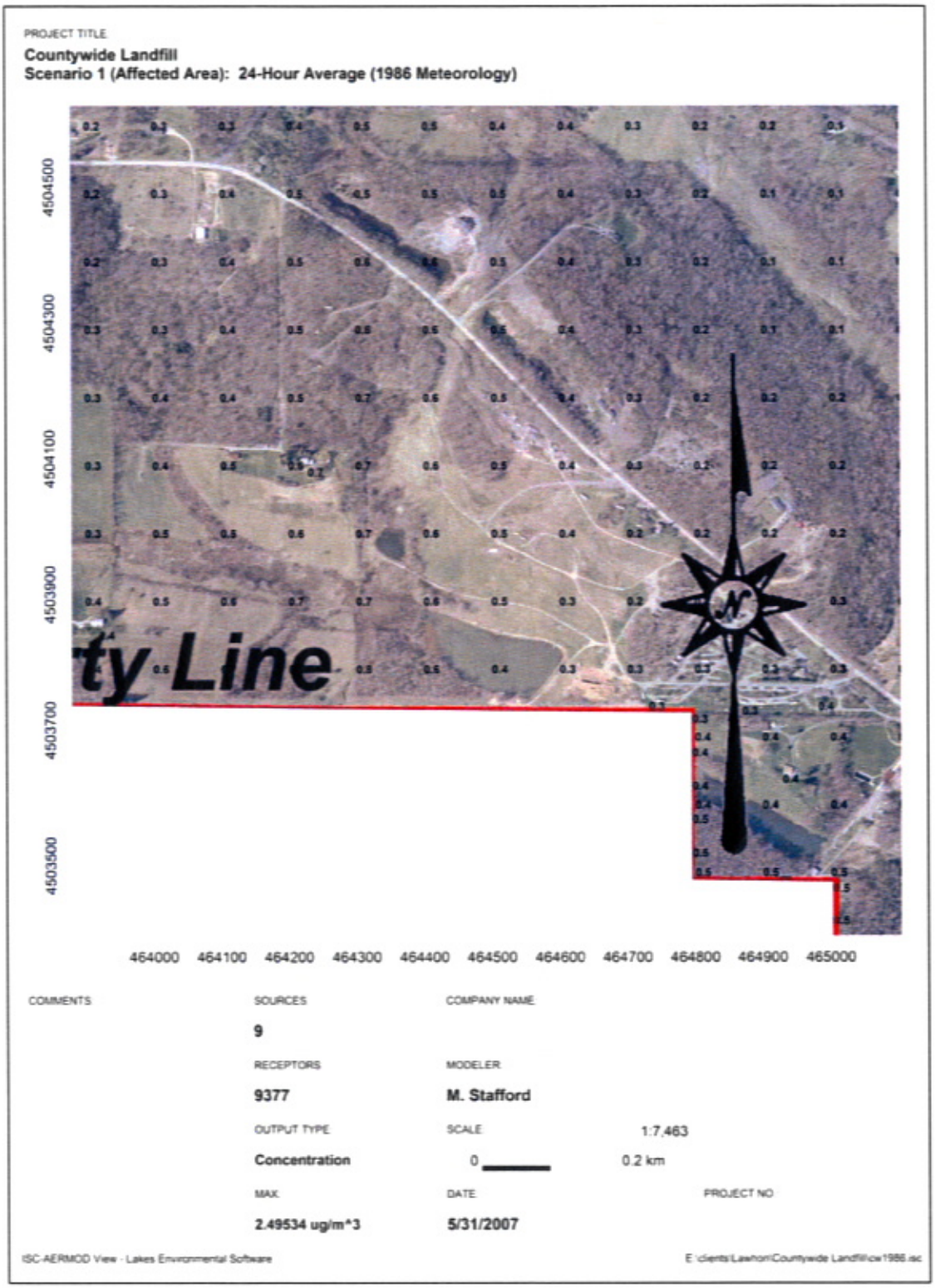

Figure 14. Results in residential area northeast of plant for Scenario 1 (24-hour average).

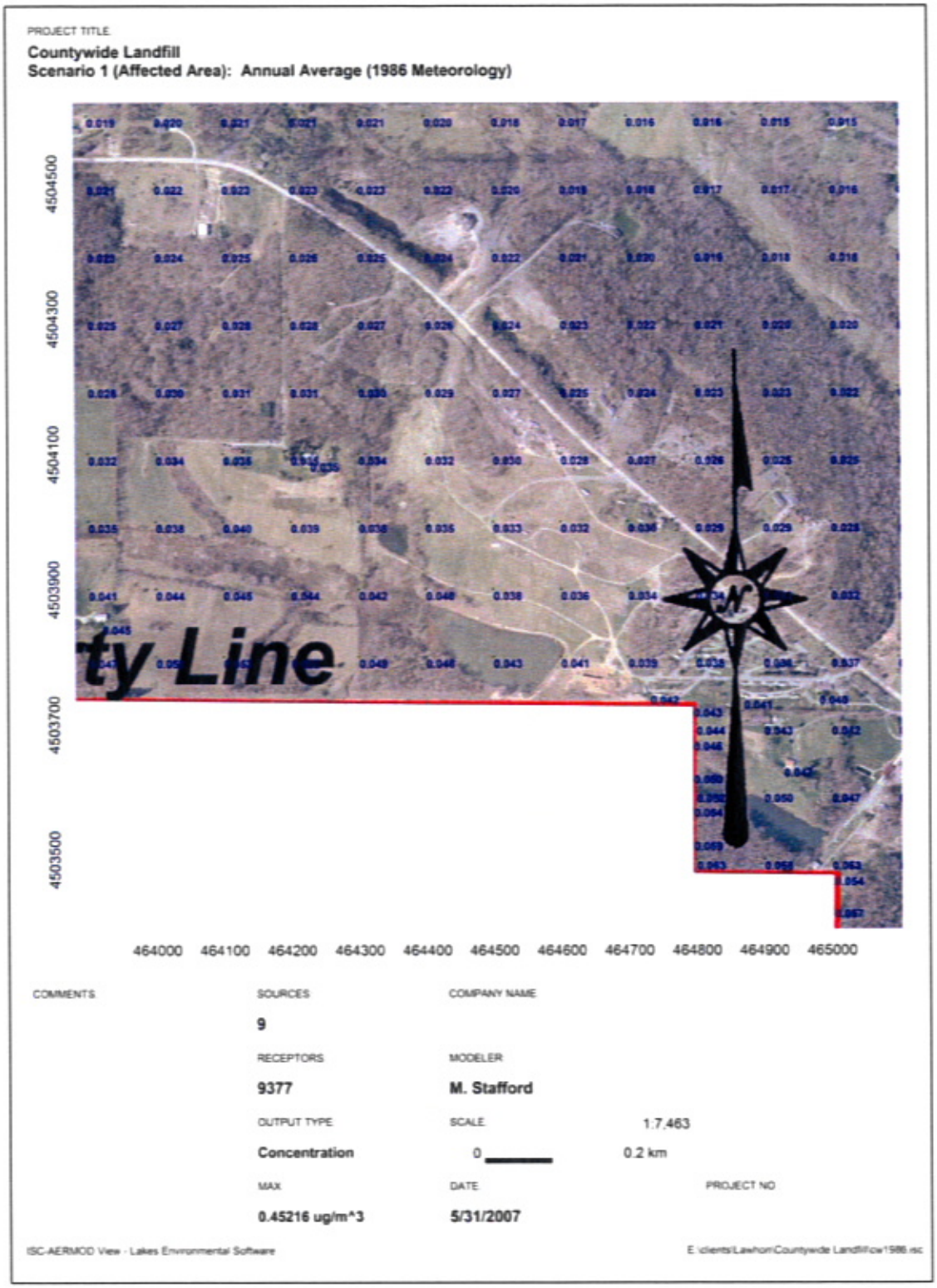

Figure 15. Results in residential area northeast of plant for Scenario 1 (annual average).

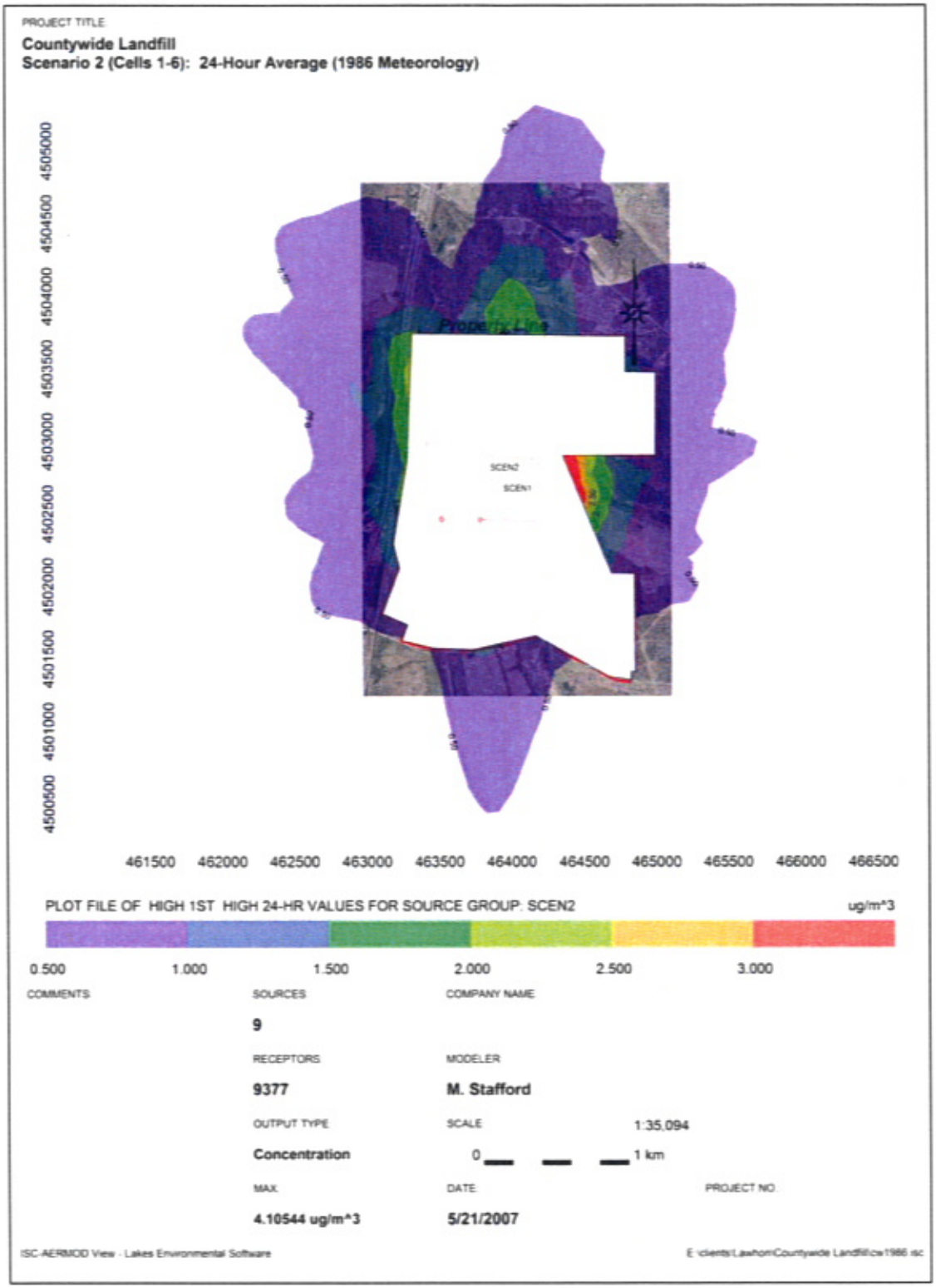

Figure 16. Coarse Grid (1-km) results for Scenario 2 (24-hour average).

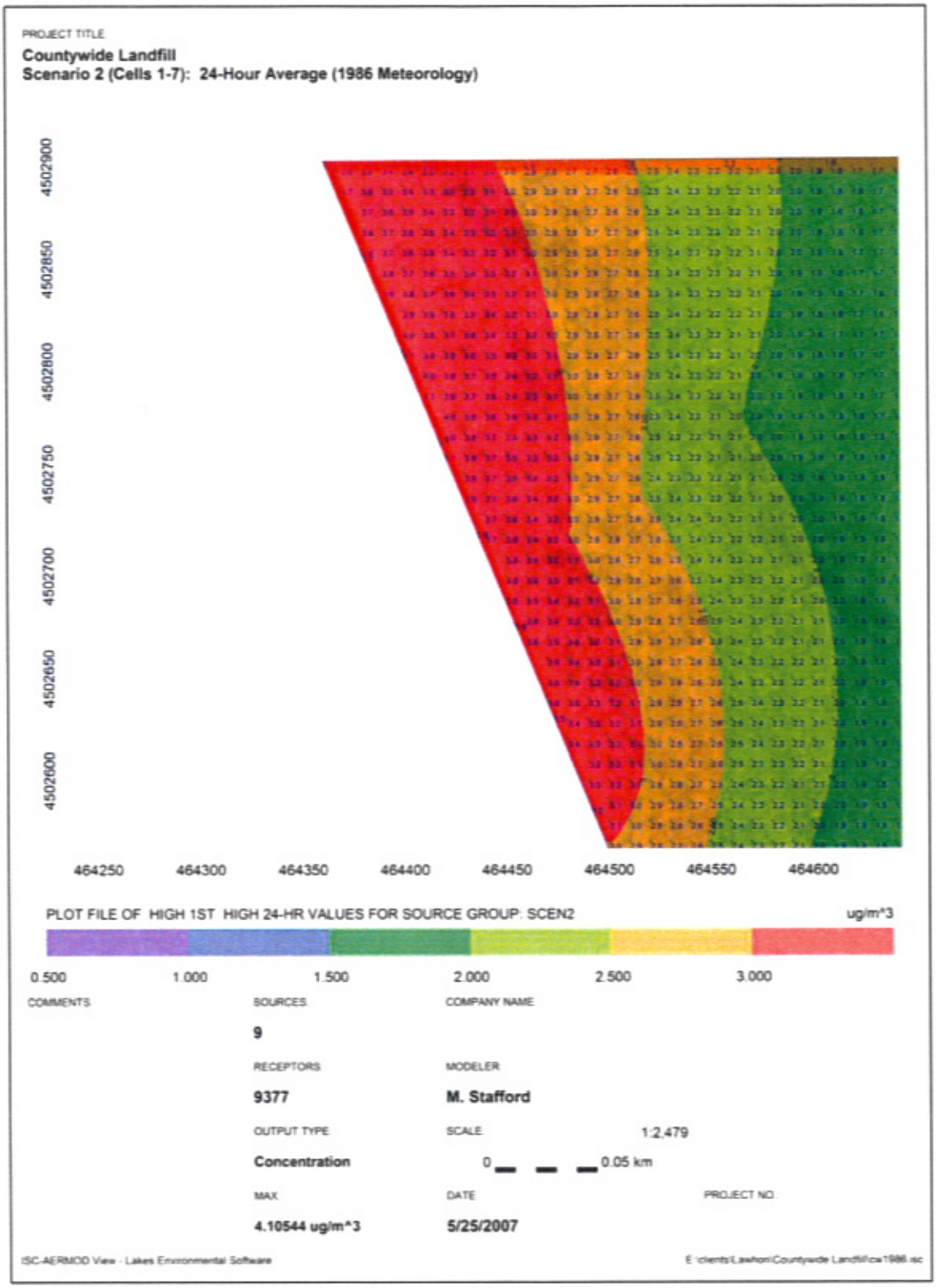

Figure 17. Fine Grid (10-m) results for Scenario 2 (24-hour average).

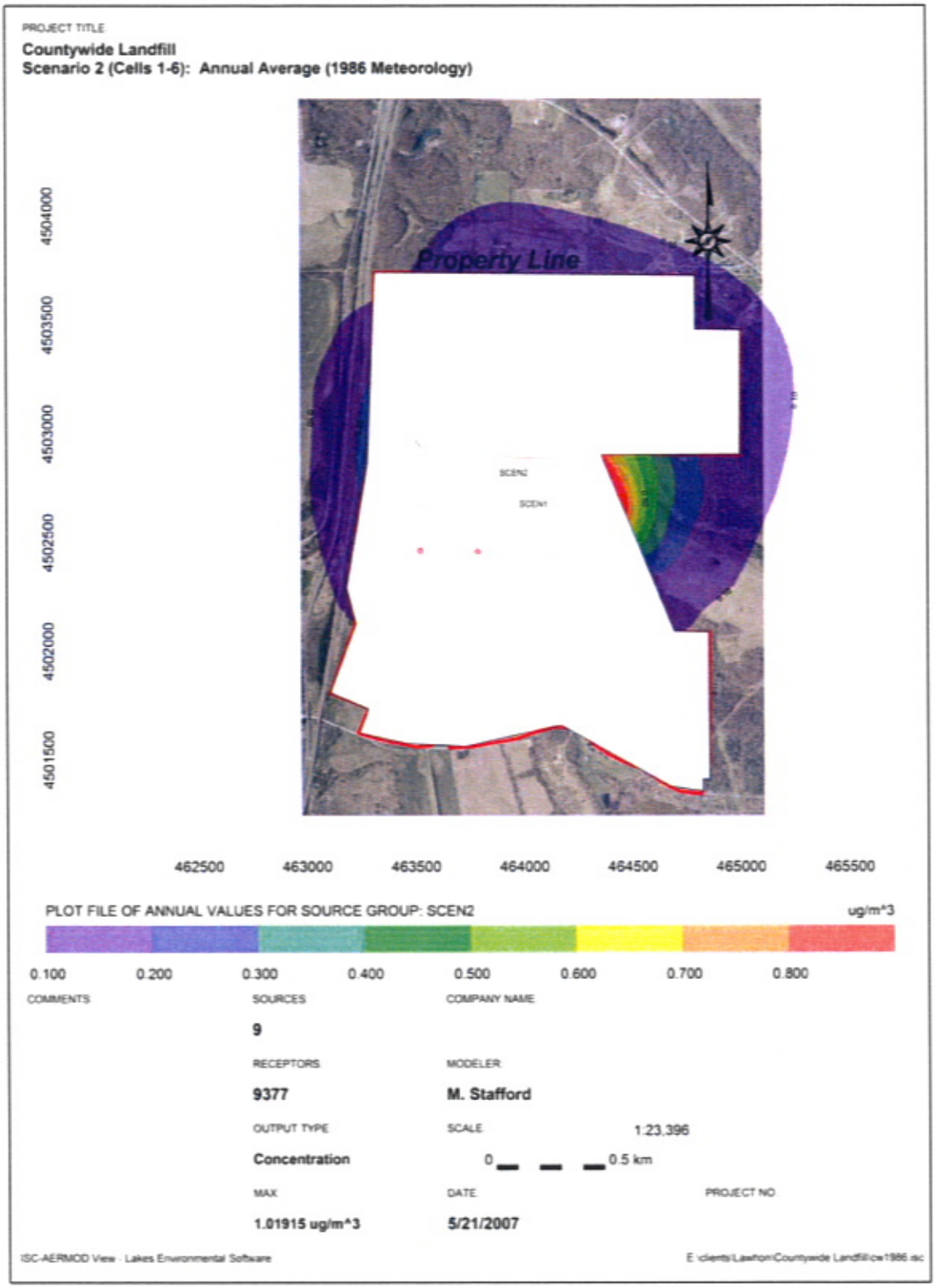

Figure 18. Coarse Grid (1-km) results for Scenario 2 (annual average).

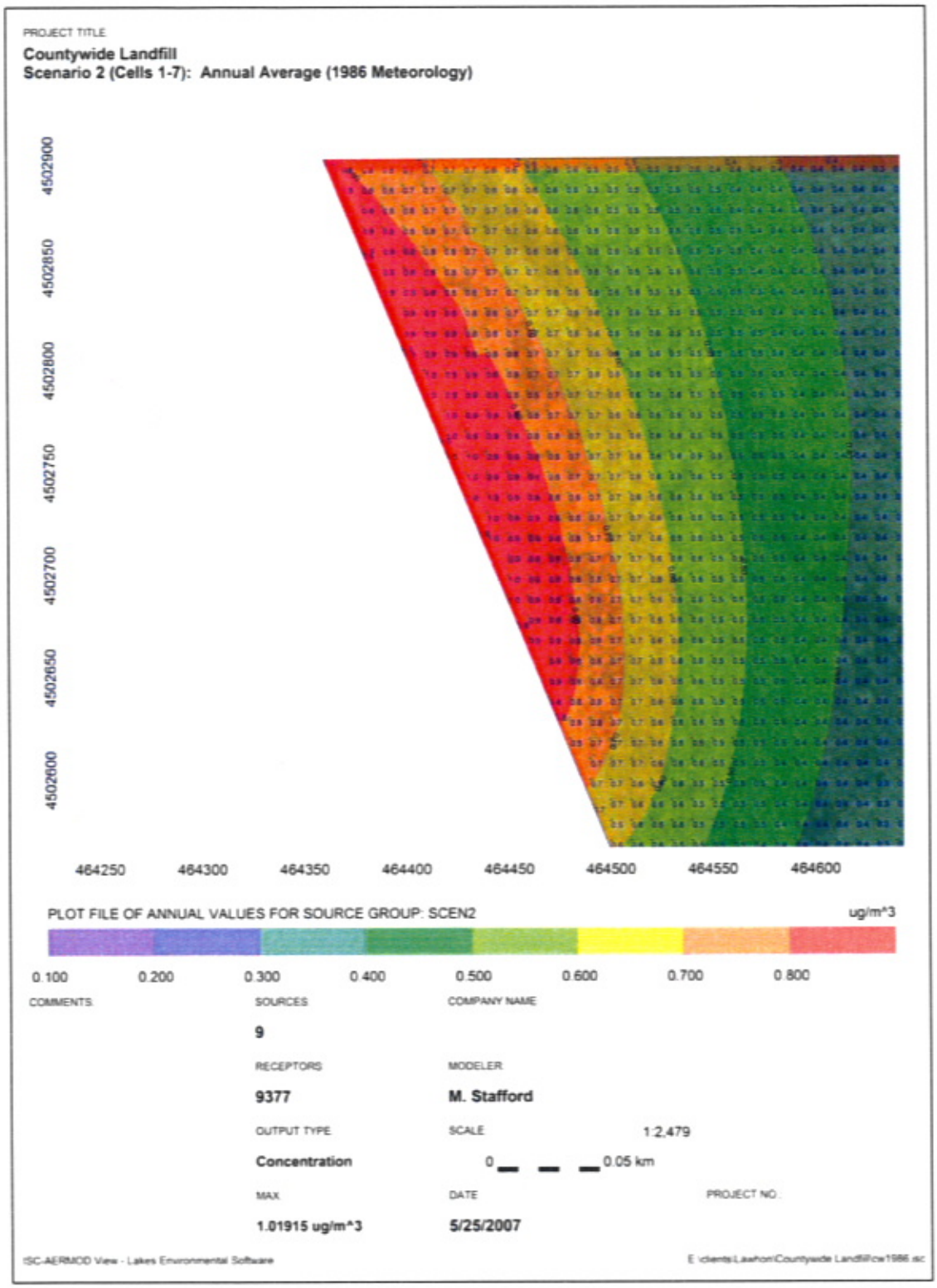

Figure 19. Fine Grid (10-m) results for Scenario 2 (annual average).

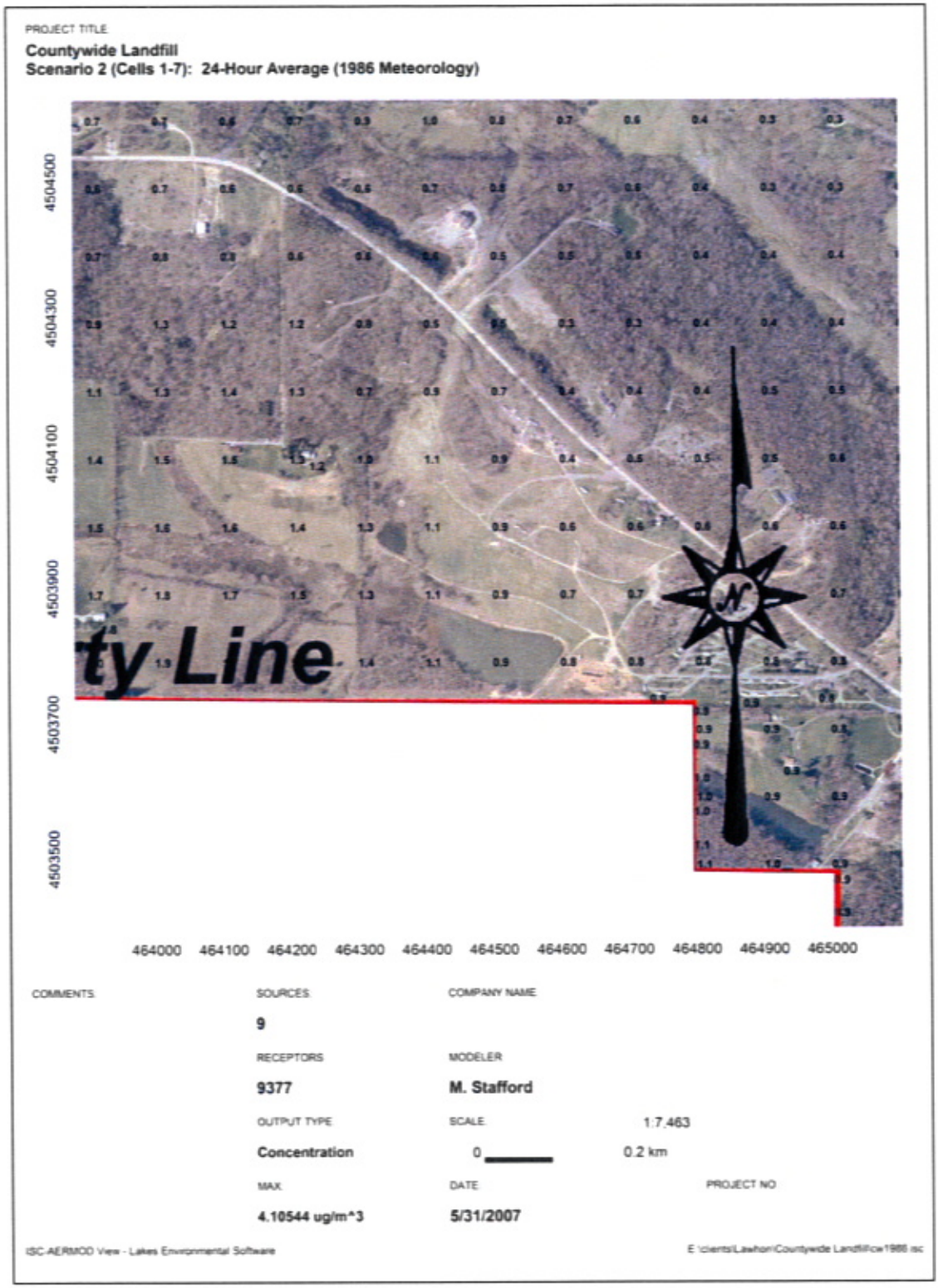

Figure 20. Results in residential area northeast of plant for Scenario 2 (24-hour average).

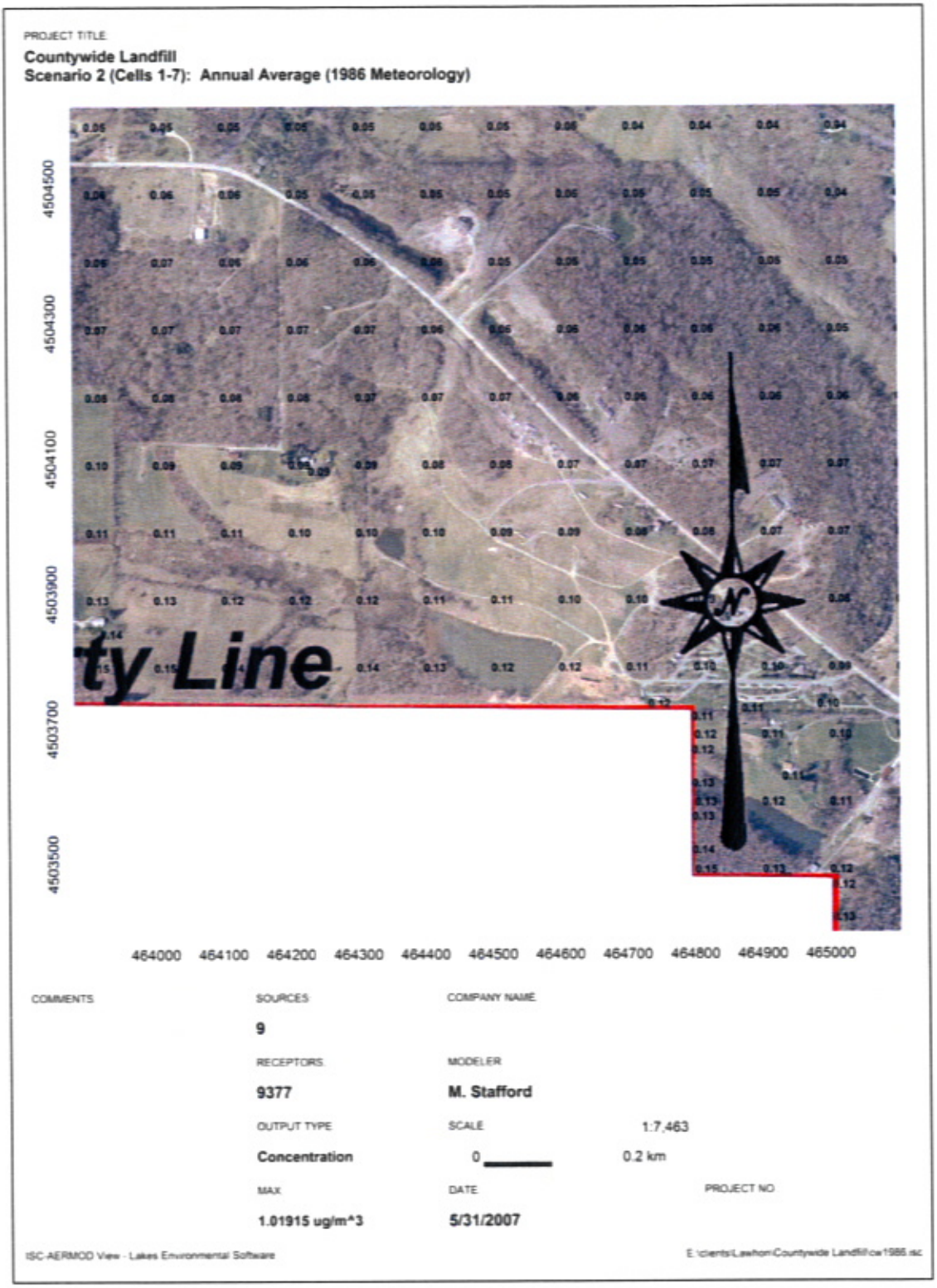

Figure 21. Results in residential area northeast of plant for Scenario 2 (annual average).

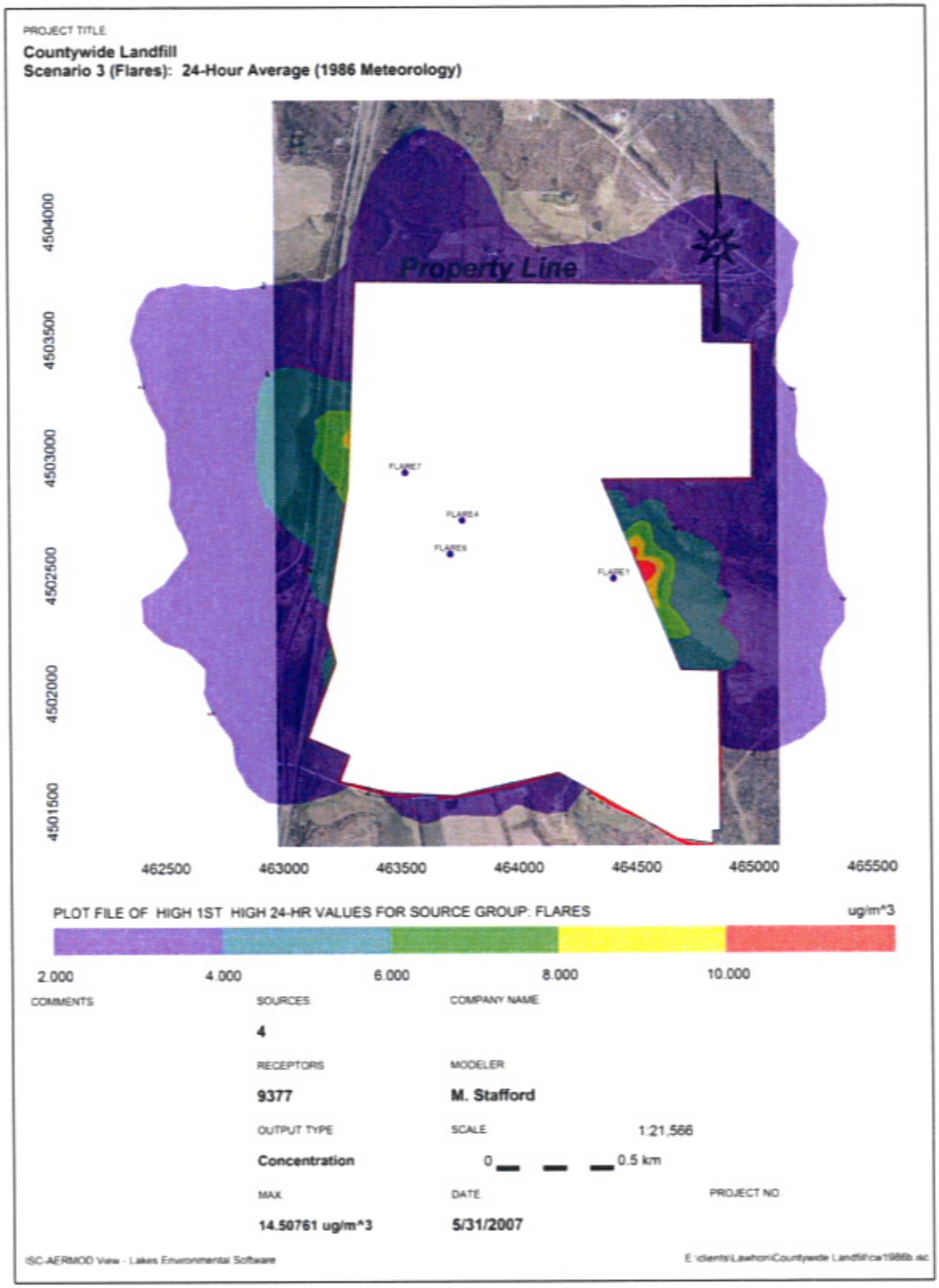

Figure 22. Coarse Grid (1-km) results for Scenario 3 (24-hour average).

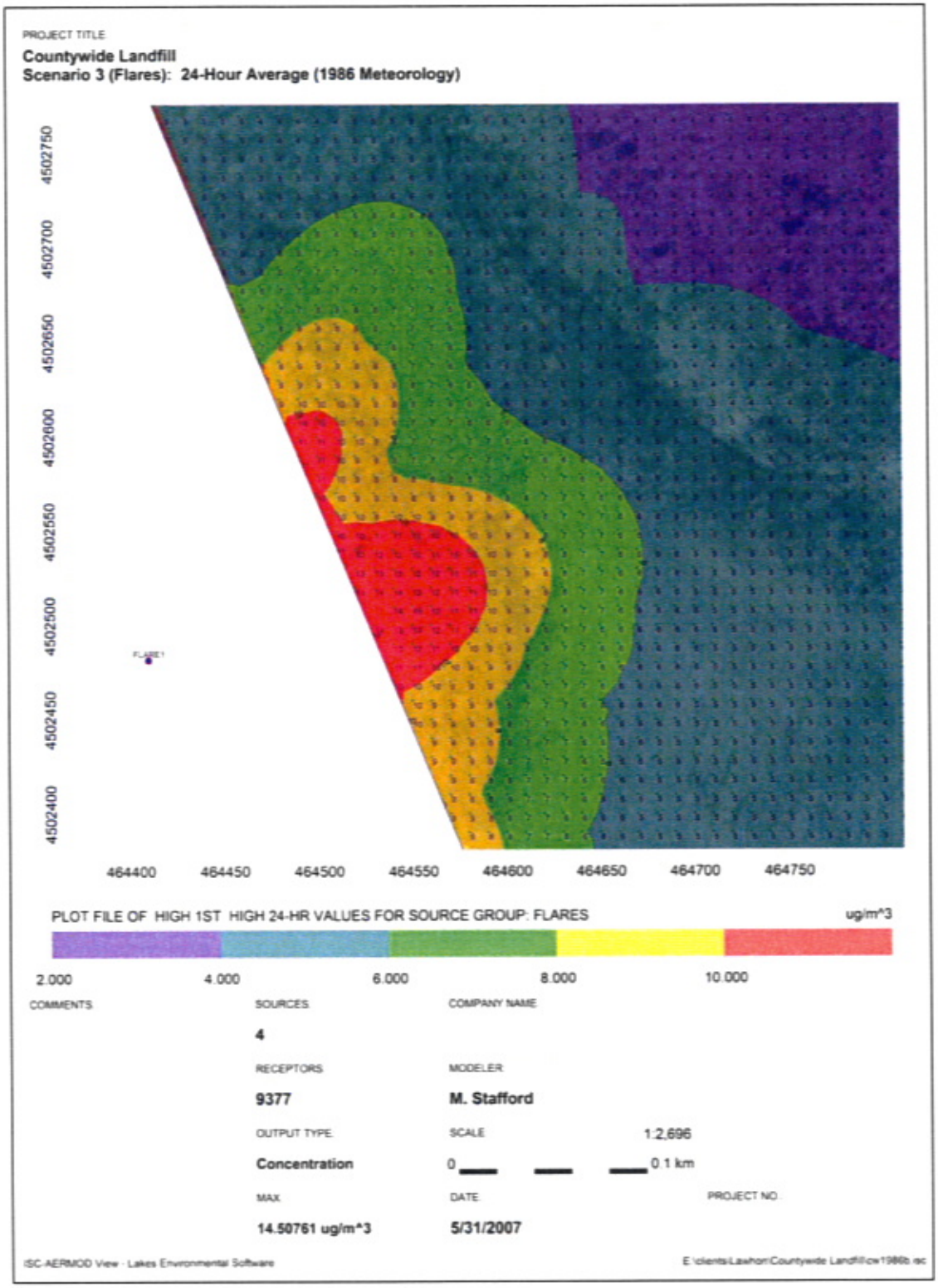

Figure 23. Fine Grid (10-m) results for Scenario 3 (24-hour average).

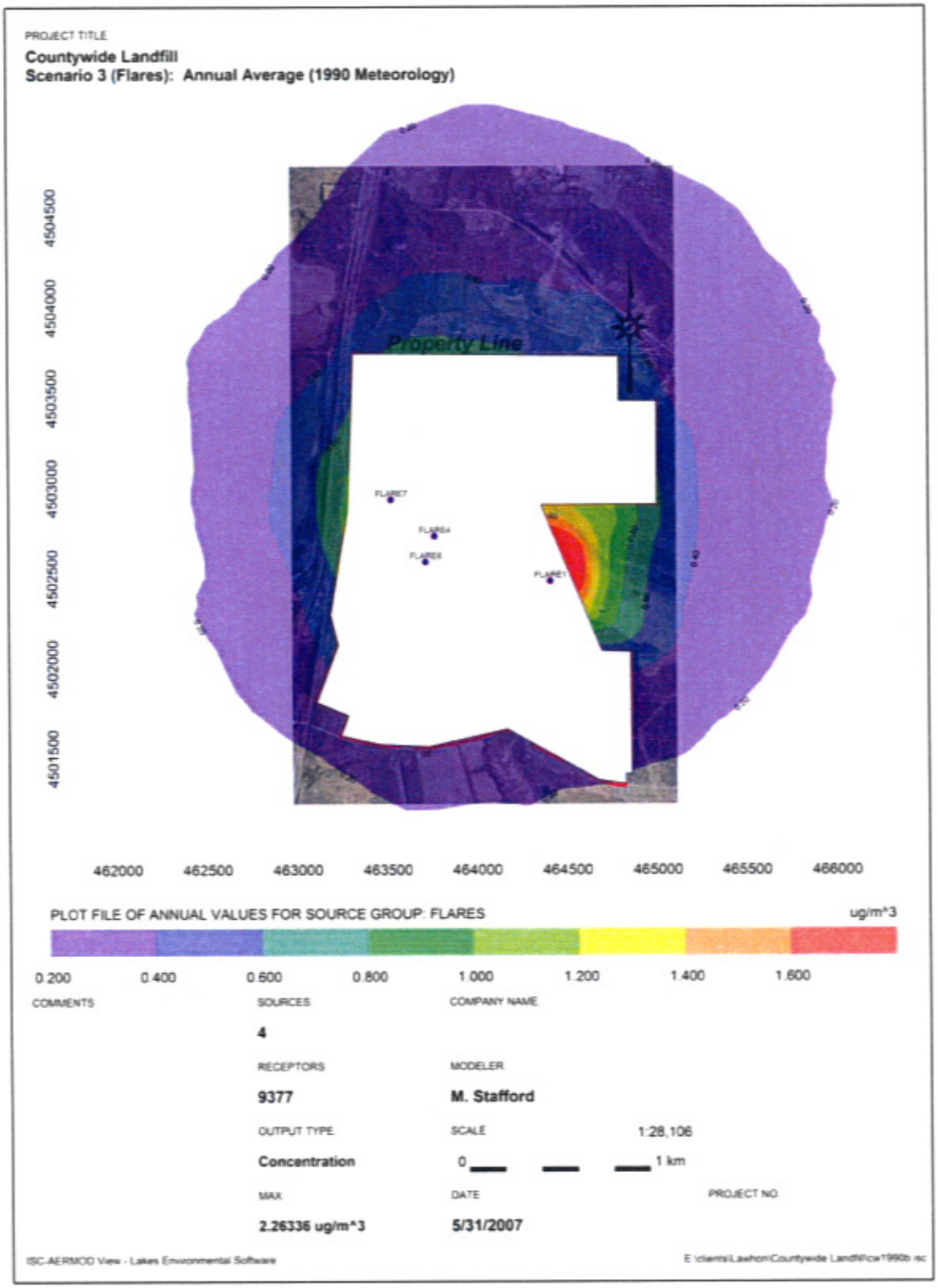

Figure 24. Coarse Grid (1-km) results for Scenario 3 (annual average).

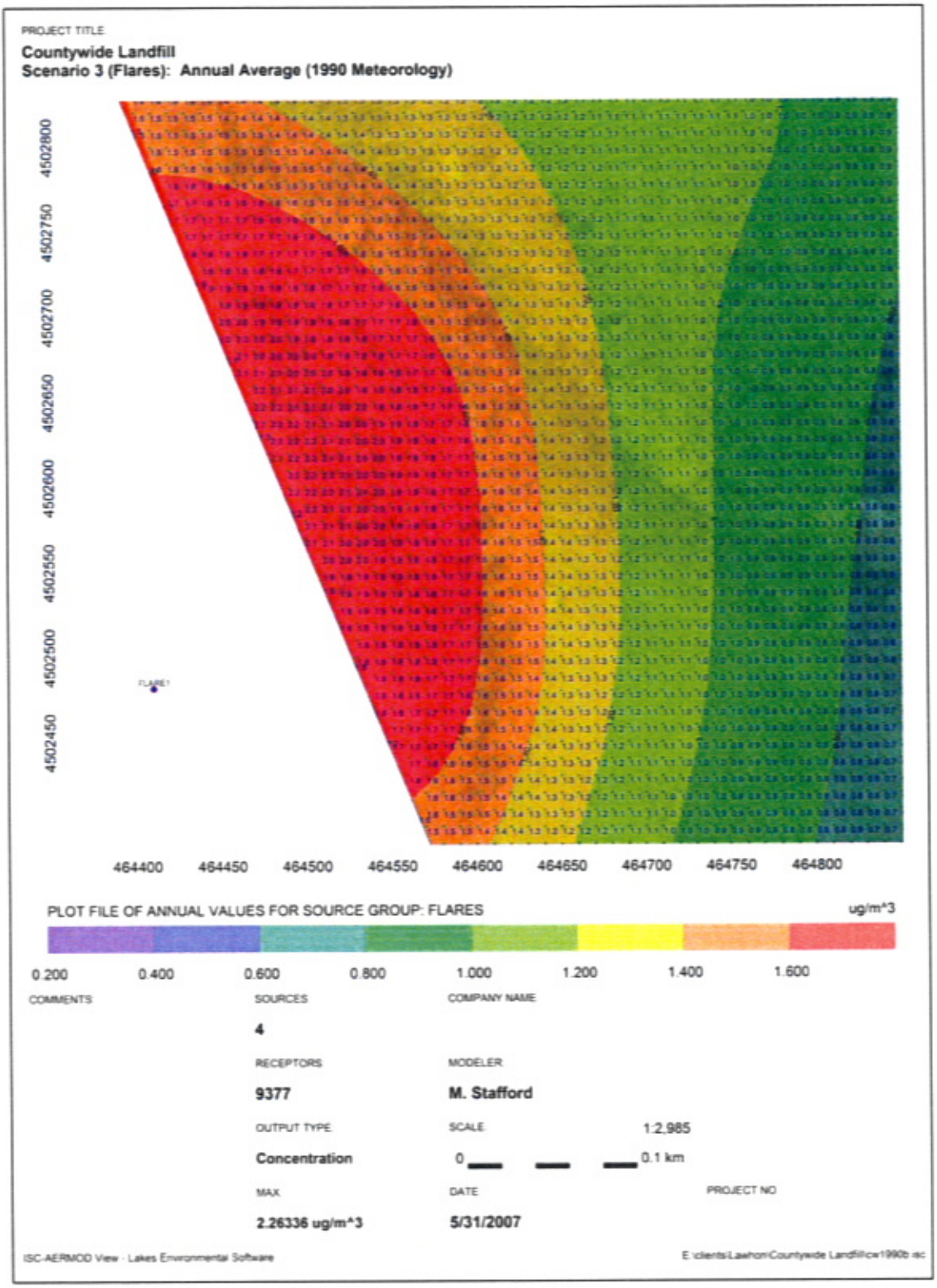

Figure 25. Fine Grid (10-m) results for Scenario 3 (annual average).

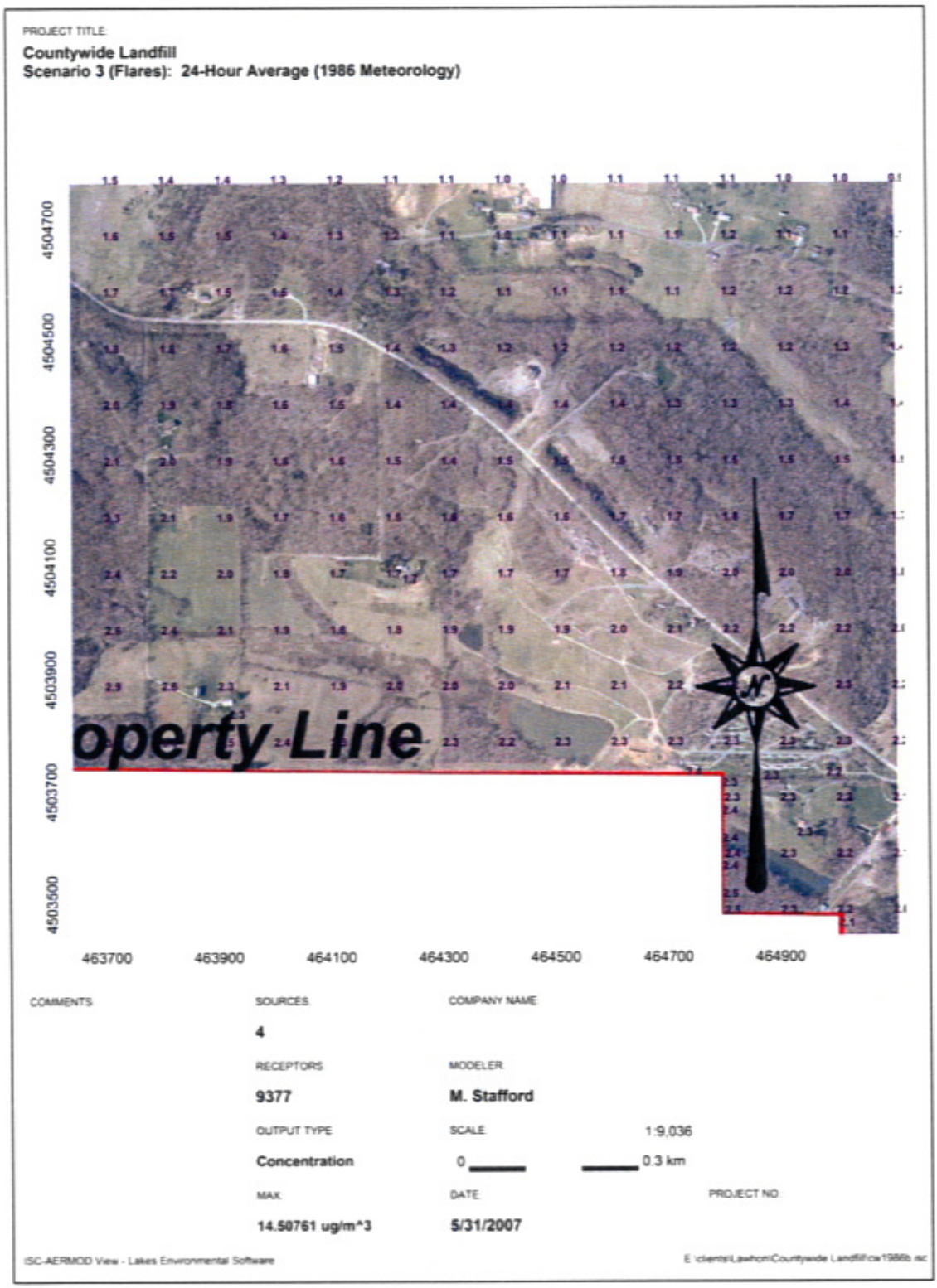

Figure 26. Results in residential area northeast of plant for Scenario 3 (24-hour average).

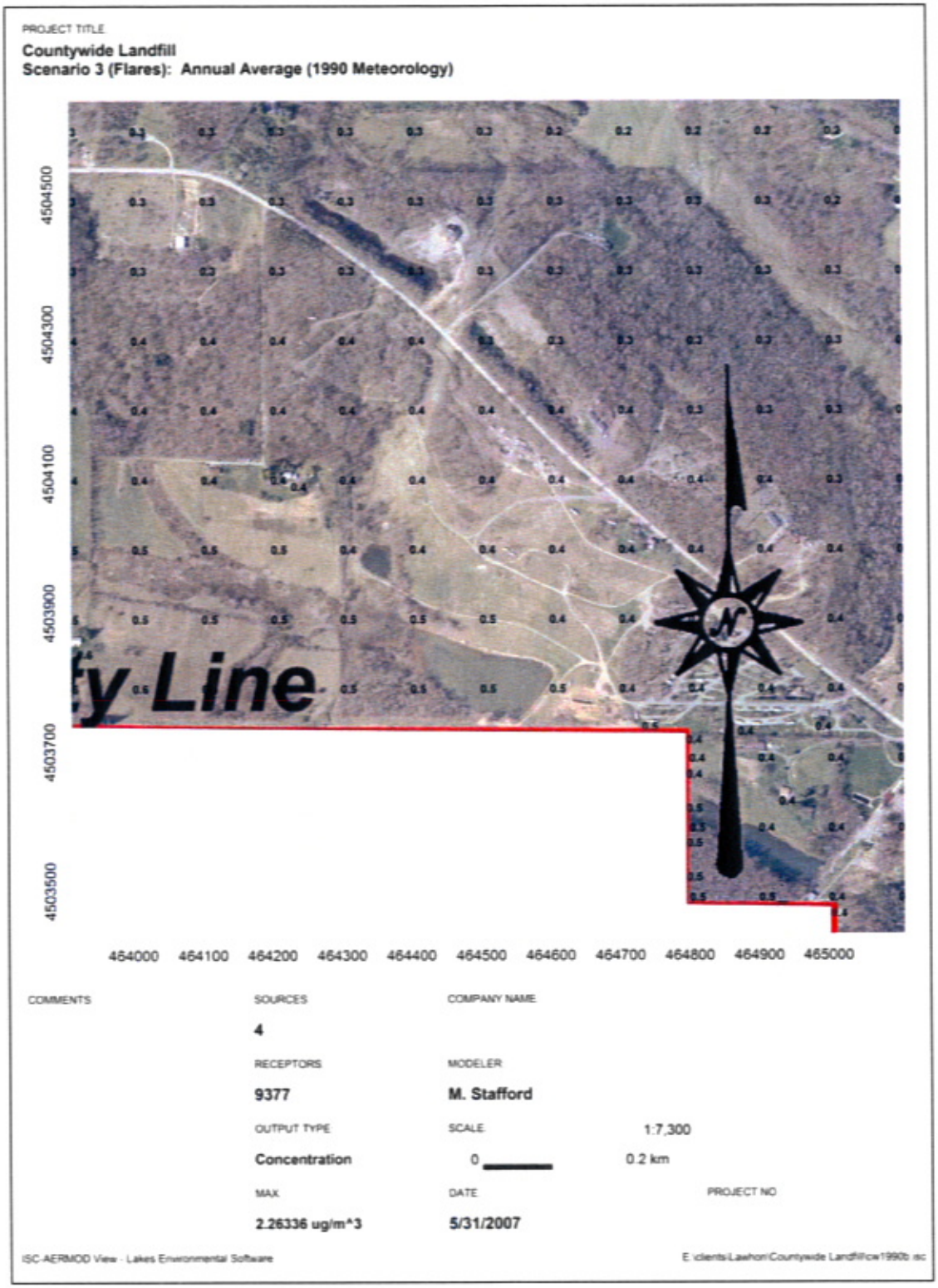

Figure 27. Results in residential area northeast of plant for Scenario 3 (annual average).