

MIDLAND COMMUNITY DIOXIN LEVELS

Information about the high levels of dioxins present in Midland community soils was made public by the EPA in 1984. However, The Dow Chemical Company had developed the analytical technology required to measure extremely low levels of dioxins in the early 1960's and had improved the technology in the 1970's and 1980's:

- 1960's - **ppm** levels of TCDD and other dioxin "families" - non-isomer specific
- 1970's - **ppb** levels of 2,3,7,8-TCDD and other dioxins, isomers
 - **ppt** levels of 2,3,7,8-TCDD and other dioxins, isomers
- 1980's - **ppq** (parts-per-quadrillion) - dioxins, isomers

With the analytical technology that the company had available in the 1960's, it is very surprising that it took almost 20 years before the Midland residents were informed about the hazardous levels of dioxins that were present in the community.

In 1984, the EPA disclosed the results of the dioxin sampling and analysis that it had carried out in Midland. In total, 33 locations were analyzed, with locations being limited to public use and recreational areas.

The restriction of sampling locations seems "understandable" if it is remembered that during the late 1970's and early 1980's, the EPA had been heavily involved with dioxin contamination in Times Beach, MO and with chemical contamination in the Love Canal neighborhoods of Niagara Falls, NY. In these two locations, residents had been evacuated and homes were eventually purchased by various governmental agencies. In addition, in the early 1980's, the EPA was becoming aware of wide-spread dioxin contamination in a low income neighborhood in Pensacola, FL. In time, the EPA would also relocate the "Mount Dioxin" residents and would purchase their properties.

With the other dioxin contaminated sites demanding EPA resources, it is very understandable if the EPA was not willing to fully define the dioxin contamination that was suspected to be present in Midland.

Midland Dioxin Levels (EPA, 1984)		
	Average	Range
TEQ, ppt (est.)	259	12.9 - 1,165
TCDD, ppt	60	3 - 270
Total Dioxins, ppt (est.)	33,562	1,678 - 151,029

In 1984, the EPA reported dioxin contamination in terms of "ppt-TCDD" and not the more current "ppt-TEQ". An updating of the 1984 data is summarized in the table on the right hand side of the page.

In 1984, the EPA concluded, "Current dioxin levels in surface soils away from the Dow Chemical plant are well below one part per billion (ppb) [1,000 ppt-TCDD]. According to the Centers for Disease Control, one ppb [1,000 ppt-TCDD] is the level at which corrective action must be considered to prevent human exposure to dioxin-contaminated soil in residential areas. Current levels of dioxins in the Midland area, therefore, do not pose an unacceptable public health risk."

Since 1984, additional scientific data has been developed about the toxicity of the other dioxins. A level of 1,000 ppt-TEQ has now been established as the level at which some degree of mandatory corrective action is required. If the TEQ standard had been in effect in 1984, the 1,165 ppt-TEQ that was found in Midland would have entailed, as a minimum, additional testing and possibly some degree of remediation.

Dioxin Levels in Midland Community Soils

A number of Midland locations with high dioxin levels have received community and media review. However, there are some Midland community locations with even higher levels of dioxin contamination that have not received as much attention

In May, 2004, the DEQ posted a map of the various Midland Area dioxin sample locations that provides an excellent perspective of community dioxin levels. A copy of the map is available via a link on DioxinSpin.com (Dioxin Levels) or via this link: [DEQ2004 Midland Dioxin](#)

For the readers that are familiar with the Midland area, the summary shown below provides dioxin levels for some of the locations shown on the DEQ map.

Midland Area Dioxin Levels (1983, 1984, 1996, 1998)			
<u>Old Towne</u>	<u>TEQ-ppt</u>	<u>Virginia Park Area</u>	<u>TEQ-ppt</u>
Tibbs St.	930	Area A	510
Jefferson and Austin	750	Area B	230
Indian and 5th St.	630	Sample No. NE-P25	121
Grove Park	230		
Patrick and Washington	230		
<u>Mark Putnam Road Area</u>	<u>TEQ-ppt</u>	<u>Longview School Area</u>	<u>TEQ-ppt</u>
Area A	1400	Area A	230
Area B	510	Area B	220
		Sample No. NE-S14	67
<u>Bullock Creek Elem. School</u>	<u>TEQ-ppt</u>	<u>Dow Chemical Perimeter</u>	<u>TEQ-ppt</u>
Area A	320	Saginaw Road	6100
Sample No. SW-S39	95	Sample No. NE-47	646
		Main Street Gate	310

Based on the above information, it is apparent that there are several general areas that have and have had dioxin levels in excess of the 90 ppt-TEQ State of Michigan criteria. This information supports the DEQ position that additional testing is needed to better define the extent of dioxin contamination in the Midland community.

DIOXIN LEVELS PRIOR TO 1984

Although the 1984 EPA data does not represent a full accounting of dioxin levels in the community, the 1984 data does have value for it can be used as the basis to calculate dioxin levels from 1984 back to 1936

Dioxins and furans have both a biological and environmental half-life. The biological half-life is the time required for a living organism to reduce the concentration of a chemical to a 50% level once further chemical intake has been discontinued. The environmental half-life is the time required for environmental forces to reduce a chemical's concentration to 50% of the original concentration, once further addition of the chemical has ceased.

The environmental half-lives of dioxins can be used to calculate ("model") dioxin levels in the community in earlier years. Additional information on the mathematical modeling (including estimates of the environmental half-lives of dioxins) can be found in the section labeled "Mathematical Modeling of Dioxin Levels" beginning on Page 13.

The modeling calculations are helped by two assumptions:

1. The Vertical Tar Burner was started up in ~1937 when Dow constructed the Phenolic Waste Water Treatment Plant to biologically treat the phenolic wastes that were responsible for the foul chemical taste in fish taken from waters downstream of Dow's discharges. Since the concentrated phenolic wastes could not be treated in the treatment plant, the VTB was needed to incinerate these wastes. Prior to the startup of the VTB, the only dioxins present in the community had been emitted by the company's coal-fired powerhouses. For modeling purposes, it is assumed that community dioxins levels were "zero" in 1936.

2. Dow constructed several tar burners and incinerators from 1936 to 1968. All of these units lacked air pollution control equipment that was capable of removing dioxin-laden particulates with high efficiency. In 1968, the company constructed the 830 Tar Burner which was based on an induced draft design that allowed the installation of a venturi scrubber that significantly reduced dioxin emissions. Shortly after 1968, the 703 Rotary Kiln Incinerator was retro-fitted with an exhaust fan and a venturi scrubber. For modeling purposes, it is assumed that the emission of high levels of dioxins was substantially reduced after 1968.

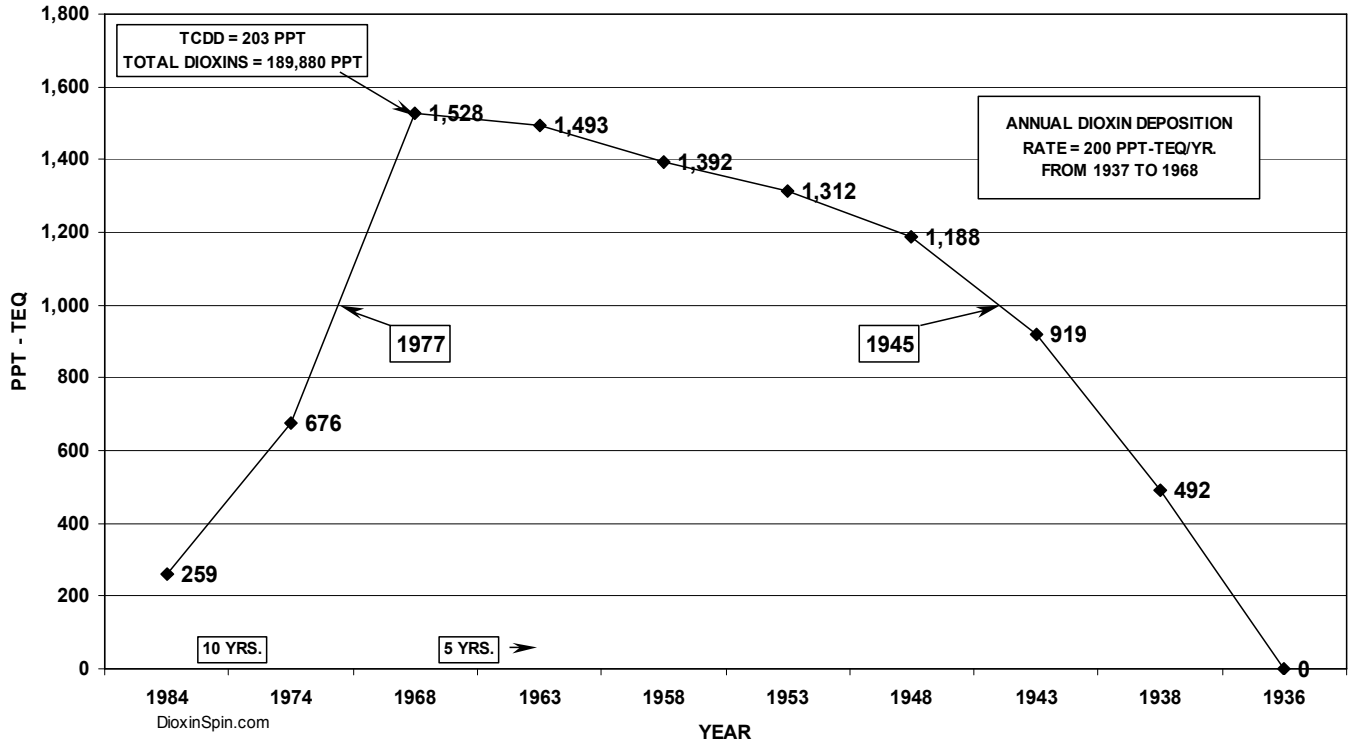
Dow's installation of air pollution equipment capable of reducing dioxin emissions in the late 1960's and early 1970s' is interesting in that the equipment was installed approximately 10 years before Federal standards on hazardous waste incinerators were developed.

While there could be several reasons for the earlier than required installations, one possible explanation was that the company had determined that the very high levels of dioxins, being found in both the Midland community and in the Midland plant, were the result of prior emissions from the company's various chemical waste incinerators. However, it does seem unusual that a company would invest millions of dollars in air pollution control equipment just to minimize the emissions of very low levels of chemicals that the company believed were harmless, except for a mild skin condition called chloroacne.

The earlier-than-needed installation also suggests that Dow may have known about the high levels of dioxins in the community and in its plant earlier than 1984.

The chart on the next page is a graphical summary of dioxin levels in the Midland community based on the average level of dioxins (ppt-TEQ) that were found in 1984 by the EPA.

MIDLAND COMMUNITY DIOXIN LEVELS
PPT-TEQ
(1984 EPA Data)



Several conclusions as to dioxin levels in the community can be drawn from the dioxin level calculations:

1. Dioxin levels increase from “0” ppt-TEQ in 1936 to a maximum of 1,528 ppt-TEQ in 1968. Although the modeling assumes a constant addition of 200 ppt-TEQ per year of dioxins into the community, it is more likely that the annual dioxin addition rates changed from year to year depending on overall production levels and which incinerator or tar burner was in operation. However, it is still reasonably certain that dioxin levels in 1936 were “0” and levels in 1968 were approximately 1,500 ppt-TEQ.
2. The modeling indicates that, at least based on the 1984 dioxin levels, that dioxin levels were greater than 1000 ppt-TEQ from approximately 1945 to approximately 1977 (32 years).
3. Once the deposition of further amounts dioxins had ceased, environmental degradation reduced community dioxin levels from 1,528 ppt-TEQ in 1968 to an average of 259 ppt-TEQ in 1984.

Calculated Midland Dioxin Levels - 1996 Dioxin Data

The dioxin level modeling that was shown on the previous page was based on dioxin levels measured in 1984. More recent dioxin data obtained from the 1996 analysis carried out by the DEQ can also be used to calculate dioxin levels in earlier years.

The 1996 DEQ sampling and analysis of Midland identified two locations that had extremely high levels of dioxins:

<u>Sample No.</u>	<u>Sample Location</u>	<u>Total Dioxin</u>	<u>TEQ</u>
NE-20	Intersection: Salzburg Rd. & Rockwell Dr.	30,116 ppt	652 ppt
NE-47	Intersection: Saginaw Rd. & Bay City Rd.	74,659 ppt	646 ppt

However, since other locations sampled in 1996 had dioxin levels that were much lower than these two locations, the data from NE-20 and NE-47 will not be used in the modeling to avoid a bias that use of the highest dioxin levels gave unusually high calculated dioxin levels.

The number of Midland locations that have been sampled in 1996 are so few in number that there is less than a 1% probability that all locations of high dioxin contamination have been identified.

In order to partially compensate for the small number of sampled locations, the arithmetic average of the three highest levels of individual dioxins (excluding NE-20 and NE-47) will be used as the basis for the first calculations. Nine locations with an average distance of 1.75 miles (range: 0.9 - 2.6 miles) from Dow's incinerators were used to estimate the dioxin levels that would be used in the 1996-based modeling.

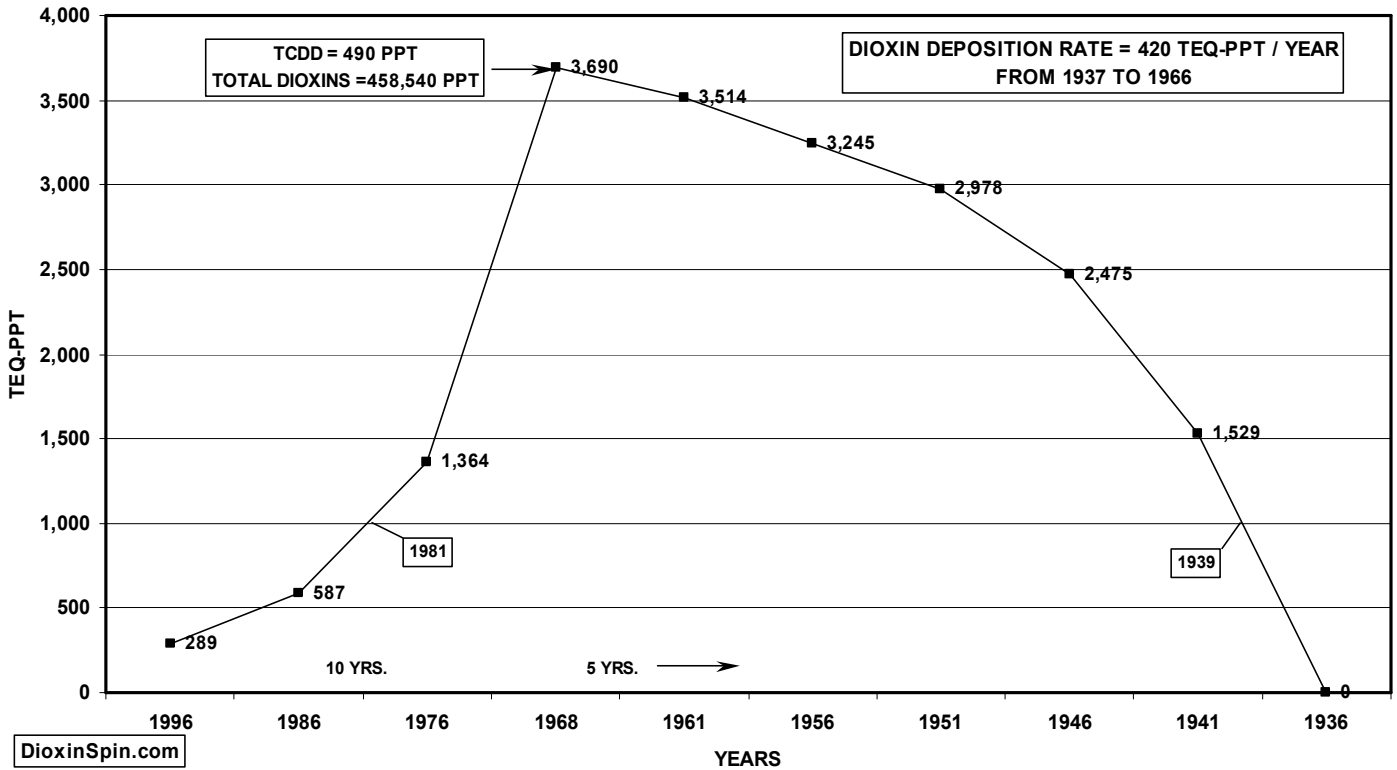
**Midland Community Dioxin Levels
(Modeling Basis : 1996 Analysis)**

Total Dioxins	34, 878 ppt
TEQ	289 ppt

It should be noted that the TEQ level that will be used for the modeling is below some of the dioxin levels found in 1998 at Dow's Corporate Center (Avg. 152 ppt TEQ, Range 77 - 513 ppt TEQ). Dow has indicated that the Corporate Center dioxin levels are representative of residential dioxin levels.

The average dioxin level of 289 ppt-TEQ found in the 1996 sampling is similar to the average dioxin level of 259 ppt-TEQ found in the 1984 sampling. However, the 12 years of difference will have a significant impact on the calculations. The chart on the next page is a chart of Midland community dioxin levels from 1996 to 1936, based on the 1996 DEQ data.

MIDLAND DIOXIN LEVELS
BASIS : AVG. 3 HIGHEST LEVELS (1996)
(1996 to 1937)

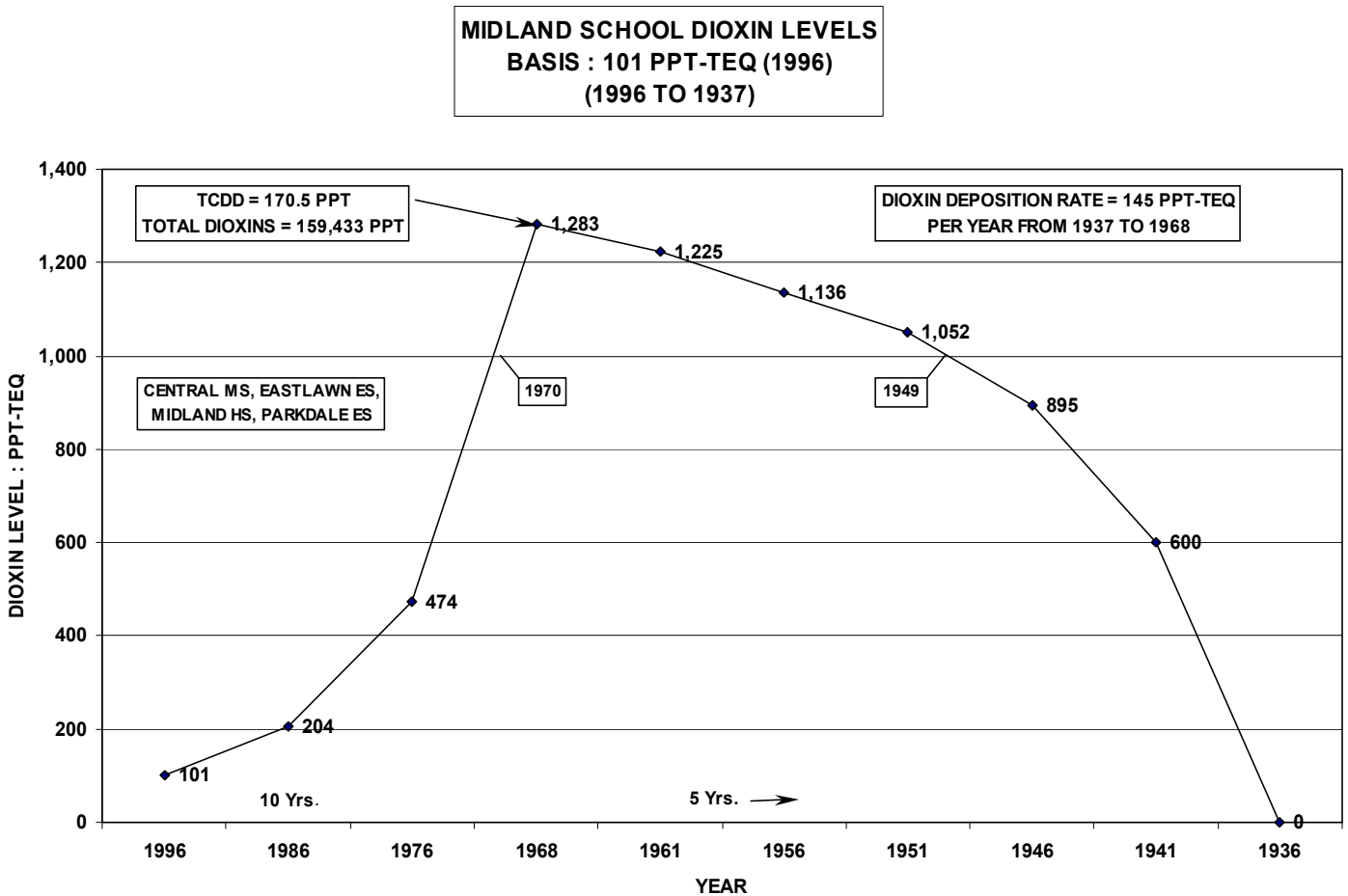


The modeling of Midland community dioxin levels based on 1996 DEQ dioxin levels shows a pattern that is similar to the modeling based on 1984 EPA dioxin data:

1. Dioxin levels increase from “0” in 1936 to a maximum of 3,690 ppt-TEQ in 1968 based on the assumption that the deposition of additional amounts of dioxins into the community averaged 420 ppt-TEQ per year.
2. The modeling indicates that dioxin levels were greater than 1000 ppt-TEQ from 1939 to 1981 (a span of 42 years).
3. With the discontinuation of additional amounts of new dioxins, average community dioxin levels dropped from 3,690 ppt-TEQ in 1968 to 289 ppt-TEQ in 1996 through environmental decomposition. By 1981, average dioxin levels had reached the critical level of 1000 ppt-TEQ but still remain higher than the allowable 90 ppt-TEQ.

Midland Public School Dioxin Levels

In 1996, the DEQ measured the dioxin levels that were present at four Midland public schools that are approximately equidistant (2.0 miles) from Dow’s incinerator complex. The 1996 data was used to calculate community dioxin levels in prior years at the schools and in neighborhoods adjacent to the schools. The four schools (Central MS, Eastlawn ES, Midland HS, Parkdale ES) had an average dioxin level of 101 ppt-TEQ and 6,991 ppt of Total Dioxins.



The modeling of dioxin levels in the vicinity of the four schools is consistent with the prior modeling of the Midland community — dioxin levels increase from 1936 to 1968 with the highest levels occurring in 1968. Without additional dioxins being added to the inventory already present, dioxin levels degrade through environmental factors from the high levels calculated in 1968 to the levels that were measured in 1996.

A lifelong resident remembered walking through “grey snow” in the morning when he was a student at Carpenter Elementary School. By the time he reached the school, his shoes and pant legs were black. His current age is unknown, but assuming that he is approximately 52 years old, he must have attended Carpenter ES from 1958 to 1965. Although the Carpenter ES location was not sampled, this school is only a 1/4 mile further away from Dow’s incinerator

complex than are the four schools that were the basis for the modeling.

On the assumption that “grey snow” and dioxins levels are similar at all of these schools, a child that lived and grew up in Midland was exposed to the following levels of dioxins while attending Carpenter ES school from 1958 to 1965.

Dioxin Levels - Carpenter ES (1958 to 1965)	
Total Dioxins, ppt	145,390 - 158,315
Dioxins, TEQ-ppt	1,170 - 1,274
TCDD, ppt	156 - 169

Dow Midland Plant Dioxin Levels: 1936 to 1998

It has been generally assumed that the 2,100+ Midland plant employees that were exposed to dioxins in the dioxin-related manufacturing plants were the Dow employees that experienced the highest degree of dioxin exposure.

Dow has never released specific information as to the dioxin exposure levels, as measured by dioxin body burden levels, of the 2,100+ employees. However, based on the levels of dioxins that have been found in the soils of the Midland site, it is almost certain that a great many more Midland plant employees had high dioxin exposures — at least higher than the 220 employees of the Erbon and Ronnel plants that were included in the studies of Dow’s dioxin exposed workers.

For those readers that are unfamiliar with the Erbon and Ronnel plants, data provided by Dow indicates that the TCDD concentration in the Ronnel plant was “Not Detectable” in 17 out of 17 tests wipe tests and “Not Detectable” in all of the process streams that were tested. Since Dow did not provide any dioxin contamination data for the Erbon plant, it must be assumed that the company recognized that TCDD would not be present in this plant and, therefore, TCDD was not measured.

Samples, taken over a number of years, indicate that the Midland plant site is heavily contaminated with dioxins.

Dow Midland Plant Dioxin Levels (ppt)

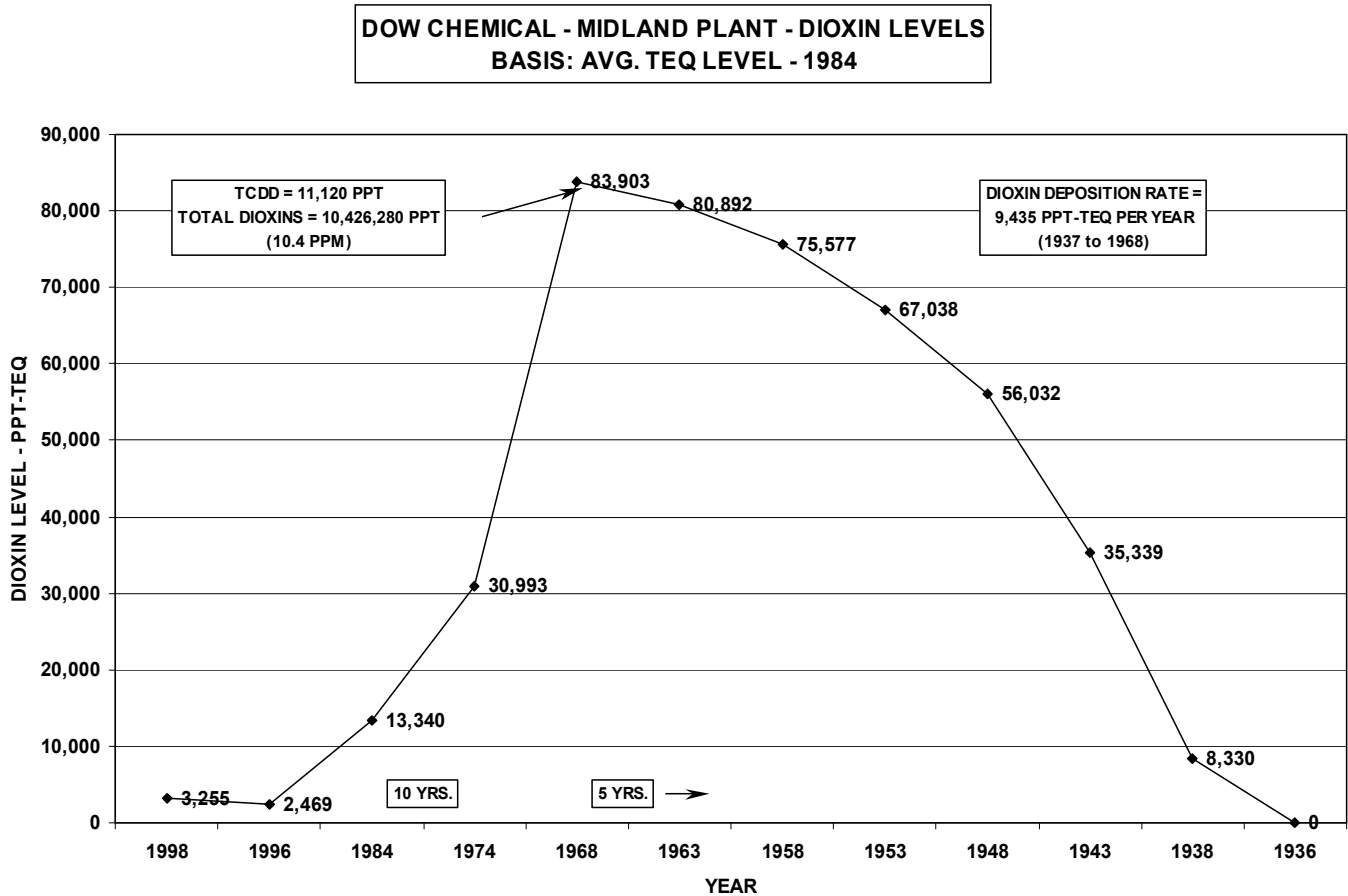
	<u>Year</u>	<u>Dioxin</u>	<u>Range</u>	<u>Average</u>
EPA	1984	TCDD	10 - 36,000	3,090
EPA	1984	TEQ*	43 - 155,400	13,340
DEQ	1996	TEQ	16.5 - 12,900	2,469
DEQ	1998	TEQ	5 - 18,000	3,255

* estimated

Dow has carried out significant remediation inside the Midland plant to reduce potential worker exposure to dioxins present in the soils and carried into the breathing zones by the winds. Remediation has included blacktopping and clay capping of certain highly contaminated areas and various other dust suppression activities.

While it is apparent that progress has been made from 1984 to 1996 (TEQ levels are 50% lower than environmental degradation), it is believed that the company must be disappointed that dioxin levels increased from 1996 to 1998 by more than 30%. It is also expected that Midland plant workers were also disappointed with the higher risk to human health, as indicated by the 1998 sampling.

With 1984 (13,340 ppt-TEQ) as the base year, Midland plant dioxin levels from 1984 to 1936 have been calculated and are shown below. Dioxin levels measured in 1996 and 1998 have also been added to the chart.



The model calculated that the average dioxin deposition rate was 9,435 ppt-TEQ per year from 1937 to 1968. Within a very few months after the startup of the Vertical Tar Burner, average dioxin levels in the plant exceeded 1,000 ppt-TEQ. Despite environmental degradation and remediate efforts by Dow, average dioxin levels were still in excess of 1,000 ppt-TEQ in 1998.

Midland Plant Dioxin Levels (continued)

Prior to the 1984 sampling by the EPA, Dow had carried various remediation activities at the Midland plant. Some of the plant locations that were sampled had undoubtedly been effected by the closure and remediation activities and it is probable that dioxin levels at some locations were lowered by more than just environmental degradation.

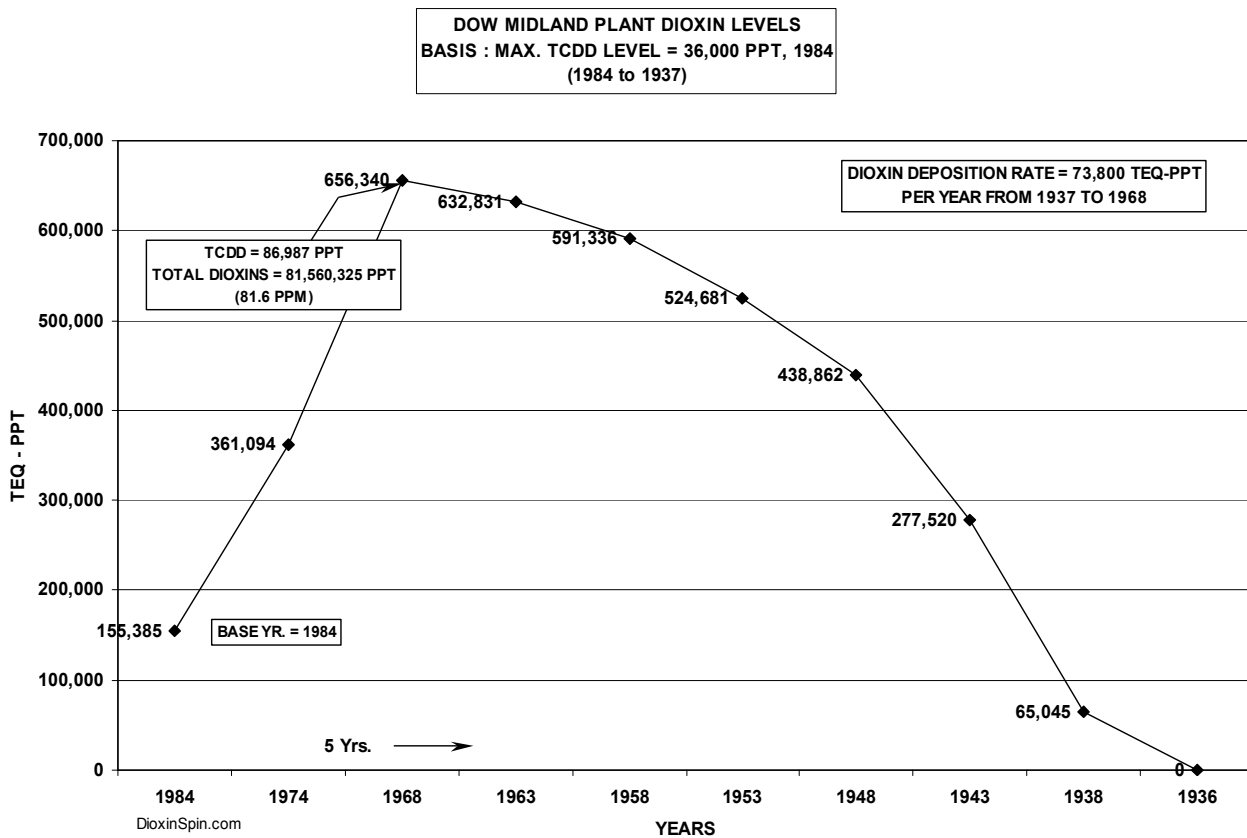
However, one sampled location may not have been impacted by the remediation efforts. The location is adjacent to a railroad track that is located inside the fence line of the plant, west of Saginaw Road and east of the Chesapeake and Ohio R.R. tracks. The first analysis found 25,000 ppt-TCDD and a re-sample found an even higher level — 36,000 ppt-TCDD. Please note that the levels are “ppt-TCDD” and not “ppt-TEQ”.

The location is approximately 0.5 miles from the incinerator complex and is almost directly downwind based on the average prevailing wind direction.

With the R.R. tracks in close proximity, it is doubtful if any remediation work had been carried out at the location. It is possible, but very unlikely, that the high TCDD levels were the result of a spill from a railcar in transit on the railroad tracks.

In all probability, the level of dioxins that were found at this location may be typical of dioxin levels in undistributed Midland plant soils downwind from the site’s incinerator complex.

The following chart is an estimate of Midland plant dioxin levels using 36,000 ppt-TCDD level found in 1984.



Midland Plant Dioxin Levels (continued)

The modeling indicates that, in order to have TCDD levels of 36,000 ppt (155,385 ppt-TEQ) in 1984, dioxin levels would need to be 86,987 ppt-TCDD (656,340 ppt-TEQ) in 1968. To reach these levels of dioxins, dioxins would need to be deposited at a rate of 73,800 ppt-TEQ per year from 1937 to 1968.

Elevated Mortality of Midland Plant Workers

The dioxin levels in certain locations in the Midland plant would seem to be very, very high. The high levels might help to explain three abnormal medication conditions that have been noted in Midland plant employees.

(1) Several Dow epidemiology studies have confirmed that the Midland site has a statistically significant elevation of mortality from very rare cancers. These cancers occur so infrequently that the International Classification of Diseases has not assigned a specific cancer category to these cancers. These rare cancers are grouped together into a single category — Cancers of Other and Unspecified Sites. The NIOSH, 1991 study found a similar elevation in chemical workers in twelve plants that were exposed to high levels of dioxins. Dow has indicated that it can not explain the elevation of these rare cancers at the Midland site.

(2) The second unusual medical condition is a statistically significant elevation of mesothelioma among Midland plant workers. Malignant mesothelioma is a rare form of cancer in which cancer cells are found in the sac lining the chest, the lining of the abdominal cavity or the lining around the heart. In the general US population, more than 90% of mesothelioma is associated with asbestos exposure. For Dow's Midland plant employees, more than 60% of mesothelioma may be related to chemical exposure, quite possibly dioxin exposure.

(3) The third unusual medical condition is an elevation of overall and cancer mortality of the hourly workers at the Midland plant versus that of the salaried employees. The mortality of the hourly workforce increases with duration of employment. With 20 years or more of Dow employment, the elevated mortality from All Cancers of the hourly worker becomes statistically significant. It is well recognized that hourly employees incur a greater degree of chemical exposure than do salaried employees. It is also possible that the Midland plant hourly workers also incurred a great degree of environmental dioxin exposure due to the greater amount of outdoor exposure due to their work activities.

Additional information on the increased mortality of the Midland plant hourly workforce can be found in the Section of the web site labeled "Dioxin Toxicity" - "Midland Plant Employees" or via this link: [Link to Midland Plant Employees](#)

Dioxin Congener Profile

A regression analysis of the dioxin congener profile of Midland area dioxin levels strongly suggests that the majority of dioxins still being found in Midland soils were emitted by Dow's first tar burner — the Vertical Tar Burner.

The next table is a comparison of congener profiles from the 1996 sampling data and the 1937 congener profiles calculated as part of the dioxin level modeling. The table also shows the average dioxin levels being emitted by current hazardous waste incinerators.

Midland Community Dioxin Composition

	<u>1996 DEQ Sampling</u>	<u>1936 Modeling</u>	<u>Typical Emissions (4)</u>
Trichlorophenol dioxins (1)	4.5%	0.5%	5.6%
Tetrachlorophenol dioxins (2)	1.0%	0.6%	4.9%
PCP based dioxins (3)	94.5%	98.9%	89.5%

(1) - 2378-TCDD, 12379-PeCDD, 2378-TCDF, 12378-PeCDF, 23478-PeCDF

(2) - 123789-HxCDD, 123678-HxCDF, 123789-HxCDF, 23478-HxCDF

(3) - 123478-HxCDD, 1234678-HpCDD, OCDD, 123478-HxCDF, 1234678-HpCDF, 1234789-HpCDF, OCDF

(4) - EPA, 2000 - Average Dioxin Profile from Hazardous Waste Incinerators

Any comparison between the dioxin profile found in Midland and the dioxin profile emissions of several modern hazardous waste incinerators is strongly influenced by the dioxin profile in the wastes being fed into the incinerators and tar burners. However, there is enough evidence to reasonably conclude that a significant majority of the dioxins that are still being found in Midland were emitted by Dow's Vertical Tar Burner during the time period from 1937 to 1958.

As readers may all ready know, the Vertical Tar Burner was Dow's first tar burner at the Midland Plant. The unit was initially coal-fired, but was converted to either gas or fuel oil when it was relocated from its original location on 11th street to the current incinerator complex. Based on information supplied by Dow and other sources, the relocation occurred between 1949 and 1962.

When a metal grate above the burning coals was visually hot enough, liquid tars were sprayed on the grate and coals. The VTB did not have any air pollution control equipment to reduce emissions. It is believed that the VTB was used primarily for the disposal of chlorinated and non-chlorinated phenolic tars from approximately 1937 to 1948. In 1948, Dow's first rotary kiln incinerator, with tar burning capability, was built at the Midland plant

From 1937 through the Second World War and to 1948, the VTB was Dow's only tar burner at the Midland plant. The unit remained on standby service until the 1960's.

In 1957, Dow constructed a new stationary tar burner and the VTB was used as a standby burner. Although the exact design of the 1957 tar burner is not known precisely, based on a 1959 photograph, it appears as if the 1957 tar burner was constructed without any air pollution control equipment.

With time, the 1957 tar burner became a recognized source of visible air pollution and it is reasonably certain that the 1957 tar burner also contributed to the buildup of dioxins in Midland.

Mathematical Modeling of Dioxin Levels in Prior Years

Dioxins have environmental half-lives that can vary substantially depending on a variety of environmental conditions. However, there is some degree of scientific agreement that the environmental half-life of 2,3,7,8-TCDD is approximately 8 to 12 years in the topmost layer of soils. A TCDD half-life of 9.8 years was used in the modeling that is presented in this paper.

Information on the environmental half-lives of the other dioxins is very limited. Estimates of the biological half-lives of the other dioxins has been developed based on a measurement of dioxin levels in human breast milk following dioxin exposure. These biological half-lives were then used to estimate the environmental half-lives used in the modeling calculations.

Estimates of the biological and environmental half-lives of the seventeen most toxic dioxins are shown in the table below.

	Biological Half-Life	Environmental Half-life		Biological Half-Life	Environmental Half-life
2378-TCDD	7.2 yrs	9.8 yrs	2378-TCDF	7.2 yrs	9.8 yrs
12378-PeCDD	15.7	23.6	12378-PeCDF	15.7	23.6
123478-HxCDD	8.4	12.6	23478-PeCDF	19.6	29.4
123678-HxCDD	13.1	19.7	123478-HxCDF	6.2	9.3
123789-HxCDD	4.9	7.4	123678-HxCDF	6	9.0
1234678-HpCDD	3.7	5.6	234678-HxCDF	5.8	8.7
OCDD	6.7	10.1	123789-HxCDF	6	9.0
			1234678-HpCDF	3	4.5
			1234789-HpCDF	3.2	4.8
			OCDF	6.7	10.1

The environmental half-life of a dioxin is the number of years in which the concentration of the dioxin is reduced (through environmental factors) to 50% of the initial level once addition of dioxin has ceased.

Dioxin levels in subsequent years can be calculated from the following equation:

$$C_{T=X} = C_{T=0} \times 0.5^{(x \text{ yrs.}/\text{Half-life, yrs.})}$$

The most precise determination of dioxin levels is based on a calculation of the level for a specific dioxin based on the individual dioxin half-life. Individual dioxin levels are then summed to yield Total Dioxin Level in a particular year.

Calculation of Total TEQ in prior years is equal to individual dioxin levels in that year times the associated TEF (Toxicity Equivalency Factor) for each dioxin and then summing the individual TEQ's.

Dioxins with shorter half-lives will degrade more rapidly for each year and, as a result, will have higher levels in previous years than will dioxins with longer half-lives. The following example illustrates this point.

	<u>Years Half-life</u>	<u>Current Concentration</u>	<u>Years</u>	<u>Prior Concentration</u>
2378-TCDD	9.8	100 ppt	10	202.8 ppt
12378-PeCDD	23.6	100	10	134.1
1234678 HpCDF	4.5	100	10	466.6

Due to the difference in half-lives between dioxins, the overall composition of the dioxin profile will change dramatically with time, with the level of the shorter half-life dioxins increasing steadily in prior years.

Readers that would like additional specific information on any of the modeling calculations that were summarized in this section are requested to contact the author via E-mail.