TCEQ REGULATORY GUIDANCE
Remediation Division
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TRRP Guidance on Polychlorinated Dioxins/Furans and Dioxin-Like PCBs

Introduction

This guidance document provides information on the process to develop and demonstrate attainment of the critical human health protective concentration levels (PCLs) for polychlorinated dibenzo-p-dioxins and dibenzofurans (dioxins/furans)[1] and dioxin-like polychlorinated biphenyls (PCBs) as required by the Texas Risk Reduction Program (TRRP). When addressing dioxins/furans and dioxin-like PCBs, this guidance document, in conjunction with the TRRP rule, may be used to determine the nature and extent of contamination and whether a remedy is required.

Background and Summary

Section 350.76 of TRRP was amended in 2025 to update the chemical-specific approaches used for developing and demonstrating attainment of the critical residential and commercial/industrial human-health PCLs for dioxins/furans and dioxin-like PCBs. Upon the effective date of the adopted revisions, any activity conducted pursuant to TRRP must comply with the updated approach for developing PCLs for dioxins/furans and dioxin-like PCBs.

The rule amendment:

- Removed the specific critical soil PCLs for dioxins/furans and dioxin-like PCBs prescribed in 350.76(e) and instead requires the critical soil PCLs to be calculated according to the equations and rule provisions provided in 350.75 (relating to Tiered Human Health PCL Evaluation).
- Removed the table of Toxicity Equivalency Factors (TEFs) for Dioxin-Like Compounds in 350.76(d)(2)(B) and requires the use of the constituents considered to be dioxins, furans, and dioxin-like PCBs, along with their respective TEFs, from the list established by the World Health Organization (WHO) in 2005, as described by USEPA (2010)[2]. A more recent list of constituents and/or more recent TEFs established by a scientifically valid source may be used only if they have been reviewed and approved by the executive director.

[1] The TRRP rule uses the term "Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans." This guidance refers to these compounds as "dioxins/furans."
[2] USEPA 2010. Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-like Compounds. EPA/100/R-10/005. December 2010. Office of the Science Advisor. Risk Assessment Forum.

This guidance document provides information on the TCEQ approach for addressing dioxins/furans and dioxin-like PCBs at sites in Texas subject to the TRRP rule. Although every attempt was made to incorporate relevant information, including responses to common questions, the assigned TCEQ project manager should be contacted for specific questions about managing dioxin/furan and dioxin-like PCB data at a site.

Common Questions and Answers

What Are Dioxins/Furans?

Dioxins/furans are mixtures of chemical compounds (congeners) that have similar chemical structures. They are persistent organic pollutants that take many years to break down once they are in the environment. They are generated from human activities such as backyard burning of trash or industrial combustion, as well as from natural processes like forest fires. They are found throughout the world and have the potential to cause multiple toxic effects. Dioxins and furans are distinct compounds that share a similar chemical structure but vary widely in toxicity depending on the number and position of chlorine atoms within the congener. Chemical structures that have chlorine atoms attached to the 2, 3, 7, and 8 positions on a dioxin or furan molecule (2,3,7,8 substituted congeners) have similar mechanisms of action and affect animals and humans in similar ways. Therefore, these dioxins/furans are often considered together when evaluating the potential for adverse health effects.

What Is a Dioxin/Furan Congener and What Is a Dioxin/Furan Homologue?

A congener is an individual chemical within a family of similar chemicals. There are 75 dioxin congeners and 135 furan congeners, of which 7 dioxin and 10 furan congeners are considered particularly toxic (see Table 1). 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) is one of the most toxic congeners.

Congeners that contain the same number of chlorine atoms can be grouped together as a homologue class. For example, there are 22 congeners that make up the tetrachlorodibenzo-p-dioxins (TCDD) homologue class. Congeners are included in a homologue class if they share the same number of chlorine atoms, regardless of where the chlorine atoms are positioned. For example: 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, and 1,2,3,7,8,9-HxCDD are all distinct hexachlorodibenzodioxin congeners, but they all have six chlorine atoms and belong to the same dioxin homologue class (hexachlorodibenzodioxins).

Homologue classes will often be composed of congeners with chlorine atoms in the 2, 3, 7, and 8 positions (such as those included in Table 1), as well as congeners with chlorine atoms in other positions. These groups are referred to as 2,3,7,8-substituted congeners, and non-2,3,7,8-substituted congeners, respectively. In general, 2,3,7,8-substituted congeners are considered to cause more toxicity than non-2,3,7,8-substituted congeners

What Are Dioxin-Like Polychlorinated Biphenyls (PCBs)?

PCBs are human-made organic chemicals that were intentionally produced until their manufacturing was banned in 1979. Due to their non-flammability, chemical stability, and insulating properties, they were used in hundreds of industrial and commercial applications. There are 12 dioxin-like PCBs out of 209 possible PCB congeners. They are called “dioxin-like” because they have a similar structure with chlorine on the 2,3,7,8 molecular positions and behave like dioxins/furans in the body. Therefore, dioxin-like PCBs are evaluated the same as (and sometimes along with) dioxins/furans.

What Are TEFs and TEQs and How Are They Used?

Toxicity equivalence factors (TEFs) are numerical estimates (i.e., weighting factors) of congener or homologue class toxicity relative to the toxicity of 2,3,7,8-TCDD. Each congener, or homologue class, concentration is multiplied by its TEF to calculate a 2,3,7,8-TCDD toxicity equivalency quotient (TEQ) concentration. The 2005 WHO TEFs listed in Table 1 should be applied to the measured concentrations (or to the appropriate proxy value for each non-detect) of each applicable congener or homologue class. The resulting 2,3,7,8-TCDD TEQ concentrations for each congener or homologue class are summed to calculate a total 2,3,7,8-TCDD TEQ concentration for the entire mixture.[3] The total 2,3,7,8-TCDD TEQ concentration is then compared to a 2,3,7,8-TCDD PCL to determine the nature and extent of contamination and whether a remedy is required.

To facilitate the calculation of 2,3,7,8-TCDD TEQs for comparison to the appropriate critical 2,3,7,8-TCDD PCLs, TCEQ has developed a calculator that can be used for dioxins/furans and dioxin-like PCBs. The calculator is referred to as the Toxicity Equivalency Quotient (TEQ) Calculator or "*TEQ Calculator*" for short. The current version of the calculator can be downloaded from the TCEQ TRRP Guidance and Forms webpage. Additionally, Attachment A of this guidance document contains a few examples to assist with using the *TEQ Calculator*.

Which Compounds Require Evaluation Using TEFs as Dioxins/Furans or Dioxin-Like PCBs?

As specified in 350.76(d)(2)(B) and (e)(1), the 2005 WHO list of congeners in Table 1 must be used. The list includes TEFs for 7 dioxins, 10 furans, and 12 dioxin-like PCBs. If a more recent list of congeners or TEFs is established by a scientifically valid source, the executive director may review this list and update guidance, if appropriate. The review of new TEFs is not intended to take place on a project-by-project or site-by-site basis, but rather as part of more in-depth and broad efforts to periodically evaluate major revisions to the entire list of TEFs.

What Type of Analytical Data Is Used to Evaluate Dioxins/Furans and Dioxin-Like PCBs?

Congener-specific concentrations are the most accurate representation of site conditions and, when available, should be used to calculate the 2,3,7,8-TCDD TEQ for each applicable environmental medium. However, some laboratories may report the data in other ways.

When a laboratory reports homologue class-specific concentrations instead of individual congeners, each homologue class is assumed to be comprised solely of the applicable 2,3,7,8-substitued congeners (as listed in Table 1), setting aside any potential contribution from the less toxic non-2,3,7,8-substituted congeners. The TEF applied to the homologue class concentration should be the highest TEF among the congeners in that class as listed in Table 1.

[3] If the TEQ for a homologue class is included in the total TEQ calculation, then TEQs calculated for the individual congeners that belong to that class should not be included in the total TEQ calculation.

When a laboratory reports concentrations as total dioxins/furans with no additional data on specific homologues or congeners, the mixture is assumed to consist solely of 2,3,7,8-TCDD, and a TEF of 1.0 shall be applied to the measured concentration to yield the 2,3,7,8-TCDD TEQ concentration for the sample.

When a laboratory reports multiple types of concentrations (e.g., congener-specific and homologue class-specific), the analytical results most representative of site conditions (i.e., congener-specific data over homologue class data) shall be used.

How Are PCBs That Are Not Dioxin-Like Evaluated?

PCBs that are not dioxin-like should be evaluated according to Section 350.76(d).

What If Dioxins/Furans and/or Dioxin-like PCBs at a Site Under TRRP Have Already Been Addressed and the TEFs Have Changed?

If a TEF changes, the calculated TEQ may not be representative of the actual toxicity of the dioxin/furan and/or dioxin-like PCB mixture at the site. The calculated TEQ may or may not be protective of human health and the environment, and so the decisions at an existing site may need to be revisited. Depending on the magnitude of the change, additional actions may or may not be necessary to protect human health and the environment. This could mean additional actions are required or could result in a response action being no longer warranted.

What About Soil PCLs for Residential and Commercial/Industrial Properties?

Prior to the 2025 TRRP rule amendment, 350.76(e)(3) specified the critical soil PCLs of 1 part per billion (ppb) for residential properties and 5 ppb for commercial/industrial properties. These critical soil PCLs have been removed from the TRRP rule. Instead, the critical soil PCLs shall be calculated for 2,3,7,8-TCDD according to the equations and rule provisions provided in Section 350.75. This establishes that the PCLs for 2,3,7,8-TCDD will be calculated in the same manner as the PCLs for other COCs and will appear in the PCL tables.

What If a Site Only Has Dioxins/Furans or Only Has Dioxin-like PCBs, but Not Both?

The *TEQ Calculator* can be used to determine the 2,3,7,8-TCDD TEQ for either group alone (i.e., dioxins/furans or dioxin-like PCBs) or in combination, depending on specific site and analytical data. It is important to follow the TRRP Rule and any Remediation Division program-specific guidance on selecting and evaluating COCs for a site.

How Are Non-Detects in a Data Set Handled?

Non-detected (ND) analytical results for a chemical does not necessarily mean the chemical is not present in the sample. Instead, an ND means the actual concentration could range anywhere from zero to just below a defined limit of detection. Whenever

analytical results are evaluated under TRRP, the provisions in 350.51(n) for evaluating ND results and using appropriate proxy values should be followed. Due to the way that dioxins/furans and dioxin-like PCBs are evaluated using TEFs to calculate a total TEQ, there are important considerations when substituting proxy values for ND results that do not necessarily apply to other chemicals.

A. Dioxin/Furan Data

Dioxin/furan congeners are often found together in the environment as a complex mixture. The congeners that contribute to dioxin/furan toxicity are listed below in Table 1. It is important to choose an appropriate proxy value for ND dioxins/furans since all the 2,3,7,8 substituted congeners, when present, contribute to the total toxicity. There are typically three options when selecting a simple proxy value for ND dioxin/furan results. Use:

1. the full value of the limit of detection;
2. half the value of the limit of detection[4]; or
3. a value of zero.

In general, factors such as site history, the congener makeup of the sample, and other sample results from the site should be considered. The specific congeners that are present or absent can indicate whether the results are likely to be from a dioxin/furan release. This information will help inform the selection of an appropriate proxy value for ND results.

The heptachloro- and octachloro-dioxins/furans are detected in many areas at very low levels, due to other anthropogenic or natural activity not related to a release (e.g., fires). Therefore, the presence of these congeners does not necessarily demonstrate a release has occurred.

Alternatively, detections of the pentachloro- or tetrachloro-dioxins/furans, which are known to occur together and move through the environment in groups, would indicate a known release is likely. Although all dioxins/furans have limited mobility once released into the environment, the congeners with fewer chlorine atoms (the tetrachloro- and pentachloro-dioxins/furans) tend to be more mobile than the congeners with more chlorine atoms (heptachloro- and octachloro-dioxins/furans). Therefore, in addition to the make-up of the actual congeners, the pattern and location of congeners in the environment could help determine whether they are from a release or from other anthropogenic activities or natural events. In general, the following list provides information on when one might consider the full detection limit, half the detection limit, or zero as a proxy value for ND results.

Use the full value of the limit of detection for ND results, **if** 2,3,7,8-TCDD is detected and/or several of the pentachloro-dioxins/furans are detected at concentrations greater than (>) the quantitation limit.

Use half the limit of detection for ND results when **no** 2,3,7,8-TCDD is detected but several of the pentachloro- or hexachloro-dioxins/furans are detected in the sample.[4]

[4] The *TEQ Calculator* does not automatically use half the detection limit for any of the non-detect congeners when calculating the TEQ. The user will need to input those values manually.

Use zero as the proxy value for ND results when **only** the heptachloro- and octachloro-dioxins/furans are detected in the samples at low concentrations (e.g. concentrations that are detected, but not quantified).

B. Dioxin-like PCB Data

The decision on which proxy value to select for ND dioxin-like PCBs is based more simply on whether dioxin-like PCBs are detected in any samples at the same site. There are two options to consider when selecting a proxy value for ND dioxin-like PCBs results.

1. Use a proxy value of half the limit of detection for ND results when dioxin-like PCB congeners are not detected in the sample but have been detected in other samples at the site.[4]
2. Use a proxy value of zero for ND results when dioxin-like PCB congeners are not detected in any sample at the site.

Table 1. Toxicity Equivalency Factors (TEFs) for Dioxin-Like Compounds

Dioxin-Like Congener	*Acronym*	*TCEQ Approved TEFs*
Dioxins		
2,3,7,8-Tetrachlorodibenzo-p-dioxin	2,3,7,8-TCDD	1
1,2,3,7,8-Pentachlorodibenzodioxin	1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-Hexachlorodibenzodioxin	1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-Hexachlorodibenzodioxin	1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-Hexachlorodibenzodioxin	1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	1,2,3,4,6,7,8-HpCDD	0.01
Octachlorodibenzodioxin	OCDD	0.0003
Furans		
2,3,7,8-Tetrachlorodibenzofuran	2,3,7,8-TCDF	0.1
1,2,3,7,8-Pentachlorodibenzofuran	1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-Pentachlorodibenzofuran	2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-Hexachlorodibenzofuran	1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	1,2,3,4,7,8,9-HpCDF	0.01
Octachlorodibenzofuran	OCDF	0.0003
Dioxin-Like PCBs		
3,3’4,4’-Tetrachlorobiphenyl (77)	PCB-77	0.0001
3,4,4’,5-Tetrachlorobiphenyl (81)	PCB-81	0.0003
3,3’4,4’,5-Pentachlorobiphenyl (126)	PCB-126	0.1
3,3’,4,4’,5,5’-Hexachlorobiphenyl (169)	PCB-169	0.03
2,3,3’,4,4’-Pentachlorobiphenyl (105)	PCB-105	0.00003
2,3,4,4’,5-Pentachlorobiphenyl (114)	PCB-114	0.00003
2,3’,4,4’,5-Pentachlorobiphenyl (118)	PCB-118	0.00003
2,3’4,4’,5’-Pentachlorobiphenyl (123)	PCB-123	0.00003
2,3,3’,4,4’5-Hexachlorobiphenyl (156)	PCB-156	0.00003
2,3,3’,4,4’,5’Hexachlorobiphenyl (157)	PCB-157	0.00003
2,3’4,4’,5,5’-Hexachlorobiphenyl (167)	PCB-167	0.00003
2,3,3’,4,4’,5,5’-Heptachlorobiphenyl (189)	PCB-189	0.00003

Attachment A. Examples of How to Use the TEQ Calculator

Attachment A provides several examples of how the *TEQ Calculator* can be used for various sampling scenarios. The four examples provided (using hypothetical analytical data) cover theoretical situations where one might use the full value of the detection limit, half the value of the detection limit, or zero as a proxy value for non-detects.

- **Example 1:** Groundwater sample from a known release of dioxins/furans, with no PCBs present. In example 1, the non-detect proxy value for dioxins/furans would be half the detection limit (2,3,7,8-TCDD was not detected), and for dioxin-like PCBs would be zero.
- **Example 2:** Soil sample from a known release of dioxins/furans and dioxin-like PCBs. In example 2, the non-detect proxy value for dioxins/furans (2,3,7,8-TCDD was not detected) and dioxin-like PCBs would be half the detection limit.
- **Example 3:** Soil sample from a site with no known releases of dioxins/furans or dioxin-like PCBs, but where anthropogenic hepta- and octa-chlorinated dioxins/furans are detected. In example 3, the non-detect proxy value for dioxins/furans and dioxin-like PCBs would be zero.
- **Example 4:** Soil sample from a site with a known release of dioxins/furans where 2,3,7,8-TCDD is detected, with no PCBs present. In example 4, the non-detect proxy values for dioxins/furans would be the full value of the detection limit, and for dioxin-like PCBs would be zero.

In each example, the *TEQ Calculator* will show a 2,3,7,8-TCDD TEQ in parts per trillion (ppt) for Dioxins/Furans plus Dioxin-Like PCBs. This value will be highlighted in red in the lower right corner of the calculator spreadsheet. For TCEQ Remediation sites under the TRRP rule, the 2,3,7,8-TCDD TEQ should be compared to the appropriate Tier 1 PCL for 2,3,7,8-TCDD.

Example 1: Groundwater Sample With Dioxins/Furans From a Known Release

You have collected a groundwater sample from a site with a known release of dioxins/furans; however, it is clear that there are not PCBs associated with the release (e.g., there is no site history information indicating a likely PCB release, and there are no other samples from groundwater or other media at the site where PCBs have been detected).

You have the following results in nanograms per liter (ng/L) or parts per trillion (ppt; the two units are equivalent to each other). A "U" flag means the congener was not detected at the estimated detection limit (EDL)[5] and would be considered "non-detect." A "J" flag means the congener was detected and measured at the concentration indicated, but the value is an estimate because it is measured below the lower method calibration limit (LMCL),[6] but above the EDL. In this example the EDL = 0.01 and the LMCL = 0.1.

Example 1: Groundwater Analytical Results

Dioxin	***Result (ng/L) (ppt)***	***Furan***	***Result (ng/L) (ppt)***
2,3,7,8-TCDD	0.01 U	2,3,7,8-TCDF	0.01 U
1,2,3,7,8-PeCDD	0.01 U	1,2,3,7,8-PeCDF	0.01 U
1,2,3,4,7,8-HxCDD	0.3	2,3,4,7,8-PeCDF	0.07 J
1,2,3,6,7,8-HxCDD	0.04 J	1,2,3,4,7,8-HxCDF	0.01 U
1,2,3,7,8,9-HxCDD	0.09 J	1,2,3,6,7,8-HxCDF	0.8
1,2,3,4,6,7,8-HpCDD	3.1	1,2,3,7,8,9-HxCDF	12.2
OCDD	16.5	2,3,4,6,7,8-HxCDF	0.01 U
		1,2,3,4,6,7,8-HpCDF	0.9
		1,2,3,4,7,8,9-HpCDF	11.2
		OCDF	29.0

For this example, to correctly use the *TEQ Calculator*, the user will need to input the detected concentrations of each congener (including those with estimated or "J-flagged" concentrations), with a value of half the detection limit used for the non-

[5] The EDL is a concentration defined, in dioxin methods, as the minimum analytical signal that distinguishes a specific dioxin analyte from the background signal level. This definition is comparable to the TRRP defined method detection limit (MDL) and can be used as a proxy value to censor and report non-detected data.

[6] The LMCL (also referred as minimum level of quantitation (ML) in Method 1668C) is the lowest calibration standard concentration and is comparable to the TRRP defined method quantitation limit (MQL).

detect or U-flagged dioxin/furan congeners, and a value of zero for the dioxin-like PCB congeners. Note that the *TEQ Calculator* does not automatically use half the detection limit for any of the non-detect congeners when calculating the TEQ. The user will need to input those values manually according to the decision matrix in the *How are Non-Detects in a Data Set Handled* Section above. The completed *TEQ Calculator* output appears below.

Example 1: TEQ Calculator Output

Dioxin-Like Congener	Input Sample Concentration in parts per trillion (ppt)	TCEQ Approved TEFs	2,3,7,8-TCDD TEQ (ppt)
Dioxins			
2,3,7,8-TCDD	0.005	1	0.005
1,2,3,7,8-PeCDD	0.005	1	0.005
1,2,3,4,7,8-HxCDD	0.3	0.1	0.03
1,2,3,6,7,8-HxCDD	0.04	0.1	0.004
1,2,3,7,8,9-HxCDD	0.09	0.1	0.009
1,2,3,4,6,7,8-HpCDD	3.1	0.01	0.031
OCDD	16.5	0.0003	0.00495
Furans			
2,3,7,8-TCDF	0.005	0.1	0.0005
1,2,3,7,8-PeCDF	0.005	0.03	0.00015
2,3,4,7,8-PeCDF	0.07	0.3	0.021
1,2,3,4,7,8-HxCDF	0.005	0.1	0.0005
1,2,3,6,7,8-HxCDF	0.8	0.1	0.08
1,2,3,7,8,9-HxCDF	12.2	0.1	1.22
2,3,4,6,7,8-HxCDF	0.005	0.1	0.0005
1,2,3,4,6,7,8-HpCDF	0.9	0.01	0.009
1,2,3,4,7,8,9-HpCDF	11.2	0.01	0.112
OCDF	29	0.0003	0.0087
2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans			**1.5**
Dioxin-like PCBs			
PCB77	0	0.0001	0
PCB81	0	0.0003	0
PCB126	0	0.1	0
PCB169	0	0.03	0
PCB105	0	0.00003	0
PCB114	0	0.00003	0
PCB118	0	0.00003	0
PCB123	0	0.00003	0
PCB156	0	0.00003	0
PCB157	0	0.00003	0
PCB167	0	0.00003	0
PCB189	0	0.00003	0
2,3,7,8-TCDD TEQ in ppt for Dioxin-Like PCBs			**0.0**

2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans plus Dioxin-Like PCBs	**1.5**

Example 2: Soil Sample With Dioxins/Furans and Dioxin-Like PCBs From a Release

You have collected a soil sample from a site with a known release of dioxins/furans and dioxin-like PCBs. In this case, you must include both the dioxins/furans and dioxin-like PCBs in the TEQ calculation.

You have the following results in nanograms per kilogram (ng/kg) or ppt (the two units are equivalent to each other). A "U" flag means the congener was not detected at the EDL[5] and would be considered "non-detect." A "J" flag means the congener was detected and measured at the concentration indicated, but the value is an estimate because it is measured below the LMCL[6], but above the EDL. In this example the EDL = 0.01 and the LMCL = 0.1.

Example 2: Soil Analytical Results

Dioxin	*Result (ng/kg) (ppt)*	*Furan*	*Result (ng/kg) (ppt)*	*PCB*	*Result (ng/kg) (ppt)*
2,3,7,8-TCDD	0.01 U	2,3,7,8-TCDF	0.01 U	PCB77	550
1,2,3,7,8-PeCDD	0.02 J	1,2,3,7,8-PeCDF	0.08 J	PCB81	614
1,2,3,4,7,8-HxCDD	0.9	2,3,4,7,8-PeCDF	2.1	PCB126	262
1,2,3,6,7,8-HxCDD	1.6	1,2,3,4,7,8-HxCDF	31.8	PCB169	0.08 J
1,2,3,7,8,9-HxCDD	1.9	1,2,3,6,7,8-HxCDF	0.09 J	PCB105	45.3
1,2,3,4,6,7,8-HpCDD	13.2	1,2,3,7,8,9-HxCDF	6.1	PCB114	102
OCDD	69.4	2,3,4,6,7,8-HxCDF	1.9	PCB118	883
		1,2,3,4,6,7,8-HpCDF	15.8	PCB123	2100
		1,2,3,4,7,8,9-HpCDF	31.0	PCB156	157
		OCDF	105	PCB157	1099
				PCB167	0.01 U
				PCB189	3360

For this example, to correctly use the *TEQ Calculator*, the user will need to input the detected concentrations of each congener (including those with estimated or "J-flagged" concentrations), with a value of half the detection limit used for the non-detect or U-flagged congeners. Note that the *TEQ Calculator* does not automatically use half the detection limit for any of the non-detect congeners when calculating the TEQ. The user will need to input those values manually according to the decision matrix in the *How are Non-Detects in a Data Set Handled* Section above. The completed *TEQ Calculator* output appears below.

Example 2: TEQ Calculator Output

Dioxin-Like Congener	Input Sample Concentration in parts per trillion (ppt)	TCEQ Approved TEFs	2,3,7,8-TCDD TEQ (ppt)
Dioxins			
2,3,7,8-TCDD	0.005	1	0.005
1,2,3,7,8-PeCDD	0.02	1	0.02
1,2,3,4,7,8-HxCDD	0.9	0.1	0.09
1,2,3,6,7,8-HxCDD	1.6	0.1	0.16
1,2,3,7,8,9-HxCDD	1.9	0.1	0.19
1,2,3,4,6,7,8-HpCDD	13.2	0.01	0.132
OCDD	69.4	0.0003	0.02082
Furans			
2,3,7,8-TCDF	0.005	0.1	0.0005
1,2,3,7,8-PeCDF	0.08	0.03	0.0024
2,3,4,7,8-PeCDF	2.1	0.3	0.63
1,2,3,4,7,8-HxCDF	31.8	0.1	3.18
1,2,3,6,7,8-HxCDF	0.09	0.1	0.009
1,2,3,7,8,9-HxCDF	6.1	0.1	0.61
2,3,4,6,7,8-HxCDF	1.9	0.1	0.19
1,2,3,4,6,7,8-HpCDF	15.8	0.01	0.158
1,2,3,4,7,8,9-HpCDF	31	0.01	0.31
OCDF	105	0.0003	0.0315
2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans			**5.7**
Dioxin-like PCBs			
PCB77	550	0.0001	0.055
PCB81	614	0.0003	0.1842
PCB126	262	0.1	26.2
PCB169	0.08	0.03	0.0024
PCB105	45.3	0.00003	0.001359
PCB114	102	0.00003	0.00306
PCB118	883	0.00003	0.02649
PCB123	2100	0.00003	0.063
PCB156	157	0.00003	0.00471
PCB157	1099	0.00003	0.03297
PCB167	0.005	0.00003	0.00000015
PCB189	3360	0.00003	0.1008
2,3,7,8-TCDD TEQ in ppt for Dioxin-Like PCBs			**26.7**

2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans plus Dioxin-Like PCBs	**32.4**

Example 3: Soil Sample With Anthropogenic Dioxins/Furans Not From a Release

You have collected a soil sample from a site with no known history of dioxin/furan or PCB releases or incineration, and no use or disposal of materials likely to contain dioxins/furans or PCBs. As part of the due diligence at the site, broad spectrum analysis of soil samples included analysis for dioxins/furans and PCBs.

You have the following results in ng/kg or ppt. A "U" flag means the congener was not detected at the EDL[5] and would be considered "non-detect." A "J" flag means the congener was detected and measured at the concentration indicated, but the value is an estimate because it is measured below the LMCL[6], but above the EDL. In this example the EDL = 0.01 and the LMCL = 0.1.

Example 3: Soil Analytical Results

Dioxin	*Result (ng/kg) (ppt)*	*Furan*	*Result (ng/kg) (ppt)*	*PCB*	*Result (ng/kg) (ppt)*
2,3,7,8-TCDD	0.01 U	2,3,7,8-TCDF	0.01 U	PCB77	0.01 U
1,2,3,7,8-PeCDD	0.01 U	1,2,3,7,8-PeCDF	0.01 U	PCB81	0.01 U
1,2,3,4,7,8-HxCDD	0.01 U	2,3,4,7,8-PeCDF	0.01 U	PCB126	0.01 U
1,2,3,6,7,8-HxCDD	0.01 U	1,2,3,4,7,8-HxCDF	0.01 U	PCB169	0.01 U
1,2,3,7,8,9-HxCDD	0.01 U	1,2,3,6,7,8-HxCDF	0.01 U	PCB105	0.01 U
1,2,3,4,6,7,8-HpCDD	28.3	1,2,3,7,8,9-HxCDF	0.01 U	PCB114	0.01 U
OCDD	8070	2,3,4,6,7,8-HxCDF	0.01 U	PCB118	0.01 U
		1,2,3,4,6,7,8-HpCDF	105	PCB123	0.01 U
		1,2,3,4,7,8,9-HpCDF	0.08 J	PCB156	0.01 U
		OCDF	327	PCB157	0.01 U
				PCB167	0.01 U
				PCB189	0.01 U

For this example, to correctly use the *TEQ Calculator*, the user will need to input the detected concentrations of each congener (including those with estimated or "J-flagged" concentrations), with a value of zero used for the non-detect or U-flagged congeners. Note that the *TEQ Calculator* does not automatically use half the detection limit for any of the non-detect congeners when calculating the TEQ. The user will need to input those values manually according to the decision matrix in the *How are Non-Detects in a Data Set Handled* Section above. The completed *TEQ Calculator* output appears below.

Example 3: TEQ Calculator Output

Dioxin-Like Congener	Input Sample Concentration in parts per trillion (ppt)	TCEQ Approved TEFs	2,3,7,8-TCDD TEQ (ppt)
Dioxins			
2,3,7,8-TCDD	0	1	0
1,2,3,7,8-PeCDD	0	1	0
1,2,3,4,7,8-HxCDD	0	0.1	0
1,2,3,6,7,8-HxCDD	0	0.1	0
1,2,3,7,8,9-HxCDD	0	0.1	0
1,2,3,4,6,7,8-HpCDD	28.3	0.01	0.283
OCDD	8070	0.0003	2.421
Furans			
2,3,7,8-TCDF	0	0.1	0
1,2,3,7,8-PeCDF	0	0.03	0
2,3,4,7,8-PeCDF	0	0.3	0
1,2,3,4,7,8-HxCDF	0	0.1	0
1,2,3,6,7,8-HxCDF	0	0.1	0
1,2,3,7,8,9-HxCDF	0	0.1	0
2,3,4,6,7,8-HxCDF	0	0.1	0
1,2,3,4,6,7,8-HpCDF	105	0.01	1.05
1,2,3,4,7,8,9-HpCDF	0.08	0.01	0.0008
OCDF	327	0.0003	0.0981
2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans			**3.9**
Dioxin-like PCBs			
PCB77	0	0.0001	0
PCB81	0	0.0003	0
PCB126	0	0.1	0
PCB169	0	0.03	0
PCB105	0	0.00003	0
PCB114	0	0.00003	0
PCB118	0	0.00003	0
PCB123	0	0.00003	0
PCB156	0	0.00003	0
PCB157	0	0.00003	0
PCB167	0	0.00003	0
PCB189	0	0.00003	0
2,3,7,8-TCDD TEQ in ppt for Dioxin-Like PCBs			**0.0**

2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans plus Dioxin-Like PCBs	**3.9**

Example 4: Soil Sample With Dioxins/Furans From a Known Release and 2,3,7,8-TCDD Has Been Detected

You have collected a soil sample from a site with a known release of dioxins/furans and the 2,3,7,8-TCDD congener has been detected. However, you are confident there are not PCBs associated with the release (e.g., there is no site history information indicating a likely PCB release, and there are no other samples from groundwater or other media at the site where PCBs have been detected).

You have the following results in ng/kg or ppt. A "U" flag means the congener was not detected at the EDL[5] and would be considered "non-detect." A "J" flag means the congener was detected and measured at the concentration indicated, but the value is an estimate because it is measured below the LMCL[6], but above the EDL. In this example the EDL = 0.01 and the LMCL = 0.1.

Example 4: Soil Analytical Results

Dioxin	*Result (ng/kg) (ppt)*	*Furan*	*Result (ng/kg) (ppt)*
2,3,7,8-TCDD	2.1	2,3,7,8-TCDF	0.01 U
1,2,3,7,8-PeCDD	0.51	1,2,3,7,8-PeCDF	0.01 U
1,2,3,4,7,8-HxCDD	1.1	2,3,4,7,8-PeCDF	0.27
1,2,3,6,7,8-HxCDD	20.3	1,2,3,4,7,8-HxCDF	0.01 U
1,2,3,7,8,9-HxCDD	15.8	1,2,3,6,7,8-HxCDF	3.3
1,2,3,4,6,7,8-HpCDD	32.0	1,2,3,7,8,9-HxCDF	15.9
OCDD	439	2,3,4,6,7,8-HxCDF	0.09 J
		1,2,3,4,6,7,8-HpCDF	0.9
		1,2,3,4,7,8,9-HpCDF	25.9
		OCDF	200

For this example, to correctly use the *TEQ Calculator*, the user will need to input the detected concentrations of each congener (including those with estimated or "J-flagged" concentrations), with a value of the full detection limit used for the non-detect or U-flagged dioxins/furans congeners, and a value of zero for the dioxin-like PCB congeners. Note that the *TEQ Calculator* does not automatically use half the detection limit for any of the non-detect congeners when calculating the TEQ. The user will need to input those values manually according to the decision matrix in the *How are Non-Detects in a Data Set Handled* Section above. The completed *TEQ Calculator* output appears below.

Example 4: TEQ Calculator Output

Dioxin-Like Congener	Input Sample Concentration in parts per trillion (ppt)	TCEQ Approved TEFs	2,3,7,8-TCDD TEQ (ppt)
Dioxins			
2,3,7,8-TCDD	2.1	1	2.1
1,2,3,7,8-PeCDD	0.51	1	0.51
1,2,3,4,7,8-HxCDD	1.1	0.1	0.11
1,2,3,6,7,8-HxCDD	20.3	0.1	2.03
1,2,3,7,8,9-HxCDD	15.8	0.1	1.58
1,2,3,4,6,7,8-HpCDD	32	0.01	0.32
OCDD	439	0.0003	0.1317
Furans			
2,3,7,8-TCDF	0.01	0.1	0.001
1,2,3,7,8-PeCDF	0.01	0.03	0.0003
2,3,4,7,8-PeCDF	0.27	0.3	0.081
1,2,3,4,7,8-HxCDF	0.01	0.1	0.001
1,2,3,6,7,8-HxCDF	3.3	0.1	0.33
1,2,3,7,8,9-HxCDF	15.9	0.1	1.59
2,3,4,6,7,8-HxCDF	0.09	0.1	0.009
1,2,3,4,6,7,8-HpCDF	0.9	0.01	0.009
1,2,3,4,7,8,9-HpCDF	25.9	0.01	0.259
OCDF	200	0.0003	0.06
2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans			**9.1**

Dioxin-like PCBs			
PCB77	0	0.0001	0
PCB81	0	0.0003	0
PCB126	0	0.1	0
PCB169	0	0.03	0
PCB105	0	0.00003	0
PCB114	0	0.00003	0
PCB118	0	0.00003	0
PCB123	0	0.00003	0
PCB156	0	0.00003	0
PCB157	0	0.00003	0
PCB167	0	0.00003	0
PCB189	0	0.00003	0
2,3,7,8-TCDD TEQ in ppt for Dioxin-Like PCBs			**0.0**

2,3,7,8-TCDD TEQ in ppt for Dioxins/Furans plus Dioxin-Like PCBs	**9.1**