HAZARDOUS AND RADIOACTIVE MATERIALS BUREAU

New Mexico Environment Department

Position Paper ***Position Paper***

APPLICATION OF INORGANIC BACKGROUND VALUES[1] IN THE RISK ASSESSMENT PROCESS[2]

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1. Introduction

The application of representative inorganic background values in the risk assessment process eliminates the need to include chemicals which occur at naturally high concentrations in the environment. Background values are relied upon by project managers (and risk assessors) to expedite the corrective action process by identifying areas of release and defining the nature and extent of contamination.

This paper does not address the decision regarding when and how to establish background values and assumes that background values have been adequately established for a specific site.

2. Procedure

The selection of contaminants of potential concern (COPCs) occurs primarily by comparing chemical concentrations with representative inorganic background values[3]. Chemicals with measured concentrations above background values are considered

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[1]*Background value* means an inorganic chemical concentration representative of background concentrations that has been approved by the Hazardous and Radioactive Materials Bureau. *Inorganic chemical concentration* means a naturally-occurring concentration of an inorganic chemical in an environmental medium (sediment, soil, air and water) **not** affected by Facility operations.

[2]This position paper was developed jointly with the Environmental Protection Agency Region 6 and adapted from the EPA-NMED concept paper of the same title dated October 9, 1997.

[3]The detection status, relative concentrations of the chemical and presence/absence of the chemicals in other media matrices should also be considered in the selection of COPCs.

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DETERMINATION OF EXTENT OF CONTAMINATION

The vertical and horizontal extent of contamination at a specific site (including off-site migration) is considered adequately determined once concentrations of (1) inorganic constituents (including radionuclides) have been spatially (in three dimensions) delineated relative to background concentrations and (2) organic constituents have been spatially (in three dimensions) delineated relative to practical quantitation limits.

The Facility may petition the Hazardous and Radioactive Materials Bureau for a variance from the above-stated requirements on a case-by-case basis by applying other criteria/considerations which demonstrate the protection of human health and the environment. Factors that may affect the determination of the extent (vertical and horizontal) of contamination include, but are not limited to, the following:

- contaminant concentration gradient,
- contaminant characteristics which influence environmental fate and transport,
- site environmental setting (e.g., geology, hydrogeology, erosion potential, etc.),
- operational history,
- number and location of samples,
- detection limits relative to background or other reference values[1],
- media,
- type of source (e.g., surface impoundment, outfall, etc.), and
- source integrity.

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[1]Other reference values may include environmental standards (e.g., New Mexico Water Quality Control Commission regulations, etc.) or criteria (e.g., Ambient Water Quality Criteria, etc.).

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COPCs and should be retained for inclusion in the risk assessment process. Conversely, chemicals with concentrations at or below established background values are not considered COPCs and are eliminated from the risk assessment process.

The potential risk posed by COPCs should be estimated based on the actual detected values[4] or on representative concentrations (e.g., 95% upper confidence limits, upper tolerance limits or maximum concentrations). Background values of COPCs should not be subtracted from actual detected or representative COPC concentrations in assessing risk for a site[5]. Risk due solely to background values may be estimated independently for comparison to the risk posed by the actual detected or representative COPC concentrations; however, the risk due solely to background constituent concentrations would not trigger corrective action.

3. Conclusion

Chemicals present at a site in concentrations at or below Facility-specific (or site-specific, if applicable) or regional background values are eliminated from the risk assessment process. The Facility should submit values representative of background concentrations to the Hazardous and Radioactive Materials Bureau (HRMB) for approval prior to their use in risk assessments.

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[4]Data should be obtained using established EPA-recommended analytical methods.

[5]The goal of the risk assessment is to establish the risk from exposure to chemical concentrations present at the site regardless of their origin (i.e., natural, anthropogenic background/fallout, or site-derived).

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USE OF TOLERANCE INTERVALS FOR DETERMINING INORGANIC BACKGROUND CONCENTRATIONS

The Hazardous and Radioactive Materials Bureau (HRMB) does not endorse the use of tolerance intervals for estimating inorganic background concentrations; however, a Facility may propose the use of tolerance intervals for identifying background constituent concentrations[1]; however this proposal must be submitted to and approved by HRMB prior to implementation. The Facility must provide type of statistical analysis performed and a complete data set[2] used to perform the statistical analysis to HRMB. **The use of tolerance intervals is conditional upon the review of the data set and the approval of the use of this procedure by HRMB.**

The use of tolerance intervals is an alternate approach to the analysis of variance in determining the presence of statistically significant contamination if 50 percent or more of the observations for a given constituent are quantified (i.e., above the detection limits) AND the original data distribution has been determined to be normal. If the original data is not normally distributed, it should be logarithmically transformed (EPA 1989 and 1992). For some data sets which are not normally or log-normally distributed, non-parametric statistical analyses may be more appropriate. For those data sets which do not meet these requirements, HRMB will determine the applicability of this approach based on an extensive review of the data sets provided.

A tolerance interval for a given constituent is constructed from the analytical results obtained from background sampling locations. The site constituent concentrations are

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[1]*Inorganic background concentrations* mean naturally-occurring concentrations of inorganic constituents in an environmental medium (sediment, soil, air and water) **not** affected by Facility operations.

[2]The complete data set includes both detectable and non-detectable constituent concentrations and all data points (sampling locations) shown on a map.

then compared with the tolerance interval. If the site constituent concentrations exceed the upper bound of the tolerance interval (UTL), contamination may be present.

UTLs may be used for determining statistically significant contaminant concentrations if the following criteria are met and documented:

1. UTLs are appropriate for sites with homogeneous soil or rock types. The presence of homogeneous soil or rock types must be verified. For instance, the tolerance interval approach is appropriate for sites that overlie extensive homogeneous geologic deposits (e.g., thick homogeneous lacustrine clays) that do not naturally display geochemical variations.

2. The data set must be evaluated for outliers (i.e., unusually high or low concentrations) which should not be used for calculating UTLs for a given constituent. Procedures for evaluating outliers and recommendations on how to handle outliers in practice are discussed by Gilbert (1987) and Gilbert and Simpson (1992). The identity and source (such as analytical laboratory transcription errors) of the outliers must be documented.

3. A normality test must be applied to the data set prior to the selection of the tolerance interval approach.

4. Based on the degree of homogeneity, the UTL must be calculated using an adequate data set (i.e., greater than 20). The size of the data set can vary and should be based on such factors as the size of the contaminated area, etc.

5. HRMB requires a coverage[3] of 95 percent. HRMB also requires a tolerance coefficient[4] of 95 percent. This means that at least 95 percent of the background population is expected to be at or below the UTL at a confidence level of 95 percent.

6. Statistical descriptors for each data set must be determined (i.e., minimum and maximum constituent concentrations; mean, median, standard deviation; and 25th, 75th and 95th percentiles). The detection limit and frequency of detection must also be provided for each constituent.

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[3]Coverage is defined as a specified proportion (percent) of a population of background observations (i.e., constituent concentrations) that is contained within a tolerance interval.

[4]The tolerance coefficient is defined as the probability that the tolerance interval includes the specified proportion of the background population.

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US EPA, 1992. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Addendum to Interim Final Guidance*, Draft. Office of Solid Waste, Permits and State Programs Division, Washington, D.C.

HAZARDOUS AND RADIOACTIVE MATERIALS BUREAU

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Position Paper *Position Paper*

Risk-based Remediation of Polychlorinated Biphenyls at RCRA Corrective Action Sites[1]

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1. Scope

This document focuses on remedial activities at sites where polychlorinated biphenyls (**PCBs**) have been identified or are suspected of being present as one of the contaminants of potential concern. The intent of this document is to expedite the remedial action process and provide a cost-effective and consistent method for the evaluation and reduction of the risk posed to human health and the environment by PCBs.

This document **does not** discuss the complex regulations governing PCBs or the sampling methodologies for PCBs or other associated contaminants. This document **does** assume that the nature and extent of PCB contamination have been defined using a site conceptual model and **does** discuss and recommend analytical methods applicable to evaluating the risk to human and ecological health for PCBs in environmental media.

This paper **does not** discuss the risk posed to ground water quality by PCB contamination; state ground water standards and federal drinking water standards[2] exist for the protection of ground water. No state or federal soil/sediment standards exist to protect ground water from the transport of PCBs from contaminated soil/sediments; however, the risk associated with the transport of PCBs from contaminated soil/sediments to ground water should be evaluated to ensure that state and federal standards for ground water are not exceeded. Methods for the evaluation of this threat to ground water are **not**, at this time, specifically addressed in this document.

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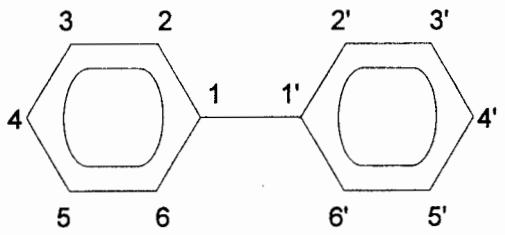
[1]This document is intended as guidance for employees of the Hazardous and Radioactive Materials Bureau (HRMB) and RCRA-regulated facilities within the State of New Mexico. This guidance does not constitute rule-making and may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person. HRMB may take action at variance to this guidance and reserves the right to modify this guidance at any time without public notice.

[2]PCBs in ground water may not exceed the Safe Drinking Water Act's maximum contaminant level of 0.5 μg/L in drinking water (Title 40 Code of Federal Regulations Parts 141-147 and 149) or the State of New Mexico's Water Quality Control Commission Regulations' standard of 1 μg/L in ground water with 10,000 mg/l or less total dissolved solids (Title 20 New Mexico Annotated Code Chapter 6.2).

2. Background Information

PCBs are a class of chlorinated organic compounds which found widespread application since their introduction into commerce in 1923. Their properties include thermal stability; resistance to acids, bases and oxidation; and resistance to direct electrical current. They were commonly used in transformers and capacitors, hydraulic and heat transfer equipment, compressors and vacuum pumps, plasticizers (surface coatings and sealants), and some paints and inks. Domestic production of commercial PCBs ceased in 1977; however, PCBs in existence at that time are still in use today.

The general chemical structure of chlorinated biphenyls is as follows:



The number and position of chlorines in the biphenyl molecule determine the physical and chemical properties of the PCB molecule. There is a total of 209 possible *congeners*[3] of PCBs, each one resulting from the chlorination of different substitution positions and varying degrees of chlorination. In general, PCB molecules with higher degrees of chlorination are more resistant to biodegradation and are more persistent in the environment.

PCB congeners may be found in commercial preparations or complex mixtures known by the names Askarel, Aroclor, Clophen, Phenoclor, Kanechlor, and Pyralène. In the United States, PCB mixtures were marketed under the trade name of Aroclor. Each Aroclor has a four-digit numeric designation: the first two digits are "12" (indicating the biphenyl parent molecule) followed by two more digits indicating the percent chlorine content by weight in the mixture. For example, Aroclor 1254 has 54% chlorine by weight. Aroclor 1016 is the exception: it contains 41% chlorine by weight (ATSDR, 1995).

PCBs are a group of environmentally persistent organic chemicals that possess the inherent properties of compounds that bioaccumulate (i.e., high octanol/water partition coefficient and low water solubility). PCBs also have the following properties of environmental relevance: low vapor pressure and low flammability.

PCBs are toxic to humans and other animals (Eisler, 1986; ATSDR, 1995; and US EPA, 1996 and 1997a). PCBs adversely impact reproduction in wildlife and in experimental animals. Other common toxic effects in mammals and birds include thymic atrophy (a wasting syndrome), microsomal enzyme induction, porphyria (manifestations include intermittent nervous system dysfunction and/or sensitivity of skin to sunlight) and related liver damage, chloracne, estrogenic activity, immunosuppression, and tumor promotion. PCBs can be transferred to young mammals (including humans) transplacentally and in breast milk.

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[3]*Congener* means any single, unique, well-defined chemical compound in the PCB category.

The United States Environmental Protection Agency (**US EPA**) and International Agency for Research on Cancer classified PCBs as Group B2; probable human carcinogens, based on sufficient evidence of carcinogenicity (manifested as hepatocellular carcinomas) in experimental animals and inadequate (due to confounding exposures to other potential carcinogens or lack of exposure quantification), yet suggestive evidence of excess risk of liver cancer in humans (US EPA, 1997c). Recent studies have indicated that all PCB mixtures can cause cancer; however, different mixtures exhibit different carcinogenic potencies (Cogliano, 1998). In addition, environmental processes may alter the PCB mixtures affecting its carcinogenic potency (see *Environmental Processes*).

The stability and lipophilicity of PCBs promote their biomagnification (i.e., the uptake of a chemical through ingestion resulting in the concentration of the chemical in tissue being greater than that of its food) once they enter the aquatic and terrestrial food chains. Through the food chain, living organisms selectively bioaccumulate persistent congeners of PCBs. Environmentally-aged PCB mixtures appear to be more toxic and persistent in the organism than commercial PCB mixtures. Biomagnification through trophic transfer governs PCB levels in animals, especially those occupying the top of the food web. Therefore, PCBs in food sources represent the most important exposure source to humans and wildlife.

In certain situations, PCBs can become contaminated with the far more toxic polychlorinated dibenzofurans (**PCDFs**) and chlorinated dibenzo-dioxins (**PCDDs**). Therefore, the presence of PCDFs and PCDDs should always be investigated if any of the following processes existed or are suspected of existing:

- combustion or incineration of PCB-contaminated waste or waste oils, or highly variable waste streams (such as municipal and commercial waste for which PCB contamination is suspected);
- manufacture of PCBs[4];
- pyrolysis of PCBs;
- photolysis of PCBs;
- incidental fire of transformers and capacitors containing PCBs; or
- treatment with chlorinating compounds (e.g., hydrochloric acid, chlorine, etc.).

3. Environmental Processes

PCBs occur as mixtures of congeners in the environment. *Partitioning*[5], chemical and biological transformation, and preferential bioaccumulation may change the composition of the PCB mixture over time: the environmentally-aged PCB mixture may vary considerably from the original congener composition (US EPA, 1996b and ATSDR, 1995). Altered PCB mixtures have been known to persist in the environment for many years.

PCBs adsorb to organic matter, sediments, and soil. Their affinity to adsorb increases with the chlorine content of the PCBs and the amount of organic matter present. PCBs can volatilize or disperse as aerosols providing an effective means of transport in the environment. Congeners with low chlorine content tend to be more volatile and more water soluble.

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[4]The concentration of PCDFs in commercial PCB samples ranged from 0.2 µg/g to 13.6 µg/g (ATSDR, 1993). Eisler (1986) reported PCDFs impurities ranging from 0.8 to 33 mg/kg in some domestic and foreign PCB mixtures.

[5]*Partitioning* includes environmental processes by which different fractions of a mixture separate into air, water, sediment, and soil.

The highly chlorinated Aroclors (Aroclor 1248, 1254, and 1260) resist both chemical and biological transformation (i.e., degradation) in the environment. Biological degradation of highly chlorinated Aroclors to lower chlorinated PCBs can occur under anaerobic conditions[6]. The extent of this dechlorination[7] is limited by the PCB chlorine content and soil/sediment PCB concentrations. Anaerobic bacteria in soil/sediments remove chlorines from low chlorinated PCBs (1 to 4 chlorines) and open the carbon rings through oxidation. PCBs with higher chlorine content are extremely resistant to oxidation and hydrolysis. Photolysis can also slowly break down highly chlorinated PCB congeners.

PCBs bioaccumulate and biomagnify through the food chain because they are highly lipid-soluble. The mixture of congeners found in biotic tissue will differ dramatically from the mixture of congeners originally released to the environment because bioaccumulation and biomagnification concentrate PCB congeners of higher chlorine content up through the food chain. This is because different congeners can exhibit different rates of metabolism and elimination in living organisms (Van den Berg, et al., 1998 and Cogliano, 1998).

By altering the congener composition of PCB mixtures, these environmental processes can substantially increase or decrease the toxicity of environmental PCBs mixture (Cogliano, 1998). Therefore, information on these environmental processes along with the results of congener-specific analyses of environmental and biota samples should be used to substantiate modeling of exposure to and health risks resulting from environmental PCBs.

4. PCB Cleanup Levels

PCB-contaminated soil/sediments should be remediated to either a default concentration of 1 mg/kg or part per million (**ppm**) *total PCBs* (defined as the sum of congeners, Aroclors or *homologues*[8]) or a *risk-based PCB concentration level*[9] established through performing a health risk evaluation. Risk-based PCB concentrations may be calculated from equations presented in *Risk Evaluation*. Once the calculations have been completed for all receptors, the lowest computed risk-based PCB concentration in a medium would represent the PCB remediation goal for that medium. These PCB remediation goals may be refined, if necessary, in the higher-level, site-specific risk assessment.

Table 1 presents the corrective action cleanup options for the remediation of PCB-contaminated soil/sediments and data quality recommendations regarding the PCB analyses of environmental media samples.

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[6]However, certain fungi have been demonstrated to degrade PCBs under aerobic conditions.

[7]Note that dechlorination is not synonymous with detoxification because it may result in the formation of carcinogenic congeners.

[8]A *homologue* is a subcategory of PCBs having an equal number of chlorine substituents. *Substituent* means an atom or group that replaces another atom or group in a molecule. PCB homologues can be quantified using EPA Method 680 or estimated using regression equations such as those found in NOAA, 1993.

[9]A *risk-based PCB concentration level* means the PCB concentration above which some adverse health effects may be produced in human and/or ecological receptors, and below which adverse health effects are unlikely to occur.

TABLE 1
PCB CLEANUP OPTIONS IN SOIL/SEDIMENT
AND
DATA QUALITY RECOMMENDATIONS [10]

Cleanup Option	Corrective Action Steps		Data Quality Recommendations
Default	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 parts per billion [ppb] or 1 ppb, respectively) in environmental media
	2	Remediate to 1 ppm	
	3	Conduct post-remediation monitoring, as necessary	
Risk-based	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 ppb or 1 ppb, respectively) and/or congener-specific environmental and biota concentrations (using a quantitation limit in the low parts per trillion)
	2	Perform health risk evaluation	
	3	Establish risk-based concentrations for all human and environmental receptors	
	4	Remediate to the lowest risk-based concentration	
	5	Conduct post-remediation monitoring, as necessary	

The following is a listing of potential PCB target analytes[11]. The 12 PCB congeners indicated in boldface italics are those which are recommended for quantitation as potential target analytes when performing a risk-based cleanup. The 16 additional congeners listed in plain text may provide valuable information, but are not required for the evaluation of risk. The analyses of all 209 congeners would greatly improve the estimate of total PCB concentrations.

[10]Modified from Valoppi, et al., 1999.

[11]The number in parentheses refers to the identification system used to specify a particular congener.

2,4′-Dichlorobiphenyl (8)
2,2′,5-Trichlorobiphenyl (18)
2,4,4′-Trichlorobiphenyl (28)
2,2′,3,5′-Tetrachlorobiphenyl (44)
2,2′,5,5′-Tetrachlorobiphenyl (52)
2,3′,4,4′-Tetrachlorobiphenyl (66)
3,3′,4,4′-Tetrachlorobiphenyl (77)
3,4,4′,5-Tetrachlorobiphenyl (81)
2,2′4,5,5′-Pentachlorobiphenyl (101)
2,3,3′,4,4′-Pentachlorobiphenyl (105)
2,3,4,4′,5-Pentachlorobiphenyl (114)
2,3′,4,4′,5-Pentachlorobiphenyl (118)
2′,3,4,4′,5′-Pentachlorobiphenyl (123)
3,3′,4,4′,5-Pentachlorobiphenyl(126)
2,2′,3,3′,4,4′-Hexachlorobiphenyl (128)
2,2′,3,4,4′,5′-Hexachlorobiphenyl (138)
2,2′,4,4′,5,5′-Hexachlorobiphenyl (153)
2,3,3′,4,4′,5-Hexachlorobiphenyl (156)
2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)
2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)
3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)
2,2′,3,3′,4,4′,5-Heptachlorobiphenyl (170)
2,2′,3,4,4′,5,5′-Heptachlorobiphenyl (180)
2,2′,3,4′,5,5′,6-Heptachlorobiphenyl (187)
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)
2,2′,3,3′,4,4′,5,6-Octachlorobiphenyl (195)
2,2′,3,3′,4,4′,5,5′,6-Nonachlorobiphenyl (206)
2,2′,3,3′,4,4′,5,5′,6,6′- Decachlorobiphenyl (209)

The 16 PCB congeners in plain text have been indicated as target analytes by the National Oceanic and Atmospheric Administration based on their toxicity, ubiquitousness in the marine environment, presence in commercial Aroclor mixtures, etc. (NOAA, 1993).

5. Analytical Methods

Aroclors are often used to characterize PCB exposures; however, the use of Aroclors in estimating the human health or ecological risk can be both imprecise and inappropriate because the PCB mixtures to which humans and other biota may be exposed are likely to be considerably different from the original Arochlor mixtures released to the environment. In addition, available analytical methods for Aroclor analyses produce estimates that are prone to errors: both qualitative and quantitative errors may arise from interpreting gas chromatography/mass spectometry (**GC/MS**) data. The GC/MS reveals a spectrum of peaks that are compared with characteristic patterns of different Aroclors (US EPA, 1996a). For environmentally weathered and altered mixtures, an absence of these characteristic patterns can suggest the absence of Aroclors, even if some congeners are present in high concentrations. Therefore, the Hazardous and Radioactive Materials Bureau (**HRMB**) recommends the use of congener-specific analyses in evaluating health risks to humans and the environment; however, total PCB analyses[12] (based on the sum of Arochlor or homologue concentrations) coupled with conservative risk assessment assumptions can also be used.

Most of the EPA-standardized analytical methods for PCB analysis were developed for the determination of non-congener-specific PCBs in environmental samples (water, soil and sediment). The recent EPA SW-846 Method 8082 (US EPA, 1996a and 1998a) uses gas chromatography to determine the concentrations of PCBs reported as Aroclors, total PCBs or individual PCB congeners (19 PCB congeners have been tested by this method to date) in extracts from solid and aqueous matrices. The method detection limits for Aroclors vary from 0.054 to 0.90 μg/L in water to 57 to 70 μg/kg in soil/sediment. Estimated quantitation limits would range from 0.54 to 9 μg/L in water to 36 to 600 μg/kg in soil/sediment.

[12]The use of either method of analyses (i.e., congener-specific or total PCB) should be consistently applied at a site to ensure data comparability. In addition to site characterization conducted using total PCB analyses, congener-specific analyses of the same samples may be a useful supplement to identify the specific congeners present.

High resolution gas chromatography methods (such as EPA Method 680, draft EPA Method 1668, or their equivalent) can be used to identify the specific concentrations of PCB homologues or individual PCB congeners in environmental media. High resolution gas chromatography tests are available at most commercial laboratories which also have dioxin/furan analytical capabilities.

Table 2 is a compilation of total PCB and congener-specific PCB analyses and their associated approximate costs modified from Valoppi, et al. (1999):

TABLE 2
RECOMMENDED ANALYTICAL METHODS FOR TOTAL PCBS
AND
INDIVIDUAL CONGENERS IN SOIL/SEDIMENT/BIOTA AND THEIR APPROXIMATE COST

	Analytical Method (Detector)	Quantitation Limit (μg/kg wet weight[13])	Approximate Cost ($/sample)	Comments
Total PCBs	Aroclor Standards (GC/ECD)	36 - 9,000	75 - 300	Often does not meet data quality objectives
	Homologues (GC/MS)	0.02 - 0.2	500 - 1,000	
	Homologues (GC/ECD)	0.5 - 5	500	Possible interference may elevate total PCB estimate
	NOAA Congeners (GC/ECD)	0.5 - 5	250	Total PCB estimate as homologues in fish tissue using regression equations (NOAA, 1993 and US EPA, 1997a)
Congeners	Potential Target Analytes[14] (GC/MS)	0.02 - 0.2	500 - 1,000	Little interference/co-elution; able to quantitate PCB congeners 77, 126 & 169
	Potential Target Analytes (GC/ECD)	0.5 - 5	250 - 750	Possible interferences; may not be able to detect PCB congeners 77, 81, 126 & 169

6. Storm Water Runoff Monitoring Recommendations

The potential for transport to human or ecological receptors (including ground and surface water) should be evaluated for all corrective action sites impacted or suspected of being impacted by PCBs. PCB

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[13]Sediment/soil values are on a wet weight basis for analytical methods. Conversion of wet weight sediment quantitation limits to dry weight may increase the value by as much as a factor of 10 (Valoppi, et al., 1999).

[14]See *PCB Cleanup Levels.*

concentrations in storm water runoff resulting from contaminated soil/sediments should be monitored **and** the soils remediated to ensure that there is no release or runoff from the SWMU or AOC which results in a total PCB concentration in excess of the Clean Water Act (**CWA**)-recommended freshwater aquatic life chronic criterion of 0.014 μg/l[15] (unfiltered water) to a *water of the State.*[16] Likewise, concentrations of PCB-contaminated stream bottom, lake or reservoir deposits should not result in total PCB concentrations in unfiltered water which exceeds the CWA-recommended freshwater aquatic life chronic criterion of 0.014 μg/l.

The evaluation of a site's PCB concentrations and erosion potential will aid in determining and prioritizing the corrective actions and best management practices (**BMPs**) necessary to protect surface water quality. Each facility should develop a method for evaluating the erosion potential[17] and present the methodology to HRMB for approval prior to implementation. This evaluation should be conducted on all known or suspected PCB sites. All PCB sites with elevated erosion potentials should implement BMPs to reduce transport of PCB-contaminated sediments and soils. BMP effectiveness should be evaluated and monitored regularly through a formalized inspection and maintenance program. BMPs should be implemented as interim actions or stabilization measures which are consistent with a final remedy and should not be misconstrued as a final remedy.

HRMB believes that controlling the total suspended solids (**TSS**) load of storm water runoff may effectively control PCB migration in surface water because PCBs are hydrophobic, tend to adsorb to soil and organic particles, and are transported in suspended sediments during storm runoff events. Therefore, the TSS should be monitored to aid in predicting and, therefore, potentially controlling the transport of PCBs into *watercourses*[18].

Storm water samples should be collected from storm water events which are greater than 0.1 inches in magnitude (US EPA, 1992). Grab samples should be collected within the first 30 minutes or as soon as practical, but not more than 1 hour after runoff discharge begins. A sufficient quantity of runoff should be collected (i.e., 5 liters) because additional analyses for PCBs may be required based upon the TSS analytical results. The runoff samples should be analyzed for TSS using Method 2540D of the most recent edition of the *Standard Methods for the Examination of Water and* Wastewater.

Grab samples should be used for monitoring. Composite samples may **not** be used for monitoring; however, flow-weighted composite samples may be used in the development and validation of storm water contaminant transport modeling.

The following bullets describe recommended trigger levels and actions based on the analytical results of TSS analyses:

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[15]This concentration is the Clean Water Act §304(a) recommended chronic criterion for aquatic life (Federal Register, December 10, 1998).

[16]*Water(s) of the State* means all interstate and intrastate water including, natural ponds and lakes, playa lakes, reservoirs, perennial streams and their tributaries, intermittent streams, sloughs, prairie potholes and wetlands (Title 20 New Mexico Annotated Code Chapter 6.1).

[17]HRMB recommends the approach to evaluating erosion potential presented in the *Matrix Approach to Contaminant Transport Potential* (Mays and Veenis, 1998).

[18]*Watercourse* means any river, creek, arroyo, canyon, draw, or wash, or any other channel having definite banks and beds with visible evidence of the occasional flow of water (Title 20 New Mexico Annotated Code Chapter 6.1).

- If TSS is less than 100 mg/L, no action is required.
- If TSS is greater than 100 mg/L, but less than 1,000 mg/L, then the effectiveness of existing BMPs should be evaluated and repaired as necessary, and additional BMPs may need to be implemented to reduce TSS loading
- If the TSS is greater than 1,000 mg/L, then the remaining portion of the sample should be centrifuged and the solids analyzed for PCBs using EPA SW-846 Method 8082 (US EPA, 1997d), EPA Method 680, or draft EPA Method 1668 (Alford-Stevens, et al., 1985 and US EPA, 1996a).

7. Risk Evaluation

The risk to human health and the environment must be evaluated for all corrective action *solid waste management units/areas of contamination*[19] (**SWMU/AOCs**) impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor. The risk posed by PCBs at these SWMU/AOCs may be modeled (based on adequate available data) and should be monitored to ensure an acceptable level of risk[20] (see *Storm Water Runoff Monitoring Recommendations*).

As discussed in *Environmental Processes*, the congener composition of environmentally-aged PCBs can dramatically differ from the original Aroclor mixture released to the environment. Consequently, environmental processes can affect both exposure to, and toxicity of, environmental PCBs. Therefore, the approach to evaluating health risks from environmental PCBs differs depending upon whether the PCB congener- or Aroclor-specific (or homologue-specific) data are available for the environmental media (see also *PCB Cleanup Levels*).

PCB congeners with chlorine atoms in positions 2 and 6 (ortho) are generally more readily metabolized, while those with chlorines in positions 4 and 4' (para) or positions 3, 4 or 3, 4, 5 on one or both rings tend to be more toxic and are retained mainly in fatty tissues (Eisler, 1986). Persistent congeners may retain biological activity long after the exposure. The most toxic PCB congeners can assume a conformation, generally similar to that of 2, 3, 7, 8-tetrachloro-dibenzo-dioxin (**TCDD**), and are approximate stereo analogs of this compound (Hoffman, et al., 1996).

These dioxin-like congeners share a common mechanism of toxicity involving binding to the aryl hydrocarbon receptor; the same mechanism of action is believed to induce the toxicity of PCDDs and PCDFs. These congeners were assigned toxicity equivalency factors (**TEFs**) expressed as a fraction of the toxicity of 2,3,7,8-TCDD. Therefore, when PCB congener-specific analytical data are available, risk evaluation of human and ecological health should consider both dioxin-like and other adverse health effects. Two sections within this document (*Human Health, Carcinogenic Effects, Dioxin-like Toxicity Approach* and *Ecological Health, Dioxin-like PCBs*) provide guidance for applying these TEFs where congener-specific analyses are available. If only Aroclor/homologue concentrations are available for a

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[19]*SWMU* means "any discernable unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released." *AOC* "...refers to releases which warrant investigation or remediation under the authorities discussed above, regardless of whether they are associated with a specific SWMU..."

[20]A risk or hazard is considered *acceptable* if an estimated risk/hazard is below pre-established target risk and/or hazard levels.

site, total PCB concentrations reported as the sum of Aroclor/homologue concentrations should be used to estimate the risk to human health and the environment.

If a health risk evaluation is based on total PCB concentrations (estimated as the sum of Aroclors or PCB homologues) and the individual congeners comprising the PCB mixtures cannot be identified, the uncertainty and potential bias in the resulting risk estimates should be described in the risk assessment report. For example, if total PCB concentrations have been estimated based on Aroclor analyses, conservative assumptions should be made about the mixture composition and toxicity: the assumption that congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of total PCBs present in a given abiotic medium at the site triggers the selection of the highest cancer slope factor from Table 3. Whereas, total PCB concentrations estimated based on the results of PCB homologue analyses may allow for a refinement of these conservative assumptions. More detailed information on an approach to evaluating the health risk from environmental PCBs and PCB data requirements can be found in US EPA (1996b); Van den Berg, et al. (1998); Cogliano (1998); Giesy and Kannan (1998) and Valoppi, et al. (1999).

a. Human Health

Since PCBs may cause both carcinogenic and non-carcinogenic adverse human health effects, separate risk assessments must be performed for each of these health effects.

i. Carcinogenic Effects

The evaluation of carcinogenic risk from exposure to PCB mixtures (i.e., represented by total PCBs or PCB congeners) should follow the slope factor approach described in *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (US EPA, 1996b) and as outlined below. This approach distinguishes among toxic potencies of different PCB mixtures by utilizing information regarding environmental processes. In the absence of PCB congener- or homologue-specific analyses (i.e., if total PCB concentrations were estimated based on Aroclor analyses), this approach requires conservative assumptions about the risk and persistence of PCB mixtures at the site.

If congener-specific concentrations are available and congener analyses indicate that congeners with more than 4 (four) chlorines comprise greater that 0.5 percent of total PCBs in a given medium, the slope factor approach should be supplemented by the analysis of dioxin toxicity equivalency quotient (**TEQ**). Risk from *dioxin-like congeners*[21] should be added to the risk estimated for the rest of the PCB mixture which does not exhibit dioxin-like toxicity.

If other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site in addition to PCBs, TEQs for dioxin-like PCBs should be added to TEQs calculated for those other dioxin-like compounds to yield a total TEQ. A slope factor for 2,3,7,8-TCDD should be applied to this total TEQ. Under these circumstances, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentration to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

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[21] *Dioxin-like congeners* of PCBs are those with dioxin-like health effects and are evaluated using dioxin TEQs (Van den Berg, et al., 1998). A complete listing of PCB congeners can be found at http:\\www.epa.gov/grtlakes/toxteam/pcbid/table.htm (US EPA's Great Lakes website).

(1) Slope Factor Approach

Site-specific carcinogenic risk evaluations should be performed using PCB cancer potency or slope factors specific to the exposure scenarios and pathways at a particular site. Table 3 provides the criteria for using these slope factors (categorized into high, medium, and low levels of risk and PCB persistence) that address a variety of exposure scenarios and the toxicity of PCB mixtures in the environment. A review of recent research on PCB toxicity that formed the basis for the derivation of these slope factors and a discussion of uncertainties surrounding toxicity information can be found in US EPA (1996b) and Cogliano (1998).

The slope factors in Table 3 represent the upper-bound slopes that are recommended for evaluating human health risk from carcinogenic effects of PCBs. Both the upper-bound and central-estimate slopes are available from the US EPA's Integrated Risk Information System (**IRIS**). The central-estimate slopes can be used to support the analysis of uncertainties inherent in available toxicity information on PCBs.

TABLE 3
PCB CANCER SLOPE FACTOR VALUES[22]
by
Level of Risk and Persistence

CRITERIA FOR USE	LEVEL OF RISK AND PERSISTENCE	PCB CANCER SLOPE FACTOR VALUES[23] [risk per mg/kg-day]
food chain exposure	High	2.0
sediment/soil ingestion		
dust/aerosol inhalation		
dermal exposure (if an absorption factor has been applied)		
presence of dioxin-like, tumor-promoting, or persistent congeners		
early-life (less than 6 years old) exposure by all pathways and to all mixtures		
congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of the total PCBs present		
congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (all pathways except soil ingestion by adults)		
ingestion of water-soluble (less chlorinated) congeners	Medium	0.4
inhalation of evaporated (less chlorinated) congeners		
dermal exposure (if no absorption factor has been applied)		
congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (soil ingestion by adults only)	Low	0.07

The cancer slope factors in Table 3 characterize the toxic potency of different environmental mixtures of PCBs. Information on potential exposure pathways and PCB mixture composition at a given site guides in the selection of the appropriate cancer slope factors for risk assessment.

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[22]Modified from Cogliano, 1998 and US EPA, 1996b and 1998c.

[23]See IRIS (US EPA, 1997c).

The highest slope factor in Table 3 (2.0 per milligram/kg-day) corresponds to the high risk and persistence of environmental PCB mixtures and, as such, should be selected for pathways (including food chain exposures, ingestion of soil and sediment, inhalation of dust or aerosol, exposure to dioxin-like, tumor-promoting or persistent congeners, and early-life exposure) where environmental processes act to increase risk.

A lower slope factor (0.4 per milligram/kg-day) corresponds to the low risk and persistence of environmental PCB mixtures and is appropriate for exposure pathways (such as ingestion of water-soluble congeners and inhalation of evaporated congeners) where environmental processes act to decrease risk.

Finally, the lowest slope factor in Table 3 (0.07 per milligram/kg-day) corresponds to the lowest risk and persistence of environmental PCB mixtures and should be selected for soil ingestion by adults when congener or homologue analyses confirm that congeners with greater than four chlorine atoms per PCB molecule comprise less than 0.5% of the total PCBs present at the site.

Once the appropriate slope factor has been selected, it is multiplied by a lifetime average daily dose (**LADD**) to estimate the risk of cancer (see US EPA, 1996b for sample risk calculations). Because the use of Aroclors to characterize PCB exposures can be both imprecise and inappropriate, total PCBs or congener analyses should be used in the following LADD calculation:

$$\mathbf{LADD = (C_T \times IR \times ED \times EF) / (BW \times AT)} \qquad \textit{Equation 1}$$

where:

LADD	=	Lifetime average daily dose (mg/kg-day)
C_T	=	Total PCBs or total non-dioxin-like congener concentration in a medium (mg/L [water], mg/kg [soil], or mg/m^3 [air])
IR	=	Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED	=	Exposure duration (years)
EF	=	Exposure frequency (days/year)
BW	=	Average body weight of the receptor over the exposure period (kg)
AT	=	Averaging time - the period over which exposure is averaged (days)[24]

The cancer slope factors and recommended Aroclor fate and transport properties(Table 4), should be used to evaluate the carcinogenic risk posed by PCB mixtures or PCB congeners which do not exhibit a dioxin-like toxicity.

[24]For carcinogens, the averaging time is 25,550 days based on a lifetime exposure of 70 years.

TABLE 4
CANCER SLOPE FACTORS
AND
FATE & TRANSPORT PROPERTIES
for PCBs

	CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	CARCINOGENIC EFFECTS	
		Dioxin-like PCBs	Other PCB Congeners[25]
CANCER SLOPE FACTORS[26] $(mg/kg\text{-}day)^{-1}$	. . . **greater than 0.5%** of the total PCBs present	1.5E+05[27]	2.0
	. . . **less than 0.5%** of the total PCBs present	NA[28]	0.07
FATE & TRANSPORT PROPERTIES	. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254	Aroclor 1254
	. . . **less than 0.5%** of the total PCBs present	Aroclor 1016	Aroclor 1016

For example, if a PCB mixture contains 45% congeners with greater than four chlorines, the cancer slope factor for 2,3,7,8-TCDD and the fate and transport properties of Aroclor 1254 would be used.

If the following special exposure conditions exist, a slope factor of 0.4 may be applied to PCBs which do not exhibit dioxin-like toxicity: ingestion of water-soluble congeners, inhalation of evaporated congeners or dermal exposure (with no applied absorption factor).

(2) Dioxin-like Toxicity Approach

Dioxin-like PCBs are some of the moderately chlorinated PCB congeners (see Table 5) which have been demonstrated to produce dioxin-like effects[29] in humans. The dioxin-like toxicity approach should be implemented **only** when congener-specific concentrations are available for environmental media at a site. In this approach,

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[25]*Other PCB congeners* means those congeners which do not exhibit dioxin-like toxicity.

[26]PCB cancer slope factors can be found in IRIS (US EPA, 1997c).

[27]See Health Effects Assessment Summary Tables (HEAST) (US EPA, 1997b).

[28]*NA* means not applicable. Do not evaluate dioxin-like PCBs if they comprise less than 0.5% of the total PCBs present; evaluate the other PCB congeners.

[29]Dioxin-like congeners can react with the aryl hydrocarbon receptor, the toxicity mechanism that is believed to initiate the adverse effects of PCDDs and PCDFs.

individual dioxin-like PCB congener concentrations are multiplied by TEFs that represent the potency of a given congener relative to 2,3,7 8-TCDD (see Table 5).

TABLE 5
HUMAN
TOXICITY EQUIVALENCY FACTOR VALUES
for Dioxin-like PCBs[30]

CONGENER	TOXICITY EQUIVALENCY FACTOR VALUES
3,3′,4,4′-Tetrachlorobiphenyl (77)[11]	0.0001
3,4,4′,5-Tetrachlorobiphenyl (81)	0.0001
2,3,3′,4,4′-Pentachlorobiphenyl (105)	0.0001
2,3,4,4′,5-Pentachlorobiphenyl (114)	0.0005
2,3′,4,4′,5-Pentachlorobiphenyl (118)	0.0001
2′,3,4,4′,5′-Pentachlorobiphenyl (123)	0.0001
3,3′,4,4′,5-Pentachlorobiphenyl (126)	0.1
2,3,3′,4,4′,5-Hexachlorobiphenyl (156)	0.0005
2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)	0.0005
2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)	0.00001
3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)	0.01
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)	0.0001

Table 5 lists the TEF values derived for dioxin-like PCB congeners. Using TEF values in the risk evaluation allows for the estimation of a combined risk resulting from an exposure to a mixture of dioxin-like PCB congeners (assuming that the risks are additive).

The carcinogenic risk resulting from exposure to dioxin-like PCBs should be estimated by calculating the TEQ. The TEQ is the sum of each congener-specific concentration in the medium multiplied by its corresponding congener-specific TEF value. Multiplying the congener-specific medium concentration by the corresponding congener-specific TEF value provides a relative (i.e., "toxicity-weighted") measure of the dioxin concentration within a medium.

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[30]Modified from the *Report from the Workshop on the Application of 2,3,7,8-TCDD Toxicity Equivalency Factors to Fish and Wildlife* (US EPA, 1998b).

The TEQ for dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ} = \sum (\mathbf{C_{mi} \times TEF_i}) \qquad \textit{Equation 2}$$

where:

TEQ	=	Toxicity equivalency quotient (mg/L [water] or mg/kg [soil or sediment])
C_{mi}	=	Concentration of *i*th congener in medium (mg/L [water] or mg/kg [soil or sediment])
TEF_i	=	Toxicity equivalency factor for *i*th congener (unitless) (Table 5)

Once the dioxin TEQ has been determined, the LADD should be calculated using the following equation:

$$\mathbf{LADD} = \mathbf{(TEQ \times IR \times ED \times EF) / (BW \times AT)} \qquad \textit{Equation 3}$$

where:

LADD	=	Lifetime average daily dose (mg/kg-day)
TEQ	=	Toxicity equivalency quotient (mg/L [water], mg/kg [soil], or mg/m^3 [air])
IR	=	Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED	=	Exposure duration (years)
EF	=	Exposure frequency (days/year)
BW	=	Average body weight of the receptor over the exposure period (kg)
AT	=	Averaging time - the period over which exposure is averaged (days)[24]

The following equation can be used to estimate carcinogenic risk from dioxin-like PCBs:

$$\mathbf{Cancer\ Risk} = \mathbf{LADD \times CSF_{TCDD}} \qquad \textit{Equation 4}$$

where:

LADD	=	Lifetime average daily dose (mg/kg-day)
CSF_{TCDD}	=	Cancer slope factor for 2,3,7,8-TCDD[31]

ii. Non-Carcinogenic Effects

For Aroclors having reference doses (**RfDs**) specified in IRIS (e.g., Aroclor 1254, 1016, etc.), the non-carcinogenic risk should also be evaluated. The evaluation of non-carcinogenic risk should follow the approach typical for other non-PCB chemicals. However, fate and transport properties of the recommended Aroclor (see Table 6) should be used to evaluate the risk posed.

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[31]The cancer slope factor for 2,3,7,8-TCDD should be obtained from the most recent IRIS (US EPA, 1997c) or HEAST (US EPA, 1997b). The current oral cancer slope factor for 2,3,7,8-TCDD of 1.5E+05 (mg/kg-day)$^{-1}$ is based on the administered dose from a 105-week dietary rat study and was adopted for inhalation exposure in HEAST (US EPA, 1997b).

TABLE 6
TOXICOLOGICAL AND FATE & TRANSPORT PROPERTIES
for PCBs with Human Health Non-carcinogenic Effects
and Ecological Health Non-dioxin-like Effects

CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	NON-CARCINOGENIC EFFECTS AND FATE AND TRANSPORT PROPERTIES
. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254
. . . **less than 0.5%** of the total PCBs present	Aroclor 1016

The RfD derived for Aroclor 1254 should typically be used when conducting a risk assessment. The RfD derived for Aroclor 1016 can be used when at least 99.5% of the mass of the PCB mixture has fewer than four (4) chlorine atoms per molecule as determined by a chromatography/spectroscopy analytical method. Using Table 6, determine which Aroclor most accurately represents the PCB mixture of concern. Use the RfD and fate and transport properties of this Aroclor as a surrogate to evaluate the non-carcinogenic effects of the PCB mixture.

b. Ecological Health

Since PCBs adversely impact both community- and class-specific guild measurement receptors, risks must be estimated for each receptor within both groups. Plants and invertebrates should be evaluated as community measurement receptors (see *Exposure Assessment for Community Measurement Receptors*).

The evaluation of PCB-specific ecological risk should follow that described in *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (US EPA, 1999).

When congener-specific concentrations are available, risk from exposure to dioxin-like PCBs should be estimated separately and added to the risk estimated for the remainder of the PCB mixture which does not exhibit dioxin-like toxicity. The resulting risk is likely to be overestimated if toxicity data from total PCBs is applied to those congeners which do not exhibit dioxin-like toxicity. This overestimation of risk should be addressed within the uncertainty analysis of the risk assessment report.

In the absence of PCB congener-specific data, total PCB concentrations, reported as the sum of Aroclor or homologue concentrations, should be used to estimate receptor exposure to PCBs and the toxicity value of the most toxic Aroclor present should be used in the site-specific ecological risk assessment.

i. Dioxin-like PCBs

Ecological risks to community- and class-specific guild measurement receptors from dioxin-like PCBs should be estimated by calculating a TEQ and then dividing it by the toxicity value for 2,3,7,8-TCDD (which is assumed to be the most toxic dioxin).

If in addition to PCBs, other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site, TEQs for dioxin-like PCBs should be added to the TEQs calculated for those other dioxin-like compounds to yield a total TEQ. The 2,3,7,8-TCDD toxicity value should be applied to this total TEQ. For this evaluation, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentrations to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

The TEF values listed in Tables 7 and 8 should be used in the TEQ calculation to convert the exposure media concentration of individual congeners to a relative measure of concentration within a medium .

TABLE 7
FISH TOXICITY EQUIVALENCY FACTOR VALUES
for Dioxin-like PCBs[32]

CONGENER	FISH TOXICITY EQUIVALENCY FACTOR VALUES[33]
3,3′,4,4′-Tetrachlorobiphenyl (77)[11]	0.0001
3,4,4′,5-Tetrachlorobiphenyl (81)	0.0005
2,3,3′,4,4′-Pentachlorobiphenyl (105)	<0.000005[34]
2,3,4,4′,5-Pentachlorobiphenyl (114)	<0.000005
2,3′,4,4′,5-Pentachlorobiphenyl (118)	<0.000005
2′,3,4,4′,5′-Pentachlorobiphenyl (123)	<0.000005
3,3′,4,4′,5-Pentachlorobiphenyl (126)	0.005
2,3,3′,4,4′,5-Hexachlorobiphenyl (156)	<0.000005
2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)	<0.000005
2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)	<0.000005
3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)	<0.000005
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)	<0.000005

[32]Modified from the *Report from the Workshop on the Application of 2,3,7,8-TCDD Toxicity Equivalency Factors to Fish and Wildlife* (US EPA, 1998b).

[33]The surrogate TEF values for fish are presented because invertebrate-specific TEF values have not yet been developed.

[34]For all fish TEFs of "<0.000005," use the value of 0.000005 as a conservative estimate.

TABLE 8
MAMMAL AND BIRD
TOXICITY EQUIVALENCY FACTOR VALUES
for Dioxin-like PCBs[35]

CONGENER	TOXICITY EQUIVALENCY FACTOR VALUES	
	MAMMALS	BIRDS
3,3′,4,4′-Tetrachlorobiphenyl (77)[11]	0.0001	0.05
3,4,4′,5-Tetrachlorobiphenyl (81)	0.0001	0.1
2,3,3′,4,4′-Pentachlorobiphenyl (105)	0.0001	0.0001
2,3,4,4′,5-Pentachlorobiphenyl (114)	0.0005	0.0001
2,3′,4,4′,5-Pentachlorobiphenyl (118)	0.0001	0.00001
2′,3,4,4′,5′-Pentachlorobiphenyl (123)	0.0001	0.00001
3,3′,4,4′,5-Pentachlorobiphenyl (126)	0.1	0.1
2,3,3′,4,4′,5-Hexachlorobiphenyl (156)	0.0005	0.0001
2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)	0.0005	0.0001
2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)	0.00001	0.00001
3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)	0.01	0.001
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)	0.0001	0.00001

Because congener-specific fate and transport data are not available for each of the dioxin-like PCBs listed in Tables 7 and 8, the fate and transport properties of Aroclor 1254 should be used in exposure modeling.

(1) Exposure Assessment for Community Measurement Receptors

To evaluate the exposure of water, sediment and soil communities to dioxin-like PCBs, a media-specific TEQ should be calculated. The TEQ is the sum of each congener-specific concentration (in the respective media to which the community is exposed) multiplied by its corresponding congener-specific TEF value derived for fish (Table 7).

The TEQ for community measurement receptors exposed to dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ} = \sum (C_{ml} \times TEF_i) \qquad \textit{Equation 5}$$

[35]Modified from the *Report from the Workshop on the Application of 2,3,7,8-TCDD Toxicity Equivalency Factors to Fish and Wildlife* (US EPA, 1998b).

where:

TEQ	=	Toxicity equivalency quotient (μg/L [water] or μg/kg [dry weight soil or sediment])
C_{mi}	=	Concentration of *i*th congener in abiotic media (μg/L [water] or μg/kg [dry weight soil or sediment])
TEF_i	=	Toxicity equivalency factor (fish) for *i*th congener (unitless) (Table 7)

Risk to the water, sediment or soil community is subsequently evaluated by comparing the media-specific TEQ to the media-specific toxicity value for 2,3,7,8-TCDD:

$$\textbf{Risk} = \textbf{TEQ} / \textbf{TRV}_{TCDD} \qquad \textit{Equation 6}$$

where:

TEQ	=	Toxicity equivalency quotient (μg/L [water] or μg/kg [dry weight soil or sediment])
TRV_{TCDD}	=	Toxicity reference value for 2,3,7,8-TCDD (μg/L [water] or μg/kg [dry weight soil or sediment])

(2) Exposure Assessment for Class-Specific Guild Measurement Receptors

To evaluate the exposure of class-specific guild measurement receptors to dioxin-like PCBs, congener-specific daily doses of food items (i.e., abiotic media, plants, animals, etc.) ingested by a measurement receptor ($\mathbf{DD_i}$)[36] should be converted to a TEQ-based daily dose ($\mathbf{DD_{TEQ}}$). This DD_{TEQ} can subsequently be compared to the 2,3,7,8-TCDD toxicity values for an evaluation of the risk posed to class-specific guild measurement receptors.

The DD_{TEQ} for each measurement receptor should be calculated as shown in the following equation:

$$\mathbf{DD_{TEQ}} = \sum \mathbf{DD_i} \times \mathbf{TEF_{MR}} \qquad \textit{Equation 7}$$

where:

DD_{TEQ}	=	Daily dose of PCB TEQ (μg/kg fresh body weight-day)
DD_i	=	Daily dose of *i*th congener (μg/kg fresh body weight-day)
TEF_{MR}	=	Toxicity equivalency factor (specific to measurement receptor) (unitless) (Table 8)

Risk to the class-specific guild being evaluated can be estimated by dividing the DD_{TEQ} by the toxicity reference value for 2,3,7,8-TCDD:

$$\textbf{Risk} = \textbf{TEQ} / \textbf{TRV}_{TCDD} \qquad \textit{Equation 8}$$

[36]The congener-specific daily doses of food items ingested by a measurement receptor should be calculated in accordance with the most current EPA and/or State guidance.

where:

DD_{TEQ} = Daily dose of PCB TEQ (μg/kg fresh body weight-day)
TRV_{TCDD} = Toxicity reference value for 2,3,7,8-TCDD (μg/kg fresh body weight-day)

ii. Other PCB Congeners

In addition to the dioxin-like PCB congeners, the remaining PCBs should be evaluated like other bioaccumulating organic contaminants by assessing ecological risks to community- and class-specific guild measurement receptors (US EPA, 1999). The fate and transport properties of Aroclor 1254[37] should be used in the exposure modeling when evaluating the risk from PCB mixtures containing congeners with equal to or greater than 4 chlorines in quantities **greater** than 0.5% of the total PCBs. And, the fate and transport properties of Aroclor 1016[38] should be used in the exposure modeling when evaluating risks from PCB mixtures containing **less** than 0.5 % of PCB congeners with more than 4 chlorines (see Table 6).

8. Conclusion

PCBs, which are a class of organic compounds that are persistent in the environment, are toxic to both humans and biota. PCBs may in certain instances become contaminated with more toxic PCDFs and PCDDs. Therefore, the potential presence of these compounds should also be evaluated and possibly investigated.

Based on federal and state regulations and standards, the HRMB recommends that PCB-contaminated sediment/soils be remediated to either 1 mg/kg total PCBs or the most stringent of the calculated health risk-based concentrations in order to adequately protect human health and the environment.

Unless soil/sediments are remediated to 1 mg/kg total PCBs, the risk posed by PCBs to human health and the environment should be evaluated using a risk-based approach. All corrective action SWMU/AOCs impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor should be evaluated and monitored, as necessary, to protect human health and the environment.

PCB concentrations in soil/sediments should also be protective of both surface water and ground water resources; PCB concentrations in surface water should not exceed 0.014 μg/l and PCB concentrations in ground water cannot exceed 0.5 μg/l (drinking water) or 1 μg/l in ground water with 10,000 mg/l or less total dissolved solids).

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[37]Approximately 77% of Aroclor 1254 is composed of PCB congeners with more than 4 chlorines.

[38]Approximately 99% of Aroclor 1016 is comprised of PCB congeners with 4 or less chlorines.

9. References

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HAZARDOUS AND RADIOACTIVE MATERIALS BUREAU

New Mexico Environment Department

Position Paper ***Position Paper***

RISK-BASED DECISION PROCESS STRATEGY

The traditional Corrective Action (CA) approach as implemented by the Environmental Protection Agency (EPA) was based on an interpretation of applicable statutory authorities, codified regulations and the detailed requirements set forth in the proposed subpart S regulations (55 FR 30798). Because this traditional approach emphasized the administrative process rather than results, it tended to be overly structured and costly to implement.

As a result, EPA, some states, and industry have undertaken initiatives to streamline the corrective action process and make cleanup decisions based on the level of risk posed to human health and the environment. A new risk-based management strategy was developed to expedite the CA process without relaxing protectiveness. Based on this new strategy, EPA Region 6 developed a draft guidance, *Risk Management Strategy* to promote and expedite the implementation of corrective action based on risk management. Once this document has been finalized, the Hazardous and Radioactive Materials Bureau intends to adopt it, all or in part (with or without modification), in the near future.

The *Strategy* establishes a non-traditional, tiered (and iterative) risk-based approach (RBA). The RBA allows for more flexibility as long as established performance standards are met. Therefore, a Facility may chose a CA path which best suits its needs. For example, a Facility may choose to perform a site-specific risk assessment, in lieu of or in addition to a screening-level risk assessment, to more closely examine risks from releases and refine the remedial objectives.

The RBA evaluates immediate threat, determines if a release has occurred, identifies the constituents of potential concern, and includes screening-level and site-specific risk assessments. The RBA emphasizes the importance of the site conceptual exposure model (SCEM). The SCEM is initially developed early in the corrective action process and is continually refined as more information is obtained.