APPENDIX B. ALLOCATION ISSUES

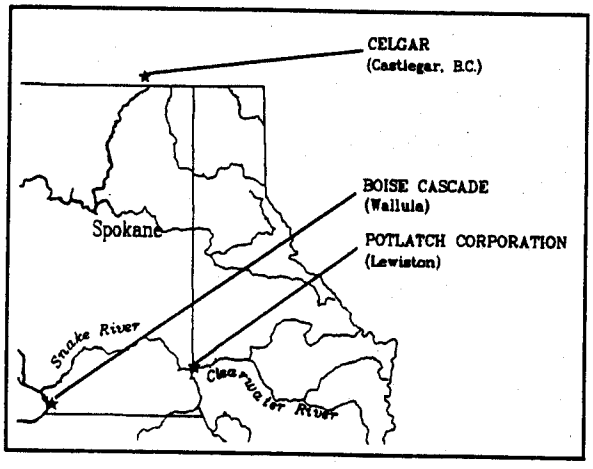
In determining appropriate allocation methods for the Columbia, several concerns have been identified that affect decisions on the TMDL. Issues identified which were considered in developing allocations for 2,3,7,8-TCDD to the Columbia River include:

- Loading from the **British Columbia pulp mill**
- Loading from **other potential sources** such as woodtreaters
- Fate, transport, and **attenuation**
- **Role of bottom sediments** (cumulative effects and resuspension)
- Framework for addressing **future allocations** (both growth within the pulp industry and allocations to other source categories)

1. British Columbia Pulp Mill

Celgar Pulp Company operates a bleached kraft pulp mill located in Castlegar, British Columbia. Wastewater from this mill is discharged to the Columbia River approximately 30 miles upstream from the United States - Canada border (Figure B-1). Studies conducted by Canadians have shown elevated concentrations of 2,3,7,8-TCDD in lake whitefish collected below the Celgar mill (Mah *et al.*, 1989; EVS, 1990). In addition, follow-up analyses by the Washington Department of Ecology of fish from Lake Roosevelt found elevated levels of TCDD and TCDF (Johnson, 1990). Lake Roosevelt is the impoundment formed by Grand Coulee Dam on the Columbia River downstream from the Celgar mill. Because of concern over the amounts of TCDD and TCDF detected in fish tissue, the Washington Department of Health took action in August 1990. A health advisory was issued that children under age four and under 40 pounds should not eat whitefish from Lake Roosevelt. Subsequent sampling by the Washington Department of Ecology suggests that concentrations of 2,3,7,8-TCDD may also be elevated in sturgeon as well.

Figure B-1. Location of Celgar Pulp Co. (Castlegar, B.C.)



The discovery of elevated levels of dioxins and furans below Celgar and other British Columbia pulp mills resulted in action by the Canadian government. New regulations under the Canadian Environmental Protection Act (CEPA) have been proposed to regulate the discharge of chlorinated organics. The Canadian federal government is proposing limits of non-detectable amounts of dioxins and furans by January 1994. In addition, the Province of British Columbia (B.C. Environment) has adopted regulations to control adsorbable organic halides (AOX) discharged from bleached kraft pulp mills. The control of AOX requires reductions in the use of chlorine which, in turn, decreases the formation of dioxins and furans. The new regulations require that, by 1993, AOX be limited to 2.5 kg per metric tonne of pulp produced.

Over the past decade, the B.C. Ministry of Environment has been trying to get various owners of the Celgar pulp mill to resolve water pollution problems caused by their failure to meet waste permit requirements. The identification of chlorinated organics as a health issue has resulted in increased urgency on the part of the Canadians to install pulping technology and effluent treatment works to resolve problems. To meet these government requirements, Celgar has proposed a mill modernization effort.

The most recent measurements of effluent quality discharged by the Celgar mill were obtained during the Canadian Pulp and Paper Association survey (CPPA, 1990). Information on present and projected levels of 2,3,7,8-TCDD and -TCDF have been provided by Celgar. These are summarized in Table B-1. The load measured in early 1990 from the Celgar pulp mill is less than 1.37 mg/day. Since this survey, the mill has made several improvements that were designed to further reduce dioxin and furan levels in the effluent. Results of the follow-up sampling will be available later this year. The amount of 2,3,7,8-TCDD measured from the Celgar mill in the 1990 survey is significantly less than the loading capacity of 2.3 mg/day for the Columbia River at the International Boundary. This does not consider other potential sources upstream of the border. However, no other sources have been identified where 2,3,7,8-TCDD has been detected.

Table B-1. Concentrations of TCDD and TCDF from Celgar Pulp

	2,3,7,8-TCDD		2,3,7,8-TCDF	
	Concentration (ppq)	Load (mg/day)	Concentration (ppq)	Load (mg/day)
CPPA 1990 Survey	ND (14)	< 1.37	310	30.4
Projected after modernization (from bleach plant)		< 0.0485		< 0.0485

Celgar is also seeking government approval to increase the mill's production from 560 to 1200 air dried metric tonnes of pulp per day. B.C. Environment recently completed public hearings regarding the proposed Celgar pulp mill expansion project. Modifications to the mill's production process are being proposed which include oxygen delignification, 70% substitution of chlorine dioxide for chlorine, and hydrogen peroxide bleaching followed by primary and secondary effluent treatment. The improvements to the Celgar mill are expected to be in place by 1994. Concentrations of TCDD and TCDF in the bleach plant effluent are expected to be below detection limits of 10 ppq. Maximum daily discharges after modernization are expected to be <0.05 mg/day for TCDD and <0.05 mg/day for TCDF (Celgar, 1990). Recognizing problems in the past, B.C. Ministry of the Environment has stated that: "Either Celgar will have to significantly upgrade pollution control technology in their existing mill to achieve compliance or they will face heavy penalties for breaking the law."

Several of the U.S. mills criticized the proposed TMDL (June 15, 1990) for a perceived lack of equity with Canada. The final TMDL estimates a loading of 0.31 mg/day from Celgar. This is equal to the loading which would be allocated to Celgar if it were a mill in Region 10. This accounts for Celgar's planned production after modernization (see Table 3-2) and applies a factor of 0.257 μg/day of 2,3,7,8-TCDD discharged per ton of bleached pulp. This is the same factor used to calculate the WLAs for the Region 10 mills. This is not a WLA but rather an estimated loading. This estimate provides a margin of safety to cover other unidentified sources in Canada and/or a possible shortfall in Celgar's attainment of the projected 0.05 mg/day loading. As additional information is assembled, this preliminary estimate may be refined.

2. Other Potential Sources

The development of the TMDL needs to consider all potential sources of 2,3,7,8-TCDD in the Columbia drainage. Besides chlorine bleaching pulp mills, other potential source categories include woodtreaters, major municipal wastewater treatment plants, agricultural areas, industrial sites, and urban areas. Table B-2 summarizes potential sources of TCDD in the Columbia, the type of available information on loading rates, and median fish tissue concentrations from the National Bioaccumulation Study (NBS) associated with the source category. The NBS was conducted as a screening investigation to determine the prevalence of selected bioaccumulative pollutants in fish. One of the study objectives was also to identify general correlations between fish tissue concentrations and sources of these pollutants.

The NBS results, listed in Table B-2, clearly indicate that the highest levels of TCDD contamination in fish were found in areas below chlorine bleaching pulp mills. However, two other site categories from the NBS in the Columbia basin which were not immediately below pulp mills had elevated levels of TCDD in fish. Both sites are located in the north Portland area. One of the sites, Columbia Slough, is affected by nonpoint sources, predominantly urban runoff and a landfill. The other site is located below a major woodtreating operation (McCormick & Baxter) which uses pentachlorophenol (PCP). TCDD contamination has been associated with PCP.

Table B-2. Potential Sources of 2,3,7,8-TCDD in the Columbia Basin

Source Category	Availability of Data for Region 10	National Bioaccumulation Study Comparative Results (from draft report)
		Median Conc. (ppt)
Chlorine Bleaching Pulp & Paper	104 mill study	4.73
Non-Chlorine Bleaching Pulp & Paper	N/A	1.30
Superfund Sites	Remedial Investigations	1.47
Woodtreaters, Incinerators, etc.	TRI , DMR	1.39
Other Industrial Sites	N/A	1.27
Urban Areas	N/A	1.27
Municipal Wastewater Treatment Plants	Sewage Sludge Survey	0.64
Agricultural Areas	N/A	0.56
Other Sites	N/A	0.63

Note: N/A - Not Available
TRI - Toxics Release Inventory (PCP)
DMR - NPDES Discharge Monitoring Reports (PCP)

Woodtreaters:

A number of current and former wood treatment facilities exist in the Columbia River basin where pentachlorophenol (PCP) has been used as a preservative. A potential source of 2,3,7,8-TCDD from woodtreating facilities is contaminated PCP. Thirteen sites near former or existing woodpreserving facilities were sampled during the National Bioaccumulation Study. The median 2,3,7,8-TCDD concentration in fish tissue at these sites was 1.39 ppt (compared to 4.73 for the chlorine bleaching pulp mills). Of the thirteen sites sampled nationally near woodtreaters, only one was in the Columbia River basin: the Willamette River at Portland (below McCormick & Baxter). Three species of aquatic organisms were sampled at that site with the following results:

Species	2,3,7,8-TCDD
Largemouth Bass	0.74 ppt
Sucker	2.22 ppt
Crayfish	2.61 ppt

The values for this site are higher than the median for the NBS. However, organisms collected from this location are also influenced by other potential sources of 2,3,7,8-TCDD, such as urban runoff.

These measured values reflect the need to evaluate information on the potential discharge of 2,3,7,8-TCDD from woodtreating facilities. EPA has recently developed a data system which contains information from the Toxics Release Inventory (TRI). A retrieval of reported releases of PCP for 1987 identifies seven facilities (woodtreaters) in the Columbia Basin (Table B-3). Five of these facilities are located in the Willamette drainage. Although the TRI information does not contain data on TCDD, the indicated releases of PCP lead to concern over woodtreaters, particularly in the Willamette basin. DMR data and inspection reports describing PCP discharges are also available for

several woodpreserving facilities with NPDES permits in the Columbia basin.

Table B-3. PCP Discharges from Columbia Basin Woodtreating Facilities

Cataloging Unit	Facility Name	Location	NPDES DMR Data	TRI Data (lbs. PCP released) 1987 (Water)	1987 (Total)	1988 (Water)	1988 (Total)
17010214	B.J. Carney	Sandpoint, ID					
17010214	L.D. McFarland	Sandpoint, ID		C	1,850	C	500
17010216	Poles, Inc.	Oldtown, ID					
17010305	B.J. Carney Industries, Inc.	Spokane, WA					
17020003	Chewelah Log and Post	Chewelah, WA					
17020003	Colville Post and Pole	Colville, WA					
17040201	Garland Pole Co.	Idaho Falls, ID					
17040219	Penta Post	Gooding, ID					
17050114	Pressure Treated Timber	Boise, ID				C	7
17050114	Roundy Pole Fence Co.	Eagle, ID					
17070105	J.H. Baxter & Co.	The Dalles, OR					
17080001	Allweather Wood Treaters	Washougal, WA					
17080001	Exterior Wood, Inc.	Washougal, WA					
17080001	Pacific Wood Treating	Ridgefield, WA	I/R	250	2,300	B	1,500
17080003	International Paper Co.	Longview, WA					
17090001	Jasper Wood Treating	Jasper, OR					
17090003	J.H. Baxter & Co.	Eugene, OR	X	250	1,250	200	202
17090003	L.D. McFarland	Eugene, OR	X	250	1,500	B	750
17090008	Taylor Lumber & Treating	Sheridan, OR	o	250	13,488	B	2,150
17090010	Dant & Russell	North Plains, OR					
17090010	Permapost	Hillsboro, OR		0	250		
17090012	McCormick & Baxter	Portland, OR	X	31	6,999	150	154

Notes TRI data for releases of PCP to: Water (discharge)
Total (includes water, air and land disposal)

B : 1 - 499 lbs.
C : No discharge to water identified
I/R : Inspection Report
X : Loads calculated for PCP
o : Only PCP concentration reported

The preamble to a proposed RCRA rule relating to the wood preserving industry (53 FR 53292, December 30, 1988) describes ranges of chlorinated dibenzodioxin and chlorinated dibenzofuran as well as PCP concentrations in wastewaters from woodtreating facilities. Thus, an estimate of potential 2,3,7,8-TCDD releases from woodtreating facilities can be made based on data on PCP discharges. The TRI data were considered in estimating TCDD wastewater releases from woodtreaters. However, there are some apparent problems. Several facilities, for instance, reported zero discharge to water while others reported the same value of 250 pounds. DMR data, on the other hand, appear to provide better information on PCP discharges. Applying assumed ratios of 2,3,7,8-TCDD per unit PCP (derived from Table 7, 53 FR 53292) to the DMR data, EPA estimates that 1 - 2 mg/day 2,3,7,8-TCDD could be originating from woodtreating operations in the Columbia basin. This estimate includes the potential release from facilities where no DMR or TRI data exists.

Levels of 2,3,7,8-TCDD observed in fish and sediments below one major woodtreating operation plus estimates of potential loads point to the need for additional data. Any allocation scheme used to develop the TMDL must leave room for these facilities. Using available information, a range of 1 - 2 mg/day appears to be a reasonable estimate. However, this estimate is preliminary and data are still being generated. As additional information is assembled, this estimate may be refined. Most of the released 2,3,7,8-TCDD is associated with site run-off during rainfall. Thus, the loading from woodtreaters could be reduced by implementing stormwater controls.

Municipal Wastewater Treatment Facilities:

National data demonstrate that the sludges removed from some municipal wastewater treatment plants contain dioxins and furans. Generally, octa-chlorinated forms predominate the dioxins found in these sludges, although 2,3,7,8-TCDD has also been detected. Where sludges are contaminated, the wastewater discharges could also contain 2,3,7,8-TCDD. Testing performed for 2,3,7,8-TCDD in sludge nationally included five municipal wastewater treatment plants in the Columbia basin ("National Sewage-Sludge Survey Facility Analytical Results", U.S. Environmental Protection Agency, 1989). Results for these five facilities are listed in Table B-4.

Table B–4. Columbia Basin Sludge Testing for 2,3,7,8-TCDD

Cataloging Unit	Facility Name	Location	2,3,7,8-TCDD (ng/kg)	Detection Limit
	Municipal WWTP's			
17050114	West Boise STP	Boise, ID	ND	(4.7)
	" " "	" "	ND	(6.1)
17080001	Columbia Blvd. STP	Portland, OR	ND	(16.0)
	" " "	" "	ND	(8.9)
17090005	Stayton STP	Stayton, OR	ND	(23.0)
17090006	Lebanon STP	Lebanon, OR	3.3	---
	" "	" "	2.2	---
17090012	Tryon Creek STP	Lake Oswego, OR	ND	(57.0)
	" " "	" " "	ND	(43.0)
	Chlorine Bl. Mills			
17060306	Potlatch Corp.	Lewiston, ID	78.0	---
17070101	Boise Cascade	Wallula, WA	70.0	---
17080001	James River	Camas, WA	12.0	---
17080003	Boise Cascade	St. Helens, OR	4.2	---
17080003	Longview Fibre	Longview, WA	69.0	---
17080003	Weyerhaeuser	Longview, WA	25.0	---
	" "	" "	35.0	---
17080003	James River	Wauna, OR	19.0 (pri.)	---
	" "	" "	89.0 (sec.)	---
17090003	Pope & Talbot	Halsey, OR	31.0	---

Of the five municipal facilities whose sludges were examined in the Columbia basin, only one had detectable levels of 2,3,7,8-TCDD. This indicates that the TMDL should leave some room for potential allocations to municipal sewage treatment plants. Analytical results for this treatment plant, however, show that the detected concentration was at levels much lower than sludge tested at chlorine bleaching pulp mills (Table B-4). Thus, it can be expected that load estimates for municipal facilities will be much lower than the loads allocated to the pulp mills based on the sludge data.

Initial estimates of 2,3,7,8-TCDD discharged from municipal wastewater treatment facilities can be made using available data. Permitted total suspended solids for each facility and an assumed average 2,3,7,8-TCDD concentration in municipal sludge form the basis of these calculations. The analysis also assumes that chlorinated dioxins / furans found in municipal sludge are associated with effluent solids at the same concentrations. The average 2,3,7,8-TCDD concentration detected was 2.8 ng/kg. The permitted total suspended solids load from Region 10 municipal wastewater treatment plants in the Columbia Basin is over 170,000 pounds per day. Based on this information, these municipal wastewater treatment facilities could, as a group, contribute an average of 0.2 mg/day 2,3,7,8-TCDD. As additional information is assembled, this preliminary estimate may be refined.

Other Industrial Sources:

Non-chlorine bleaching pulp mills (Table B-5) and other potential industrial sources also need to be considered in the allocation process. No data has been presented on 2,3,7,8-TCDD concentrations in either wastewater or sludges for Columbia basin non-chlorine bleaching pulp mills. Another potential industrial source of 2,3,7,8-TCDD is Rhone-Poulenc, located in north Portland. This plant has produced chlorophenolic herbicides since 1956. The facility discharges boiler blowdown, cooling water, site runoff, and treated groundwater to the Willamette River (across from McCormick & Baxter). The effluent is known to contain chlorinated phenols, although 2,3,7,8-TCDD was not detected during a National Dioxin Study.

Table B-5. Non Chlorine Bleaching Pulp Mills in the Columbia Basin

Cataloging Unit	Facility	Location
17010305	Inland Empire Paper Co.	Spokane, WA
17080001	Boise Cascade Corp.	Vancouver, WA
17090003	Willamette Industries	Albany, OR
17090004	Weyerhaeuser	Springfield, OR
17090007	Smurfit Newsprint	Newberg, OR
17090012	James River II	West Linn, OR
17090012	Smurfit Newsprint	Oregon City, OR

An estimate of loadings from these sources cannot be determined at this time. With respect to non-chlorine bleaching pulp mills, an analysis cannot be conducted because no data has been identified which describes 2,3,7,8-TCDD in either effluents

or sludges. As to Rhone-Poulenc, available data from the National Dioxin Study showed non-detect for 2,3,7,8-TCDD. However, the detection limits were higher than present day limits. As additional information is gathered, it will be possible to estimate loadings from these sources.

3. Fate, Transport, and Attenuation

Losses of 2,3,7,8-TCDD in the water column can occur through sedimentation (see discussion in next section), photolysis, and volatilization, as well as through uptake by aquatic organisms. 2,3,7,8-TCDD's structural properties, laboratory bioconcentration experiments, and field observations also indicate a strong potential for bioaccumulation. Thus, the role of these processes needs to be expressed in terms of potential bioavailability. Limited information exists which can be used to provide initial estimates on the effects of fate, transport and attenuation in the Columbia River system. Readily available, quality data have been considered. This includes information from the Northwest Pulp & Paper Association's Columbia River Fish Study (1989), from EPA's National Bioaccumulation Study (1987), from the Washington Department of Ecology's work on Lake Roosevelt (1989-90), and from efforts in Canada.

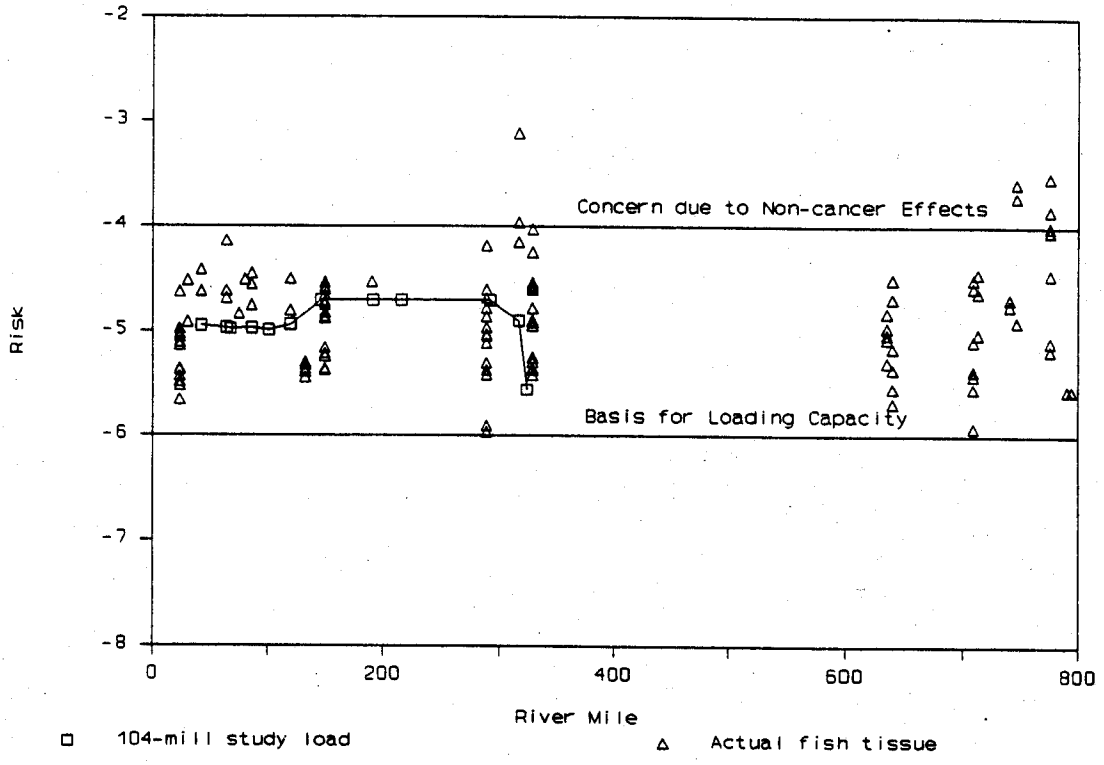
Several approaches exist to evaluate the effects of fate, transport, and attenuation. Water quality models, using a variety of assumptions, can be used to assess ambient data and to evaluate the need for additional controls. Available analytical tools range from simple estimates to complex data-intensive dynamic models. Analyses can include a loss rate which considers potential adsorption of TCDD on particulate matter within the water column. The potential release of TCDD from the sediment to the overlying water or the potential effect of sediment bound TCDD on the benthic and aquatic life food chain must also be considered. However, quantitative predications of bioaccumulation for specific cases and regulatory actions are complicated by many uncertainties. These uncertainties include the degree of partitioning between dissolved and bound phases, definition of the food chain structure plus bioenergetic parameters, and the relative importance of other fate and transport phenomena.

The Clean Water Act specifically states that TMDL's shall be established with a margin of safety which takes into account any lack of knowledge. Based on the lack of knowledge concerning attenuation of TCDD in the Columbia River basin, assumptions must be made with respect to attenuation in determining the loading capacity of the system and allocations of that capacity. A review of comments received on the proposed TMDL did not provide conclusive evidence that **net** attenuation occurs. Although TCDD may be lost to the sediments, that loss may only be temporary because of resuspension, desorption, or biological uptake directly from the sediments.

Figure B-2 superimposes predicted fish tissue concentration data on a graph of the actual (measured) fish tissue data plotted in Figure 2-1 in Section 2 of this document. Water column concentrations of 2,3,7,8-TCDD were modeled based on (1) the results of TCDD sampling in source effluents (the "104-Mill Study), (2) receiving

water dilution calculated from the harmonic mean flows at the discharge points, and (3) an assumption of no net attenuation. Predicted fish tissue concentrations were then calculated using a bioconcentration factor of 5,000 (the factor used in developing the water quality criterion). As in Figure 2-1, all fish tissue concentrations (both measured and predicted) are displayed in terms of estimated cancer risk based on the factors used to calculate EPA's water quality criterion for 2,3,7,8-TCDD. Both the 10^{-6} and 10^{-4} risk levels are identified. The 10^{-6} risk level corresponds to the 0.013 ppq ambient 2,3,7,8-TCDD concentration which is the basis of the TMDL, while 10^{-4} represents a level of possible concern due to non-cancer effects. Note that the line plotted between data predicted based on an assumption of no net attenuation closely follows the data points based on directly measured fish tissue concentrations.

Figure B-2. Columbia River Fish Tissue: TCDD



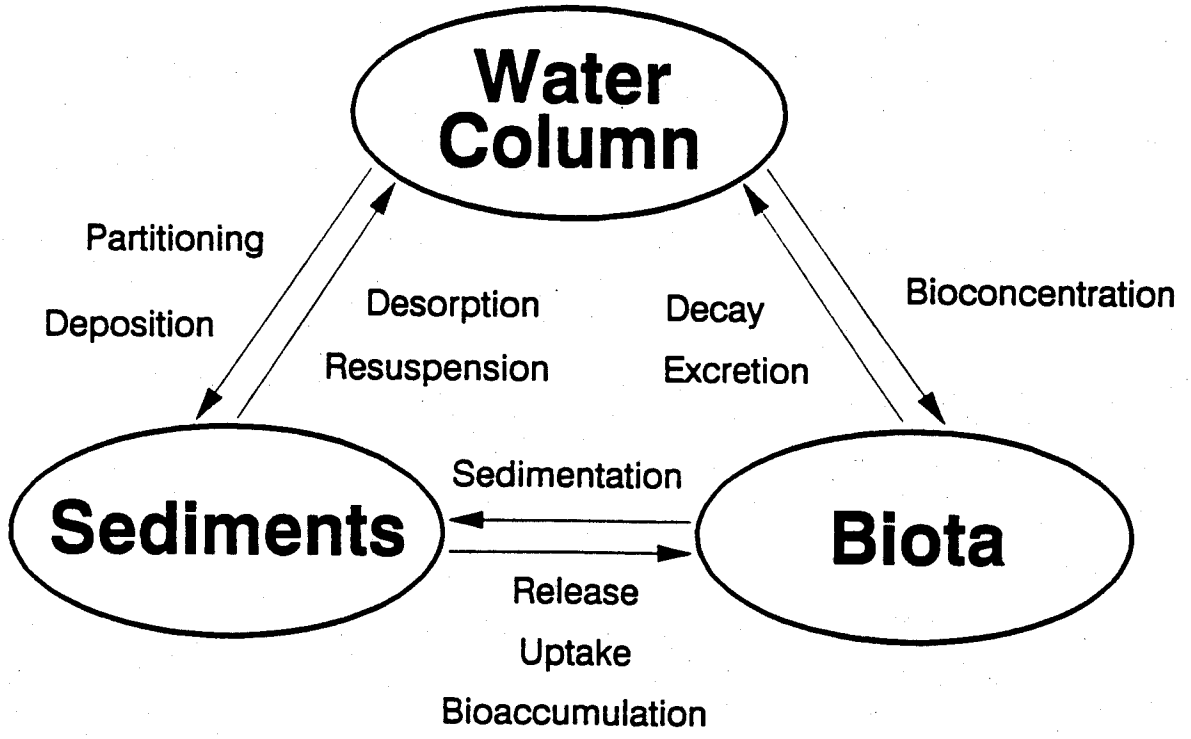
Based on the comparison in Figure B-2 of predicted tissue concentrations with observed values, an assumption of no net attenuation appears to be reasonable. Thus, for purposes of developing this TMDL, all 2,3,7,8-TCDD discharged is assumed to remain in the water column and remain biologically available. Because this is a conservative assumption, this TMDL should lead to the attainment of water quality standards regardless of the actual level of attenuation. If future studies quantify a net attenuation rate, allocations can be modified to reflect this. This capacity could be used to provide an increased margin of safety to account for unknown sources, increase allocations for existing sources, or accommodate future growth needs. By the same token, if studies indicate that TCDD releases from historical accumulations in

the sediments constitute a problem, tighter controls may be needed (see discussion in following section).

4. Role of Bottom Sediments

Sediment concentrations are the result of a complex series of interactions between TCDD, the overlying water column, solids, aquatic organisms, and the external loading of TCDD. Because of the hydrophobic nature of dioxin, there is a tendency for TCDD to move from the water column to the sediments and aquatic biota. Although attenuation may result in a net loss of TCDD from the water column, the potential also exists for the sediments to act as a source of dioxin through the release of TCDD which has accumulated (Figure B-3).

Figure B-3. Exchange of TCDD Between Water Column, Sediments, and Biota



Some fraction of the TCDD which enters a river is quickly associated with solids. The adsorption of TCDD to particulate matter may ultimately determine levels in fish tissue. There are a number of different theories about the role of equilibrium partitioning and bioaccumulation from contaminated sediments. The fate of TCDD in the aquatic environment is increasingly being discussed in terms of food chain mechanisms. Dioxins are believed to be adsorbed to bacteria, fungi, and organic sediment particles. These particles are eaten by filter-feeding benthic invertebrates which in turn are consumed by fish.

In addition, solids tend to settle to the bottom of the receiving water. In areas where the river is not filling in, these particles (and the TCDD associated with them) will continue to be carried downstream as either bedload or resuspended sediments. In areas of sediment accretion, typically where river velocities are diminished, TCDD will tend to accumulate in the bottom sediments where it may be available to aquatic organisms. Resuspension of sediments either through high streamflows, boat traffic, or dredging activities must also be considered.

Current knowledge of the Columbia system is not adequate to determine the availability of TCDD associated with particulate matter to benthic organisms or fish on a basin-wide basis. Existing sediment concentrations probably reflect a combination of both current and historical discharges of TCDD. Because the Region's pulp mills have implemented some process changes recently, such as the use of different defoamers, it is unlikely that existing sediment contamination levels are in equilibrium with current loadings to the basin. Also, if desorption of dioxin occurs slowly, it may take several years to observe the effect of reduced discharges in sediments and in biota.

Limited sediment sampling for dioxin has been done in the Columbia system. Data collected in the mainstem Columbia River below Bonneville Dam have not detected 2,3,7,8-TCDD. However, current detection limits may be above the level of concern considering the low organic content of the sediments analyzed. TCDD has been detected in Willamette River sediments below a woodtreating operation. These spatial differences reflect both physical characteristics and the influence of specific sources. Thus, future studies on the effect of sediments should address site-specific concerns.

Given these conditions it would not be appropriate to assume a permanent loss of 2,3,7,8-TCDD through sedimentation. Indeed, a portion of the loading capacity should remain unallocated to account for potential release from the sediments and from TCDD currently stored in the food chain. As indicated in the discussion on attenuation, tighter controls will be needed if data show that the cumulative effects of historical discharges significantly delay attainment of TCDD standards under the reduced loadings required by this TMDL.

5. Future Allocations

TMDLs may provide a framework for dealing with future allocations. Examples include the assignment of any unallocated portion of the loading capacity to specific point or nonpoint sources. Future growth of the pulp industry in the Columbia River basin, either expansion of existing mills or new mills, is a possibility which should be considered in this TMDL.

Developing an equitable framework for future allocations is not an easy task. This TMDL reserves a portion of the loading capacity as unallocated for 2,3,7,8-TCDD to account for uncertainties and to provide for future growth. As uncertainties are reduced, the amount held back can be made available to other sources or for additional future growth. Decisions on the use of the unallocated load will be made on

a case-by-case basis by EPA in consultation with the affected States. If proposed projects are not consistent with this TMDL, a revised TMDL would need to be established before the proposed increased loadings could be allowed.