

EXHIBIT 1

Total PCB delivered to the Lower Hudson is estimated as the product of the Tri+ load at Waterford and the Total PCB to Tri+ ratio. In the original estimates given in the FS, the Total PCB to Tri+ ratio at Schuylerville of 2.2 (developed from the GE data collected at Schuylerville) was used as the ratio at Waterford. Thus the application of the value estimated for Waterford (1.4) yields load estimates of Total PCB that are one-third lower than originally calculated. Although both the Tri+ and Total PCB loads are estimated, it is important to note that the values estimated for Total PCBs include a higher degree of uncertainty due to this additional step in the estimation process.

Sediments

The estimation of a Total PCB to Tri+ ratio for the sediments of the Upper Hudson was made difficult by the heterogeneous nature of sediment contamination in the Upper Hudson and the lack of a Total PCB data set that could be considered spatially representative of the entire area. The heterogeneity was due to several factors including variable rates of deposition and scour, as well as dechlorination of PCB in the sediments. Dechlorination directly increases the ratio since it produces monochloro and dichloro congeners by converting heavier congeners to lighter ones. As noted in the DEIR (USEPA, 1997), the degree of dechlorination in the sediments of the Upper Hudson is dependent on the concentration of PCBs. In general, the most contaminated sediments typically exhibit the greatest degree of dechlorination. In addition, extensive dechlorination in the Hudson River appears largely limited to sediments above an initial concentration of 30 ppm Total PCB. Thus, sediments with low levels of contamination are expected to have relatively low ratios of Total PCB to Tri+, as compared to highly contaminated sediments³.

The need for an estimate of the Total PCB to Tri+ ratio for each river section of the Upper Hudson was dependent on the available data and the engineering data requirements. Thus the ratio was estimated for each river section for each sediment subclass on an as-needed basis. The data sets available to provide this information were different in each river section. The derivation of the necessary information for each river section is described below.

River Section 1 (TI Pool)

During the preparation of the FS, it was recognized that no study existed in River Section 1 that could provide a complete description of the Total PCB inventory in the sediments. A ratio was needed to describe Total PCBs for the entire TI Pool. The 1984 data set represented the best coverage for an estimate of the Tri+ concentrations and inventory but was not well suited for the estimate of Total PCB. In the FS, as well as prior EPA reports, the estimate of Total PCB mass for the TI Pool was based on the sum of Aroclors as originally reported by Brown *et al.*, 1988. This approach was considered a low-end estimate since it was recognized that the 1984 results did not capture the monochloro and dichloro fractions well. Upon subsequent review of the most recent GE data (1999 coring data) in conjunction with the existing set of Phase 2 low-resolution cores, Phase 2 high-resolution cores, the 1991 GE composite samples, and the 1998 GE

³ Evidence suggests that most dechlorination in the Upper Hudson River occurs rapidly after sediment deposition, and subsequent dechlorination is limited. As discussed at length in the DEIR (USEPA, 1997), it is unlikely that historically deposited sediments will undergo further, substantial dechlorination.

composite samples, it was decided that a sufficient amount of data were available to support an independent estimate of the Total PCB to Tri+ ratio for the TI Pool.

To best estimate the Total PCBs to Tri+ ratio, it is important to recognize that this ratio varies almost directly with the degree of dechlorination. This is because the mono- and di-homologue fractions increase and the Tri+ fractions decrease in response to the dechlorination process. Thus, highly dechlorinated mixtures have a high ratio, and vice versa. As extensively documented in the DEIR (USEPA, 1997), the extent of dechlorination in the sediment varies logarithmically with the concentration in the sediment. Thus, the Total PCB to Tri+ ratio should also vary with concentration.

This correlation was best demonstrated by the Phase 2 high-resolution cores (as shown in the first diagram of Figure 424694-1). These core samples represent relatively thin core segments (2- to 4-cm thick), a scale at which sediment concentrations are expected to be relatively homogeneous within the sediment. Thus, the relationship between sediment concentration and dechlorination should be clearest for these samples. The Total PCBs to Tri+ ratio clearly increases with concentration. A weighted curve has been fit to the data to suggest how the mean ratio varies with concentration. The initial value of 1.25, which applies below 10 mg/kg of Tri+, is quite close to the theoretical starting value of 1.17 for Aroclor 1242. This is consistent with the findings of the DEIR, which stated that little dechlorination occurs at low concentrations. As sediment concentrations rise above 10 mg/kg Tri+, the Total PCB to Tri+ ratio increases substantially, reaching a value around 4 above 100 mg/kg Tri+. Clearly, the Total PCB to Tri+ ratio is dependent on the sediment concentration.

This can also be seen in the GE coring data from 1998 and 1999. These data also represent relatively thin core segments and would be expected to yield a similar relationship between the sediment concentration and the Total PCB to Tri+ ratio. This is illustrated in the second diagram of Figure 424694-1. Again a weighted curve has been fit to the data to track the mean ratio. A few outliers were excluded from the weighted curved determination, based on a statistical Mahalanobis analysis (SAS, 1997).

This diagram also shows an initial low value for the Total PCB to Tri+ ratio, rising to a much higher value at higher concentrations. The absolute value of the mean ratio is higher than that obtained from the high-resolution cores. This is attributed to the differences in analytical technique between the two data sets. Part of the difference may lie in the quantitation techniques used by GE. Essentially, the mono and di congeners are analyzed on a congener-specific basis, whereas the Tri+ fraction is tied to an Aroclor standard (Hydroqual, 1997). Thus, the absolute value of the Total PCB to Tri+ ratio for the GE data is strongly dependent on the internal calibration of the two analytical bases. Nonetheless, both the Phase 2 and the GE data sets suggest about a threefold increase in the ratio at high concentrations. In both sets, individual samples can attain ratios nearly double the mean high-end value.

Both data sets demonstrate a strong relationship between Tri+ concentration and the Total PCB to Tri+ ratio. However, both data sets represent small sampling intervals (less than or equal to five cm), much shallower than the 1984 NYSDEC coring data set (nominally 30 cm). As documented in the LRC (USEPA, 1998), the process of collecting thick segments serves to confound ratio-to-concentration relationships, since layers of many different properties are

blended into a single analysis. This is evident in the third diagram of Figure 424694-1, where the low-resolution core results are presented. As was seen for the molar dechlorination product ratio (USEPA, 1998), the relationship for the Total PCB to Tri+ ratio to Tri+ concentration is much noisier than that for the high-resolution cores.

However, these samples are closest in collection technique to the 1984 survey, and so are best suited to describe the Total PCB to Tri+ ratio for the 1984 data. Additionally, the conversion of the 1984 data set to a Tri+ basis is founded on the EPA's congener-specific analytical technique. Thus, for both sampling technique and analytical approach, the curve developed for the low-resolution cores is most applicable to the 1984 data set.

A review of the third diagram would not, of itself, suggest a strong relationship. However, the strength of the Total PCB to Tri+ ratio relationship is already well established by the high-resolution core and GE core data sets. As a result, a relationship was developed that parallels the relationship seen in the high-resolution cores (Figure 424694-2).

The upper diagram of the figure shows the weighted mean curves from each of the data sets. Notably, the low-resolution core curve is similar to the GE curve at low concentrations (less than 10 mg/kg), and converges to approximately the same value as the high-resolution cores at high concentrations (greater than 100 mg/kg). The weighted curve developed for the low-resolution curve was then approximated as three segments, as follows:

Tri+ Concentration	Total PCB to Tri+ Ratio
Less than 10 mg/kg	2.2
Between 10 and 100 mg/kg	$2.2 + \log(\text{Tri+Conc} / 10)$
Greater than 100 mg/kg	3.8

This approximation is shown in the second diagram of Figure 424694-2.

As explained in White Paper – Sediment PCB Inventory Estimates, this curve was applied to the length-weighted average Tri+ concentrations of the TI Pool to estimate the Total PCB concentrations in the sediments. Each individual 1984 core or grab was corrected to estimate the local Total PCB concentration. These results were then integrated over the area of the pool and the volume of sediment to be removed. Based on this integration, the mass-integrated Total PCB to Tri+ ratio for the TI Pool was estimated at 3.1. For the sediments to be remediated under the selected remedy, the ratio was estimated at 3.4. These ratios are summarized in Table 424694-2.

The relationship between Total PCB and Tri+ is such that the most contaminated sediments have the highest ratios. These are also the sediments that are preferentially targeted for removal under the selected remedy. As a result, the estimates for Total PCBs in the areas slated for removal under the selected remedy increased more than the areas to be left untouched. This modification has the effect of increasing the estimate of the fraction of Total PCBs to be removed under the selected remedy. As discussed in White Paper – Sediment PCB Inventory Estimates, the estimate for the *in situ* Total PCB inventory of the TI Pool increased 3-fold to 45 metric tons. Of this inventory, approximately 80 percent, or 36 metric tons, will be removed. The result of the increase in the Total PCB inventory estimate for the TI Pool serves to increase the overall

importance of the TI Pool to the PCB inventories of the Upper Hudson. Correspondingly, the mass of PCBs removed for this river section has increased as well. Ultimately, since both estimates increase, this leads to an overall increase in the fraction of PCB removed from the Upper Hudson for the selected remedy.

River Sections 2 and 3 (TI Dam to Waterford)

In these river sections, there is no single synoptic data set of sufficient quality and recent age that can be used to estimate Tri+ or Total PCB concentrations or inventories on a section-wide basis. However, as the data available contain estimates for both Total PCB and for Tri+, there is no need to independently estimate their ratio, as was done for River Section 1. As discussed in White Paper – Sediment PCB Inventory Estimates, the low-resolution coring data set provided a basis for assessing both Total PCB and Tri+ in the areas to be remediated, effectively equivalent to the cohesive sediment areas. For noncohesive sediments, the 1991 GE composite samples were used. The application of these data is discussed in detail in White Paper – Sediment PCB Inventory Estimates. This discussion will focus on the Total PCB to Tri+ ratio for these areas.

Because the relatively recent low-resolution cores and 1991 GE composites samples could be used to estimate inventories and concentrations and because these samples provide direct estimates of Tri+ and Total PCBs, the data could be used to estimate the Tri+ and Total PCB values for the river sections independently. However, it is useful to compute the Total PCB to Tri+ ratio simply for comparative purposes, providing further support for the approach used in River Section 1. These results are summarized in Table 424694-2.

The ratios given in the table agree well with the values found for the TI Pool. Specifically, the values obtained for the sediments targeted for remediation in River Sections 2 and 3 (3.4 and 2.7, respectively) compare well with the value obtained for the sediments targeted for remediation in the TI Pool (3.4). These data support the derivation of a ratio for the TI Pool, as was described above.

Fish

Results for fish samples collected by EPA were used to examine the Total PCB to Tri+ ratio in Hudson River fish. This data set, like the other Phase 2 results, is able to provide an independent estimate of the Total PCB and Tri+ concentration for each sample. The ratio is, therefore, not needed for calculations, but rather to support the modeling and risk-calculation assumptions. In the presentations of the BERA and RBMR, the observation that PCBs in fish are nearly entirely represented by the Tri+ summation has been stated many times but not quantitated. This examination will briefly summarize the results.

The 207 fish samples collected in Phase 2 and analyzed via EPA's congener-specific methodology form the basis for this calculation. Sample replicates of the same species from the same station were averaged prior to inclusion in the region-wide calculation; *e.g.*, five white perch samples from the station were averaged together prior to inclusion in the calculation. In this manner, stations and species were more evenly represented. After this summation, 60 unique species/station samples were available. These were arithmetically averaged together on a