ISSUE PAPER

PSDDA MONITORING PLAN AND DY 1992 ELLIOTT BAY FULL MONITORING

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INTRODUCTION AND BACKGROUND

PERIMETER CHEMISTRY GUIDELINE VALUES

The PSDDA non-dispersive disposal site monitoring program assesses physical chemical, and biological effects at and adjacent to the disposal sites. One of the three primary questions addressed by the monitoring plan is whether or not the deposited dredged material stays on-site.

This question is addressed by two monitoring techniques: sediment-profile photography and sediment chemistry measurements. These data are collected at up to twelve stations located around a disposal site's perimeter. The sediment-profile system provides information on the distribution and thickness of dredged material layers as thin as 1 cm. Complimentary sediment chemistry measurements are designed to provide evidence that contaminants are not migrating off-site, whether or not discernible dredged material layers are observed in the profile images.

The PSDDA disposal site monitoring plan established a perimeter chemistry guideline approach to assess whether contaminant levels were elevated at a station relative to baseline levels (C-14). The monitoring plan originally set trigger levels of 1.25X the baseline concentration for each chemical of concern (both metals and organics). This trigger level was developed using best professional judgment, but in the absence of specific information on the sediment chemical heterogeneity at the PSDDA sites.

During the 1989 Puget Sound Ambient Monitoring Program and 1990 PSDDA disposal site sampling events, triplicate sediment chemical samples were obtained at 11 stations throughout Puget Sound (six of these stations were located in Elliott Bay and Port Gardner). These data were used to re-evaluate the trigger values based on the actual measured replicate heterogeneity (C-15). The revised trigger level remained at 1.25X for metals but increased to 1.47X for the organics. The revised trigger levels were calculated using the 95th percentile of coefficients of variation measured in 1989 and 1990 for both organic compounds and metals to estimate the standard error of the mean. This standard error was then used to calculate 80% confidence intervals for both metals and organics. The trigger factors (1.25X for metals and 1.47X for organics) were generated by dividing the upper confidence limit by the mean. By this method, the PSDDA agencies acknowledged a 20% probability that a measured concentration would exceed a guideline value by chance (i.e., give a false positive indication of an elevated chemical concentration at a given site). This approach is consistent with other PSDDA monitoring triggers.

1990 POST-DISPOSAL MONITORING RESULTS (C-15)

In the 1990 Elliott Bay survey, the sediment-profile mapping of the dredged material footprint indictated that all of the disposed sediments were contained within the disposal site boundary. However, there were multiple guideline exceedances for organic compounds and metals (using both the original and revised trigger values) at all four perimeter chemistry stations sampled. Moreover, triplicate samples had been obtained at two of the perimeter stations and, for a number of chemical concentrations, exceeded trigger levels in one or two, but not in all three replicates.

In Port Gardner, the sediment-profile mapping indicated that thin layers of dredged material were

present at perimeter stations located west of the site boundary. Of the twelve perimeter stations sampled for chemistry, exceedances for metals (predominately) and some organics occurred at eight stations. As in Elliott Bay, exceedances often occurred in some replicates from a triplicated station but not others. Moreover, according to the sediment-profile mapping, dredged material layers were present at only three of the eight Port Gardner perimeter stations which showed chemical exceedances. In other words, the exceedances measured at the remaining five stations occurred at stations apparently unaffected by dredged material disposal.

Finally, in both embayments, many of the chemicals exceeding the guideline values at the perimeter stations were not detected in the dredged material on-site and many chemicals measured on the dredged material mound were not detected at the perimeter. For example, in Elliott Bay, PCB concentrations exceeded perimeter guidelines but were not detected on-site, while DDT/DDE were evident in the dredged material but not observed at the perimeter. In Port Gardner, the pesticide lindane exceeded perimeter guideline values but was not detected on-site in the dredged material samples, and several metals that exceeded perimeter guidelines exhibited extremely low concentrations at the disposal site.

The above observations support the conclusion that the perimeter exceedances observed in 1990 at Elliott Bay and Port Gardner were not due to dredged material disposal. As mentioned above, however, due to the 80% trigger level confidence interval used in calculating the trigger levels, chance exceedances were to be expected, especially given the large number of individual chemical guideline comparisons made. It is evident from the data presented below that the number of exceedances can be accounted for by the statistical criteria used to generate the trigger values.

DISPOSAL SITE	NUMBER OF COMPARISONS	NUMBER OF EXCEEDANCES EXPECTED *	NUMBER OF EXCEEDANCES OBSERVED
Port Gardner	171	34	21
Elliott Bay	197	39	32

*By chance, based on an 80% Confidence Interval

This further supports the conclusion that dredged material disposal activity did not influence the perimeter chemical concentrations observed in 1990.

PROBLEM IDENTIFICATION

BASELINE PERIMETER CHEMISTRY SAMPLING DESIGN

The above analysis points to the need to revise PSDDA perimeter chemistry baseline sampling design. During 1988 and 1989 baseline monitoring the number of perimeter chemistry stations occupied varied among the five non-dispersive sites. At the major urban sites Elliott and Commencement Bays, twelve stations were occupied. At Anderson-Ketron and Bellingham Bay, four stations were occupied, and at Port Gardner, five baseline stations were occupied. Single, unreplicated chemical measurements were made at each of these baseline stations. The PSDDA site monitoring plan defines two levels of post-disposal monitoring intensity, partial and full. The monitoring intensity at a given site is a function of the volume of dredged material disposed there since the previous monitoring event. Partial monitoring calls for the occupation of four, unreplicated perimeter chemistry stations; full monitoring includes twelve, unreplicated perimeter stations. It became obvious in 1990, therefore, that full-monitoring events at the Port Gardner, Anderson-Ketron, and Bellingham Bay sites would entail collecting chemistry data

at perimeter stations for which no baseline data existed. Because the guideline approach requires both a trigger value and a baseline concentration, the 1990 full monitoring data assessment at Port Gardner included the calculation of "baseline concentrations" for stations not occupied during baseline; these "concentrations" were calculated based on measured concentrations at adjacent stations. This approach was used at seven of twelve perimeter stations occupied during 1990 full monitoring at Port Gardner. The approach used to calculate these "baseline" values is described in (C-15).

Under the circumstances, the PSDDA agencies believed the approach used in 1990 was the most reasonable way to deal with the lack of baseline data at some perimeter stations. However, the long-term incorporation of this method into the monitoring program remained in question.

BIOACCUMULATION MONITORING INTERPRETATION

During the 1990 disposal site monitoring, the re-evaluation of the established PSDDA trigger levels (2X baseline for metals and 5X baseline for organics) was also restricted to the metals data due to the paucity of organic compound "hits". Trigger levels were determined using a power analysis routine which calculates the minimum detectable difference (MDD) as a percentage of the mean for a parameter (when a real difference exists; i.e., null hypothesis is false) as a function of the following variables:

1) the significance level of the test;

2) the number of stations,

3) the number of replicates; and

4) a measure of the natural variability of the parameter measured.

Of these items, 1 through 3 are fixed in the PSDDA monitoring design, so the MDD (and the associated trigger level) is a function of the variability inherent in the data. The lower the variability the smaller the real difference that can be detected at a given power (or probability) level. The degree of variability in the data is reflected by the coefficient of variation (CV), i.e., the standard deviation expressed as a percentage of the mean. Listed below are the CVs for the 1991 *Molpadia* data for each metal and for each metals grouped.

COEFFICIENT OF VARIATIONS FOR METALS (n = 9) IN *MOLPADIA* TISSUES:

Metal:	Sb	As	Cd	Cu	Pb	Hg	Ni	Ag	Zn
CV%:	56	56	50	100	80	56	41	133	78

It should be apparent from the above that all else being equal the MDD, and therefore the trigger level, will vary among metal species. In addition, the combined metal CV is less than or equal to the individual metal CVs in all cases. Therefore a trigger level established based on the combined metal CV would underestimate the actual detectable difference. In other words, trigger level exceedances would occur that were not associated with the PSDDA-set 80% power level. Some individual metal exceedances could reflect a lower statistical power, i.e., a lower probability that an exceedance represents a "real" environmental change.

PROPOSED ACTIONS/MODIFICATIONS

PERIMETER CHEMISTRY

In view of both the baseline sampling design and the pattern of perimeter

exceedances observed during the 1990 post-disposal monitoring, the PSDDA agencies

propose the following changes to the monitoring perimeter chemistry plan.

1. Use of new perimeter chemistry guideline or "trigger" values, which were derived from actual triplicate station data available in 1990, reflecting the current best estimate of heterogeneity inherent in Puget Sound sediments. The new guideline Values are: 1.25X for trace metals and 1.47X for organic COCs. As additional triplicate station data are gathered (e.g., the 1992 site monitoring, see item 2 below), these values may be re-evaluated.

2. Replacement of the twelve, unreplicated perimeter chemistry stations, established as part of the full monitoring sampling grid, into four stations with three field replicates each. It is virtually certain that some perimeter chemistry exceedances will continue to occur due to the statistical assumptions of the guideline approach. Therefore, the acquisition of three replicate values for each analyte at each station will provide information critical to a weight-of-evidence assessment. Consistent exceedances for certain chemicals of concern in all replicates from a single station will point more forcefully to a "real" chemical change at that location than scattered exceedances 'm some replicates but not others. This information should lead to more straightforward and technically-defensible conclusions regarding the elevation, or lack thereof, of contaminants at a site's perimeter.

There are two major ancillary benefits of this replicated approach. First, the weakness in the baseline sampling design is addressed. Baseline data exists for at least four perimeter stations at all PSDDA sites. Obviously, these baseline stations would be targeted for post-disposal reoccupation and replicate sampling. Second, simple temporal and spatial statistical comparisons (e.g., t-tests) could be performed on the replicated perimeter chemistry data from 1990 onward. Such statistical significance testing would be used to supplement the PSDDA "weight-of-evidence" approach, not replace it. Over several monitoring events at each site, the replicated station data may allow long-term patterns of within-station and between-station chemical heterogeneity to be discerned.

The major disadvantage to this revised sampling approach is the reduction in spatial coverage around the perimeter of the sites. (Fiscal restraints do not allow triplication at twelve stations). We will obtain data at only four locations around a site rather than twelve. During the sediment-profile mapping (accomplished prior to the chemical sampling), the most probable direction of dredged material movement away from the sites will have been documented. While the four monitoring stations will be placed to coincide with baseline (or previous post-disposal) sampling locations, floating station(s) in area(s) of concern that are not covered by a baseline station could be added, on a case-by-case basis. Finally, the areal coverage afforded by the four-station design is not anticipated to be a major problem. Physical mapping of dredged material disposal mounds throughout coastal regions of the United States indicates that dredged material deposits are generally circular in form. Therefore if disposed dredged material extends beyond the site boundary, it is likely to breach a good portion of the perimeter line.

OTHER PSDDA SITE PERIMETER CHEMISTRY EVALUATION ISSUES

1. Beginning in 1992, PSDDA monitoring data will be assessed in light of both the program's established interpretive criteria, as modified here, and the State Sediment Management Standards. Chemical concentrations at perimeter stations will be compared to the Sediment Quality Standards

contained in WAC 173-204-320 (sediments posing no adverse effects on biological resources and no significant human health risk). For disposal sites distant from major anthropogenic pollution sources, such as the Anderson-Ketron site, comparison of PSDDA monitoring results (C-16) to State Standards could eventually supplant the use of the perimeter chemistry trigger level approach entirely. For urbanized sites, such as Elliott and Commencement Bay, where sediment chemical concentrations at the perimeter may be influenced by anthropogenic activity unrelated to dredged material disposal, the PSDDA guideline approach will likely need to be applied in tandem with comparisons to State Standards for the foreseeable future. This is because baseline sediment concentrations in the vicinity of these sites may presently exceed State Standards for some chemicals of concern.

2. Beginning in 1992, the PSDDA disposal site monitoring contractor will be required to report the Limit of Quantitation (LOQ) associated with each sample/compound analyzed. It is hoped that this additional analytical data will a) facilitate the temporal comparisons of chemical values reported by different laboratories which approach the sample limits of detection (LOD), and b) over the long-term, shed light on the relationship between LOD, LOQ, and the PSDDA screening levels for sediments which vary widely in physical and chemical characteristics.

BIOACCUMULATION MONITORING INTERPRETATION

The PSDDA agencies will work during 1992 to re-evaluate tissue guideline values based on chemical-specific data and variability for metals. In the meantime, the established PSDDA tissue guidelines (2X baseline for metals) will remain in effect.

REFERENCES

C-14 PSDDA, 1988. Management Plans Technical Appendix - Phase I (Central Puget Sound). Puget Sound Dredged Disposal Analysis. June 1988.

C-15 SAIC, 1991. PSDDA 1990 Monitoring - Post-Disposal Surveys of Elliott Bay and Port Gardner, Final Report. Prepared for the Washington Department of Natural Resources. August 1991.

C-16 PSDDA, 1989. Baseline Survey of Phase H Disposal Sites. Prepared for the Washington Department of Ecology by PTI Environmental Services, Inc.

Enclosure 8

PROPOSED CHANGES TO BIOACCUMULATION APPROACH

1. COLLECT/ANALYZE ONLY MEDIUM MOLPADIA (8-12 cm) AND ONLY LARGE COMPSOMYAX (> 6.0 cm)

SIZE (n = 3)	MOLPADIA VARIANCE	COMPSOMYAX VARIANCE
SMALL	6.76	0.37
MEDIUM	2.69	16.74
LARGE	15.80	0.25

2. CALCULATE INDIVIDUAL TRIGGER LEVELS FOR EACH METAL AND SPECIES (COMPLETE BEFORE 1993 MONITORING, NO BIOACCUMULATION IN 1992)

IN ADDITION, REVIEW NON-PSDDA DATA SETS TO ASSESS 5X TRIGGER FOR ORGANICS AND DEGREE OF COMPOUND-TO-COMPOUND VARIABILITY

PROPOSED CHANGES TO PERIMETER CHEMISTRY APPROACH

1. FORMALLY ADOPT THE REVISED TRIGGERS OF 1.47X FOR ORGANICS, BUT REVISIT FOLLOWING 1992 MONITORING (SEE ITEM 2).

2. FOR FULL MONITORING SCHEME, CONVERT THE TWELVE UNREPLICATED PERIMETER STATIONS INTO FOUR TRIPLICATED STATIONS.

ADVANTAGES:

-WITHIN-STATION REPLICATES WILL ADD TO WEIGHT-OF-EVIDENCE APPROACH IN ASSESSING EXCEEDANCES

-BOTH WITHIN AND AMONG STATION VARIABILITY ASSESSED, OVER TIME MAY BE ABLE TO REDUCE LEVEL OF EFFORT

-ALLEVIATES NEED TO "ESTIMATE" BASELINE CONCENTRATIONS AT STATIONS NOT ACTUALLY OCCUPIED

DISADVANTAGES:

-SPATIAL COVERAGE REDUCED, BUT AVAILABILITY OF SVPS DATA WILL ALLOW FLOATING STATIONS TO BE PLACED AS NEEDED