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**MEMO**

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**DATE:** January 23, 2009  
**TO:** Brian Bartkowiak  
**FROM:** Jim Johnson  
**RE:** SBC Sediment Data Work-up

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Brian,

Per your request, we have completed a data visualization work-up of the Silver Bow Creek stream sediment data.

Appended below are a series of graphs which present the sediment concentration of five COCs (As, Cd, Cu, Pb, Zn) at eleven sediment monitoring stations, for the years 2003 to 2008. The results for each COC are presented on a separate page, with six annual graphs. The graphs are stacked and their dimensions, stationing and scale are held constant. When these are printed on an 11"x17" page, this permits year to year comparison of a single station's COC data by scanning down the page, and spatial comparison of a single year's data by scanning across each annual graph. For each station, four concentration values are presented:

1. The concentration of the COC in the less than 0.063mm size fraction.
2. The concentration of the COC in the 0.063-1mm size fraction.
3. The concentration of the COC in the 1mm-2mm size fraction.
4. The concentration of the COC in the less than 2mm size fraction.

All values are the average (arithmetic mean) of all samples collected at that station in the given year. That is typically four samples collected quarterly, but may be fewer for some stations in some years. The first three values are raw concentration data for the three size fractions that we analyze. The fourth is a composite value, which weights the three fraction concentrations according to their contribution (by weight) to the entire less-than-2mm material size that is often considered 'stream sediment'. This less-than-2mm size fraction is the most mobile and biologically and chemically active component of the stream bed, and typically constitutes approximately 50% (by weight) of the material captured in the stream bed material samples that are collected for the SBC monitoring.

We present the raw concentration data for the individual size fractions because they are the most extreme values and because they can be useful in interpreting trends in the whole sample concentration. The individual size fraction raw concentrations can be misleading, however. It is very often the case that one of the size fractions (typically the finest) will have a much higher COC concentration than the others in that sample, but at the same time will make up a very small portion of the sample (oftentimes less than 1%) and thus have very little effect on the total sediment concentration and COC load to the stream. For this reason we present the weighted average composite concentration as well, and it is that value that should be referred to when assessing the overall sediment contamination issue.

Temporally, the overall trend of sediment COC concentration is declining across the period 2003-2008, and (within likely sampling uncertainty) flat or declining within any

406-585-9500  
fax 406-582-9142

P.O. Box 1133  
1115 N. 7<sup>th</sup> Ave, Suite 1  
Bozeman, MT 59771-1133

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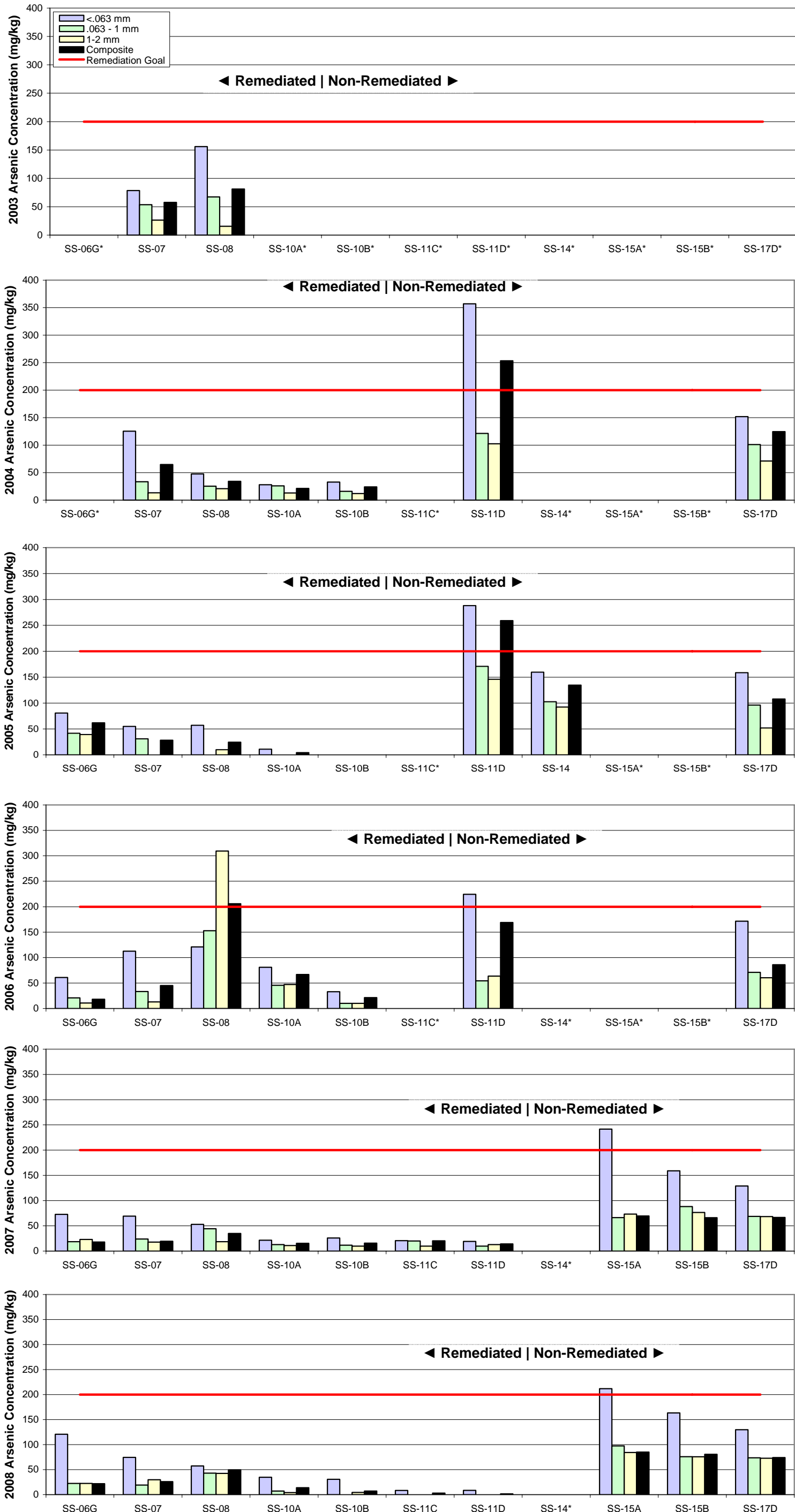
subset of those years. This is true for all five COCs analyzed, and for all stations monitored within both the remediated and unremediated areas of the project.

The exception to this trend is the year 2006. With very few exceptions, 2006 sediment concentration of all five COCs increased vs the prior year's values at all monitoring sites within the remedy, and remained high at the unremediated sites. The increase in COC concentration was quite dramatic, with 2006 values often exceeding same site 2005 results by a factor of five or more. The 2006 increase in COC concentration was also well distributed across the analyzed gradations. Though the finest fraction typically posts the highest COC concentration within a given sample, in 2006 the 1mm and 2mm fractions typically showed greater increase in COC concentration than the <0.063 fraction, and often exceeded its concentration. This issue was examined in the 2006 SBC monitoring report. Though it was difficult to draw firm conclusions from sparse data, the peaked bi-modal distribution of the 2006 quarterly monitoring COC results appeared to suggest that a pulse or perhaps two of contaminated material had entered the project area and was making its way downstream.

This apparent pulse persisted in the downstream monitoring sites in the unremediated reaches through spring 2007, and did not return. Annualized 2007 sediment concentrations were substantially lower than 2006 values for all COCs at all monitoring locations. They were typically equal to or lower than 2005 concentrations as well, continuing the long term downward trend. Sediment concentrations for 2007 met remedy goals for the five COCs at all monitoring locations.

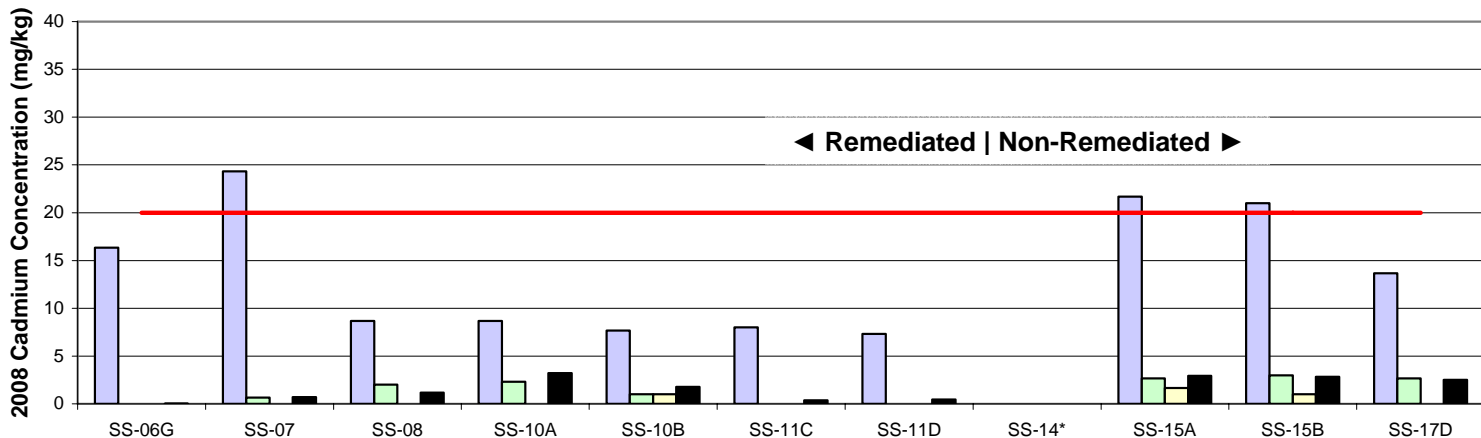
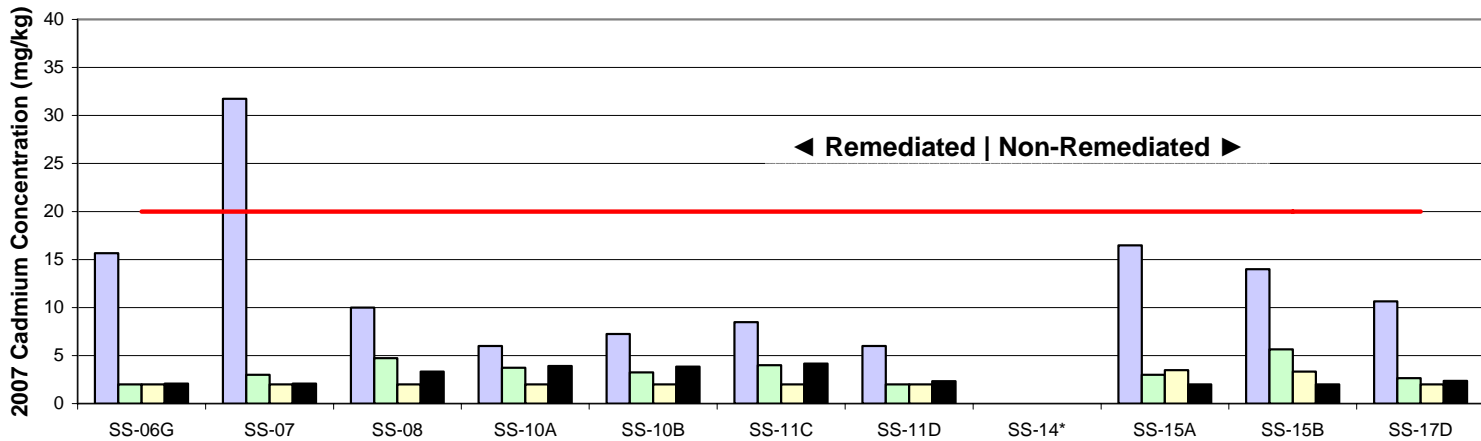
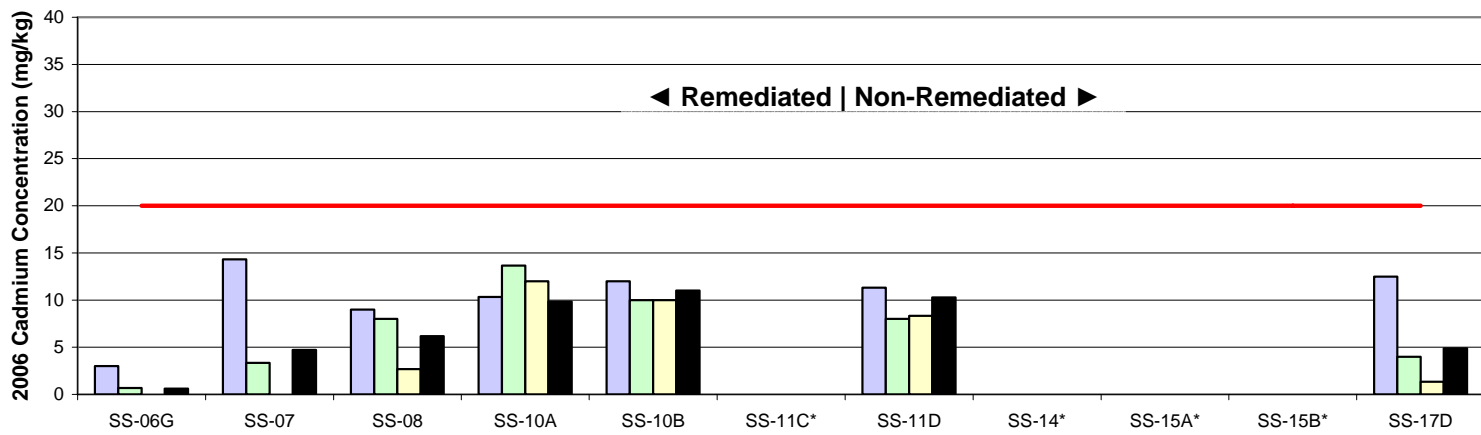
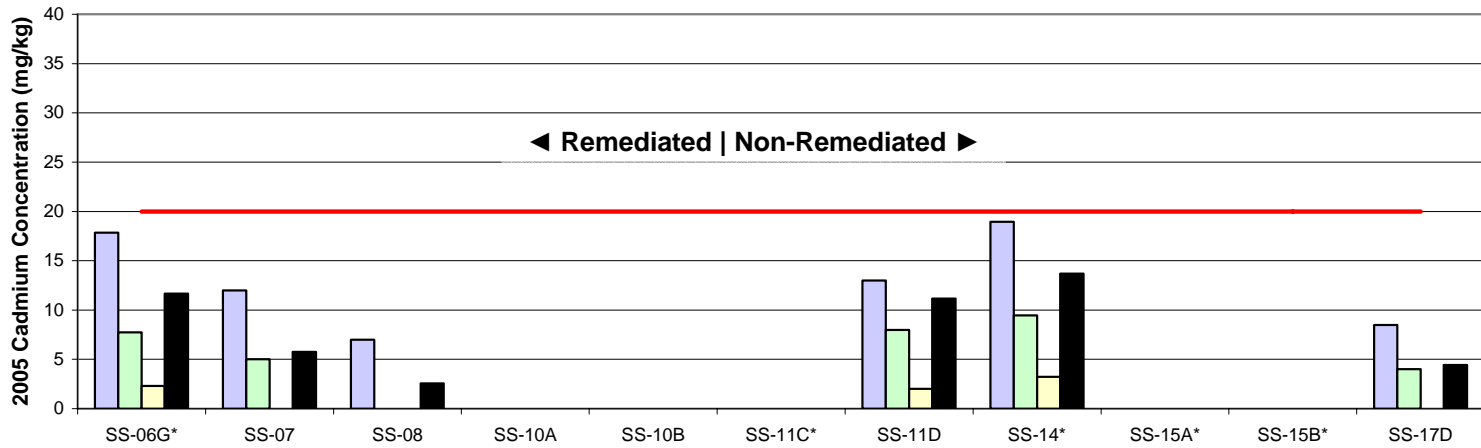
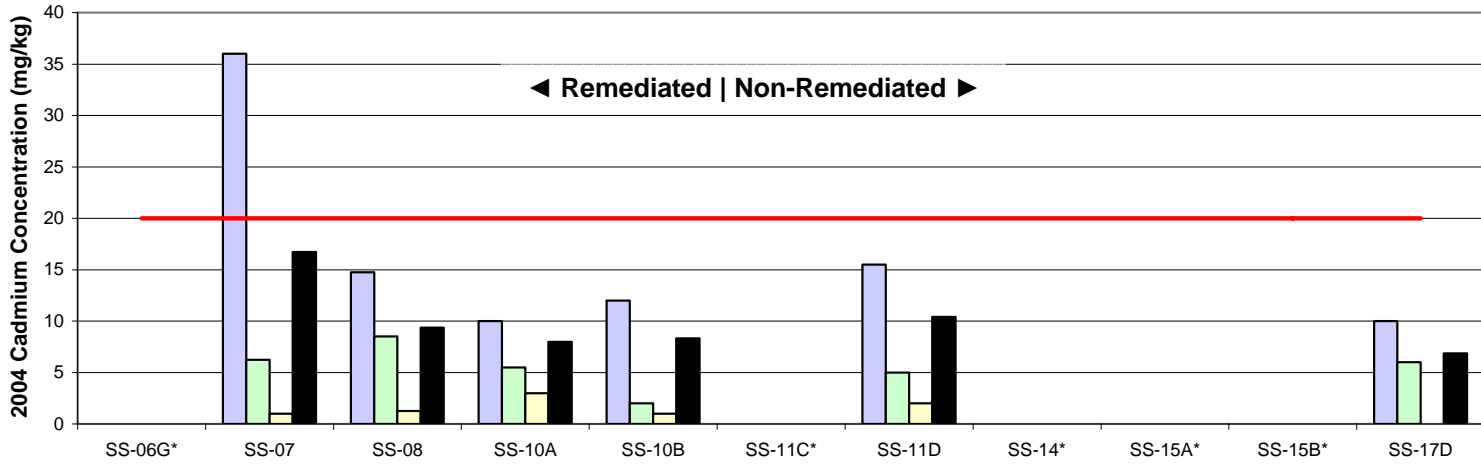
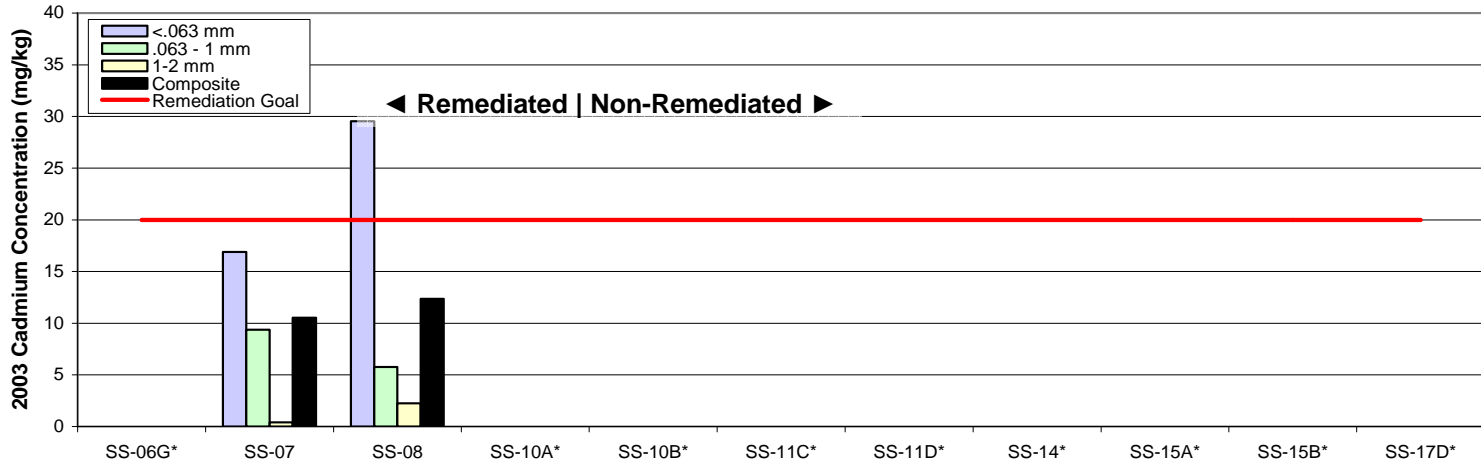
The trend continues in 2008 with the five COC's flat or declining vs 2007 values within the likely sampling uncertainty, for all stations within the remedy. Annualized 2008 sediment concentrations for the five COCs are well below remedy goals at all remediated stations, and at all unremediated stations for all COCs except zinc. Within the remedy, annualized concentrations of the five COCs meet the more restrictive Probable Effects Concentration standard at many stations, and are near it at the balance.

## ARSENIC 2003-2008



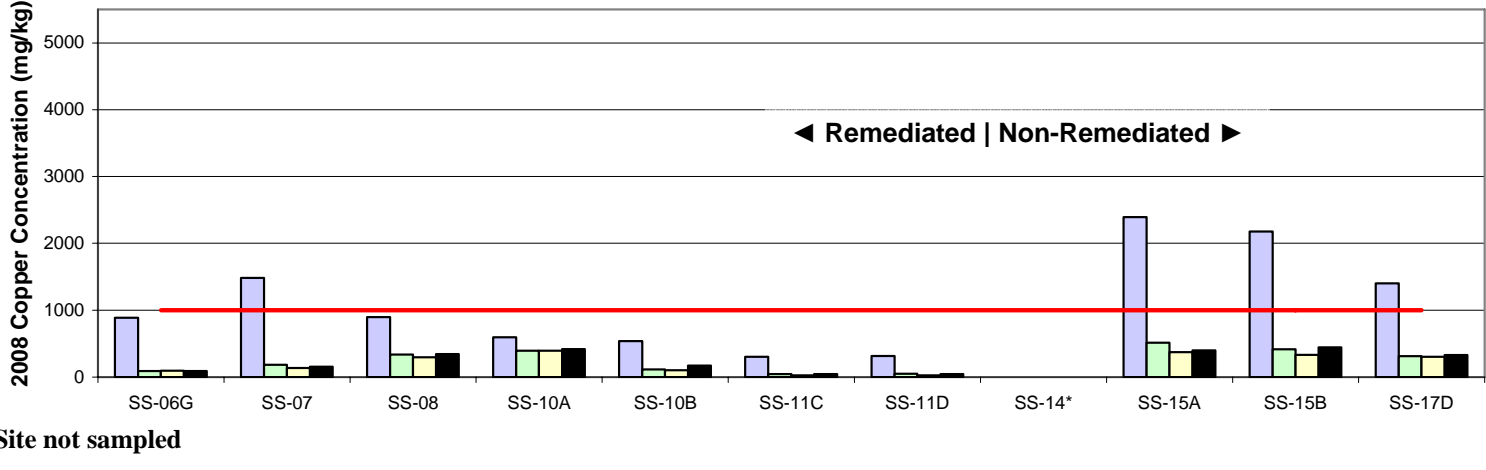
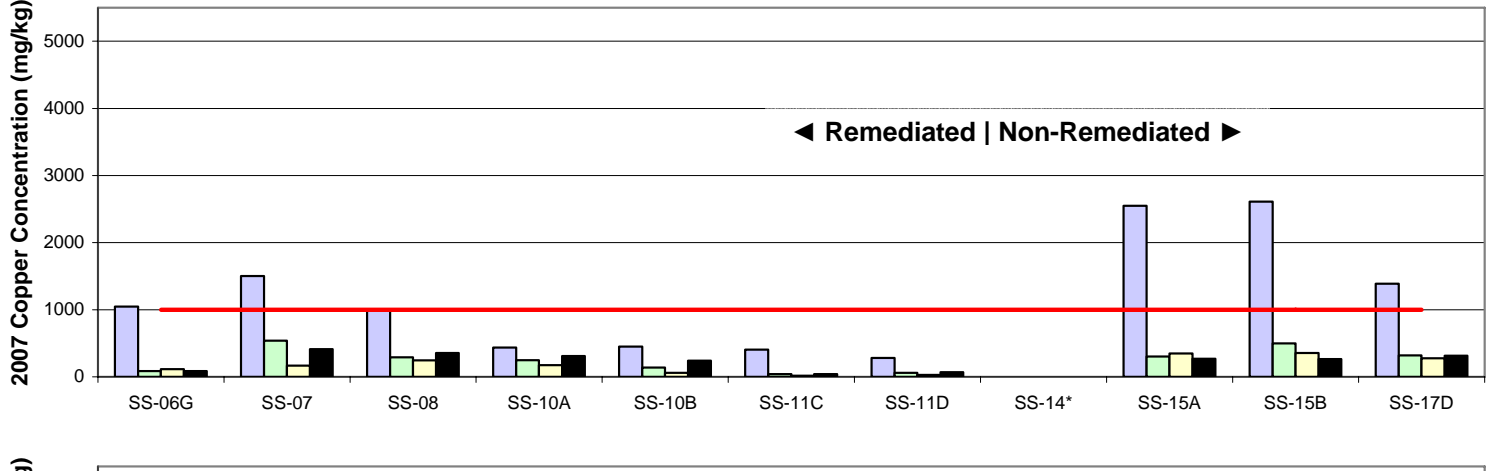
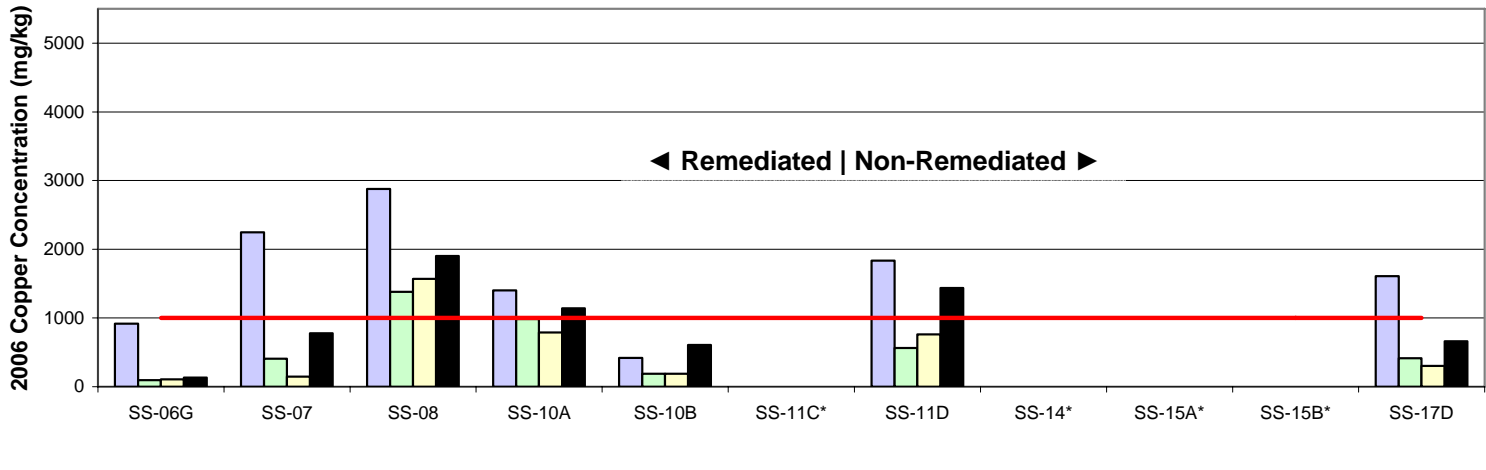
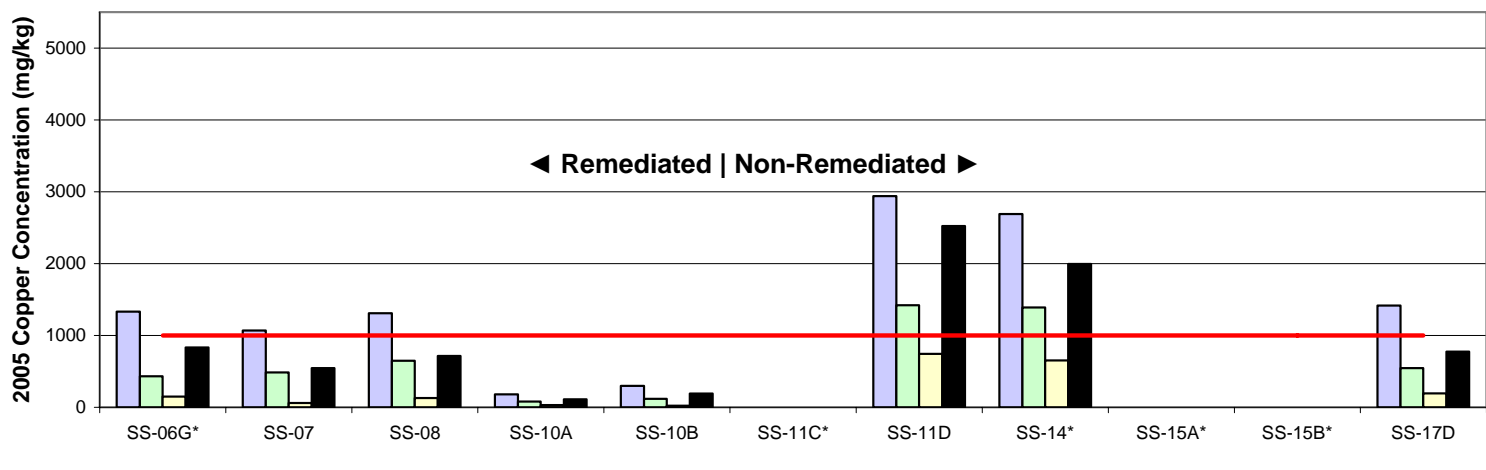
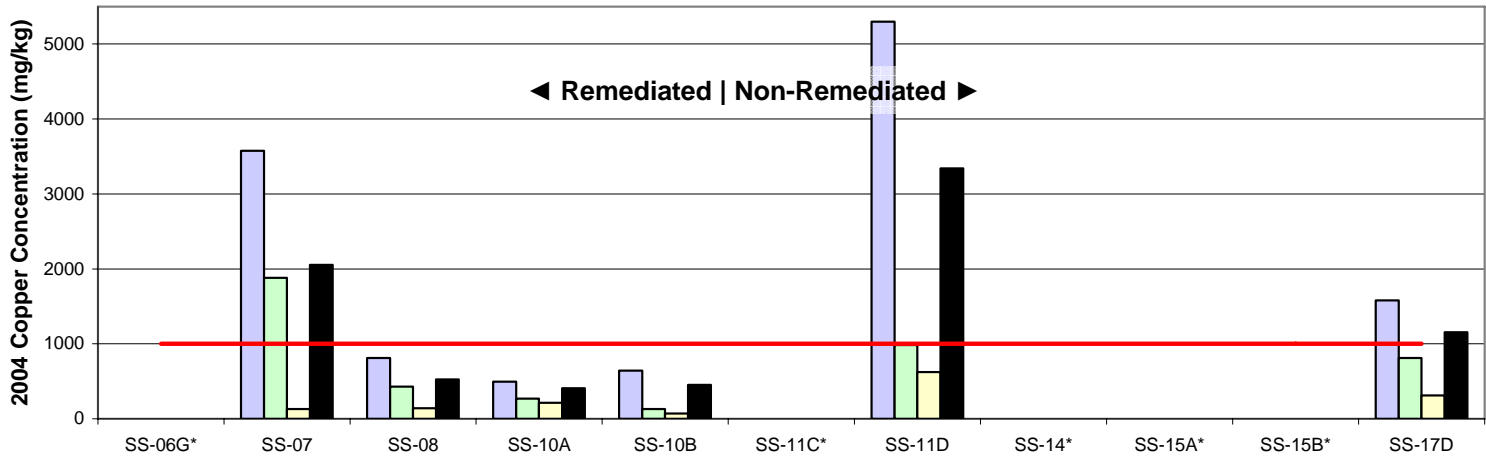
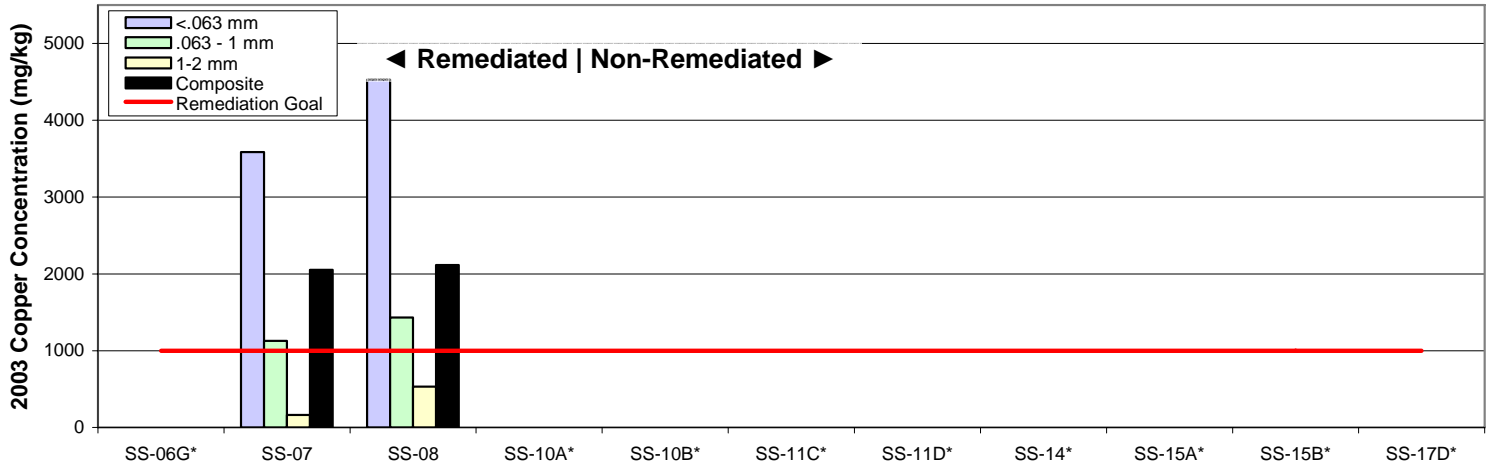
\* Site not sampled

### CADMIUM 2003-2008



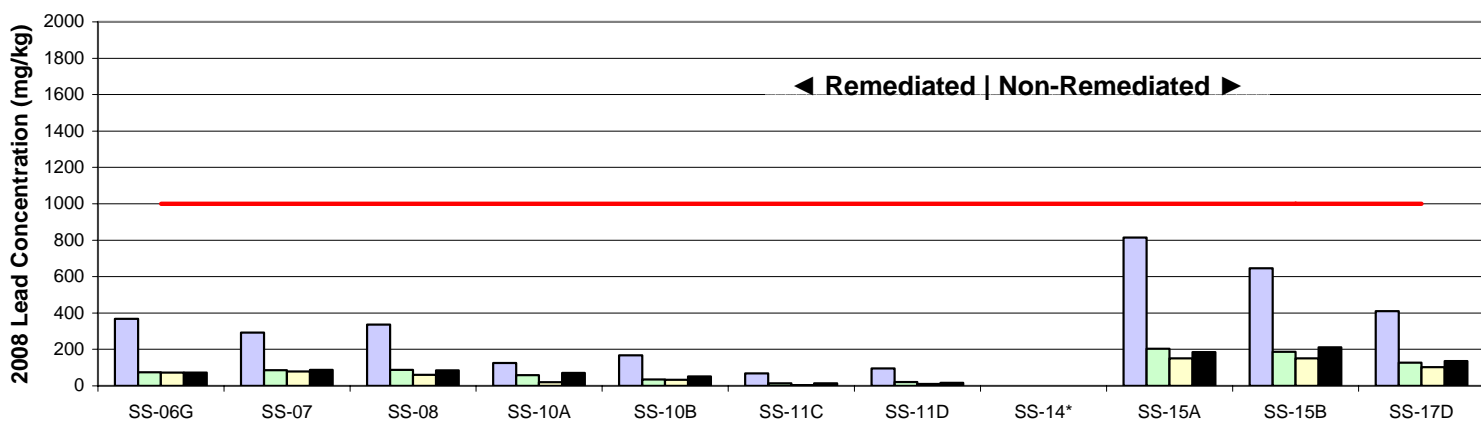
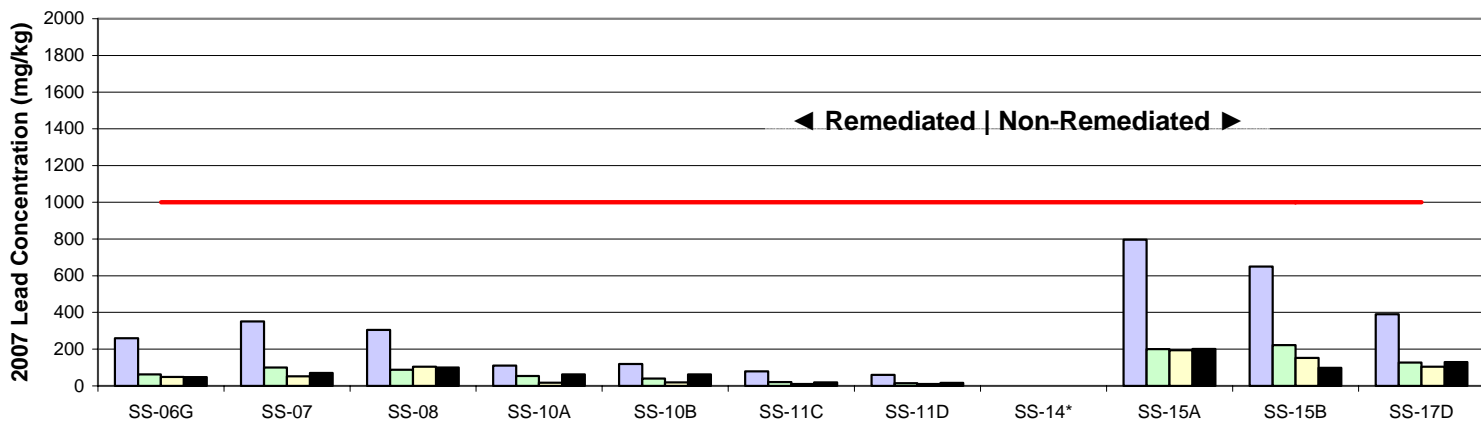
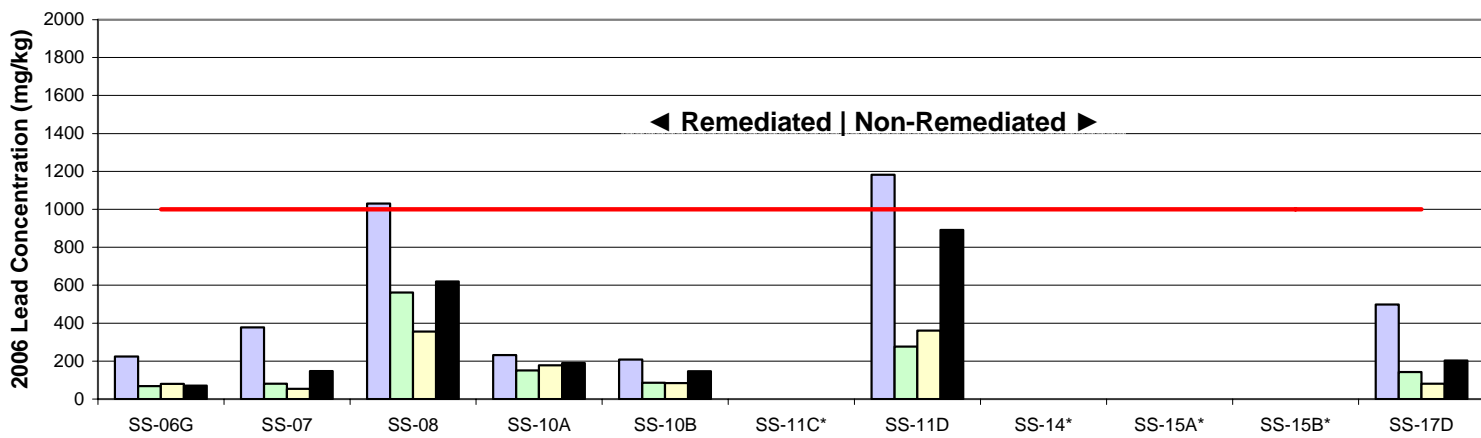
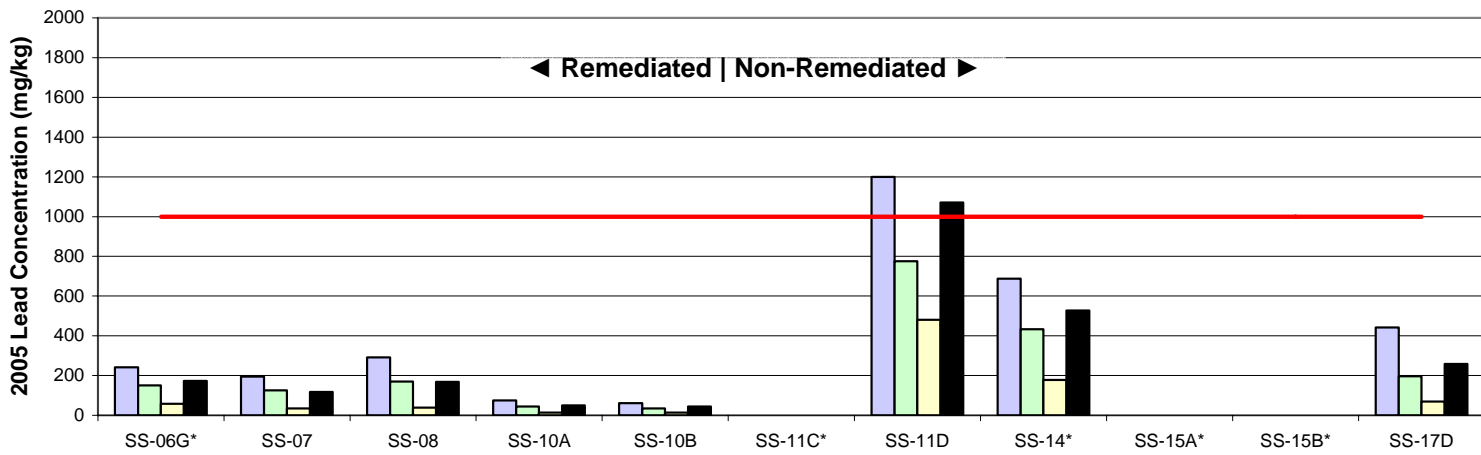
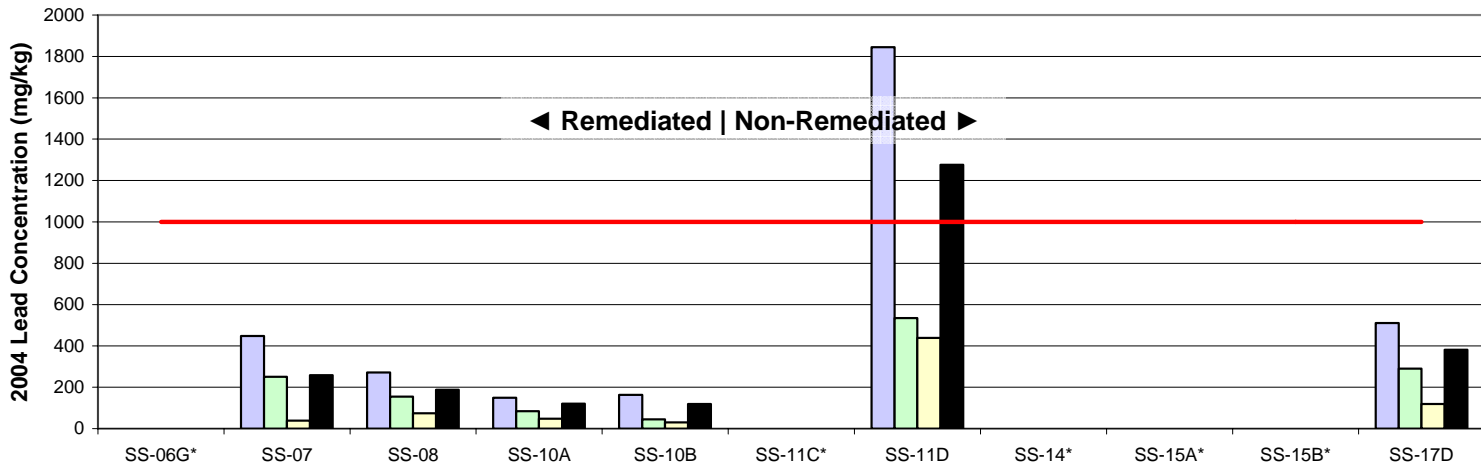
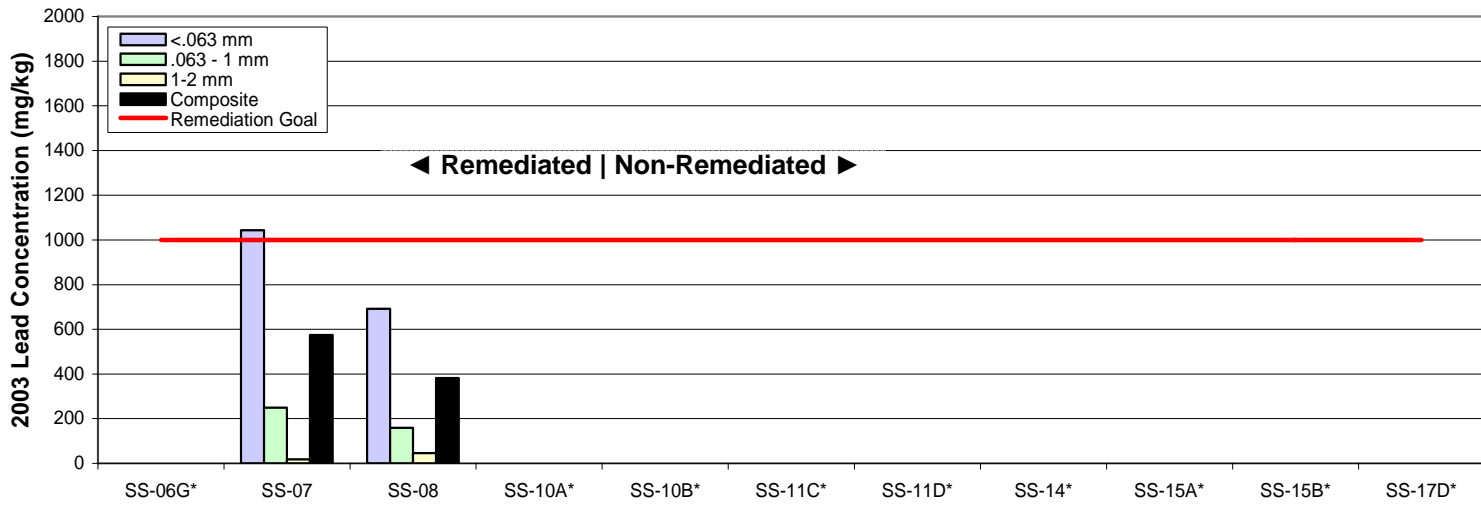
\* Site not sampled

### COPPER 2003-2008



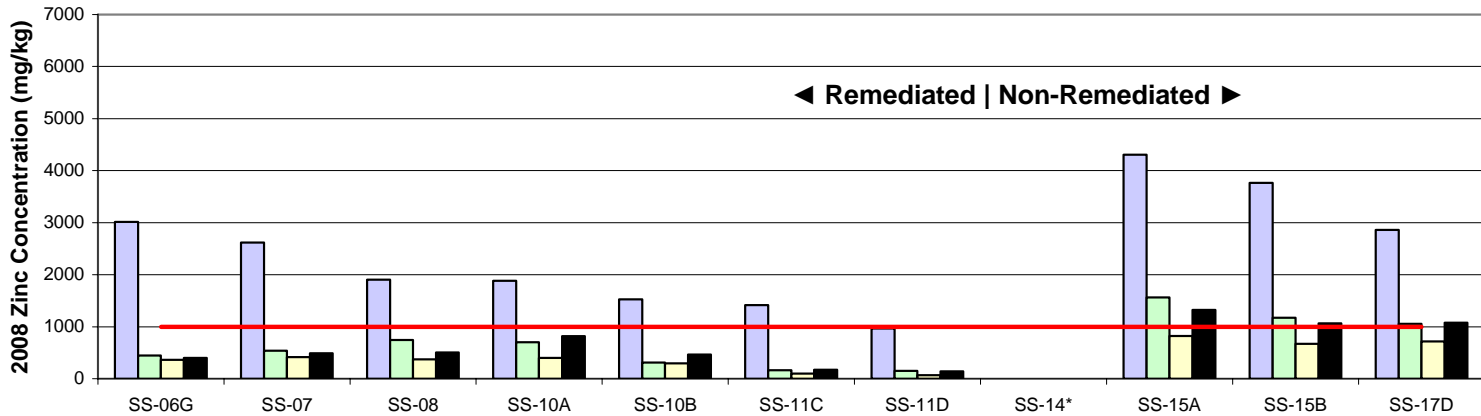
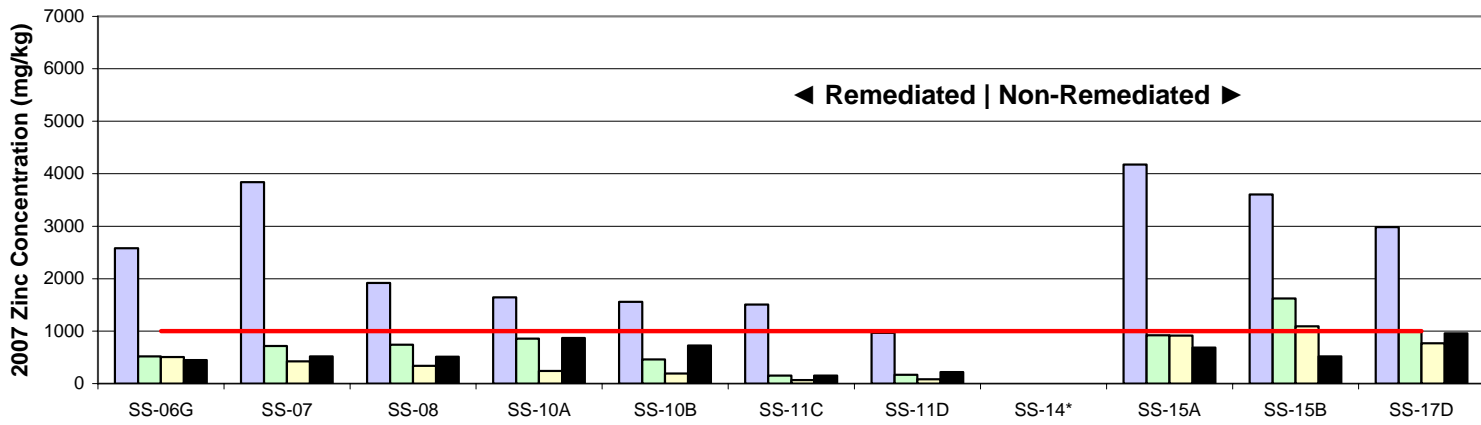
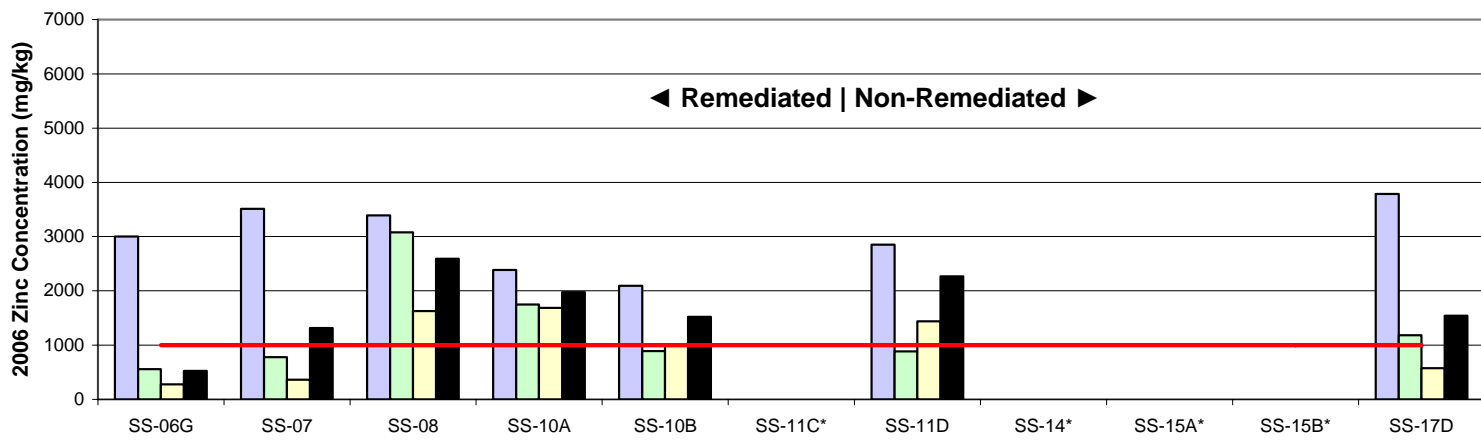
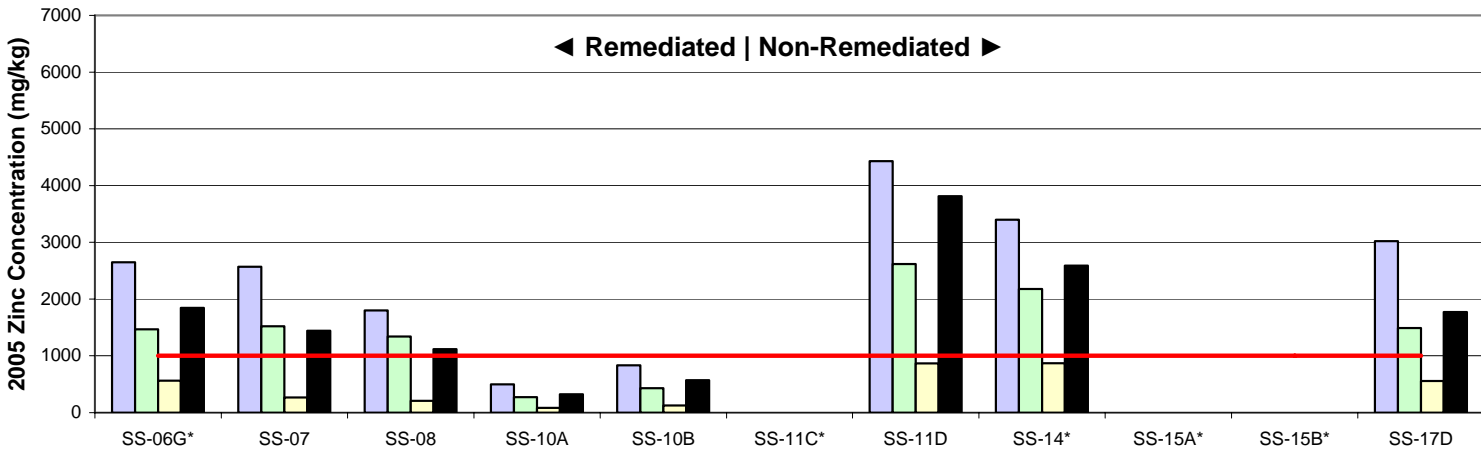
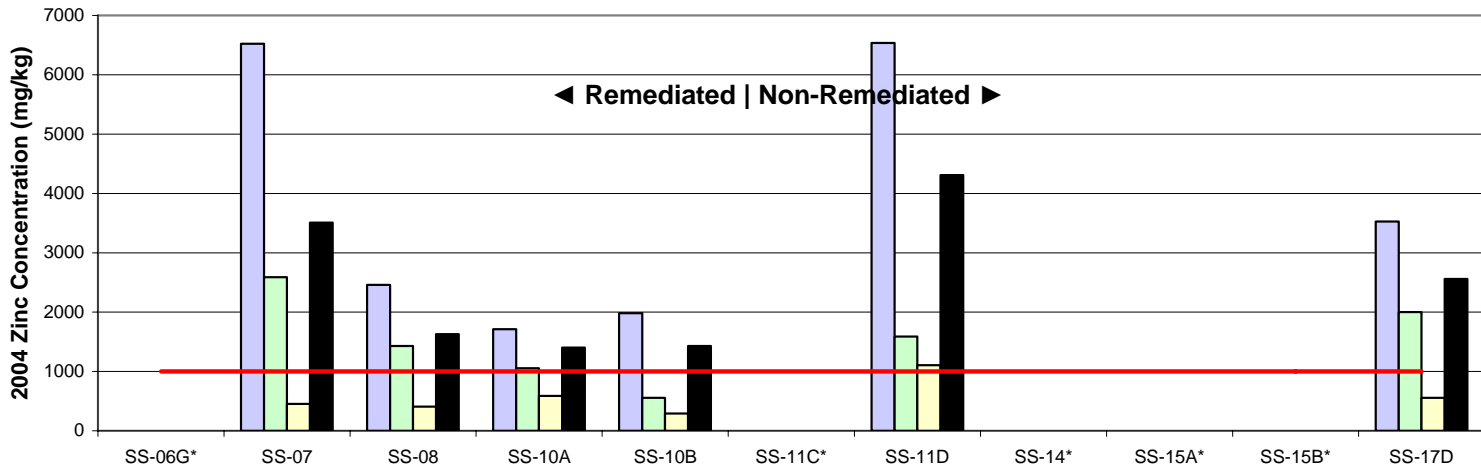
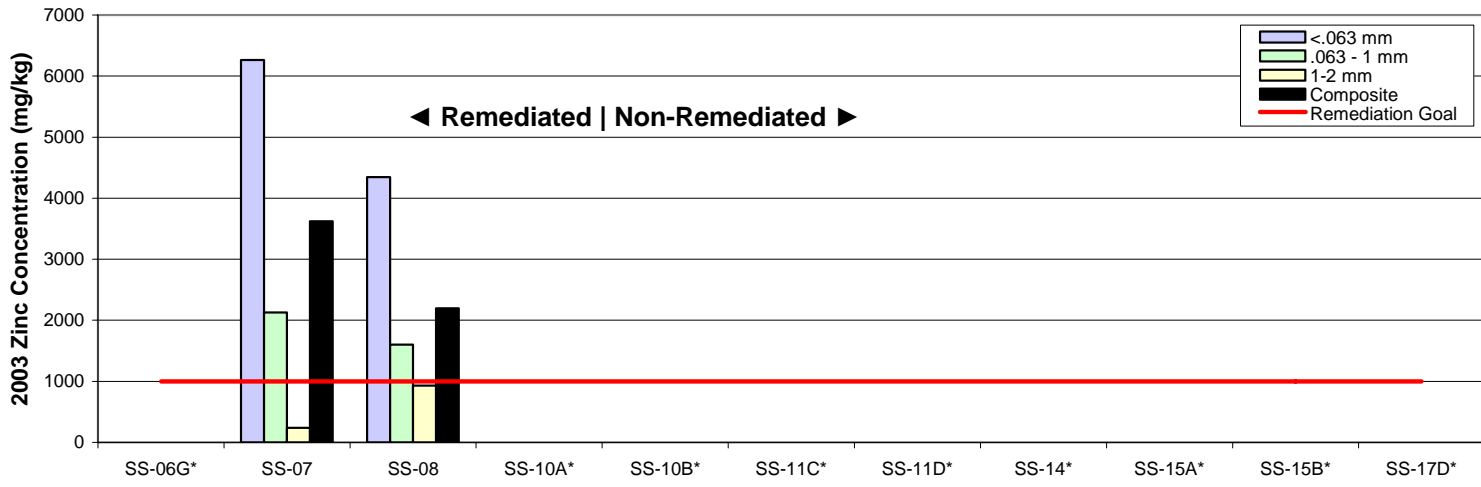
\* Site not sampled

### LEAD 2003-2008



\* Site not sampled

## ZINC 2003-2008



\* Site not sampled