6.0 SUMMARY

The conceptual model provides a description of mercury behavior in the Guadalupe River Watershed that is based on the analysis of the existing data and the results of extensive field surveys conducted in 2003 and 2004. The conceptual model summarizes this new information and identifies remaining uncertainties that need to be addressed in developing the watershed-wide mercury TMDL.

The following is a summary of the findings of the conceptual model.

6.1 MERCURY SOURCES AND LOADING

Measurements of mercury concentrations at different points in the watershed are required to quantify the loading associated with the different sources. Measurements of mercury, TSS, and flow rates were made to provide new information for estimating mercury loads during the wet season in 2004. Further mercury sampling was conducted in the dry season of 2004 to provide information needed to estimate methylmercury production in the reservoirs.

The major findings of the data collection program were consistent with expectations. Most total mercury is transported in the wet season, particularly at high flows when suspended solids are high. Most of the methylmercury is produced in the dry season in the anoxic portion of the hypolimnion in the reservoirs. Loads were estimated for all three forms of mercury (total, dissolved, and methylmercury) from the upper watershed to the reservoirs, then to the downstream creeks, the Guadalupe River, and finally to South San Francisco Bay. The information obtained and remaining uncertainties are summarized below by waterbody type:

- **Reservoirs**. Mercury loading to the reservoirs from atmospheric deposition was estimated using existing wet and dry deposition data collected at various locations around San Francisco Bay. Measurement of total mercury and methylmercury (particulate and dissolved), TSS, and flow rates were obtained for the wet season at four reservoirs (Almaden, Calero, Guadalupe, and Lexington) and for the dry season at Almaden and Guadalupe Reservoirs.

Most of the methylmercury is produced in the dry season in the anoxic portion of the reservoirs. Remaining uncertainties involve the role of sediment in methylmercury production. Co-located sampling of mercury in the deep hypolimnion and sediment in one or two reservoirs would be needed to evaluate the importance of reservoir sediment.

- **Streams and creeks in the upper watershed above reservoirs**
  Measurements of TSS, total mercury, and flow rates were made at locations on many of the tributaries to the reservoirs. The data showed differences between creeks in the mining area and those outside of it. While additional sampling during high flows would be helpful to refine the mercury contribution of the tributaries to the reservoirs, the new data showed that creeks in the Lexington Reservoir watershed were not affected by mining.

- **Streams and creeks below impoundments affected by mining**
  Measurements of TSS, total mercury, and flow rates were made at multiple locations on Alamitos Creek and Guadalupe Creek. The mercury data show higher total and particulate mercury concentrations in these two creeks than the urban creeks. Mercury loads from these creeks to the Guadalupe River were estimated, but may be low, since the sampling occurred on low flow days.

- **Urban Creeks**
  Measurements of TSS, total mercury, and flow rates were made at multiple locations along Los Gatos Creek, Ross Creek and Canoas Creek. While high suspended solids was contributed on high flow days from Los Gatos Creek, the total mercury concentrations and loads were less than those measured below the Alamitos drop structure. Additional sampling at high flows at the same time as the mouth of Alamitos and Guadalupe Creeks and the main stem of the Guadalupe River would help refine the present load estimates.

- **Guadalupe River**
  Measurements of TSS, total mercury, and flow rates were made at multiple locations along the main stem. Suspended solids and total mercury were greater at high flows, as expected. Methylmercury remained high from below the Alamitos drop structure to the Highway 101 gauge station, suggesting that resuspension of sediments may be occurring. The total mercury load estimate made using data at the Highway 101 gauging station suggest that additional mercury sources are entering the river than were accounted for using the approach and available data. Loads from the river to South San Francisco Bay have a high uncertainty on a year-to-year and inter-annual basis due to widely-varying rainfall. Additional sampling at high flows at the mouth of Alamitos, Guadalupe and the three urban creeks; several large storm drains that directly enter the lower reaches of the river, and the main stem of the Guadalupe River would help refine the present load estimates.

6.2 MERCURY PRODUCTION, FATE & TRANSPORT PROCESSES

The results of the Synoptic Survey and Data Collection effort indicate that a portion of the mercury in solids conveyed to the reservoirs enters the solution phase and represents a significant source of bioavailable methylmercury. However, answers to several questions are crucial to establishing a TMDL linkage and to providing a basis for developing and implementing effective intervention strategies.

- **Where is mercury methylated in the system?** The new dry season data showed that most of the methylmercury leaving the reservoirs was produced in the anoxic portion of the hypolimnion of the reservoirs.

  The Synoptic Survey showed a decrease in methylmercury concentration in the creeks with distance downstream from the reservoirs. The implication is that the creeks are net demethylators. This is not to say that methylation was not occurring in the creeks, but only that in-creek methylation rates did not keep up with the loss rates. In-stream methylation may be significant in specific locations such as in small impoundments on the downstream creeks.

- **What are the mechanisms of mercury methylation?** The TMDL process requires the ability to both predict the reduction in mercury or methylmercury concentration that is required to achieve the selected numeric target(s) and to identify effective interventions. The establishment of this predictive ability requires the identification of the primary mercury source (e.g., crystalline and amorphous HgS and absorbed mercury in sediments, or dissolved mercury in the water column). The new data did not directly answer this question, although the greater methylmercury concentrations in the outlets of Almaden and Guadalupe Reservoirs compared to Calero and Lexington Reservoirs suggest that sediment is important. The recently collected sediment data provide support for this hypothesis, in that Lexington and Calero Reservoirs had lower total mercury concentrations in the bottom sediments than did Guadalupe Reservoir. Almaden Reservoir was not sampled, but historical data show that high concentrations were present. Co-located methylmercury measurements in the deep sediment and hypolimnion would be needed to help answer this question.

6.3 MERCURY BIOCONCENTRATION AND BIOACCUMULATION IN FISH

The results of the 2004 sampling program have established a baseline for fish mercury concentrations in the watershed and have clearly demonstrated the ability to establish a predictive relationship between methylmercury concentrations in water and mercury concentrations in fish tissue. Age-1 largemouth bass and California roach have been shown to be sensitive biosentinels that can be used to monitor recovery in the impoundments and creeks of the watershed. These data are believed to provide a strong foundation on which to build initial fish-tissue and aqueous methylmercury numeric targets.

It is important to note that these results are to a large extent based on a single set of samples, and additional information is needed to quantify and provide uncertainty estimates for the predictive relationships. The fish tissue data exhibit low variability and are the stronger element of the predictive relationships. An emphasis should be placed on the collection of additional water samples to more fully describe the variability of methylmercury concentrations in the water column. Data collected during the implementation phase of the TMDL can be used to reduce the uncertainty and predictability of the relationship between fish tissue and aqueous mercury concentrations.

The fish-tissue mercury measurements that have been developed provide the ability to calculate bioaccumulation factors for each of the fish-species and fish-size groups sampled. In addition, the measurements of mercury concentrations in adult and age-1 largemouth bass provide the ability to calculate the site-specific trophic transfer coefficients that can be used to assess the potential effects of mercury contamination in the watershed on wildlife. Additional analyses are required to bring together mercury data for fish and other aquatic organisms to assess potential risks to wildlife. The focus should be on the development of uncertainty estimates to help bracket the potential risks for wildlife in the watershed.