Strategy for Addressing Mercury Contamination in Fish Tissue in Caddo Lake

Introduction

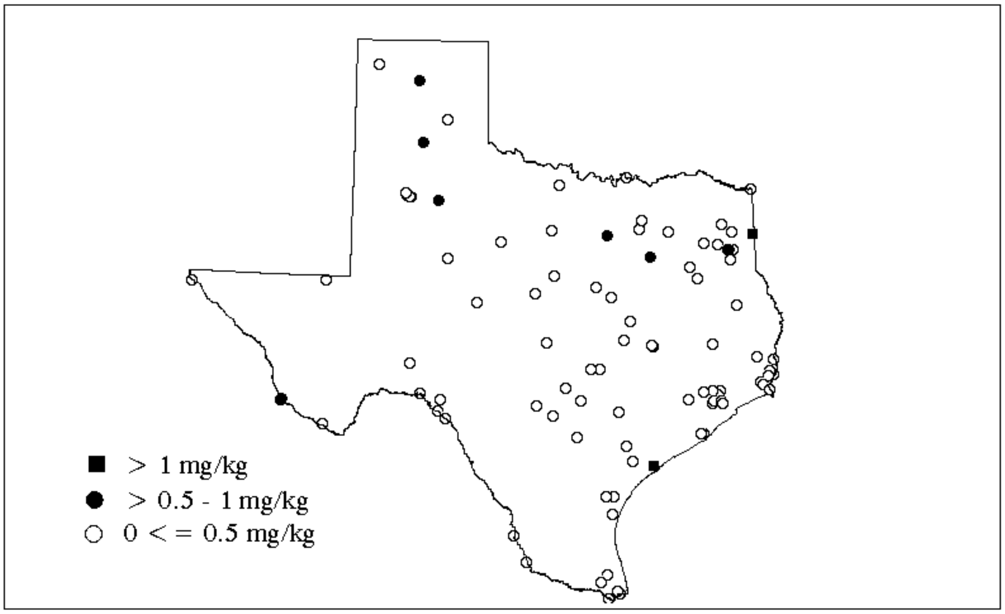
There are currently 14 water bodies listed on the 2000 State of Texas Clean Water Act 303(d) List for non-attainment of the State's mercury standards (1 listing for mercury in water and 13 listings for mercury in fish tissue). Of these water bodies, Caddo Lake stands out as having some of the highest mercury concentrations in fresh water fish tissue in the state (Figure 1). Available information points to atmospheric deposition as a probable source of mercury loading into water bodies in Eastern and Coastal areas of Texas, including Caddo Lake[1]. The Federal Clean Water Act requires the state of Texas develop Total Maximum Daily Loads (TMDLs) for all constituents that do not meet the state's applicable water quality standards. The TCEQ is the principle state agency responsible for developing TMDLs.

TMDLs determine the maximum amount (or load) of a pollutant a body of water can receive and still support its designated uses. TMDLs are also designed to allocate the estimated maximum allowable load among three major categories of sources, point sources, non-point sources, and to provide a margin of safety in the TMDL analysis. Additional allocations are sometimes made for future growth and for natural background sources. In order to arrive at these allocations, a plausible cause-and-effect relationship must be established between the sources of pollution and the impairment(s) observed in the listed water body. These cause-and-effect relationships must be based on sound science that will support policy decisions and activities. In most cases, pollutant/impairment cause-and-effect relationships are established through the use of mathematical models which simulate natural processes associated with the fate and transport of pollutants in the environment.

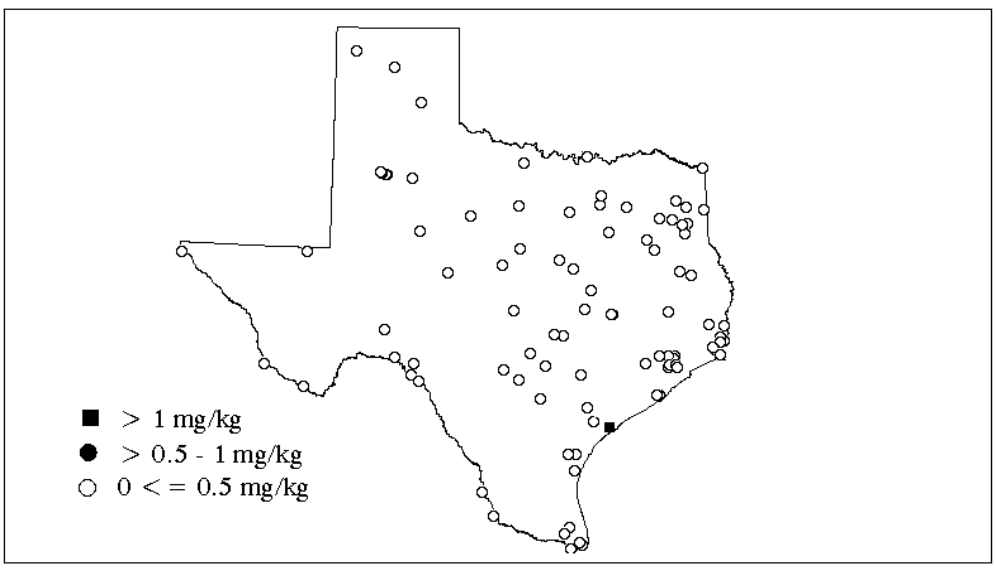
Fate and Transport of Mercury

Mercury contamination in fish tissue is a widespread problem in the United States and in the world. Much of the mercury that ends up in fish tissue is emitted into the environment through the combustion of fossil fuels for energy production[7]. Other sources of mercury in the environment include municipal and medical waste incineration, wastewater discharges, industrial wastes (generated by facilities such as chlor-alkalai and metal scrapping plants), mine drainage, and natural sources such as volcanic eruptions and leaching of mercury ore deposits.

Mercury can exist in a number of forms in the environment, but is most often found in one of three chemical forms or oxidation states, elemental mercury Hg(0), methyl mercury MeHg, and divalent mercury Hg(II):



Distribution of Maximum Mercury in Tissue Concentrations
for All Species at 93 TNRCC Sites, 1984-1993



Distribution of Median Mercury Tissue Concentrations
for All Species at 93 TNRCC Sites, 1984-1993

Figure 1. Maximum and median mercury concentrations in water bodies in Texas (Source: Twidwell 2000)

1. Elemental Mercury Hg(0) - A liquid at room temperature, Hg(0) also exists as a vapor in the atmosphere. Hg(0) is the most common form of mercury found in the global atmospheric pool (95-98% of atmospheric Hg is elemental mercury). Hg(0) is thought to be relatively non-reactive and tends to stay in the atmosphere for long periods of time (1-3 years). However, dry deposition of H(0) has been documented.

2. Divalent Mercury Hg(II) - Also known as gaseous reactive mercury (GRM), divalent mercury is highly soluble and often forms various mercury salts in the environment including $HgCl_2$, $Hg(OH)_2$, and HgS. Divalent mercury can be deposited as wet deposition during rainfall events or may adsorb to particulate matter which settles onto land, canopy, or water surfaces forming dry deposition.

3. Methyl Mercury MeHg - An organic mercury compound, methyl mercury is created by microorganisms living in soil and sediments. Methylation makes mercury bioavailable to higher organisms and allows the concentration of mercury in animal tissue at successive levels in the food web.

Mercury undergoes a series of complex chemical reactions and physical transformations in the environment (Figure 2). Many of these transformations are still not well understood and need further research. For example, under certain conditions, elemental mercury Hg(0) can be deposited and may oxidize to form Hg(II). The reverse reaction ($Hg^{++} \rightarrow Hg^0$) will also occur under a different set of environmental conditions (i.e. photoreduction in the atmosphere or in the water column). In aqueous environments, Hg(II) and MeHg can sorb to sediment and particulate or dissolved organic matter and can be transported to receiving water bodies where methylation, demethylation and remethylation occur. Mercury may also be evaded back into the atmosphere as Hg(0).

Elements of a Mercury TMDL for Caddo Lake

Because of the complex chemical transformations and phase partitioning associated with mercury transport to Caddo Lake (e.g. from atmospheric source to fish tissue via air, water, and sediment), a TMDL for Caddo Lake must include technical elements associated with each of the environmental media playing a role in the transport and ultimate fate of mercury in fish tissue in Caddo Lake.

To identify all the necessary technical elements for a TMDL, it is often useful to analyze the reactions, transport mechanisms and phase partitioning independently in a backward direction from the receptor (fish in Caddo Lake) to the source. In other words, we will begin by analyzing the processes associated with the incorporation of MeHg into fish tissue in the lake and conclude with an analyses of the sources of mercury to the water body. This is done strictly to determine the technical requirements of the TMDL analysis, including identification of data to be collected and modeling needs. In doing so, care must be taken not to conceptualize the processes as separate or unidirectional. In reality the reactions and transformations which must be measured or simulated occur in multiple directions and often simultaneously.

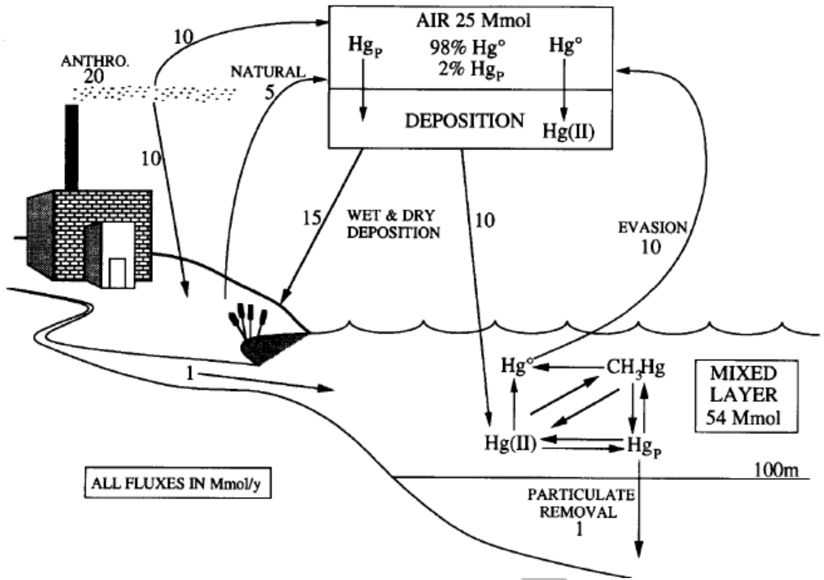


Figure 2. Global Mercury Cycle with estimated budgets and fluxes (Source: Mason, et.al., 1994)

When viewed in this way, the mechanisms involved in the transport, transformation, and partitioning of mercury to and in Caddo Lake fall into three major compartments:

1. In-lake processes
2. Watershed processes
3. Atmospheric processes

<u>In-Lake Processes</u>
Although highly interrelated, in-lake processes can be separated into physical and biochemical processes occurring in the water column and physical and biochemical processes occurring just below the sediment/water interface of the lake (Figure 3). Following the backwards progression discussed above these processes can be reviewed in the following order:

Bioaccumulation/biomagnification–>Methylation/demethylation–>Sedimentation /adsorption/advection/reduction/defusion/evasion (volatilization)/deposition (to the lake)

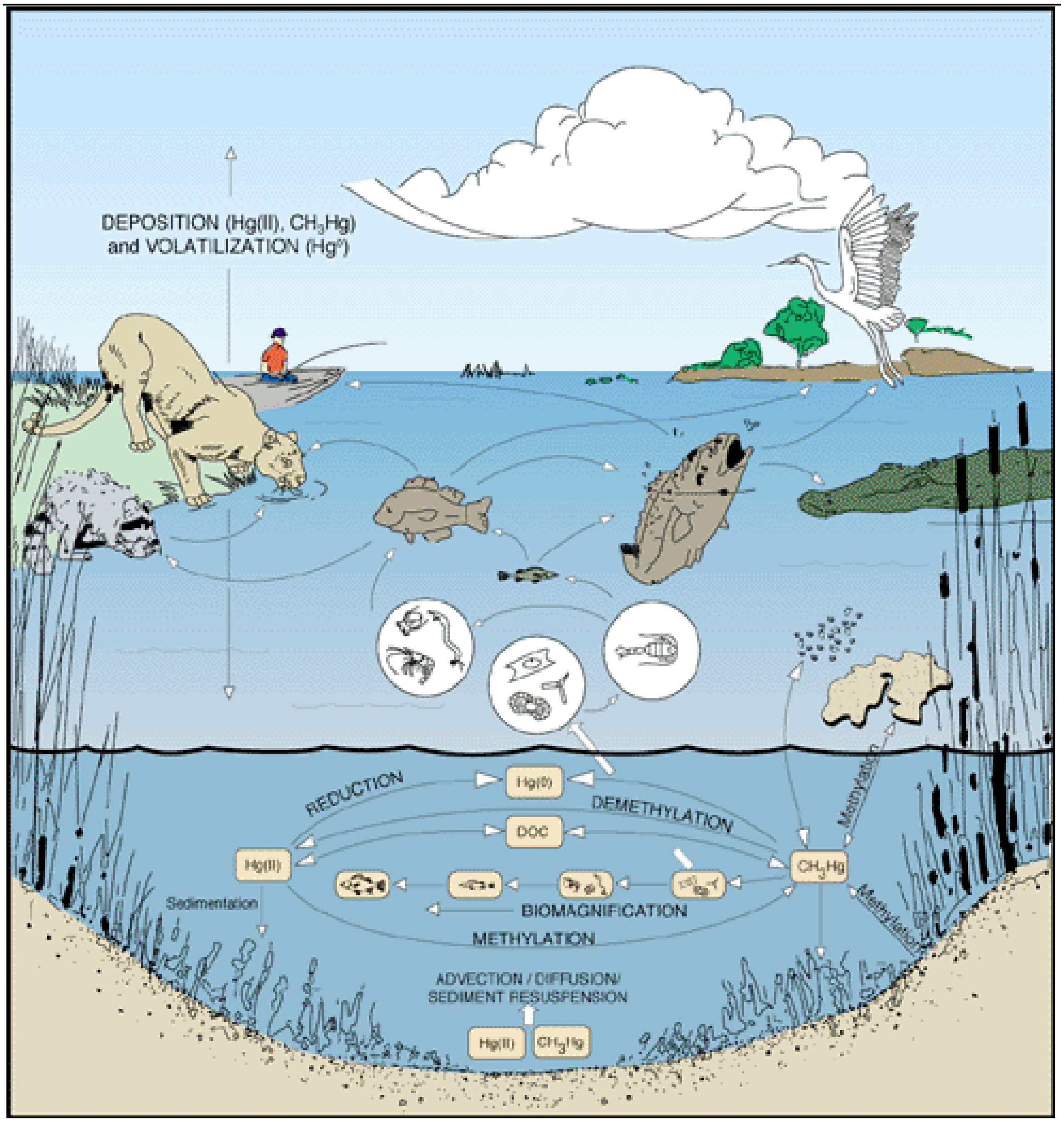


Figure 3. In-lake mercury processes (Source: Hg Technology Services Inc.)

Simulation of in-lake processes documented in EPA-approved mercury TMDLs developed by various states range from very sophisticated representations of methylation/demethylation and food web processes (e.g. Florida Everglades Mercury TMDL Pilot Study[2]) to simple assumptions of linearity between estimated mercury loading rates and observed fish tissue mercury concentrations (e.g. Mercury TMDLs for Subsegments Within the Mermentau and Vermillion-Teche River Basins in Louisiana[3]).

Currently, mercury-specific food web models available in the public domain cannot be applied broadly among ecosystems due to limited understanding of key processes, such as sites and rates of microbial methylation and demethylation, effects of dissolved organic matter, and interactions between sediments and water. A poorly understood aspect of mercury in the environment is the link between loading rates to aquatic systems and resultant concentrations in fish. At this time, neither the magnitude of response nor the response time for fish mercury concentration changes following long-term changes in loading rates can be accurately predicted. Research conducted under the Mercury Experiment to Assess Atmospheric Loading in Canada and the United States (METAALICUS) project and the U.S. Geological Survey's (USGS) National Water-Quality Assessment Program will provide results and answers that will enhance applicability of the mercury-specific food web models to diverse aquatic ecosystems, ultimately providing a reliable tool to predict ecosystem responses as a function of atmospheric deposition rates.

For this reason, the approach proposed for Caddo Lake does not include detailed simulations of methylation/demethylation and food web processes within the lake, but does, however, include a hydrodynamic/water quality model of the lake for the simulation of various physical, and bio-chemical processes that control the movement and transformation of mercury in the lake. Methylation/demethylation and bioconcentration will be measured directly and the measured rates used as factors in steady state.

The proposed approach to simulating in-lake mercury processes in Caddo Lake consists of three separate efforts, two focused data collection efforts and an intensive modeling effort. The two data collection efforts will be designed to determine average bioaccumulation rates and methylation/demethylation rates for the lake. These rates will be derived directly from chemical and biological data collected at the lake.

Measurement of methylation and demethylation rates:
Two locations in Caddo Lake will be chosen to represent areas of highest and lowest methylation potential based on observed physical and chemical attributes (i.e. shallow backwater swamp and an open, deep water area). Mesocosms will be set up at these sites to protect and control mass outflows. Radioactive isotopes of mercury will be introduced and tracked at each of the mesocosm sites though periodic water column and sediment sampling. The study will be conducted over a one year period to establish rates of transformation of Hg(II) to MeHg at varying flow and temperature regimes. Analysis of the data collected at the mesocosm sites will yield average methylation and demethylation rates for Caddo Lake. The US Geological Survey has proposed conducting this study in Caddo Lake with financial support from TCEQ.

Measurement of bioaccumulation/biomagnification rates:
Biological sampling of fish, macroinvertebrates, zooplankton, and phytoplankton will be conducted at various locations in Caddo Lake and the samples will be analyzed for mercury concentrations in tissue. The fish samples will be aged using otolith analyses to determine the age of each fish sampled. All pertinent trophic categories of fish will be sampled and an appropriate range of ages will be included in the sampling. Analysis of the biological data collected will yield average bioaccumulation and biomagnification rates for Caddo Lake. The US Geological Survey has proposed conducting this study in parallel with the previously-described methylation/demethylation studies in Caddo Lake with financial support from TCEQ.

Hydrodynamic and Water Quality Modeling:
A hydrodynamic and water quality model of Caddo Lake will be developed to simulate physical, chemical, and bio-chemical processes that control the movement, cycling and transformation of mercury within the lake. Several types of software are available to accomplish this task. EPA's Water Quality Analysis Simulation Program (WASP) version 6.1 has been used to model mercury fate and transport in several EPA-approved TMDLs (e.g. Savannah River TMDL[4].) WASP has several advantages in that it is a fully dynamic model and can simulate water bodies in three dimensions. However, the mercury modeling capability of WASP is a relatively new feature to this model and WASP does not have a hydrodynamic component incorporated into the water quality function. Observed chlorides data can be used to calibrate the hydrodynamics in WASP or a separate hydrodynamic model can be used to simulate hydrodynamics in Caddo Lake (e.g. DYNHYD or EFDC) and the output used to drive WASP for mercury simulation.

A recent enhancement of the Watershed Analysis Risk Management Framework (WARMF) (developed by Systech Engineering under funding by the Electric Power Research Institute) includes fully hydrodynamic in-lake mercury modeling capabilities in addition to watershed mercury loading simulation capabilities. The model has been peer-reviewed and tested successfully. WARMF is proprietary software. It is TCEQ policy to develop TMDLs using only publicly available software. WARMF will only be considered for use in TMDL development if the computer code and software are made available to the public for use and/or review.

Watershed Processes
In contrast to direct deposition from air, there is significant uncertainty associated with the contribution of mercury to receiving water bodies from their watersheds. While some studies estimate contributions of mercury to water bodies from their watersheds to be as low as 16% of the total mercury entering the water body[5] other studies have reported percentages as high as 78%[6]. An October 2000 EPA report estimates that, while atmospheric deposition provides about 75% of the total mercury input to water bodies, inputs from watersheds provide more than 80% of the MeHg transported to water bodies[6].

While it is clear that the major source of mercury to most water bodies is directly from the air, it is equally clear that watershed sources cannot be ignored. For this reason, the TMDL study proposed for Caddo Lake includes the development of a watershed model capable of simulating current loading to the lake as well as load reduction scenarios. Additionally, flow measurements and whole water quality sampling, and suspended sediment sampling will be also be conducted in the major tributaries to Caddo Lake to aid in model calibration.

Watershed processes include wet and dry deposition of Hg(0) and Hg(II), transformations of Hg(0) and Hg(II) in soils and other surfaces, adsorption of Hg(II) to organic (humus) and inorganic particles in soils and in the leaf canopy, methylation and demethylation of Hg(II) in soils, infiltration of Hg(II) and MeHg to shallow and deep groundwater, erosion of legacy Hg(II) and MeHg from soils, and runoff/transport of MeHg with organic and inorganic particles and with dissolved organic matter (Figure 4). Additionally, in-stream processes analogous to in-lake processes also take place in creeks and streams that contribute flow to Caddo Lake.

The proposed approach to simulate watershed processes in the Caddo Lake watershed consists of a focused sampling effort and a watershed modeling effort.

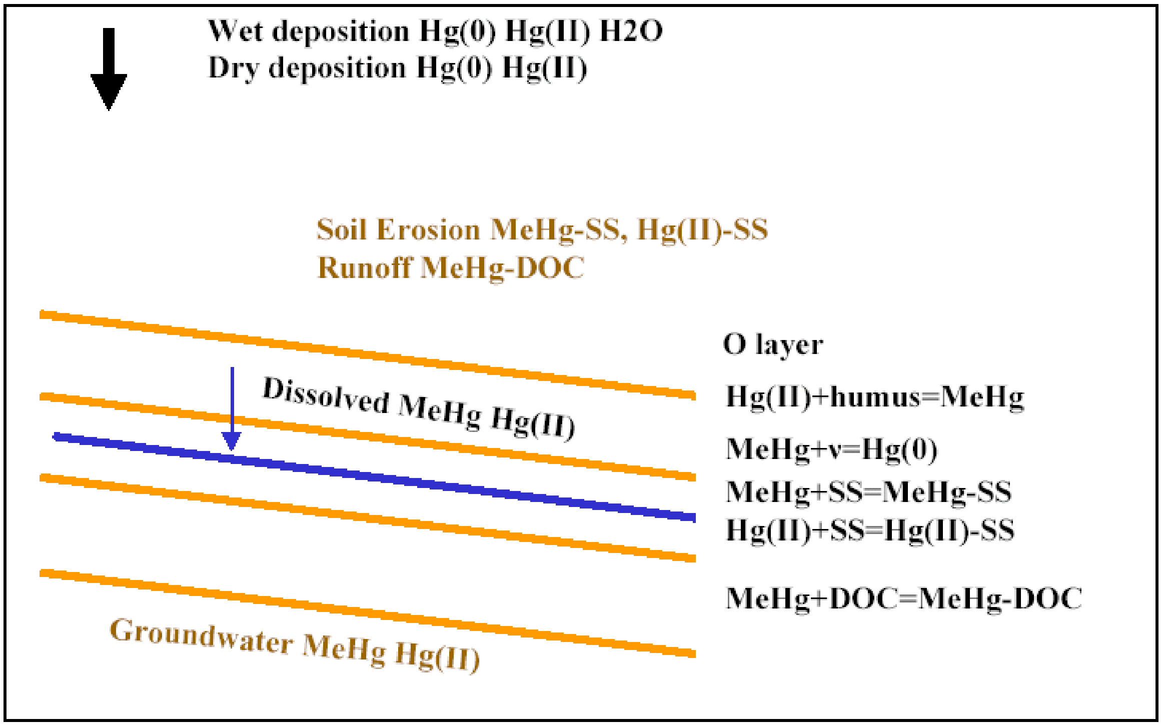


Figure 4. Watershed processes for mercury (Source: R.A. Goldstein, 2003)

***Tributary Loading Rates*:**
The tributary sampling effort proposed herein is designed to determine average total mercury and MeHg loading rates to Caddo Lake from the watershed and will consist of bi-monthly sampling of whole water, and suspended sediment at sampling sites located on the five major tributaries to Caddo Lake (and two
Lake sites). The sampling effort will be conducted over a two-year period. Clean metals sampling techniques will be used in the sampling effort and instrumentation yielding the lowest detection limits possible will be used for the analyses.

The average loading values derived from the tributary sampling will be used as part of the input data used for the in-lake water quality model described previously.
Data collected from the tributary monitoring will also be used to provide calibration time series for the watershed model. The tributary monitoring in Caddo Lake will include two in-lake sites that will be sampled to provide calibration data for the in-lake water quality model.

***Watershed Modeling*:**
There are several types of software available for estimating mercury loading from watersheds. The Watershed Characterization System (WCS) developed by USEPA was recently modified to estimate mercury watershed loadings. The new Hg loading extension to WCS allows the user to estimate gross annual loads of total mercury to a receiving water body as a function of total suspended solids. Although the model is relatively simple to set up and run, WCS was designed to provide screening-level assessment information for TMDL development and, generally, does not provide sophisticated representations of mercury watershed processes.

Another option for modeling mercury watershed loadings is the Hydrologic Simulation Program in Fortran (HSPF). HSPF provides a sophisticated representation of watershed processes such as the build-up, washoff, infiltration, and transport of pollutants. However, HSPF was not designed specifically to model mercury and does not include mercury-specific algorithms that may be necessary to satisfy the technical requirements of the TMDL. HSPF does, however, have the ability to model general water quality constituents, allowing the input of pollutant-specific rates and constants supplied by the user. This capability could conceivably result in acceptable representations of mercury watershed processes and a resulting mercury watershed loadings for Caddo Lake.

Recent enhancements to the Watershed Analysis Risk Management Framework (WARMF) include a sophisticated capability to simulate mercury watershed processes including algorithms for species-specific reactions of mercury compounds in leaf canopy, soils, surface runoff, and deep and shallow groundwater. WARMF also includes in-stream and in-lake processes discussed previously. Although the capabilities of the WARMF modeling system are impressive and peer-reviewed, as mentioned previously, the software is proprietary.

<u>Atmospheric Processes</u>
Direct atmospheric deposition is a major source of mercury loading into many East Texas water bodies, including Caddo Lake[1]. Consequently, any analysis of the mercury impairment in Caddo Lake must include an investigation of wet and dry deposition of mercury into the lake and its associated watershed.

Mercury deposition occurs in two forms, wet deposition (related to rainfall) and dry deposition (related to particulate settling). Mercury deposition from rainfall (wet deposition) is measured directly at 200 Mercury Deposition Network (MDN) sites distributed nation-wide (Figure 5), including MDN site TX21 located in Longview, Texas. Extrapolation of the wet deposition data observed at TX21 to a point 40 miles to the northeast in Caddo Lake presents a challenge.

While wet deposition is routinely measured at MDN stations, no widely-accepted method for measuring dry deposition of mercury currently exists. A gross measure of dry mercury deposition flux may be possible using speciated PM 2.5 and PM 10 data collected at the state's Continuous Air quality Monitoring stations (CAMs) located within the Caddo Lake airshed/watershed (Figure 6). This method would be acceptable only if the assumption can be made that these particulate matter fractions represent the bulk of the components of dry deposition and if an accurate deposition velocity can be estimated for each fraction. The Caddo Lake watershed has been defined based on digital elevation models for the area. For the purpose of this document, the Caddo Lake airshed is defined as all counties located within an area delineated using a 100 km buffer around the Caddo lake watershed (Figure 7). This is in keeping with the definition proposed in the EPA Mercury Study Report to Congress[7].

Currently, mercury concentrations in PM 2.5 are measured routinely at a CAMs site located at Caddo Lake (station C85 in Karnack - Figure 8).

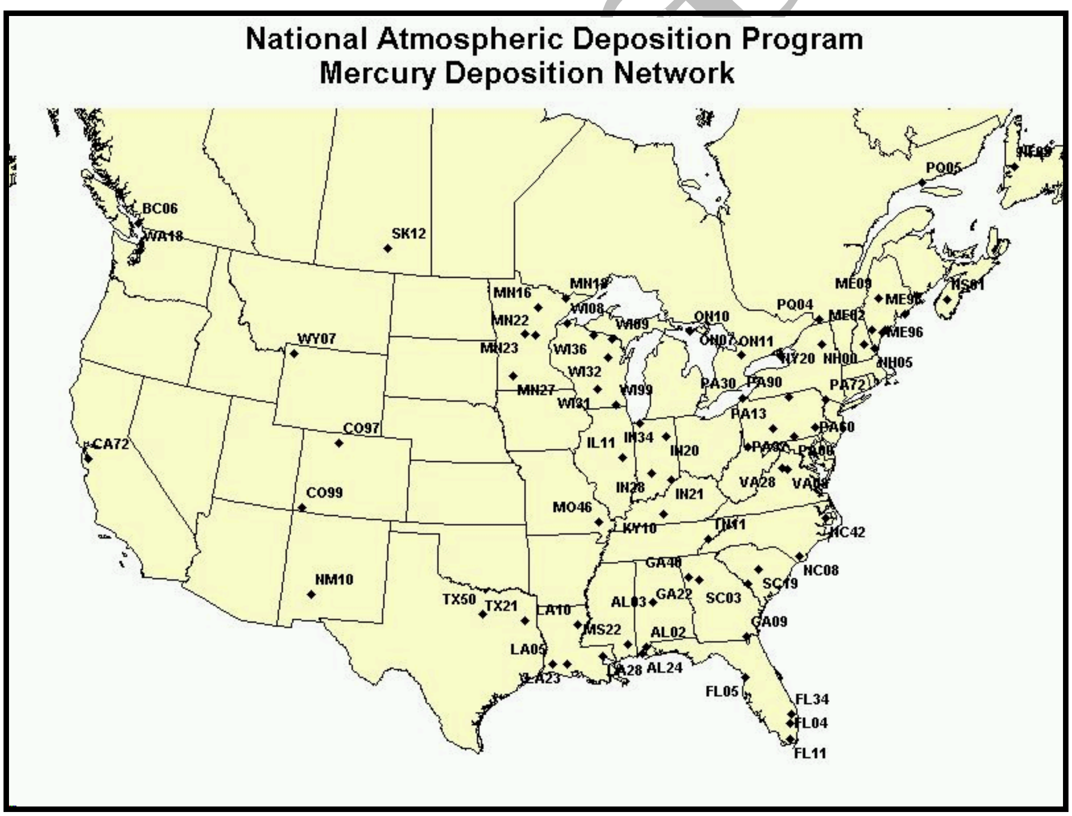


Figure 5. Mercury Deposition Network Sites in the U.S.

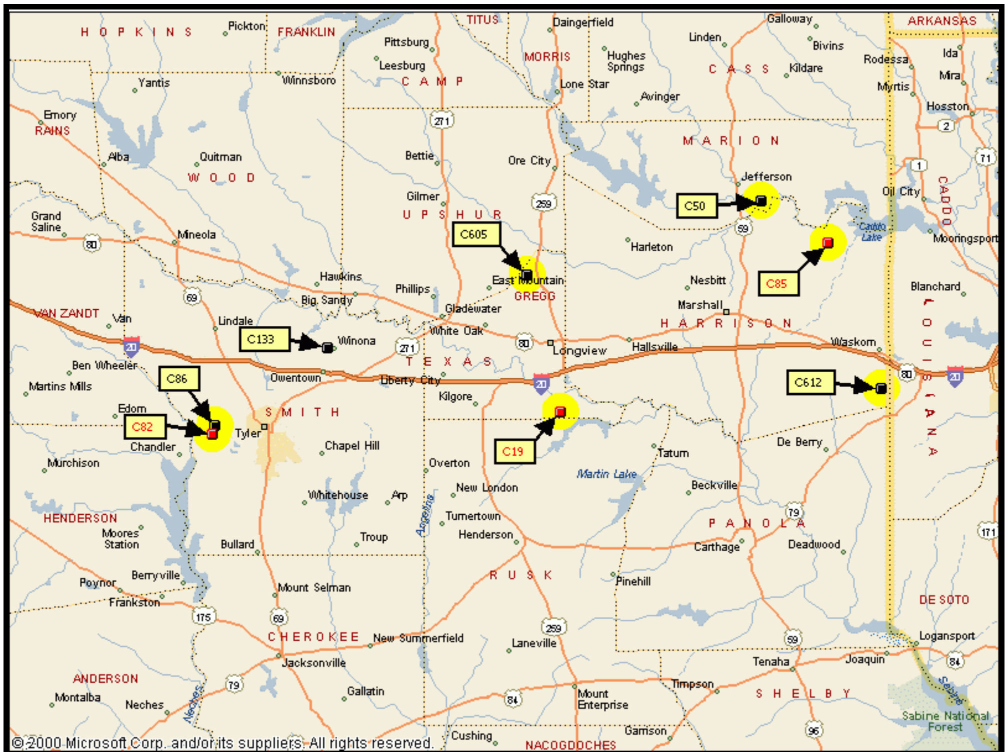


Figure 6. Continuous Air Monitoring Stations located in NE Texas

Figure 7. Caddo Lake Watershed and Airshed

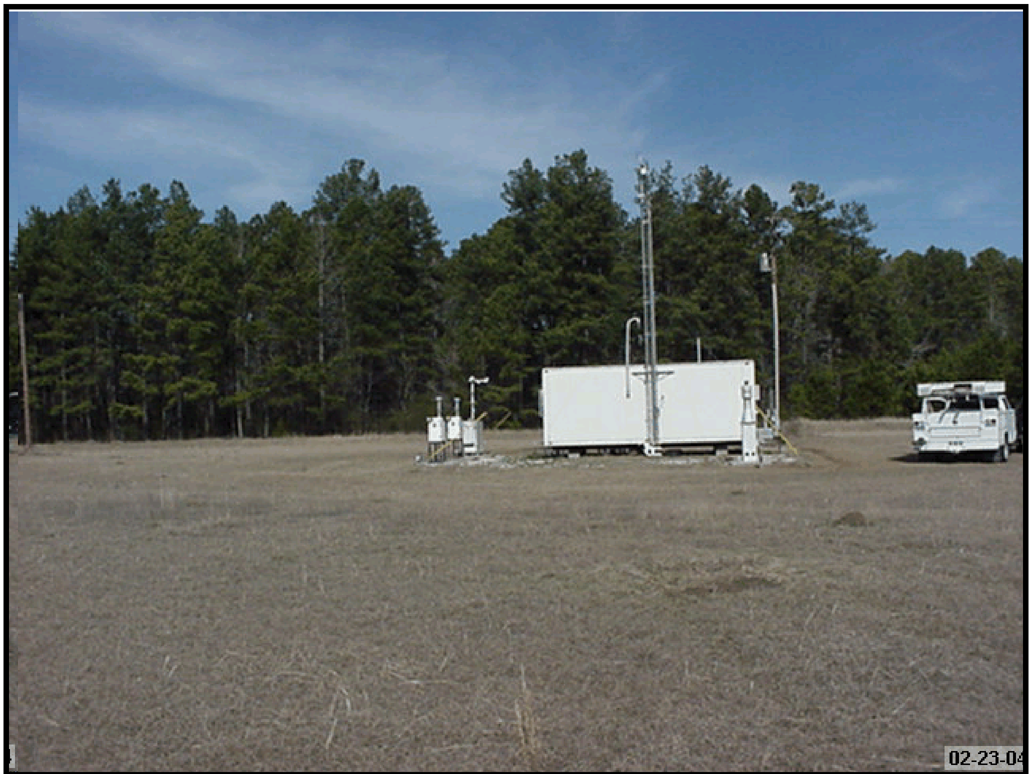
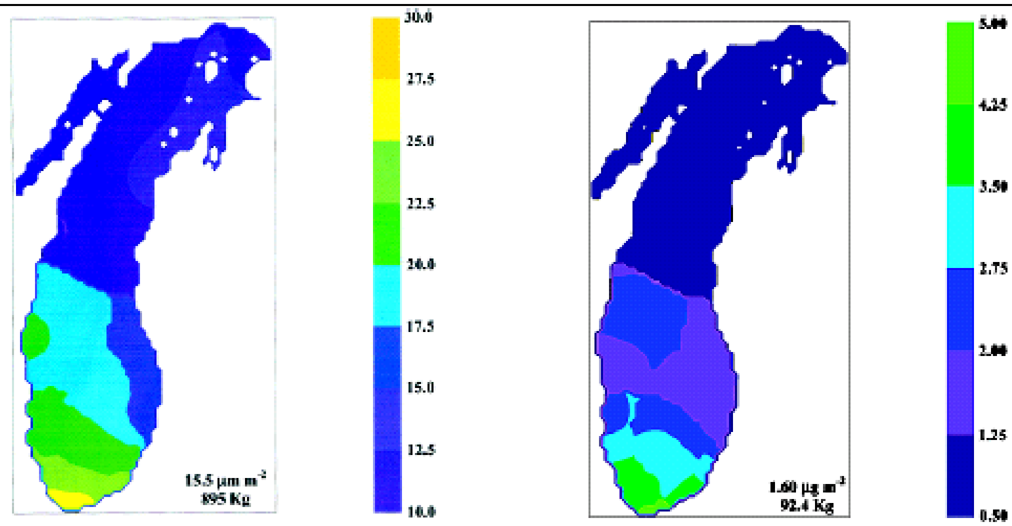


Figure 8. Continuous Air Monitoring Station C85 in Karnack, Texas

The most commonly accepted method for estimating wet and dry deposition of mercury is through the use of air deposition models. In addition to providing estimates of wet and dry atmospheric deposition at high levels of spatial resolution, air models have the capability of estimating the effects of emissions reduction scenarios on deposition which is a distinct advantage over direct measurements.

Recently, researchers at EPA have used novel hybrid receptor modeling techniques to estimate total atmospheric deposition to Lake Michigan and to attribute these fluxes to loads from specific emission sources (Figure 9). The technique involves the direct measurement of wet deposition and ambient air concentrations of mercury and trace elements at various locations in the water body. Dry deposition is estimated using various methods employed to calculate settling velocities. The resulting wet and dry deposition values are extrapolated to the entire water body using modified kriging methods.

Volatilization from the lake back to the atmosphere is also modeled using a hydrodynamic lake model developed by NOAA. Geographic attribution of source is accomplished with 24-hr back-trajectory analysis using HY-SPLIT. Source type identification (i.e. coal combustion, petroleum distillate combustion, waste incineration, etc.) is accomplished using a statistical, cluster analysis of trace element data. While this novel methodology has scientific merit, the level of technical complication is significant and it is uncertain that the approach would withstand industry scrutiny under a TMDL scenario. In any case, mechanistic modeling of wet and dry atmospheric deposition is a well



Estimated over-water wet deposition flux (July 1, 1994–October 31, 1995).

Estimated over-water Hg(p) dry deposition flux (July 1, 1994–October 31, 1995).

Figure 9. Estimated wet and dry mercury deposition over Lake Michigan (Source: A.L. Vette et.al. 2002)

accepted approach that has been used successfully in several high-profile mercury TMDL studies (i.e. HY-SPLIT in the Florida Everglades study[2], REMSAD in the Devils Lake, Wisconsin study[8].)

The proposed approach to simulate atmospheric processes and wet and dry mercury deposition in the Caddo Lake airshed/watershed consists of a focused air quality monitoring and analysis effort and an air quality/atmospheric deposition modeling effort.

Air Quality Parameters:

To augment the wet mercury deposition data collected at MDN monitoring station TX21 and the speciated PM2.5 data collected at CAMs station C85, additional wet mercury deposition and air quality monitoring is proposed to provide data for parameter adjustment and performance testing of the air quality/atmospheric deposition modeling effort.

The current CAMs site in Karnack (C85) will be modified to analyze ambient air for total and particulate-bound mercury concentrations. CAMs station C85 will also be equipped with a rainfall collection system for wet deposition sampling and analysis. Additionally, a dedicated mobile trailer-mounted monitoring system equipped with identical instrumentation will be used to collect meteorological, air quality and wet deposition data at strategic locations in the Caddo Lake airshed/watershed.

***Air Quality/Atmospheric Deposition Modeling*:**

The U.S. Environmental Protection Agency has recently developed estimates of mercury deposition (wet and dry) for all areas of the continental U.S. for the year 1998 using the REMSAD model (Figure 10).

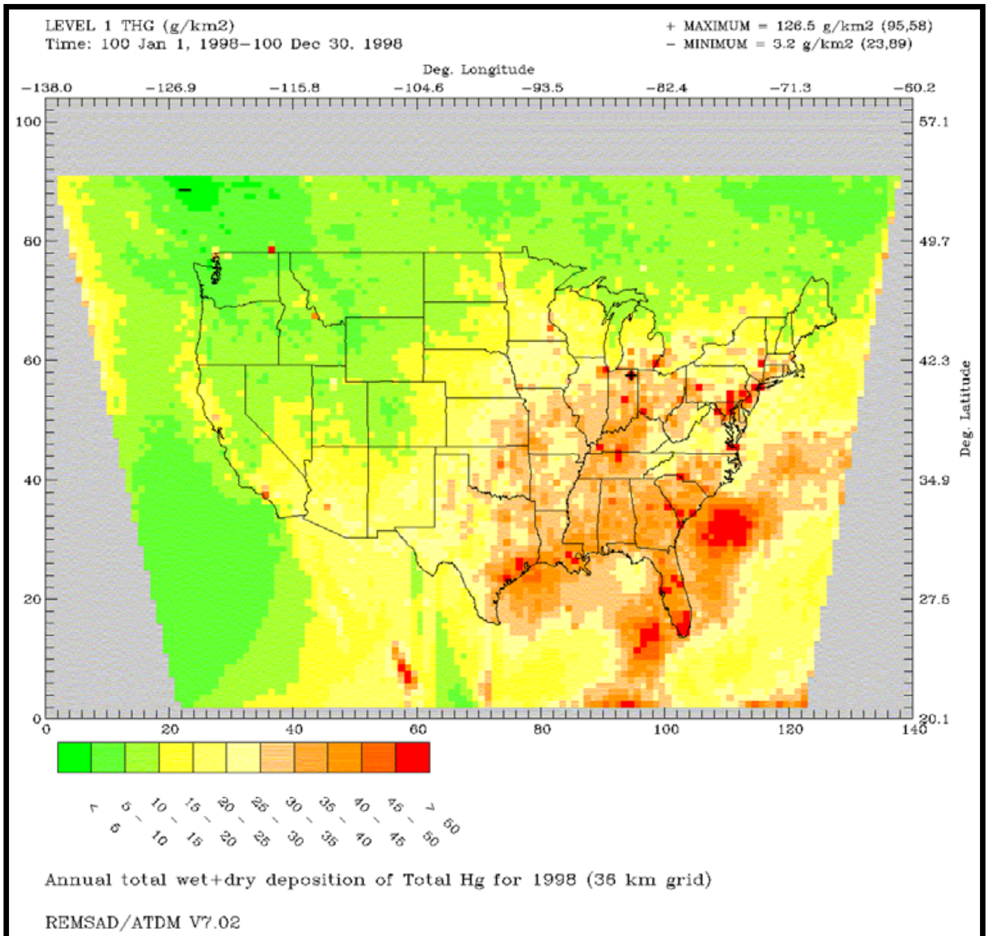


Figure 10. REMSAD simulation of annual total wet and dry mercury deposition in 1998 (Source: Atkinson, 2003)

The REMSAD model is capable of estimating long-range wet and dry flux values which can be used to develop TMDLs. Accurate simulation of atmospheric deposition using REMSAD (or any other air quality model) will require an accurate inventory and characterization of all air emission sources in the model domain and a grid (cell) size commensurate with the spatial and temporal scale of chemical transformations and transport in the airshed/watershed.

Estimates of mercury deposition (wet and dry) for the entire continental U.S. have also been performed for the year 2002 using a modified version of the Comprehensive Air Quality Model with extensions (CAMx). The mercury deposition modeling performed for 2002 using the modified version of CAMx (Hg-CAMx) was conducted by ENVIRON Inc. and was funded by the state of Wisconsin. CAMx has also been used by the State of Texas to develop its current generation of air quality plans, and therefore, a set of fully evaluated CAMx based air quality modeling episodes for Texas are available for simulation of mercury deposition.

The air quality/atmospheric deposition modeling effort proposed for Caddo Lake involves the use of the Hg-CAMx software to simulate wet and dry deposition directly to Caddo Lake and in the Caddo Lake watershed. The Hg-CAMx model was chosen because CAMx is the model used by the TCEQ to establish State Implementation Plans (SIPs). This allows the use of in-house expertise to peer-review the model (*we will need someone assigned to this*).

The air quality/atmospheric deposition modeling effort proposed for Caddo Lake will consist of two separate 1-year models which will be developed in separate phases.

Phase I of the air modeling effort will be based on the existing 2002 Hg-CAMx mercury deposition model developed for Wisconsin DNR by ENVIRON Inc. The current 2002 model will be adjusted and used to determine wet and dry deposition occurring in the Caddo Lake watershed in 2002. The adjustments to the 2002 Hg-CAMx model will include updated local emissions information as well as a nested grid of finer resolution around the Caddo Lake Watershed. Assessment of model performance, and adjustment of model parameters for the phase I (2002) modeling will be accomplished using data collected at MDN station TX21 and CAMs station C85 (e.g. speciated PM 2.5 data)

In addition to the 2002 Hg-CAMx model for Caddo Lake, a second Hg-CAMx air quality model will be developed for the year 2005 under phase II. Updated meteorological and emissions information for the year 2005 will be used to develop an air quality/atmospheric deposition model for Caddo Lake. The phase II modeling effort will represent the most up-to-date modeling of atmospheric deposition in Caddo Lake available for use in a TMDL. Together, both modeling phases will produce annual values of atmospheric deposition of mercury to Caddo Lake which will be compared and used to derive an average annual flux rate for local wet and dry deposition of mercury. Assessment of model performance, and adjustment of model parameters will be accomplished using data collected at the modified CAMs station C85, the dedicated mobile air quality monitoring trailer, and using MDN station TX21.

The Hg-CAMx air quality/atmospheric deposition modeling effort proposed for Caddo Lake is expected to take 8 months for phase I and up to 1 year for phase II.

Load Allocation:
The capabilities of the REMSAD model include source tracking using a technique referred to as “zeroing-out”. The technique consists of running the model with all meteorological inputs but only the emission source being assessed. Using this technique, the relative impact of individual sources on mercury deposition can be assessed. The most recent version of CAMx also contains new features enabling the tracking of mercury emissions and the estimation of revised mercury deposition rates, which could also be used to develop footprints of deposition associated with particular mercury sources.

As with simulations of wet and dry fluxes, simulation of emission reduction scenarios, assessment of model performance, and adjustment of model parameters can all be accomplished using observed data.

Interstate Cooperation/Collaboration and Stakeholder Participation

Interstate Cooperation/Collaboration

Caddo Lake is located on the state border with Louisiana. Portions of the Caddo Lake watershed are also located in Louisiana and the preliminary airshed defined for Caddo Lake encompasses areas of Louisiana, Arkansas and Oklahoma (Figure 7). A significant amount of the data and information needed to establish a mercury TMDL for Caddo Lake is associated with sources and features located in these states. The data requirements of the TMDL and the potential interstate implications of load allocations resulting from a mercury TMDL on Caddo lake are compelling reasons for the TCEQ to include the governments of Louisiana, Arkansas, and Oklahoma in the proposed TMDL effort.

The Louisiana Department of Environmental Quality (LADEQ) maintains one water quality monitoring station on Caddo Lake near Moringsport, Louisiana (Figure 11). Water quality data collected at this station has been provided to the TCEQ and discussions are underway between TCEQ and LADEQ on collaborative monitoring efforts associated with mercury-related issues in Caddo Lake. As part of the proposed TMDL, these discussions will be expanded to include cooperation/collaboration of LADEQ in data collection and modeling efforts specifically-related to the proposed TMDL. The TCEQ will also request the participation of the state governments of Louisiana, Arkansas and Oklahoma in the TMDL effort to facilitate the exchange of information and ideas related to data collection and modeling (i.e. modeling protocols, emission inventories, characterizations of natural sources, and data on local meteorology, stream flow, air quality, water quality, and fish tissue concentrations.) Additionally, the TCEQ will consult with representatives of these state governments regarding potential impacts of TMDL load allocation scenarios on facilities located within their respective jurisdictions.

Stakeholder Participation

Experience shows that consensus-based approaches to TMDL development have a higher probability of success. It is the standard policy of the TCEQ to identify and involve a diverse and inclusive group of stakeholders in all TMDL-related projects. The TCEQ will facilitate the formation of a stakeholder group for the Caddo Lake TMDL project following the protocols specified in the guidance[8] and adhering to the requirements of House Bill 2912 passed by the 77th Texas State Legislature.

The TCEQ will use methods of communication that are accessible to all stakeholders and will develop a plan for consensus-building and/or dispute resolution between stakeholders. Meeting times and locations will be convenient to all stakeholders and the public. When forming the Caddo Lake TMDL stakeholder committee the TCEQ will strive to include representation from industry, agriculture, water quality permittees, water right owners, and any other interested users, including the public.

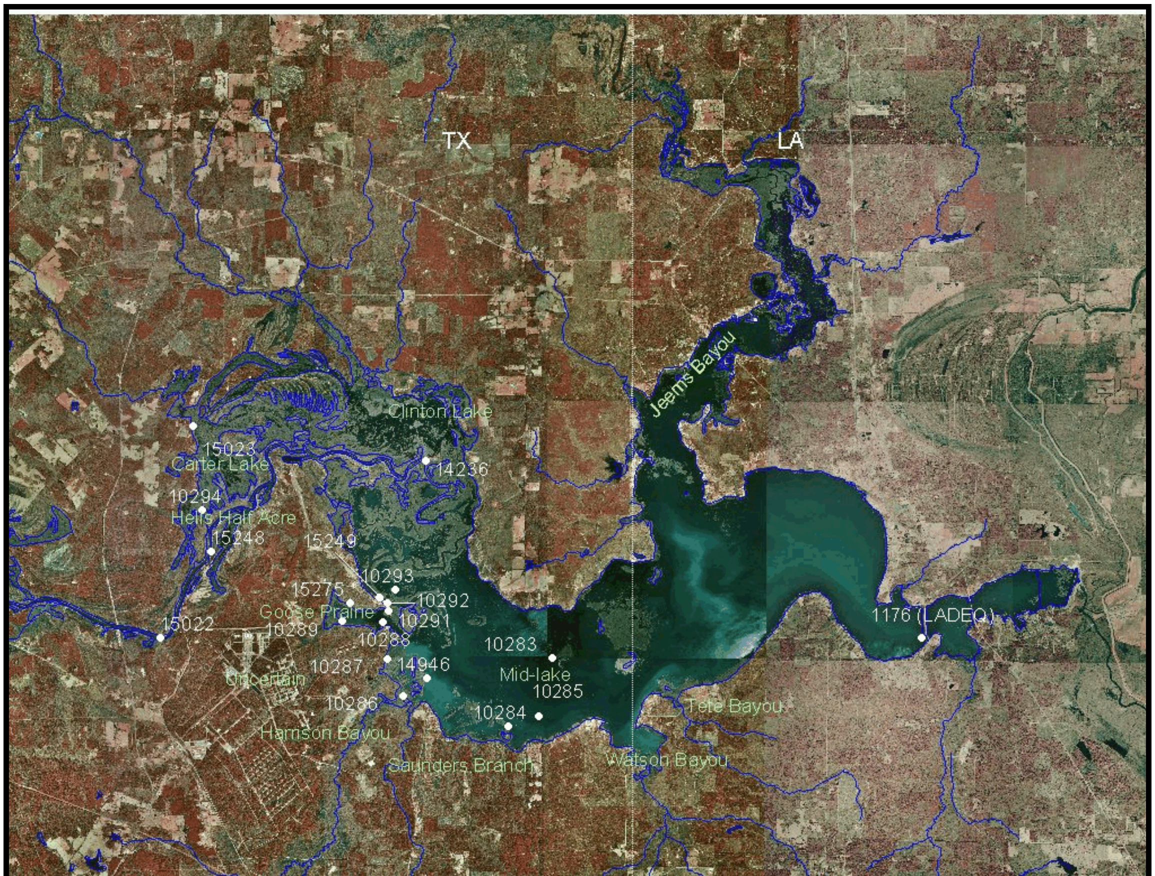


Figure 11. Water Quality Monitoring stations on Caddo Lake (station 1176 is an LADEQ site)

Summary

Caddo Lake is listed in the 2000 State of Texas Clean Water Act 303(d) List and again in the Draft 2002 and 2004 State of Texas Clean Water Act 303(d) List for mercury contamination in fish tissue. Concentrations of mercury in fish from Caddo Lake are among the highest in Texas. The major processes controlling the fate and transport of mercury to Caddo Lake can be viewed as occurring simultaneously in three distinct environmental compartments or media and include in-lake processes, watershed processes, and atmospheric processes.

The Environmental Planning and Implementation Division proposes the strategy outlined above to address mercury contamination in Caddo Lake through the establishment of a TMDL. The strategy is a conceptual design describing a methodology to quantitatively define the transport and fate of mercury form its sources to fish tissue in Caddo lake. The strategy is currently in draft form and available for comment. As such, all estimates of the funding resources and time necessary to implement the strategy have been intentionally excluded from this draft.

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Figure References

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