FINAL

TECHNICAL MEMORANDUM

TO: Vic Ramirez, LCRA

DATE: March 18, 2009
Revised May 11, 2009

FROM: Emily Chen, Anchor QEA
Jim Patek, Parsons
Jennifer Benaman, Anchor QEA

RE: Lake Travis scenario runs - FINAL

CC: Lisa Hatzenbuehler, LCRA
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JOB#: PARcrm:161

This memo summarizes the scenarios performed using the watershed and lake water quality models developed for Lake Travis for Phase 2 of the Colorado River Environmental Models (CREMs) project. The goal was to investigate the sensitivity of water quality in the lake to various potential changes in the Lake Travis watershed. Specifically, ten scenarios were evaluated that focused on three variables:

- the increase of point source discharges to the lake at locations with a wastewater treatment facility and current and pending land application permits and at a location close to Max Starcke Dam;
- the increase of urbanization in subbasins undergoing potential development within the Lake Travis watershed, with and without the Highland Lakes Watershed Ordinance (HLWO) in place; and
- the increase of nutrient and organic loadings at the upstream boundary of Lake Travis (i.e., the load coming into Lake Travis over Max Starcke Dam, which represents the load from Lake Marble Falls).

The Lake Travis model is comprised of linked watershed (SWAT) and lake water quality (CE-QUAL-W2) models. Details on the model development, calibration, and model sensitivity can be found in the *Colorado River Environmental Models Phase 2: Lake Travis Final Report* (Anchor QEA and Parsons 2009).

SCENARIO DEVELOPMENT

Table 1 presents an overview of the ten scenarios that were applied to the calibrated watershed and lake water quality models in order to investigate the sensitivity of the lake water quality to these watershed changes. As illustrated in Table 1, of the ten scenarios, four (#1, #2, #3, and #4) involve only an increase in point source discharges, two (#5 and #6) are a function solely of

Table 1. Scenario overview.

SCENARIO	Point Source Dischargers[a]				Urbanization			Upstream Loadings	
	No new point source dischargers	10 MGD point source (wet-weather discharge)[b]	10 MGD point sources (constant discharge)	2 MGD point source into upstream part of lake	Current land use (2000 USGS/USEPA)	Increased urbanization (20 yrs into future) HLWO not in-place	Increased urbanization (20 yrs into future) HLWO in-place	Current	Increased loading by 10%
1. All point sources (10 million gallons per day [MGD], incl. wastewater treatment facilities and current/pending land applications)			x		x			x	
2. Point sources (wet-weather discharge) only		x			x			x	
3. Point source (2 MGD) into upstream portion of lake				x	x			x	
4. Point source (2 MGD) into upstream portion of lake & all point sources (10 MGD)			x	x	x			x	
5. Increased urbanization without Highland Lakes Watershed Ordinance (HLWO) in place	x					x		x	
6. Increased urbanization with HLWO in place	x						x	x	
7. Increased upstream loading	x				x				x
8. All point sources & increased urbanization without HLWO in place			x			x		x	
9. All point sources, increased urbanization without HLWO in place, & increased upstream loading			x			x			x
10. All point sources (wet-weather discharge), increased urbanization without HLWO in place, & increased upstream loading		x				x			x

Notes: a. The following will be assumed regarding a discharge: Flow = 1 MGD, BOD = 10 mg/L, TSS = 15 mg/L, DO = 4 mg/L, NH_3-N = 1 mg/L, NO_2+NO_3 = 20 mg/L, TP = 1mg/L (all immediately "available" for algal growth)

b. Wet-weather discharge in operation when modeled flows from Sandy Creek were above 1 cfs.

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urbanization, one (#7) entails only an increase in upstream loading, one (#8) involves both an increase in point source discharges and urbanization, and two (#9 and #10) scenario include changes in all three variables. These scenarios considered changes in only one of the three areas described above, as well as cumulative impacts from a combination of different changes occurring "simultaneously" over the watershed.

For all of the scenarios simulated, the impact is measured relative to the calibrated model result, which represents "current" conditions. The hydrologic condition that is simulated for the scenarios in the model is the same period as the calibration (1984 – 2006). This 23-year period represents a range of low, high, and somewhat average precipitation conditions (Figure 1; all figures can be found after the memo text). By running the future scenarios using the same hydrology as the calibration, it is possible to observe relative impacts in the lake to changes on the watershed during both wet and dry periods. A bounding calibration was developed that represents an estimate of uncertainty in the model prediction. The scenarios were also run using this bounding calibration and these results were used in conjunction with the base-calibration future scenario results to show a potential range of chlorophyll-*a* concentrations for a given watershed change.

REPRESENTATION OF THE SCENARIOS WITHIN THE MODEL FRAMEWORK

Increases in Point Source Discharges

Of the ten scenarios, seven involve an increase in point source discharges. For such scenarios to be a reality, the current Texas Commission on Environmental Quality (TCEQ) Highland Lakes Point Source Discharge Ban, which precludes the discharge of wastewater treatment plant effluent into Lake Travis except for those facilities in operation before the ban went into effect, would have to be lifted. For the seven future scenarios involving point source discharges, it was assumed that the discharge ban was lifted and that current and pending land application permit holders were allowed to discharge at permitted flows through wastewater treatment facilities into Lake Travis at locations closest to those in their permit applications. Specification of the point sources in the lake water quality model required information on location (spatially and at depth), discharge rate, and effluent concentration.

For scenarios where discharges within ten stream miles of Lake Travis included flows from one wastewater treatment facility and flows from 38 current and pending (as of April 2008) land application permits, the model segments into which the discharges were assigned are shown on Figure 2. Discharges were placed in the lake "at depth" (about a meter above the sediment bed at all locations).

For Scenarios #1, #4, #8, and #9, it was assumed that all point source discharges will total approximately 10 million gallons per day (MGD). The total flow rate, however, of all wastewater treatment dischargers and current and pending land application permits is about 7 MGD. In order to increase the total rate to 10 MGD, an additional 3 MGD of discharge was assigned to permittees located upstream of Turkey Bend to represent possible increases (number of permittees, permitted discharge quantities, etc.) in the future. The 3 MGD was prorated among these locations using the ratios of the permitted discharge rates. Point source discharges for these scenarios were constant for the duration of the model simulation.

Two of the point source discharge scenarios assume that discharges would only be allowed at times when natural flows into Lake Travis exceed a certain threshold. In order to simulate such wet-weather conditions (Scenarios #2 and #10), the point sources of all wastewater treatment dischargers and current and pending land application permits (including the proration up to 10 MGD) were activated on days during the model simulation when the modeled flow in Sandy Creek was greater than 1 cubic feet per second (cfs). An evaluation of modeled daily flow rates for Sandy Creek from the lake model's water balance showed that 1 cfs was an appropriate threshold; flow exceedance of this threshold occurred about 12% of the time (Figure 3). Therefore, whenever modeled flow rates exceeded 1 cfs in Sandy Creek, point source discharges were "turned on" in the lake water quality model. For the scenarios, no adjustments were made to allow augmented discharges during wet-weather; in other words, only 12% of the total load from point sources enters Lake Travis over the course of the 23-year simulation during wet-weather conditions, compared to the loads discharged in the continuous discharge simulation.

Two of the point source discharge scenarios assumed an additional point source discharge of 2 MGD into the upstream portion of the lake. The discharge rate of 2 MGD is typical of the amount of volume expected from the municipalities in the basin. Scenarios #3 and #4 included a 2 MGD point source into the most upstream model segment at one meter above the sediment bed. Scenario #3 tested the effects of the 2 MGD discharge only and Scenario #4 tested the cumulative impacts of the 2 MGD discharge together with the 10 MGD point source discharges described above.

For all discharge scenarios, the concentrations of pollutants in the effluent were based on current point source discharge limits and professional judgment. These values are provided in Table 2. To be conservative, all phosphorus from the discharge was assumed to be immediately "available" for algal growth when it enters the lake (i.e., total phosphorus [TP] is all dissolved orthophosphate [PO_4]). No organic nitrogen was assumed present in the discharge.

Table 2. Assumptions for point source discharge concentrations.

Constituent	Application in CE-QUAL-W2	Discharge Concentrations (mg/L)
Biochemical Oxygen Demand (5-day)	Included as a CBOD group; assumed no organic P or organic N	10
Total Suspended Solids (TSS)	Assumed only inorganic solids (ISS = TSS)	15
Dissolved Oxygen (DO)	DO	4
Ammonia Nitrogen (NH_3-N)	NH_3-N	1
Nitrite and Nitrate (NO_2+NO_3)	NO_3	20
Total Phosphorus (TP)	Assumed no organic P (TP = PO_4)	1

Notes: CBOD – carbonaceous biochemical oxygen demand; N - nitrogen; P – phosphorus; PO_4 – orthophosphate.

Increases in Urbanization

Five scenarios depict an increase in urbanization in the Lake Travis watershed 20 years into the future (for details in assumptions made regarding urbanization, see Appendix A). Four (#5, #8, #9, and #10) represent future urbanization without the HLWO in place and one (#6) portrays it in place. Urbanization was assumed to occur in the most common land uses that bordered currently urbanized land: brushy-rangeland, evergreen forest, and grass-rangeland. Development was modeled as low-density residential (<0.5 unit/acre, or on average 12% impervious). As a result, urbanization in the lower portion of the watershed model (adjacent to Lake Travis; see Figure 4) increased from 1.8% in the "current" conditions (i.e., calibration run) to 11.3% in the future scenario runs. Using the same approach, the urbanization in the upper portion of the watershed model (adjacent to the Pedernales River; see Figure 4) increased from 0.8% to 3.4%. Because the calibration of the watershed model used data from subbasins where most of the land was not urbanized or whose urbanization was grandfathered and is not affected by the HLWO, this future urbanization represents urbanization without the HLWO in place. In other words, the model parameters that were established during the calibration of the watershed model were set using data from areas without the HLWO in place. These same parameters were used on any "new" urbanized land in the future scenarios. Therefore, urban land introduced in the model for four future scenarios reflects the urbanization without the HLWO in place.

In terms of increased nutrient and organic matter loadings due to the urbanization without the HLWO in place, Table 3 shows the total watershed loads for the entire simulation and the percentage change from the calibration run.

Table 3. Changes in watershed loadings due to urbanization (no HLWO in place).

Constituent	Total watershed load (lb/yr)		% Change
	"Current" (Calibration)	Future Urbanization	
Orthophosphate	5,559	5,655	2%
Organic Matter – Phosphorus	275,673	288,422	5%
Phosphorus - Algal	4,122	4,889	19%
Ammonia Nitrogen	170,043	181,450	7%
Nitrate	2,597,617	2,648,803	2%
Organic Matter – Nitrogen	848,587	906,003	7%
Nitrogen - Algal	63,934	76,682	20%
Organic Matter	9,993,734	11,796,059	18%
Algae	1,522,050	1,825,905	20%

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The scenario representing future urbanization *with* the HLWO in place (#6) was created in several steps. First, the differences in nutrient and organic loads between the base-calibration run and the future urbanization run (Scenario #5) were presumed to be due to urbanization *without* the

HLWO. Then, subbasins with at least 25% of their area within the boundary of the HLWO were identified (Figure 4). Next, best management practices, in accordance with the HLWO, were assumed to be 70% efficient, meaning that 30% of the load from the urban area enters the lake.[1] Finally, future loads with urbanization and the HLWO in place were calculated as the sum of the calibration load from both the upper (adjacent to the Pedernales River) and lower (adjacent to Lake Travis; Figure 4) models, the increase in load from the upper model due to increased urbanization (unaffected by the HLWO), and 30% of the increase in load from the lower model due to increased urbanization. The BMPs were applied to each daily load and each subbasin included in the lake model; on days when future urbanization loads were lower than those for the base calibration, the future urbanization loads were used.

Increases in Upstream Boundary Conditions

Three model scenarios (#7, #9, and #10) included the increase of upstream loadings by 10% to simulate potential future loadings coming over Max Starcke Dam (i.e., from Lake Marble Falls). The upstream loadings of algae, inorganic suspended solids (ISS), NH_4, NO_2+NO_3, all organic matter groups, and PO_4 were increased (Table 4).

Table 4. Comparison of 10% increase in upstream load to current total load to Lake Travis.

Constituent	Load for 23-year simulation period (metric tons)	
	10% of upstream load (change applied to upstream)	Total load to system (from upstream, tributaries, direct drainage) for calibration
Inorganic Suspended Solids	31,534	23,603,800
Orthophosphate	20	262
Organic Matter - Phosphorus	88	3,760
Phosphorus - Algal	5	95
Ammonia Nitrogen	126	3,034
Nitrite and Nitrate	606	33,155
Organic Matter – Nitrogen	1,316	22,008
Nitrogen - Algal	81	1,473
Organic Matter	23,135	335,609
Algae	1,918	35,059

SCENARIO RESULTS

Impacts of the changes in the watershed due to the scenarios on water quality in the lake were assessed at five locations: near the upstream boundary near Max Starcke Dam (Model Segment 6), at Turkey Bend (Segment 28), at Arkansas Bend (Segment 78), at the downstream boundary of Mansfield Dam (Segment 93), and in Hurst Cove (Segment 140; Figure 2). Assessment compared average and maximum of predicted daily average chlorophyll-*a* concentrations in the

[1] It should be noted that the Best Management Practices (BMPs) treat runoff only in the newly urbanized areas, and that BMP retrofitting in established neighborhoods is not being modeled.

top two meters of the water column for each scenario during the summer months (June through September) to the model output from the current conditions (or calibration run). Chlorophyll-*a* concentrations were used to determine impact because algal blooms are potentially more important to stakeholders and because the parameter is linked to changes to nutrients such as phosphorus and nitrogen. The model was set up to print daily average results to an output file for the 23-year simulation period; for ease of comparison, however, the average and maximum of the daily average chlorophyll-*a* concentrations during summertime periods for the entire run were used in the presentation of the model results below.

In the figures, model results are shown as percent changes in chlorophyll-*a* concentrations from the current concentrations over the entire 23-year simulation period. These percent changes can be considered relative to the absolute summer surface water chlorophyll-*a* concentrations for the current, or calibration, run.[2] Model results for each simulated year are included in Appendix B. Table 5 presents the daily average summer surface water chlorophyll-*a* concentrations for current conditions.

Table 5. Mean and maximum summer surface water chlorophyll-*a* concentrations predicted for current conditions.

	Daily Average Summer Chlorophyll-*a* (µg/L)	
Location	**Mean**	**Max**
Near Max Starcke Dam	8.2	24.1
Turkey Bend	5.7	14.2
Arkansas Bend	6.6	14.2
Mansfield Dam	3.7	10.5
Hurst Cove	5.8	12.7

Impact of Increases to Point Source Discharges (Scenarios #1 through #4)

For all scenarios that include an increase in point source discharges, the model predicts an increase in summertime surface chlorophyll-*a* concentrations. The magnitude of the increase is related to the location and duration of the discharges and the lake characteristics at those places. Because of where the majority of the point sources enter Lake Travis (Figure 2), the largest changes in summer surface chlorophyll-*a* concentrations occurred in the downstream portion of the lake (Figure 5). For the scenario with constant point source discharges amounting to about 10 MGD (Scenario #1), average and maximum chlorophyll-*a* concentrations increased between 42% and 102% at Arkansas Bend, Mansfield Dam, and Hurst Cove compared to little overall

[2] The model results were evaluated by pairing the scenario concentration and current concentration for each simulated year, dividing the difference between the scenario concentration and current concentration by the current concentration and multiplying by 100, and averaging the percent changes for each year over the entire 23-year simulation. In this manner, the average percent change captures the variability in scenario results during the entire run, which includes different hydrologic conditions. The percent change is not the change in the overall average (i.e., not the percent change between the average scenario and average current results) and should not, therefore, be used directly to compute an absolute summer surface water chlorophyll-*a* concentration but instead be used in a manner relative to other scenario results.

change near Max Starcke Dam and a 5% to 11% change at Turkey Bend. Allowing point sources to discharge only during wet-weather (Scenario #2) reduced the increase in summer surface chlorophyll-*a* concentrations predicted with constant point source discharges up to 80%.

Near Max Starcke Dam and Turkey Bend, the introduction of a 2 MGD point source (Scenario #3) resulted in algal growth proportional to increased nutrient loadings (Figure 5). The 22% and 23% increases in mean summer surface chlorophyll-*a* at Max Starcke Dam and Turkey Bend, respectively, were on par with the increase to nutrients (e.g., an addition of 64 metric tons of PO_4 by the 2 MGD point source was in-line with 24% of the total PO_4 load to the system). This signal was attenuated (e.g., diluted) by the time the water reached the downstream locations, but still showed a signal at Mansfield Dam with about an 2% increase in chlorophyll-*a*. The introduction of the loading as a point source instead of a non-point source was chosen due to the ease of implementation in the model; any difference in loading placement within the water column (point sources were included at depth versus non-point sources would enter at the surface) presumably would be minimal as dilution and/or mixing would have occurred by the time water reaches the downstream assessment locations.

Scenario #4 shows the cumulative effects of the additional 2 MGD point source and the accumulated 10 MGD point sources (Figure 5). As expected, the 2 MGD point source dominated in the upper portion of the lake and then the accumulated 10 MGD point sources had a greater influence in the downstream portion.

Impact of Increases in Urbanization (Scenarios #5, #6, and #8)

For the scenarios that include an increase in urbanization, the model predicts smaller increases in summertime surface chlorophyll-*a* concentrations compared to scenarios with continuous point source discharges. At the downstream locations, increasing watershed urbanization 20 years into the future (Scenario #5) had a smaller impact on summer surface chlorophyll-*a* concentrations than increasing continuous point source discharges in the future (Scenario #1; Figure 6). Scenario #5 shows increases of summer surface chlorophyll-*a* of 2% to 4% at Arkansas Bend, Mansfield Dam, and Hurst Cove compared to 42% to 102% change for Scenario #1. Near Max Starcke Dam, urbanization increased chlorophyll-*a* concentrations less than point sources and at Turkey Bend, the impact of urbanization on average and maximum chlorophyll-*a* was generally low (2% increase). The combination of the two scenarios (Scenario #8) shows the cumulative increase of up to 101% in summer surface chlorophyll-*a* concentrations.

Having the HLWO in place 20 years into the future (Scenario #6) resulted in smaller, if any, increases in chlorophyll-*a* at all five locations than if the HLWO was not in place (Scenario #5; Figure 7). With the ordinance in place, the mean and maximum summer surface chlorophyll-*a* compared to the current conditions did not change or increased up to 4%. Without the ordinance in place, the percent changes ranged from 0% to 13%.

Impact of Increases in Upstream Boundary Conditions (Scenario #7)

The percent changes to mean summer surface chlorophyll-*a* concentrations for the scenario with a 10% increase in upstream loadings (Scenario #7) were higher near Max Starcke Dam and lower at the downstream locations (Figure 8). A 6% increase was predicted near Max Starcke Dam. This upstream signal was observable at Mansfield Dam and in Hurst Cove with 3% and 4% increases, respectively, compared to the current conditions.

Impact of Scenario Combinations (Point Source – Constant and Wet-Weather Discharge, Urbanization, and Increased Upstream Loading) (Scenarios #9 and #10)

The results for Scenario #9 show the cumulative impacts of potential future point sources, increased urbanization 20 years into the future without the HLWO in place, and an increase to the upstream loadings by 10% (Figure 9). The percent changes in mean summer surface chlorophyll-*a* increased by 11% to 21% at the upstream locations (near Max Starcke Dam and Turkey Bend) and by 48% to 104% at the downstream locations (Arkansas Bend, Mansfield Dam, and Hurst Cove). This pattern reflects the fact that the majority of point source dischargers enter the lake at the downstream end and that point sources have the largest impact on summer surface chlorophyll-*a* of the three scenario areas tested. Allowing point sources to discharge only during wet-weather (Scenario #10) reduced the average and maximum daily average summer surface chlorophyll-*a* concentrations up to 76%; in other words, the increases in concentrations due to the constant point source discharges were reduced up to 76%.

Sensitivity to Point Source Water Quality Concentrations

Because the scenario results indicated that about 10 MGD of combined point sources have a substantial impact on summer surface chlorophyll-*a* concentrations, the sensitivity of the model to the assumed discharge concentrations for the point sources was tested using Scenario #1 as the original model run (Table 6). One sensitivity run tested the lake's response to a reduction in the nitrite and nitrate (NO_2+NO_3) concentration from 20 milligrams per liter (mg/L) to 4 mg/L. Another sensitivity run assessed the lake's response to assuming that none of the total phosphorus was immediately "available" for algal growth. To do this, the total phosphorus from the discharge was set to all organic (i.e., $PO_4 = 0$ mg/L). The complete removal of orthophosphate is not achievable due to technological limitations, and therefore, this sensitivity represents a lower bound to predicted chlorophyll-*a* concentrations if PO_4 levels are decreased. The last two sensitivities were performed to evaluate the lake's response to various reductions in BOD, total suspended solids (TSS), TP, and NO_2+NO_3 concentrations from the point sources if advanced treatment was implemented at the treatment plants.

Table 6. Assumptions for sensitivity testing of point source discharge concentrations.

Constituent	Application in CE-QUAL-W2	Scenarios	Sensitivity Testing			
		#1	Reduction in NO_2+NO_3	No immediately "available" P for algal growth	Advanced Treatment 1	Advanced Treatment 2
		Discharge Concentration (mg/L)				
Biochemical Oxygen Demand (5-day)	Included as a CBOD group; assumed no organic P or organic N	10	10	10	5	5
Total Suspended Solids	Assumed only inorganic solids (ISS = TSS)	15	15	15	5	5
Dissolved Oxygen	DO	4	4	4	4	4
Ammonia Nitrogen	NH_3-N	1	1	1	1	2
Nitrite and Nitrate	NO_3	20	4	20	10	4
Total Phosphorus	Assumed no organic P (PO_4 = TP)	1	1	1 (PO_4 = 0)	1	0.15

Reducing the nutrient concentrations in the constant point source discharges had favorable impacts on the summer surface chlorophyll-*a* concentrations (Figure 10). Compared to the scenario with constant discharges of about 10 MGD (Scenario #1), reducing the NO_2+NO_3 concentration to 4 mg/L lowered the increase in summer surface chlorophyll-*a* concentrations up to 25%. Not allowing any phosphorus to be immediately "available" for algal growth resulted in reductions up to 84%. Decreasing the point source discharge concentrations to reflect advanced treatment reduced summer surface chlorophyll-*a* levels up to 16% using advanced treatment set 1 and up to 52% using advanced treatment set 2 concentrations; in other words, the increases in concentrations due to the constant point source discharges were reduced by up to 16% and 52%, respectively. Even with the increased levels of treatment, however, the impacts of the constant point source discharges are still observable in the model predictions.

UNCERTAINTY IN SCENARIO RESULTS

Uncertainties exist in the scenario predictions given the uncertainties in the model predictions. During the Phase 2 Lake Travis calibration, an upper-bound calibration was determined by changing three of the most sensitive model input parameters to simulate higher summer surface chlorophyll-*a* concentrations while still maintaining agreement with various measured data. This process is called a "bounding calibration" and provides an estimate of the upper-bound uncertainties on the chlorophyll-*a* concentrations predicted by the model. Each of the ten scenarios was rerun using this upper-bound calibration. These results, combined with the results from the original scenario runs, provide an "upper-range" of possible chlorophyll-*a* concentrations.[3] Figures 11 and 12 show the average and maximum daily average summer chlorophyll-*a* concentrations for all scenarios runs with the original calibration as the base and the concentrations with the bounding calibration as the base. The uncertainty in the model results is a function of location (there was less uncertainty in the model predictions at upstream locations) and predicted concentration (the higher the concentration, the higher the uncertainty in the model predictions). The hatched bars in the figures indicate the upper ranges of uncertainty in the model predictions for the scenarios. For the scenarios performed, the bands of uncertainty for the average summer surface chlorophyll-*a* ranged from zero up to 2 μg/L.

CONCLUSIONS

From the ten scenarios and three sensitivities performed using the Lake Travis water quality model, the following conclusions can be made:

- Model results indicate increased point source dischargers would have the largest impact on lake water quality. Results are sensitive to assumptions made regarding discharge concentrations and nutrient availability.
- Requiring point sources to discharge during wet-weather would mitigate some of the impact. In the scenarios, loadings from the wastewater treatment plants were reduced to 12% of their load allowed during continuous discharge.
- Urbanization and upstream loading increases also have impacts lake-wide.
- Future urbanization impacts can likely be controlled with the HLWO. Maintaining the TCEQ Point Source Discharge Ban will aid in managing increased loads due to urbanization and increased loads from upstream. The HLWO aids in controlling chlorophyll-*a* increases due to urbanization.
- Changes in loadings are measurable lake-wide and not constrained to "localized" effects. Even a change in the upstream load can be "seen" at Mansfield Dam and in Hurst Cove.
- Because of model uncertainty, the model predictions for average summer surface chlorophyll-*a* for these future scenarios could be up to 0.1 to 2.0 μg/L higher (depending on scenario and assessment location) than the concentrations predicted using the base calibration.

REFERENCES

Anchor QEA and Parsons, 2009. *Colorado River Environmental Models Phase 2: Lake Travis Final Report*. Final draft submitted to LCRA on March 18, 2009; revised on May 11, 2009.

[3] Because a lower-bound calibration was not determined, these results should be viewed as "conservative" or the most likely estimate (i.e., base calibration) and an upper-bound estimate (i.e., bounding calibration) of possible chlorophyll-*a* concentrations in the lake.

FIGURES

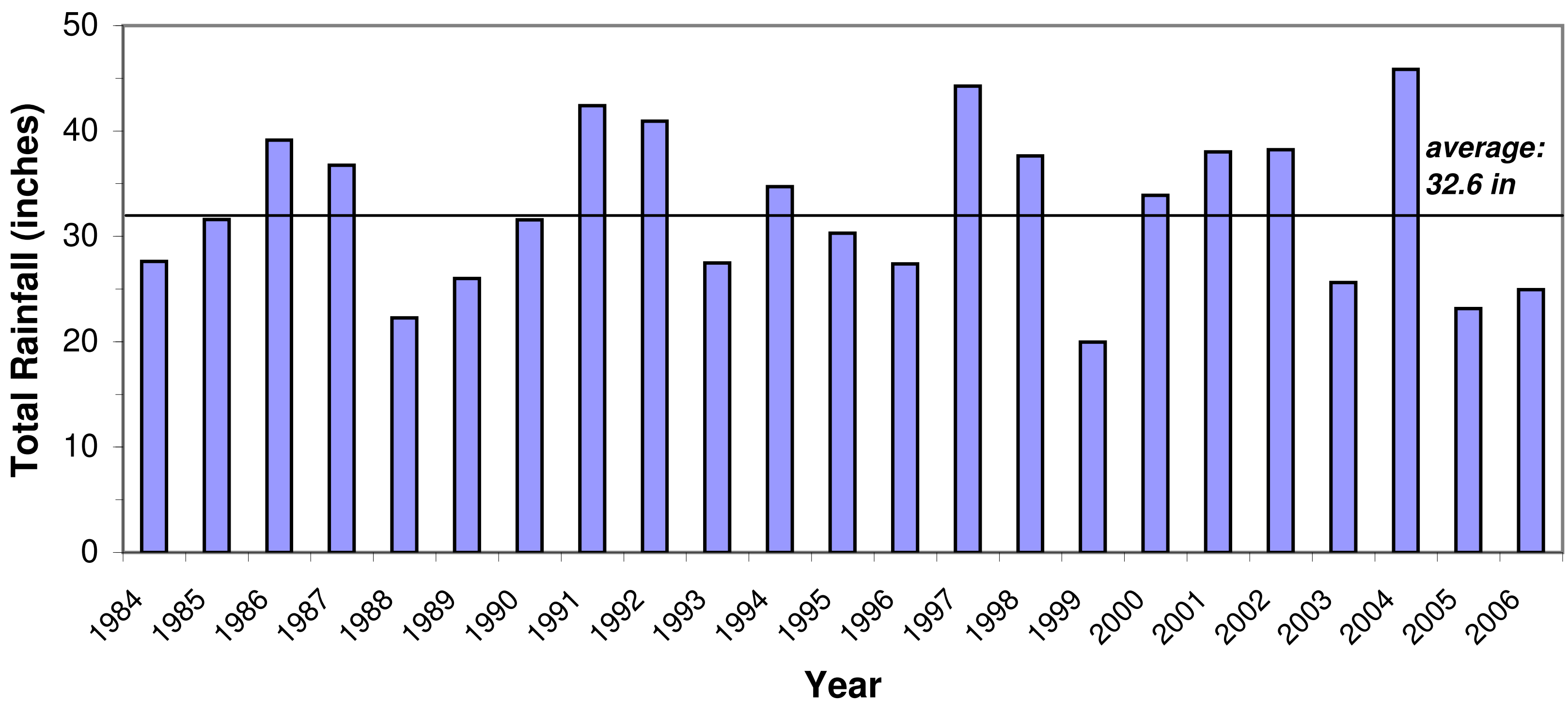

Figure 1. Annual precipitation in Lake Travis watershed over simulation period.
Based on National Climatic Data Center (NCDC) data at 17 stations surrounding Lake Travis.

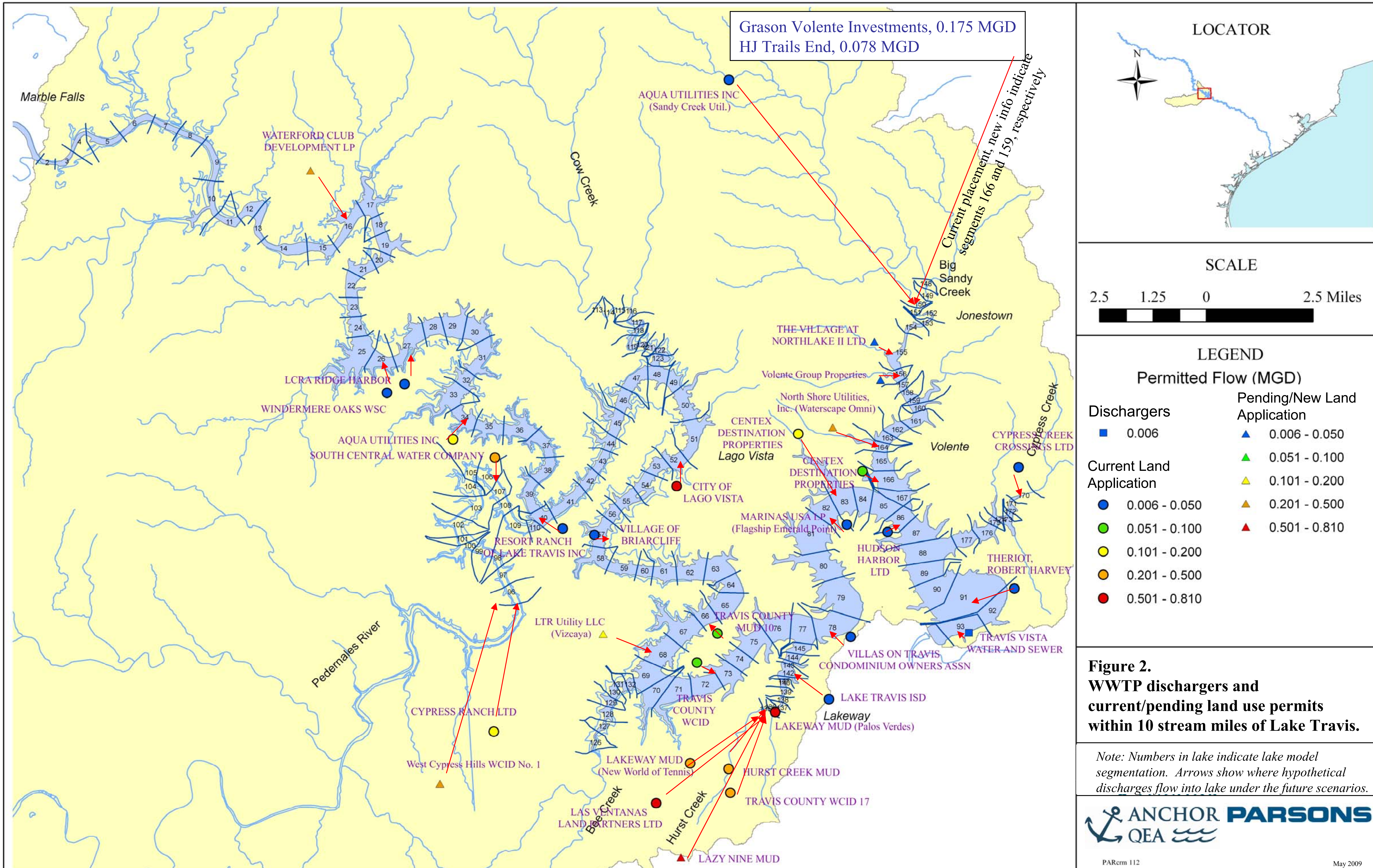

Figure 2.
WWTP dischargers and current/pending land use permits within 10 stream miles of Lake Travis.

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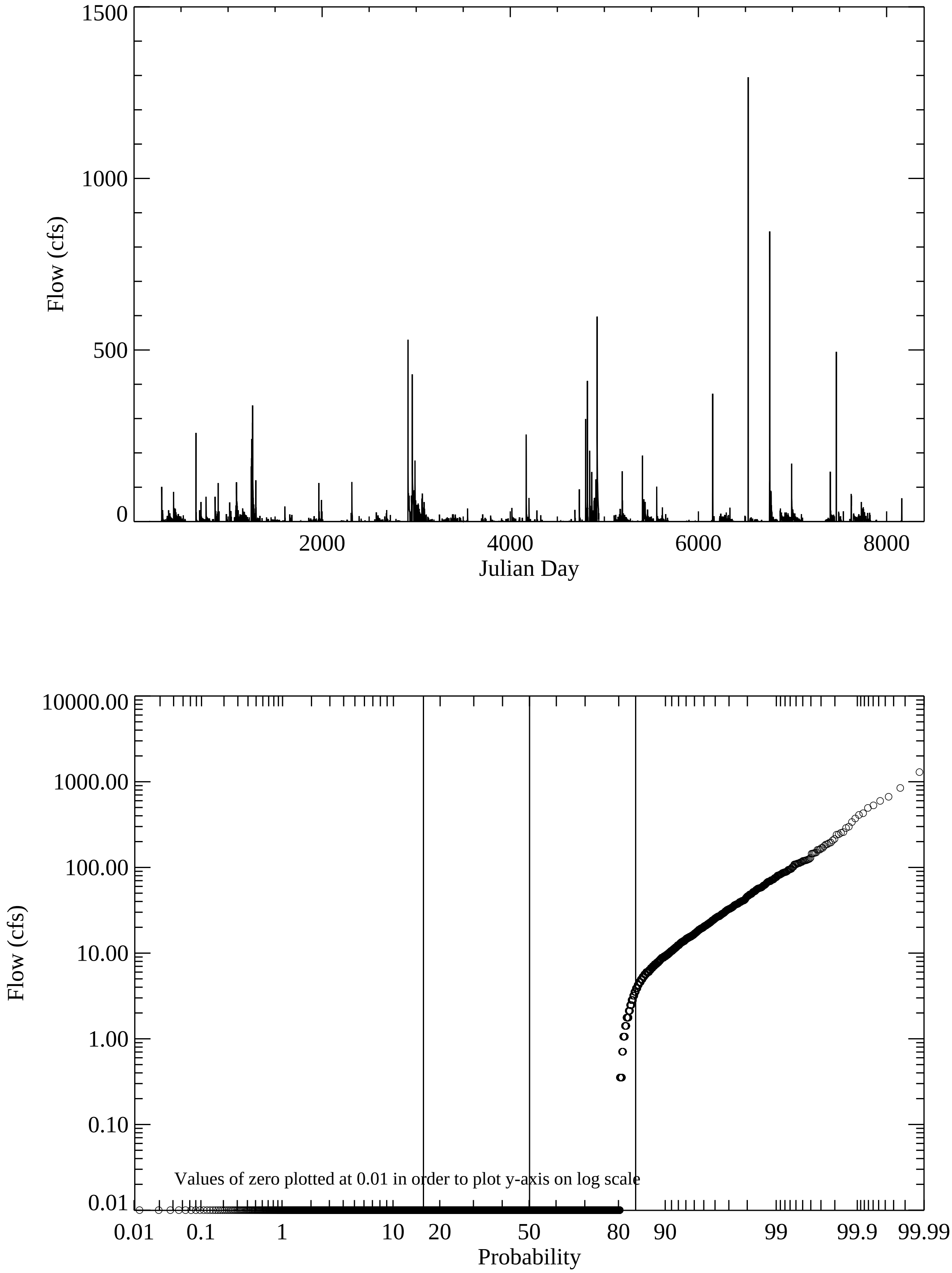

Figure 3. Temporal and probability plot of flow for Sandy Creek.

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Flows from model input file (flow balance)

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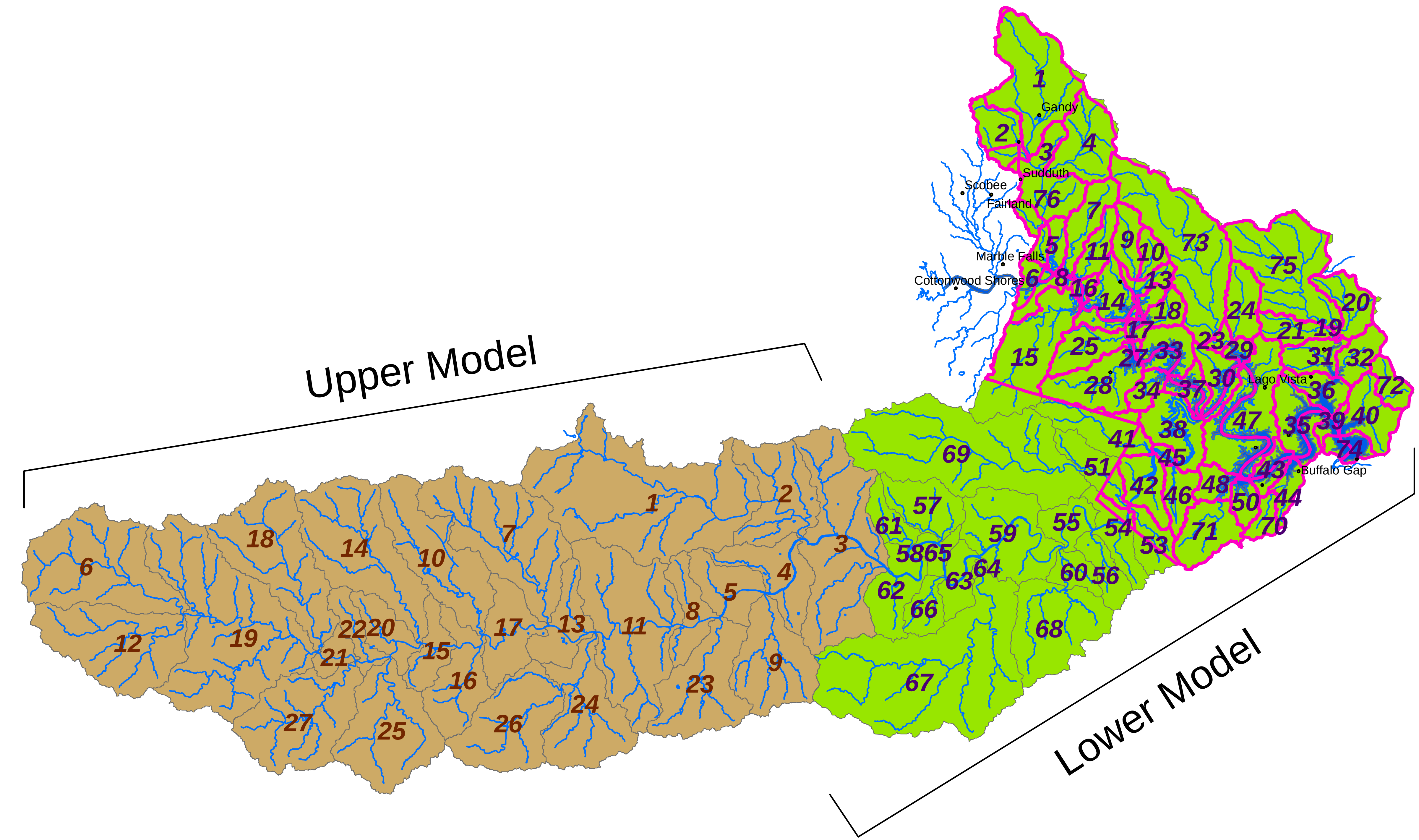

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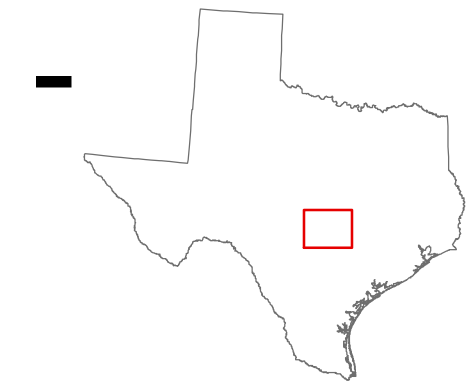

SCALE

LEGEND

Figure 4.
Phase 2 CREMs watershed model segmentation and watershed ordinance area.

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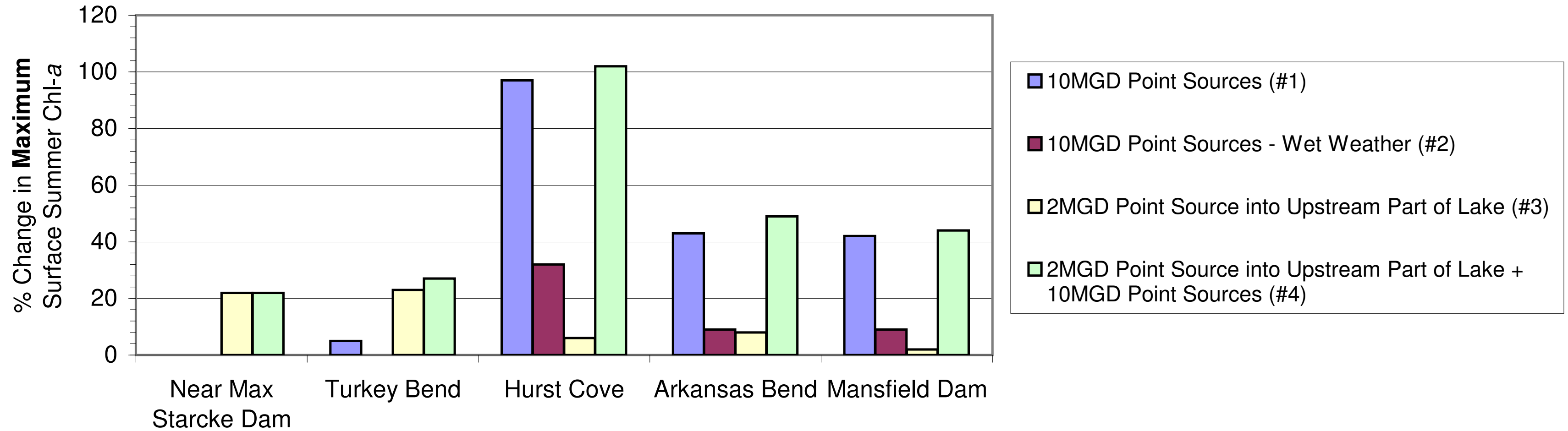
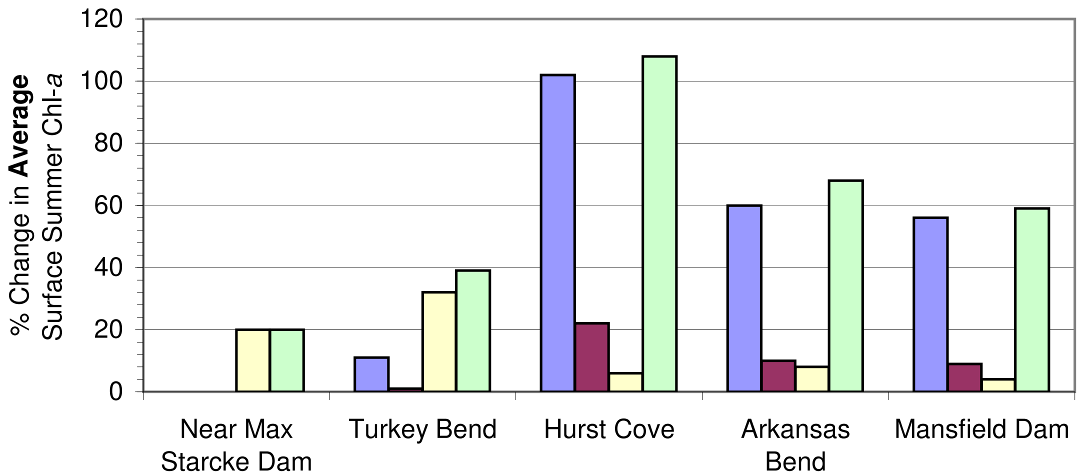




Base Case (µg/L)

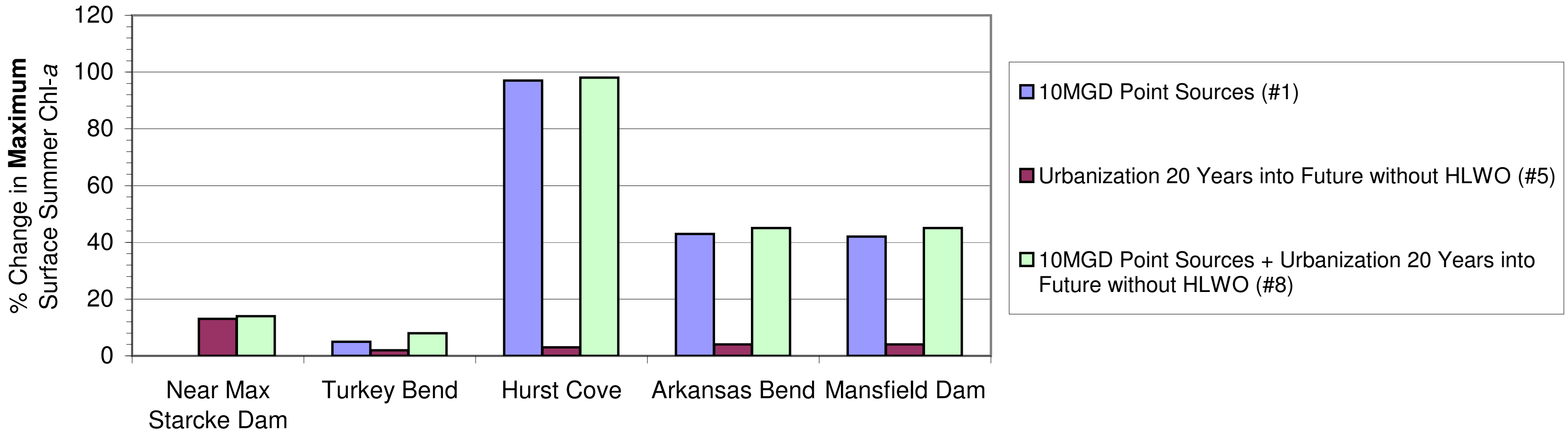
Location	Mean	Max
Near Max Starcke Dam	8.2	24.1
Turkey Bend	5.7	14.2
Hurst Cove	5.8	12.7
Arkansas Bend	6.6	14.2
Mansfield Dam	3.7	10.5

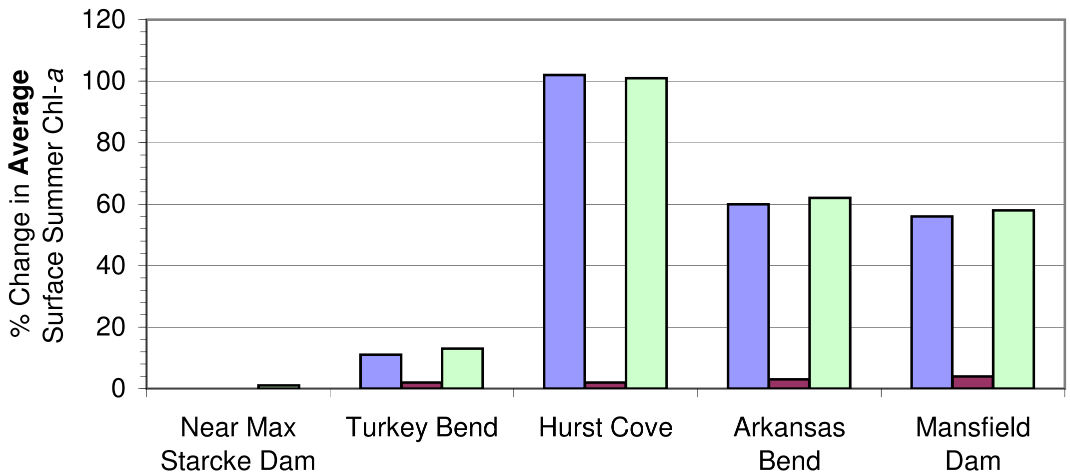
Figure 5. Impacts of point sources on summer surface chlorophyll-*a* concentrations.

Percent changes from base case values calculated by pairing yearly results and then computing averages and maximums of daily model predictions over the 23-year simulation.

Surface summertime chl-a concentrations for the base case (calibration) run are shown in the bottom right corner.

Surface was considered to be the top two meters of the water column. Summertime was assumed to be June through September.

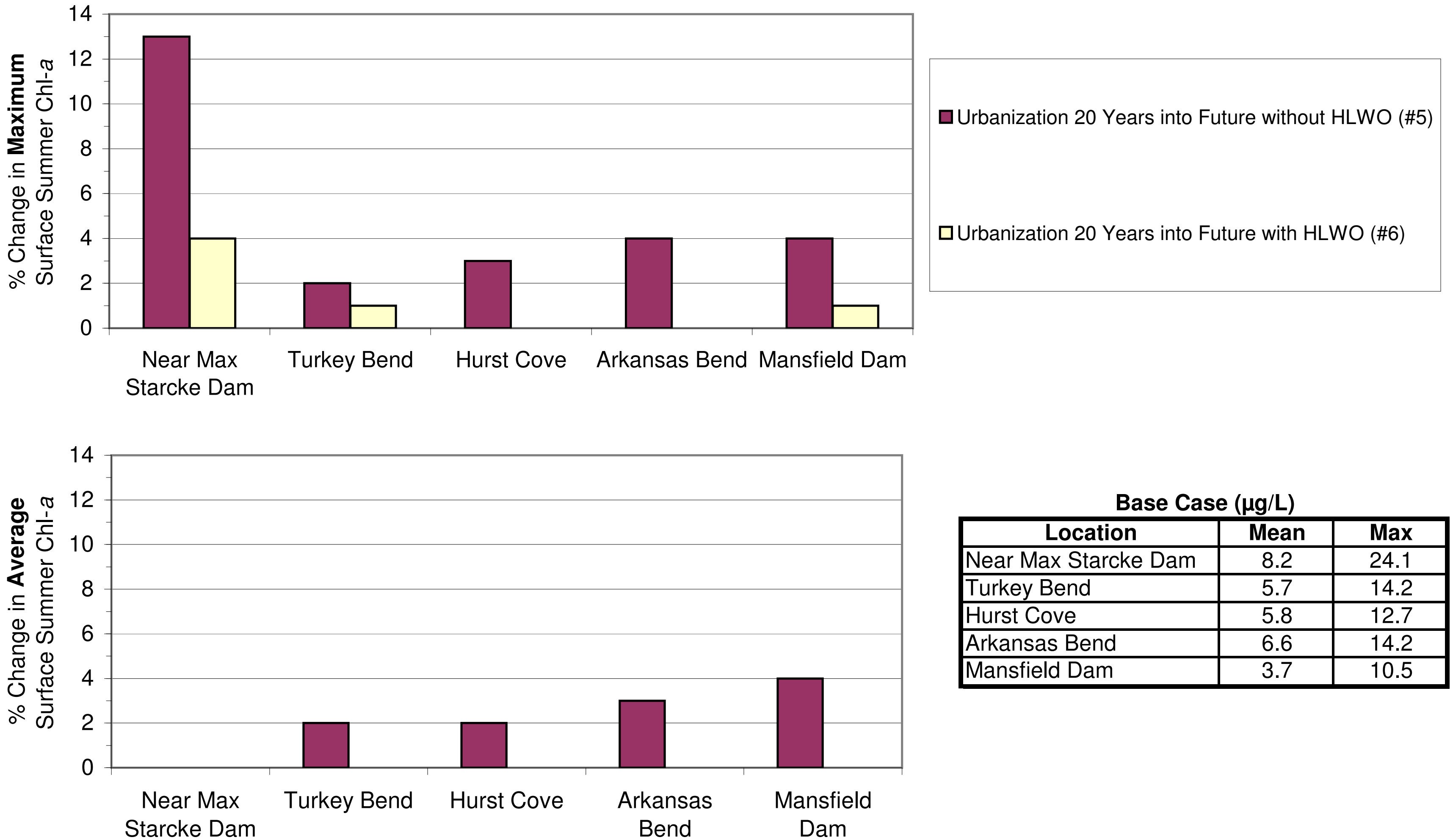




Base Case (µg/L)

Location	Mean	Max
Near Max Starcke Dam	8.2	24.1
Turkey Bend	5.7	14.2
Hurst Cove	5.8	12.7
Arkansas Bend	6.6	14.2
Mansfield Dam	3.7	10.5

Figure 6. Impacts of urbanization on summer surface chlorophyll-*a* concentrations.
Percent changes from base case values calculated by pairing yearly results and then computing averages and maximums of daily model predictions over the 23-year simulation.
Surface summertime chl-a concentrations for the base case (calibration) run are shown in the bottom right corner.
Surface was considered to be the top two meters of the water column. Summertime was assumed to be June through September.



Base Case (µg/L)

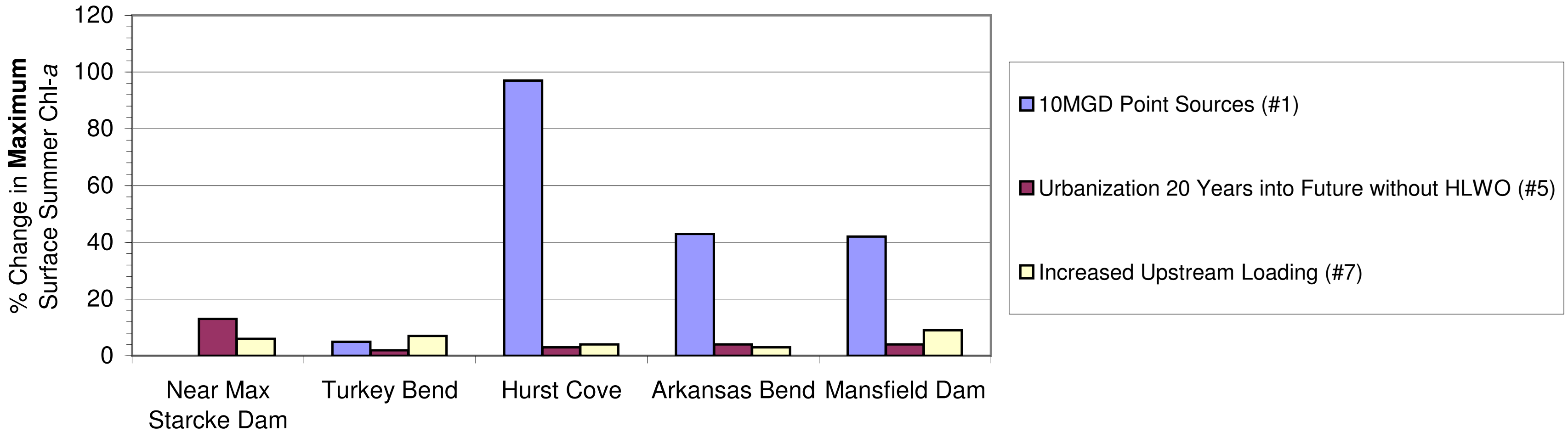
Location	Mean	Max
Near Max Starcke Dam	8.2	24.1
Turkey Bend	5.7	14.2
Hurst Cove	5.8	12.7
Arkansas Bend	6.6	14.2
Mansfield Dam	3.7	10.5

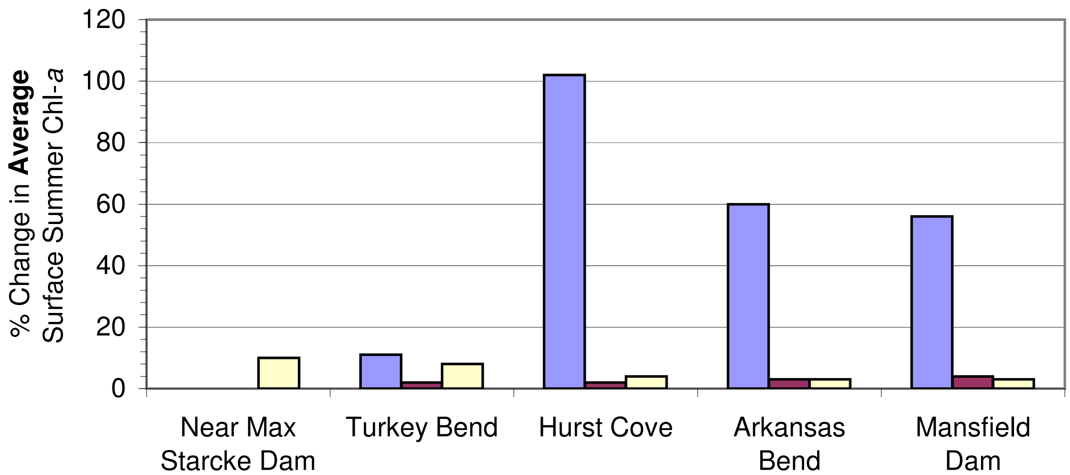
Figure 7. Impacts of future urbanization with HLWO on summer surface chlorophyll-*a* concentrations.

Percent changes from base case values calculated by pairing yearly results and then computing averages and maximums of daily model predictions over the 23-year simulation.

Surface summertime chl-a concentrations for the base case (calibration) run are shown in the bottom right corner.

Surface was considered to be the top two meters of the water column. Summertime was assumed to be June through September.

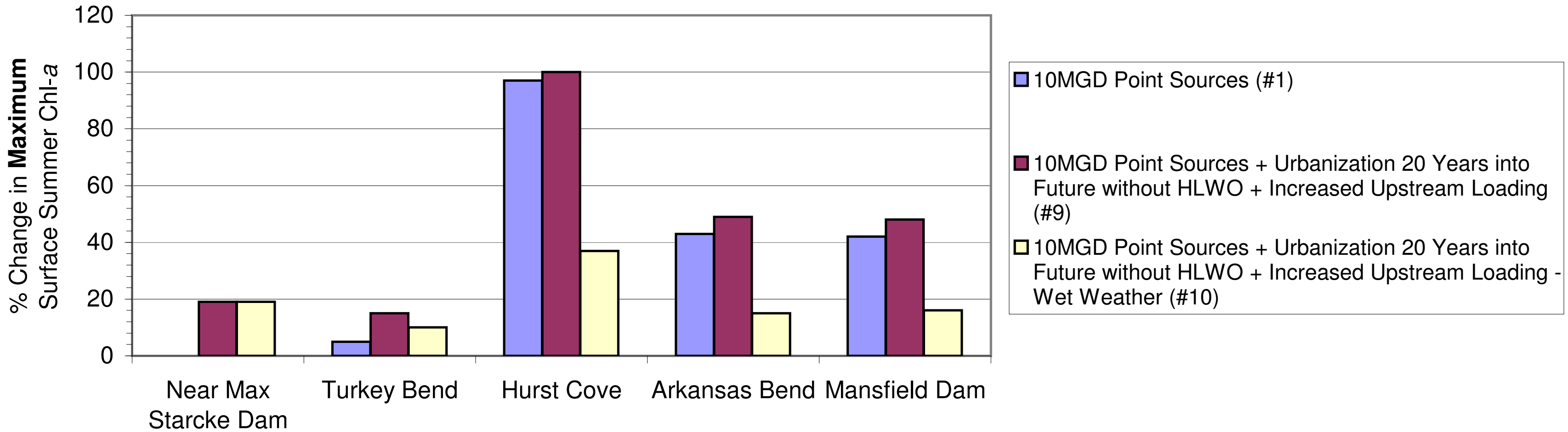


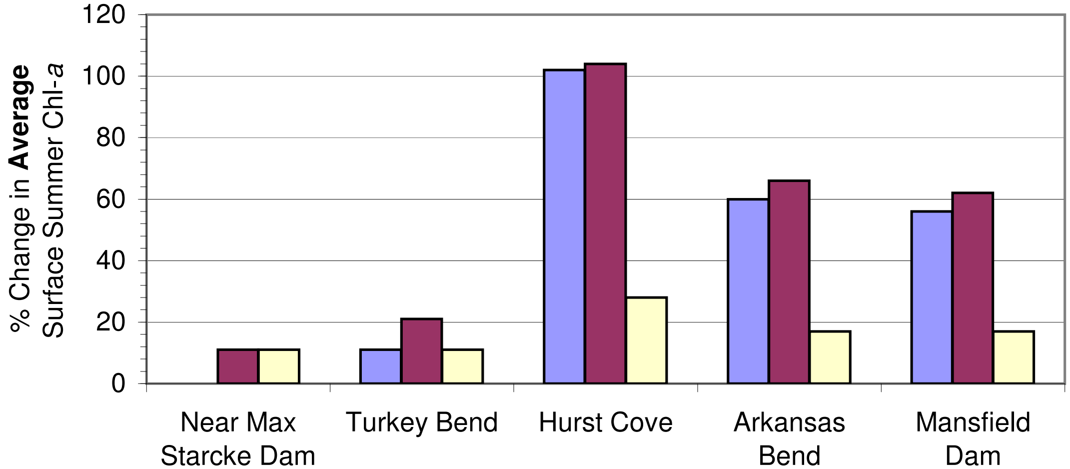


Base Case (µg/L)

Location	Mean	Max
Near Max Starcke Dam	8.2	24.1
Turkey Bend	5.7	14.2
Hurst Cove	5.8	12.7
Arkansas Bend	6.6	14.2
Mansfield Dam	3.7	10.5

Figure 8. Impacts of upstream loading on summer surface chlorophyll-*a* concentrations.
Percent changes from base case values calculated by pairing yearly results and then computing averages and maximums of daily model predictions over the 23-year simulation.
Surface summertime chl-a concentrations for the base case (calibration) run are shown in the bottom right corner.
Surface was considered to be the top two meters of the water column. Summertime was assumed to be June through September.

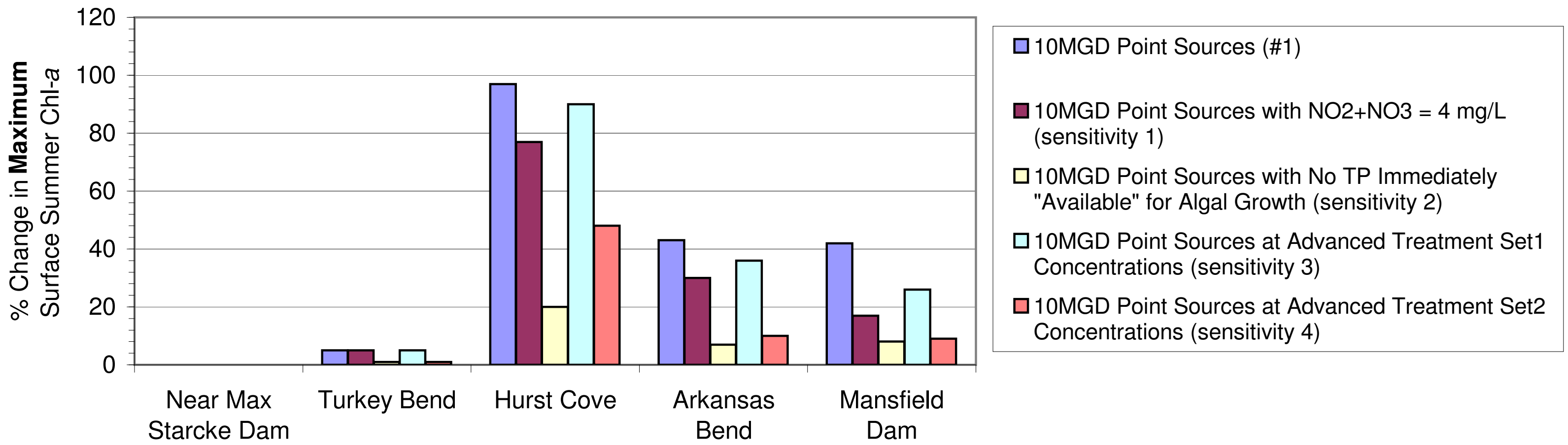


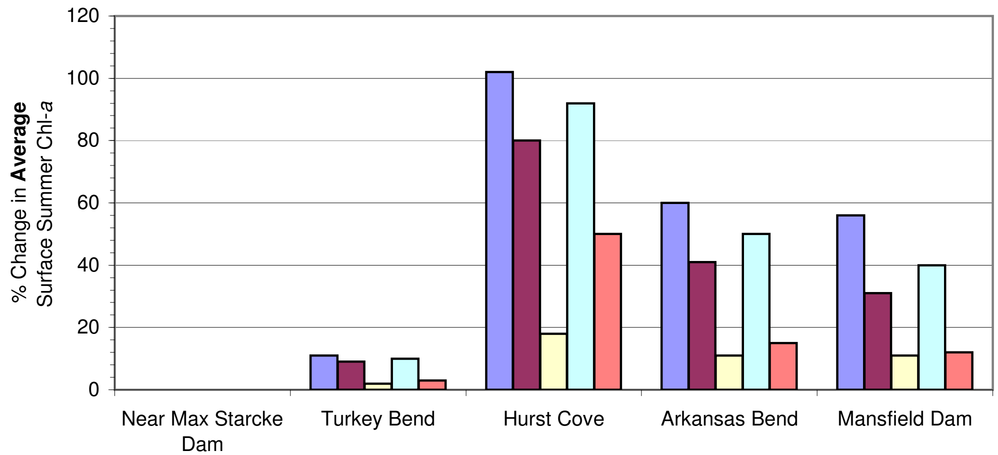


Base Case (µg/L)

Location	Mean	Max
Near Max Starcke Dam	8.2	24.1
Turkey Bend	5.7	14.2
Hurst Cove	5.8	12.7
Arkansas Bend	6.6	14.2
Mansfield Dam	3.7	10.5

Figure 9. Combined impacts on summer surface chlorophyll-*a* concentrations.
Percent changes from base case values calculated by pairing yearly results and then computing averages and maximums of daily model predictions over the 23-year simulation.
Surface summertime chl-a concentrations for the base case (calibration) run are shown in the bottom right corner.
Surface was considered to be the top two meters of the water column. Summertime was assumed to be June through September.





Base Case (µg/L)

Location	Mean	Max
Near Max Starcke Dam	8.2	24.1
Turkey Bend	5.7	14.2
Hurst Cove	5.8	12.7
Arkansas Bend	6.6	14.2
Mansfield Dam	3.7	10.5

Figure 10. Sensitivity of summer surface chl-*a* concentrations to assumed point source water quality concentrations.
Percent changes from base case values calculated by pairing yearly results and then computing averages and maximums of daily model predictions over the 23-year simulation.
Surface summertime chl-a concentrations for the base case (calibration) run are shown in the bottom right corner.
Surface was considered to be the top two meters of the water column. Summertime was assumed to be June through September.
Tertiary treatment assumptions: 5/5/1/1 (CBOD/TSS/NH3/TP) & 10 mg/L NOx
Advanced treatment assumptions: 5/5/2/0.15 (CBOD/TSS/NH3/TP) & 4 mg/L NOx

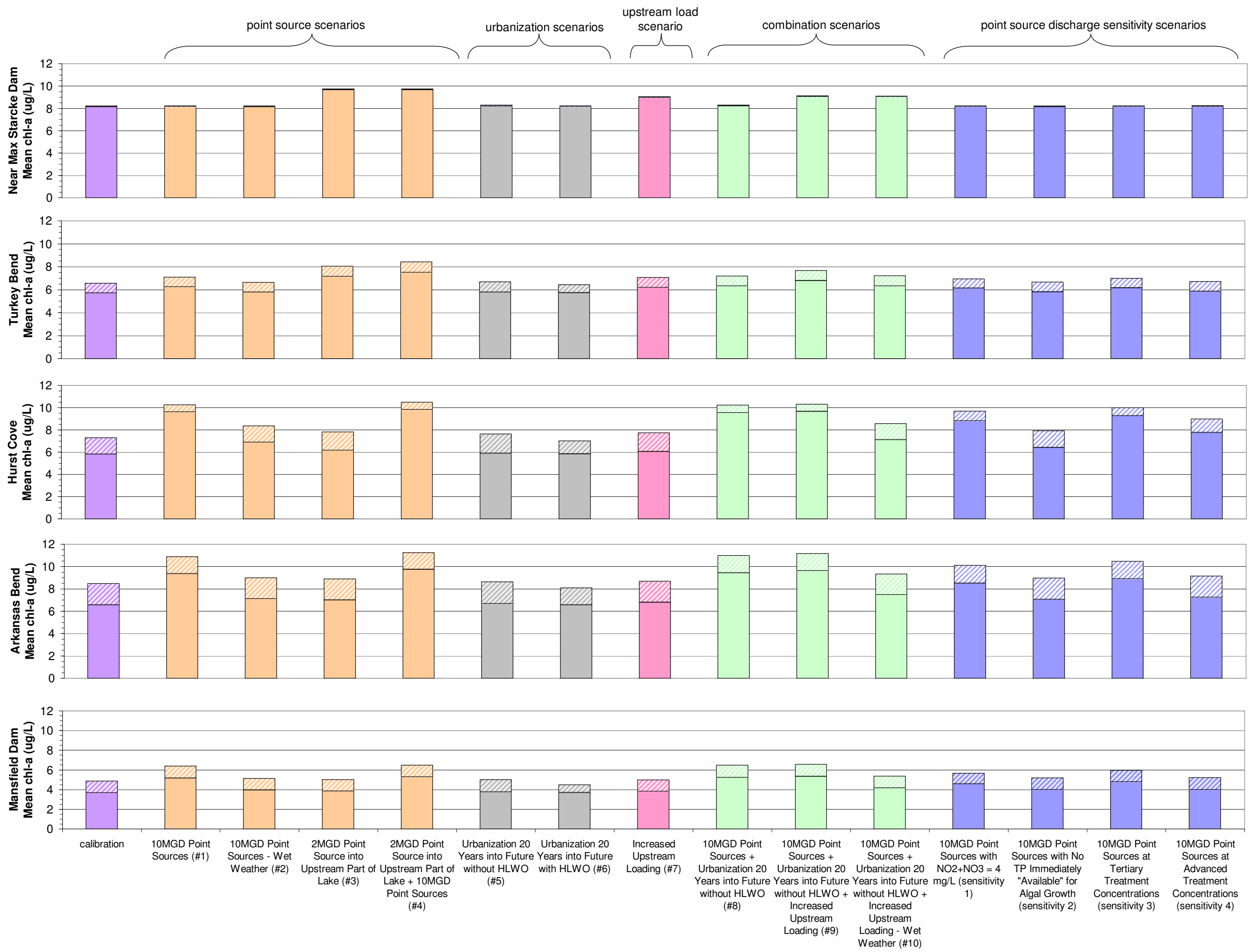


Figure 11. Average daily mean summertime chlorophyll-a concentrations predicted in surface waters under different future scenarios for Lake Travis.
Surface = top 2 meters of water column; summertime = June through September
The model predicts daily average values for the 23-year calibration period. The values shown are the means of the yearly average predictions.
The solid bars indicate the model prediction using the calibration run (best estimate) and the hatched bars show the bounding estimate that reflects the uncertainty of the most sensitive model parameters.
See the Phase 2: Lake Travis Final Report (Anchor QEA and Parsons 2009) for details on the bounding calibration.

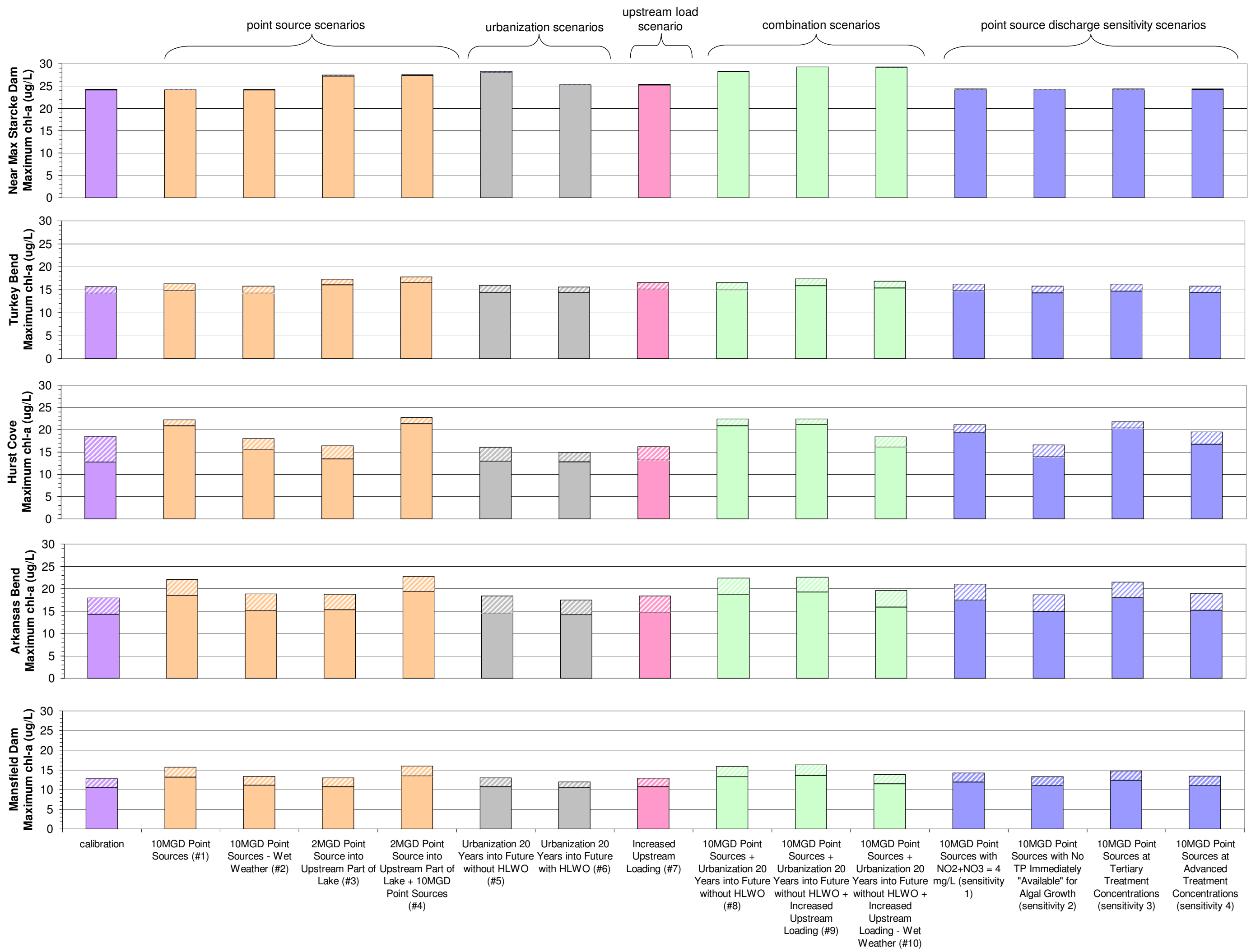


Figure 12. Average daily maximum summertime chlorophyll-a concentrations predicted in surface waters under different future scenarios for Lake Travis.
Surface = top 2 meters of water column; summertime = June through September
The model predicts daily average values for the 23-year calibration period. The values shown are the means of the maximum daily average predictions.
The solid bars indicate the model prediction using the calibration run (best estimate) and the hatched bars show the bounding estimate that reflects the uncertainty of the most sensitive model parameters.
See the Phase 2: Lake Travis Final Report (Anchor QEA and Parsons 2009) for details on the bounding calibration.

APPENDIX A
ASSUMPTIONS REGARDING URBANIZATION

ANCHOR QEA

PARSONS

CREMs Phase 2
Watershed Urbanization Assumptions
March 25, 2008
Prepared by LCRA

Guiding Principle – Future urbanization condition in approximately 20 years.

Upper Model

Hwy 290/Pedernales River
Subwatersheds that include U.S. Highway 290 and the Pedernales River can anticipate more rapid urbanization rates than subwatersheds without major highways and the Pedernales River.

- Assume 4% of subwatershed becomes urbanized.

Rural areas

- Assume 1% of subwatershed becomes urbanized.

Urbanizing/Fredericksburg
For subwatersheds shown as urbanizing under present conditions (near Fredericksburg), we will assume that 15% of the total watershed will become urbanized in approximately 20 years.

- Assume 15% of subwatershed becomes urbanized.

Lower Model

Rural areas

- Assume 1% of subwatershed becomes urbanized.

Pedernales River
Anticipate more urbanization along the river as it nears Austin.

- Assume 3% of subwatershed becomes urbanized.

Upper Lake Travis
As we see today, more concentrated urbanization along the lake. Even though this area is more distant from Austin, the Marble Falls area is growing rapidly and will influence development patterns along the upper lake.

- Assume 5% of subwatershed becomes urbanized.

Urbanized areas
Areas that are near the lake, but somewhat distant from Austin and the Bee Cave/Lakeway area are anticipated to have less urbanization than land closer to the cities.

- Assume 15% of subwatershed becomes urbanized.

Heavily urbanized areas
Areas closer to Austin and along the Highway 71 corridor and have access to treated surface water will experience urbanization similar to what is found in the Bee Cave/Lakeway area today.

- Assume 20% of subwatershed becomes urbanized.

Super urbanized areas
Areas that include Lakeway, Bee Cave, Jonestown, Cedar Park, Leander, and Lago Vista are experiencing rapid growth. With urbanization in several watersheds already exceeding 20%, this category is necessary to illustrate subwatersheds with very high levels of urbanization.

- Assume 30% of subwatershed becomes urbanized.

LCRA Highland Lakes Watershed Ordinance Permitting

To put some context on actual development levels in the Lake Travis watershed, a review of the ordinance data base was performed to determine area permitted and developed since the ordinance inception in 1990. Over a 17-year period, approximately 77 square miles of land was converted to some form of urbanization via the development process. This results in almost 2,900 acres of land per year changing from woodlands and meadows to subdivisions, commercial centers, and office space.

The watershed ordinance jurisdiction includes a portion of Burnet and Llano County, so some of the ordinance jurisdiction is outside the Phase 2 CREMs watershed models area, however, the LCRA permit data base does not include the rapidly growing communities of Lakeway, Cedar Park, and Lago Vista that administer their own ordinance. Thus, the observed growth in these three cities is most likely equal to or greater than the amount of development in Burnet and Llano Counties over this time period. Therefore, an urbanization rate of approximately 2,900 acres per year for the Lake Travis watershed in Travis County is anticipated to compare closely to the urbanization rate in the lower model. The lower model spreadsheet computed an average urbanization rate of 2,482 acres per year (Table A-1).

Considering this rate of urbanization in the upper model which can be expected to experience less rapid urbanization due to the distance from Austin, the upper model area is computed to urbanize at a rate of 738 acres per year (Table A-2).

Table A-1. Urbanization assumed for scenarios for lower model.

Subwatershed	Subwatershed Development Type	Total Area (acres)	Existing Urban Area (acres)	Existing % Urban/Sub	Future % Urban/Sub	Future Urban Area (acres)
1	Urbanized	20,269	1,202	5.9%	15.0%	3,040
2	Urbanized	6,551	33	0.5%	15.0%	983
3	Urbanized	3,319	14	0.4%	15.0%	498
4	Urbanized	11,321	-	0.0%	15.0%	1,698
5	Urbanized	3,873	-	0.0%	15.0%	581
6	Urbanized	4,395	2	0.0%	15.0%	659
7	Rural	6,460	-	0.0%	1.0%	65
8	Urbanized	310	-	0.0%	15.0%	47
9	Rural	4,460	-	0.0%	1.0%	45
10	Rural	2,703	-	0.0%	1.0%	27
11	Urbanized	4,301	-	0.0%	15.0%	645
12	Rural	291	-	0.0%	1.0%	3
13	Upper Lake Travis	2,505	-	0.0%	5.0%	125
14	Upper Lake Travis	7,415	50	0.7%	5.0%	371
15	Urbanized	19,061	66	0.3%	15.0%	2,859
16	Upper Lake Travis	1,303	-	0.0%	5.0%	65
17	Upper Lake Travis	1,471	-	0.0%	5.0%	74
18	Upper Lake Travis	2,950	-	0.0%	5.0%	148
19	Heavily Urbanized	129	-	0.0%	20.0%	26
20	Super Urbanized	6,314	67	1.1%	30.0%	1,894
21	Super Urbanized	4,541	9	0.2%	30.0%	1,362
22	Urbanized	93	-	0.0%	15.0%	14
23	Urbanized	1,143	-	0.0%	15.0%	171
24	Rural	6,087	-	0.0%	1.0%	61
25	Urbanized	6,391	54	0.8%	15.0%	959
26	Upper Lake Travis	1,140	17	1.5%	5.0%	57
27	Upper Lake Travis	496	-	0.0%	5.0%	25
28	Urbanized	11,044	71	0.6%	15.0%	1,657
29	Urbanized	1,520	-	0.0%	15.0%	228
30	Urbanized	5,385	26	0.5%	15.0%	808
31	Super Urbanized	4,950	827	16.7%	30.0%	1,485
32	Super Urbanized	4,749	21	0.4%	30.0%	1,425
33	Upper Lake Travis	6,291	-	0.0%	5.0%	315
34	Heavily Urbanized	2,883	40	1.4%	20.0%	577
35	Super Urbanized	8,045	418	5.2%	30.0%	2,413
36	Super Urbanized	4,434	45	1.0%	30.0%	1,330
37	Upper Lake Travis	3,540	84	2.4%	5.0%	177
38	Super Urbanized	8,962	131	1.5%	30.0%	2,689
39	Super Urbanized	1,654	267	16.1%	30.0%	496
40	Super Urbanized	7,523	245	3.3%	30.0%	2,257
41	Urbanized	10,067	50	0.5%	15.0%	1,510
42	Pedernales River	6,579	2	0.0%	3.0%	197
43	Super Urbanized	3,238	662	20.4%	30.0%	972
44	Super Urbanized	3,228	803	24.9%	30.0%	969
45	Heavily Urbanized	976	25	2.6%	20.0%	195
46	Super Urbanized	4,598	62	1.4%	30.0%	1,379

Subwatershed	Subwatershed Development Type	Total Area (acres)	Existing Urban Area (acres)	Existing % Urban/Sub	Future % Urban/Sub	Future Urban Area (acres)
47	Heavily Urbanized	18,263	3,014	16.5%	20.0%	3,653
48	Heavily Urbanized	3,182	24	0.8%	20.0%	636
49	Heavily Urbanized	33	-	0.0%	20.0%	7
50	Super Urbanized	2,961	187	6.3%	30.0%	888
51	Pedernales River	6,740	-	0.0%	3.0%	202
52	Pedernales River	7	-	0.0%	3.0%	0
53	Pedernales River	5,643	-	0.0%	3.0%	169
54	Pedernales River	7,388	-	0.0%	3.0%	222
55	Pedernales River	5,526	-	0.0%	3.0%	166
56	Rural	5,312	-	0.0%	1.0%	53
57	Urbanized	9,319	44	0.5%	15.0%	1,398
58	Pedernales River	1,078	-	0.0%	3.0%	32
59	Pedernales River	18,126	-	0.0%	3.0%	544
60	Rural	4,199	-	0.0%	1.0%	42
61	Pedernales River	4,631	29	0.6%	3.0%	139
62	Urbanized	9,829	623	6.3%	15.0%	1,474
63	Pedernales River	5,464	-	0.0%	3.0%	164
64	Pedernales River	651	-	0.0%	3.0%	20
65	Pedernales River	2,286	-	0.0%	3.0%	69
66	Pedernales River	4,908	-	0.0%	3.0%	147
67	Rural	55,940	234	0.4%	1.0%	559
68	Rural	19,513	68	0.3%	1.0%	195
69	Rural	45,543	99	0.2%	1.0%	455
70	Super Urbanized	2,675	486	18.2%	30.0%	802
71	Super Urbanized	8,486	71	0.8%	30.0%	2,546
72	Super Urbanized	3,627	117	3.2%	30.0%	1,088
73	Rural	27,325	-	0.0%	1.0%	273
74	Super Urbanized	3,090	181	5.9%	30.0%	927
75	Urbanized	21,770	60	0.3%	15.0%	3,266
76	Urbanized	8,113	2	0.0%	15.0%	1,217
Total		520,319	9,331	1.8%	11.3%	58,932

Notes:

Assuming 20-year period for urbanization *2480 acres urbanized per year*

Table A-2. Urbanization assumed for scenarios for upper model.

Subwatershed	Subwatershed Development Type	Total Area (acres)	Existing Urban Area (acres)	Existing % Urban/Sub	Future % Urban/Sub	Future Urban Area (acres)
1	Rural	57,177	82	0.1%	1.0%	572
2	Rural	16,868	-	0.0%	1.0%	169
3	290/Pedernales	35,602	123	0.3%	4.0%	1,424
4	290/Pedernales	12,074	27	0.2%	4.0%	483
5	290/Pedernales	9,286	15	0.2%	4.0%	371
6	Rural	31,232	146	0.5%	1.0%	312
7	Rural	32,111	96	0.3%	1.0%	321
8	290/Pedernales	7,821	32	0.4%	4.0%	313
9	Rural	18,111	42	0.2%	1.0%	181
10	Urbanized	22,185	2,526	11.4%	15.0%	3,328
11	290/Pedernales	35,056	219	0.6%	4.0%	1,402
12	Rural	26,527	3	0.0%	1.0%	265
13	290/Pedernales	9,323	51	0.6%	4.0%	373
14	Urbanized	29,608	517	1.7%	15.0%	4,441
15	290/Pedernales	6,524	48	0.7%	4.0%	261
16	Urbanized	13,354	180	1.3%	15.0%	2,003
17	290/Pedernales	11,472	44	0.4%	4.0%	459
18	290/Pedernales	27,198	99	0.4%	4.0%	1,088
19	Rural	50,834	132	0.3%	1.0%	508
20	Rural	7,261	46	0.6%	1.0%	73
21	Rural	3,505	13	0.4%	1.0%	35
22	Rural	5,147	27	0.5%	1.0%	51
23	Rural	19,457	26	0.1%	1.0%	195
24	Rural	19,486	11	0.1%	1.0%	195
25	Rural	23,546	71	0.3%	1.0%	235
26	Rural	20,860	-	0.0%	1.0%	209
27	Rural	24,872	177	0.7%	1.0%	249
Total		576,497	4,753	0.8%	3.4%	19,516

Notes:

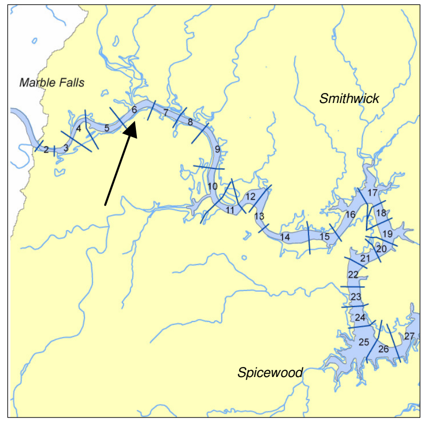
Assuming 20-year period for urbanization 738 *acres urbanized per year*

APPENDIX B
SCENARIO RESULTS BY YEAR

CREMs Phase 2 - Lake Travis

Average of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Near Max Starcke Dam (segment 6)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case

- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Average Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	not enough information										
1985	31.6	6.2	6.2	8.2	8.2	6.2	6.2	6.8	6.2	6.9	6.9	6.2
1986	39.1	6.2	6.2	8.2	8.2	6.2	6.2	6.9	6.2	6.9	6.9	6.2
1987	36.7	4.6	4.6	4.9	4.9	4.6	4.6	5.1	4.6	5.1	5.1	4.6
1988	22.3	5.6	5.6	5.6	5.6	5.6	5.6	6.2	5.6	6.2	6.2	5.6
1989	26.0	4.4	4.4	4.5	4.5	4.4	4.4	4.9	4.4	4.9	4.9	4.4
1990	31.6	11.0	11.0	12.7	12.7	10.9	11.0	12.1	11.0	12.1	12.1	11.0
1991	42.4	8.7	8.7	10.8	10.8	8.8	8.8	9.6	8.8	9.6	9.7	8.7
1992	40.9	6.3	6.3	6.3	6.3	6.3	6.3	6.9	6.3	6.9	6.9	6.3
1993	27.5	9.3	9.2	11.9	12.0	9.3	9.2	10.2	9.3	10.2	10.2	9.2
1994	34.7	8.7	8.7	8.7	8.7	8.7	8.6	9.6	8.6	9.5	9.5	8.7
1995	30.3	5.3	5.2	10.9	10.8	5.2	5.3	5.8	5.3	5.9	5.9	5.2
1996	27.4	not enough information										
1997	44.3	7.5	7.4	9.6	9.5	7.4	7.4	8.1	7.5	8.2	8.1	7.4
1998	37.6	11.4	11.4	11.8	11.8	11.7	11.5	12.6	11.7	12.8	12.8	11.4
1999	20.0	14.4	14.4	16.3	16.2	14.6	14.5	15.9	14.7	16.1	16.1	14.4
2000	33.9	not enough information										
2001	38.0	6.0	6.1	6.9	6.9	6.2	6.1	6.6	6.2	6.8	6.8	6.1
2002	38.2	11.5	11.5	13.3	13.3	11.5	11.5	12.6	11.6	12.7	12.7	11.5
2003	25.6	11.3	11.3	12.2	12.2	11.4	11.3	12.5	11.4	12.6	12.6	11.3
2004	45.8	11.1	11.1	13.9	13.9	11.0	11.0	12.2	11.0	12.2	12.2	11.1
2005	23.2	5.6	5.6	7.1	7.1	5.6	5.6	6.2	5.6	6.2	6.2	5.6
2006	25.0	not enough information										
	Average	8.2	8.2	9.7	9.7	8.2	8.2	9.0	8.2	9.0	9.0	8.2

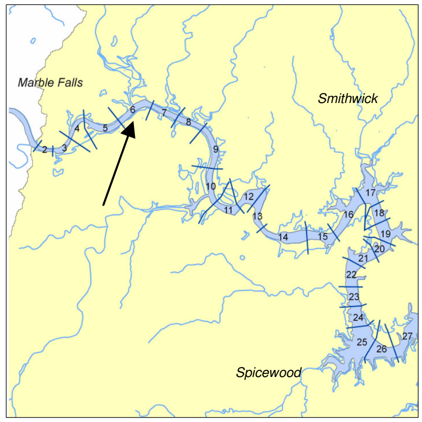
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	not enough information									
1985	31.6	0	0	33	33	1	0	11	1	11	11
1986	39.1	0	0	32	32	0	-1	11	0	11	11
1987	36.7	0	0	6	6	1	0	11	1	12	12
1988	22.3	0	0	0	0	1	0	10	1	11	11
1989	26.0	-1	-1	2	3	0	0	10	0	11	10
1990	31.6	0	0	15	16	-1	0	10	0	10	10
1991	42.4	0	0	24	24	1	0	10	1	10	11
1992	40.9	0	0	1	0	1	0	10	0	10	10
1993	27.5	0	0	29	30	0	0	10	0	11	10
1994	34.7	0	0	0	0	0	-1	10	-1	10	10
1995	30.3	1	0	108	107	-1	0	10	2	13	12
1996	27.4	not enough information									
1997	44.3	1	0	29	29	0	0	9	1	10	10
1998	37.6	0	0	3	3	2	1	10	2	12	12
1999	20.0	0	0	13	13	2	0	10	2	12	12
2000	33.9	not enough information									
2001	38.0	-1	0	14	14	2	0	9	2	12	12
2002	38.2	0	0	16	16	0	0	10	1	10	10
2003	25.6	0	0	8	8	1	0	10	1	12	11
2004	45.8	0	0	26	26	0	0	10	0	10	10
2005	23.2	0	0	27	27	0	0	11	0	11	11
2006	25.0	not enough information									
	Average	0	0	20	20	0	0	10	1	11	11

CREMs Phase 2 - Lake Travis

Maximum of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Near Max Starcke Dam (segment 6)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case

- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Maximum Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	not enough information										
1985	31.6	17.5	17.5	24.5	24.3	21.0	18.4	18.5	21.0	21.9	21.9	17.5
1986	39.1	16.1	16.1	24.5	24.6	16.8	16.4	16.4	16.9	17.2	17.2	16.1
1987	36.7	8.7	8.7	8.9	9.0	10.5	9.3	9.3	10.5	10.6	10.9	8.7
1988	22.3	19.9	19.8	19.8	19.8	24.8	21.4	20.4	24.9	25.6	25.5	19.8
1989	26.0	9.8	9.8	10.5	10.4	10.2	9.9	10.1	10.2	10.6	10.6	9.8
1990	31.6	17.7	17.7	26.8	26.8	17.7	17.7	19.4	17.7	19.4	19.4	17.7
1991	42.4	36.3	36.2	36.2	36.3	37.1	36.5	37.0	37.2	38.1	38.0	36.2
1992	40.9	10.1	10.2	10.6	10.5	10.9	10.3	11.8	10.8	11.9	11.9	10.2
1993	27.5	54.2	54.1	54.1	54.2	55.7	54.6	55.4	55.9	57.3	57.2	54.1
1994	34.7	19.4	19.4	20.5	20.5	19.4	19.3	21.4	19.5	21.5	21.5	19.3
1995	30.3	12.2	12.2	29.5	29.5	12.2	12.1	13.6	12.2	13.6	13.6	12.1
1996	27.4	not enough information										
1997	44.3	26.8	26.4	26.5	27.1	29.8	27.4	27.1	29.9	30.2	30.3	26.3
1998	37.6	35.6	35.1	35.2	35.6	55.4	41.4	36.5	56.5	58.1	57.3	35.2
1999	20.0	25.9	25.7	25.8	25.3	37.8	30.0	27.0	38.2	39.5	39.2	25.7
2000	33.9	not enough information										
2001	38.0	63.7	62.9	63.1	64.1	78.8	67.8	63.7	80.0	81.3	80.4	62.9
2002	38.2	22.9	22.7	22.7	22.9	23.7	22.8	23.7	23.7	24.8	24.7	22.7
2003	25.6	38.7	38.6	38.7	38.8	45.3	40.7	40.0	45.6	47.0	46.9	38.6
2004	45.8	15.2	15.2	20.9	21.0	15.2	15.2	16.8	15.2	16.8	16.8	15.2
2005	23.2	10.2	10.2	18.1	18.1	10.3	10.2	11.5	10.1	11.4	11.4	10.3
2006	25.0	not enough information										
	Average	24.3	24.1	27.2	27.3	28.0	25.3	25.2	28.2	29.3	29.2	24.1

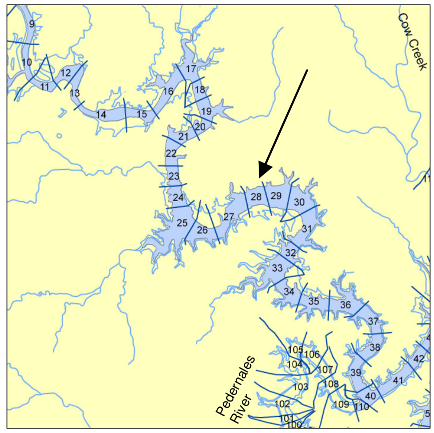
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	not enough information									
1985	31.6	0	0	40	39	20	5	6	20	25	25
1986	39.1	0	0	52	53	5	2	2	5	7	6
1987	36.7	0	0	2	3	20	6	6	20	21	25
1988	22.3	0	0	0	0	25	8	3	26	29	29
1989	26.0	0	0	7	6	5	1	3	5	8	8
1990	31.6	0	0	51	51	0	0	10	0	10	10
1991	42.4	0	0	0	0	2	1	2	3	5	5
1992	40.9	-1	0	4	3	7	1	15	6	17	17
1993	27.5	0	0	0	0	3	1	2	3	6	6
1994	34.7	0	0	6	6	1	0	11	1	11	11
1995	30.3	0	0	143	143	0	0	12	0	12	12
1996	27.4	not enough information									
1997	44.3	2	1	1	3	13	4	3	14	15	15
1998	37.6	1	0	0	1	57	18	4	61	65	63
1999	20.0	1	0	0	-2	47	17	5	48	54	52
2000	33.9	not enough information									
2001	38.0	1	0	0	2	25	8	1	27	29	28
2002	38.2	1	0	0	1	5	1	4	5	9	9
2003	25.6	0	0	0	0	17	5	4	18	22	22
2004	45.8	0	0	37	38	0	0	10	0	10	10
2005	23.2	-1	0	77	76	1	0	12	-1	11	11
2006	25.0	not enough information									
	Average	0	0	22	22	13	4	6	14	19	19

CREMs Phase 2 - Lake Travis

Average of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Turkey Bend (segment 28)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case
- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Average Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	8.4	7.7	9.1	9.4	7.7	7.7	8.5	8.4	9.2	8.5	7.7
1985	31.6	9.0	8.2	10.3	11.0	8.1	7.9	8.4	9.0	9.3	8.5	8.0
1986	39.1	5.0	4.4	5.6	6.1	4.4	4.3	4.6	5.1	5.4	4.8	4.3
1987	36.7	7.0	6.8	7.5	7.6	6.9	6.9	7.3	7.1	7.6	7.5	6.7
1988	22.3	8.7	8.6	10.0	10.0	8.7	8.6	9.4	8.7	9.5	9.4	8.7
1989	26.0	8.8	7.9	9.6	10.6	7.9	7.9	8.0	9.1	9.5	8.4	7.8
1990	31.6	6.0	5.7	7.0	7.2	5.7	5.7	6.3	6.0	6.6	6.4	5.7
1991	42.4	4.7	4.0	5.4	5.9	4.2	4.0	4.3	4.9	5.1	4.5	4.0
1992	40.9	11.2	11.2	11.8	11.8	11.2	11.2	12.2	11.3	12.3	12.3	11.2
1993	27.5	3.7	3.4	4.0	4.4	3.5	3.4	3.4	3.9	4.0	3.7	3.3
1994	34.7	13.2	13.1	14.2	14.2	13.1	13.1	14.2	13.3	14.3	14.2	13.1
1995	30.3	4.7	4.2	5.0	5.5	4.1	4.2	4.5	4.8	5.1	4.7	4.2
1996	27.4	2.9	2.6	3.4	3.6	2.7	2.6	2.8	3.0	3.2	3.0	2.6
1997	44.3	6.5	6.5	7.0	7.2	6.4	6.3	6.8	6.5	6.9	6.9	6.4
1998	37.6	4.8	4.4	5.6	6.1	4.2	4.2	4.6	4.7	5.0	4.7	4.3
1999	20.0	5.5	5.4	7.1	7.0	5.5	5.4	5.9	5.6	6.1	6.0	5.4
2000	33.9	7.6	6.0	8.9	9.7	6.0	6.0	6.5	7.7	8.3	6.7	5.8
2001	38.0	3.4	3.0	4.5	4.8	3.0	2.9	3.2	3.4	3.6	3.3	2.9
2002	38.2	5.8	5.6	6.5	6.6	5.6	5.5	6.0	5.8	6.4	6.1	5.5
2003	25.6	3.6	3.4	4.7	4.8	3.6	3.5	3.7	3.7	4.0	3.9	3.4
2004	45.8	5.0	4.9	5.8	6.0	4.9	4.8	5.3	5.1	5.5	5.4	4.8
2005	23.2	2.1	2.0	3.9	4.0	2.1	1.9	2.1	2.3	2.5	2.3	1.9
2006	25.0	6.0	3.9	7.8	8.9	3.8	3.9	4.2	6.1	6.4	4.4	3.9
	Average	6.2	5.8	7.2	7.5	5.8	5.7	6.2	6.3	6.8	6.3	5.7

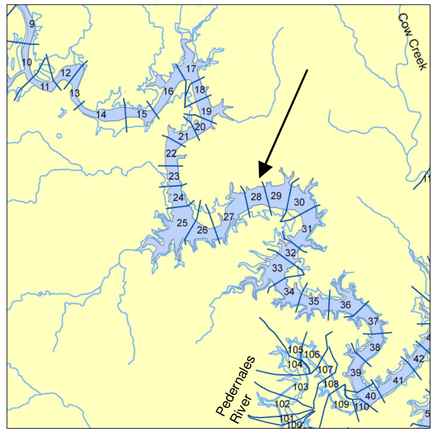
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	9	0	18	21	0	0	10	9	20	10
1985	31.6	12	2	28	37	0	-1	5	12	16	6
1986	39.1	16	3	30	42	2	0	8	18	26	12
1987	36.7	4	1	11	14	3	3	8	6	14	11
1988	22.3	0	0	16	15	0	0	9	1	10	9
1989	26.0	13	1	23	36	2	1	3	17	22	8
1990	31.6	5	1	22	26	1	0	11	6	16	12
1991	42.4	17	1	36	48	4	1	7	21	29	13
1992	40.9	1	0	5	6	0	0	9	1	10	10
1993	27.5	14	3	23	35	6	3	4	19	23	12
1994	34.7	1	0	8	8	0	0	8	1	9	8
1995	30.3	12	1	20	31	-2	1	8	14	23	12
1996	27.4	12	0	30	39	4	1	9	14	25	15
1997	44.3	3	2	10	13	0	-1	7	2	9	8
1998	37.6	12	4	31	42	-2	-2	8	10	18	9
1999	20.0	2	0	31	29	3	0	9	5	12	11
2000	33.9	29	2	53	67	2	3	12	32	42	14
2001	38.0	17	3	52	63	2	0	8	17	23	12
2002	38.2	5	2	19	20	2	1	9	6	16	12
2003	25.6	3	0	37	39	4	1	8	7	15	13
2004	45.8	3	1	20	24	2	0	10	5	14	12
2005	23.2	14	4	106	111	10	3	10	24	34	23
2006	25.0	54	-2	98	128	-3	-1	8	55	63	11
	Average	11	1	32	39	2	0	8	13	21	11

CREMs Phase 2 - Lake Travis

Maximum of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Turkey Bend (segment 28)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case
- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Maximum Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	12.2	12.0	12.9	13.4	11.9	12.0	13.1	12.2	13.6	13.1	12.0
1985	31.6	27.0	26.2	28.5	28.6	26.1	25.9	26.8	26.5	27.1	26.8	26.2
1986	39.1	11.6	10.9	13.0	13.2	10.9	10.8	11.3	11.6	12.3	11.7	10.8
1987	36.7	20.1	20.0	20.0	20.2	21.4	21.4	20.5	21.4	21.9	21.8	20.0
1988	22.3	20.2	20.3	21.1	21.0	20.2	20.2	21.5	20.1	21.3	21.3	20.3
1989	26.0	19.7	18.4	20.0	21.6	18.0	19.3	18.4	20.5	20.6	18.0	19.5
1990	31.6	13.9	13.7	14.1	14.4	13.8	13.6	14.7	14.0	15.0	14.9	13.6
1991	42.4	8.9	8.8	11.1	11.9	8.9	8.9	9.6	9.3	9.7	9.7	8.8
1992	40.9	28.2	28.2	28.4	28.5	28.1	28.1	30.5	28.2	30.4	30.7	28.1
1993	27.5	8.8	8.3	8.8	9.4	8.9	8.8	8.3	9.3	9.5	9.1	8.1
1994	34.7	35.6	35.2	36.0	36.4	34.6	34.9	37.7	35.2	37.8	37.3	35.1
1995	30.3	7.9	7.8	8.2	8.3	8.0	7.8	8.6	8.1	8.9	8.8	7.8
1996	27.4	7.6	7.2	8.0	8.2	7.4	7.2	8.0	7.8	8.6	8.2	7.3
1997	44.3	14.8	14.8	16.6	16.6	15.0	14.8	16.4	15.1	16.7	16.7	14.7
1998	37.6	8.4	7.4	10.5	12.2	7.3	7.1	7.6	9.1	9.8	8.2	6.9
1999	20.0	8.3	7.7	11.2	11.0	8.6	7.9	8.3	8.7	8.9	8.8	7.7
2000	33.9	14.4	12.4	15.3	15.7	12.4	12.9	13.8	14.2	15.8	13.7	12.5
2001	38.0	9.0	8.7	11.2	11.6	8.3	8.4	9.1	8.7	9.1	9.0	8.6
2002	38.2	20.6	20.2	20.2	20.6	20.5	20.7	20.6	21.0	21.5	21.2	20.1
2003	25.6	12.9	13.0	15.1	15.0	13.2	13.1	14.5	13.0	14.2	14.3	13.1
2004	45.8	10.1	10.0	11.8	11.7	10.3	10.1	11.0	10.6	11.5	11.3	10.0
2005	23.2	3.8	3.4	9.2	9.3	4.0	3.4	3.7	4.0	4.4	4.6	3.4
2006	25.0	14.7	12.1	17.3	19.5	12.0	12.5	13.3	14.7	16.5	13.7	11.7
	Average	14.7	14.2	16.0	16.4	14.3	14.3	15.1	14.9	15.9	15.3	14.2

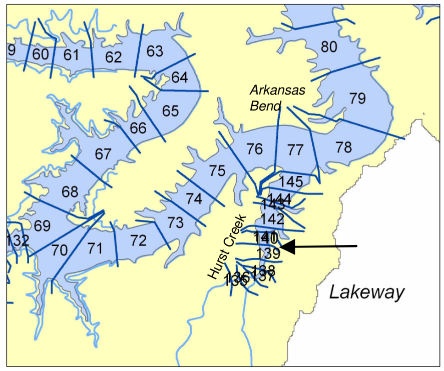
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	2	0	7	11	-1	0	9	1	13	9
1985	31.6	3	0	9	9	-1	-1	2	1	3	2
1986	39.1	7	1	20	22	1	0	5	8	14	8
1987	36.7	1	0	0	1	7	7	2	7	10	9
1988	22.3	-1	0	4	3	-1	-1	6	-1	5	5
1989	26.0	1	-6	3	11	-8	-1	-6	5	6	-8
1990	31.6	2	1	4	6	1	0	8	3	10	10
1991	42.4	1	0	26	35	1	1	8	5	10	9
1992	40.9	0	0	1	1	0	0	8	0	8	9
1993	27.5	8	2	8	16	9	8	2	15	17	12
1994	34.7	2	0	3	4	-1	-1	7	0	8	7
1995	30.3	1	1	6	7	2	0	11	3	14	13
1996	27.4	4	-1	10	13	1	-1	10	7	18	13
1997	44.3	1	1	12	13	2	1	11	2	13	14
1998	37.6	21	6	51	76	5	3	9	31	42	18
1999	20.0	8	0	46	43	12	3	7	14	16	14
2000	33.9	15	-1	22	26	-1	3	11	14	26	9
2001	38.0	5	2	30	36	-3	-2	6	1	7	5
2002	38.2	2	0	0	2	2	3	3	4	7	5
2003	25.6	-2	-1	15	14	1	0	11	-1	8	9
2004	45.8	1	0	18	17	3	1	10	6	15	13
2005	23.2	13	0	175	178	18	1	9	20	31	38
2006	25.0	26	3	48	67	3	7	14	26	42	17
	Average	5	0	23	27	2	1	7	8	15	10

CREMs Phase 2 - Lake Travis

Average of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Hurst Creek (segment 140)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case

- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

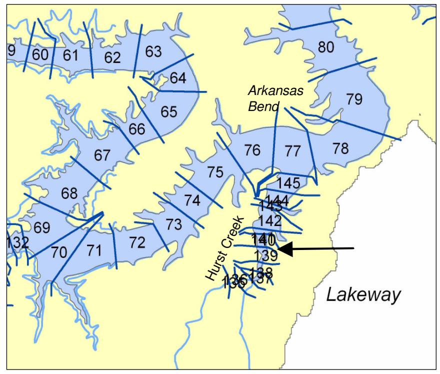
Average Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	7.8	4.2	4.4	8.4	4.3	4.1	4.4	8.0	8.1	4.5	4.2
1985	31.6	15.4	14.2	12.7	15.6	12.1	12.1	12.7	15.2	15.3	14.3	12.2
1986	39.1	10.3	10.0	10.3	10.5	9.8	9.8	10.0	10.2	10.2	10.1	9.8
1987	36.7	8.5	8.1	6.8	8.7	6.7	6.8	6.9	8.4	8.6	8.3	6.6
1988	22.3	13.6	8.8	8.7	13.9	7.8	7.8	8.1	13.5	13.6	9.2	7.7
1989	26.0	9.5	9.4	9.3	9.6	9.0	9.0	9.0	9.3	9.5	9.5	9.0
1990	31.6	12.0	9.2	8.9	12.2	8.4	8.4	8.8	11.9	12.0	9.5	8.4
1991	42.4	7.1	4.0	3.2	7.3	3.3	3.2	3.3	7.2	7.3	4.3	3.2
1992	40.9	9.6	9.2	8.1	9.8	7.7	7.7	8.4	9.6	9.8	9.6	7.8
1993	27.5	7.9	4.2	3.8	7.9	3.9	3.8	3.9	8.0	7.9	4.5	3.7
1994	34.7	13.3	11.3	10.8	13.4	10.3	10.4	10.8	13.1	13.1	11.3	10.5
1995	30.3	7.2	6.8	6.9	7.4	6.2	6.5	6.7	7.1	7.2	6.9	6.5
1996	27.4	4.5	2.1	2.4	4.9	2.3	2.1	2.1	4.6	4.7	2.5	2.0
1997	44.3	10.1	8.2	5.8	10.2	5.6	5.6	5.9	10.0	10.2	8.4	5.6
1998	37.6	8.8	5.4	4.8	8.9	4.8	4.7	4.8	8.7	8.9	5.8	4.7
1999	20.0	11.1	7.8	4.5	10.9	4.7	4.7	4.8	11.0	11.0	7.6	4.8
2000	33.9	6.2	2.3	2.5	6.3	2.6	2.3	2.3	6.1	6.1	2.5	2.4
2001	38.0	11.5	5.2	4.6	11.7	4.4	4.1	4.3	11.5	11.6	5.8	4.0
2002	38.2	7.9	6.1	5.9	7.9	5.9	5.9	5.9	7.8	7.9	6.2	5.8
2003	25.6	10.4	6.3	5.1	10.8	4.8	4.7	4.8	10.4	10.5	6.6	4.7
2004	45.8	9.9	8.4	5.9	10.4	5.5	5.4	5.6	9.9	10.1	8.7	5.4
2005	23.2	7.6	2.3	1.2	8.0	1.2	1.1	1.1	7.5	7.7	2.4	1.1
2006	25.0	10.9	4.8	5.0	11.3	4.3	4.2	4.3	10.8	10.9	4.9	4.3
	Average	9.6	6.9	6.2	9.8	5.9	5.8	6.0	9.5	9.7	7.1	5.8

Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	88	0	5	101	3	-1	5	93	96	8
1985	31.6	26	17	4	28	0	-1	4	25	25	18
1986	39.1	5	1	4	6	-1	0	2	3	4	2
1987	36.7	29	23	3	31	2	2	4	27	30	26
1988	22.3	76	15	12	81	2	1	5	75	77	19
1989	26.0	6	4	4	7	0	0	0	3	6	6
1990	31.6	43	10	6	46	0	0	5	42	44	14
1991	42.4	124	27	1	129	6	0	4	127	131	35
1992	40.9	24	18	4	26	0	0	9	23	26	24
1993	27.5	112	14	3	111	4	1	4	114	111	20
1994	34.7	27	8	3	28	-2	0	3	25	26	8
1995	30.3	11	4	5	13	-5	0	3	9	11	7
1996	27.4	128	4	21	145	15	6	8	134	139	25
1997	44.3	80	46	3	83	1	-1	5	79	83	51
1998	37.6	89	16	3	92	4	1	4	86	90	24
1999	20.0	132	64	-5	128	-2	-1	0	129	131	60
2000	33.9	153	-8	3	159	7	-6	-4	149	151	3
2001	38.0	189	32	16	195	11	3	8	191	193	47
2002	38.2	35	4	1	35	1	1	3	34	36	7
2003	25.6	122	35	10	131	3	1	3	122	124	40
2004	45.8	85	56	10	93	2	0	3	84	88	62
2005	23.2	599	112	14	637	7	2	4	591	606	123
2006	25.0	156	12	17	166	1	-1	1	154	156	15
	Average	102	22	6	108	2	0	4	101	104	28

CREMs Phase 2 - Lake Travis



Maximum of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Hurst Creek (segment 140)
- Summertime (June thru Sept)
- Top two meters of water column

Compared to Base Case
- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Maximum Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	16.8	8.7	9.4	18.2	9.1	8.9	9.3	17.6	17.4	9.5	8.7
1985	31.6	27.4	26.9	21.2	27.6	21.4	21.2	21.9	27.5	27.6	27.4	21.0
1986	39.1	23.2	25.4	27.0	23.2	26.5	26.6	26.6	23.1	23.1	25.4	26.6
1987	36.7	22.5	21.9	16.9	22.7	17.4	17.3	17.7	22.0	23.5	23.0	16.5
1988	22.3	32.0	15.7	15.4	33.1	13.6	13.5	13.8	32.2	32.1	16.7	13.3
1989	26.0	16.6	16.7	17.0	16.7	16.6	16.2	16.4	16.7	16.6	17.1	16.1
1990	31.6	29.3	19.9	20.1	29.8	19.4	19.6	20.2	29.3	29.9	20.5	19.6
1991	42.4	12.8	8.5	5.6	12.9	5.3	5.0	5.7	12.8	12.8	8.5	5.5
1992	40.9	22.7	20.6	16.3	23.0	15.3	15.6	17.0	22.4	23.1	21.9	15.7
1993	27.5	22.9	10.1	8.9	23.2	8.7	8.6	9.0	23.1	23.4	10.3	8.6
1994	34.7	30.8	25.5	22.2	31.0	20.8	21.3	22.0	30.7	30.9	25.2	21.4
1995	30.3	19.8	19.5	19.1	20.2	18.5	18.1	18.9	19.9	20.1	20.1	18.1
1996	27.4	11.4	5.8	6.3	12.2	6.9	6.0	5.8	12.4	12.6	7.4	5.6
1997	44.3	17.5	17.4	11.4	18.5	11.1	11.0	11.5	17.1	18.1	18.2	10.9
1998	37.6	17.4	15.0	14.5	17.5	14.3	14.2	14.5	17.2	17.5	15.2	14.1
1999	20.0	19.0	15.0	7.9	18.7	7.3	7.0	7.4	18.5	18.5	14.5	7.1
2000	33.9	14.1	4.3	4.3	14.1	4.8	4.3	4.4	14.2	13.9	4.8	4.5
2001	38.0	23.8	14.8	11.9	24.4	11.4	10.7	11.2	23.9	24.0	15.9	10.7
2002	38.2	18.4	12.4	11.4	18.5	11.5	11.6	11.7	18.2	18.3	13.1	11.3
2003	25.6	17.3	12.6	8.2	18.2	7.7	7.7	7.8	17.5	17.5	12.8	7.6
2004	45.8	20.5	19.0	14.1	21.3	13.3	13.2	13.4	20.4	21.0	19.4	13.3
2005	23.2	15.2	7.7	3.0	15.8	2.9	2.8	2.9	15.2	15.5	7.7	2.8
2006	25.0	28.7	15.1	15.9	29.2	13.4	13.3	13.7	28.6	28.5	15.3	13.4
	Average	20.9	15.6	13.4	21.3	12.9	12.8	13.2	20.9	21.1	16.1	12.7

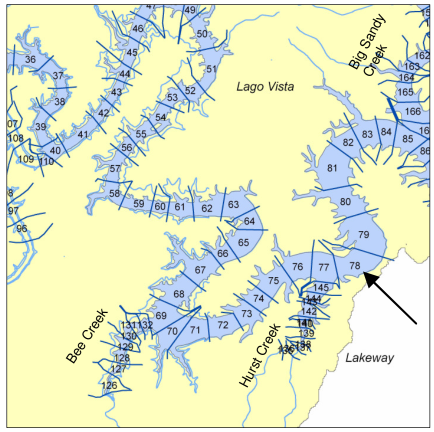
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	93	0	7	108	5	2	7	102	100	10
1985	31.6	31	28	1	32	2	1	4	31	32	31
1986	39.1	-13	-4	1	-13	0	0	0	-13	-13	-4
1987	36.7	36	32	2	37	5	5	7	33	42	39
1988	22.3	141	18	16	149	3	2	4	143	142	26
1989	26.0	3	4	6	4	3	0	2	4	3	6
1990	31.6	50	2	3	52	-1	0	3	50	53	5
1991	42.4	133	54	2	134	-4	-9	4	132	132	55
1992	40.9	45	32	4	47	-3	0	9	43	47	40
1993	27.5	166	17	4	170	1	1	5	169	172	20
1994	34.7	44	19	3	45	-3	-1	3	43	44	18
1995	30.3	9	8	6	11	2	0	4	10	11	11
1996	27.4	103	3	12	118	23	8	4	121	125	31
1997	44.3	60	59	4	69	1	0	5	57	66	67
1998	37.6	23	6	3	24	1	1	3	22	24	8
1999	20.0	169	112	12	164	3	-1	5	161	162	106
2000	33.9	211	-5	-4	213	6	-5	-2	215	208	6
2001	38.0	123	39	12	129	7	0	5	124	125	49
2002	38.2	63	10	1	64	2	3	4	62	63	17
2003	25.6	128	66	8	140	2	1	2	131	130	69
2004	45.8	55	43	6	60	0	-1	1	53	58	46
2005	23.2	446	176	6	468	4	1	3	446	458	177
2006	25.0	114	13	18	117	-1	-1	2	113	112	14
	Average	97	32	6	102	3	0	4	98	100	37

CREMs Phase 2 - Lake Travis

Average of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Arkansas Bend (segment 78)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case

- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Average Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	8.7	5.5	6.2	9.3	5.7	5.5	5.6	9.2	9.3	5.7	5.5
1985	31.6	17.0	14.6	14.2	17.5	13.4	13.1	13.8	16.9	17.1	14.9	13.3
1986	39.1	10.9	10.2	10.5	11.3	10.0	10.0	10.1	10.9	11.0	10.4	10.0
1987	36.7	8.4	8.0	7.7	8.7	7.6	7.6	7.8	8.6	8.8	8.4	7.5
1988	22.3	13.2	9.8	10.5	14.2	9.4	9.3	9.7	13.2	13.6	10.4	9.2
1989	26.0	11.0	10.1	10.1	11.3	9.8	9.8	9.8	11.2	11.2	10.3	9.8
1990	31.6	11.2	9.0	9.3	11.8	8.7	8.7	9.1	11.3	11.7	9.5	8.7
1991	42.4	6.6	4.2	3.9	6.7	4.1	3.9	4.0	6.9	7.1	4.7	3.9
1992	40.9	10.4	9.7	9.5	10.7	9.2	9.1	9.9	10.4	10.9	10.4	9.1
1993	27.5	7.4	5.5	5.2	7.5	5.2	5.1	5.3	7.4	7.5	5.7	5.1
1994	34.7	15.2	13.3	13.4	15.5	12.7	12.8	13.4	15.2	15.4	13.7	12.8
1995	30.3	7.9	6.9	7.1	8.2	6.4	6.8	7.0	7.8	8.0	7.2	6.7
1996	27.4	4.5	2.3	2.7	5.0	2.6	2.4	2.4	4.8	5.0	2.8	2.2
1997	44.3	8.7	7.8	6.7	8.9	6.6	6.5	6.8	8.7	9.0	8.1	6.5
1998	37.6	8.3	6.0	5.7	8.5	5.5	5.3	5.6	8.5	8.7	6.5	5.3
1999	20.0	10.6	8.0	6.6	10.5	6.6	6.6	6.8	10.4	10.5	7.9	6.7
2000	33.9	7.0	2.8	3.2	7.4	3.4	2.9	2.9	6.9	7.0	3.1	3.1
2001	38.0	9.5	5.1	4.8	10.0	4.5	4.2	4.4	9.7	9.9	5.7	4.1
2002	38.2	7.1	5.6	5.5	7.1	5.7	5.6	5.6	7.2	7.4	6.0	5.4
2003	25.6	8.7	6.3	5.5	9.2	5.1	5.0	5.1	8.8	8.9	6.6	4.9
2004	45.8	7.9	6.2	6.0	8.5	5.5	5.4	5.7	7.9	8.2	6.5	5.4
2005	23.2	4.1	1.9	1.5	4.3	1.3	1.3	1.3	4.1	4.2	2.0	1.3
2006	25.0	11.2	4.9	5.3	11.9	4.5	4.4	4.5	11.2	11.2	5.1	4.5
	Average	9.4	7.1	7.0	9.7	6.7	6.6	6.8	9.4	9.6	7.5	6.6

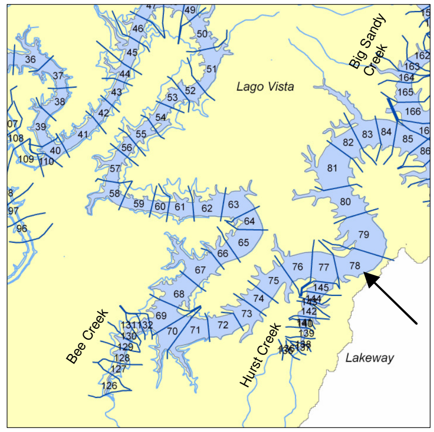
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	58	0	11	67	3	-1	2	66	68	3
1985	31.6	27	9	6	31	0	-2	3	27	28	12
1986	39.1	9	3	6	13	0	0	2	9	10	5
1987	36.7	13	6	3	16	2	2	4	14	18	13
1988	22.3	43	7	14	55	2	1	5	44	48	13
1989	26.0	12	3	4	15	1	0	0	14	15	5
1990	31.6	30	3	7	36	1	0	6	30	35	9
1991	42.4	71	10	2	75	7	2	4	79	84	22
1992	40.9	13	6	4	17	0	0	8	13	20	14
1993	27.5	45	7	2	46	2	0	3	46	47	12
1994	34.7	19	4	5	21	0	0	5	19	21	8
1995	30.3	17	3	6	21	-5	0	4	16	19	7
1996	27.4	105	3	23	126	17	7	7	118	125	26
1997	44.3	34	20	3	37	1	0	4	34	39	24
1998	37.6	57	13	8	61	3	1	5	60	64	22
1999	20.0	59	20	-1	58	-1	-1	2	56	57	19
2000	33.9	123	-11	2	135	7	-8	-7	119	123	0
2001	38.0	131	25	16	143	10	2	7	137	140	39
2002	38.2	30	3	1	31	4	3	4	32	36	10
2003	25.6	76	28	12	88	3	1	3	78	81	33
2004	45.8	45	15	11	56	2	0	4	46	50	20
2005	23.2	221	50	18	244	5	2	4	225	231	61
2006	25.0	150	11	19	167	0	-1	1	150	151	14
	Average	60	10	8	68	3	0	3	62	66	17

CREMs Phase 2 - Lake Travis

Maximum of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Arkansas Bend (segment 78)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case
- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Maximum Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	16.2	12.8	14.2	17.8	12.3	11.7	12.4	16.9	17.6	12.9	12.8
1985	31.6	27.1	26.8	26.2	28.5	26.1	26.1	26.5	27.4	28.0	26.9	26.1
1986	39.1	26.4	24.5	26.6	28.4	23.5	23.2	23.7	26.8	26.9	25.4	23.1
1987	36.7	16.3	16.2	16.2	16.7	16.0	16.2	16.1	16.7	17.8	16.3	16.1
1988	22.3	26.9	18.3	20.7	30.4	17.7	17.7	17.6	26.9	27.3	18.7	17.5
1989	26.0	17.8	16.2	16.9	17.9	16.1	16.0	16.1	18.1	17.8	17.0	15.9
1990	31.6	23.0	19.1	19.6	23.8	18.8	18.6	19.9	23.2	24.2	20.5	18.2
1991	42.4	12.1	7.0	6.7	12.2	6.8	6.4	6.4	12.0	12.1	7.5	6.1
1992	40.9	24.7	23.5	22.3	25.3	21.4	21.3	23.3	24.7	26.0	25.3	21.4
1993	27.5	14.4	11.0	10.7	14.7	11.1	10.4	10.6	15.0	15.2	11.7	10.4
1994	34.7	34.0	31.6	32.8	36.1	30.7	30.7	34.0	33.8	36.9	34.2	30.8
1995	30.3	16.4	14.5	15.0	17.3	14.3	14.1	14.8	16.6	17.2	15.3	14.1
1996	27.4	11.8	8.0	9.3	13.1	9.7	8.4	8.2	13.9	14.3	10.3	7.8
1997	44.3	13.1	12.1	11.1	13.3	11.0	10.9	11.2	13.2	13.5	12.6	10.9
1998	37.6	14.0	12.9	12.4	14.4	12.5	12.1	12.4	14.4	14.8	13.9	12.0
1999	20.0	16.8	12.8	12.1	17.1	11.3	11.0	11.5	16.8	16.9	13.3	11.0
2000	33.9	12.9	5.6	6.9	13.0	8.1	5.8	5.7	13.2	13.6	6.4	7.1
2001	38.0	17.5	13.4	12.1	18.5	11.4	10.8	11.3	17.8	18.4	14.4	10.8
2002	38.2	16.5	10.9	10.8	16.6	11.3	11.0	11.2	16.6	16.8	11.8	10.5
2003	25.6	14.4	10.2	9.2	14.6	8.5	8.3	8.4	14.4	14.7	10.7	8.2
2004	45.8	18.6	18.7	18.6	18.7	18.4	18.7	18.7	18.4	18.6	18.6	18.6
2005	23.2	7.5	4.4	3.0	7.9	2.7	2.7	2.8	7.5	7.6	4.5	2.7
2006	25.0	26.2	16.1	18.1	28.8	14.7	15.0	15.3	26.0	26.1	16.0	15.2
	Average	18.5	15.1	15.3	19.4	14.5	14.2	14.7	18.7	19.2	15.8	14.2

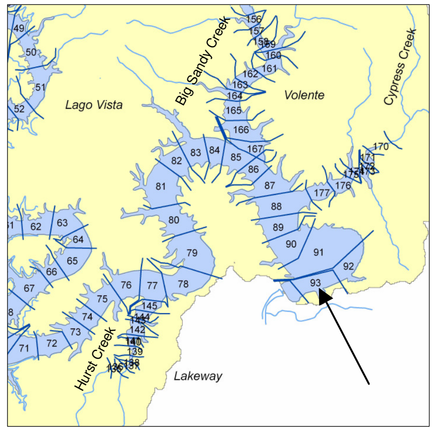
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	27	0	12	39	-4	-8	-3	32	38	1
1985	31.6	4	3	1	10	0	0	2	5	7	3
1986	39.1	14	6	15	23	2	1	2	16	17	10
1987	36.7	1	0	1	4	-1	1	0	4	11	1
1988	22.3	54	4	18	74	1	1	1	54	56	7
1989	26.0	12	2	6	13	1	0	1	13	12	7
1990	31.6	27	5	8	31	3	2	9	28	33	13
1991	42.4	97	14	10	99	11	4	5	96	98	22
1992	40.9	16	10	4	19	0	0	9	15	22	18
1993	27.5	39	6	3	42	6	0	2	44	46	13
1994	34.7	10	2	6	17	0	0	10	10	20	11
1995	30.3	17	3	6	23	1	0	5	18	22	9
1996	27.4	51	3	19	68	24	8	6	78	83	33
1997	44.3	20	12	2	22	1	1	3	22	24	16
1998	37.6	17	8	3	20	5	2	4	20	24	16
1999	20.0	53	16	9	55	2	-1	4	52	53	21
2000	33.9	81	-21	-3	82	13	-19	-20	86	91	-11
2001	38.0	63	24	12	72	6	1	5	65	71	33
2002	38.2	57	4	3	58	7	5	7	58	60	13
2003	25.6	76	24	11	78	3	1	3	76	79	31
2004	45.8	0	0	0	0	-1	0	1	-1	0	0
2005	23.2	179	64	11	192	2	1	3	178	183	68
2006	25.0	73	6	19	90	-3	-1	1	71	72	6
	Average	43	9	8	49	4	0	3	45	49	15

CREMs Phase 2 - Lake Travis

Average of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Mansfield Dam (segment 93)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case
- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Average Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	4.1	2.4	2.5	4.2	2.5	2.5	2.5	4.3	4.3	2.6	2.4
1985	31.6	9.0	8.0	7.5	9.1	7.5	7.4	7.8	9.0	9.3	8.2	7.4
1986	39.1	8.9	8.2	8.2	9.1	7.9	7.9	8.0	8.9	8.9	8.3	7.9
1987	36.7	6.1	5.3	5.2	6.3	5.1	5.1	5.2	6.1	6.4	5.7	5.0
1988	22.3	6.3	4.5	4.6	6.7	4.4	4.3	4.3	6.5	6.6	4.8	4.2
1989	26.0	7.5	6.1	6.2	7.6	5.9	5.8	5.9	7.7	7.7	6.5	5.8
1990	31.6	9.2	6.8	7.0	9.5	6.7	6.6	6.9	9.2	9.4	7.2	6.6
1991	42.4	3.2	2.2	2.0	3.2	2.1	1.9	2.1	3.2	3.3	2.4	2.0
1992	40.9	4.3	3.8	3.6	4.4	3.5	3.3	3.7	4.3	4.6	4.2	3.4
1993	27.5	3.3	2.5	2.3	3.3	2.4	2.3	2.3	3.4	3.5	2.7	2.2
1994	34.7	5.3	4.4	4.4	5.4	4.2	4.3	4.3	5.3	5.3	4.4	4.3
1995	30.3	6.2	5.6	5.6	6.3	5.1	5.5	5.6	6.1	6.2	5.7	5.5
1996	27.4	2.6	1.2	1.3	2.7	1.3	1.2	1.3	2.6	2.7	1.4	1.2
1997	44.3	3.8	3.3	3.0	3.9	2.9	2.8	3.0	3.9	4.0	3.5	2.9
1998	37.6	4.6	3.6	3.4	4.6	3.4	3.4	3.4	4.7	4.8	3.8	3.3
1999	20.0	3.5	2.7	2.3	3.4	2.6	2.5	2.5	3.6	3.7	2.9	2.5
2000	33.9	3.4	1.4	1.5	3.4	1.6	1.5	1.5	3.4	3.5	1.6	1.5
2001	38.0	3.6	2.7	2.5	3.5	2.5	2.4	2.5	3.6	3.8	3.0	2.4
2002	38.2	5.3	4.5	4.5	5.3	4.5	4.4	4.5	5.3	5.4	4.7	4.4
2003	25.6	3.8	2.9	2.5	3.8	2.8	2.5	2.5	4.2	4.3	3.3	2.4
2004	45.8	6.6	4.6	4.4	6.9	4.0	3.9	4.1	6.7	6.7	4.9	3.9
2005	23.2	2.1	1.1	0.8	2.1	0.8	0.7	0.8	2.2	2.2	1.2	0.7
2006	25.0	6.2	3.0	3.0	6.4	2.7	2.7	2.7	6.1	6.1	3.1	2.7
	Average	5.2	4.0	3.8	5.3	3.8	3.7	3.8	5.2	5.3	4.2	3.7

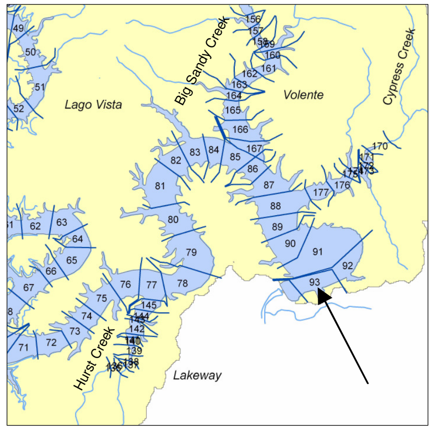
Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbanization 20 Years into Future without HLWO	#6 Urbanization 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	68	0	5	71	5	2	3	76	79	8
1985	31.6	22	8	0	22	1	0	5	21	25	11
1986	39.1	14	4	5	15	0	0	2	13	14	6
1987	36.7	22	7	4	25	3	2	5	23	29	15
1988	22.3	52	9	11	62	6	3	4	56	59	16
1989	26.0	30	6	7	32	3	1	1	33	33	12
1990	31.6	39	4	7	44	1	0	4	39	43	9
1991	42.4	56	10	1	58	4	-5	4	59	64	17
1992	40.9	26	11	5	31	2	-2	10	28	37	23
1993	27.5	46	10	2	48	7	3	5	52	56	21
1994	34.7	24	3	1	25	-1	0	1	23	23	2
1995	30.3	14	2	3	16	-6	0	2	12	14	4
1996	27.4	119	4	9	127	9	3	7	124	130	18
1997	44.3	32	15	3	35	2	-1	5	34	37	21
1998	37.6	38	8	2	38	4	1	3	40	44	15
1999	20.0	42	10	-5	38	4	0	0	47	48	16
2000	33.9	120	-6	0	124	6	-5	-2	122	127	5
2001	38.0	52	13	6	51	7	2	8	55	62	26
2002	38.2	21	3	2	22	2	1	3	22	24	7
2003	25.6	59	19	4	61	17	5	3	77	80	40
2004	45.8	67	18	10	75	2	0	3	68	70	23
2005	23.2	189	51	7	194	7	2	4	196	201	64
2006	25.0	128	10	13	138	2	-1	1	125	127	14
	Average	56	9	4	59	4	0	3	58	62	17

CREMs Phase 2 - Lake Travis

Maximum of Predicted Daily Mean Chlorophyll-*a* Concentrations

- Mansfield Dam (segment 93)
- Summertime (June thru Sept)
- Top two meters of water column



Compared to Base Case

- Increase ≥ 50%
- Increase ≥ 10% and <50%
- Increase < 10%
- No Change
- Decrease < 10%
- Decrease ≥ 10% and < 50%
- Decrease ≥ 50%

Maximum Chl-a Concentration (µg/L)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbaniza-tion 20 Years into Future without HLWO	#6 Urbaniza-tion 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)	Base Case
1984	27.6	7.1	4.8	4.8	7.2	5.1	4.9	4.8	7.6	7.7	5.5	4.8
1985	31.6	23.8	23.6	22.5	23.9	22.8	22.4	23.6	23.7	24.3	23.5	22.3
1986	39.1	25.9	25.9	25.8	25.7	25.8	25.9	25.9	25.8	25.7	25.7	25.9
1987	36.7	17.8	16.8	16.3	18.0	16.5	16.4	16.8	18.0	18.7	17.7	16.0
1988	22.3	11.3	10.4	10.4	13.4	10.8	10.9	10.4	12.0	12.6	9.3	10.7
1989	26.0	16.8	11.4	11.8	17.0	11.1	11.0	11.4	16.8	16.9	12.0	11.0
1990	31.6	29.6	25.1	25.9	29.7	24.3	24.0	25.1	29.5	29.5	26.1	24.1
1991	42.4	8.3	6.7	6.1	8.3	6.0	5.6	6.7	8.3	8.4	6.7	6.1
1992	40.9	9.6	8.4	7.8	10.1	7.4	7.1	8.4	9.5	10.2	9.1	7.4
1993	27.5	7.8	5.4	5.0	8.0	5.4	4.9	5.4	8.7	9.0	6.4	4.8
1994	34.7	13.8	12.4	12.4	14.1	12.0	12.2	12.4	13.8	13.8	12.3	12.1
1995	30.3	18.6	17.9	18.1	18.7	17.8	17.8	17.9	18.5	18.6	18.1	17.8
1996	27.4	6.5	3.1	3.0	6.8	3.4	3.1	3.1	6.5	6.6	3.6	3.0
1997	44.3	11.0	9.1	8.8	11.6	8.4	8.2	9.1	11.1	11.6	10.0	8.3
1998	37.6	12.8	12.6	12.4	12.8	12.4	12.3	12.6	12.8	12.8	12.6	12.3
1999	20.0	7.7	5.3	4.5	7.5	4.9	4.7	5.3	8.0	8.1	5.5	4.7
2000	33.9	7.5	3.3	3.4	7.5	3.5	3.3	3.3	7.3	7.6	3.9	3.3
2001	38.0	9.8	8.4	7.6	9.8	7.9	7.8	8.4	10.0	10.5	9.1	7.7
2002	38.2	15.0	11.4	11.1	15.1	11.5	11.2	11.4	14.9	15.1	12.0	11.1
2003	25.6	7.4	6.3	4.6	7.5	6.7	5.3	6.3	8.6	8.7	7.7	4.6
2004	45.8	17.0	13.4	12.5	17.1	12.4	12.4	13.4	16.8	16.9	13.7	12.3
2005	23.2	6.2	4.5	3.1	6.1	3.2	3.0	4.5	6.3	6.7	4.8	3.0
2006	25.0	11.3	7.8	8.1	12.0	6.9	7.2	7.8	11.3	11.4	8.0	7.4
	Average	13.2	11.0	10.7	13.4	10.7	10.5	11.0	13.3	13.5	11.5	10.5

Change from Base Case (%)

Year	Total Rainfall (in)	#1 10MGD Point Sources	#2 10MGD Point Sources (Wet Wthr)	#3 2MGD Point Source into Upstream Part of Lake	#4 #1 + #3	#5 Urbaniza-tion 20 Years into Future without HLWO	#6 Urbaniza-tion 20 Years into Future with HLWO	#7 Increased Upstream Loading	#8 #1 + #5	#9 #1 + #5 + #7	#10 #2 + #5 + #7 (Wet Wthr)
1984	27.6	47	0	-2	50	7	3	0	58	59	13
1985	31.6	7	6	1	7	2	0	6	6	9	5
1986	39.1	0	0	0	0	0	0	0	0	0	0
1987	36.7	11	5	2	13	3	3	5	13	17	11
1988	22.3	6	-2	-3	26	1	3	-2	13	18	-13
1989	26.0	53	4	7	55	1	1	4	54	54	9
1990	31.6	23	4	7	23	1	0	4	22	22	8
1991	42.4	37	10	1	37	-2	-8	10	36	38	10
1992	40.9	30	14	6	37	0	-4	14	29	39	23
1993	27.5	63	11	3	67	12	2	11	81	87	33
1994	34.7	14	2	3	16	-1	0	2	14	14	1
1995	30.3	4	1	2	5	0	0	1	4	5	2
1996	27.4	116	5	1	127	13	3	5	118	122	20
1997	44.3	32	10	6	39	2	-1	10	34	40	20
1998	37.6	4	2	1	4	1	0	2	4	4	2
1999	20.0	65	13	-3	61	5	1	13	72	73	18
2000	33.9	127	1	2	126	7	-1	1	122	129	17
2001	38.0	26	8	-1	27	1	1	8	29	36	18
2002	38.2	36	3	1	37	4	1	3	35	36	9
2003	25.6	62	38	0	63	47	16	38	88	89	69
2004	45.8	38	9	1	39	0	0	9	37	37	11
2005	23.2	108	51	4	102	6	1	51	110	124	61
2006	25.0	54	6	10	63	-6	-2	6	54	55	8
	Average	42	9	2	44	4	1	9	45	48	16