

Appendix M
Lake Mexia Yield Study



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MEMORANDUM

To: David Dunn, HDR Engineering, Inc.

From: Andres Salazar, Ph.D., Freese and Nichols, Inc.

Re: Updated Yield of Lake Mexia

Date: June 2, 2004

Description of the Lake

Lake Mexia and Bistone Dam are located on the Navasota River in Limestone County, about seven miles west of Mexia. The initial capacity was 10,000 acre-feet, covering an area of 1,200 acres at the top of conservation pool of 448.3 feet. The maximum water elevation is 460.1 feet.

The Bistone Municipal Water Supply District owns and operates the Lake. The District owns the Certificate of Adjudication 5287, which authorizes the impoundment of 9,600 acre-feet in Lake Mexia and a diversion of 2,887 acre-feet per year for municipal use and 65 acre-feet per year for industrial purposes. The priority date is April 15, 1957.

Sedimentation Estimates

Reported sedimentation rates for the Navasota River watershed ranges from 0.34 to 1.51 acre-feet per square mile.

Generally, the sedimentation rate in a reservoir can be determined by the difference in capacity between two volumetric surveys. Future losses in capacity may be estimated by extrapolating the results of the surveys. The Texas Water Development Board surveyed Lake Mexia in May 1996. This survey determined the capacity to be 4,806 acre-feet at the top conservation pool elevation of 448.3 feet¹. The loss of conservation capacity from 10,000 to 4,806 acre-feet indicates an average annual sedimentation rate of 0.76 acre-feet per square mile of contributing watershed. However, this number may not be fully representative of the actual rate of sediment production in the watershed because some portion of the sediment may have accumulated in the flood zone, which was not measured in the 1996 survey.

¹ Texas Water Development Board. "Volumetric Survey of Lake Mexia". August 1996

Another method for estimating sedimentation rates is by comparison with nearby reservoirs. Lake Limestone, located 25 miles downstream of Lake Mexia on the Navasota River, provides reliable information for estimating the sedimentation rate in the watershed. The capacity of Lake Limestone before its initial impoundment in October 1978 was 225,400 acre-feet. Two subsequent volumetric surveys have been completed by the TWDB. A survey in May 1993 determined the capacity to be 214,827 acre-feet². The most recent survey completed in April 2002 indicated a capacity of 208,017 acre-feet³. Using this information, the long-term average sedimentation rate between 1978 and 2002 in Lake Limestone is 1.51 acre-feet per square mile of watershed.

Other rates have been reported by the Soil Conservation Service. Bulletin 5912⁴ shows a rate of 0.34 acre-feet per square mile per year in the Navasota watershed. Report 268⁵ shows a sedimentation rate of 1.34 acre-feet per square mile.

The annual sedimentation rate adopted for this task was 0.76 acre-feet per square mile, which is the value obtained with the volumetric survey of Lake Mexia. This value is about half the reported sedimentation of Lake Limestone. Actual sediment production rates in the watershed may be greater than 0.76 because extreme flood events may deposit silt in the flood pool and suspended sediment may exit the reservoir through releases or spills. By 1996, the reservoir had lost 52% of its initial conservation capacity. The rate of accumulation in the conservation pool may reduce with age as the capacity of the conservation pool is reduced, increasing the frequency of water elevations above 448.3 feet and decreasing the trap efficiency of the reservoir. Freese and Nichols adopted the following procedure to refine estimates of sediment accumulation within the conservation pool to obtain area-capacity estimates for 2000 and 2060.

Estimates of Area-Capacity Characteristics for Years 2000 and 2060

The estimated area-capacity characteristics for years 2000 and 2060 assume that a portion of the sediment will be deposited in the conservation pool, with the remainder being accumulated in the flood pool. Using data from the 1996 survey, an average of 145 acre-feet of sediment per year has been accumulating below the conservation pool level. This rate will decrease as the reservoir becomes silted because as conservation capacity is reduced, water elevations above 448.3 will be more frequent. With time, a larger proportion of sediment will be deposited per year in the flood pool and less in the conservation pool.

For development of future area-capacity characteristics, the conservation capacity was divided into intervals. The total estimated capacity loss was divided by the change in capacity of each interval (between 1957 and 1996) to determine the percentage of sediment accumulated at each elevation. This sediment distribution expressed as a percentage of sediment for each elevation

² Texas Water Development Board and Brazos River Authority. "Volumetric Survey of Lake Limestone". September 1993.

³ Texas Water Development Board. "Volumetric Survey of Lake Limestone". July 2003.

⁴ Soil Conservation Service. "Inventory and Use of Sedimentation Data in Texas". Bulletin 5912. January 1959.

⁵ Soil Conservation Service. "Erosion and Sedimentation by Water in Texas". Report 268. February 1982.

was assumed to continue during the extrapolation period. Once an interval becomes silted, accumulation of sediment in that interval stops, decreasing the rate deposited in the conservation pool. The remainder of the sediment is assumed to be accumulated in the flood pool.

Once the volume of each interval was computed, corresponding areas were obtained using the average area method in reverse. Average areas were adjusted as necessary to remove inconsistent looping (less area as the capacity increases). Final estimates for the area-capacity characteristics for 2000 and 2060 for Lake Mexia are presented in Attachment A.

Firm Yield Results

Freese and Nichols evaluated the firm yield of Lake Mexia using a version of the Texas Commission on Environmental Quality (TCEQ) Water Availability Model of Brazos River Basin modified by HDR Engineering for the Brazos G Regional Planning Group. The results are summarized below:

	Year 2000	Year 2060
Capacity (acre-feet)	4,330	1,163
Permitted Diversion (acre-feet per year)	2,952	2,952
Firm yield (acre-feet per year)	1,180	144

ATTACHMENT A

Area Capacity Tables

Area Capacity Characteristics for Lake Mexia for 2000 Conditions

Elevation (Feet)	Area (Acres)	Capacity (Acre-Feet)
415.0	0	0
438.0	67	67
440.0	154	287
441.0	184	456
442.0	249	672
443.0	292	943
444.0	435	1,307
445.0	508	1,778
446.0	700	2,382
447.0	823	3,143
448.3	1,000	4,330

Area Capacity Characteristics for Lake Mexia for 2060 Conditions

Elevation (Feet)	Area (Acres)	Capacity (Acre-Feet)
415.0	0	0
445.0	0	0
446.0	363	380
447.0	272	698
448.3	660	1,164