Appendix FF
Denver Tri-Lakes Projects Chatfield Sediment Depletion Rates – Future Conditions

DENVER TRI-LAKES PROJECTS
CHATFIELD SEDIMENT DEPLETION RATES - FUTURE CONDITIONS
January 2012

US Army Corps of Engineers ®
Omaha District

CHATFIELD LAKE, USACE OMAHA, JUNE 2010

Prepared by: **U.S. Army Corps of Engineers, Omaha District**
Engineering Division
Hydrologic Engineering Branch
Sedimentation and Channel Stabilization Section

EXECUTIVE SUMMARY

The purpose of the Denver Tri-Lakes Projects Sediment Depletion Rates in Chatfield Lake – Future Conditions Report is to project long-term sediment depletion for the next 50 and 100 years. Storage capacity data is available for the pre-project estimate and Chatfield Lake hydrographic surveys in 1977 and 2010.

The pre-project reservoir design storage depletion rate was calculated at -189.5 acre-feet/year and the 2010 measured long-term depletion rate is -30.3 acre-feet/year. The difference between the depletion rates is probably due to mis-interpretation of limited sediment load measurement data from the upper South Platte River basin during project design, as stated in Section 2.2. The Chatfield Lake sediment contributing basin size is small at approximately 1,261 mi^2. Periods of drought also may have lessened sediment inflow into Chatfield Lake. In addition, the construction of upstream reservoirs has also impacted sediment inflow. Other impacts such as basin land use, extreme hydrologic events, and forest fires can also have a significant impact on basin sediment yield. In a small basin such as Chatfield, the impacts on sediment inflow from these types of changes are magnified.

The measured long-term sediment depletion rate between 1977 and 2010 is calculated to be -30.3 acre-feet per year. The +50-year (year 2060) reservoir storage capacity at the multipurpose pool (elev. 5432.0 feet), using the current depletion rate will be 25,561 acre-feet with 90.8% storage capacity remaining. The +100-year (year 2110) reservoir storage capacity at the multi-purpose will be 24,046 with 85.4% capacity remaining. For comparison purposes, the sediment depletion rate at Cherry Creek of -44.0 acre-feet per year was also evaluated.

For evaluation purposes, all three sediment depletion rates should be considered. Selection of the most appropriate design sediment depletion rate, between the -30.3 Chatfield measured rate, the -44.0 Cherry Creek comparison rate, and the original project design rate of -189.5 acre feet/year will depend on project objectives. When selecting the design depletion rate, it should be noted that:

- Past rates should be evaluated with caution. Sediment depletion rates are highly event driven and respond to extreme hydrologic events.
- Basin land use can quickly impact rates.
- Specific events such as forest fires can dramatically alter sediment yields.
- The long-term depletion rate at Chatfield will vary over time and will be monitored with data from additional hydrographic surveys. Future hydrographic surveys will be completed at 10-year intervals as time, manpower, and funding permits.

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ACKNOWLEDGEMENTS

The Report, Denver Tri-Lakes Project - Chatfield Lake – Sedimentation in Chatfield Lake Future Conditions (+50 & +100 Years), January 2012 was prepared by the U.S. Army Corps of Engineers, Omaha District, Engineering Division, Hydrologic Engineering Branch, Sediment & Channel Stabilization Section (CENWO-ED-HF).

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NOTE: ALL ELEVATIONS IN THIS DOCUMENT ARE REPORTED IN NGVD 1929 VERTICAL DATUM.

1 Chatfield Project – General Information

1.1 Purpose

The purpose of the Omaha District's Sedimentation Program and this report is to document geomorphic conditions and trends for Chatfield Dam and Reservoir. Of specific interest to this report are the nature, extent and quantification of sediment accumulation. Presented in the report are project statistical data, cross section data, pool elevation records, capacity and sediment depletion data, and shoreline erosion information.

1.2 Scope of Work

The purpose of this analysis and report is to evaluate current short- and long-term sediment depletion rates at Chatfield Lake. This report is to be used as a reference document that predicts future 50-year and 100-year sediment conditions.

1.3 Authorization

Chatfield Dam and Reservoir was authorized by the Flood Control Act of 1950, House Document 669, Eightieth Congress, 2nd Session. The primary purpose of the project is to provide flood protection to metropolitan Denver, Colorado.

The authority for the Omaha District's Sedimentation Program is contained in EM 1110-2-4000, "Reservoir Sedimentation Investigation Program, dated 31 October 1995. The Sedimentation & Channel Stabilization Section, Hydrologic Engineering Branch, Engineering Division, is responsible for all related activities, operations, and studies connected with the sedimentation program.

1.4 Project History

Chatfield Lake is located on the South Platte River at the confluence of Plum Creek about eight miles upstream from downtown Denver, Colorado. The right abutment of the dam is located in Douglas County, Section 7, T6S, R68W and the left abutment of the dam is located in Jefferson County, Section 1, T6S, and R69W. The lake is located in portions of Arapahoe, Douglas and Jefferson Counties. Initial construction began in 1967 with closure occurring in 1974. The anticipated cost of the Project was $26,000,000. Authorized purposes include flood control, recreation, irrigation, water rights, and water supply. Chatfield Dam and reservoir is operated by the U.S. Army Corps of Engineers, Northwestern Division, Omaha District.

1.5 Study Area

The South Platte River originates along the eastern slope of the Continental Divide and flows in a southeasterly direction through the South Park Meadow Area to Eleven Mile Canyon Reservoir as shown in Figure 2-3. Below Eleven Mile Canyon Dam, the South Platte enters a much narrower valley and the surrounding terrain becomes considerably steeper. This stretch includes Cheesman Reservoir. Several major tributaries enter the South Platte River between Eleven Mile Canyon and the foothills including Tarryall Creek and the North Fork South Platte River. Plum Creek is a right bank tributary that joins the South Platte River just upstream of the dam in the reservoir.

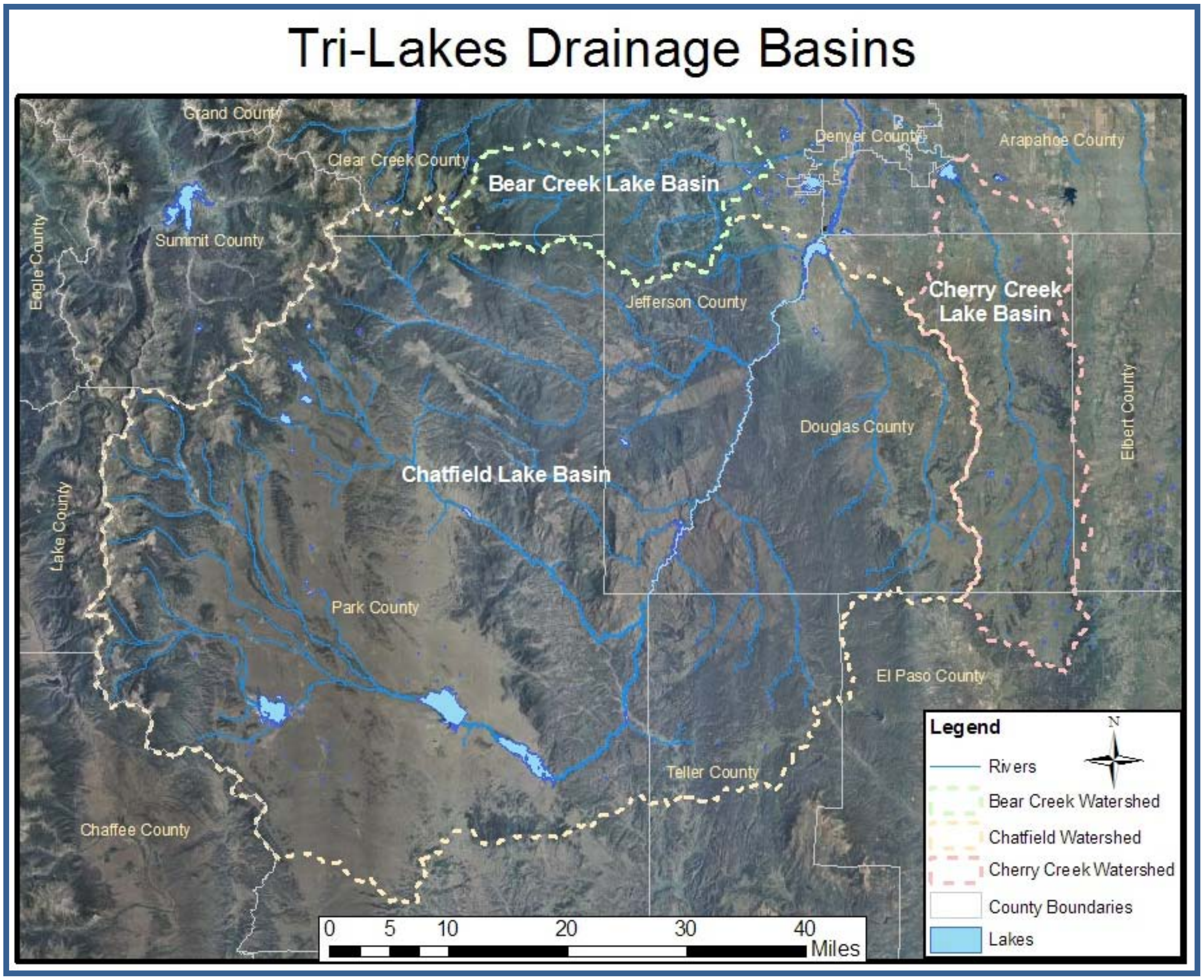

Figure 1-1 Denver Tri-Lakes Drainage Basin Map

1.6 Geography and Topography

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The drainage area above Chatfield Dam is 3,018 square miles, much of which is rugged mountain terrain. A summary of the tributary drainage areas is shown in Table 2-1. The 450 square miles of drainage area near the dam are characterized by high plains and rolling foothills between the approximate elevations of 5,500 and 7,000 feet. This part of the basin is mostly grassland with some forested areas. About 10 miles upstream from Chatfield Dam, the front range of the Rocky Mountains crests at elevations near 9,000 feet, except where the range is cut by canyon streams. Above this point is located the bulk of the mountainous terrain found in the basin. This area is about 1,300 square miles and is comprised of high mountain peaks ranging up to 13,000 feet, heavily forested with steep mountain valleys where the streams have eroded their channels. Above this mountainous area is located an area of about 1,000 square miles of high meadow ground where topography is extremely rugged with elevations rising sharply from the meadow area of 9,500 feet to peak elevations in excess of 14,000 feet located along the Continental Divide.

Table 1-1 Drainage Basin Size above Chatfield Lake

Description	Drainage Area (mi^2)		Approx. Channel Slope (ft/mi)
	Total	Sediment Contributing	
South Platte River	963	0	35
South Platte River	160	0	100
Tarryall Creek	333	0	45
Tarryall Creek	146	0	100
Lost Park a& Turkey Creeks	155	0	100
West Creek	222	222	75
Wigwam Creek	39	39	130
North Fork South Platte River	479	479	100
Plum Creek	324	324	90
Dam Site to Mouth of West Creek	197	197	
Total Drainage Basin Size =	**3,018**	**1,261**	

1.7 Climate

The climate of the plains in the vicinity of Chatfield Lake is distinctly continental. Situated a long distance from any moisture source and separated from the Pacific Ocean source by a high mountain barrier, the plains area experiences light rainfall, low relative humidity, a large daily range in temperature, high daytime temperatures in summer, a few protracted cold spells in winter, moderately high wind movement, and a high percentage of sunshine. The mean annual temperature in the plains and foothills is about 50 degrees Fahrenheit. Temperatures of 100 degrees, or over, have been observed at all stations in the region, and daytime temperatures of 95 degrees, or higher, are common in the summer. In the foothills portion of the area, summer afternoon temperatures are frequently lowered by afternoon cloudiness and thunderstorms over and near the mountains. Cold air masses from the north can be abrupt and severe, intensified by the high altitude. However, many of the cold air masses out of Canada that spread southward over the Northern Great Plains are too shallow to reach the area's altitude and move off over the lower plains to the east. The lowest temperatures observed in the plains and foothills region have ranged from 30 to 40 degrees below zero. The mean annual precipitation averages about 14 to 17 inches, the amounts increasing with proximity to the mountains. Over 70 percent of the annual precipitation falls in the six-month period from April through September, much of it from the intense isolated summer thunderstorms. Winter snowfall averages from 3 to 5 feet on the plains, and from 5 to 7 feet in the foothills.

The climatic variations between mountain weather stations are substantially greater than between plains weather stations. The weather pattern in general is lower temperatures and increased precipitation and wind movement with increased altitude. However, local conditions can change this pattern quite markedly. The diurnal range in temperature is low on the mountain slopes and high in the valleys. At the mountain peaks the average annual temperature is less than 32 degrees. Readings of zero or lower are much more common than on the plains, although minimum temperatures of record are about the same. The daytime temperatures decrease with increasing elevation, while the minimum temperatures are a function of cold air drainage. The rainfall in the mountain areas depends largely on the elevation and exposure to moisture bearing winds. On the eastern slopes of the Front Range the precipitation pattern resembles that of the plains. Survey History

Reservoir capacity changes and depletion rates are calculated from successive hydrographic surveys of the twenty-four previously established sediment cross sections at Chatfield (See Figure 2-1). U.S. Army Corps of Engineers (USACE) personnel performed the original surveys of the cross section lines. Subsequent surveys were performed by either USACE or independent contract survey firms. Hydrographic surveys of Chatfield Lake were completed in 1977, 1991, 1998, and 2010.

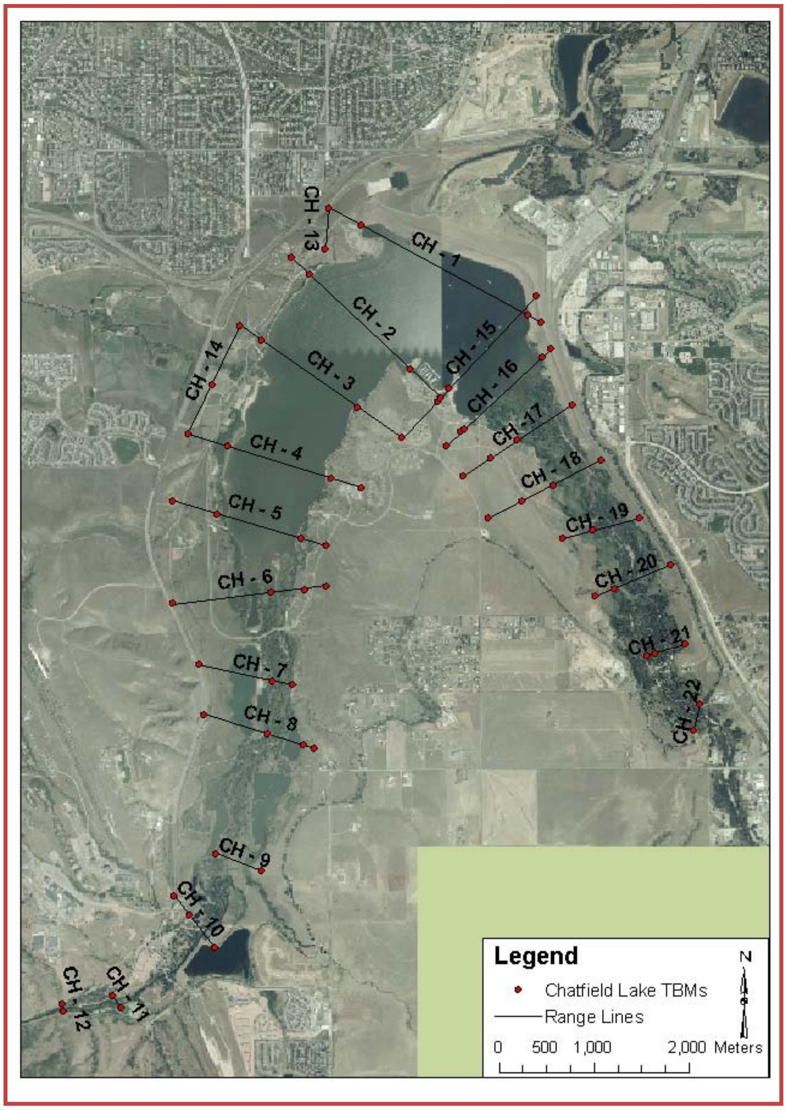

Figure 1-2 Chatfield Lake - Sediment Cross Section Location Map

2 Engineering Data & Analysis

2.1 Omaha District Reservoir Storage Capacity Calculations

Reservoir storage capacity calculations were completed for the 2010 Chatfield hydrographic survey data utilizing one of the two versions of the Omaha District's Reservoir Area-Capacity Analysis software. The original software was a package of four programs originally written in FORTRAN programming language by the Omaha District in August 1992. The program set includes SATOVOL, SACHELM, VOLRATIO, and SAREACAP. The program AreaCapacity, developed by WEST Consultants, Inc. in August 2000, is a Windows® based graphical user interface integrating the four original programs. A synopsis of this procedure can be found in Appendix A. The Windows® based program was used to calculate the 2010 Chatfield capacity tables.

General procedures for executing the area-capacity programs can be found in the manuals "Reservoir Area-Capacity Analysis (on the Microcomputer)," August 1992, Omaha District, U. S. Army Corps of Engineers; and "User's Manual AreaCapacity Computer Program," August 2000, Omaha District, U. S. Army Corps of Engineers. Data output files containing results from the execution of area-capacity programs as well as cross section data input files are stored in the USACE Omaha District Sedimentation and Channel Stabilization Section.

2.2 Original Reservoir Capacity & Depletion Rate Calculations

Chatfield Reservoir was designed to contain the sediment yield for a 100-year period. The data is summarized in Table 2-1. Based on an eight year suspended sediment load record on the South Platte River at Littleton, Colorado, a 23-year runoff record at this same location, and a similar 17-year record on Plum Creek at Louviers, Colorado, the depletion rate of reservoir storage from sedimentation was estimated to average 189.5 acre-feet per year, or a total of 18,950 acre-feet over 100-years. The original sediment analysis considered also the sedimentation rates observed at Cherry Creek reservoir located in the adjacent drainage basin to the east of Plum Creek, and the abnormal sediment runoff from the Plum Creek basin for the period of time it takes nature to heal the presently torn and deteriorated channel. The observed rates at the Cherry Creek project included the record runoff contribution from the 16-17 June 1965 flood.

Reservoir sediment deposits will accumulate generally near or below the sediment pool elevation, except during the infrequent periods when runoff occurs during higher pool stages. Deposition occurring in the flood control storage zone would be confined primarily within the stream channel banks and would be subject to a progressive redistribution into the sediment pool zone by subsequent cycles of medium or low flow runoff. During the first several decades after project construction, separate delta formations will encroach into the sediment pool from the two reservoir arms, but the smaller Plum Creek arm will deteriorate faster due to the relatively greater sediment production potential from that basin. Later these sediments will tend to accumulate along the embankment near the outlet structure. Some of the finer particles will eventually pass through the outlet works, but this accumulation should not be detrimental to reservoir operations. It is anticipated that 15% of the sediment will be deposited in the flood control zone and the remaining 85% will deposit below the level of the multipurpose pool.

Table 2-1 Chatfield Lake – Pre-Project Design Sediment Depletion Projections

Design Reservoir Volume by Pool Elevation					
Pool Zone	**Elevation**	**Surface Area**	**Initial Volume**	**Projected 100-year Volume**	**Projected Depletion Rate**
Maximum Surcharge	5521.6	6,245 acres	354,905 ac-ft	335,958 ac-ft	189.5 ac-ft/yr
Flood Control	5500.0	4,822 acres	235,000 ac-ft	216,053 ac-ft	
Multipurpose	5430.0	1,348 acres	23,800 ac-ft	4,853 ac-ft	
Sediment	5426.0	1,097 acres	18,947 ac-ft	0	

2.3 1977 Reservoir Storage Capacity Calculations

The initial conditions survey of the twenty-four sediment cross sections at Chatfield Lake occurred in 1977. The reservoir capacity table calculated from this survey is summarized in Table 2-2. The projected capacity of 23,800 acre-feet was calculated for a multipurpose pool elevation of 5430.0. Sometime in the 1970’s, the top of the multipurpose pool elevation was changed to elevation 5432.0 feet. The measured value of the capacity of the multipurpose pool elevation was 28,076 acre-feet. This value is the starting point for all projected calculations of future reservoir depletion.

2.4 2010 Reservoir Storage Capacity Calculations

The current area and capacity tables for Chatfield Lake are calculated from the 2010 in-house hydrographic surveys and summarized in Table 2-3. The long-term reservoir depletion rate (1977-2010) is calculated at -30.3 acre-feet/year. Plotted cross sections for sediment cross sections CH-01 thru CH-05 and CH-15 thru CH-17 are presented in Figures 3-3 to 3-10. These plotted cross sections represent sections within the Chatfield multipurpose pool and show little evidence of major deposition.

Table 2-2 1977 Reservoir Storage Capacity Table

DENVER TRI-LAKES PROJECT - CHATFIELD LAKE RESERVOIR STORAGE CAPACITY IN ACRE-FEET (From 1977 Hydrographic Survey Data)										
ELEV.	0	1	2	3	4	5	6	7	8	9
5370	0	0	0	0	0	0	0	0	0	1
5380	1	3	6	10	17	29	42	56	75	103
5390	145	194	246	312	405	533	698	893	1116	1368
5400	1648	1954	2285	2646	3040	3470	3937	4439	4974	5542
5410	6142	6774	7438	8135	8862	9620	10406	11220	12067	12948
5420	13868	14823	15812	16838	17906	19022	20185	21392	22643	23937
5430	25274	26654	28076	29542	31052	32609	34211	35857	37549	39288
5440	41076	42913	44799	46732	48713	50740	52814	54934	57102	59316
5450	61578	63886	66239	68640	71090	73592	76148	78757	81415	84116
5460	86857	89637	92460	95325	98233	101183	104174	107205	110280	113402
5470	116575	119799	123071	126392	129760	133177	136642	140156	143718	147326
5480	150980	154678	158421	162211	166049	169937	173871	177849	181878	185964
5490	190114	194327	198599	202930	207321	211773	216286	220860	225494	230185
5500	234932	239734	244592	249507	254480	259512	264602	269750	274957	280221
5510	285543	290924	296365	301863	307416	313022	318681	324396	330164	335987
5520	341862	347790	353770	359805	365894	372041	378244	384503	390818	397189
5530	403616									

Table 2-3 2010 Reservoir Storage Capacity Table

DENVER TRI-LAKES PROJECT - CHATFIELD LAKE RESERVOIR STORAGE CAPACITY IN ACRE-FEET (From 2010 Hydrographic Survey Data)										
ELEV	0	1	2	3	4	5	6	7	8	9
5380	0	0	0	1	6	16	27	40	57	84
5390	123	170	221	285	371	486	628	792	981	1198
5400	1448	1727	2033	2370	2742	3154	3610	4108	4640	5200
5410	5781	6379	6997	7644	8325	9048	9814	10618	11458	12334
5420	13243	14184	15159	16169	17217	18306	19433	20595	21798	23046
5430	24343	25687	27076	28511	29997	31534	33124	34764	36455	38196
5440	39986	41830	43727	45672	47658	49679	51730	53816	55942	58116
5450	60344	62625	64954	67333	69763	72245	74782	77374	80015	82701
5460	85426	88190	90997	93846	96739	99675	102654	105676	108742	111851
5470	115005	118200	121436	124717	128050	131440	134890	138395	141953	145557
5480	149205	152895	156629	160410	164239	168117	172040	176008	180026	184101
5490	188242	192446	196710	201034	205420	209870	214385	218966	223607	228307
5500	233061	237871	242739	247664	252643	257676	262760	267897	273089	278339
5510	283648	289018	294447	299933	305477	311078	316737	322454	328228	334056
5520	339935	345865	351847	357882	363973	370120	376324	382583	388898	395269
5530	401695									

3 Chatfield Reservoir Storage Capacity Projections

3.1 +50 and +100 Year Reservoir Storage Capacity Projections

Table 3-1 is a comparison of historical short- and long-term sediment depletion rates. There is little variation between the short- and long-term depletion rates in any time period.

Table 3-1 Comparison of Short- & Long-Term Depletion Rates

Short-Term Rate Acre-feet/year	*Time Period*	*Long-Term Rate Acre-feet/year*	*Time Period*
-32.3	*1977-1991*	*-32.3*	*1977-1991*
-28.0	*1991-1998*	*-30.9*	*1977-1998*
-29.3	*1998-2010*	*-30.3*	*1977-2010*

The difference between the design storage depletion rate of 189.5 acre-feet/year and the 2010 measured long-term depletion rate is probably due to the lack of any sediment load measurements in the upper South Platte River basin stated in Section 2.2 when computing the original sediment rate estimates.

Future reservoir capacities using the measured depletion rate of -30.3 acre-feet/year are summarized in Tables 3-2, 3-3 and plotted in Figure 3-1. Also presented in Figure 3-1 is an upper range depletion rate using the adjacent Cherry Creek Reservoir (-44.0 acre-feet/year). Using the measured storage depletion rate of -30.3 acre-feet/year, the reservoir storage capacity in 50 years (year 2060) at Chatfield will be 25,561 acre-feet when 90.8% of total storage capacity will remain (at the multipurpose pool elevation of 5432.0). The reservoir storage capacity in 100 years (year 2110) will be 24,046 acre-feet when 85.4% of total storage capacity will remain.

Past rates should be evaluated with caution. Periods of drought may have lessened sediment inflow into Chatfield Lake. In addition, the construction of upstream reservoirs has also impacted sediment inflow. Other impacts such as basin land use, extreme hydrologic events, and forest fires can also have a significant impact on basin sediment yield. In a small basin such as Chatfield, the impacts on sediment inflow from these types of changes are magnified.

3.2 Recommended Design Rate

For evaluation purposes, all three sediment depletion rates should be considered. These rates are presented in Table 3-2, Table 3-3, and Figure 3-1. Selection of the most appropriate design sediment depletion rate, between the -30.3 Chatfield measured rate, the -44.0 Cherry Creek comparison rate, and the original project design rate of -189.5 acre feet/year will depend on project objectives. When selecting the design depletion rate, it should be noted that:

- Past rates should be evaluated with caution. Sediment depletion rates are highly event driven and respond to extreme hydrologic events.
- Basin land use can quickly impact rates.
- Specific events such as forest fires can dramatically alter sediment yields.

Table 3-2 Reservoir Sediment Depletion Projections (+50 and +100 years) From Year 1977

Chatfield Lake – Reservoir Depletion Projections at Elevation 5432.0 (top of multipurpose pool)								
Multipurpose Pool Elev. 5432.0	1977 Reservoir Capacity	Sediment Depletion Rate	2010 Reservoir Capacity		2060 (+ 50 years) Reservoir Capacity		2110 (+ 100 years) Reservoir Capacity	
	Acre-Feet	Acre-Feet/Year	Acre-Feet	Capacity Remaining	Acre-Feet	Capacity Remaining	**Acre-Feet**	Capacity Remaining
Design Depletion Rate	28,076	189.5	21,633	77.1%	12,158	43.3%	2,683	9.6%
Measured Depletion Rate	28,076	30.3	27,046	96.3%	25,531	90.9%	24,016	85.5%
Upper Range – Cherry Creek	28,076	44.0	26,580	94.7%	24,380	86.8%	22,180	79.0%

Table 3-3 Reservoir Storage Capacity Summary (Elev. 5432.0 - top of multipurpose pool)

Design	2010		Time Period	Year
	Measured	Adjusted		
189.5	30.3	44.0		
acre-feet/year			year	
28,076			-33	1977
21,823	27,076	27,076	0	2010
12,348	25,561	24,876	50	2060
2,873	24,046	22,676	100	2110

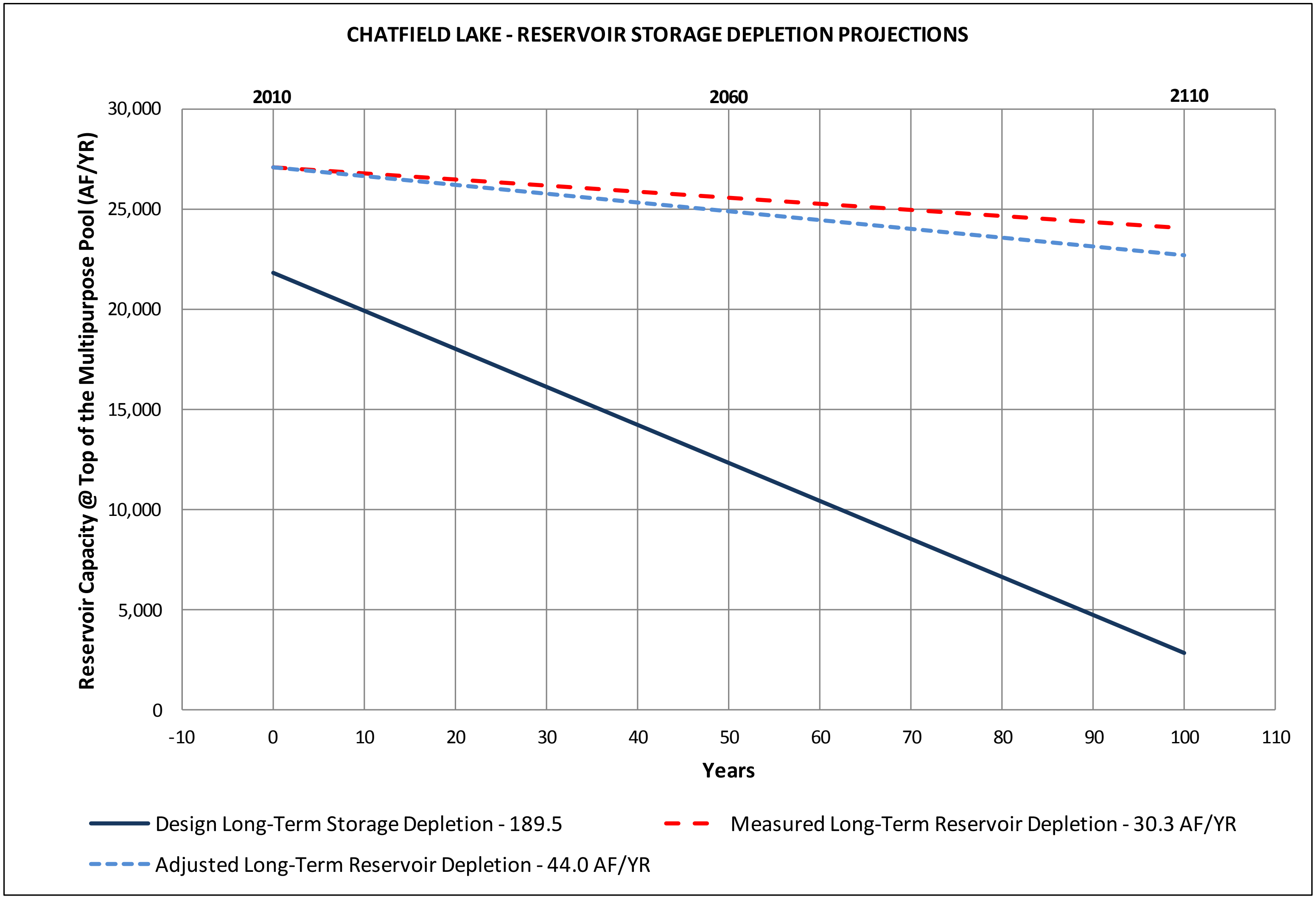

Figure 3-1 Chatfield Lake - Reservoir Storage Depletion Projections @ Elev. 5432.0 (top of multipurpose pool)

Chatfield Lake – Cross Section Plots

DENVER TRI-LAKES PROJECTS
SEDIMENT DEPLETION RATES IN CHATFIELD LAKE
FUTURE CONDITIONS (+50 & +100 YEARS)

January 2012

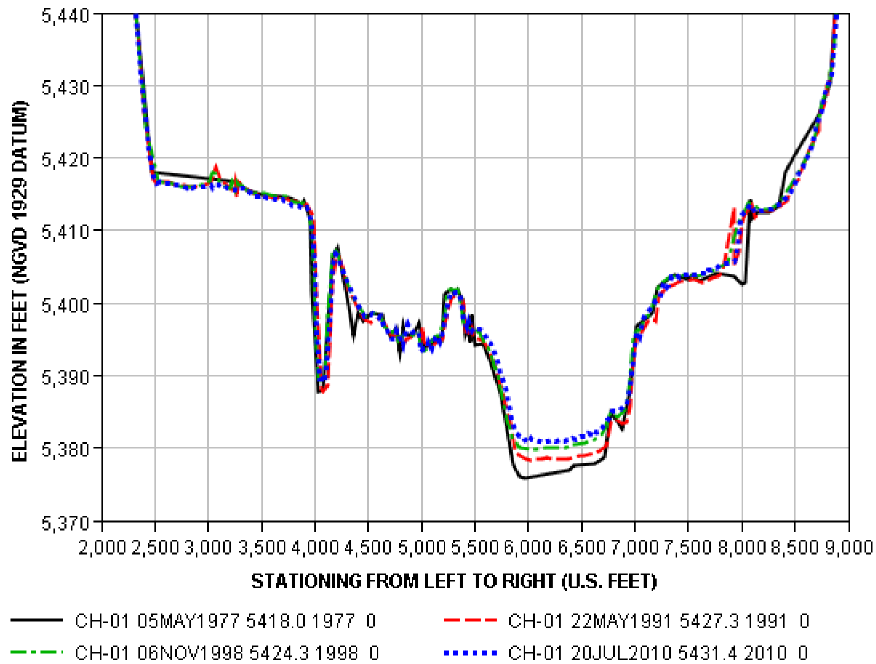

Figure 3-2 Chatfield Cross Section CH-01 (S. Platte River Arm)

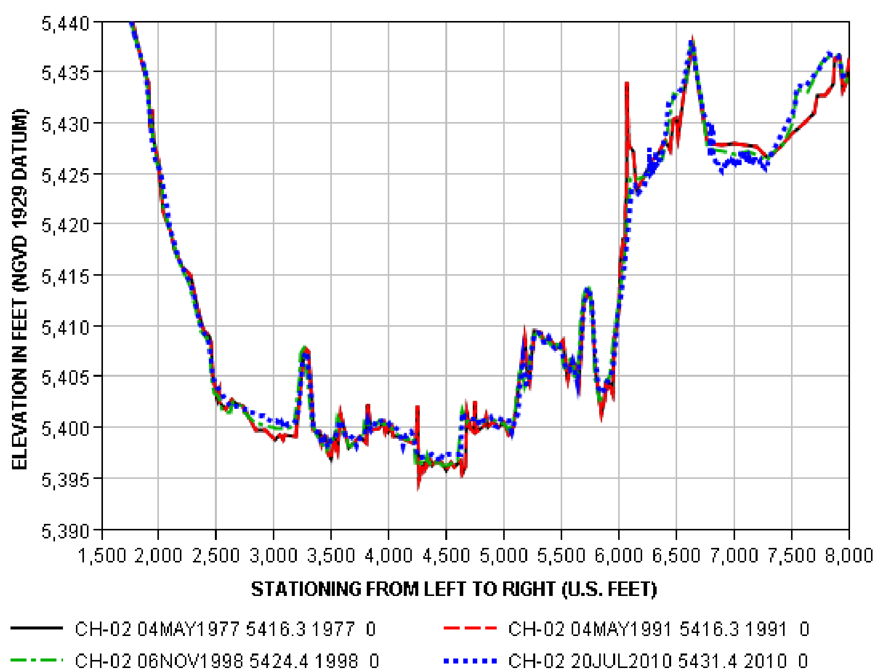

Figure 3-3 Chatfield Cross Section CH-02 (S. Platte River Arm)

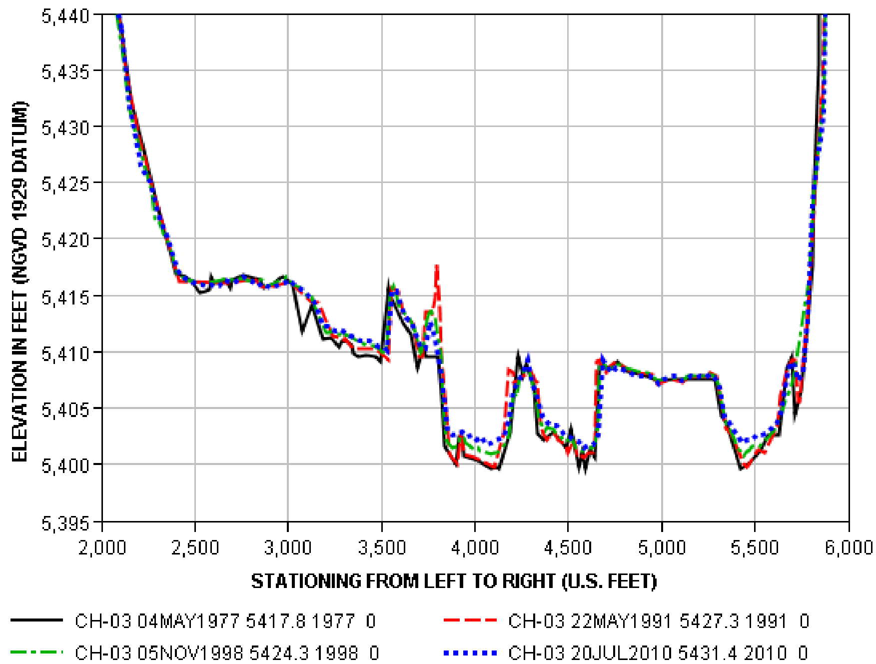

Figure 3-4 Chatfield Cross Section CH-03 (S. Platte River Arm)

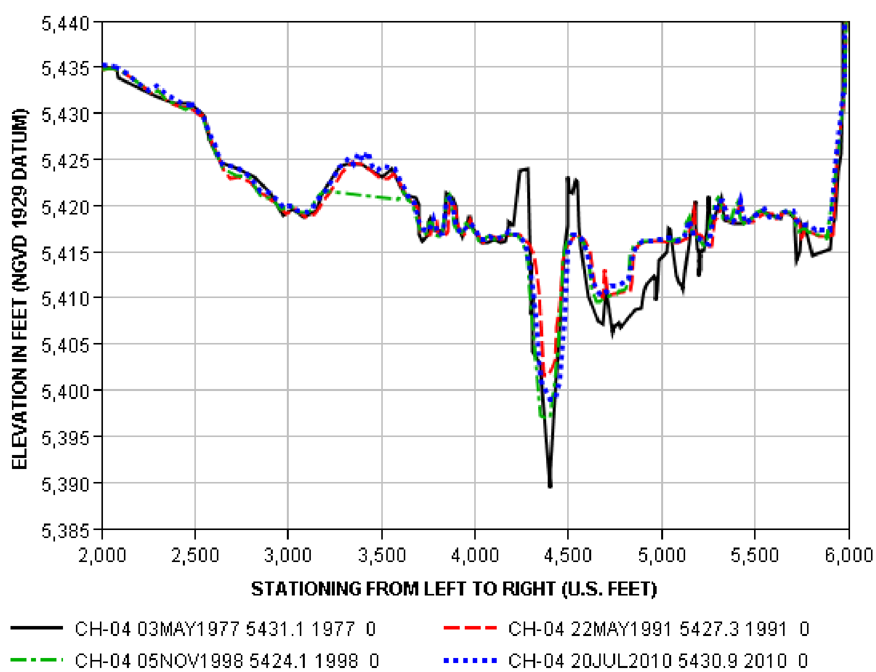

Figure 3-5 Chatfield Cross Section CH-04 (S. Platte River Arm)

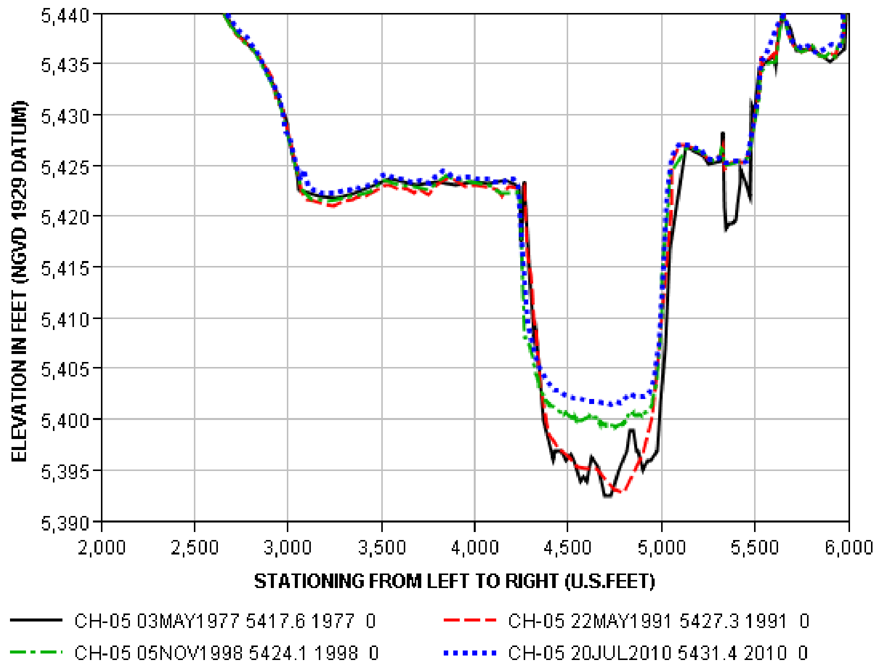

Figure 3-6 Chatfield Cross Section CH-05 (S. Platte River Arm)

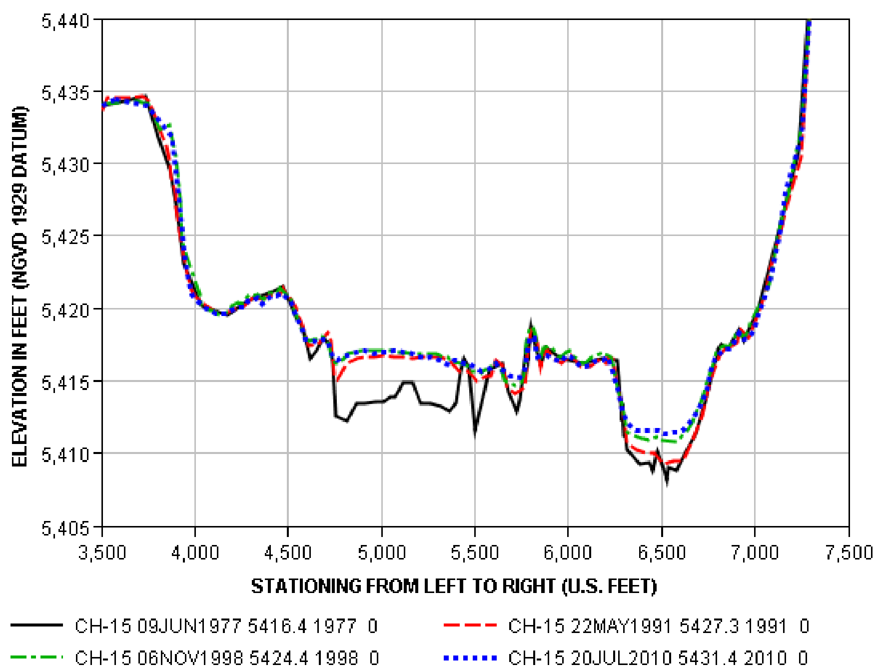

Figure 3-7 Chatfield Cross Section CH-15 (Plum Creek Arm)

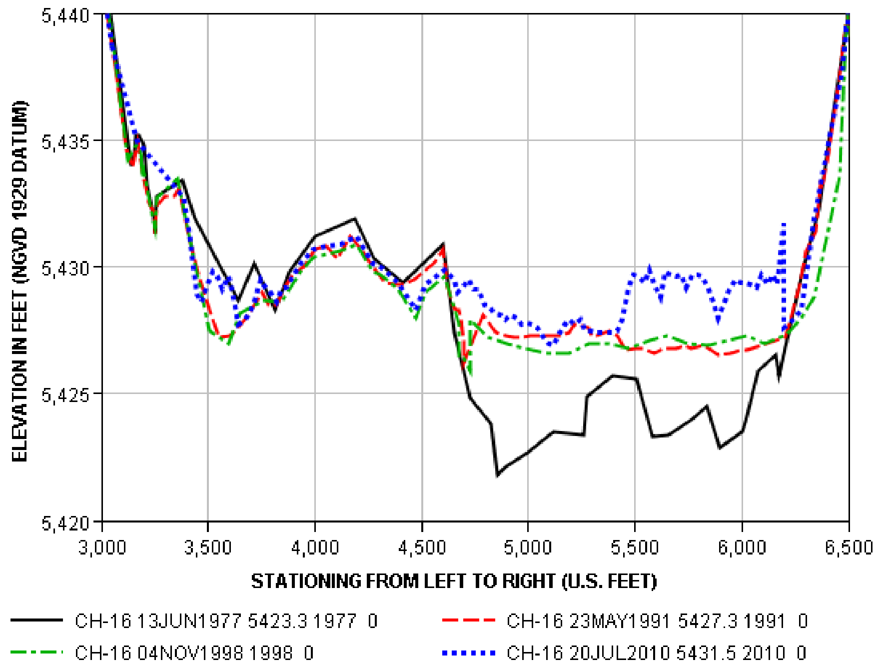

Figure 3-8 Chatfield Cross Section CH-16 (Plum Creek Arm)

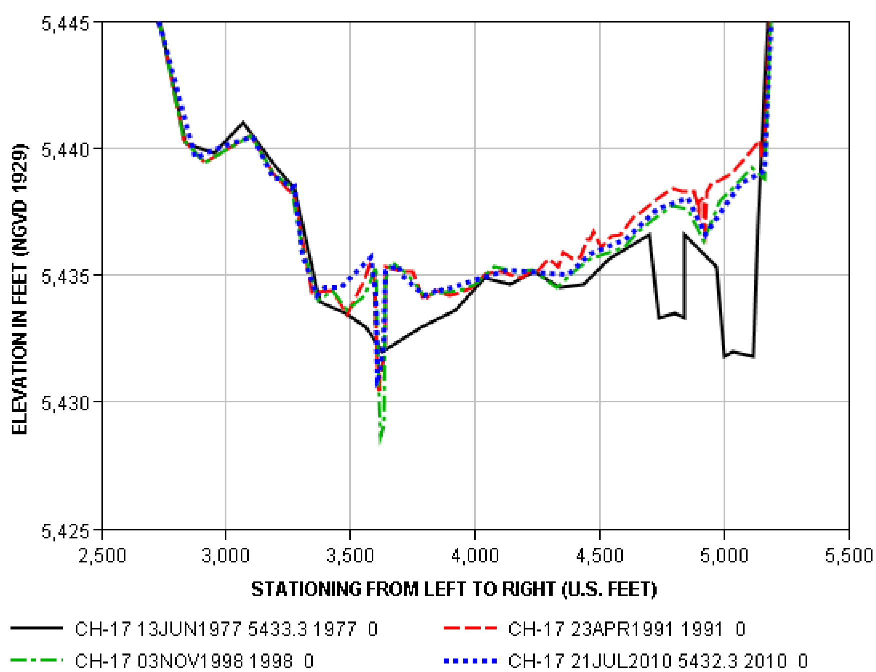

Figure 3-9 Chatfield Cross Section CH-17 (Plum Creek Arm)

Appendix A

Omaha District Reservoir Area-Capacity Analysis

DENVER TRI-LAKES PROJECTS
SEDIMENT DEPLETION RATES IN CHATFIELD LAKE
FUTURE CONDITIONS (+50 & +100 YEARS)

January 2012

Area-Capacity Computation Procedure

The constant factor method is the USACE Omaha District procedure for determining reservoir capacity by elevation which is an offshoot of the traditional "average-end-area" method, adjusted to include factors that take into account the non-uniformity of reservoir contours. For this procedure, portions of the reservoir bounded by one or more sediment range lines and the dam crest contour are considered as segments for determining storage capacity. Those portions of a segment situated between consecutive contours are referred to as sub-segments. The four steps required in developing the constant factor method are as follows:

$$L = \frac{V_o}{\frac{1}{2}(A_o' + A_o'')} \qquad \textbf{\textit{Equation 1}}$$

$$V_f = \frac{(A_f' + A_f'')\,L}{2} \qquad \textbf{\textit{Equation 2}}$$

$$V_f = \frac{V_o}{(A_o' + A_o'')}(A_f' + A_f'') \qquad \textbf{\textit{Equation 3}}$$

$$Let\ f = \frac{V_o}{(A_o' + A_o'')}$$

$$V_f = f(A_f' + A_f'') \qquad \textbf{\textit{Equation 4}}$$

Where:

L = the effective length of the sub-segment

V_o = Original volume of the sub-segment

V_f = Future volume of the sub-segment (difference between V_o and sediment volume)

A_o'= Original area of downstream sub-segment section

A_o'' = Original area of upstream sub-segment section or sections

A_f' and A_f'' = Respective future sub-segment section areas

f = Constant factor (ratio) for sub-segment

The first equation above is based upon the effective length of an incremental volume, namely, the distance by which the mean end area is multiplied to obtain the original volume. Equation 2 shows it is possible to estimate the subsequent volume having the same effective length as the original volume. In

Equation 3, the effective length cancels out and the constant factor (also referred to as "ratio") obtained is simply a ratio of the original volume to the sum of the original end areas. Substituting the factor f for this ratio, Equation 4 becomes the simplified formula for computing volumes. Once determined for a unit, this factor is assumed constant and is applied for all future sedimentation surveys.

The capacity computations were originally part of a four part software package written in FORTRAN programming language that was developed by the USACE Omaha District in 1960's and 1970's. The software package includes SATOVOL, SACHELM, VOLRATIO, and SAREACAP. The output from each program serves as an input file to the program that follows. The program AreaCapacity, developed by WEST Consultants, Inc. in August 2000, for the USACE Omaha District, is a Windows® based graphical user interface integrating the four original programs.

The first program, SATOVOL, uses the surface areas at given contour elevations for each segment of the reservoir to compute original segment volumes at incremental elevations (V_o in the above equations). These volumes are combined with original cross section end areas (A_o' and A_o'' above), computed by SACHELM, to calculate sub-segment ratios (the constant factor f in Equation 3 and 4) using VOLRATIO. This surface area-to-volume-to-ratio procedure needs to be run only for the original capacity computations of each reservoir since the computed ratios are assumed to remain constant for all subsequent resurveys. The remaining program in the series, SAREACAP, combines reservoir sub-segment and segment volumes to compute total reservoir volume by elevation, the area and capacity tables. For resurveys the reservoir storage-elevation relationship is updated (to account for sediment deposition) by multiplying the new segment end areas by the original constant factor (Equation 4).

END OF REPORT.