CDM

Illinois Environmental
Protection Agency

Middle Fork Saline River Watershed TMDL
Stage Three
Draft Report

August 2010

Draft Report

THIS PAGE INTENTIONALLY LEFT BLANK

Contents

Section 9 Implementation Plan for the Middle Fork Saline River Watershed

Figures

THIS PAGE INTENTIONALLY LEFT BLANK

Tables

THIS PAGE INTENTIONALLY LEFT BLANK

Acronyms

°F	degrees Fahrenheit
ALMP	Ambient Lake Monitoring Program
BMP	best management practice
BOD	biochemical oxygen demand
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
cfs	cubic feet per second
CRP	Conservation Reserve Program
CWA	Clean Water Act
DEM	Digital Elevation Model
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
DP	dissolved phosphorus
ft	foot
GIS	geographic information system
GWLF	generalized watershed loading function
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICLP	Illinois Clean Lakes Program
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
ILLCP	Illinois Interagency Landscape Classification Project
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
LA	load allocation
LC	loading capacity
MBI	Macroinvertebrate Biotic Index
mg/L	milligrams per liter
MOS	margin of safety
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NRCS	National Resource Conservation Service
PO_4	phosphate
SSURGO	Soil Survey Geographic Database

STATSGO	State Soil Geographic
STORET	Storage and Retrieval
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	waste load allocation

Section 7
Methodology Development for the Middle Fork Saline River Watershed

7.1 Total Maximum Daily Load Overview

A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, the Illinois Environmental Protection Agency (Illinois EPA) must identify water bodies not meeting water quality standards and then establish TMDLs for restoration of water quality. Illinois EPA lists water bodies not meeting water quality standards every two years. This list is called the 303(d) list and water bodies on the list are then targeted for TMDL development.

In general, a TMDL is a quantitative assessment of water quality problems, contributing sources, and pollution reductions needed to attain water quality standards. The TMDL specifies the amount of pollution or other stressor that needs to be reduced to meet water quality standards, allocates pollution control or management responsibilities among sources in a watershed, and provides a scientific and policy basis for taking actions needed to restore a water body.

Water quality standards are laws or regulations that states authorize to enhance water quality and protect public health and welfare. Water quality standards provide the foundation for accomplishing two of the principal goals of the CWA. These goals are:

- Restore and maintain the chemical, physical, and biological integrity of the nation's waters
- Where attainable, to achieve water quality that promotes protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water

Water quality standards consist of three elements:

- The designated beneficial use or uses of a water body or segment of a water body
- The water quality criteria necessary to protect the use or uses of that particular water body
- An antidegradation policy

Examples of designated uses are recreation and protection of aquatic life. Water quality criteria describe the quality of water that will support a designated use. Water quality criteria can be expressed as numeric limits or as a narrative statement. Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected.

7.2 TMDL Goals and Objectives for the Middle Fork Saline River Watershed

The Illinois EPA has a three-stage approach to TMDL development. The stages are:

- Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection
- Stage 2 – Data Collection (optional)
- Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

This report addresses Stage 3 TMDL development for the Middle Fork Saline River watershed. Stage 1 of the TMDL (available at http://www.epa.state.il.us/water/tmdl/report-status.html) was completed in 2008. Following are the impaired water body segments in the Middle Fork Saline watershed for which TMDLs were developed (Figure 7-1):

- Bankston Fork (ATGC-01)
- Bankston Fork (ATGC-02)
- Bankston Fork (ATGC-11)
- Brushy Creek (ATGH-09)
- Brushy Creek (ATGH-10)
- Harco Branch (ATGM-01)
- Harrisburg Reservoir (RAI)

7.3 Methodology Overview

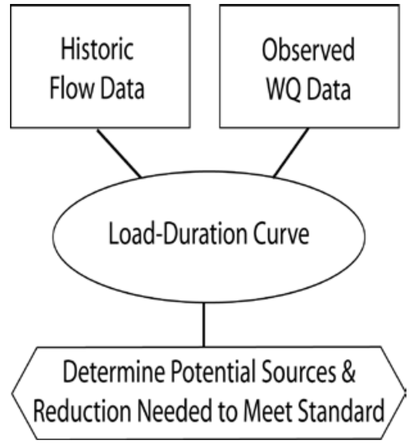
Table 7-1 contains information on the methodologies selected and used to develop TMDLs for impaired segments within the Middle Fork Saline River watershed.

Table 7-1 Methodologies Used to Develop TMDLs in the Middle Fork Saline River Watershed

Segment Name/ID	Causes of Impairment	Methodology
Bankston Fork - ATGC-01	Manganese, Silver, Sulfates, Fecal coliform	Load Duration Curves
Bankston Fork - ATGC-02	Manganese, Silver, Sulfates	Load Duration Curves
Bankston Fork - ATGC-11	Manganese, Sulfates	Load Duration Curves
Brushy Creek - ATGH-09	Manganese, Sulfates	Load Duration Curves
Brushy Creek - ATGH-10	Silver, Sulfates	Load Duration Curves
Harco Branch - ATGM-01	Copper, Manganese, Nickel, pH, Silver, Sulfates, Zinc	Load Duration Curves
Harrisburg Reservoir - RAI	Total Phosphorus	BATHTUB

7.3.1 Load-Duration Curve Overview

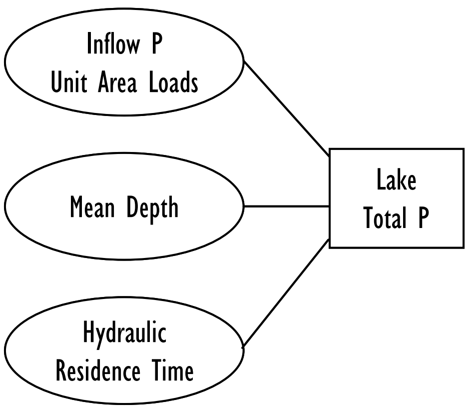
Loading capacity analyses were performed for each of the impaired stream segments in this watershed (ATGC-01, ATGC-02, ATGC-11, ATCH-09, ATGH-10, and ATGM-10). A load-duration curve is a graphical representation of the maximum load of a pollutant that a stream segment can assimilate over a range of flow scenarios while still meeting the instream water quality standard. The load-duration curve approach utilizes historic flow data and observed water quality data to provide useful information regarding the magnitude and frequency of exceedences as well as the flow scenarios when exceedences occur most often (see Schematic 1). In the Middle Fork Saline River watershed, load duration curves were constructed for a number of contaminants including; copper, manganese, nickel, silver, zinc, sulfates, and fecal coliform.



Schematic 1

7.3.2 BATHTUB Overview

TMDL analysis for total phosphorus in Harrisburg Reservoir involved the use of observed data coupled with the rational method as inputs to the BATHTUB model. This method required inputs from several sources including online databases and GIS-compatible data.



Schematic 2

Schematic 2 shows the data inputs for the BATHTUB model that was used to calculate the TMDL. Subbasin flows were estimated using the area ratio method and phosphorus loadings to the reservoir from the surrounding watersheds were estimated using the unit area load method, also known as the "export coefficient" method (USEPA 2001). This method is based on the assumption that, on an annual basis and normalized to area, a roughly constant runoff pollutant loading can be expected for a given landuse type. This method also requires that unit area loads are not applied to watersheds that differ greatly in climate, hydrology, soils, or ecology from those from which the parameters were derived (USGS 1997).

Once the subbasin flows and concentrations were estimated, they were used as input for the BATHTUB model. The BATHTUB model uses empirical relationships between mean reservoir depth, total phosphorus inputted to the lake, and the hydraulic residence time to determine in-reservoir concentrations (see Schematic 2).

7.4 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine copper, manganese, nickel, silver, zinc, sulfates, fecal coliform, and total phosphorus levels in the impaired waterbodies in the Middle Fork Saline River watershed.

Harco Branch segment ATGM-01 is also listed for impairment caused by pH. pH is a measure of acidity and/or alkalinity in the stream and not associated with a pollutant load but rather the amount of H^+ ion in the solution. It is anticipated that pH issues will be addressed by implementing load reduction strategies for the TMDL pollutants associated with the segment, as outlined in Section 9 of this document. Therefore, a specific TMDL calculation for pH on Harco Branch segment ATGM-01 will not be developed at this time.

7.4.1 Load Duration Curve Development

Load duration curves are used to gain understanding of the range of loads allowable throughout the flow regime of a stream. This approach was used to characterize the current loading of contaminants to impaired segments of Bankston Fork (ATGC-01, ATGC-02, and ATGC-11), Brushy Creek (ATGH-09 and ATGH-10), and Harco Branch (ATGM-01).

7.4.1.1 Watershed Delineation and Flow Estimation

Watersheds for the areas contributing directly to the impaired stream segments at the Illinois EPA data collection stations were delineated with GIS analyses through use of the NED as discussed in Section 2.2 of the Stage 1 report. The delineation determined that Bankston Fork segments ATGC-01, ATGC-02, and ATGC-10 capture flows from directly contributing watersheds of approximately 76.3, 39.2, an 10.1 square miles, respectively. Brushy Creek segment ATGH-09 captures flows from a directly contributing watershed of 21.8 square miles and the watershed for Brushy Creek segment ATGH-10 is 16.6 square miles. Stream segment ATGM-01 on Harco Branch is somewhat smaller with a watershed area of approximately 4.0 square miles. Figure 7-2 shows the location of the water quality stations on each segment as well as the boundary of the GIS-delineated watersheds.

In order to create a load duration curve, it is necessary to obtain flow data corresponding to each water quality sample. As discussed in Section 2.6.3 of the Stage 1 report, there are no USGS stream gages within the watersheds that have current, or even recent, streamflow data. Therefore, the drainage area ratio method, represented by the following equation, was used to estimate flows.

$$\mathbf{Q_{gaged}}\left(\frac{\mathbf{Area_{ungaged}}}{\mathbf{Area_{gaged}}}\right)=\mathbf{Q_{ungaged}}$$

where	Q_{gaged}	=	Streamflow of the gaged basin
	$Q_{ungaged}$	=	Streamflow of the ungaged basin
	$Area_{gaged}$	=	Area of the gaged basin
	$Area_{ungaged}$	=	Area of the ungaged basin

The assumption behind the equation is that the flow per unit area is equivalent in watersheds with similar characteristics. Therefore, the flow per unit area in the gaged watershed multiplied by the area of the ungaged watershed estimates the flow for the ungaged watershed.

USGS gage 05597500 (Crab Orchard Creek near Marion, Illinois) was chosen as an appropriate gage from which to estimate flows for all impaired stream segments in the

Middle Fork Saline River watershed. The Crab Orchard Creek watershed is approximately 9 miles west of the nearest sampling site on the impaired segments in the Middle Fork Saline River watershed (ATGC-11) and approximately 19 miles west of the furthest sampling site in the watershed (ATGC-01). The gage drains an area of 31.7 square miles, which is within an order of magnitude in size as the watersheds delineated for the impaired segments in the Middle Fork Saline River watershed and receives comparable precipitation throughout the year.

Data were downloaded through the USGS for the Crab Orchard Creek gage and multiplied by the area ratio method discussed above to estimate flows for each watershed. Only one of the four NPDES permitted facilities in the Crab Orchard watershed has a measureable permitted flow (Crab Orchard Grade & High School permit number IL0037311). The facility is permitted to discharge 0.003 million gallons per day (mgd). These flows were subtracted from the gage to account for point source influence. The Liberty Mine (NPDES IL 0059749) has two outfalls that discharge upstream of Brushy Creek segment ATGH-10. Stormwater sedimentation ponds discharge from outfalls 005 and 009 at rates of 0.074 mgd and 0.002 mgd, respectively. Additional adjustments were made to account for these flows in Brushy Creek and Bankston Fork segment ATGC-01 which are downstream of these outfalls. Spreadsheets used for the area ratio flow calculations are provided in Appendix A.

7.4.1.2 Manganese: Bankston Fork ATGC-01, ATGC-02, ATGC-11, Brushy Creek ATGH-09, and Harco Branch ATGM-01

Flow duration curves for each impaired segment were generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. The flows in the duration curve were then multiplied by the water quality standard for manganese to generate a load duration curve. The general use water quality standard for manganese is 1.0 mg/L (302.208(g)).

Data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development and data collected by Illinois EPA in 2008 and 2009 were paired with the corresponding flow for the sampling dates and plotted against the load duration curves. Figures 7-3 through 7-7 show the load duration curves as solid lines and the historically observed pollutant loads for manganese as points on each graph.

Historic data are limited within the watershed with the exception of Bankston Fork segment ATGC-01. The load duration curve for manganese on this segment shows that, out of the 137 total samples collected since 1990, 59 have exceeded the total manganese standard of 1.0 mg/L (or 1,000 ug/L). Eighty percent of the exceedences for manganese on this segment have occurred during mid-range to high flows and there have been zero exceedences in the lowest flow category.

The remaining segments (Bankston Fork ATGC-02 and ATGC-11, Brushy Creek ATGH-09, and Harco Branch ATGM0-01) each have six historic samples available for analysis. The load duration curves for manganese on these segments show that all exceedences occurred under mid-range to high flow conditions. Spreadsheets used for the calculation of manganese load duration curves are provided in Appendix B.

7.4.1.3 Silver: Bankston Fork ATGC-01, ATGC-02, Brushy Creek ATGH-10, and Harco Branch ATGM-01

Flow duration curves for analysis of silver loads to impaired segments were generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. The flows in the duration curve were then multiplied by the water quality standard for silver to generate a load duration curve. The general use water quality standard for silver is 5 ug/L (302.208(g)).

Data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development and data collected by Illinois EPA in 2008 and 2009 were paired with the corresponding flow for the sampling dates and plotted against the load duration curves. Figures 7-8 through 7-11 show the load duration curves as solid lines and the historically observed pollutant loads for silver as points on each graph.

The load duration curve for silver on Bankston Fork ATGC-01 shows that 29 of the 137 total samples exceeded the water quality criteria since 1990. Exceedences at ATGC-01 are distributed evenly throughout the range of flows with the greatest number of exceedences occurring in the mid-range of flow values. The load duration curve developed for silver at ATGC-02 shows the 2 of 6 samples exceeded the water quality standard. One of the exceedences was in a relatively high flow range and the other was in a relatively low flow range. Analysis of the load duration curve developed for silver at Brushy Creek segment ATGH-10 shows that there has only been 1 exceedence of the silver criteria since 1990. The one exceedence occurred under relatively low flow conditions. Appendix C contains spreadsheets used for the calculation of the load duration curves for silver.

7.4.1.4 Sulfates: Bankston Fork Segment ATGC-01, ATGC-02, ATGC-11, Brushy Creek ATGH-09, ATGH-10, and Harco Branch ATGM-01

Flow duration curves for sulfate analysis were generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. The sulfate standard has recently been updated in the State of Illinois (2008). The general use standard was previously 500 mg/L as outlined in Section 302.208(g) of the water quality standards. The recently adopted standard for sulfate states that "the following concentrations for sulfate must not be exceeded except in receiving waters for which mixing is allowed pursuant to Section 302.102:

1. At any point where water is withdrawn or accessed for purposes of livestock watering, the average of sulfate concentrations must not exceed 2,000 mg/L when measured at a representative frequency over a 30 day period.

2. The results of the following equations provide sulfate water quality standards in mg/L for the specified ranges of hardness (in mg/L as $CaCO_3$) and chloride (in mg/L) and must be met at all times:

    a. If the hardness concentration of receiving waters is greater than or equal to 100 mg/L but less than or equal to 500 mg/L, and if the chloride concentration of waters is greater than or equal to 25 mg/L but less than or equal to 500 mg/L, then: C = [1276.7 + 5.508 (hardness) – 1.457 (chloride)] * 0.65 where, C = sulfate concentration

    b. If the hardness concentration of waters is greater than or equal to 100 mg/L but less than or equal to 500 mg/L, and if the chloride concentration of waters is greater than or equal to 5 mg/L but less than 25 mg/L, then: C = [-57.478 + 5.79 (hardness) + 54.163 (chloride)] * 0.65 where C = sulfate concentration

3. The following sulfate standards must be met at all times when hardness (in mg/L as $CaCO_3$) and chloride (in mg/L) concentrations other than specified in (h)(2) are present:

    a. If the hardness concentration of waters is less than 100 mg/L or chloride concentration of waters is less than 5 mg/L, the sulfate standard is 500 mg/L.

    b. If the hardness concentration of waters is greater than 500 mg/L and the chloride concentration of waters is 5 mg/L or greater, the sulfate standard is 2,000 mg/L.

    c. If the combination of hardness and chloride concentrations of existing waters are not reflected in subsection (h)(3)(A) or (B), the sulfate standard may be determined in a site-specific rulemaking pursuant to section 303(c) of the Federal Water Pollution Control Act of 1972 (Clean Water Act), 33 USC 1313, and Federal Regulations at 40 CFR. 131.10(j)(2).

In order to develop a load duration curve to analyze sulfate, the flows in the duration curves were multiplied by the most commonly calculated standards for sulfates (500 and 2,000 mg/L).

Data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development were paired with the corresponding flow for the sampling date and plotted against the load duration curve. Data collected by IEPA in 2008, but not available for the Phase 1 report, were also included in the load duration plots. Figures 7-12 through 7-17 show the load duration curves as two solid lines (sulfate loads at 2,000 mg/L and 500 mg/L) and the observed pollutant loads as points on each graph. Actual exceedences of calculated sulfate criteria are highlighted using an alternate point symbol. Appendix D contains the spreadsheet used for this analysis.

On Bankston Fork at ATGC-01, a total of 14 of 116 sulfate samples exceeded the calculated standard with a higher concentration of exceedences observed in the lower flow ranges (2 additional exceedences were observed in the zero-flow range, but are not shown on the load duration plot). Using the new calculated standard, data show no violations on segment ATGC-02 of Bankston Fork or on Harco Branch segment ATGM-01. No further TMDL analysis for sulfates will be completed for these segments as loads do not need to be reduced. Load duration analysis for sulfates at Bankston Fork segment ATGC-11 reveals that 3 of 6 samples collected in this segment since 1990 exceed the calculated water quality criteria. The exceedences are found in low, medium and high flow conditions, suggesting that sulfate exceedences can occur across a broad range of flow conditions. Analysis for sulfates at segment ATGH-09 reveals that 1 of 6 samples collected in this segment since 1990 exceed the calculated water quality criteria. The exceedence occurred under relatively low flow conditions. Load duration analysis for sulfates at segment ATGH-10 reveals that 1 of 6 samples collected in this segment since 1990 exceed the calculated water quality criteria. The exceedence occurred under low flow conditions.

7.4.1.5 Copper, Nickel, and Zinc: Harco Branch ATGM-01

Flow duration curves for Harco Branch ATGM-01 were generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. Water quality standards for dissolved copper, dissolved nickel, and dissolved zinc can be found in Section 302.208(e) of the Illinois water quality standards. Standards for these metals are expressed as acute and chronic calculations that are dependent on instream hardness values. The load duration curves for each parameter were developed by multiplying the flow duration values by the acute standards calculated for the lowest observed hardness value on the segment (100 mg/L). Actual exceedences of the standards are based on acute standards calculated for each sample using total hardness data collected at the time of sampling and are also shown on Figures 7-18 through 7-20.

The load duration curve developed for copper shows 2 exceedences of the calculated acute standard for the 6 dissolved copper samples reported since 1990. Both exceedences occurred under medium to high flow conditions. Similarly, 3 of 6 samples collected for dissolved nickel and 3 of 6 samples collected for dissolved zinc at ATGM-01 since 1990 have exceeded the calculated acute water quality standard. The exceedences for nickel and zinc also occurred at medium to moderately elevated flow levels. Spreadsheets used for the calculation of load duration curves for copper, nickel and zinc at segment ATGM-01 are provided in Appendix E.

7.4.1.6 Fecal Coliform: Bankston Fork ATGC-01

A flow duration curve was developed for Bankston Fork segment ATGC-01 by determining the percent of days each estimated flow was exceeded, and then graphically plotting the results. Because the fecal coliform standard is seasonal and is only applicable between the months of May and October, only flows during this time period were used in the analysis. The flows in the duration curve were then multiplied by the water quality standard of 200 cfu/100mL to generate a load duration curve. Fecal coliform data collected between May and October were compiled from data amassed during Stage 1 of TMDL development. These data were then paired with the corresponding flows for the sampling dates and plotted against the load duration curve. Figure 7-21 shows the load duration curve for the segment as a solid line and the observed pollutant loads as points on the graphs. The load duration curve for fecal coliform indicates, since 1990, 24 of the 64 samples collected between the months of May and October have exceeded the geometric mean standard of 200 cfu/100mL, with a higher proportion of exceedences occurring in the mid to high flow ranges. Exceedences during high flows are likely attributable to the fecal matter introduced to the stream via overland runoff and the re-suspension of fecal material in the stream sediment. Appendix F contains spreadsheets used for the calculation of the load duration curves for fecal coliform at Bankston Fork segment ATGC-01.

7.4.2 BATHTUB Development for Harrisburg Reservoir

Harrisburg Reservoir is an approximately 220 acre reservoir located 1 mile east of Galatia, Illinois. The reservoir has a reported maximum depth of around 30 feet and an average depth of approximately 10 feet.

The BATHTUB model was used to develop the total phosphorus TMDL for Harrisburg Reservoir. BATHTUB has three primary input interfaces: global, reservoir segment(s), and watershed inputs. The individual inputs for each of these interfaces are described in the following sections along with watershed and operational information for the lake.

7.4.2.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in the Stage 1 report, the average annual precipitation input to the model was 38.4 inches, and the average annual evaporation input to the model was 36.1 inches (ISWS 2008). The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kilograms per square kilometer ($kg/km^{2)}$-year (U.S. Army Corps of Engineers [USACE] 1999). This value is based on a compilation of available historic data and Illinois EPA believes that it is appropriate for use in this watershed where site-specific rates of deposition are not available.

7.4.2.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Harrisburg Reservoir is modeled with three segments in BATHTUB. The segment boundaries are shown on Figure 7-22. Segmentation was established based on available water quality sampling locations and lake morphologic data. Segment inputs to the model include average depth, surface area, segment length, and depth to the metalimnion. The lake depth was represented by the 2002 data from the water quality stations discussed in the Stage 1 report. Segment lengths and surface areas were determined in GIS. These data are shown below (Table 7-2) for reference.

Table 7-2 Harrisburg Reservoir Segment Data

Segment	Surface Area (km^2)	Segment Length (km)	Average Depth (m)
RAI-1	0.232	0.83	7.69
RAI-2	0.433	1.40	4.40
RAI-3	0.286	0.96	2.55

7.4.2.3 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. Figure 7-22 also shows the subbasin boundaries. The watershed was broken up into three tributaries for purposes of the model. There is one primary tributary stream that flows into Harrisburg Reservoir, however, no water quality or flow data are available for this tributary. Therefore, the three areas contributing loads to each lake segment were used for the BATHTUB tributary inputs.

As discussed in Section 7.4.1, there are no flow gages within the watershed and the drainage area ratio method was used to estimate flows. The total mean flow into Harrisburg Reservoir was estimated to be 6.09 cfs. The flow contribution from each tributary was estimated by multiplying the average inflow by the ratio of the subbasin areas. The estimated flow from each tributary is shown in Table 7-3.

Table 7-3 Harrisburg Reservoir Tributary Subbasin Areas and Estimated Flows

Tributary Name	Lake Segment	Area (acres)	Flow Rate (cfs)
Overland Flow to RAI-3	Segment 1: RAI-3	3,226	4.88
Overland Flow to RAI-2	Segment 2: RAI-2	589	0.89
Overland Flow to RAI-1	Segment 3: RAI-1	212	0.32
	TOTAL	**4,027**	**6.09**

According to the USACE, the normal storage volume for Harrisburg Reservoir is 6,233 acre-feet (USACE, National Dam Inventory data for the Harrisburg Reservoir dam). Based on this storage volume and the inflow of 6.09 cfs, the lake residence time is approximately 1.41 years.

Because there are no available historic concentration data, phosphorus loads from the contributing watershed were estimated based on land use data and the median annual export coefficients for each land use. Export coefficients for each land use category found in the Harrisburg Reservoir watershed were extracted from the USEPAs PLOAD version 3.0 user's manual. This document provides an extensive list of phosphorus export coefficients for various land uses in several regions of the country compiled from a number of sources in the literature. The export coefficients for each land use are reported in lbs/acre/year which can then be multiplied by the number of acres of each land use in the Harrisburg Reservoir watershed to provide a total median phosphorus load into the reservoir. The overall load is then distributed to each tributary area for modeling input based on the proportion of the overall watershed represented by each subbasin.

7.4.2.4 BATHTUB Confirmatory Analysis

Historical water quality data for Harrisburg Reservoir are summarized in Section 5.1.2 of the Stage 1 report. These data were used to help confirm model calculations. Although the analyses presented below do lend confidence to the modeling, they should not be considered a true model "calibration." Additional lake and tributary water quality and flow data are required to fully calibrate the model.

The Harrisburg Reservoir BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. The lake concentrations are lower than the incoming tributary concentrations indicating that the lake is a net sink of total phosphorus. Therefore, in order to achieve a calibration, the model calibration coefficients for "sedimentation" rates (nutrient removal rates) were adjusted, rather than adjusting internal loads.

The model was simulated using the median phosphorus loads calculated with the unit area load method. These initial results showed that the predicted lake concentrations were consistently lower than observed lake concentrations. Therefore, the default phosphorus decay coefficient was lowered to increase predicted total phosphorus concentration. The reduction in phosphorus decay rate brought predicted phosphorus levels in line with the observed concentrations. As can be seen in Table 7-4, an excellent match was achieved, lending significant support to the predictive ability of this simple model. A printout of the BATHTUB model files is provided in Appendix G of this report.

Table 7-4 Summary of Model Confirmatory Analysis- Harrisburg Reservoir Total Phosphorus (mg/L)

Lake Site	***Observed***	***Predicted***
Segment 1 : RAI-3	0.0920	0.0923
Segment 2 : RAI-2	0.0855	0.0854
Segment 3 : RAI-1	0.0697	0.0698
Lake Average	0.0836	0.0837

THIS PAGE INTENTIONALLY LEFT BLANK

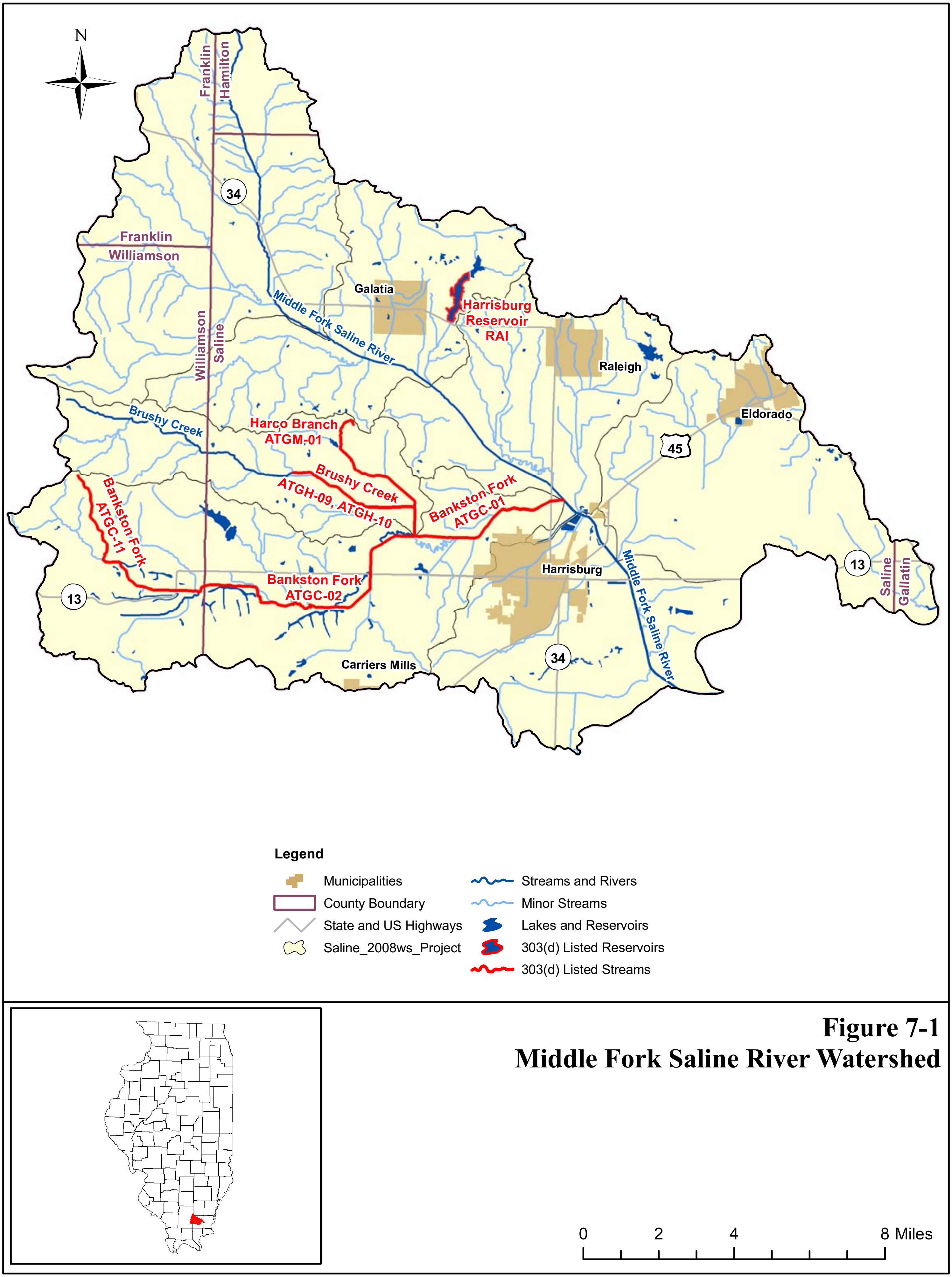


Figure 7-1
Middle Fork Saline River Watershed

THIS PAGE INTENTIONALLY LEFT BLANK

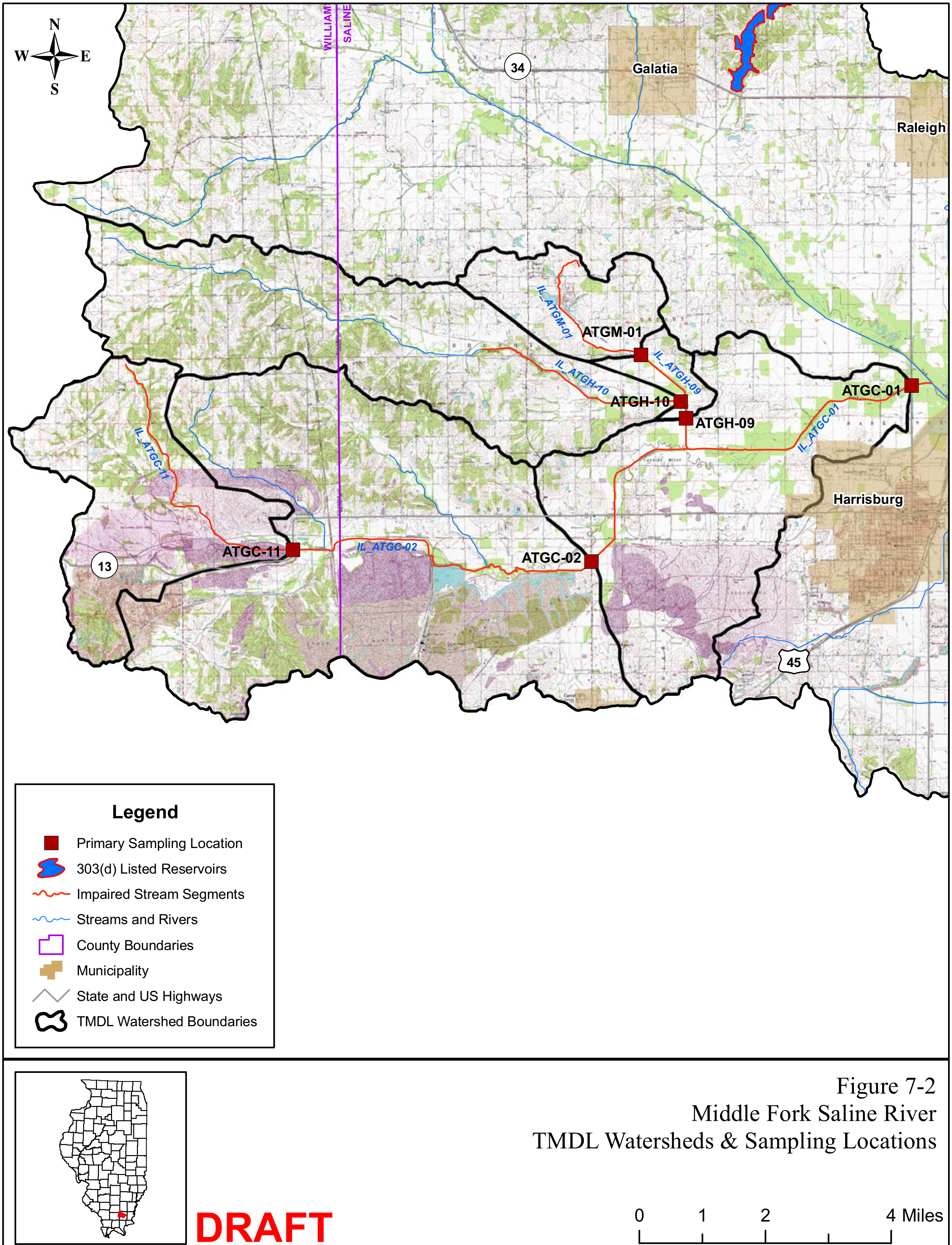


Figure 7-2
Middle Fork Saline River
TMDL Watersheds & Sampling Locations

DRAFT

THIS PAGE INTENTIONALLY LEFT BLANK

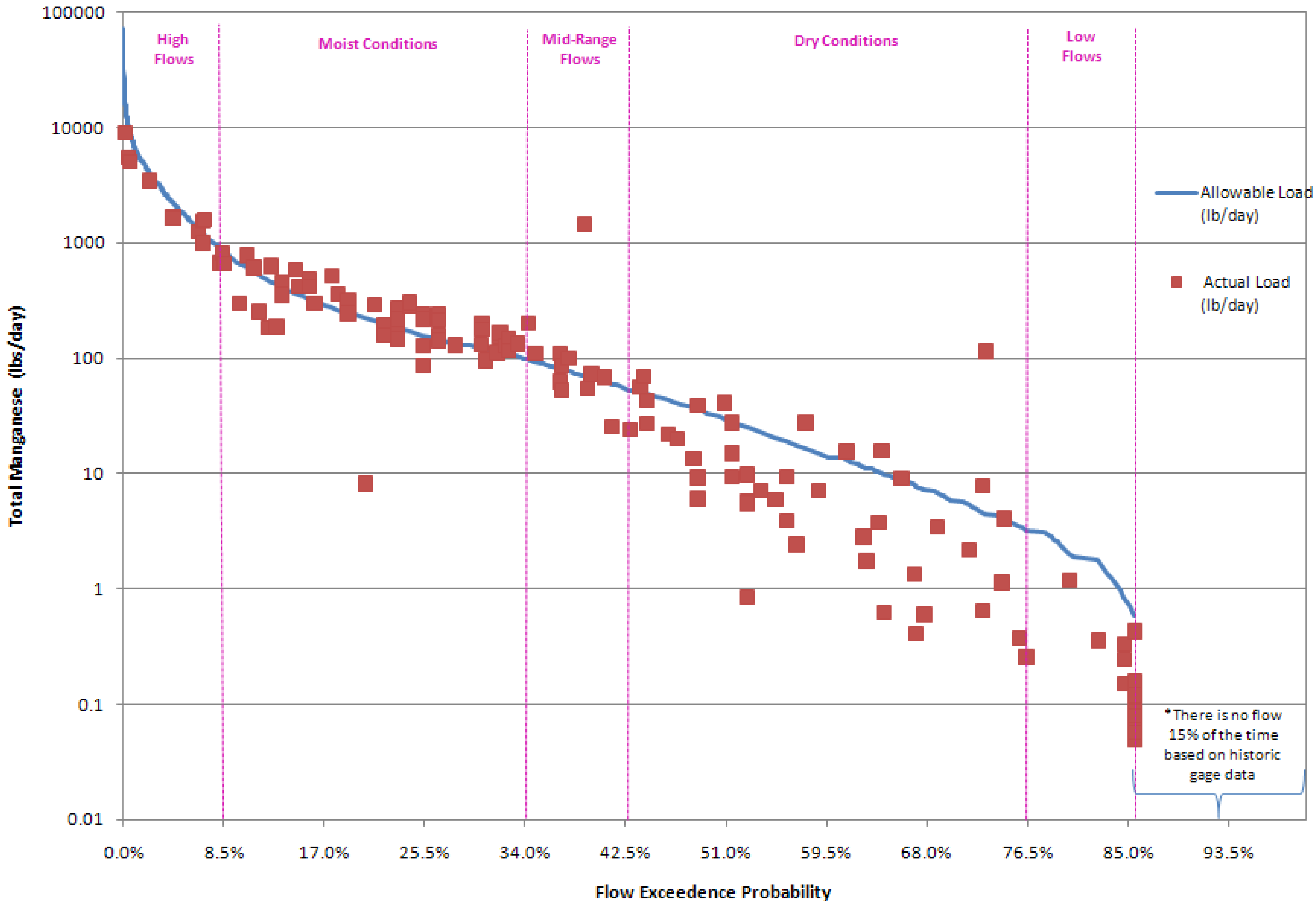


Figure 7-3
Bankston Fork Segment ATGC-01
Manganese Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

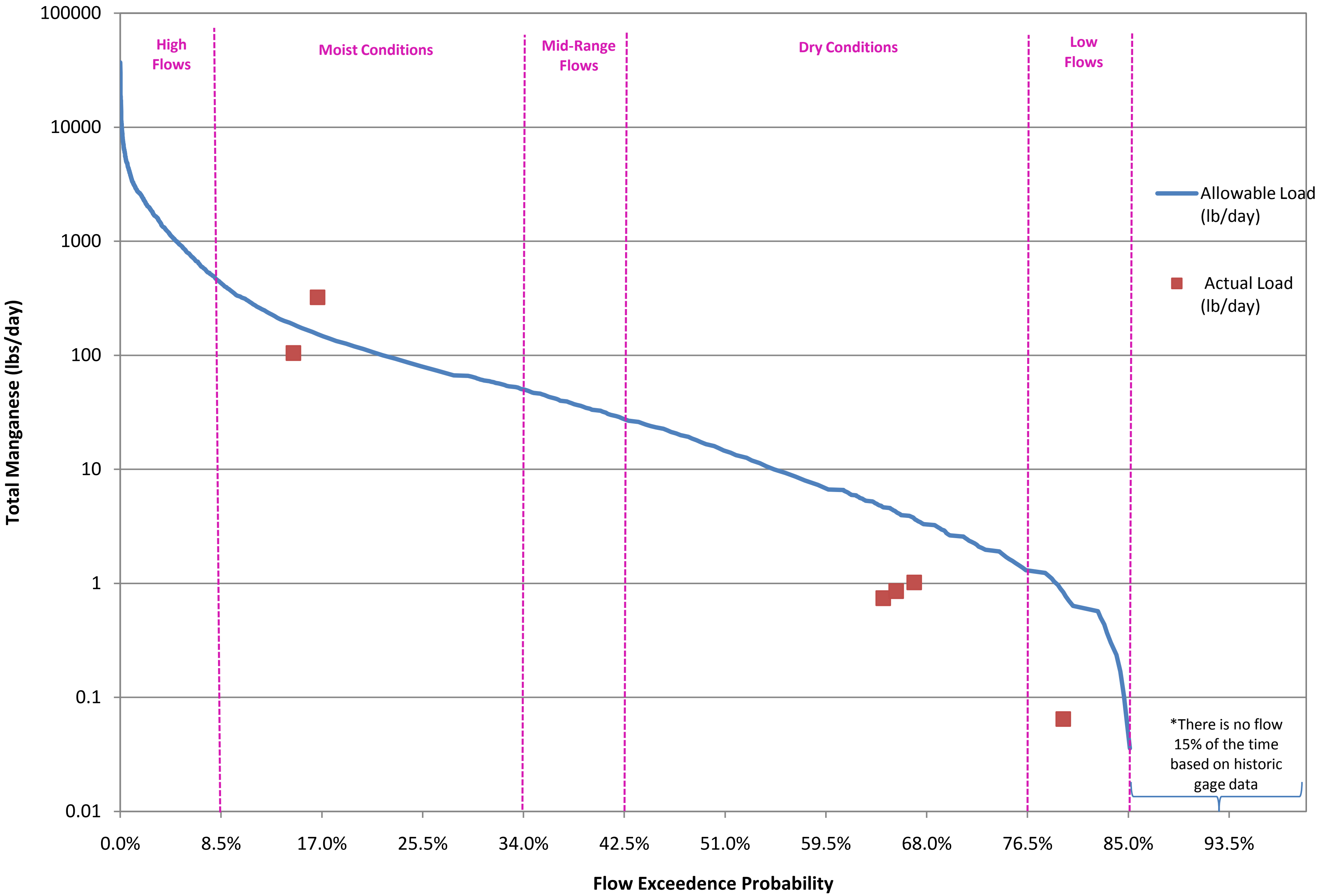


Figure 7-4
Bankston Fork Segment ATGC-02
Manganese Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

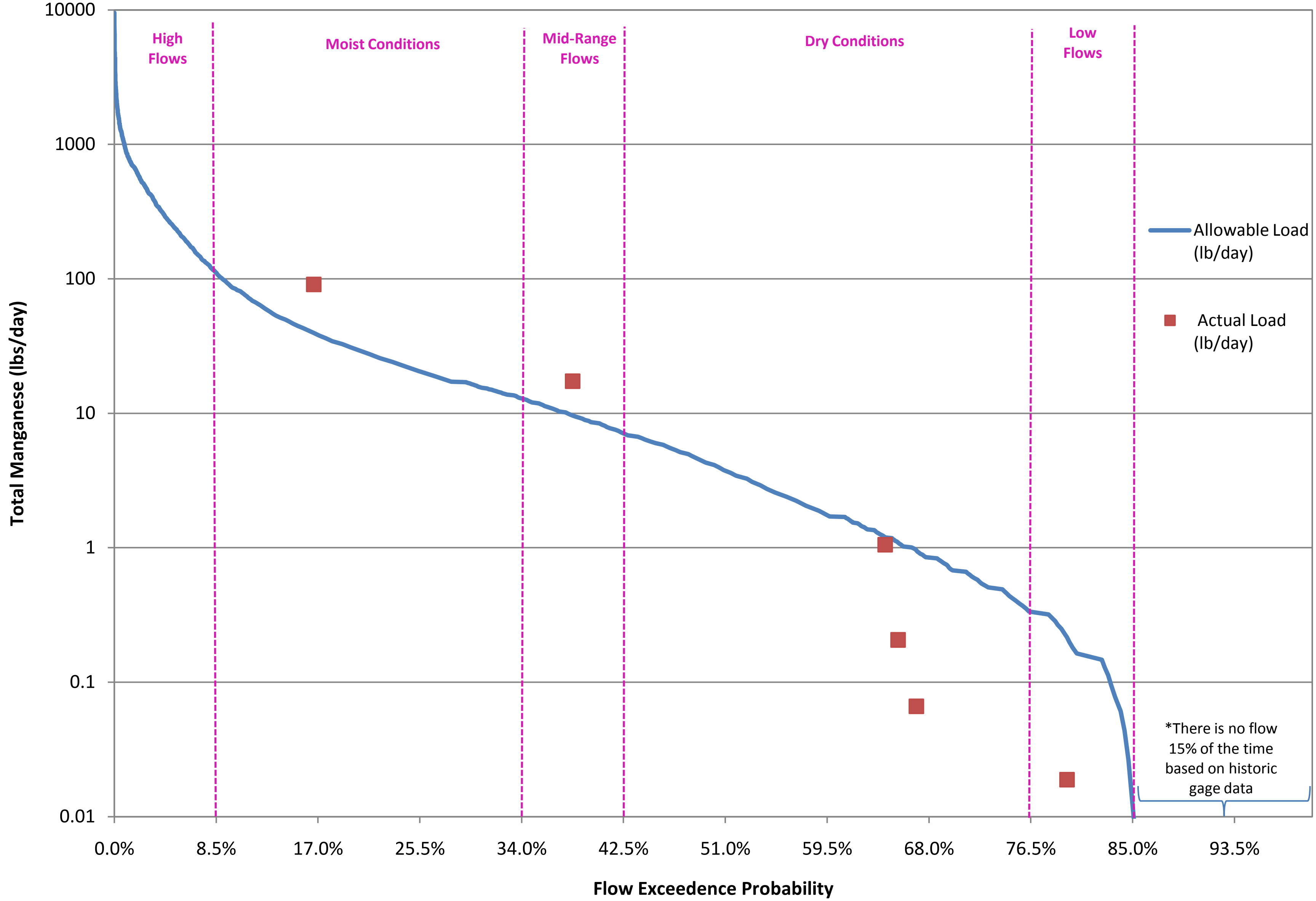


Figure 7-5
Bankston Fork Segment ATGC-11
Manganese Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

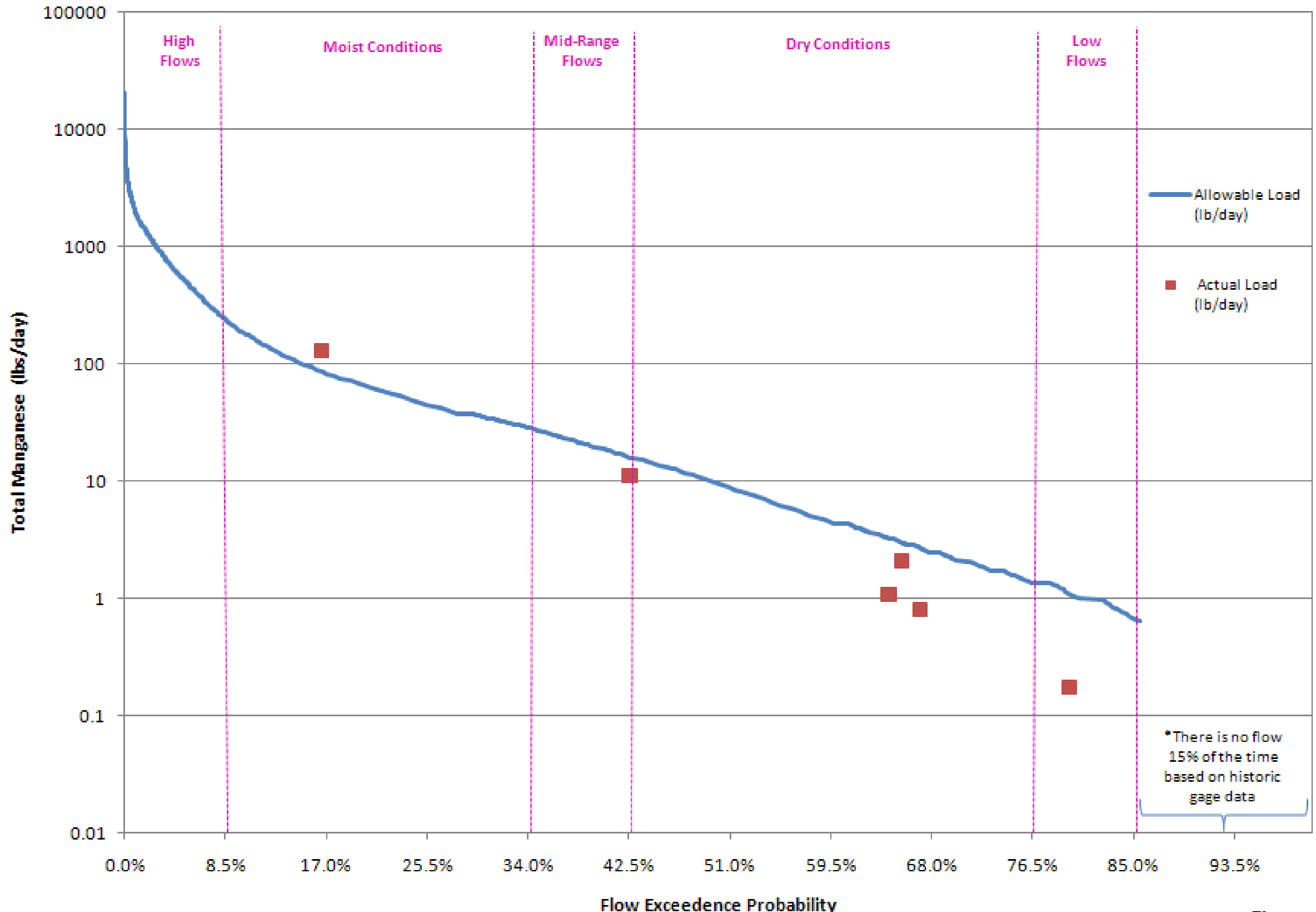


Figure 7-6
Brushy Creek Segment ATGH-09
Manganese Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

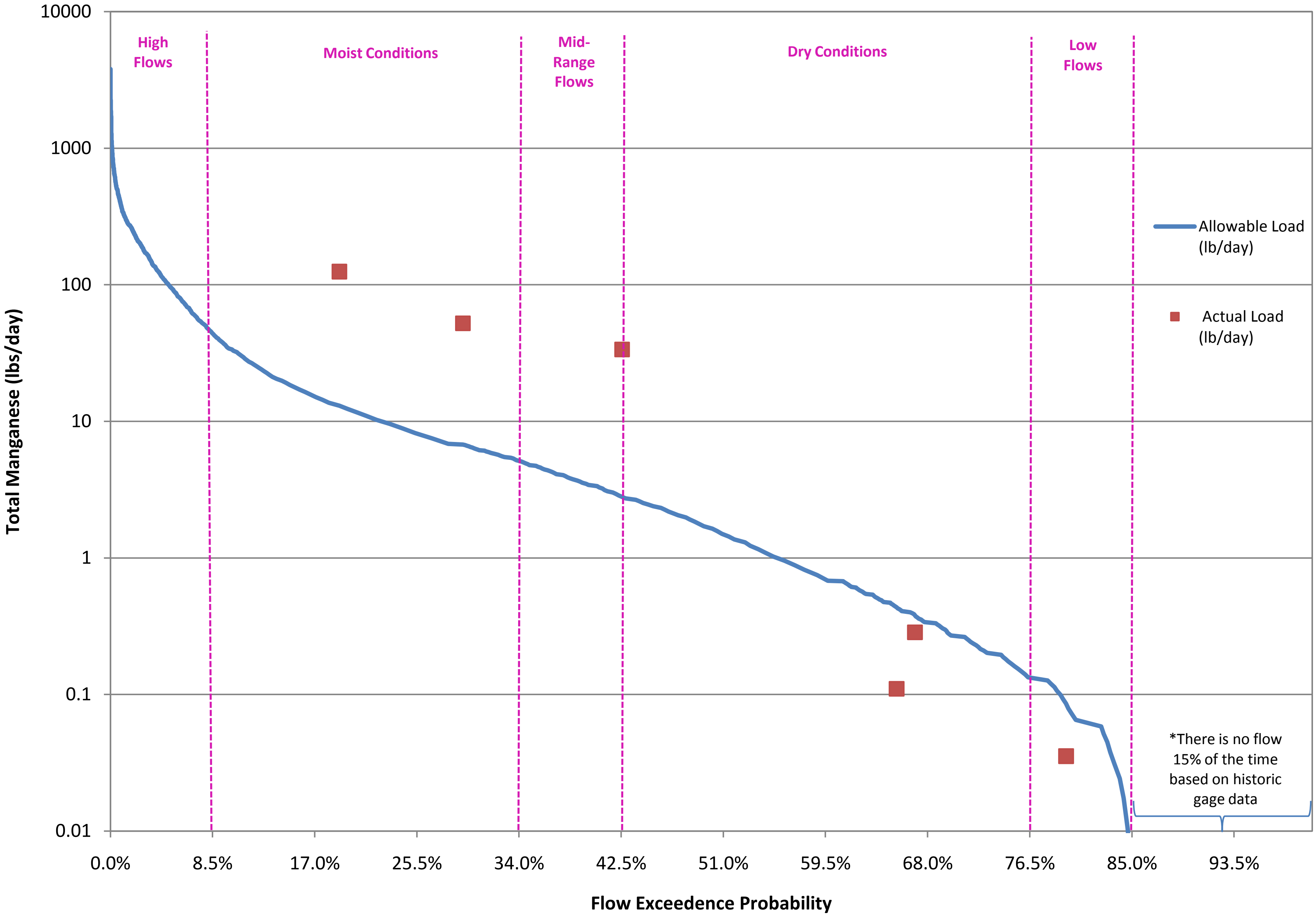


Figure 7-7
Harco Branch Segment ATGM-01
Manganese Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

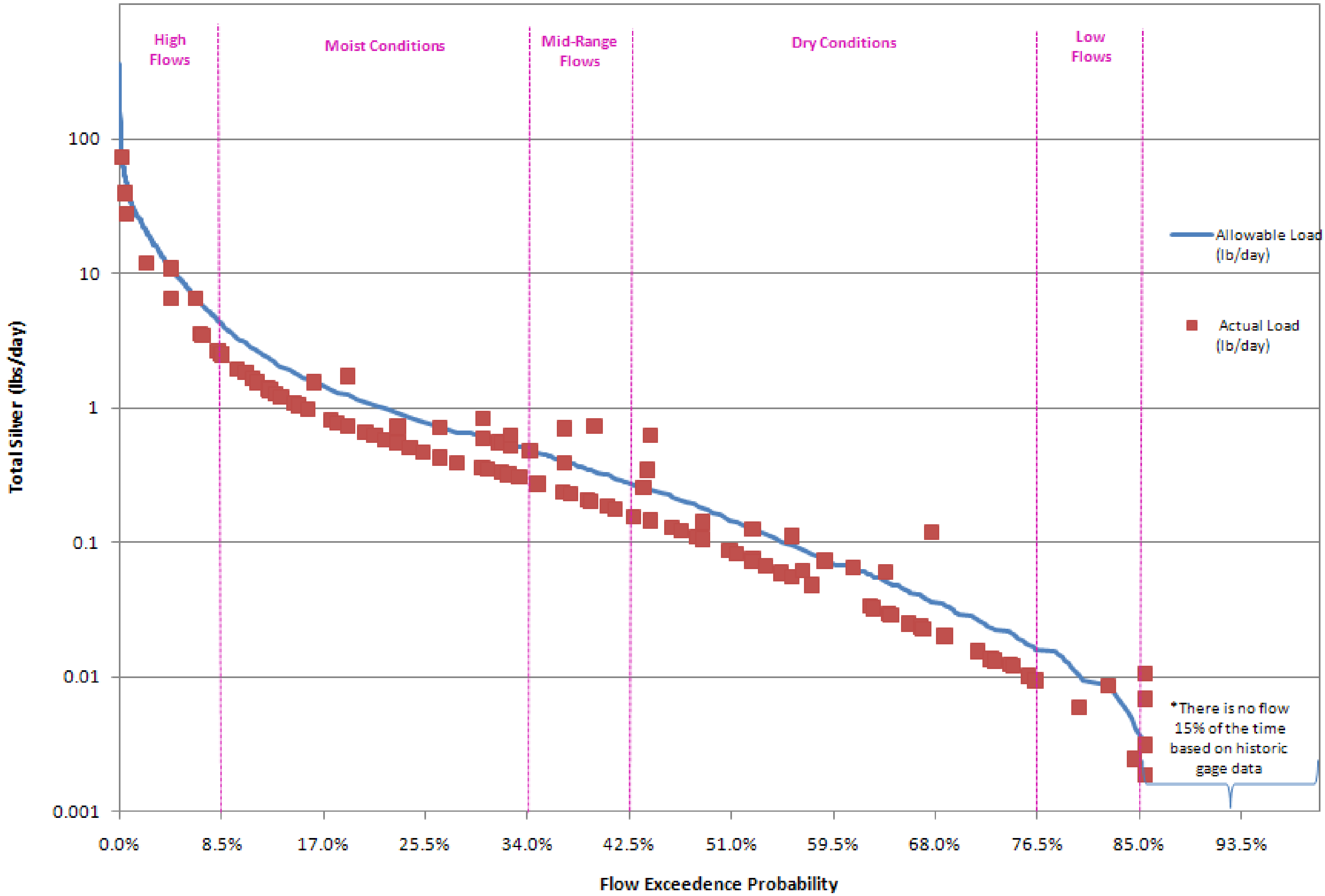


Figure 7-8
Bankston Fork Segment ATGC-01
Silver Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

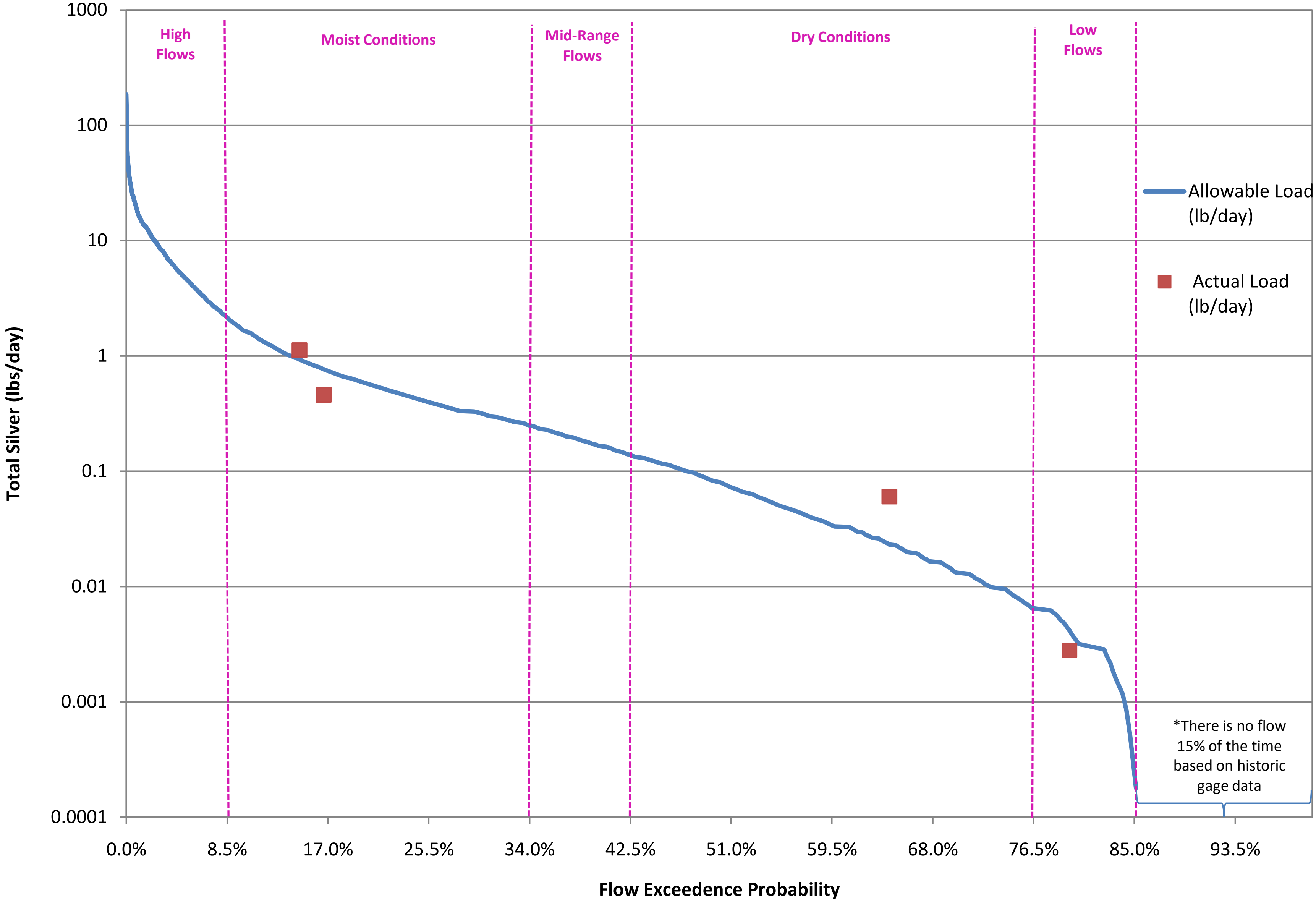


Figure 7-9
Bankston Fork Segment ATGC-02
Silver Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

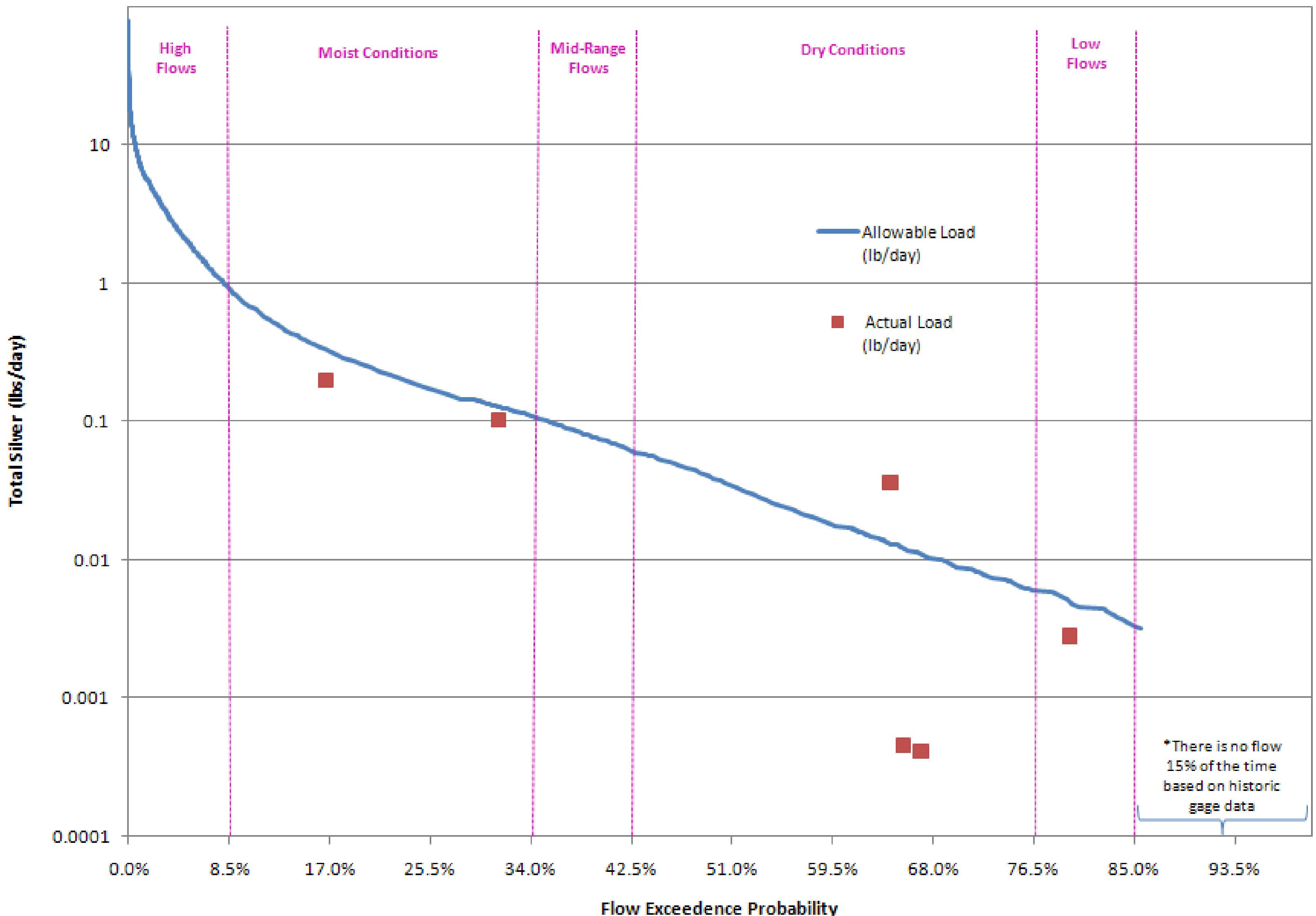


Figure 7-10
Brushy Creek Segment ATGH-10
Silver Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

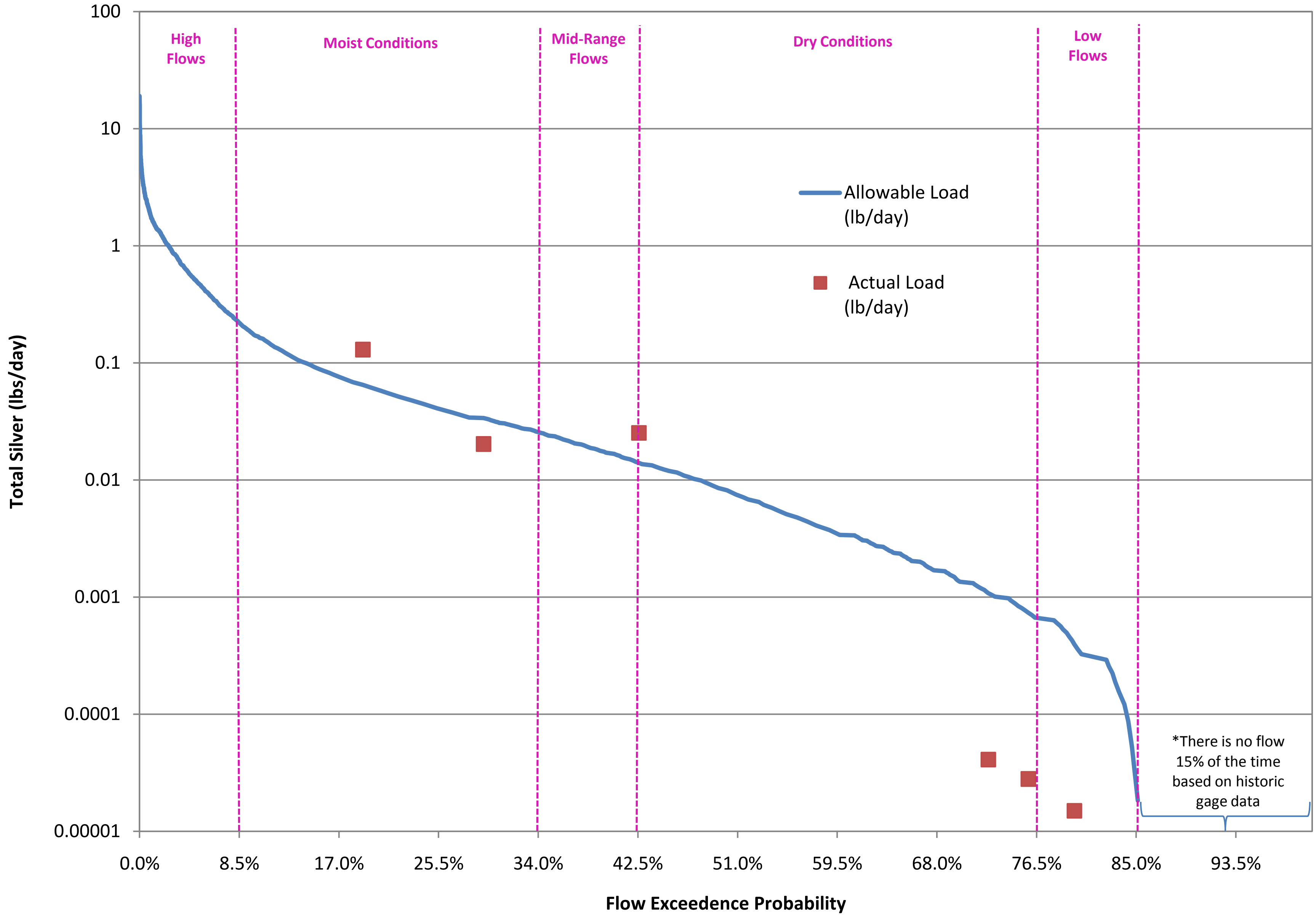


Figure 7-11
Harco Branch Segment ATGM-01
Silver Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

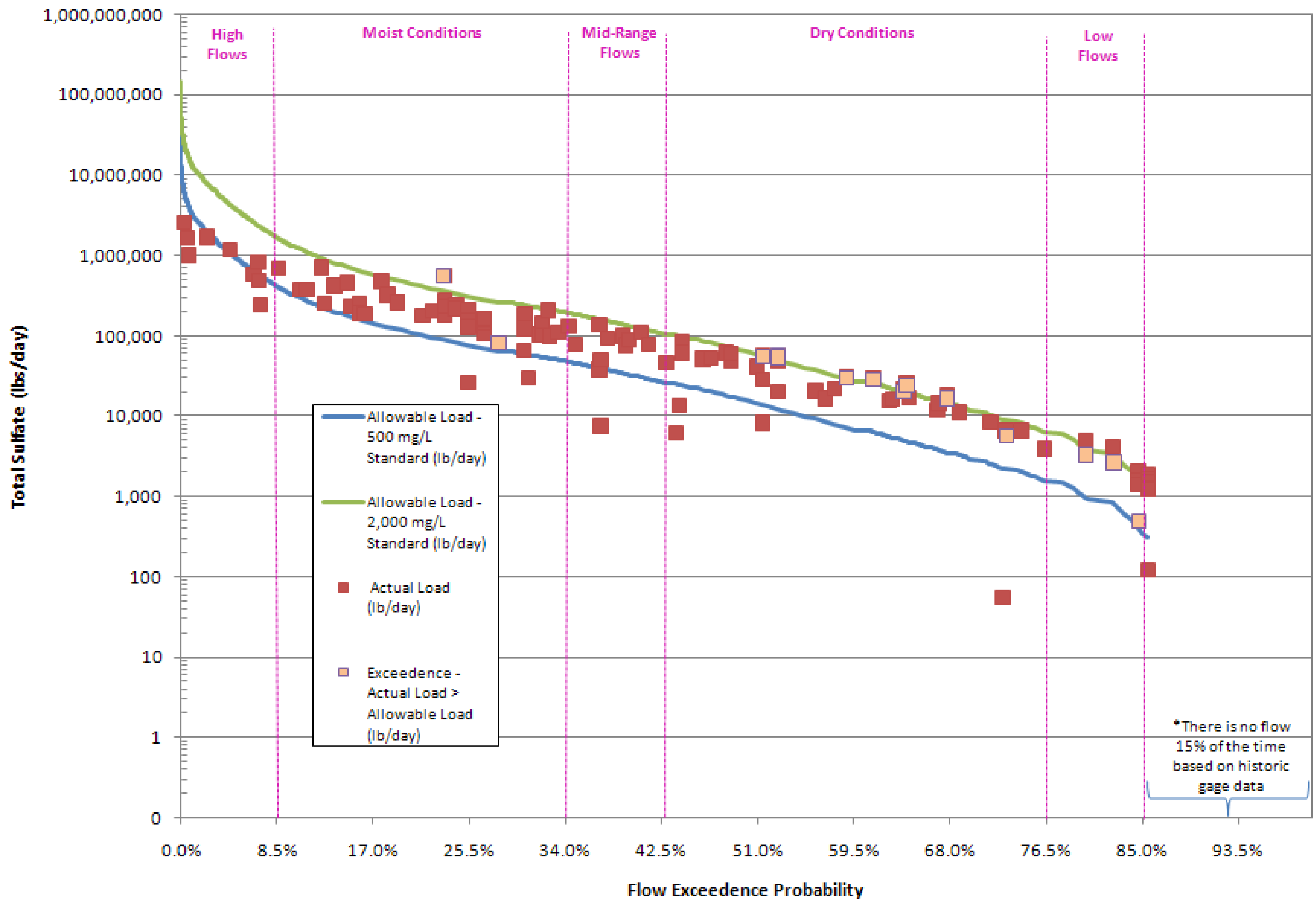


Figure 7-12
Bankston Fork Segment ATGC-01
Sulfate Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

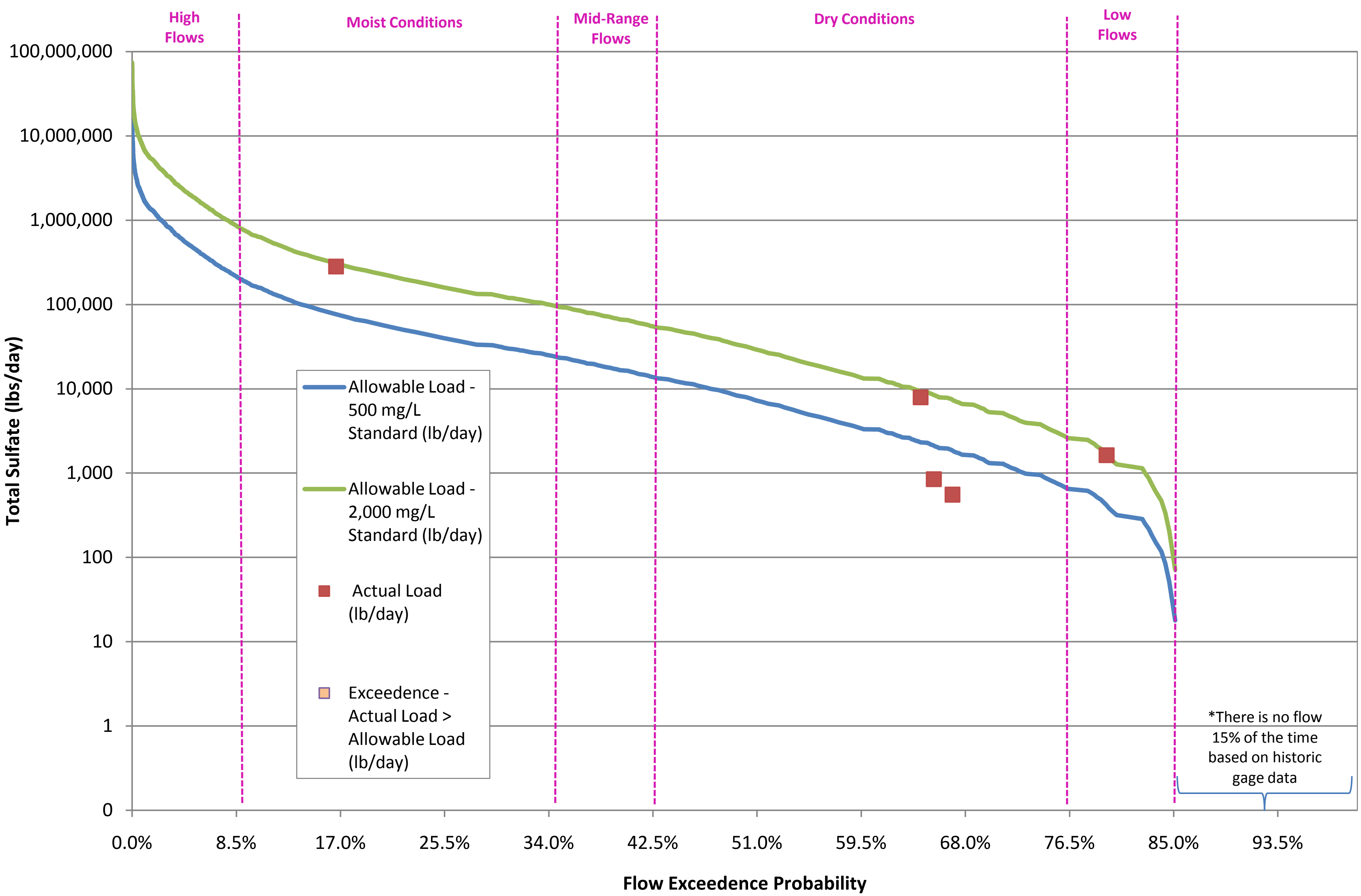


Figure 7-13
Bankston Fork Segment ATGC-02
Sulfate Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

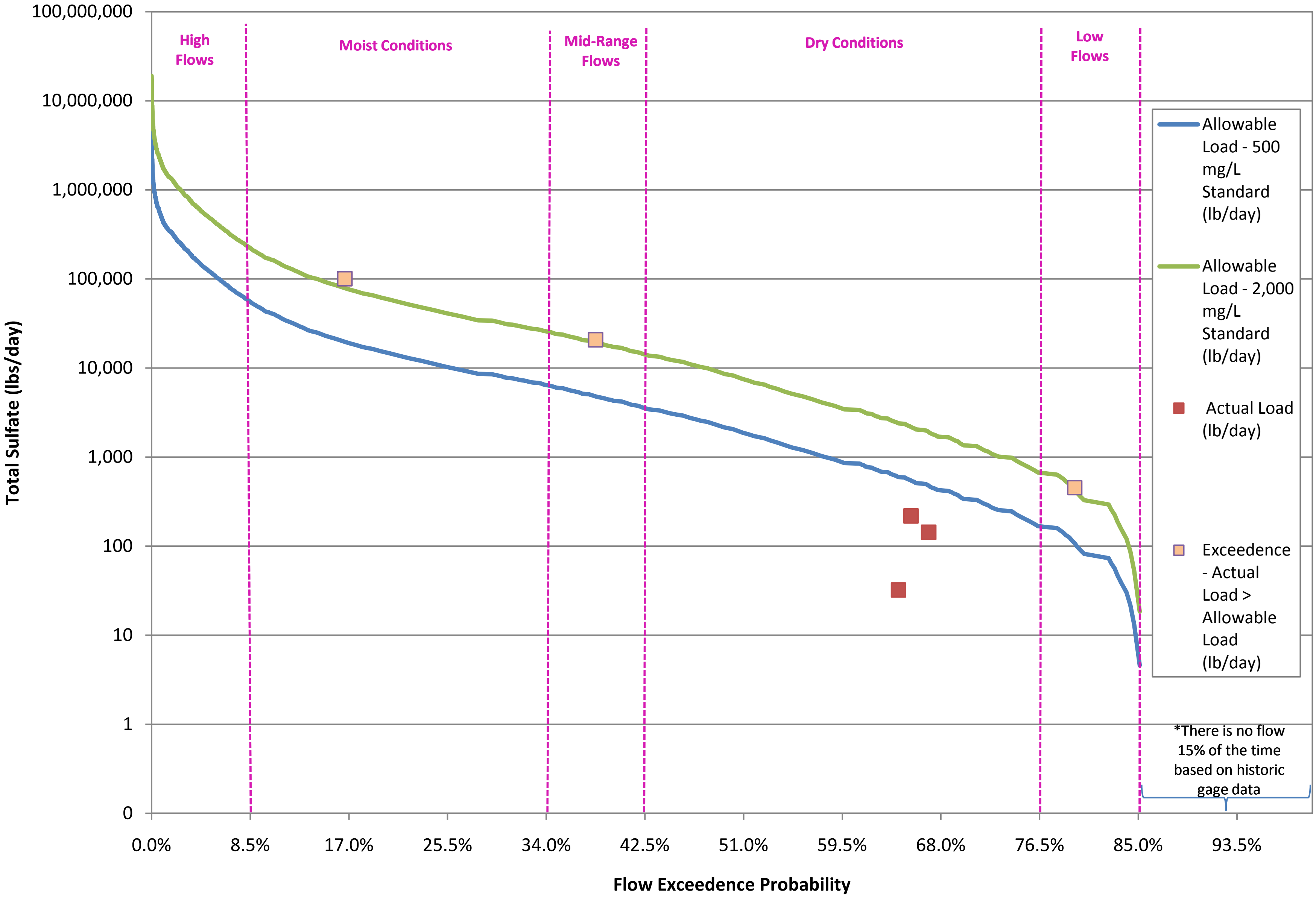


Figure 7-14
Bankston Fork Segment ATGC-11
Sulfate Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

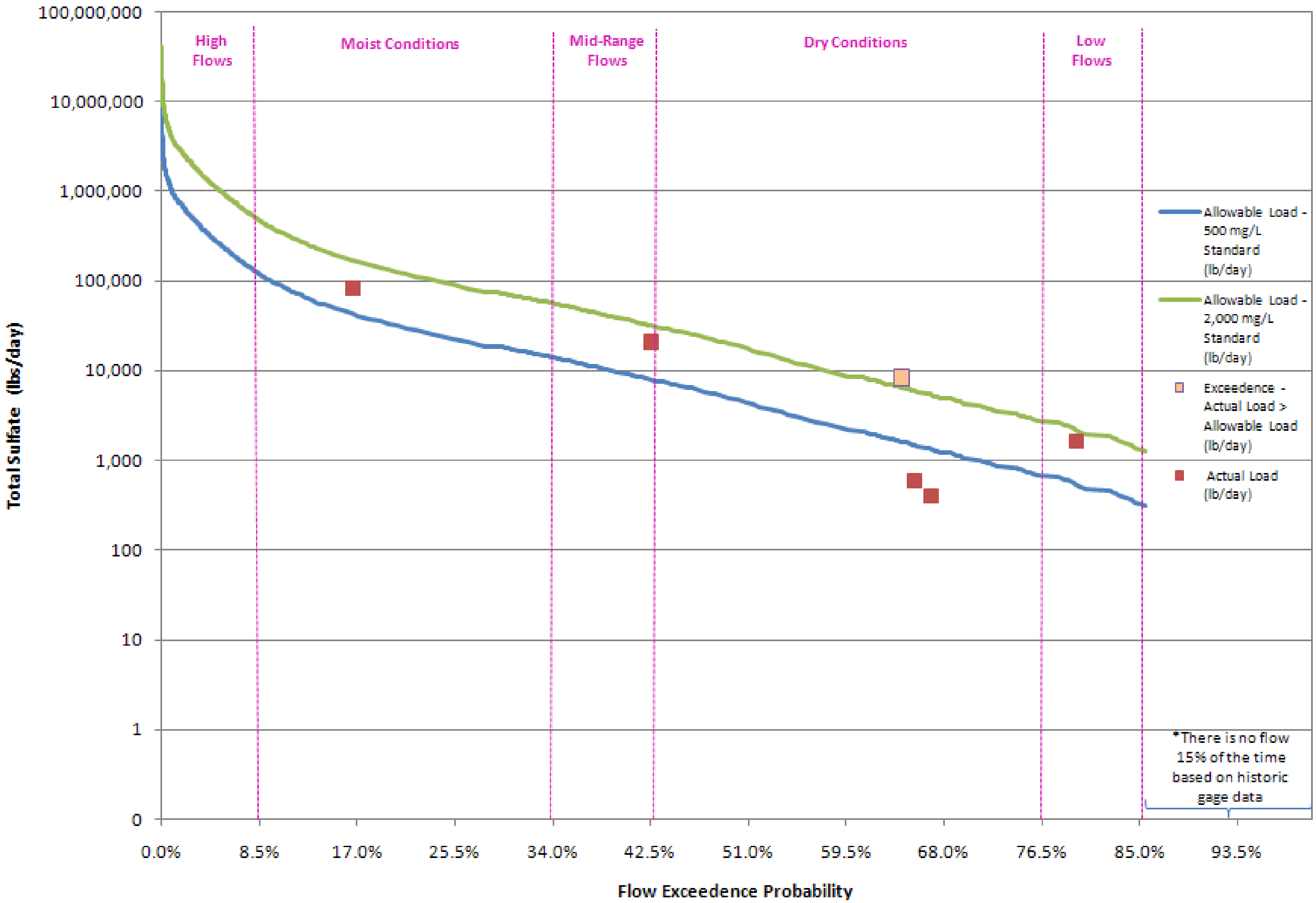


Figure 7-15
Brushy Creek Segment ATGH-09
Sulfate Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

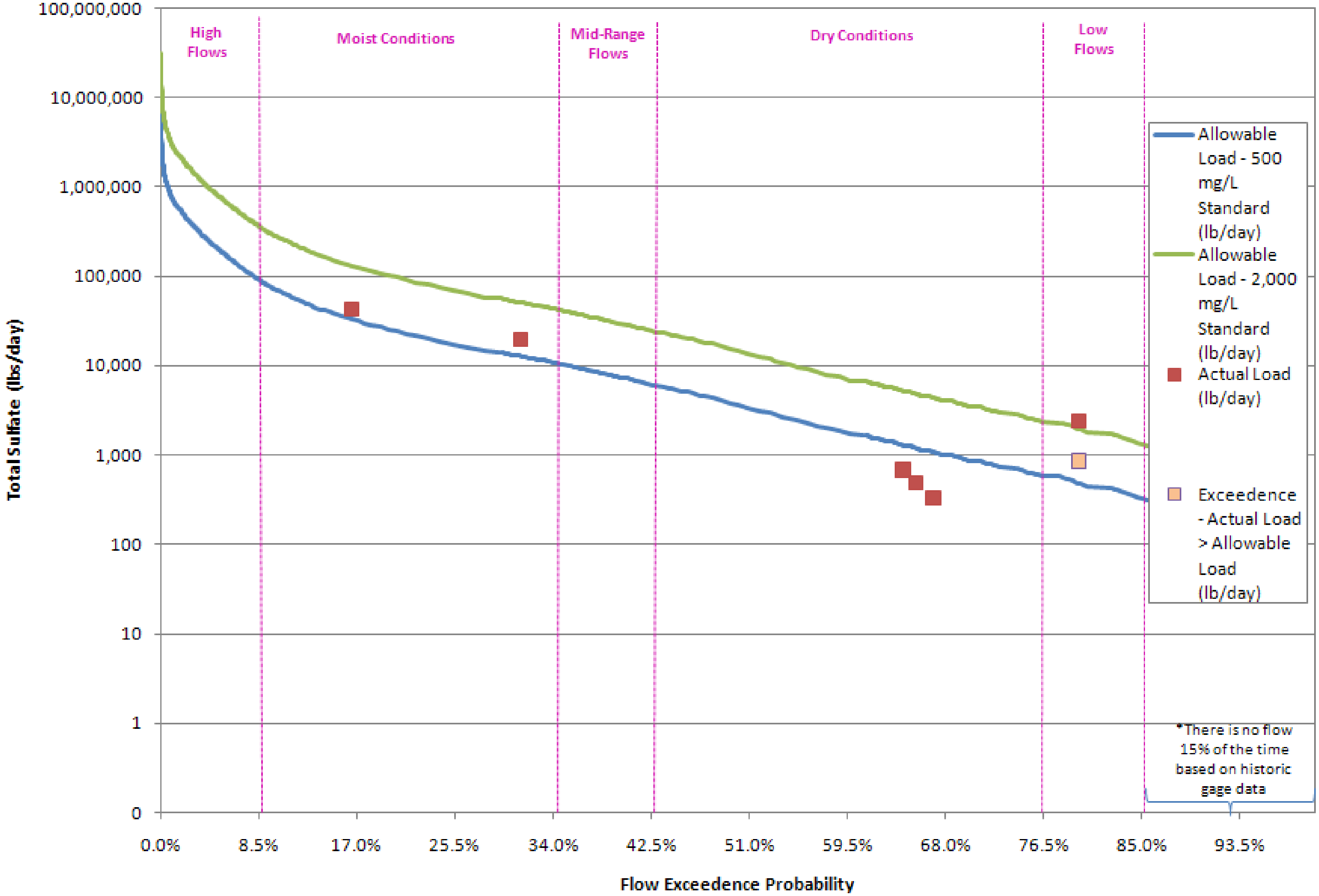


Figure 7-16
Brushy Creek Segment ATGH-10
Sulfate Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

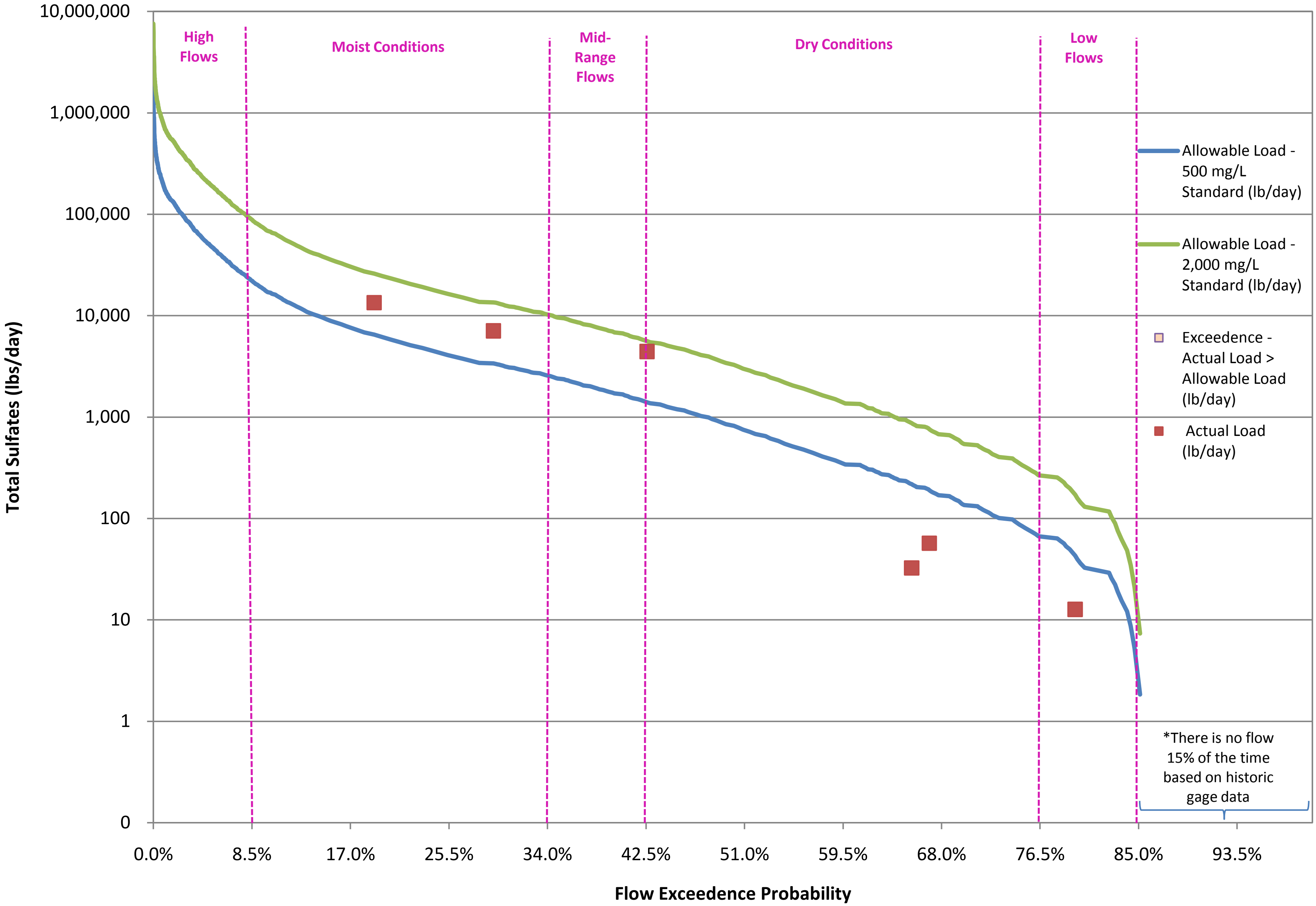


Figure 7-17
Harco Branch Segment ATGM-01
Sulfate Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

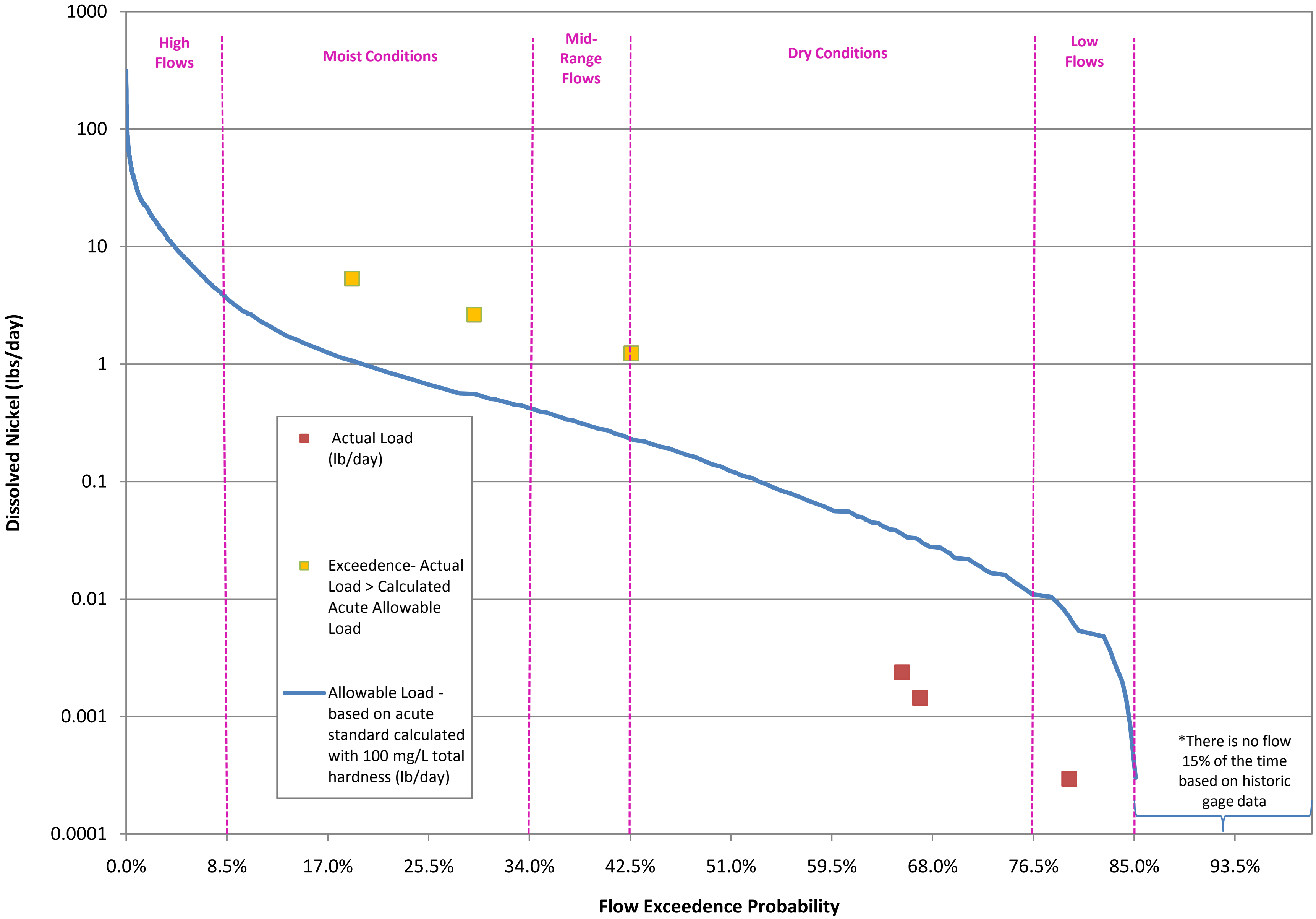


Figure 7-18
Harco Branch Segment ATGM-01
Nickel Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

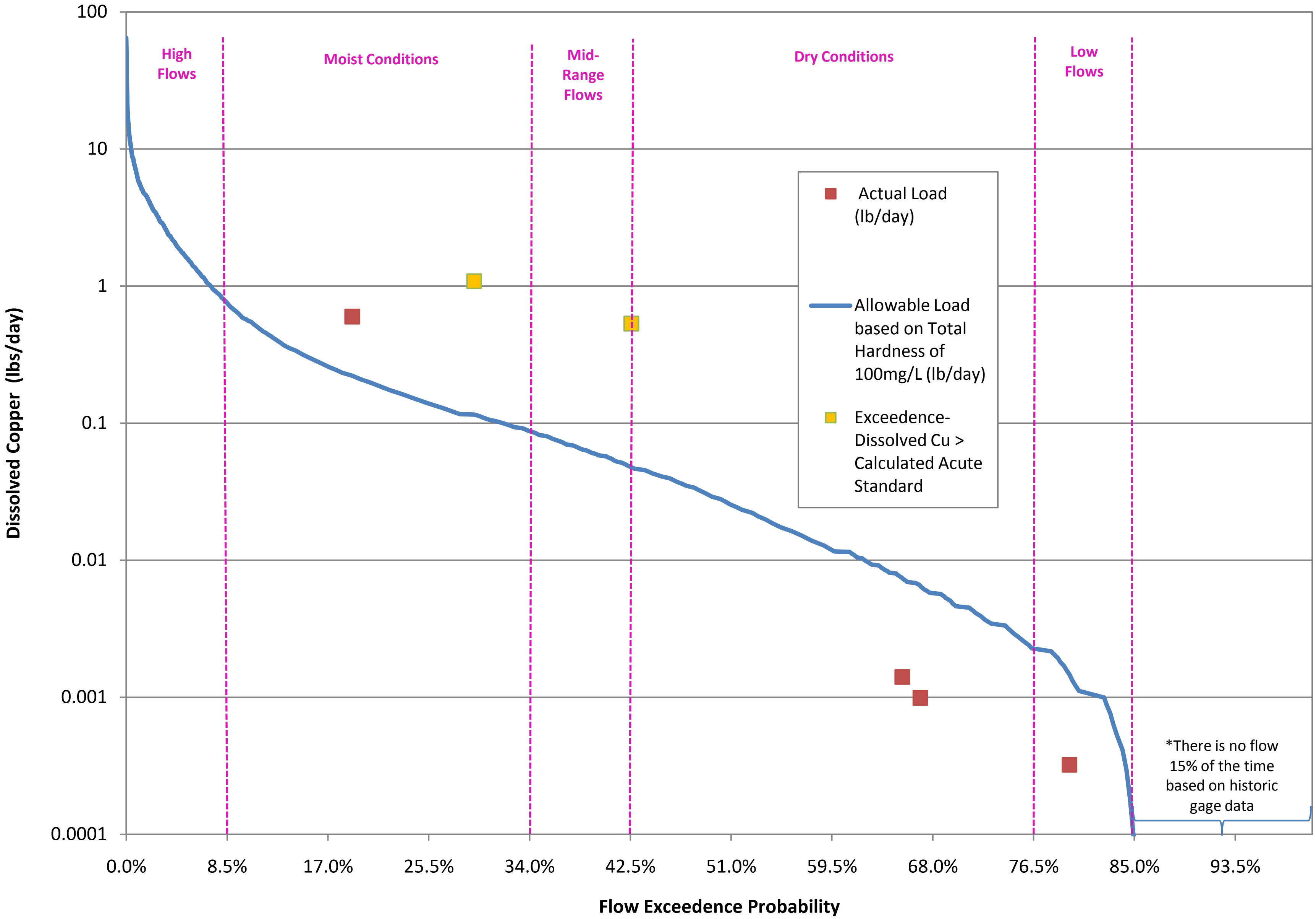


Figure 7-19
Harco Branch Segment ATGM-01
Copper Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

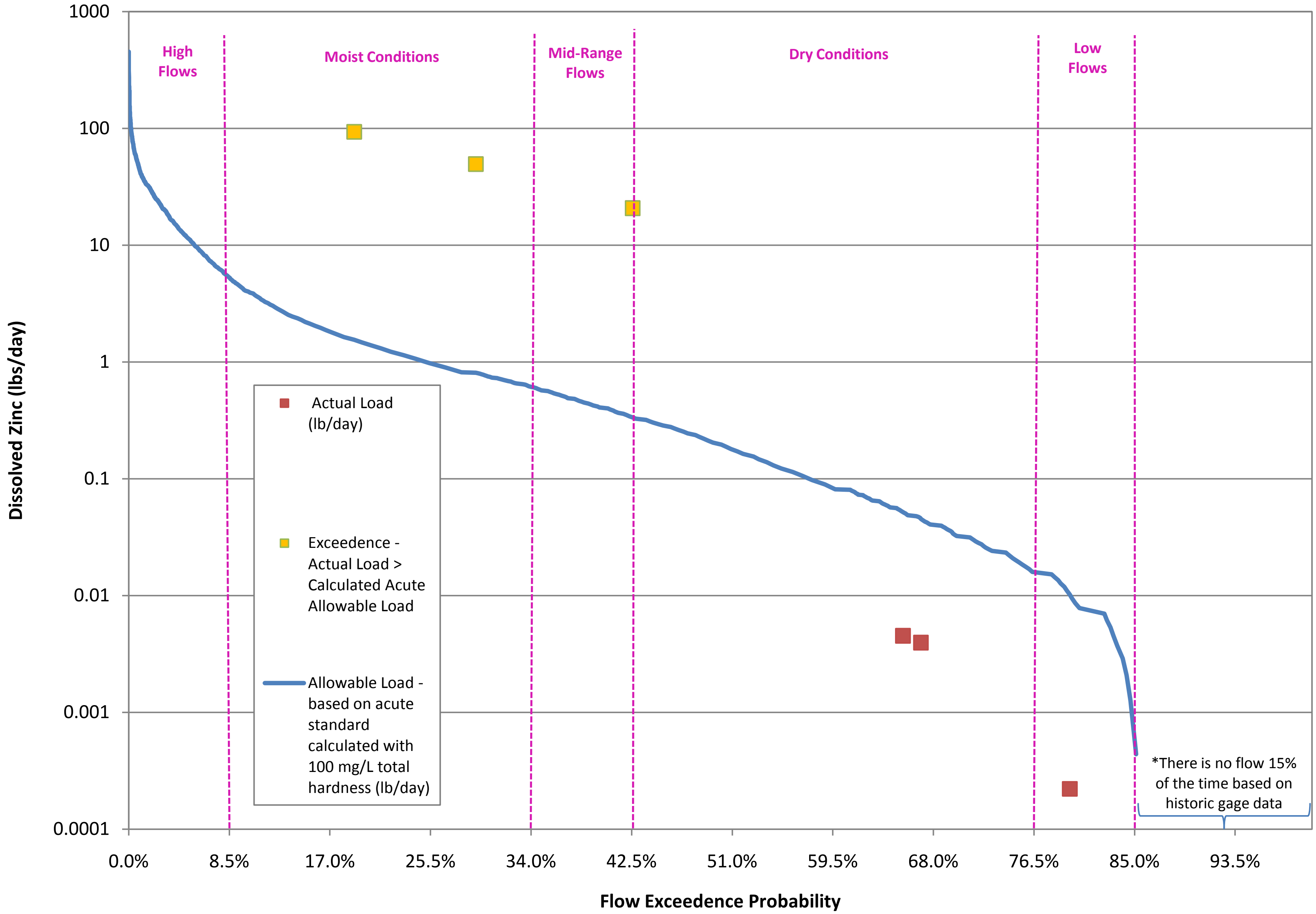


Figure 7-20
Harco Branch Segment ATGM-01
Zinc Load Duration Curve

THIS PAGE INTENTIONALLY LEFT BLANK

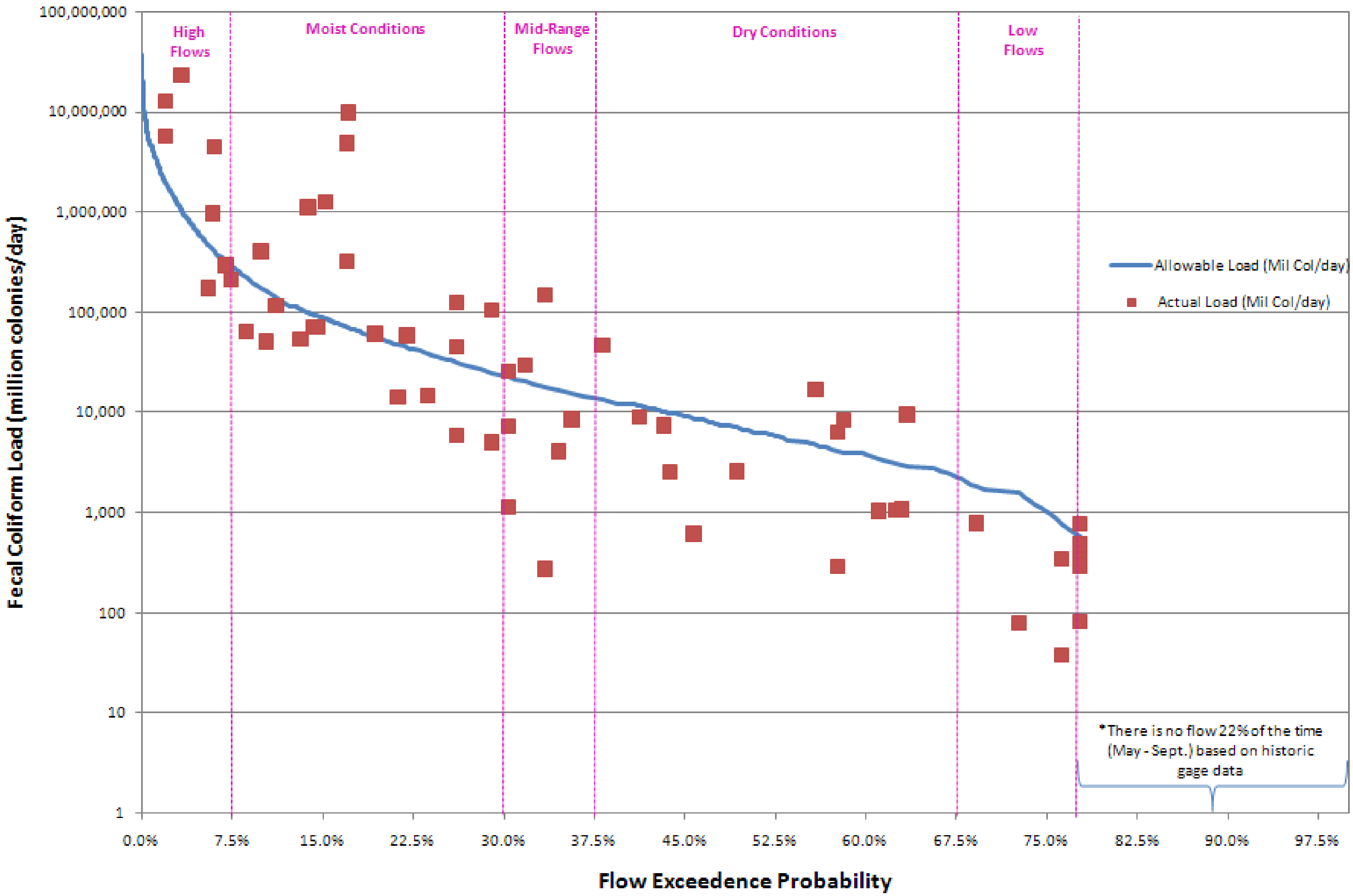


Figure 7-21
Bankston Fork Segment ATGC-01
Fecal Coliform Load Duration Curve

CDM

THIS PAGE INTENTIONALLY LEFT BLANK

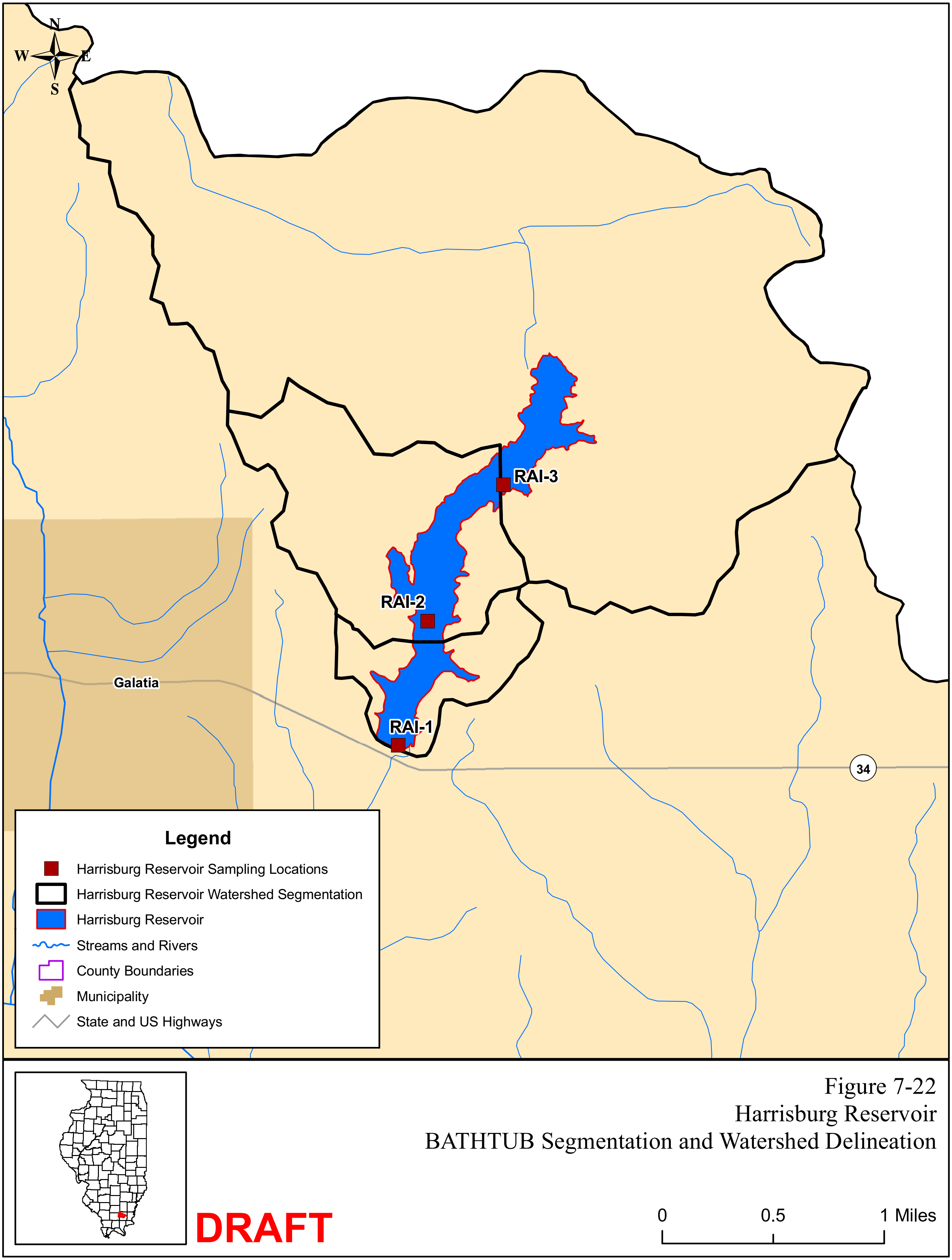


Figure 7-22
Harrisburg Reservoir
BATHTUB Segmentation and Watershed Delineation

DRAFT

THIS PAGE INTENTIONALLY LEFT BLANK

Section 8
Total Maximum Daily Load for the Middle Fork Saline River Watershed

8.1 TMDL Endpoints for the Middle Fork Saline River Watershed

The TMDL endpoints for copper, manganese, nickel, phosphorus, silver, sulfates, fecal coliform, and zinc are summarized in Table 8-1. For all parameters, the concentrations must be below the TMDL endpoint. The TMDL endpoint for copper, nickel, and zinc can vary from sample to sample because the water quality standards are derived through calculations based on the measured total hardness of the water at the time of sampling. TMDL endpoints for sulfates are also variable due to the water quality standards for sulfates, which are calculated for each sample based on total hardness and chloride concentrations. All of these endpoints, plus the TMDL endpoints for manganese and silver, are based on protection of aquatic life in the impaired segments of Bankston Fork, Brushy Creek, and Harco Branch. TMDL endpoints for fecal coliform on segment ATGC-01 of Bankston Fork are based on protection of the primary body contact recreation designated use and endpoints for phosphorus in Harrisburg Reservoir are established to protect the aesthetic quality designated use for this reservoir.

Some of the average concentrations presented in Table 8-1 meet the desired endpoints. However, the data sets have maximum or minimum values, presented in the Stage 1 report, which do not meet the desired endpoints and this was the basis for TMDL analysis. Further monitoring as outlined in the monitoring plan presented in Section 9, will help further define when impairments are occurring in the watershed and support the TMDL allocations outlined in the remainder of this section.

Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Middle Fork Saline River Watershed

Segment Name/ID	Parameter	TMDL Endpoint	Average Observed Value
Bankston Fork - ATGC-01	Manganese	1,000 µg/L	1,147 µg/L
	Silver	5 µg/L	4.00 µg/L
	Sulfate	Calculated based on Total Hardness and Chlorides	1,287 mg/L
	Fecal Coliform	400 cfu/100 mL (October - May)	1,063 cfu/100mL
Bankston Fork - ATGC-02	Manganese	1,000 µg/L	562 µg/L
	Silver	5 µg/L	4.35 µg/L
	Sulfate	Calculated based on Total Hardness and Chlorides	1,170 mg/L
Bankston Fork - ATGC-11	Manganese	1,000 µg/L	888 µg/L
	Sulfate	Calculated based on Total Hardness and Chlorides	1,198 mg/L

Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Middle Fork Saline River Watershed (cont)

Segment Name/ID	Parameter	TMDL Endpoint	Average Observed Value
Brushy Creek - ATGH-09	Manganese	1,000 µg/L	620 µg/L
	Sulfate	Calculated based on Total Hardness and Chlorides	1,217 mg/L
Brushy Creek - ATGH-10	Silver	5 µg/L	4.1 µg/L
	Sulfate	Calculated based on Total Hardness and Chlorides	739 mg/L
Harco Branch - ATGM-01	Copper	Calculated base on Total Hardness	68 µg/L
	Manganese	1,000 µg/L	5,119 µg/L
	Nickel	Calculated base on Total Hardness	209 µg/L
	pH	6.5 - 9.0	2.64
	Silver	5 µg/L	3.9 µg/L
	Sulfates	Calculated based on Total Hardness and Chlorides	672 mg/L
	Zinc	Calculated base on Total Hardness	3,654 µg/L
Harrisburg Reservoir - RAI	Total Phosphorus	0.05 mg/L	0.08 mg/L

8.2 Pollutant Source and Linkages

Potential pollutant sources for the Middle Fork Saline River watershed include both point and nonpoint sources as described in Section 5 of the Stage 1 report. Load duration curves were developed for the majority of the TMDLs described in this section. Load duration curves are useful in that they provide a link between historic sampling values and hydraulic condition. Table 8-2 shows the example source area/hydrologic condition consideration developed by EPA.

Table 8-2 Example Source Area/Hydrologic Condition Considerations (EPA, 2007)

Contributing Source Area	Duration Curve Zone				
	High Flow	**Moist**	**Mid-Range**	**Dry**	**Low Flow**
Point Source				M	H
Onsite Wastewater System			H	M	
Riparian Areas		H	H	H	
Stormwater: Impervious Areas		H	H	H	
Combined sewer overflows	H	H	H		
Stormwater: Upland	H	H	M		
Bank Erosion	H	M			

Note: potential relative importance of source area to contribute loads under given hydrologic conditions (H: High; M: Medium)

Further pollutant source discussion is provided throughout this section and implementation activities to reduce loading from the potential sources are outlined in Section 9.

8.3 Allocation

As explained in the Stage 1 report, the TMDL for impaired segments in the Middle Fork Saline River watershed will address the following equation:

$$TMDL = LC = \Sigma WLA + \Sigma LA + MOS$$

where:
- LC = Maximum amount of pollutant loading a water body can receive without violating water quality standards
- WLA = The portion of the TMDL allocated to existing or future point sources
- LA = Portion of the TMDL allocated to existing or future nonpoint sources and natural background
- MOS = An accounting of uncertainty about the relationship between pollutant loads and receiving water quality

Each of these elements will be discussed in this section as well as consideration of seasonal variation in the TMDL calculation.

8.3.1 Manganese TMDLs

Five segments within the Middle Fork Saline River watershed are listed for impairment caused by manganese: Bankston Fork ATGC-01, ATGC-02, and ATGC-11; Brushy Creek ATGH09; and Harco Branch ATGM-01. Load duration curves were developed (see Section 7) to determine load reductions needed to meet the instream water quality standard of 1,000 µg/L total manganese at varying flow levels.

8.3.1.1 Loading Capacities

The LC is the maximum amount of manganese that the impaired segments can receive and still maintain compliance with the water quality standard. In order to determine the loading capacity at various flow conditions, a range of flows were multiplied by the water quality standard. Table 8-3 contains the loading capacity for manganese.

Table 8-3 Manganese Loading Capacity for Impaired Segments in the Middle Fork Saline River Watershed

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
5	27
10	54
50	270
100	539
500	2,697
1,000	5,394
5,000	26,969
10,000	53,938
15,000	80,907

8.3.1.2 Seasonal Variations

Consideration to seasonality is inherent in the load duration analysis described above. The standard is not seasonal and the full range of expected flows is represented in the loading capacity table (Table 8-3). Therefore, the loading capacity represents conditions throughout the year. Load duration curve development and analysis (Section 7) showed that manganese violations in the impaired segments are most likely to occur under mid-range to moist conditions. By considering and addressing all flow scenarios, these critical conditions when the stream segments are most vulnerable to water quality exceedences were addressed.

8.3.1.3 Margins of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The manganese TMDLs developed for the impaired segments within the Middle Fork Saline River watershed contain an explicit MOS of 10 percent. Ten percent is considered adequate to compensate for any uncertainty in the TMDLs.

8.3.1.4 Waste Load Allocations

There are two permitted facilities in the Middle Fork Saline River watershed. The Delta Mine Holding Company (NPDES Permit No. IL006402) is a reclaimed surface coal mine site that is permitted to discharge stormwater from multiple outfalls to Bankston Fork and Brushy Creek. The permit requires monitoring for pH and settleable solids only and has no flow information. Additionally, Western Fuels-Illinois, Inc operates the Liberty under NPDES Permit No. IL0059749. The facility is currently in the process of permit renewal for acid mine drainage from outfalls 002 and 005. These outfalls discharge to Brushy Creek ATGH-04 which is upstream of segments ATGH-10 and ATGH-09. Outfalls 002 and 005 are permit to discharge a maximum daily concentration of 1 mg/L manganese at 0.002mgd and 0.074mgd, respectively. WLA for Brushy Creek segment ATGH-09 were developed based on the permitted concentrations and discharge rates. Both permits have conditions that state that the facilities will be considered in violation if it is determined that the permittee is not utilizing "good mining practices which are applicable in order to minimize the discharge of TDS, chloride, sulfate, iron and manganese".

8.3.1.5 Load Allocations and TMDL Summaries

The manganese loads have been allocated between the LAs (nonpoint sources) and the MOSs. Table 8-4 shows the summary of the manganese TMDLs for the impaired segments along with the percent reductions required at various flow levels.

Table 8-4 Total Manganese TMDLs for the Middle Fork Saline River Watershed

Bankston Fork Segment ATGC-01							
Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-8.5	2,166.8	1,950.1	0	216.7	6,166.0	65%
Moist	8.5-17	441.6	397.4	0	44.2	705.9	37%
	17-25.5	208.1	187.3	0	20.8	364.3	43%
	25.5-34	119.9	107.9	0	12.0	233.9	49%
Mid-Range	34-42.5	71.9	64.7	0	7.2	215.9	67%
Dry	42.5-51	40.8	36.7	0	4.1	60.9	33%
	51-59.5	18.7	16.9	0	1.9	25.9	28%
	59.5-68	9.7	8.7	0	1.0	16.7	42%
	68-76.5	4.5	4.0	0	0.4	28.4	84%
Low Flow	76.5-85	1.9	1.7	0	0.2	0.7	0%

Table 8-4 Total Manganese TMDLs for the Middle Fork Saline River Watershed (cont)

Bankston Fork Segment ATGC-02							
		LC	LA	WLA	MOS		Percent
Zone	Flow Exceedence Range (%)	(lbs/day)	(lbs/day)	(lbs/day)	(10% of LC)	Actual Load[1] (lbs/day)	Reduction Needed (%)
High	0-8.5	1,113.40	1,002.00	n/a	111.3	-	-
	8.5-17	226.7	204	0	22.7	300.4	25%
	17-25.5	106.6	96	0	10.7	-	-
Moist	25.5-34	61.3	55.2	0	6.13	-	-
Mid-Range	34-42.5	36.6	33	0	3.66	-	-
	42.5-51	20.6	18.6	0	2.06	-	-
	51-59.5	9.3	8.4	0	0.93	-	-
	59.5-68	4.6	4.2	0	0.46	1	0%
Dry	68-76.5	2	1.8	0	0.2	-	-
Low Flow	76.5-85	0.6	0.6	0	0.06	0.1	0%
Bankston Fork Segment ATGC-11							
		LC	LA	WLA	MOS		Percent
Zone	Flow Exceedence Range (%)	(lbs/day)	(lbs/day)	(lbs/day)	(10% of LC)	Actual Load[1] (lbs/day)	Reduction Needed (%)
High	0-8.5	286.84	258.16	0	28.68	-	-
	8.5-17	58.39	52.55	0	5.84	90.9	36%
	17-25.5	27.47	24.73	0	2.75	-	-
Moist	25.5-34	15.79	14.21	0	1.58	-	-
Mid-Range	34-42.5	9.44	8.5	0	0.944	17.31	45%
	42.5-51	5.32	4.79	0	0.532	-	-
	51-59.5	2.4	2.16	0	0.24	-	-
	59.5-68	1.19	1.07	0	0.119	0.88	0%
Dry	68-76.5	0.51	0.46	0	0.051	-	-
Low Flow	76.5-85	0.16	0.15	0	0.016	0.02	0%
Brushy Creek Segment ATGH-09							
		LC	LA	WLA	MOS		Percent
Zone	Flow Exceedence Range (%)	(lbs/day)	(lbs/day)	(lbs/day)	(10% of LC)	Actual Load[1] (lbs/day)	Reduction Needed (%)
High	0-8.5	618.62	556.12	0.63	61.86	-	-
	8.5-17	126.44	113.16	0.63	12.64	127.72	11%
	17-25.5	59.83	53.21	0.63	5.98	-	-
Moist	25.5-34	34.66	30.56	0.63	3.47	-	-
Mid-Range	34-42.5	20.97	18.24	0.63	2.10	10.77	0%
	42.5-51	12.09	10.25	0.63	1.21	-	-
	51-59.5	5.80	4.58	0.63	0.58	-	-
	59.5-68	3.21	2.25	0.63	0.32	1.50	0%
Dry	68-76.5	1.73	0.92	0.63	0.17	-	-
Low Flow	76.5-85	0.99	0.25	0.63	0.10	0.08	0%

Table 8-4 Total Manganese TMDLs for the Middle Fork Saline River Watershed (cont)

Harco Branch Segment ATGM-01							
		LC	LA	WLA	MOS		
Zone	Flow Exceedence Range (%)	(lbs/day)	(lbs/day)	(lbs/day)	(10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-8.5	114.27	102.84	0	11.43	-	-
	8.5-17	23.26	20.94	0	2.33	-	-
	17-25.5	10.95	9.85	0	1.09	124.86	91%
Moist	25.5-34	6.29	5.66	0	0.63	52.17	88%
Mid-Range	34-42.5	3.76	3.38	0	0.38	33.65	89%
	42.5-51	2.12	1.91	0	0.21	-	-
	51-59.5	0.95	0.86	0	0.1	-	-
	59.5-68	0.48	0.43	0	0.05	0.27	0%
Dry	68-76.5	0.2	0.18	0	0.02	-	-
Low Flow	76.5-85	0.07	0.06	0	0.007	0.04	0%

[1] Actual Load was calculated using the 90th percentile of observed total manganese concentrations in a given flow range (EPA 2007)

8.3.2 Silver TMDLs

Four segments within the Middle Fork Saline River watershed are listed for impairment caused by silver: Bankston Fork ATGC-01 and ATGC-02; Brushy Creek ATGH10; and Harco Branch ATGM-01. Load duration curves were developed (see Section 7) to determine load reductions needed to meet the instream water quality standard of 5 µg/L silver at varying flow scenarios.

Table 8-5 Loading Capacity for Silver for Impaired Segments in the Middle Fork Saline River Watershed

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
5	0.13
10	0.27
50	1.3
100	2.7
500	13.5
1,000	27.0
5,000	134.8
10,000	269.7
15,000	404.5

8.3.2.1 Loading Capacities

The LC is the maximum amount of silver that the impaired segments can receive and still maintain compliance with the water quality standard. In order to determine the loading capacity at various flow conditions, a range of flows were multiplied by the water quality standard. Table 8-5 contains the loading capacity for manganese.

8.3.2.2 Seasonal Variations

Consideration to seasonality is inherent in the load duration analysis described above. The standard is not seasonal and the full range of expected flows is represented in the loading capacity table (Table 8-5). Therefore, the loading capacity represents conditions throughout the year. Load duration analysis showed that exceedances have occurred over most flow regimes on the impaired segments. By considering and addressing all flow scenarios, the critical conditions when the stream segment is most vulnerable to water quality exceedences were addressed.

8.3.2.3 Margins of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The TMDLs developed for silver contain an explicit MOS of 10 percent. Ten percent is considered adequate to compensate for any uncertainty in the TMDLs.

8.3.2.4 Waste Load Allocations

There are two permitted facilities in the Middle Fork Saline River watershed. The Delta Mine Holding Company (NPDES Permit No. IL006402) is a reclaimed surface coal mine site that is permitted to discharge stormwater from multiple outfalls to Bankston Fork and Brushy Creek. The permit requires monitoring for pH and settlable solids only and has no flow information. Additionally, Western Fuels-Illinois, Inc operates the Liberty under NPDES Permit No. IL0059749. The facility is currently in the process of permit renewal for acid mine drainage from outfalls 002 and 005. These outfalls discharge to Brushy Creek ATGH-04 which is upstream of segments ATGH-10 and ATGH-09. Outfalls 002 and 005 are permit to discharge 0.002mgd and 0.074mgd, respectively. Although the permit does not require monitoring for silver, a WLA was developed for Brushy Creek segment ATGH-10 based on the discharge rates and the water quality standard.

8.3.2.5 Load Allocations and TMDL Summaries

Because there is no WLA in these TMDLs, the silver loads have been allocated between the LAs (nonpoint sources) and the MOSs. Table 8-6 shows the summary of the silver TMDLs for the impaired segments along with reductions needed at various flow levels.

Table 8-6 Silver TMDLs for the Middle Fork Saline River Watershed

Bankston Fork Segment ATGC-01							
Zone	**Flow Exceedence Range (%)**	**LC (lbs/day)**	**LA (lbs/day)**	**WLA (lbs/day)**	**MOS (10% of LC)**	**Actual Load[1] (lbs/day)**	**Percent Reduction Needed (%)**
High	0-8.5	10.834	9.750	0	1.083	36.985	74%
Moist	8.5-17	2.208	1.987	0	0.221	1.783	0%
	17-25.5	1.041	0.937	0	0.104	0.782	0%
	25.5-34	0.600	0.540	0	0.060	0.714	24%
Mid-Range	34-42.5	0.360	0.324	0	0.036	0.678	52%
Dry	42.5-51	0.204	0.184	0	0.020	0.336	45%
	51-59.5	0.094	0.084	0	0.009	0.119	29%
	59.5-68	0.048	0.043	0	0.005	0.067	35%
	68-76.5	0.022	0.020	0	0.002	0.015	0%
Low Flow	76.5-85	0.009	0.008	0	0.001	0.005	0%

Table 8-6 Silver TMDLs for the Middle Fork Saline River Watershed (cont.)

Zone	Flow Exceedance Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
Bankston Fork Segment ATGC-02							
High	0-8.5	5.567	5.010	0	0.5567	-	-
Moist	8.5-17	1.133	1.020	0	0.1133	1.055	0%
	17-25.5	0.533	0.480	0	0.0533	-	-
	25.5-34	0.307	0.276	0	0.0307	-	-
Mid-Range	34-42.5	0.183	0.165	0	0.0183	-	-
Dry	42.5-51	0.103	0.093	0	0.0103	-	-
	51-59.5	0.047	0.042	0	0.0047	-	-
	59.5-68	0.023	0.021	0	0.0023	0.060	62%
	68-76.5	0.010	0.009	0	0.0010	-	-
Low Flow	76.5-85	0.003	0.003	0	0.0003	0.003	0%
Brushy Creek Segment ATGH-10							
Zone	**Flow Exceedence Range (%)**	**LC (lbs/day)**	**LA (lbs/day)**	**WLA (lbs/day)**	**MOS (10% of LC)**	**Actual Load[1] (lbs/day)**	**Percent Reduction Needed (%)**
High	0-8.5	2.3588	2.1197	0.003	0.2359	-	-
Moist	8.5-17	0.4827	0.4344	0.003	0.0483	0.1947	0%
	17-25.5	0.2288	0.2059	0.003	0.0229	-	-
	25.5-34	0.1329	0.1196	0.003	0.0133	0.0993	0%
Mid-Range	34-42.5	0.0807	0.0726	0.003	0.0081	-	-
Dry	42.5-51	0.0468	0.0421	0.003	0.0047	-	-
	51-59.5	0.0229	0.0206	0.003	0.0023	-	-
	59.5-68	0.0130	0.0117	0.003	0.0013	0.0231	44%
	68-76.5	0.0073	0.0066	0.003	0.0007	-	-
Low Flow	76.5-85	0.0045	0.0041	0.003	0.0005	0.0010	0%
Harco Branch Segment ATGM-01							
Zone	**Flow Exceedence Range (%)**	**LC (lbs/day)**	**LA (lbs/day)**	**WLA (lbs/day)**	**MOS (10% of LC)**	**Actual Load[1] (lbs/day)**	**Percent Reduction Needed (%)**
High	0-8.5	0.5714	0.5142	0	0.05714	-	-
Moist	8.5-17	0.1163	0.1047	0	0.01163	-	-
	17-25.5	0.0547	0.0493	0	0.00547	0.1301	58%
	25.5-34	0.0315	0.0283	0	0.00315	0.0203	0%
Mid-Range	34-42.5	0.0188	0.0169	0	0.00188	0.0252	25%
Dry	42.5-51	0.0106	0.0095	0	0.00106	-	-
	51-59.5	0.0048	0.0043	0	0.00048	-	-
	59.5-68	0.0024	0.0021	0	0.00024	-	-
	68-76.5	0.0010	0.0009	0	0.00010	0.00004	0%
Low Flow	76.5-85	0.0003	0.0003	0	0.00003	0.00002	0%

[1] Actual Load was calculated using the 90th percentile of observed total silver concentrations in a given flow range (EPA 2007)

8.3.3 Sulfate TMDLs

Six segments within the Middle Fork Saline River watershed are listed for impairment caused by sulfate: Bankston Fork ATGC-01, ATGC-02, and ATGC-11; Brushy Creek ATGH09 and ATGH10; and Harco Branch ATGM-01. The water quality standard for sulfates in Illinois was revised in 2008. The new standard considers the total hardness and chloride conditions present at the time of sample collection to calculate the sulfate standard. Using the new calculated standard, data showed no violations on segment ATGC-02 of Bankston Fork or on Harco Branch segment ATGM-01. No further

TMDL analysis for sulfates will be completed for these segments as loads do not need to be reduced. The load duration curves for the remaining impaired segments were used to determine load reductions needed to meet an instream water quality standard of 500 mg/L at varying flow scenarios (further discussion provided in Section 8.3.3.1 below).

8.3.3.1 Loading Capacities

The LC is the maximum amount of sulfate that the impaired segments can receive and still maintain compliance with the water quality standards. As discussed above, the water quality standard for sulfates in Illinois was revised in 2008. The new standard considers the total hardness and chloride conditions present at the time of sample collection to calculate the sulfate standard. The minimum hardness and chloride values seen in the watershed result in a sulfate standard of 500 mg/L. Table 8-7 contains the loading capacity for sulfate at 500 mg/L for varying flows in the impaired segments.

Table 8-7 Sulfate Loading Capacity for Impaired Segments in the Middle Fork Saline River Watershed

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
5	13,484
10	26,969
50	134,844
100	269,689
500	1,348,444
1,000	2,696,888
5,000	13,484,440
10,000	26,968,879
15,000	40,453,319

8.3.3.2 Seasonal Variations

Consideration to seasonality is inherent in the load duration analysis described above. The standard is not seasonal and the full range of expected flows is represented in the loading capacity table (Table 8-7). Therefore, the loading capacity represents conditions throughout the year. Exceedances of the standar have been recorded under most flow scenarios with the highest percent of exceedances occurring during dry and low flows. By considering and addressing all flow scenarios, the critical conditions when the stream segment is most vulnerable to water quality exceedences were addressed.

8.3.3.3 Margins of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The TMDLs developed for sulfate in impaired segments in the Middle Fork Saline River watershed contain implicit MOSs because the TMDLs are based on the allowable loads calculated for the minimum calculated water quality standard of 500 mg/L. Therefore, the TMDL calculations underestimate the allowable loads for the stream segment under various flow conditions, providing a conservative estimate of the TMDLs.

8.3.3.4 Waste Load Allocation

There are two permitted facilities in the Middle Fork Saline River watershed. The Delta Mine Holding Company (NPDES Permit No. IL006402) is a reclaimed surface coal mine site that is permitted to discharge stormwater from multiple outfalls to Bankston Fork and Brushy Creek. The permit requires monitoring for pH and settlable solids only and has no flow information. Additionally, Western Fuels-Illinois, Inc operates the Liberty under NPDES Permit No. IL0059749. The facility is currently in the process of permit renewal for acid mine drainage from outfalls 002 and 005. These outfalls discharge to Brushy Creek ATGH-04 which is upstream of segments ATGH-10 and ATGH-09. Outfalls 002 and 005 are permit to discharge a maximum daily concentration of 2000 mg/L sulfate at 0.002 mgd and 0.074 mgd, respectively. WLA for Brushy Creek segments ATGH-09 and ATGH-10 were developed based on the permitted concentrations and discharge rates. The TMDL was developed based on the endpoint of 500 mg/L sulfate. At low flows, the WLA based on maximum permitted concentrations and flow rates exceed the LCs of the segments. In these instances, the WLA was set to the LC. Both permits have conditions that state that the facilities will be considered in violation if it is determined that the permittee is not utilizing "good mining practices which are applicable in order to minimize the discharge of TDS, chloride, sulfate, iron, and manganese."

8.3.3.5 Load Allocation and TMDL Summary

The sulfate loads have been allocated between the LA (nonpoint sources) and the MOS. Table 8-8 shows the summary of the sulfate TMDLs for the impaired segments along with the percent reductions required at various flow levels.

Table 8-8 Total Sulfate TMDLs for the Middle Fork Saline River Watershed

Bankston Fork Segment ATGC-01							
Zone	**Flow Exceedence Range (%)**	**LC[1] (lbs/day)**	**LA[1] (lbs/day)**	**WLA (lbs/day)**	**MOS**	**Actual Load[2] (lbs/day)**	**Percent Reduction Needed (%)**
High	0-8.5	1,083,385	1,083,385	0	implicit	1,769,911	39%
Moist	8.5-17	220,798	220,798	0	implicit	479,314	54%
	17-25.5	104,057	104,057	0	implicit	400,972	74%
	25.5-34	59,955	59,955	0	implicit	174,635	66%
Mid-Range	34-42.5	35,958	35,958	0	implicit	129,057	72%
Dry	42.5-51	20,392	20,392	0	implicit	60,879	67%
	51-59.5	9,367	9,367	0	implicit	56,023	83%
	59.5-68	4,827	4,827	0	implicit	25,016	81%
	68-76.5	2,233	2,233	0	implicit	8,811	75%
Low Flow	76.5-85	935	935	0	implicit	3,094	70%
Bankston Fork Segment ATGC-11							
Zone	**Flow Exceedence Range (%)**	**LC[1] (lbs/day)**	**LA[1] (lbs/day)**	**WLA (lbs/day)**	**MOS**	**Actual Load[2] (lbs/day)**	**Percent Reduction Needed (%)**
High	0-8.5	143,420	143,420	0	implicit	-	-
Moist	8.5-17	29,196	29,196	0	implicit	100,464	71%
	17-25.5	13,737	13,737	0	implicit	-	-
	25.5-34	7,897	7,897	0	implicit	-	-
Mid-Range	34-42.5	4,720	4,720	0	implicit	20,772	77%

Table 8-8 Total Sulfate TMDLs for the Middle Fork Saline River Watershed (cont.)

Zone	Flow Exceedence Range (%)	LC[1] (lbs/day)	LA[1] (lbs/day)	WLA (lbs/day)	MOS	Actual Load[2] (lbs/day)	Percent Reduction Needed (%)
Bankston Fork Segment ATGC-11 (cont)							
Dry	42.5-51	2,658	2,658	0	implicit	-	-
	51-59.5	1,198	1,198	0	implicit	-	-
	59.5-68	597	597	0	implicit	203	0%
	68-76.5	254	254	0	implicit	-	-
Low Flow	76.5-85	82	82	0	implicit	455	82%
Brushy Creek Segment ATGH-09							
High	0-8.5	309,308	308,041	1268	implicit	-	-
Moist	8.5-17	63,219	61,951	1268	implicit	81,145	22%
	17-25.5	29,913	28,645	1268	implicit	-	-
	25.5-34	17,331	16,063	1268	implicit	-	-
Mid-Range	34-42.5	10,485	9,217	1268	implicit	19,865	47%
Dry	42.5-51	6,044	4,777	1268	implicit	-	-
	51-59.5	2,899	1,631	1268	implicit	-	-
	59.5-68	1,604	336	1268	implicit	6,727	76%
	68-76.5	863	0	863	implicit	-	-
Low Flow	76.5-85	493	0	493	implicit	682	28%
Brushy Creek Segment ATGH-10							
Zone	**Flow Exceedence Range (%)**	**LC[1] (lbs/day)**	**LA[1] (lbs/day)**	**WLA (lbs/day)**	**MOS**	**Actual Load[2] (lbs/day)**	**Percent Reduction Needed (%)**
High	0-8.5	235,878	234,610	1,268	implicit	-	-
Moist	8.5-17	48,270	47,002	1,268	implicit	41,609	0%
	17-25.5	22,880	21,612	1,268	implicit	-	-
	25.5-34	13,288	12,020	1,268	implicit	19,118	30%
Mid-Range	34-42.5	8,069	6,801	1,268	implicit	-	-
Dry	42.5-51	4,683	3,415	1,268	implicit	-	-
	51-59.5	2,285	1,017	1,268	implicit	-	-
	59.5-68	1,298	30	1,268	implicit	480	0%
	68-76.5	734	0	734	implicit	-	-
Low Flow	76.5-85	451	0	451	implicit	853	47%

[1] Allowable loads calculated based on the minimum calculated water quality standard of 500 mg/L
[2] Actual Load was calculated using the 90th percentile of observed total sulfate concentrations in a given flow range (EPA 2007)

8.3.4 Copper, Nickel, and Zinc TMDLs

Harco Branch segment ATGM-01 in the Middle Fork Saline River Watershed is also listed for impairment caused by copper, nickel, and zinc. Load duration curves were developed (see Section 7) to determine load reductions needed to meet the instream water quality standards at varying flow scenarios.

8.3.4.1 Loading Capacities

The LC is the maximum amount of a constituent that an impaired segment can receive and still maintain compliance with the water quality standard. In order to determine the loading capacity of each constituent at various flow conditions, a range of flows were multiplied by the water quality standard. The water quality standards copper, nickel and zinc are dependent on total hardness. Therefore, the minimum reported hardness in the watershed of 100 mg/L was used for calculation of the standard and development of the load duration curves for each parameter. Table 8-9 contains the loading capacities for copper, nickel, and zinc based on a total hardness of 100 mg/L.

Table 8-9 Copper, Nickel, and Zinc Loading Capacities for Harco Branch Based on Minimum Reported Hardness in the Watershed

Estimated Mean Daily Flow (cfs)	Copper Load Capacity (lbs/day)	Nickel Load Capacity (lbs/day)	Zinc Load Capacity (lbs/day)
1	0.1	0.4	0.6
5	0.5	2.2	3.2
10	0.9	4.4	6.4
25	2.3	11.1	16.1
50	4.6	22.2	32.2
100	9.2	44.4	64.4
500	45.9	222.2	322.2
1,000	91.8	444.3	644.5

8.3.4.2 Seasonal Variations

Consideration to seasonality is inherent in the load duration analysis described above. The standards for copper, nickel, or zinc apply year-round and the full range of expected flows is represented in the loading capacity table (Table 8-9). Therefore, the loading capacity represents conditions throughout the year. Load duration curve development and analysis (Section 7) showed that violations for copper, nickel, and zinc segment ATGM-01 are most likely to occur under mid-range to moist conditions. By considering and addressing all flow scenarios, these critical conditions when the stream segments are most vulnerable to water quality exceedences were addressed.

8.3.4.3 Margins of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The TMDLs developed for copper, nickel, and zinc for Harco Branch segment ATGM-01 contain implicit MOSs because of conservative assumptions made in the development of the TMDL. The TMDL calculations were made using the minimum reported total hardness value for the watershed as a variable in the acute water quality standard calculations. The water quality criteria increases with total hardness and therefore, using the minimum reported total hardness results in an underestimation of the loading capacity of the segment.

8.3.4.4 Waste Load Allocations

There are no facilities within the watershed that discharge to Harco Branch. Because of this, WLAs were not calculated and were set to zero.

8.3.4.5 Load Allocations and TMDL Summaries

Table 8-10 shows the summary of the copper, nickel, and zinc TMDLs for Harco Branch segment ATGM-01 along with the percent reductions required at various flow levels.

Table 8-10 Dissolved Copper, Nickel, and Zinc TMDLs for Harco Branch Segment ATGM-01

Copper TMDL for Harco Branch Segment ATGM-01

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-8.5	1.944	1.944	0	implicit	-	-
	8.5-17	0.396	0.396	0	implicit	-	-
	17-25.5	0.186	0.186	0	implicit	0.598	69%
Moist	25.5-34	0.107	0.107	0	implicit	1.084	90%
Mid-Range	34-42.5	0.064	0.064	0	implicit	0.533	88%
	42.5-51	0.036	0.036	0	implicit	-	-
	51-59.5	0.016	0.016	0	implicit	-	-
	59.5-68	0.008	0.008	0	implicit	0.001	0%
Dry	68-76.5	0.003	0.003	0	implicit	-	-
Low Flow	76.5-85	0.001	0.001	0	implicit	0.0003	0%

Nickel TMDL for Harco Branch Segment ATGM-01

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-8.5	9.413	9.413	0	implicit	-	-
	8.5-17	1.916	1.916	0	implicit	-	-
	17-25.5	0.902	0.902	0	implicit	5.33	83%
Moist	25.5-34	0.518	0.518	0	implicit	2.64	80%
Mid-Range	34-42.5	0.31	0.31	0	implicit	1.23	75%
	42.5-51	0.174	0.174	0	implicit	-	-
	51-59.5	0.079	0.079	0	implicit	-	-
	59.5-68	0.039	0.039	0	implicit	0.002	0%
Dry	68-76.5	0.017	0.017	0	implicit	-	-
Low Flow	76.5-85	0.005	0.005	0	implicit	-	-

Zinc TMDL for Harco Branch Segment ATGM-01

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-8.5	13.654	13.654	0	implicit	-	-
	8.5-17	2.78	2.78	0	implicit	-	-
	17-25.5	1.308	1.308	0	implicit	93.64	99%
Moist	25.5-34	0.752	0.752	0	implicit	49.46	98%
Mid-Range	34-42.5	0.449	0.449	0	implicit	20.75	98%
	42.5-51	0.253	0.253	0	implicit	-	-
	51-59.5	0.114	0.114	0	implicit	-	-
	59.5-68	0.057	0.057	0	implicit	0.004	0%
Dry	68-76.5	0.024	0.024	0	implicit	-	-
Low Flow	76.5-85	0.008	0.008	0	implicit	0.0002	0%

1 Actual Load was calculated using the 90th percentile of observed concentrations in a given flow range (EPA 2007)
2 Allowable loads calculated using minimum reported hardness in watershed (100mg/L)

8.3.5 Fecal Coliform TMDL

Bankston Fork segment ATGC-01 in the Middle Fork Saline River watershed is also listed for impairment caused by fecal coliform. A load duration curve was developed (see Section 7) to determine load reductions needed to meet the instream water quality standards at varying flow scenarios.

8.3.5.1 Loading Capacity

The LC is the maximum amount of fecal coliform that Bankston Fork segment ATGC-01 can receive and still maintain compliance with the water quality standards. The allowable fecal coliform loads that can be generated in the watershed and still maintain the geometric mean standard of 200 cfu/100mL were determined with the methodology discussed in Section 7. The fecal coliform loading capacity according to flow is presented in Table 8-11.

Table 8-11 Fecal Coliform Loading Capacity for Bankston Fork Segment ATGC-01

Estimated Mean Daily Flow (cfs)	Load Capacity (mil col/day)
5	24,466
10	48,932
50	244,663
100	489,332
500	2,446,689
1,000	4,893,434
5,000	24,467,455
10,000	48,935,475
15,000	73,404,063

8.3.5.2 Seasonal Variation

Consideration of seasonality is inherent in the load duration analysis. Because the load duration analysis represents the range of expected stream flows, the TMDL has been calculated to meet the standard during all flow conditions. In addition, seasonality is addressed because the TMDL has been calculated to address loading only when the seasonal standard is applicable (May through October).

For this TMDL, the critical period for fecal coliform is the primary contact recreation season which is May through October each year. There is no one critical condition during the recreation season. The fecal coliform standard must be met under all flow scenarios and standard exceedances have occurred during the majority of flow scenarios. By using the load duration curve method, all of these "critical conditions" are accounted for in the loading allocations.

8.3.5.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the ATGC-01 TMDL is implicit as the analysis used the more conservative 200 cfu/100mL standard and did not consider die-off of bacteria which is likely occurring in the system but unquantified.

8.3.5.4 Waste Load Allocation

There are no facilities within the watershed that discharge to segment ATGC-01 of Bankston Fork. Because of this, WLAs were not calculated and were set to zero.

8.3.5.5 Load Allocation and TMDL Summary

Table 8-12 shows a summary of the TMDL for Bankston Fork segment ATGC-01.

Table 8-12 Fecal Coliform TMDL for Bankston Fork segment ATGC-01

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-7.5	883,694	883,694	0	implicit	15,940,920	94%
Moist	7.5-15	141,830	141,830	0	implicit	618,236	77%
	15-22.5	60,578	60,578	0	implicit	6,881,269	99%
	22.5-30	31,139	31,139	0	implicit	113,695	73%
Mid-Range	30-37.5	18,186	18,186	0	implicit	63,310	71%
Dry	37.5-45	11,474	11,474	0	implicit	34,163	66%
	45-52.5	7,470	7,470	0	implicit	2,214	0%
	52.5-60	4,644	4,644	0	implicit	12,536	63%
	60-67.5	2,878	2,878	0	implicit	5,583	48%
Low Flow	67.5-77	1,700	1,700	0	implicit	353	0%

1 Actual Load was calculated using the 90th percentile of observed fecal coliform concentrations in a given flow range (EPA 2007)

8.3.6 Total Phosphorus TMDL for Harrisburg Reservoir

8.3.6.1 Loading Capacity

The LC of Harrisburg Reservoir is the pounds of total phosphorus that can be allowed as input to the lake per day and still meet the water quality standard of 0.05 mg/L total phosphorus. The allowable phosphorus loads that can be generated in the watershed and still maintain water quality standards were determined with the BATHTUB model that was set up and confirmed as discussed in Section 7. To accomplish this, the loads calculated using average values from the historic data were reduced by a percentage and entered into the BATHTUB models until the water quality standard of 0.05 mg/L total phosphorus was met in Harrisburg Reservoir. The allowable phosphorus load determined by reducing modeled inputs to Harrisburg Reservoir through BATHTUB is 2.66 lbs/day.

8.3.6.2 Seasonal Variation

A season is represented by changes in weather; for example, a season can be classified as warm or cold as well as wet or dry. Seasonal variation is represented in the Harrisburg Reservoir TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal effects the lake will undergo during a given year. Since the pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., various portions of the agricultural season resulting in different runoff characteristics), the loadings for this TMDL will focus on average annual loadings converted to daily loads rather than specifying different loadings by season. The Harrisburg Reservoir Watershed would most likely experience critical conditions annually based on the growing season. Because an average annual basis was used for TMDL development, it is assumed that the critical condition is accounted for within the analysis.

8.3.6.3 Margin of Safety

The margin of safety (MOS) can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Harrisburg Reservoir TMDL is implicit. The analysis completed for this waterbody was conservative because of the following:

- In the absence of site-specific data, an atmospheric loading rate of 30 mg/m^2-yr total phosphorus (USACE 1999) was taken from literature values and used in the BATHTUB model. This is a conservative value because atmospheric loadings of phosphorus are attributed to erosion that becomes wind borne and because of the low amount of agricultural practices in the surrounding area, the atmospheric loading is most likely negligible. This conservative value likely overestimates loading resulting in a conservatively high percentage reduction needed to meet the TMDL endpoints.

- Default values were used in the BATHTUB model, which in absence of site-specific information are conservative. Default model values, such as the phosphorus assimilation rate, are based on scientific data accumulated from a large survey of lakes. Because no site-specific data are available, default model rates are used which are based on error analysis calculations. The model used for this analysis uses estimates of second-order sedimentation coefficients which are generally accurate to within a factor of 2 for phosphorus and a factor of 3 for nitrogen. This provides a conservation range of where the predictions could fall and provides confidence in the predicted values.

8.3.6.4 Waste Load Allocation

There are no point sources within the Harrisburg Reservoir watershed. Therefore, the WLA is set to zero for this TMDL.

8.3.6.5 Load Allocation and TMDL Summary

Table 8-13 shows a summary of the TMDL for Harrisburg Reservoir. A total reduction of 52 percent of total phosphorus loads to Harrisburg Reservoir would result in compliance with the water quality standard of 0.05 mg/L total phosphorus.

Table 8-13 TMDL Summary for Harrisburg Reservoir

Load Source	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Current Load (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Total	2.66	0	2.66	Implicit	5.54	2.88	52%
Internal	0.00	0	0.00	Implicit	0.00	0.00	0%
External	2.66	0	2.66	implicit	5.54	2.88	52%

Section 9
Implementation Plan for the Middle Fork Saline River Watershed

9.1 Adaptive Management

An adaptive management or phased approach is recommended for the TMDLs developed for the Middle Fork Saline River watershed due to the limited amount of data available for the TMDL analysis. Adaptive management is a systematic process for continually improving management policies and practices through learning from the outcomes of operational programs. Some of the differentiating characteristics of adaptive management are:

- Acknowledgement of uncertainty about what policy or practice is "best" for the particular management issue
- Thoughtful selection of the policies or practices to be applied (the assessment and design stages of the cycle)
- Careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking
- Monitoring of key response indicators
- Analysis of the management outcomes in consideration of the original objectives and incorporation of the results into future decisions (British Columbia Ministry of Forests 2000)

Implementation actions, point source controls, management measures, or BMPs are used to control the generation or distribution of pollutants. BMPs are either structural, such as wetlands, sediment basins, fencing, or filter strips; or managerial, such as conservation tillage, nutrient management plans, or crop rotation. Both types require good management to be effective in reducing pollutant loading to water resources (Osmond et al. 1995).

It is generally more effective to install a combination of point source controls and BMPs or a BMP system. A BMP system is a combination of two or more individual BMPs that are used to control a pollutant from the same critical source. In other words, if the watershed has more than one identified pollutant, but the transport mechanism is the same, then a BMP system that establishes controls for the transport mechanism can be employed (Osmond et al. 1995).

To assist in adaptive management, implementation actions, management measures, available assistance programs, and recommended continued monitoring are all discussed throughout the remainder of this section.

9.2 Implementation Actions and Management Measures for Metals, pH, and Sulfates in the Middle Fork Saline River Watershed

Violations of the water quality standards for manganese have been documented on segments ATGC-01, ATGC-02, ATGC-11, ATGH-09, and ATGM-01 in the Middle Fork Saline River watershed. Segments ATGC-01, ATGC-02, ATGH-10, and ATGM-01 have had violations for silver recorded since 1990. Violations of the sulfate standards have been reported on all 6 impaired stream segments in the watershed. In addition, segment ATGM-01 has had violations of the water quality standards for copper, nickel, zinc, and pH. The most likely sources of these contaminants are runoff from historic mining operations in the watershed as well as natural sources including overland runoff, soil erosion, and groundwater.

As discussed in the Stage 1 report, there are a number of active and historic mining operations in the Middle Fork Saline River watershed that may contribute to the loads of these contaminants to the impaired stream segments. Impacts from abandoned mine lands, acid mine drainages, surface mining, and mine tailings have all been identified in the 303(d) list as potential sources of sulfates, metals, and pH violations in the watershed. Implementation actions and management measures available to address the water quality issues associated with these sources of contaminants in all of the impaired stream segments in the Middle Fork Saline River watershed are discussed below.

9.2.1 Point Sources of Metals, pH, and Sulfates

9.2.1.1 Permitted Mining Outfalls

There are two permitted facilities in the Middle Fork Saline River watershed. The Delta Mine Holding Company (NPDES Permit No. IL006402) is a reclaimed surface coal mine site that is permitted to discharge stormwater from multiple outfalls to Bankston Fork and Brushy Creek. The permit requires monitoring for pH and settlable solids only and has no flow information. Additionally, Western Fuels-Illinois, Inc operates the Liberty under NPDES Permit No. IL0059749. The facility is currently in the process of permit renewal for acid mine drainage from outfalls 002 and 005. These outfalls discharge to Brushy Creek ATGH-04 which is upstream of segments ATGH-10 and ATGH-09. It should be noted that segment ATGH-04 is not listed for impairment on the 303(d) list.

Table 9-1 contains permit information for these facilities. The Liberty Mine permit is currently in the process of renewal and Table 9-1 contains information to reflect this.

Table 9-1 Point Source Discharges in the Middle Fork Saline River Watershed

Facility Name	Outfall	Permit Number	Daily Average Flow (mgd)	Manganese (mg/L)	Sulfate (mg/L)
				Daily Maximum	Daily Maximum
Liberty Mine - previous permit	002. 005. 009	IL0059749	n/a	4	3500
Liberty Mine - 2010 renewal	002. 005. 009	IL0059749	0.002, 0.074, 0*	1	2000
Delta Mining Company	**	IL0060402	0	-	-

n/a = information not available
* 009 only is described in the permit as "emergency only"
** The Delta Mine has multiple stormwater outfalls. Receiving waters include Bankston Fork, Unnamed Tribs to Bankston Fork, and Brushy Creek

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as the permits are due for renewal. The City of Paris STP permit has limits for BOD_5 and ammonia-nitrogen. Both permits have conditions that state that the facilities will be considered in violation if it is determined that the permittee is not utilizing "good mining practices which are applicable in order to minimize the discharge of TDS, chloride, sulfate, iron and manganese". Mine effluent limitations are provided in Part 406 of the Illinois Administrative Code Section 406.202 states:

> *In addition to the other requirements of this Part, no mine discharge or non-point source mine discharge shall, alone or in combination with other sources, cause a violation of any water quality standards of 35 Ill. Adm. Code 302 or 303. When the Agency finds that a discharge which would comply with effluent standards contained in this Part would cause or is causing a violation of water quality standards, the Agency shall take appropriate action under Section 31 or 39 of the Environmental Protection Act to require the discharge to meet whatever effluent limits are necessary to ensure compliance with the water quality standards. When such a violation is caused by the cumulative effect of more than one source, several sources may be joined in an enforcement or variance proceeding and measures for necessary effluent reductions will be determined on the basis of technical feasibility, economic reasonableness and fairness to all discharges (IPCB 1999b).*

These permit and their associated limits are thought to be adequately protective of aquatic life uses within the receiving waters.

9.2.2 Nonpoint Sources of Sulfates, pH, and Metals

A potential source of metals, sulfates, and pH in the Middle Fork Saline River watershed is abandoned mining operations. For this source, chemical treatment methods, passive treatment methods, and mine reclamation are potential implementation activities. Active chemical treatment typically involves the addition of alkaline chemicals, such as calcium carbonate, sodium hydroxide, sodium bicarbonate, and anhydrous ammonia to acid mine drainage. These chemicals raise the pH to acceptable levels and decrease the solubility of dissolved metals. Metal precipitates form and settle out of the solution. Active chemical treatment is not likely to be a viable option for the Middle Fork Saline River watershed because the chemicals are expensive, and the treatment system requires additional costs associated with operation and maintenance, as well as the disposal of metal-laden sludge.

Reclamation of abandoned mines is another method of controlling pollutants.

Reclamation of abandoned mine land involves clearing site vegetation, removing contaminated topsoil and coal, and restoring functionality of the site for recreational, agricultural, or wildlife habitat purposes. The environmental benefits realized from abandoned mine reclamation projects are numerous and significant, including restoring land for future use and improving water quality. Restoration of the land can result in increased and enhanced pasture land, recreational areas, or wildlife habitat (Pennsylvania Department of Environmental Protection [PDEP] 2002). However, reclamation projects tend to be costly and resource intensive and may not be appropriate for all abandoned mine sites in Middle Fork Saline River watershed.

Passive methods could be utilized until full reclamation of a mine occurs. Chemical addition and energy consuming treatment processes are virtually eliminated with passive treatment systems. The operation and maintenance requirements of passive systems are considerably less than active treatment systems (PDEP 2002). Therefore, passive treatment systems may be the best solution for controlling metals, sulfates, and pH originating from mining operations in the Middle Fork Saline River watershed.

Following are examples of the passive treatment technologies:

- Aerobic wetland
- Compost or anaerobic wetland
- Open limestone channels
- Diversion wells
- Anoxic limestone drains
- Vertical flow reactors
- Pyrolusite process

Additional sources of some metals contamination may be from high background levels of the metals in the soils of the watershed. As such, nonpoint source controls that are designed to reduce erosion may provide a secondary benefit of reducing any contaminants that may be attached to the soil.

Following are examples of potentially applicable erosion control measures:

- Filter Strips
- Sediment Control Basins
- Streambank Stabilization/Erosion Control

The remainder of this section discusses these technologies and management options.

9.2.2.1 Aerobic Wetland

An aerobic wetland consists of a large surface area pond with horizontal surface flow.

The pond may be planted with cattails and other wetland species. Aerobic wetlands can only effectively treat water that is net alkaline (pH greater than 7). In aerobic wetland systems, metals are precipitated through oxidation reactions to form oxides and hydroxides. A typical aerobic wetland will have a water depth of 6 to 18 inches (PDEP 2002).

9.2.2.2 Compost or Anaerobic Wetland

Compost wetlands, or anaerobic wetlands as they are sometimes called, consist of a large pond with a lower layer of organic substrate. The flow is horizontal within the substrate layer of the basin. Piling the compost a little higher than the free water surface can encourage the flow within the substrate. Typically, the compost layer consists of spent mushroom compost that contains about 10 percent calcium carbonate.

Other compost materials include peat moss, wood chips, sawdust, or hay. A typical compost wetland will have 12 to 24 inches of organic substrate and be planted with cattails or other emergent vegetation (PDEP 2002).

9.2.2.3 Open Limestone Channels

Open limestone channels may be the simplest passive treatment method available. Open limestone channels are constructed in two ways. In the first method, a drainage ditch constructed of limestone collects contaminated acid mine drainage water. The other method consists of placing limestone fragments directly in a contaminated stream. Dissolution of the limestone adds alkalinity to the water and raises the pH. This treatment requires large quantities of limestone for long-term success (PDEP 2002).

9.2.2.4 Diversion Wells

Diversion wells are another simple way to increase the alkalinity of contaminated waters. Acidic water is conveyed by a pipe to a downstream "well," which contains crushed limestone aggregate. The hydraulic force of the pipe flow causes the limestone to turbulently mix and abrade into fine particles preventing armoring (PDEP 2002).

9.2.2.5 Anoxic Limestone Drains

An anoxic limestone drain is a buried bed of limestone constructed to intercept subsurface mine water flow and prevent contact with atmospheric oxygen. Keeping oxygen out of the water prevents oxidation of metals and armoring of the limestone.

An anoxic limestone drain can be considered a pretreatment step to increase alkalinity and raise pH before the water enters a constructed aerobic wetland (PDEP 2002).

9.2.2.6 Vertical Flow Reactors

Vertical flow reactors were conceived as a way to overcome the alkalinity producing limitations of anoxic limestone drains and the large area requirements of compost wetlands. The vertical flow reactor consists of a treatment cell with an underdrained limestone base topped with a layer of organic substrate and standing water. The water flows vertically through the compost and limestone and is collected and discharged through a system of pipes. The vertical flow reactor increases alkalinity by limestone dissolution and bacterial sulfate reduction (PDEP 2002).

9.2.2.7 Pyrolusite Process

The pyrolusite process is a patented process, which utilizes site-specific cultured microbes to remove iron, manganese, and aluminum from acid mine drainage. The treatment process consists of a shallow bed of limestone aggregate inundated with acid mine drainage. After laboratory testing determines the proper combination, microorganisms are introduced to the limestone bed by inoculation ports located throughout the bed. The microorganisms grow on the surface of the limestone chips and oxidize the metal contaminants while etching away limestone, which in turn increases the alkalinity and raises the pH of water. This process has been used on several sites in western Pennsylvania with promising results (PDEP 2002).

9.2.2.8 Filter Strips

Filter strips can be used as a control to reduce pollutant loads from runoff and sedimentation to impaired stream segments in the Middle Fork Saline River watershed. Filter strips implemented along stream segments slow and filter runoff and provide bank stabilization decreasing erosion and deposition. The following paragraphs focus on the implementation of filter strips in the watershed.

Filter strips may help control contaminant levels by removing loads associated with sediment from runoff; however, no studies were identified as providing an estimate of removal efficiency. Grass filter strips have been shown to remove as much as 75 percent of sediment and 45 percent of total phosphorus from runoff, so it is assumed that the removal of other contaminants such as metals and sulfates from runoff may fall within this range (NCSU 2000). Riparian vegetation also provides bank stability that further reduces sediment loading to the stream and therefore reduces the loading of silver and manganese found in soils.

Filter strip widths for the impaired stream segments TMDLs were estimated based on the land slope. According to the NRCS Planning and Design Manual, the majority of sediment is removed in the first 25 percent of the width (NRCS 1994). Table 9-2 outlines the guidance for filter strip flow length by slope (NRCS 1999).

Table 9-2 Filter Strip Flow Lengths Based on Land Slope

Percent Slope	0.5%	1.0%	2.0%	3.0%	4.0%	5.0% or greater
Minimum	36	54	72	90	108	117
Maximum	72	108	144	180	216	234

GIS land use data described in Section 5 of the Stage 1 report were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in Section 2.4.1 of the Stage 1 report, there is a wide diversity of soil types in the watershed with no single soil type accounting for more than 2% of the watershed. Because soil type and corresponding slope values vary so widely across the watershed, maximum values associated with 5% or greater slopes were used for this analysis. Based on this slope value, filter strip widths of 234 feet could be incorporated into agricultural lands adjacent to the ditch and its tributaries.

Mapping software was then used to buffer impaired stream segments and their major tributaries to determine the total area found within 234 feet the stream channels. There are approximately 2,260 total acres within this buffer distance throughout the watershed. The land use data were then clipped to the buffer area to determine the amount of this land that is agricultural. There are an estimated 932 acres of agricultural land surrounding tributaries of the Middle Fork Saline River watershed where filter strips and riparian buffers could potentially be installed. The relative areas within the buffer distance for each impaired stream segment and its tributaries are provided in Table 9-3. Landowners should evaluate their land near the stream and its tributaries and install or extend filter strips according to the NRCS guidance provided in Table 9-1. Programs available to fund the construction of these buffer strips are discussed in Section 9.5.

Table 9-3 Total Area and Area of Agricultural Land Within 234-feet Buffer by Segment

Stream Name	Segment ID	Area in 234 ft Buffer (Acres)	Agricultural Land In 234 ft Buffer (Acres)
Bankston Fork	ATGC-01	2260.5	932.2
	ATGC-02	1142.3	460.2
	ATGC-11	483.9	243.3
Brushy Creek	ATGH-09	869.4	346.0
	ATGH-10	605.1	119.2
Harco Branch	ATGM-01	178.7	90.2

9.2.2.9 Sediment Control Basins

Sediment control basins are designed to trap sediments (and the pollutants bound to the sediment) prior to reaching a receiving water. Sediment control basins are typically earthen embankments that act similarly to a terrace. The basin traps water and sediment running off cropland upslope from the structure, and reduces gully erosion by controlling flow within the drainage area. The basin then releases water slowly, which also helps to decrease streambank erosion in the receiving water.

Sediment control basins are usually designed to drain an area of 30 acres or less and should be large enough to control runoff form a 10-year, 24-hour storm. Locations are determined based on slopes, tillage and crop management, and local NRCS can often provide information and advice for design and installation. Maintenance includes reseeding and fertilizing the basins in order to maintain vegetation and periodic checking, especially after large storms to determine the need for embankment repairs or excess sediment removal.

9.2.2.10 Streambank Stabilization/Erosion Control

Soil erosion is the process of moving soil particles or sediment by flowing water or wind. Eroding soil transports pollutants, such as manganese, that can potentially degrade water quality.

Following are three available approaches to stabilizing eroding banks that could, in turn, decrease nonpoint source manganese and silver loads:

- Stone Toe Protection (STP)
- Rock Riffle Grade Control (RR)
- Floodplain Excavation

Stone Toe Protection uses non-erodible materials to protect the eroding banks. Meandering bends found in the ATGC-01 watershed could possibly be stabilized by placing the hard armor only on the toe of the bank. STP is most commonly implemented "using stone quarry stone that is sized to resist movement and is placed on the lower one third of the bank in a windrow fashion" (STREAMS 2005).

Naturally stable stream systems typically have an alternating riffle-pool sequence that helps to dissipate stream energy. Rock Riffle Grade Control places loose rock grade control structures at locations where natural riffles would occur to create and enhance the riffle-pool flow sequence of stable streams. By installing RR in an incised channel, the riffles will raise the water surface elevation resulting in lower effective bank heights, which increases the bank stability by reducing the tractive force on the banks (STREAMS 2005).

Rather than raising the water level, Floodplain Excavation lowers the floodplain to create a more stable stream. Floodplain Excavation uses mechanical means to restore the floodplain by excavating and utilizing the soil that would eventually be eroded away and deposited in the stream (STREAMS 2005).

The extent of streambank erosion in the Middle Fork Saline River watershed is unknown. It is recommended that further investigation be performed to determine the extent that erosion control measures could help manage nonpoint source manganese and silver loads to the creek.

9.3 Implementation Actions and Management Measures for Fecal Coliform in Bankston Fork Segment ATGC-01

The TMDL analysis performed for fecal coliform in ATGC-01 showed that although exceedences were reported over the full range of flow conditions, the majority of the samples collected that exceeded the standard were collected during higher flow conditions. This indicates the majority of the exceedances have occurred as a result of stormwater runoff and resuspension of instream fecal material.

9.3.1 Point Sources of Fecal Coliform

9.3.1.1 Stormwater Sources

A portion of the Bankston Fork segment ATGC-01 watershed is urban in nature (approximately 6% of the watershed area). However, none of the municipalities within the ATGC-01 watershed are required to have stormwater permits. Therefore, little information is available regarding stormwater runoff in the watershed. It is recommended that a storm sewer survey be performed to determine the amount of fecal coliform that may be contributed to the stream via urban stormwater sources.

9.3.1.2 Permitted Mining Operations

The permitted mining facilities in the Middle Fork Saline River watershed were discussed in Section 9.2.1.1. The facilities associated with these NPDES permits are significantly upstream of the impaired segment and are not expected to be a significant source of fecal coliform loads to the stream segment.

9.3.2 Nonpoint Sources of Fecal Coliform

Several management options have been identified to help reduce fecal coliform counts in Bankston Fork segment ATGC-01. These management options focus on the most likely sources of fecal coliform within the basin, such as agricultural runoff, septic systems, and livestock. The alternatives that were identified are:

- Filter Strips
- Private Septic System Inspection and Maintenance Program
- Restrict Livestock Access to Harding Ditch and Tributaries

Each alternative is discussed briefly in this section.

9.3.2.1 Filter Strips

Filter strips were discussed in Section 9.2.2.8 for control of sulfates and metals loadings into impaired waterbodies. Filter strips will have a similar impact in reducing loads of fecal coliform from overland runoff in the watershed. Therefore the same technique for evaluating available land can be applied to fecal coliform controls. As described in Section 9.2.2.8, there are approximately 2,260 acres of land within 234 feet of ATGC-01 and its major tributaries, of this area, approximately 932 acres are categorized as agricultural and could potentially be converted into filter.

9.3.2.2 Private Septic System Inspection and Maintenance Program

As discussed in the Stage 1 report, a relatively small number of septic systems are likely to exist in the ATGC-01 watershed associated with the rural residences in the area. Failing or leaking septic systems can be a significant source of fecal coliform pollution. A program that actively manages functioning systems and addresses non-functioning systems could be put in place. The USEPA has developed guidance for managing septic systems, which includes assessing the functionality of systems, public health, and environmental risks (EPA 2005). It also introduces procedures for selecting and implementing a management plan.

To reduce the excessive amounts of contaminants from a faulty septic system, a regular maintenance plan that includes regular pumping and maintenance of the septic system should be followed. The majority of failures originate from excessive suspended solids, nutrients, and BOD loading to the septic system. Reduction of solids to the tank can be achieved via limiting garbage disposals use and water conservation.

Septic system management activities can extend the life and maintain the efficiency of a septic system. Water conservation practices, such as limiting daily water use or using low flow toilets and faucets, are the most effective methods to maintain a properly functioning septic system. Additionally, the system should not be used for the disposal of solids, such as cigarette butts, cat litter, cotton swabs, coffee grinds, disposable diapers, etc. Finally, physical damage to the drainfield can be prevented by:

- Maintaining a vegetative cover over the drainfield to prevent erosion
- Avoiding construction over the system
- Protecting the area down slope of the system from excavation
- Landscape the area to divert surface flow away from the drainfield (Johnson 1998)

The cost of each management measure is site specific and there is not specific data on septic systems and management practices for the watershed; therefore, costs for these practices were not outlined in Section 9.5.

Alternatively, a long-range solution to failing septic systems is a connection to a municipal sanitary sewer system. Installation of a sanitary sewer would reduce existing fecal coliform sources by replacing failing septic systems and will allow communities to develop without further contribution of fecal material to Bankston Fork. Costs for the installation are generally paid over a period of several years (average of 20 years) instead of forcing homeowners to shoulder the entire cost of installing a new septic system. In addition, costs are sometimes shared between the community and the utility responsible for treating the wastewater generated from replacing the septic tanks. The planning process is involved and requires participation from townships, cities, counties, and citizens.

9.3.2.3 Restrict Livestock Access to Bankston Fork and Tributaries

As discussed in the Stage 1 report, livestock are present in the ATGC-01 watershed. Saline County NRCS reported a few small cattle operations and a few chicken and hog CAFOs, but no definite numbers of operations were available. It is unknown to what extent these animals have access to the Bankston Fork or its tributaries. Reduction of livestock access to streams, however, is recommended to reduce bacteria loads. The USEPA found that livestock exclusion from waterways and other grazing management measures were successful in reducing fecal coliform counts by 29 to 46 percent (2003). Fencing and alternate watering systems are effective ways to restrict livestock from streams.

9.4 Implementation Actions and Management Measures for Phosphorus in Harrisburg Reservoir

Phosphorus loads in the Harrisburg Reservoir watershed originates from external sources. As discussed in previous sections, possible sources of total phosphorus in the Harrisburg Reservoir watershed include runoff from the surrounding watershed. To achieve a reduction of total phosphorus for this reservoir, management measures must address loading through sediment and surface runoff controls and internal nutrient cycling through in-lake management.

9.4.1 Point Sources of Phosphorus

Harrisburg Reservoir does not have any point source contributions and the associated WLA was therefore set to zero.

9.4.1.1 Urban Stormwater Sources

The 303(d) list identified urban runoff and storm sewers as potential pollutant sources of total phosphorus to Harrisburg Reservoir. Land use analysis indicates that there are approximately 65 acres of developed urban land in the watershed that may contribute urban runoff of phosphorus into the reservoir. In addition the town of Galatia, Illinois is located just west of the Harrisburg Reservoir watershed and may contribute urban runoff to the reservoir. There are no MS4 stormwater permits issued for Galatia or other nearby areas so quantification of urban runoff contributions is not possible. However, due to the limited amount of urban area in the watershed, the overall contribution from urban stormwater runoff is unlikely to be a major source of phosphorus into Harrisburg Reservoir.

9.4.2 Nonpoint Sources of Phosphorus

Potential sources of nonpoint source phosphorus pollution to Harrisburg Reservoir identified by the 303(d) list include crop production, forest/grassland/parkland runoff, Littoral/shore area modifications, and urban runoff.

BMPs available that could be utilized to treat these nonpoint sources in the watershed include:

- Conservation tillage practices
- Filter strips
- Wetlands
- Nutrient management

Total phosphorus originating from cropland is most efficiently treated with a combination of no-till or conservation tillage practices and grass filter strips. Wetlands located upstream of the reservoir could provide further reductions in total and dissolved phosphorus in runoff from croplands in the watershed. Nutrient management focuses on source control of nonpoint source contributions to the reservoir.

9.4.2.1 Conservation Tillage Practices

For the Harrisburg Reservoir watershed, conservation tillage practices could help reduce nutrient loads into the reservoir. The reservoir potentially receives nonpoint source runoff from the approximately 1,530 acres in the watershed which is under cultivation, which accounts for 38 percent of the total watershed area. Total phosphorus loading from cropland can be controlled through management BMPs, such as conservation tillage. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003). The 2006 Illinois Department of Agriculture's Soil Transect Survey estimated that conventional till currently accounts for 45 percent of corn, 15 percent of soybean, and 0 percent of small grain tillage practices in Saline County. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all agricultural areas in Harrisburg Reservoir watershed.

9.4.2.2 Filter Strips

Filter strips were discussed in Section 9.2.2.8. The same technique for evaluating available land was applied to the Harrisburg Reservoir watershed. In the Harrisburg Reservoir watershed there are 410 acres of land within 234 feet of the lake and its tributaries. Of this area, 187 acres are categorized as agricultural and could potentially be converted into filter strips.

9.4.2.3 Wetlands

The use of wetlands as a structural control is applicable to nutrient reduction from agricultural lands in the Harrisburg Reservoir watershed. To treat loads from agricultural runoff, a wetland could be constructed on the upstream end of the reservoir. Wetlands are an effective BMP for sediment and phosphorus control because they:

- Prevent floods by temporarily storing water, allowing the water to evaporate or percolate into the ground
- Improve water quality through natural pollution control such as plant nutrient uptake
- Filter sediment
- Slow overland flow of water thereby reducing soil erosion (USDA 1996)

A properly designed and functioning wetland can provide very efficient treatment of pollutants, such as phosphorus. Design of wetland systems is very important and should consider soils in the proposed location, hydraulic retention time, and space requirements. Constructed wetlands, which comprise the second or third stage of nonpoint source treatment, can be effective at improving water quality. Studies have shown that artificial wetlands designed and constructed specifically to remove pollutants from surface water runoff have removal rates for suspended solids of greater than 90 percent, 0 to 90 percent for total phosphorus, 20 to 80 percent of orthophosphate, and 10 to75 percent for nitrogen species (Johnson, Evans, and Bass 1996; Moore 1993; USEPA 1993; Kovosic et al. 2000). Although the removal rate for phosphorus is low in long-term studies, the rate can be improved if sheet flow is maintained to the wetland and vegetation and substrate are monitored to ensure the wetland is operation optimally. Sediment or vegetation removal may be necessary if the wetland removal efficiency is lessened over time (USEPA 1993; NCSU 2000).

Table 9-4 Acres of Wetland for Harrisburg Reservoir Watershed

Subbasin	Area (acres)	Recommended Wetlands (acres)
RAI-1	212	1.3
RAI-2	589	3.5
RAI-3	3,226	19.4
Total	4,027	24.2

Guidelines for wetland design suggest a wetland to watershed ratio of 0.6 percent for nutrient and sediment removal from agricultural runoff. Table 9-4 outlines estimated wetland areas for each agricultural subbasin in the Harrisburg Reservoir watershed based on these recommendations. A wetland system to treat agricultural runoff from the three subbasins could be approximately 68 acres (Denison and Tilton 1993).

9.4.2.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to Harrisburg Reservoir. Crop management of nitrogen and phosphorus originating in the agricultural portions of the watershed can be accomplished through Nutrient Management Plans, which focus on increasing the efficiency with which applied nutrients are used by crops, thereby reducing the amount available to be transported to both surface and groundwater. In the past, nutrient management focused on application rates designed to meet crop nitrogen requirements but avoid groundwater quality problems created by excess nitrogen leaching. This results in buildup of soil phosphorus above amounts sufficient for optimal crop yields. Illinois, along with most Midwestern states, demonstrates high soil test phosphorus in greater than 50 percent of soil samples analyzed (Sharpley et al. 1999).

The overall goal of phosphorus reduction from agriculture should increase the efficiency of phosphorus use by balancing phosphorus inputs in feed and fertilizer with outputs in crops and animal produce as well as managing the level of phosphorus in the soil. Reducing phosphorus loss in agricultural runoff may be brought about by source and transport control measures, such as filter strips or grassed waterways. The Nutrient Management Plans account for all inputs and outputs of phosphorus to determine reductions. Nutrient Management Plans include:

- Review of aerial photography and soil maps
- Regular soil testing

- Review of current and/or planned crop rotation practices
- Yield goals and associated nutrient application rates
- Nutrient budgets with planned rates, methods, timing and form of application
- Identification of sensitive areas and restrictions on application when land is snow covered, frozen or saturated

In Illinois, Nutrient Management Plans have successfully reduced phosphorus application to agricultural lands by 36-lb/acre. National reductions range from 11 to 106-lb/acre, with an average reduction of 35-lb/acre (USEPA 2003).

9.5 Reasonable Assurance

Reasonable assurance means that a demonstration is given that nonpoint source reductions in this watershed will be implemented. It should be noted that all programs discussed in this section are voluntary and some may currently be in practice in the watershed. The discussion in Sections 9.2 through 9.4 provided information on available BMPs for reducing phosphorus loads from point and nonpoint sources. The remainder of this section discusses an estimate of costs to the watershed for implementing nonpoint source management practices and programs available to assist with funding.

9.5.1 Available Programs for Nonpoint Source Management

There are several voluntary conservation programs established through the 2008 U.S. Farm Bill, which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to crop fields and rural grasslands that are presently used as pasture land. Each program is discussed separately in the following paragraphs.

9.5.1.1 Illinois Department of Agriculture and Illinois EPA Nutrient Management Plan Project

The IDA and Illinois EPA are presently co-sponsoring a cropland Nutrient Management Plan project in watersheds that have or are developing a TMDL. This voluntary project supplies incentive payments to producers to have Nutrient Management Plans developed and implemented. Additionally, watersheds that have sediments or phosphorus identified as a cause for impairment (as is the case in this watershed), are eligible for cost-share assistance in implementing traditional erosion control practices through the Nutrient Management Plan project.

9.5.1.2 Conservation Reserve Program

This voluntary program encourages landowners to plant long-term resource-conserving cover to improve soils, water, and wildlife resources. The Conservation Reserve Program (CRP) is the USDA's single largest environmental improvement program and one of its most productive and cost-efficient. It is administered through the Farm Service Agency (FSA) by USDA's Commodity Credit Corporation (CCC). The program was initially established in the Food & Security Act of 1985. The duration of the contracts under CRP range from 10 to 15 years.

Eligible land must be one of the following:

1. Cropland that is planted or considered planted to an agricultural commodity four of the six most recent crop years (including field margins) and must be physically and legally capable of being planted in a normal manner to an agricultural commodity.

2. Certain marginal pastureland enrolled in the Water Bank Program.

In addition to the eligible land requirements, cropland must meet one of the following criteria:

- Have a weighted average erosion index of 8 or higher;
- Be expiring CRP acreage; or
- Be located in a national or state CRP conservation priority area.

The CCC bases rental rates on the relative productivity of soils within each county and the average of the past three years of local dry land cash rent or cash-rent equivalent. The maximum rental rate is calculated in advance of enrollment. Producers may offer land at the maximum rate or at a lower rental rate to increase likelihood of offer acceptance. In addition, the CCC provides cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices (USDA 2006).

Finally, CCC offers additional financial incentives of up to 20 percent of the annual payment for certain continuous sign-up practices (USDA 2006). Continuous sign-up provides management flexibility to farmers and ranchers to implement certain high-priority conservation practices on eligible land. The land must be determined by NRCS to be eligible and suitable for any of the following practices:

- Riparian buffers
- Filter strips
- Grass waterways
- Shelter belts
- Field windbreaks
- Living snow fences
- Contour grass strips
- Salt tolerant vegetation
- Shallow water areas for wildlife
- Eligible acreage within an EPA-designated wellhead protection area (FSA 1997)

The current extent of land enrolled in CRP within the Middle Fork Saline River Watershed watershed is unknown.

9.5.1.3 Clean Water Act Section 319 Grants

Section 319 was added to the CWA to establish a national program to address nonpoint sources of water pollution. Through this program, each state is allocated Section 319 funds on an annual basis according to a national allocation formula based on the total annual appropriation for the section 319 grant program. The total award consists of two categories of funding: incremental funds and base funds. A state is eligible to receive EPA 319(b) grants upon USEPA's approval of the state's Nonpoint Source Assessment Report and Nonpoint Source Management Program. States may reallocate funds through subawards (e.g., contracts, subgrants) to both public and private entities, including local governments, tribal authorities, cities, counties, regional development centers, local school systems, colleges and universities, local nonprofit organizations, state agencies, federal agencies, watershed groups, for-profit groups, and individuals.

USEPA designates incremental funds, a $100-million award, for the restoration of impaired water through the development and implementation of watershed-based plans and TMDLs for impaired waters. Base funds, funds other than incremental funds, are used to provide staffing and support to manage and implement the state Nonpoint Source Management Program. Section 319 funding can be used to implement activities which improve water quality, such as filter strips, streambank stabilization, etc. (USEPA 2003).

Illinois EPA receives federal funds through Section 319(h) of the CWA to help implement Illinois' Nonpoint Source (NPS) Pollution Management Program. The purpose of the program is to work cooperatively with local units of government and other organizations toward the mutual goal of protecting the quality of water in Illinois by controlling NPS pollution. The program emphasizes funding for implementing cost-effective corrective and preventative BMPs on a watershed scale; funding is also available for BMPs on a non-watershed scale and the development of information/education NPS pollution control programs.

The Maximum Federal funding available is 60 percent, with the remaining 40 percent coming from local match. The program period is two years unless otherwise approved. This is a reimbursement program.

Section 319(h) funds are awarded for the purpose of implementing approved NPS management projects. The funding will be directed toward activities that result in the implementation of appropriate BMPs for the control of NPS pollution or to enhance the public's awareness of NPS pollution. Applications are accepted June 1 through August 1.

9.5.1.4 Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is a voluntary program that provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands. The goal of WRP is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

The program offers three enrollment options:

1. *Permanent Easement* is a conservation easement in perpetuity. USDA pays 100 percent of the easement value and up to 100 percent of the restoration costs.

2. *30-Year Easement* is an easement that expires after 30 years. USDA pays up to 75 percent of the easement value and up to 75 percent of the restoration costs. For both permanent and 30-year easements, USDA pays all costs associated with recording the easement in the local land records office, including recording fees, charges for abstracts, survey and appraisal fees, and title insurance.

3. *Restoration Cost-Share Agreement* is an agreement to restore or enhance the wetland functions and values without placing an easement on the enrolled acres. USDA pays up to 75 percent of the restoration costs.

The total number of acres that can be enrolled in the program is 3,041,200 – an increase of 766,200 additional acres over the previous Farm Bill.

- Payments for easements valued at $500,000 or more will be made in at least five annual payments.

- For restoration cost-share agreements, annual payments may not exceed $50,000 per year.

- No easement shall be created on land that has changed ownership during the preceding 7 years.

- Eligible acres are limited to private and Tribal lands.

9.5.1.5 Environmental Quality Incentive Program

The Environmental Quality Incentive Program (EQIP) is a voluntary USDA conservation program for farmers and private landowners engaged in livestock or agricultural production who are faced with serious threats to soil, water, and related natural resources. Through EQIP, the NRCS develops contracts with agricultural producers to implement conservation practices to address environmental natural resource problems. Payments are made to producers once conservation practices are completed according to NRCS requirements.

Persons engaged in livestock or agricultural production and owners of non-industrial private forestland are eligible for the program. Eligible land includes cropland, rangeland, pastureland, private non-industrial forestland, and other farm or ranch lands. Persons interested in entering into a cost-share agreement with the USDA for EQIP assistance may file an application at any time.

NRCS works with the participant to develop the EQIP plan of operations. This plan becomes the basis of the EQIP contract between NRCS and the participant. NRCS provides conservation practice payments to landowners under these contracts that can be up to 10 years in duration.

The EQIP objective to optimize environmental benefits is achieved through a process that begins with National priorities that address: impaired water quality, conservation of ground and surface water resources improvement of air quality reduction of soil erosion and sedimentation, and improvement or creation of wildlife habitat for at-risk species. National priorities include: reductions of nonpoint source pollution, such as nutrients, sediment, pesticides, or excess salinity in impaired watersheds consistent with TMDLs where available as well as the reduction of groundwater contamination and reduction of point sources such as contamination from confined animal feeding operations; conservation of ground and surface water resources; reduction of emissions, such as particulate matter, nitrogen oxides (NOx), volatile organic compounds, and ozone precursors and depleters that contribute to air quality impairment violations of National Ambient Air Quality Standards reduction in soil erosion and sedimentation from unacceptable levels on agricultural land; and promotion of at-risk species habitat conservation.

EQIP provides payments up to 75 percent of the incurred costs and income foregone of certain conservation practices and activities. The overall payment limitation is $300,000 per person or legal entity over a 6-year period. The Secretary of Agriculture may raise the limitation to $450,000 for projects of special environmental significance. Payment limitations for organic production may not exceed an aggregate $20,000 per year or $80,000 during any 6-year period for installing conservation practices.

Conservation practices eligible for EQIP funding which are recommended BMPs for this watershed TMDL include field borders, filter strips, cover crops, grade stabilization structures, grass waterways, riparian buffers, streambank shoreline protection, terraces, and wetland restoration.

The selection of eligible conservation practices and the development of a ranking process to evaluate applications are the final steps in the optimization process. Applications will be ranked based on a number of factors, including the environmental benefits and cost effectiveness of the proposal. More information regarding State and local EQIP implementation can be found at www.nrcs.usda.gov/programs/eqip.

9.5.1.6 Wildlife Habitat Incentives Program

The Wildlife Habitat Incentive Plan (WHIP) is a voluntary program administered by NRCS which is designed to assist those who want to develop and improve wildlife habitat primarily on private lands and nonindustrial private forest land. It provides both technical assistance and cost share payments to help:

- Promote the restoration of declining or important native fish and wildlife species.

- Protect, restore, develop, or enhance fish and wildlife habitat to benefit at-risk species.
- Reduce the impacts of invasive species in fish and wildlife habitat.
- Protect, restore, develop, or enhance declining or impaired aquatic wildlife species habitat.

Participants who own or control land agree to prepare and implement a wildlife habitat development plan. The NRCS provides technical and financial assistance for the establishment of wildlife habitat development practices. In addition, if the landowner agrees, cooperating State wildlife agencies and nonprofit or private organizations may provide expertise or additional funding to help complete a project.

Participants work with the NRCS to prepare a wildlife habitat development plan in consultation with the local conservation district. The plan describes the participant's goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement. This plan may or may not be part of a larger conservation plan that addresses other resource needs such as water quality and soil erosion.

The NRCS and the participant enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts from 5 to 10 years from the date the agreement is signed for general applications and up to 15 years for essential habitat applications. Cost-share payments may be used to establish new practices or replace practices that fail for reasons beyond the participant's control.

WHIP has a continuous sign-up process. Applicants can sign up anytime of the year at their local NRCS field office. Conservation practices eligible for WHIP funding which are recommended BMPs for this watershed TMDL include but are not limited to filter strips, field borders, riparian buffers, streambank and shoreline protection, and wetland restoration.

9.5.1.7 Illinois Conservation and Climate Initiative

The Illinois Conservation and Climate Initiative (ICCI) is a joint project of the State of Illinois and the Delta Institute that allows farmers and landowners to earn revenue through the sale of greenhouse gas emissions credits when they use conservation practices such as no-till, grass plantings, reforestation, or manure digesters.

The Chicago Climate Exchange (CCX®) quantifies, credits, and sells greenhouse gas credits from conservation practices. The credits are aggregated, or pooled, from farmers and landowners in order to sell them to CCX® members that have made voluntary commitments to reduce their greenhouse gas contributions.

ICCI provides an additional financial incentive for farmers and landowners to use conservation practices that also benefit the environment by creating wildlife habitat and limiting soil and nutrient run-off to streams and lakes.

Many farmers and landowners are already using conservation practices eligible for carbon credits on the CCX® such as no-till farming, strip-till farming, grass plantings, afforestation/reforestation, and the use of methane digesters. To be eligible, the producer or landowner must make a contractual commitment to maintain the eligible practice through 2010. CREP and CRP land is eligible for enrollment in the ICCI as long as it meets CCX® eligibility requirements for the practice (www.illinoisclimate.org).

9.5.1.8 Local Program Information

The Farm Service Agency (FSA) administers the CRP. NRCS administers the EQIP, WRP, and WHIP. Local NRCS contact information in Saline, Hamilton, Franklin, and Williamson counties are listed in the Table 9-5 below.

Table 9-5 Local NRCS and FSA Contact Information

County	Contact	Address	Phone
Local SWCD Office			
Franklin County	Carla Barnes	711 N. DuQuoin Street Benton, IL 62812	(618) 438-4021
Hamilton County	Rebecca Barr	R.R.#5, P.O. Box 277 McLeansboro, IL 62859-0277	(618) 643-4326
Saline County	Carolyn R. Hathaway	912 S. Commercial Street Harrisburg, IL 62946	(618) 253-7292
Williamson County	Jodi Hawkins	502 Comfort Drive, Suite C Marion, Illinois 62959	(618) 993-5396
Local FSA Office			
Franklin County	Terry Swift	711 N. DuQuoin Street Benton, IL 62812	(618) 438-4021 ext. 2
Hamilton County	Bruce Morrison	R.R.#5, P.O. Box 277 McLeansboro, IL 62859-0277	(618) 643-4326 ext. 2
Saline County	Gary Ellis	912 S. Commercial Street Harrisburg, IL 62946	(618) 252-8621 ext. 2
Williamson County	Amanda Grundy	502 Comfort Drive, Suite C Marion, Illinois 62959	(618) 993-5396 ext. 2
Local NRCS Office			
Franklin County	Diane Wallace	711 N. DuQuoin Street Benton, IL 62812	(618) 438-4021 ext. 3
Hamilton County	Rhonda Cox	R.R.#5, P.O. Box 277 McLeansboro, IL 62859-0277	(618) 643-4326 ext. 3
Saline County	James R. Warder	912 S. Commercial Street Harrisburg, IL 62946	(618) 253-7292 ext. 3
Williamson County	V. Tony Korando	502 Comfort Drive, Suite C Marion, Illinois 62959	(618) 993-5396 ext. 3

9.5.2 Cost Estimates of BMPs

Cost estimates for different BMPs and individual practice prices such as filter strip installation are detailed in the following sections. Finally, an estimate of the total order of magnitude costs for implementation measures in the Middle Fork Saline River watershed are presented in Section 9.5.2.6 and Table 9-5.

9.5.2.1 Wetlands

The price to establish a wetland is very site specific. There are many different costs that could be incurred depending on wetland construction. Examples of costs associated with constructed wetlands include excavation costs. EQIP program cost documentation for Illinois published in 2009 estimates $1,700/acre for wetland excavation, earthwork, and native seeding. More information can be found at: ftp://ftp-fc.sc.egov.usda.gov/IL/farmbill/EQIPpaymnt_schdl_Tradtnl_0509.pdf

9.5.2.2 Filter Strips and Riparian Buffers

The Illinois EQIP document used for wetland pricing also provides filter strip and riparian buffer cost estimates. Filter strip implementation that includes seedbed preparation and native seed was estimated at $88/acre while riparian buffers ranged from $130/acre for herbaceous cover up to $800/acre for forested buffers

9.5.2.3 Nutrient Management Plan – NRCS

A significant portion of the agricultural land in the Middle Fork Saline River watershed is comprised of cropland. The service for developing a nutrient management plan averages $6 to $18/acre. This includes soil testing, manure analysis, scaled maps, and site specific recommendations for fertilizer management.

9.5.2.4 Nutrient Management Plan – IDA and Illinois EPA

The costs associated with development of Nutrient Management Plans co-sponsored by the IDA and the Illinois EPA is estimated at $10/acre paid to the producer and $3/acre for a third party vendor who develops the plans. There is a 200 acre cap per producer. The total plan development cost is estimated at $13/acre.

9.5.2.5 Conservation Tillage

Conservation tillage is assumed to include tillage practices that preserve at least 30 percent residue cover of the soil after crops are planted. Costs associated with converting to conservation tillage will depend on the degree of conservation tillage practices implemented. The University of Iowa has estimated a cost for conversion to no-till practices. The study acknowledged that some equipment conversion is needed, but converting to no-till only means (for most producers) the addition of heavier down-pressure springs, row cleaners, and possibly a coulter on each planter row unit. The cost of converting existing equipment ranges between $300 and $400 per planter row, which for many producers, amounts to a nominal additional production cost of approximately $1 or $2 per acre per year (Al-Kaisi 2002).

9.5.2.6 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 9-6. The column labeled "Program" or "Sponsor" lists the financial assistance program or sponsor available for various BMPs. The programs and sponsors represented in the table are the Wetlands Reserve Program (WRP), the Conservation Reserve Program (CRP), National Resource Conservation Service (NRCS), Conservation Cost-Share

Program (CPP), Illinois EPA, and Illinois Department of Agriculture (IDA). It should be noted that IEPA 319 Grants are applicable to all of these practices.

Table 9-6 Cost Estimate of Various BMP Measures

Source	Program	Sponsor	BMP	Installation Mean $
Nonpoint	CRP	NRCS and IDA	Filter strip (seeded)	$88/acre
	CRP	NRCS and IDA	Riparian Buffer	$130-$800/acre
	WRP	NRCS	Wetland	$1,700/acre
		NRCS	Nutrient Management Plan	$6-18
		IDA and Illinois EPA	Nutrient Management Plan	$13
	CRP	NRCS and IDA	Conservation Tillage	varies

Total watershed costs will depend on the combination of BMPs selected to target non-point sources within the watershed. Regular monitoring will support adaptive management of implementation activities to most efficiently reach the TMDL goals.

9.6 Monitoring Plan

The purpose of the monitoring plan for the Middle Fork Saline River watershed is to assess the overall implementation of management actions outlined in this section. This can be accomplished by conducting the following monitoring programs:

- Track implementation of management measures in the watershed
- Estimate effectiveness of management measures
- Continued monitoring of impaired stream segments and Harrisburg Reservoir
- Storm-based monitoring of high flow events
- Tributary monitoring

Tracking the implementation of management measures can be used to address the following goals:

- Determine the extent to which management measures and practices have been implemented compared to action needed to meet TMDL endpoints

- Establish a baseline from which decisions can be made regarding the need for additional incentives for implementation efforts

- Measure the extent of voluntary implementation efforts

- Support work-load and costing analysis for assistance or regulatory programs

- Determine the extent to which management measures are properly maintained and operated

Estimating the effectiveness of the BMPs implemented in the watershed could be completed by monitoring before and after the BMP is incorporated into the watershed.

Additional monitoring could be conducted on specific structural systems such as a constructed wetland. Inflow and outflow measurements could be conducted to determine site-specific removal efficiency.

IEPA monitors lakes every three years and conducts Intensive Basin Surveys every five years. Additionally, ambient sites are monitored nine times a year. Continuation of this state monitoring program will assess lake and stream water quality as improvements in the watershed are completed. This data will also be used to assess whether water quality standards in the impaired segments are being attained.

9.7 Implementation Time Line

Implementing the actions outlined in this section for the Middle Fork Saline River watershed should occur in phases and assess effectiveness of the management actions as improvements are made. It is assumed that it may take up to five years to secure funding for actions needed in the watershed and five to seven years after funding to implement the measures. Once improvements are implemented, it may take 10 years or more for impaired waters to reach water quality standard targets. In summary, it may take up to 20 years for the impaired waterbodies to meet the applicable water quality standards.

THIS PAGE INTENTIONALLY LEFT BLANK