Final Report

Detailed Watershed Plan for the Upper Salt Creek Watershed: Volume 1

Prepared for

Metropolitan Water Reclamation District of Greater Chicago

November 2009

MWH

Executive Summary

Background

The Metropolitan Water Reclamation District of Greater Chicago (District) has authority for regional stormwater management within Cook County as granted by the Illinois General Assembly in Public Act 93-1049 (the Act). The Act requires the District to develop watershed plans for six Cook County watersheds, which include the North Branch of the Chicago River, Lower Des Plaines River, Calumet-Sag Channel, Little Calumet River, Poplar Creek, and Upper Salt Creek. The District published the *Cook County Stormwater Management Plan* (CCSMP) in February 2007 to identify stormwater management goals and to outline the District's approach to watershed planning. Chapter 6 of the CCSMP defines the District's approach to and standards for Detailed Watershed Plans (DWPs), which address regional stormwater problems in Cook County. The six major watersheds for which DWPs are being developed cover approximately 730 square miles in Cook County. The primary goals of the DWPs are as follows:

- Document stormwater problem areas.
- Evaluate existing watershed conditions using hydrologic and hydraulic (H&H) models.
- Produce flow, stage, frequency, and duration information about flood events along regional waterways.
- Estimate damages associated with regional stormwater problems.
- Evaluate potential solutions to regional stormwater problems.

The Upper Salt Creek DWP was developed to meet the goals for the Upper Salt Creek Watershed as described in the CCSMP. The Act required the formation of Watershed Planning Councils (WPCs) to advise the District during development of its countywide stormwater management program; therefore, the DWPs were developed in coordination with the WPCs. Membership of the WPCs consists of the chief elected official of each municipality and township in each watershed, or their designees. Many municipalities and townships are represented by engineers, elected officials, or public works directors. WPC meetings are also open to the public. Frequent coordination with WPCs was performed to ensure that local knowledge is integrated into the DWP and the DWP reflects the communities' understanding of watershed issues as well as the practicability of proposed solutions.

Detailed Watershed Plan Scope

The scope of the Upper Salt Creek DWP includes the development of stormwater improvement projects to address regional problem areas along open waterways. Regional problems are defined as problems associated with waterways whose watersheds encompass multiple jurisdictions and drain an area greater than 0.5 square miles. Problems arising from capacity issues on local systems, such as storm sewer systems and minor open channel ditches, even if they drain more than one municipality, were considered local and beyond the scope of this study. Erosion problems addressed in this plan were limited to active erosion along regional waterways that pose an imminent risk to structures or critical infrastructure. Interstate highways, U.S. highways, state routes, county roads with four or more lanes, and smaller roads providing critical access that are impacted by overbank flooding of regional waterways at depths exceeding 0.5 feet were also considered regional problems.

Watershed Overview

Salt Creek is divided into two hydrologic parts by Busse Woods Dam: Upper Salt Creek and Lower Salt Creek. However, for the purposes of the development of this DWP, “Upper Salt Creek” will refer, hereafter, to the Salt Creek stream reaches and tributaries located upstream of the DuPage County/Cook County border. The “Watershed” will refer, hereafter, to the Upper Salt Creek Watershed. The total Watershed area is approximately 55 square miles. Land use is predominately residential with concentrations of commercial, light manufacturing and trucking facilities. Several large forest preserves are also present, notably Ned Brown Preserve (also known as Busse Woods), Paul Douglas Forest Preserve and Deer Grove Forest Preserve. Figure ES.1 shows a schematic of the Watershed showing the drainage boundary, stream channels, and municipality boundaries of the Watershed.

The Watershed is composed of three distinct subwatersheds: the Arlington Heights branch, the Mainstem, and the West Branch. The Arlington Heights Branch subwatershed covers the north and northeast portion of the watershed and flows directly into the Mainstem upstream of Algonquin Road in the City of Rolling Meadows. The West Branch subwatershed covers the southwest portion of the watershed and joins the Mainstem at the Busse Woods Reservoir.

Existing Conditions Evaluation

Locations with historic flooding and stream bank erosion problems on regional waterways exist throughout the watershed. Information on existing problem areas was solicited from WPC members as well as federal and state agencies and other stakeholders during the data collection and evaluation phase of the DWP development, which also included the collection of data regarding the watershed and evaluation of the data’s acceptability for use. Responses from stakeholders were used to help identify locations of concern, and where field assessment or surveys were needed to support hydrologic and hydraulic modeling.

Hydrologic models were developed to represent runoff generated by rainfall throughout the Upper Salt Creek Watershed. The runoff was then routed through hydraulic models, which were created for the major open channel waterways within the watershed. Design rainfall events were simulated for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval events based upon Bulletin 71 rainfall data (ISWS, 1992). The simulated water surface profiles were overlaid upon a ground elevation model of the study area to identify structures at risk of flooding.

Property damages due to flooding were estimated using a methodology consistent with the U.S. Army Corps of Engineers (USACE) Flood Damage Assessment program. Estimated flood damages resulting from a range of possible storms was considered in combination with the probability of a particular storm occurring to estimate an expected annual damage. Erosion damages were assessed for structures or infrastructure at risk of loss due to actively eroding stream banks. Damages reported within this document refer to economic damages estimated over a 50-year period of analysis that result from regional overbank flooding or erosion of a regional waterway. Additional damages throughout the watershed exist, including damages due to flooding from local waterways and storm sewer systems, and also damages not easily quantified in financial terms such as water quality, wetland, riparian, and habitat impact, loss of emergency access, and loss of business or operations due to limited access.

FIGURE ES.1
Upper Salt Creek Watershed Overview (see Figure 1 in Volume 2 to view full color, 11 x 17 version of this map)

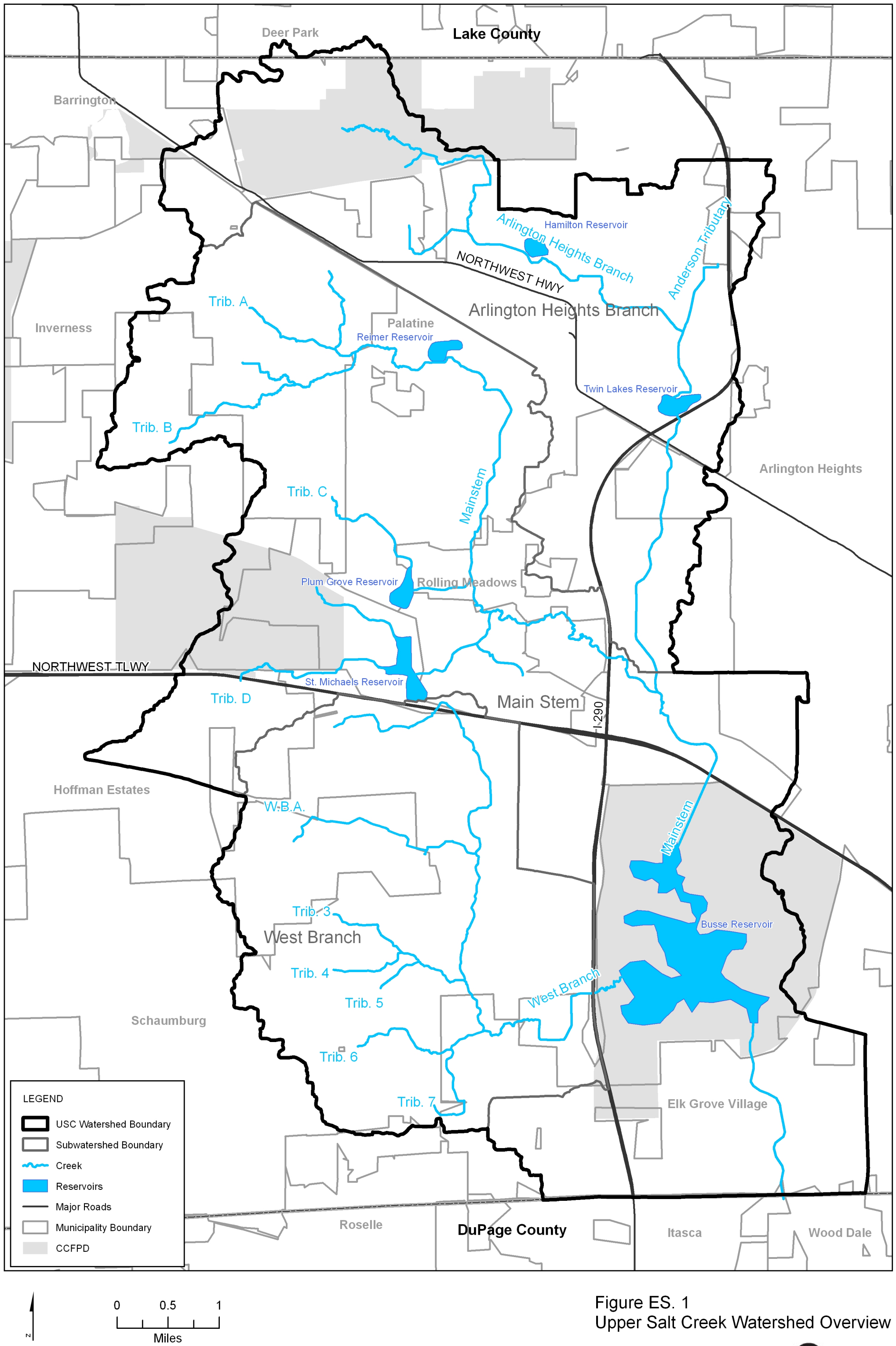

Figure ES. 1
Upper Salt Creek Watershed Overview

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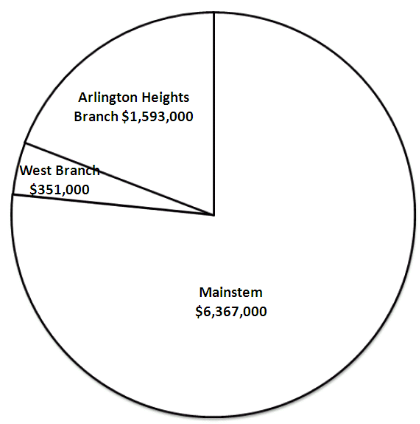
Figure ES.2 summarizes the distribution of existing conditions damages within the Upper Salt Creek Watershed over a planning period of analysis of 50 years. The Mainstem and its tributaries comprise nearly 75 percent of the existing conditions damage within the watershed; this system has the largest tributary area and the most river miles and is the most densely developed of the three subwatersheds in this DWP.

The estimated damages summarized in Figure ES.2 include calculated regional damages related to overbank flooding, transportation damages, and erosion problems on regional waterways that threaten structures only. Localized problems, such as storm-sewer capacity related problems, are not included in this estimate. Reported problems classified as local are presented in Table 2.2.1 in Section 2.2.1. Also provided in Table 2.2.1 is the reasoning behind classifying the problems as local or regional.

FIGURE ES.2
Summary of Existing Conditions Damages within the Upper Salt Creek Watershed over 50-Year Period of Analysis



Evaluation of Alternatives

Stormwater improvements, or alternatives, were developed to address regional stormwater problems along intercommunity waterways. WPC members participated in the alternative development process by providing input on possible solutions and candidate sites for new stormwater infrastructure. It should be noted that the alternatives presented in the DWP are developed at a conceptual level of feasibility.

Hydrologic and hydraulic models were used to determine the benefit of alternative stormwater improvement projects. Models were run and damages were calculated for the existing conditions evaluation. Benefits were calculated for each project as the difference between existing and alternative conditions damages. Only regional financial benefits (e.g., relief of flooding due to a regional problem as defined above) were considered. Local benefits (e.g., improved sewer drainage due to reduced outlet elevation) and non-economic benefits (e.g. improved emergency access, improved wetland, riparian, and habitat, and improved access to businesses) are not included in the benefits. The alternative stormwater improvement projects may have significant local and non-economic benefits. Local benefits are not reported in the DWP, which focuses on regional benefits.

Conceptual level cost estimates were produced to represent the estimated costs for design, construction, and maintenance of a specific alternative over a 50-year period of analysis. The cost estimates were developed using standard unit cost items located within a District database and used for all six watershed plans. In addition, standard markups on the estimated capital costs, such as utility relocation, design and engineering costs, profit and contingency were included.

A benefit-to-cost (B/C) ratio was developed for each alternative, which represents the ratio of estimated benefits to costs. The B/C ratios calculated may be used to rank the alternatives in a relative manner as the District's Board of Commissioners prioritizes the implementation of recommended stormwater improvement projects. Only regional financial benefits were considered in determination of the B/C ratios. The B/C ratios do not include local and noneconomic benefits and should not be interpreted to be the sole measure of justification of an alternative. In addition to the B/C ratio, noneconomic criteria such as water-quality impact, number of structures protected, and impact on wetland and riparian areas were noted for each alternative. These criteria may also be considered along with the calculated B/C ratios as the District's Board of Commissioners prioritizes the implementation of recommended stormwater improvement projects.

Recommendations

Alternatives were recommended based upon consideration of their ability to reduce stormwater damages and to address problems reported by communities. Table ES.1 lists the recommended alternatives, their costs, and regional financial benefits.

Table ES.2 summarizes the extent to which the recommended alternatives address existing regional financial damages within each tributary, ordered by increasing existing conditions damages.

TABLE ES.1
Recommended Alternatives Summary for the Upper Salt Creek Watershed

Project	Category	Description	B/C Ratio	Total Benefits	Total Project Cost	Probable Construction Cost	Cumulative Structures Protected	Communities Involved
SCUP-49	Conveyance	Widen channel and increase conveyance capacity of five bridges.	0.15	$1,701,000	$11,030,000	$6,393,000	61	Palatine
SCUP-56	Conveyance/ Levee	Install pumping station with flap gate and construct three levees.	0.12	$166,000	$1,403,000	$956,500	0*	Rolling Meadows
SCAH-50	Conveyance	Widen channel and increase the conveyance capacity of two culverts.	0.93	$1,593,000	$1,707,000	$975,000	18	Palatine
SCWB-52	Conveyance	Lower weirs on two detention basins, increase capacity of bridge and create ditch in place of culvert.	0.31	$351,000	$1,149,000	$665,000	3	Schaumburg

* This alternative addresses regional transportation damages. The project cost includes $ 1,253,000 for necessary local improvements.

TABLE ES.2
Upper Salt Creek Watershed Alternatives Summary

Watershed	Existing Conditions Damages	Benefits from Recommended Alternatives	Percent of Damages Addressed	Benefit Cost Ratio
Upper Main Stem	$6,367,000	$1,867,000	29%	0.15
Arlington Heights Branch	$1,593,000	$1,593,000	100%	0.93
West Branch	$351,000	$351,000	100%	0.31
Total	$8,311,000	$3,811,000	46%	0.25

The Upper Salt Creek DWP integrated stormwater data from a large number of sources in order to identify and prioritize solutions to existing stormwater problems. An extensive data collection effort undertaken for the DWP development included surveying of streams, bridges, and culverts throughout the entire watershed. Field reconnaissance was performed throughout the watershed to understand conditions unique to the watershed. This compilation of current, accurate data was used by the District to document and identify existing stormwater problems throughout the study area.

Several alternatives were developed and evaluated for their effectiveness in reducing regional damages within the Upper Salt Creek Watershed. The alternatives listed in Table ES.1 were identified as the most effective improvements for reducing expected damages due to flooding within the watershed. In some tributaries, greater opportunities to reduce regional flooding were identified than in others. Factors such as the lack of availability of land and location of structures relative to stream channels limited the practicality of alternative projects to eliminate all flooding damages for all design storms evaluated.

The data provided in the Upper Salt Creek DWP will be used by the District, along with consistently developed data in DWPs for the other five major Cook County Watersheds, to prioritize the implementation of stormwater improvement projects.

Contents

Tables

Figures
Note: Figures not embedded in the chapters are contained in Volume 2.

Appendices

Acronyms and Abbreviations

ABM	Articulated Block Mat
AMC	Antecedent Moisture Conditions
B/C	Benefit to Cost Ratio
CCHD	Cook County Highway Department
CCSMP	Cook County Stormwater Management Plan
CCTA	Cook County Tax Assessor
cfs	cubic feet per second
CIP	Capital Improvement Program
CMAP	Chicago Metropolitan Agency for Planning
CN	Curve Number
CoCoRaHS	Community Collaborative Rain, Hail & Snow Network
CSSC	Chicago Sanitary and Shipping Canal
CWA	Clean Water Act
CWS	Chicago Waterway System
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
District	Metropolitan Water Reclamation District of Greater Chicago
DTM	Digital Terrain Model
DWP	Detailed Watershed Plan
FEMA	Federal Emergency Management Agency
FFE	first floor elevation
FGCS	Federal Geodetic Control Subcommittee
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
GPS	Geographic Positioning System
H&H	Hydrologic and Hydraulic
HARN	High Accuracy Reference Network
HEC-DSS	Hydrologic Engineering Center Data Storage System
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
IDNR	Illinois Department of Natural Resources
IDOT	Illinois Department of Transportation
IEPA	Illinois Environmental Protection Agency
ISWS	Illinois State Water Survey
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
M&O	Maintenance and Operations
NAD 29	North American Datum, 1929
NAD 83	North American Datum, 1983
NAVD 88	North American Vertical Datum, 1988

NGVD 29	National Geodetic Vertical Datum, 1929
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act of 1994
NGS	National Geodetic Survey
NIPC	Northeastern Illinois Planning Commission
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OWR	Office of Water Resources
PCB	Polychlorinated Biphenyl
ROW	Right-of-Way
SCS	Soil Conservation Service
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WPC	Watershed Planning Council
WSEL	Water Surface Elevation
WSP	Water Surface Profile

1. Introduction

The Upper Salt Creek Watershed in northwestern Cook County drains an area of 55.3 square miles that includes 15 communities. Figure ES.1 shows an overview of the Watershed. The watershed is primarily residential with concentrations of commercial, light manufacturing and trucking facilities. Several large forest preserves are also present, notably Ned Brown Preserve (also known as Busse Woods), Paul Douglas Forest Preserve and Deer Grove Forest Preserve.

All tributaries in the Watershed ultimately flow through the Busse Woods Reservoir and out of Cook County into DuPage County via the Salt Creek Mainstem. Since the flow from the subwatersheds merge and flow out through a common location, the subwatersheds were modeled together in one model rather than separately. However, the subwatersheds are described and summarized separately in this DWP.

The Upper Salt Creek DWP was developed by the Metropolitan Water Reclamation District of Greater Chicago (District) with the participation of the Upper Salt Creek Watershed Planning Council (WPC) which provided local input to the District throughout the development process. The DWP was developed to accomplish the following goals:

- Document stormwater problem areas.
- Evaluate existing watershed conditions using hydrologic and hydraulic (H&H) models.
- Produce flow, stage, frequency, and duration information along regional waterways.
- Estimate damages associated with regional stormwater problems.
- Evaluate solutions to regional stormwater problems.

Regional problems are defined as problems associated with waterways whose watersheds encompass multiple jurisdictions and drain an area greater than 0.5 square miles. Problems arising from capacity issues on local systems, such as storm sewer systems and minor open channel ditches, even if they drain more than one municipality, were considered local and beyond the scope of a regional stormwater management program. Erosion problems addressed in this plan were limited to active erosion along regional waterways that pose an imminent risk to structures or critical infrastructure. Interstate highways, U.S. highways, state routes, county roads with four or more lanes, and smaller roads providing critical access that are impacted by overbank flooding of regional waterways at depths exceeding 0.5 feet were also considered regional problems.

1.1 Scope and Approach

The Upper Salt Creek DWP scope included data collection and evaluation, H&H modeling, development and evaluation of alternatives, and recommendation of alternatives. The data collection and evaluation task included collection and evaluation of existing H&H models, geospatial data, previous studies, reported problem areas, and other data relevant to the watershed plan. H&H models were developed to produce inundation mapping for existing conditions for the 100-year storm event and to evaluate stormwater improvement project alternatives. Stormwater improvement project alternatives were developed and evaluated to determine their effectiveness in addressing regional stormwater problems. Estimates of damage reduction, or benefits, associated with proposed projects were considered along with conceptual cost estimates and noneconomic criteria to develop a list of recommended improvement projects for the Upper Salt Creek Watershed.

1.2 Data Collection and Evaluation

The data collection and evaluation phase (Phase A) of the DWP focused on obtaining data regarding the watershed and evaluation of the material's acceptability for use. The District contacted all WPC members as well as federal and state agencies and other stakeholders requesting relevant data. Coordination with WPC members to support the DWP took place throughout development of the DWP. Existing and newly developed data was evaluated according to use criteria defined in Chapter 6 of the *Cook County Stormwater Management Plan* (CCSMP), included in Appendix B. Where data was unavailable or insufficient to complete the DWP, additional data was collected. This report includes information on all data collected and evaluated as a part of the Upper Salt Creek DWP development. Table 1.3.1 lists key dates of coordination activities including meetings with WPC members prior to and throughout DWP development.

1.3 Hydrologic and Hydraulic Modeling

This section of the report provides a description of H&H modeling completed to support the DWP development. H&H models were developed for all tributaries within the watershed containing open waterways. The Hydrologic model was developed independent of any past modeling efforts. Data from previously developed models (see Section 1.3.6) in addition to new data that was collected during Phase A was used to support development of the Hydraulic model. Hydraulic model extent was defined based upon the extent of detailed study for effective Flood Insurance Rate Maps (FIRMs). However, revised Digital Flood Insurance Rate Map (DFIRM) data produced by the Federal Emergency Management Agency's (FEMA's) Map Modernization Program was unavailable at the time of model definition. The new models were extended further, where appropriate, to aid evaluation of damages associated with regional stormwater problems. Appendix A includes a comparison of FEMA's revised DFIRM panels with inundation areas developed for DWP modeling purposes. Tables comparing DWP inundation area to FEMA floodplain mapping by community and subwatershed are also included in Appendix A.

H&H models were developed to be consistent with the protocols defined in Chapter 6 of the CCSMP. In numerous instances, models included additional open channel or other drainage facilities not strictly required by Chapter 6, to aid the evaluation of community reported problem areas. Available monitoring data, including USGS stream gauge data, District facility data, information provided by some communities in the Watershed, and high water marks observed following storm events were used to perform model verification and calibration consistent with Chapter 6 guidelines. All H&H modeling data and documentation of the data development are included in the appendices as referenced in the report sections below.

TABLE 1.3.1
Upper Salt Creek DWP WPC Coordination Activities

06-495-5C Upper Salt Creek Detailed Watershed Plan - Phase A - Contract start date		December 1, 2006
07-496-5C Upper Salt Creek Detailed Watershed Plan - Phase B - Contract start date		August 13, 2007
Information Gathering		
Data Request (Forms A and B) sent out as part of Phase A		November 24, 2006
Watershed field visit		December 27, 2007
District phone calls to communities after the September 13th and 14th, 2008 storm event		September 15, 2008
Upper Salt Creek Watershed Planning Council Meetings (12)		
October 18, 2006	January 17, 2007	April 18, 2007
July 18, 2007	October 17, 2007	January 16, 2008
April 16, 2008	July 16, 2008	October 15, 2008
April 15, 2009	July 15, 2009	October 21, 2009
Modeling Results and Alternatives Review Meetings		
Initial Model Review Workshop		April 1, 2008
Preliminary Alternatives and Inundation Map Review Workshop		July 16, 2008
Alternatives and Inundation Map Review Workshop		August 26, 2008
Final Alternatives and Inundation Map Presentation (working session)		April 15, 2009
MWRDGC Board of Commissioners' Study Sessions		January 10, 2006
		April 27, 2006
		October 2, 2008

1.3.1 Model Selection

H&H models were developed within the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) Version 3.3.0 modeling application and Hydrologic Engineering Center-River Analysis System (HEC-RAS) Version 4.0. These applications were identified as acceptable in Tables 6.10 and 6.11 of the CCSMP. The Soil Conservation Service (SCS) curve number (CN) loss module was used with the Clark's Unit Hydrograph methodology within HEC-HMS to model basin hydrology. The dynamic unsteady flow routing methodology was used within HEC-RAS. Both applications have an extensive toolkit to interface with geographic information systems (GIS) software to produce input data and display model results.

1.3.2 Model Setup and Unit Numbering

1.3.2.1 Hydrologic Model Setup

ArcView GIS Version 9.2 served as the primary tool to develop and extract data required for the hydrologic analysis from the available GIS data. Basic GIS functions were utilized to calculate the CN, define the longest flow path, and to determine basin slope and length. HEC-HMS was used to create stormwater runoff hydrographs tributary to the stream branches and reservoirs/detention basins modeled within HEC-RAS. Hydrologic model data was transferred between HEC-HMS and HEC-RAS through HEC-DSS files.

Subbasin Delineation. The entire watershed was subdivided into subbasins ranging from 34 acres to 3091 acres with an average subbasin size of approximately 250 acres, excluding the two very large subbasins directly tributary to the Busse Woods reservoir. These subbasins form the basis of the hydrologic model and were modeled assuming a unified response to rainfall based on land use characteristics and soil type. Elevation data provided by Cook County, described in Section 2.3.4, was the principal data source used for subbasin delineation. Drainage divides were established based upon consideration of the direction of steepest descent from local elevation maxima, and refined in some instances to reflect modifications to topographic drainage patterns caused by stormwater management infrastructure (storm sewer systems, culverts, etc.). Subbasin boundaries were modified to encompass areas with similar development patterns. Finally, boundaries were defined to most accurately represent the area tributary to specific modeled elements, such as constrictions caused by crossings, and reservoirs. GIS data was developed for all subbasins delineated and used for hydrologic model data development.

Runoff Volume Calculation. The SCS CN loss model uses the empirical CN parameter to calculate runoff volumes based on landscape characteristics such as soil type, land cover, imperviousness, and land use development. Areas characterized by saturated or poorly infiltrating soils, or impervious development, have higher CN values, converting a greater portion of rainfall volume into runoff. The SCS methodology uses Equation 1.1 to compute stormwater runoff volume for each time step:

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad (1.1)$$

Where:

Q	=	runoff volume (in.)
P	=	precipitation (in.)
S	=	storage coefficient (in.)
I_a	=	initial abstractions (in.)

Rainfall abstractions due to ponding and evapotranspiration can be simulated using an initial abstractions (I_a) parameter. In this DWP, the commonly used default value of I_a, estimated as $0.2 \times S$, where S is the storage coefficient for soil in the subbasin. S is related to CN through Equation 1.2:

$$S = \frac{1000}{CN} - 10 \qquad (1.2)$$

where:

CN	=	curve number (dimensionless)
S	=	storage coefficient (in,)

Table 1.3.2 describes the input data used to develop the CN values throughout the watershed.

TABLE 1.3.2
Description of Curve Number Input Data

Variable Used to Determine CN	Approach for Definition of Variable for Upper Salt Creek Watershed Hydrologic Modeling
Ground cover	Chicago Metropolitan Agency for Planning (CMAP) 2001 land use inventory (v.1.2 2006) is used to define land use. A lookup table was developed to link CMAP categories to categories for which CN values have been estimated.
Soil type	The Natural Resources Conservation Service (NRCS) publishes county soil surveys that include a hydrologic classification of A, B, C, or D. If a soil group's infiltration capacity is affected by a high water table, it is classified as, for instance, "A/D," meaning the drained soil has "A" infiltration characteristics, undrained "D." It was assumed that all of this soil adjacent to the FEMA floodplain was undrained and the other areas were considered drained.
Antecedent moisture condition	Antecedent Moisture Conditions (AMC) reflect the initial soil storage capacity available for rainfall. AMC values used for the modeling were based on calibration procedures, described in Section 1.3.8.

Specific combinations of land use and soil type were linked to CN values using a lookup table based on values recommended in Table 1.3.3 excerpted from *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture [USDA], 1986). The CN matrix includes assumptions about the imperviousness of land use classes, and therefore, percent impervious does not need to be explicitly considered as the SCS runoff volume calculation. Since the CMAP land-use data does not correspond to the categories in Table 1.3.3, a mapping between TR-55 land use categories and CMAP land use categories was necessary. This process is detailed in Appendix C, which includes a technical memorandum detailing the process used to develop CN values for the Upper Salt Creek Watershed. The memorandum was prepared by CH2MHill, a consultant to the District.

Runoff Hydrograph Production.

The runoff volume produced for a subbasin is converted into a basin-specific hydrograph by using a standard unit hydrograph and an estimate of basin time of concentration. The time of concentration is the time it takes for a drop of water to travel from the hydraulically furthest point in a watershed to the outlet. The time of concentration can be estimated as the sum of the travel time for three different segments of flow, split-up by flow type in each subbasin.

The current study used the Clark unit hydrograph method to generate the runoff hydrographs. When this method is used the time of concentration is estimated from Equation 1.3.

$$(T_C + R) = 35.2 \cdot L^{0.39} \cdot S^{0.78} \qquad (1.3)$$

where:

T_c	=	Time of Concentration
R	=	Watershed Storage Coefficient
L	=	Flow path length (mi)

S = Main Channel Slope (ft/mi)

The storage coefficient is determined during calibration of the hydrologic model. Starting values are taken using Equation 1.4.

$$\frac{R}{T_C + R} = C \qquad (1.4)$$

where C is a constant that is determined during the calibration process. Initial values were taken from USGS Water Resources Investigation Report 00-4184.

The two equations are solved simultaneously to determine R and T_c for use in HEC-HMS.

TABLE 1.3.3
Runoff Curve Numbers for Urban Areas

Cover Type and Hydrologic Condition	Avg. % Impervious Area	A	B	C	D
Fully developed urban areas (vegetation established)					
Open Space (lawns, parks, golf courses, cemeteries, etc.)					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50 to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious Areas					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western Desert Urban Areas					
Natural desert landscaping (pervious areas only)		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin barriers		96	96	96	96
Urban Districts					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93

TABLE 1.3.3
Runoff Curve Numbers for Urban Areas

Cover Type and Hydrologic Condition	Avg. % Impervious Area	A	B	C	D
Residential Districts by Average Lot Size					
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing Urban Areas					
Newly Graded Areas (pervious areas only, no vegetation)		77	86	91	94

Note: Average runoff condition, and $I_a = 0.2S$.

Source of table is *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture [USDA], 1986)

Rainfall Data. Observed and design event rainfall data was used to support modeling evaluations for the DWP. Monitored rainfall data is described in Section 2.3.1. Design event rainfall data was obtained from Bulletin 71, *Rainfall Frequency Atlas of the Midwest* (Huff, 1992). Design event rainfall depths obtained from Bulletin 71 were used to support design event modeling performed for existing and proposed conditions assessment.

1.3.3 Storm Duration

A critical-duration analysis was performed to determine the storm duration that generally results in higher water surface estimates for a range of tributary sizes within the Watershed. The 24-hour duration storm was identified as the critical duration. A third quartile storm is recommended for storms of this duration (Huff, 1992). Table 1.3.4 summarizes rainfall depths for the 24-hour duration storm.

TABLE 1.3.4
Rainfall Depths

Recurrence Interval	24-hr Duration Rainfall Depth
2-year	3.04
5-year	3.80
10-year	4.47
25- year	5.51
50- year	6.46
100-year	7.58
500-year	11.00

[a]500-year rainfall depth was determined based on a logarithmic relationship between rainfall depth and recurrence interval.

1.3.4 Areal Reduction Factor

The rainfall depths presented in Table 1.3.4 summarize expected point rainfall accumulation for modeled recurrence intervals. The probability of uniform rainfall across a subwatershed decreases with increasing watershed size. Table 21 of Bulletin 71 relates areal mean rainfall depth to rainfall depth at a point (Huff, 1992). Subwatersheds in the Upper Salt Creek Watershed were not large enough to warrant use of an areal reduction factor.

1.3.5 Hydrologic Routing

Stormwater runoff hydrographs were sometimes routed within HEC-HMS in upstream areas where the resolution of subbasins defined was greater than the hydraulic model extent. In areas where a channel cross section could be identified from topographic data, Muskingum-Cunge routing was performed using the approximate channel geometry from a representative cross section of the modeled hydrologic reach. Where no channel was discernable, a kinematic wave routing was performed.

1.3.6 Hydraulic Model Setup

The hydraulic model was largely completed using data from previously developed models with the addition of new data that was collected as part of this DWP as necessary. Model coverage of the streams within the Watershed was very extensive for both the IDNR HEC-2 (1996) and the DuPage County FEQ (1998) models reviewed during Phase A of the watershed planning process. The steady state HEC-2 hydraulic model used for the most recent FEMA floodplain mapping was selected as the base for the DWP and was converted for use with unsteady flows and extended to meet the CCSMP criteria for sub-basin size. Most tributary models end at detention basins within less than one square mile of the edge of the Watershed. Where necessary the models of some small tributaries were extended to come closer to the edge of the watershed.

Numerous errors in channel reach lengths were found in the original HEC-2 model when overlaid on the aerial photography – and were corrected. Cross-section data used for this model was collected in the late 1980's. As such, some of the base cross sections required field verification or resurveying. All previously surveyed model cross sections were updated in the floodplain using the most recent topographic mapping.

1.3.6.1 Bridges, Culverts, and Hydraulic Structures

Bridges, culverts, and hydraulic structures were surveyed consistent with FEMA mapping protocol as identified in *Guidelines and Specifications for Flood Hazard Mapping Partners*, "Guidance for Aerial Mapping and Surveying" (FEMA 2003). A State of Illinois licensed professional land surveyor certified each location as FEMA compliant. Documentation of certifications is provided in Appendix D. Bridges, culverts, and hydraulic structures were surveyed consistent with the NAVD 1988 datum using 5-centimeter or better GPS procedures (as specified in NGS-58 for local network accuracy) or third-order (or better) differential leveling, or trigonometric leveling for short distances. Ineffective flow areas were placed at cross sections upstream and downstream of crossings, generally assuming a contraction ratio of 1:1 and an expansion ratio of 2:1. Contraction and expansion coefficients generally were increased to 0.3 and 0.5, respectively, at cross sections adjacent to crossings.

1.3.6.2 Cross-Sectional Data

Cross-sectional data was surveyed consistent with FEMA mapping protocol as identified in *Guidelines and Specifications for Flood Hazard Mapping Partners*, "Guidance for Aerial Mapping and Surveying" (FEMA 2003).

All survey work, including survey of cross sections, was certified as compliant to FEMA mapping protocol by a licensed professional land surveyor. Documentation of certifications is provided in Appendix D. Cross sections were surveyed consistent with the North American Vertical Datum, 1988 (NAVD 1988) using 5-centimeter or better GPS procedures (as specified in NGS-58 for local network accuracy) or third-order (or better) differential leveling, or trigonometric leveling for short distances. Cross sections were interpolated at many locations within the hydraulic models, to aid model stability and reduce errors.

In total, 97 cross sections and 43 structures (culverts and bridges) were surveyed. In general, the surveyed sections were in areas where the model was extended past the extent of the existing models (Arlington Heights South Branch, Mainstem Tributary A North, Mainstem Tributaries B and D, West Branch) as well as other areas within the watershed that were a need for more data points between existing cross sections or for verification of data that was in the existing models was identified.

1.3.6.3 Boundary Conditions

The separate tributaries were combined in one model. As a result, only one boundary condition was necessary for the model setup. The downstream boundary condition at the DuPage County line was developed from the flows and stages presented in the current Cook County FIS (2008) for Upper Salt Creek.

1.3.7 Model Run Settings

All hydraulic model simulations were carried out using the fully dynamic, unsteady flow simulation settings within HEC-RAS. The Saint-Venant equations, or the continuity and momentum balance equations for open channel flow, were solved using implicit finite difference scheme. HEC-RAS has the ability to model storage areas and hydraulic connections between storage areas and between stream reaches. The computational time step for model runs varied between 1 and 3 minutes, adjusted as necessary for model stability.

1.3.8 Model Calibration and Verification

Model calibration and verification were performed to ensure that the hydrologic and hydraulic models accurately predict stormwater runoff response for a range of storm magnitudes. As the tributaries were modeled together in one model, the tributaries were calibrated together. Two recent events were used in the calibration: September 13, 2008 and August 19, 2007. These events were selected as the largest in the recent record for which the current land use would still be applicable and for which substantial rainfall data and stream gauge data are available. During the September 2008 event, approximately 9 inches of rainfall fell in 30 hours, which is equivalent to about a 100-year storm event. This event resulted in overbank flooding in several locations within the watershed. During the August 2007 event, approximately 5 inches of rain fell in little more than 24 hours, which is equivalent to an approximately 15-year event and produced water levels in the channels to the tops of banks in many areas.

Two stream flow gauges are available within the Watershed to be used to compare simulated results: at Algonquin Road (also known as the Rolling Meadows gauge) on the Upper Mainstemand at the Busse Woods Dam. Both gauges are located within the Mainstem tributary, one downstream of the Arlington Heights confluence and one downstream of the West Branch confluence. The location of these gauges allowed for separate calibration of the West Branch tributary.

Runoff and stage values were compared to modeled values for the calibration and verification storms. Hydrologic and hydraulic parameters with uncertainty were modified within a reasonable range to better match measured flows and stages.

Initial calibration model results generally over-predicted peak flow rates and stages. Modification to the storage coefficient and curve number estimates, in the hydrologic model, and the roughness coefficient in the hydraulic model, was considered to address the observed differences. Reduction of curve number values was considered the best method of achieving better correspondence between observed and modeled parameters followed closely by the adjustment of the storage coefficient. Adjustment of the curve numbers was done on a watershed wide basis while the determination of the storage coefficient was done separately for the West Branch and the Mainstem/Arlington Heights Branches.

After several iterations, it was determined that the base curve numbers used should be set to those equivalent to the curve numbers represented by the AMC I. A value of $R/(T_c+R)$ of 0.6 for the Mainstem and 0.9 for the West Branch was used to determine the storage coefficient for the Clark Unit hydrograph method and time of concentration as discussed in Section 1.3.2.1.

Detailed calibration results are presented in the subwatershed subsections, including hydrographs and comparisons of stage and flow values.

1.3.9 Flood Inundation Mapping

Flood inundation maps were produced to display the inundation areas associated with the 100-year event. The flood inundation maps were produced by overlaying the results of the hydraulic modeling on the ground elevation model of the watershed, which was derived from Cook County LiDAR data.

1.3.10 Discrepancies between Inundation Mapping and Regulatory Flood Maps

Discrepancies may exist between inundation mapping produced under this DWP and regulatory flood maps. Discrepancies may be the result of updated rainfall data, more detailed topographic information, updated land use data, and differences in modeling methodology. A discussion of discrepancies is included in Appendix A.

1.3.11 Model Review

The hydrologic and hydraulic models developed under this DWP were independently reviewed by Christopher B. Burke Engineering, Ltd (CBBEL). CBBEL's review of the hydrologic models included a general verification of drainage areas, sub-basin divides, and hydrologic model parameters such as Curve Number and Time of Concentration. CBBEL's review of the hydraulic models included a general verification of roughness values, bank stations, ineffective flow areas, hydraulic structures, boundary conditions and connectivity with the hydrologic model output files. A significant recommendation from the independent review was to calibrate the models to a large storm event which occurred in the Upper Salt Creek watershed over the period September 13th to 14th, 2008. This and other recommendations from the independent review have been addressed in the hydrologic and hydraulic models developed to support the Upper Salt Creek DWP.

1.4 Development and Evaluation of Alternatives

1.4.1 Problem Area Identification

Problem area data for the Upper Salt Creek Watershed was generated from two sources. The first was community, agency and stakeholder response data that identified flooding, erosion, water quality, and maintenance issues recognized by the communities to be problems. In addition, problem areas were identified by overlaying the results of H&H modeling on the ground elevation model of the watershed to identify structures at risk of flooding along regional waterways. Modeled flood problems generally corroborated the communities' reported problems; however, in many instances, the model results also showed additional areas at risk of flooding for larger magnitude events. A secondary source of problem area identification was the existing FEMA FIRM panel maps. Areas shown within FEMA floodplain were carefully considered in H&H modeling and communication with communities in order to identify problem areas.

1.4.2 Economic Analysis

1.4.2.1 Flood Damages

Property damages due to flooding were assessed based upon the intersection of inundation areas for modeled recurrence intervals (2-, 5-, 10-, 25-, 50-, and 100-year) with the Cook County parcel data, considering ground elevation data, to calculate estimated flood depths. Damages were estimated using a methodology consistent with one developed by the USACE that estimates structure and contents damage as a fraction of structure value and based upon the estimated depth of flooding (USACE 2003). The general procedure estimating property damage due to flooding is outlined in Appendix F of the CCSMP. This method of damage calculation requires estimating a number of parameters for properties at risk of flooding which are detailed below.

The foundation for property damage values due to flooding is derived from the 2006 Cook County Tax Assessor (CCTA) data multiplied by a standard factor derived from a statistical analysis comparing recent sales data to the CCTA property values. The CCTA data includes tax assessed value of land, improvements, total tax assessed value, structure class (residential single family, multi-family, industrial etc.), number of stories, basement information, land area (square footage), and other data fields not relevant to this study.

1.4.2.2 Identification of Parcels at Risk of Flooding

An initial estimate was made to identify parcels at risk of flooding by using the existing FEMA 100-yr inundation boundary plus a 100-ft buffer to a reasonable upper bound of what might be included in the new flood inundation boundary.

For all parcels within this area a point was placed manually at the low side of the structure as identified from the aerial photographs and topographic mapping. Intersection of the floodplain surface with the location of these points was then performed for each modeled recurrence interval storm and used to identify parcels within the subwatershed that may, based upon their zero-damage elevations, be subject to property damage due to flooding for a particular recurrence interval.

In addition, a second area was developed to identify structures at risk of stream bank erosion by taking the stream centerline and adding a 30-ft buffer to either side.

1.4.2.3 Parcel Zero Damage Elevation

Structures do not incur damage due to flooding until the water surface exceeds the *zero-damage elevation,* at which water is assumed to begin flowing into the structure and cause damages. For most structures, the zero-damage elevation is the ground surface. Floodwaters exceeding the ground surface may enter the structure through doorways, window wells, and other openings within the structure. The zero-damage elevation was assumed to be the ground elevation for all parcels within the Upper Salt Creek Watershed. The ground elevation estimate was obtained at the point representing the parcel, generally on the lower, stream-side of the actual structure.

1.4.2.4 Parcel First Floor Elevation

USACE depth-damage curves relate flooding depths to the first floor elevation of the structure, a value not provided within the CCTA data. First floor elevations (FFE) generally were not surveyed for the Upper Salt Creek DWP, as that would require several hundred field measurements. As an alternative, in each area of significant overbank flooding a sample of field measurements of the FFE offset from ground elevation were collected.. A review of the collected first floor elevations identified a pattern used to predict the FFE based upon general groupings of similar structures in each area. These values varied from 0.5 to 1.5 ft.

1.4.2.5 Structure Estimated Value

The estimated value of flooded structures is an input to damage calculations. The CCTA data included data that identified values for the land value as well as the improvement value (i.e., building, garage, etc.). The values in the CCTA data are assessed valuations of the estimated property value, which require a factor to bring the value, depending on the structure’s use, to the CCTA estimation of property value. For example, residential structures receive an assessed valuation of 16 percent, thus the value identified by CCTA is the CCTA estimated value divided by a standardized 0.16. The adjusted CCTA data (reported values divided by the assessed valuation factor) was then compared with recent sales data throughout the county to statistically derive a multiplier that brings the 2006 CCTA estimated value of the properties to 2008 market value of properties. This multiplier was calculated to be 1.66. Since this plan analyzes damage to the structure, the land component of the property value was removed from the analysis by applying the assessed valuation multiplier and the District calculated market value multiplier to the improvement value identified in the CCTA data to produce a value of the structure. This method was used on all property types to generate information to be used in the damage calculations.

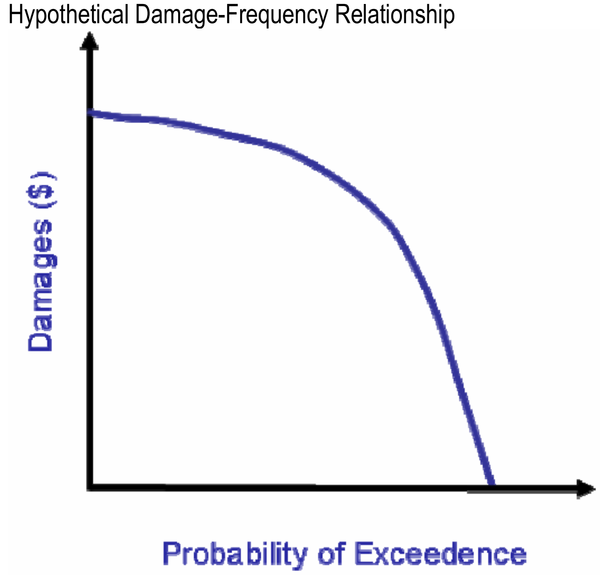
1.4.2.6 Depth-Damage Curves

Six residential depth-damage curves were obtained from the USACE technical guidance memorandum EGM 04-01 (USACE, 2003) to relate estimated structure and contents damage to structure replacement value as a function of flooding depth. These damage curves are one story, two-story, and split-level resident structures, either with or without basements. For nonresidential structures, a depth-damage curve representing the average of structure and contents depth damage curves for a variety of structure types, generated by the Galveston District of the USACE was selected for use. Appendix F contains the depth-damage curves used to calculate property damage due to flooding. CCTA data was analyzed to identify the number of stories on residential structures and the presence or absence of a basement.

1.4.2.7 Property Damage Calculation

The estimated structure value, flooding depth, and depth-damage curve information were used to estimate the property damage from flooding for a specific structure due to a storm of given recurrence interval. Higher magnitude events, such as the 100-year event, cause higher damages for flooded properties but also have a lower likelihood of occurring in a given year. Figure 1.4.1 shows the hypothetical relationship between expected damage and modeled recurrence interval. Estimated annual damages were calculated according to Appendix F of Chapter 6 of the CCSMP, essentially weighting the expected annual damages by their annual probability of occurrence. Damages were then capitalized over a 50-year period of analysis, consistent with the period of analysis over which maintenance and replacement costs were calculated, using the federal discount rate for 2008 of 4.875 percent.

FIGURE 1.4.1
Hypothetical Damage-Frequency Relationship



1.4.2.8 Erosion Damages

Locations of potential erosion risk were identified through community response data. The CCSMP directs that erosion damages be estimated as the full value of structures at "imminent risk" of damage due to stream bank erosion, and that erosion damages not be assessed for loss of land. Field visits to areas identified as erosion problems were performed. No properties or infrastructure were judged to be at imminent risk within the watershed.

1.4.2.9 Transportation Damages

Transportation damage generally was estimated as 15 percent of property damage due to flooding. In some specific instances, significant transportation damages may occur in absence of attendant property damage due to flooding. For the Upper Salt Creek Watershed, specific transportation damages were calculated when flooding fully blocked all access to a specific area in the watershed and these damages were not adequately captured as a fraction of property damages. In such instances, transportation damages were calculated according to FEMA guidance in the document "What Is a Benefit?" (FEMA, 2001). The duration of road closure was estimated for the modeled storms, and transportation damage was calculated according to a value of $32.23 per hour of delay per vehicle based on average traffic counts.

1.4.3 Alternative Development and Evaluation

Potential stormwater improvements, referred to within the DWP as alternatives, were developed using a systematic procedure to screen, develop, and evaluate technologies consistently throughout the Upper Salt Creek Watershed. Tributary-specific technologies were screened and evaluated in consideration of the stormwater problems identified through community response data and modeling. An alternative is defined as a combination of the technologies developed to address the identified stormwater problems.

Alternatives were evaluated with respect to their ability to reduce flooding under existing conditions. The reduction in expected damages for an alternative is called a *benefit.* Conceptual level costs were developed for each alternative using countywide unit cost data that considered expected expenses such as excavation, land-acquisition, pipe costs, channel lining, etc. Standard countywide markups were used to account for the cost of utility relocation, profit, design engineering and construction management costs, and contingency. Expected maintenance and replacement costs were considered over a 50-year design period. Detailed design studies are required to confirm details associated with the feasibility of construction and precise configuration of proposed facilities.

Additional non-economic factors, such as the number of structures protected, the expected water-quality benefit, and the impact on wetland or riparian areas were considered in alternative development and evaluation.

1.4.3.1 Flood Control

Flood control technologies were considered during the development of alternatives for addressing flooding problems, as summarized in Table 1.4.1. After selection of an appropriate technology or technologies for a problem area, and review of information provided by communities and obtained from other sources (such as aerial photography and parcel data) regarding potentially available land, conceptual alternatives were developed.

Hydrologic or hydraulic models for alternative conditions were created to analyze the effect of the conceptual alternatives. Initial model runs were performed to determine whether an alternative significantly affected water surface elevation (WSEL) near the target problem area, or had negative impacts in other parts of the tributary area. For models that resulted in significant reduction in WSEL, a full set of alternative conditions model runs was performed, and expected damages due to flooding were evaluated for the alternative conditions. Benefits were calculated based on damages reduced from existing to proposed conditions.

TABLE 1.4.1
Flood Control Technologies

Flood Control Option	Description	Technology Requirements
Detention/Retention		
Detention facilities (Dry basins)	Impoundments to temporarily store stormwater in normally dry basins.	Open space, available land. Only an upstream option.
Retention facilities (Wet basins)	Impoundments that include a permanent pool which stores stormwater and removes it through infiltration and evaporation. Retention facilities generally have an outfall to the receiving waterway that is located at an elevation above the permanent pool.	Open space, available land. Only an upstream option.
Pumped detention	Similar to detention or retention facilities, but includes a portion of the impoundment which cannot be drained by gravity and must be pumped out.	Open space, available land. Only an upstream option. Best applied when significant area is available to allow for filling only during large storms.
Underground detention	A specialized form of storage where stormwater is detained in underground facilities such as vaults or tunnels. Underground detention may also be pumped.	Space without structures, available land. Only an upstream option. Significantly more expensive than above ground facilities. Surface disruption must be acceptable during construction.
Bioretention	Decentralized microbasins distributed throughout a site or watershed to control runoff close to where it is generated. Runoff is detained in the bioretention facilities and infiltrated into the soil and removed through evapotranspiration.	Open space, multiple available opportunities for various sizes of open space.
Conveyance Improvement		
Culvert/bridge replacement	Enhancement of the hydraulic capacity of culverts or bridges through size increase, roughness reduction, and removal of obstacles (for example, piers).	Applicable only if restricted flow and no negative impact upstream or downstream. May require compensatory storage to prevent negative downstream impact. Permitting requirements and available adjacent land.
Channel improvement	Enhancement of the hydraulic capacity of the channels by enlarging cross sections (for example, floodplain enhancement), reducing roughness (for example, lining), or channel realignment.	No negative upstream or downstream impact of increased conveyance capacity. Permitting requirements and available adjacent land. Permanent and/or construction easements.
Flood Barriers		
Levees	Earth embankments built along rivers and streams to keep flood waters within a channel.	Permitting requirements and available adjacent land. Wide floodplains will be analyzed. Requires 3 feet of freeboard to remove structures behind levees from regulatory floodplain. Often requires compensatory storage.
Floodwalls	Vertical walls typically made of concrete or other hard materials built along rivers and streams to keep flood waters within a channel.	Permitting requirements and available adjacent land. Permanent and/or construction easements.

TABLE 1.4.1
Flood Control Technologies

Flood Control Option	Description	Technology Requirements
Acquisition	Acquisition and demolition of properties in the floodplain to permanently eliminate flood damages. In some cases, acquired property can be used for installation of flood control facilities.	Severe flooding, repetitive losses, other alternatives are not feasible.
Floodproofing		
Elevation	Modification of a structure's foundation to elevate the building above a given flood level. Typically applied to houses.	Severe flooding, repetitive losses, other alternatives are not feasible.
Dry Floodproofing	Installation of impermeable barriers and flood gates along the perimeter of a building to keep flood waters out. Typically deployed around commercial and industrial buildings that cannot be elevated or relocated.	Better suited for basement or shallow flooding. Need the ability to provide closure of openings in walls or levees. Plan for emergency access to permit evacuation.
Wet Floodproofing	Implementation of measures that do not prevent water from entering a building but minimize damages; for example, utility relocation and installation of resistant materials.	Most applicable for larger buildings where content damage due to flooding can be minimized. Waterproofing sealant applied to walls and floors, a floor drain and sump pump.

1.4.3.2 Floodproofing and Acquisition

Alternatives consisting of structural flood control measures may not feasibly provide a 100-year level of protection for all structures. The DWP identifies areas that will experience flooding at the 100-year event, even if recommended alternatives are implemented. Floodproofing and/or acquisition of such structures are nonstructural flood control measures that may reduce or eliminate damages during flood events, which is why these measures are listed in Table 1.4.1. However, due to the localized nature of implementing such solutions, the District may look to address structures that are candidates for nonstructural flood control measures under separate initiatives, outside of the Capital Improvement Program (CIP).

1.4.3.3 Streambank Stabilization

As discussed above, this watershed does not have any structures known to be threatened by erosion and therefore no exclusively streambank stabilization alternatives were considered. Several projects require channel bank modification, however. For these projects streambank stabilization is included as part of the project. A full range of alternative technologies is summarized in Table 1.4.2.

1.4.3.4 Water Quality

The potential effect of alternatives on water quality was considered qualitatively. Most detention basins built for flood control purposes have an ancillary water quality benefit because pollutants in sediment will settle out while water is detained. Sediments can be removed as a part of maintenance of the detention basin, preventing the pollutants from entering the waterway. Detention basins typically have a sediment forebay specifically designed for this purpose. Some detention basins could be designed as created wetland basins with wetland plants included which could naturally remove pollutants and excess nutrients from the basin. Streambank stabilization alternatives can help address water quality problems through reduction of sedimentation.

TABLE 1.4.2
Streambank Stabilization Technologies

Streambank Stabilization Option	Description	Technology Requirements
Natural (vegetated or bioengineered) stabilization	The stabilization and protection of eroding overland flow areas or stream banks with selected vegetation using bioengineering techniques. The practice applies to natural or excavated channels where the stream banks are susceptible to erosion from the action of water, ice, or debris and the problem can be solved using vegetation. Vegetative stabilization is generally applicable where bankfull flow velocity does not exceed 5 ft/sec and soils are more erosion resistant, such as clayey soils. Combinations of the stabilization methods listed below and others may be used.	Requires stream bank slopes flat enough to prevent slope failure based upon underlying soils. Channels with steep banks with no room for expansion or high bank full velocities (> 5 ft/sec) should avoid these technologies.
Vegetating by sodding, seeding, or planting	Establishing permanent vegetative cover to stabilize disturbed or exposed areas. Required in open areas to prevent erosion and provide runoff control. This stabilization method often includes the use of geotextile materials to provide stability until the vegetation is established and able to resist scour and shear forces.	
Vegetated armoring (joint planting)	The insertion of live stakes, trees, shrubs, and other vegetation in the openings or joints between rocks in riprap or articulated block mat (ABM). The object is to reinforce riprap or ABM by establishing roots into the soil. Drainage may also be improved through extracting soil moisture.	
Vegetated cellular grid (erosion blanket)	Lattice-like network of structural material installed with planted vegetation to facilitate the establishment of the vegetation, but not strong enough to armor the slope. Typically involves the use of coconut or plastic mesh fiber (erosion blanket) that may disintegrate over time after the vegetation is established.	
Reinforced grass systems	Similar to the vegetated cellular grid, but the structural coverage is designed to be permanent. The technology can include the use of mats, meshes, interlocking concrete blocks, or the use of geocells containing fill material.	
Live cribwall	Installation of a regular framework of logs, timbers, rock, and woody cuttings to protect an eroding channel bank with structural components consisting of live wood.	
Structural stabilization	Stabilization of eroding stream banks or other areas by use of designed structural measures, such as those described below. Structural stabilization is generally applicable where flow velocities exceed 5 ft/sec or where vegetative stream bank protection is inappropriate.	Applicable to areas with steep stream bank slopes (> 3:1) and no room for channel expansion, or areas with high velocities (> 5 ft/sec) can benefit from this technology.
Interlocking concrete	Interlocking concrete may include A-Jacks®, ABM, or similar structural controls that form a grid or matrix to protect the channel from erosion. A-Jacks armor units may be assembled into a continuous, flexible matrix that provides channel toe protection against high velocity flow. The matrix of A-Jacks can be backfilled with topsoil and vegetated to increase system stability and to provide in-stream habitat. ABM can be used with or without joint planting with vegetation. ABM is available in several sizes and configurations from several manufacturers. The size and configuration of the ABM is determined by the shear	

TABLE 1.4.2
Streambank Stabilization Technologies

Streambank Stabilization Option	Description	Technology Requirements
	forces and site conditions of the channel.	
Riprap	A section of rock placed in the channel or on the channel banks to prevent erosion. Riprap typically is underlain by a sand and geotextile base to provide a foundation for the rock, and to prevent scour behind the rock.	
Gabions	Gabions are wire mesh baskets filled with river stone of specific size to meet the shear forces in a channel. Gabions are used more often in urban areas where space is not available for other stabilization techniques. Gabions can provide stability when designed and installed correctly, but failure more often is sudden rather than gradual.	
Grade Control	A constructed concrete channel designed to convey flow at a high velocity (greater than 5 ft/sec) where other stabilization methods cannot be used. May be suitable in situations where downstream areas can handle the increase in peak flows and there is limited space available for conveyance.	
Concrete channels	Prevent stream bank erosion from excessive discharge velocities where stormwater flows out of a pipe. Outlet stabilization may include any method discussed above.	

2. Watershed Characteristics

2.1 General Watershed Description

Salt Creek is divided into two hydrologic parts by Busse Woods Dam: Upper Salt Creek and Lower Salt Creek. However, for the purposes of the development of this DWP, "Upper Salt Creek" will refer, hereafter, to the Salt Creek stream reaches and tributaries located upstream of the DuPage County/Cook County border. The "Watershed" will refer, hereafter, to the Upper Salt Creek Watershed.

The total Watershed area is approximately 55 square miles. Land use is predominately residential with concentrations of commercial, light manufacturing and trucking facilities. Several large forest preserves are also present, notably Ned Brown Preserve (also known as Busse Woods), Paul Douglas Forest Preserve and Deer Grove Forest Preserve. Figure 1 shows a schematic of the Watershed showing the drainage boundary, stream channels, and municipality boundaries.

Upper Salt Creek is comprised of three branches: the Mainstem, the West Branch, and the Arlington Heights Branch. Starting at the downstream end of the Watershed at the DuPage County/Cook County border, Upper Salt Creek proceeds north to the Ned Brown Preserve and Busse Woods Reservoir. Above the dam that forms the reservoir, Upper Salt Creek divides into two branches – the West Branch and the Mainstem. Following the West Branch upstream, the channel leaves the reservoir heading due west, crossing under Interstate 290 (I-290) and Meacham Road before turning north paralleling Plum Grove Road. The headwaters of the stream are in a small detention pond located just upstream of Roselle Road and south of Interstate 90 (Northwest Tollway). The West Branch has several tributaries, designated (north to south) Tributaries A, 3, 4, 5, 6 and 7.

Just upstream of Algonquin Road is the confluence of the Arlington Heights Branch and the Mainstem. The Arlington Heights Branch parallels I-290 until it crosses Palatine Road, where it turns northwesterly. The headwaters of this branch are located within the Deer Grove Forest Preserve. This branch has a small tributary called the Anderson Drive Tributary that connects to the Arlington Heights Branch upstream of Palatine Road. A small tributary, the South Branch, of the Arlington Heights Branch is near the Branch's headwaters within the Forest Preserve.

From the confluence with the Arlington Heights Branch, the Mainstem heads upstream westerly and northerly until finally splitting into two small tributaries (designated A and B) near Roselle Road. The Mainstem has two other tributaries (designated C and D) that join near where the Mainstem turns northerly.

During the late 1970's and early 1980's a number of flood control reservoirs were constructed within the Watershed: the Busse Woods Dam and Reservoir in 1976, the Tom Hamilton Reservoir in 1981, the Margreth Riemer and Plum Grove Reservoirs in 1984, and the

Saint Michaels and Twin Lakes Reservoirs in 1986. These reservoirs were constructed based on a plan prepared for the NRCS and sponsored by the District, and have a combined active storage capacity of approximately 4000 acre-feet.

Table 2.1.1 lists the municipalities within the Upper Salt Creek Watershed. Table 2.1.2 lists the major streams and tributaries to the Upper Salt Creek and stream lengths. Each stream is briefly described with a narrative in the following subsection.

Table 2.1.1
Municipalities in the Upper Salt Creek Watershed

Municipality	Total Area (square miles)	% of Municipality Area within Upper Salt Creek Watershed	% of Upper Salt Creek Watershed Area by Municipality
Village of Schaumburg	11.2	58.9	20.2
Village of Palatine	11.1	85.4	20.0
FPDCC	7.2	-	13.1
Village of Hoffman Estates	5.5	27.2	10.0
Village of Elk Grove Village	5.3	47.7	9.6
City of Rolling Meadows	4.8	87.3	8.6
Village of Inverness	4.5	69.2	8.2
Palatine Township*	2.5	-	4.6
Village of Arlington Heights	1.5	9.1	2.7
Schaumburg Township*	0.9	4.7	1.6
Elk Grove Township*	0.4	-	0.7
Village of Barrington	0.2	4.1	0.4
Wheeling Township*	0.1	-	0.2
Village of Itasca	<0.1	0.4	<0.1
Village of Deer Park	<0.1	2.7	<0.1
Village of Wood Dale	<0.1	<0.1	<0.1
TOTAL	55.3	-	100%

* Includes only unincorporated portions of townships (excludes FPDCC)

Table 2.1.2
Upper Salt Creek Watershed Open Channel Stream Lengths

Open Channel Name	Length (miles)	Open Channel Name	Length (miles)
Upper Main Stream	13.7	Mainstream D Branch North Tributary	1.1
Arlington Heights Branch	9.3	Arlington Heights Branch South	0.9
West Branch	7.5	Mainstream A Branch North Tributary	0.9
Salt Creek Tributary D	3.0	Anderson Drive Tributary	0.8
West Branch Tributary A	2.2	Salt Creek Tributary B	0.8
Salt Creek Tributary C	2.0	West Branch Tributary 4	0.8
West Branch Tributary 3	1.6	Mainstream D Branch South Tributary	0.6
West Branch Tributary 6	1.6	West Branch Tributary 5	0.5
Salt Creek Tributary A	1.3	Deer Grove Tributary	0.2
West Branch Tributary 7	1.1	West Branch Tributary A South	<0.1
		TOTAL	49.9

Table 2.1.3 lists the subwatersheds each municipality drains to, with subwatersheds listed in decreasing order based upon the area within the municipality. Although municipalities contribute stormwater to the listed subwatersheds, the actual stream may not be included within the municipality's boundaries.

TABLE 2.1.3
Municipality and Subwatersheds within the Municipality Boundary

Municipality	Subwatersheds within Municipality boundary (square miles)
Arlington Heights	Arlington Heights Branch, (0.87), Mainstem (0.64)
Barrington	Arlington Heights Branch, (0.21)
Deer Park	Arlington Heights Branch, (<0.1) [b]
Elk Grove Township[c]	Mainstem(0.39), West Branch (<0.1)[b]
Elk Grove Village	Mainstem(4.26), West Branch (1.04)
FPDCC	Mainstem(5.46), Arlington Heights Branch (1.75), West Branch (<0.1) [b]
Hoffman Estates	Mainstem(3.23), West Branch (2.31)
Itasca	Mainstem(<0.1) [b]
Inverness	Mainstem(4.07), Arlington Heights Branch (0.47)
Palatine	Arlington Heights Branch (7.02), Mainstem(4.06)
Palatine Township[c]	Mainstem(1.3), Arlington Heights Branch (1.23)
Rolling Meadows	Mainstem(2.61), Arlington Heights Branch (2.17)
Schaumburg	West Branch (8.22), Mainstem(2.96)
Schaumburg Township[c]	West Branch (0.58), Mainstem(0.32)
Wheeling Township[c]	Arlington Heights Branch (0.11)
Wood Dale	Mainstem(<0.1)[b]

[a]Subwatersheds are ordered in decreasing order of area within municipality
[b]Less than 0.1 square miles within municipality contributes to subwatershed
[c]Includes only unincorporated portions of townships (excludes FPDCC)

2.2 Stormwater Problem Data

To support DWP development, the District solicited input from stakeholders within the watershed. Municipalities, townships, and countywide, statewide, and national agencies such as Cook County Highway Department (CCHD), Illinois Department of Natural Resources (IDNR), Illinois Department of Transportation (IDOT), and the USACE, for example, were asked to fill out two forms with information to support DWP development. Organizations such as ecosystem partnerships were also contacted by the District as part of this information-gathering effort. Form A included questions on stormwater data and regulations, Form B questions on known flooding, erosion, and stream maintenance problem areas. In addition to problem areas reported by municipalities, townships, public agencies and other stakeholders, results of H&H modeling performed as a part of DWP development identified stormwater problem areas. The H&H modeling process is described in general in Section 1.3 and specifically for each modeled tributary in Chapter 3.

Figure 2.2.1 and Table 2.2.1 summarize the responses to Form B questions as well as other problem area information collected by the District about flooding, erosion, and stream maintenance problem areas. As noted, the scope of the DWP addresses regional problems along open channel waterways. The definition of regional problems was provided in Chapter 1.

Table 2.2.1
Summary of Responses to Form B Questionnaire

ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
1	Elk Grove Village	Bank Erosion & Sedimentation	Cypress Lane & Rev. Morrison Boulevard (6 channels from Cypress Lane to Salt Creek)	Channels have become inundated with heavy vegetation, debris, silt, and bank erosion obstructing the conveyance of storm water	Local	5
2	Elk Grove Village	Bank Erosion & Sedimentation	Devon Avenue & Arlington Heights Road, Unincorporated Cook County (Salt Creek / Devon Avenue, north 600 feet)	Severe erosion, slope failure and exposed tree roots along 1,200-foot section of Salt Creek in unincorporated Elk Grove Township	Regional	1
3	Hoffman Estates and Schaumburg	Flooding	Golf Road & Higgins Road	Intersection flooding at Jones and Highland, typically in medium to heavy rainfall events. Study and design completed	Local	5
4	Elk Grove Village	Stream Maintenance	Near intersection of Elmhurst Rd. and Landmeier Rd.	Flooding - Outside of the Watershed	Local	-
5	Palatine Township	Flooding	Plum Grove Estates Neighborhood; Mainstem and Briarwood Lane.	Overbank flooding	Regional	1
6	Hoffman Estates	Stream Maintenance, Streambank Erosion	West Branch Between Apple St. and Basswood St.	Streambank erosion	Regional	1
7	Inverness	Flooding	Upstream of Mainstem Tributary B; 2211 Palatine Rd.	Flooding damaging residence	Local	4
8	Rolling Meadows	Streambank Erosion and Water Quality	Mainstem between Rt. 53 and Rt. 62	Erosion affects downstream water quality	Regional	1
9	Rolling Meadows	Streambank Erosion	Mainstem Tributary C at Kennedy Pond	Erosion	Regional	1
10	Schaumburg	Flooding	Ditch along Tower Rd. and State Parkway	Flooding along roadway median; begins to flood streets and encroaches industrial properties	Local	4
11	Schaumburg	Streambank Erosion	East of Schaumburg Village Hall; including parts of the West Branch and West Branch Tributaries 3 and 5	Erosion	Regional	1

Table 2.2.1
Summary of Responses to Form B Questionnaire

ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
12- 13	Cook County Highway Department	Flooding	Various	Flooding - Outside of the Watershed	Local	-
14	Illinois Department of Transportation (IDOT)	Flooding	Route 68 and Route 12	Pavement Flooding - Outside of the Watershed	Local	-
15	IDOT	Flooding	Route 62 at Magnolia Rd.	Pavement Flooding	Local	4
16	IDOT	Flooding	Route 62 at Plume Grove Rd.	Pavement Flooding	Local	4
17	IDOT	Flooding	Route 62 at Meacham Rd.	Pavement Flooding	Local	4
18	IDOT	Flooding	Higgins Rd. and I-290	Pavement Flooding	Local	4
19	IDOT	Flooding	Golf Rd. and Plum Grove Rd.	Pavement Flooding	Local	4
20	IDOT	Flooding	Golf Rd. and Roselle Rd.	Pavement Flooding	Local	4
21	IDOT	Flooding	Higgins Rd. and Roselle Rd.	Pavement Flooding	Local	4
22	IDOT	Flooding	Higgins Rd. and Woodfield Rd.	Pavement Flooding	Local	4
23	IDOT	Flooding	Higgins Rd. and Woodfield Rd.	Pavement Flooding	Local	4
24	IDOT	Flooding	Higgins Rd. at Golf Rd.	Pavement Flooding	Local	4
25	IDOT	Flooding	Palatine Rd. at Ela Rd.	Pavement Flooding	Local	4
26	IDOT	Flooding	Palatine Rd. at Smith Rd.	Pavement Flooding	Local	4
27	IDOT	Flooding	I 290 at Biesterfield Rd.	Pavement Flooding	Local	4

Table 2.2.1
Summary of Responses to Form B Questionnaire

ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
28	IDOT	Flooding	I 290 at Devon Ave.	Pavement Flooding	Local	4
29	IDOT	Flooding	IL 53 at US 12	Pavement Flooding - Outside of the Watershed	Local	-
30	IDOT	Flooding	IL 53, US 14 to Euclid Ave.	Pavement Flooding	Local	4
31	IDOT	Flooding	IL 53 at Palatine Rd.	Pavement Flooding - Outside of the Watershed	Local	4
32	IDOT	Flooding	IL 53 at Algonquin Rd.	Pavement Flooding	Local	4
33	IDOT	Flooding	Rand Rd. at Kennicott Ave.	Pavement Flooding - Outside of the Watershed	Local	-
34	IDOT	Flooding	NW Hwy at Sterling Rd. to Baldwin Rd.	Pavement Flooding	Local	4
35	IDOT	Flooding	NW Hwy at Ela Rd.	Pavement Flooding	Local	4
36	IDOT	Flooding	NW Hwy at Dundee Rd.	Pavement Flooding	Local	4
37	IDOT	Flooding	NW Hwy at Euclid Ave. to Ridge Rd.	Pavement Flooding - Outside of the Watershed	Local	-
38	IDOT	Flooding	Hicks Rd. at Rand Rd. to Dundee Rd.	Pavement Flooding - Outside of the Watershed	Local	-
39	IDOT	Flooding	Arlington Heights Rd at IL72	Pavement Flooding - Outside of the Watershed	Local	-
40	IDOT	Flooding	Arlington Heights Rd at I 90	Pavement Flooding - Outside of the Watershed	Local	-
41	Palatine	Flooding	Palanois Park	Combined sewer overflow	Local	5
42	Palatine	Flooding	Winston Park	Flooding – sewer	Local	5
43	Palatine	Flooding	South/ Central Downtown Palatine	Flooding - sewer	Local	5

Table 2.2.1
Summary of Responses to Form B Questionnaire

ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
44	Palatine	Flooding	Palatine Rd. at Winston Dr.	Flooding - sewer	Local	5
45	Schaumburg Township	Flooding	Outside of the Watershed	Outside of the Watershed	Local	-
46	Schaumburg	Flooding	Ditch along Tower Rd. and State Parkway	Village performed study and recommended improvements are completed	Local	5
47	Schaumburg	Flooding	Niagara Ave. and Sunset Dr.	Flooding – sewer and overbank	Local	5
48	Elk Grove Village	Flooding	Rev. Morrison Blvd. & Elk Grove Village Blvd.	Drainage ditches overtop, resulting in flooding of the roadways. Village performed study in the 1990's and recommended improvements addressing up to the 10-year flood completed.	Local	5
49	Forest Preserve District of Cook County (FPDCC)	Water Quality	Lake-Cook Rd. and Quentin Rd.	Sump pump discharge into the preserve results in degradation of water and habitat quality	Local	7
50	FPDCC	Water Quality	Woodfield Rd. and Rohlwing Rd.	Runoff from Woodfield Mall discharges into the ditch draining to Busse Reservoir causing erosion and adding sediment and pollution to the reservoir	Local	7
51	FPDCC	Erosion	Hillside Rd. and Ela Rd.	Overland flow into Deer Grove Preserve causes erosion	Regional	6
52	FPDCC	Water Quality	Golf Rd. and I-90	Salt Creek floodwaters are heavily silted causing habitat degradation in Busse Reservoir	Local	7
53	Rolling Meadows	Flooding	Main Stem at Algonquin Road	Street/Surface Flooding -- data from Sept. 2008 rainfall	Regional	1

Table 2.2.1
Summary of Responses to Form B Questionnaire

ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
54	Rolling Meadows	Flooding	Arlington Heights Branch north of Central Road	Street/Surface Flooding -- data from Sept. 2008 rainfall	Regional	1
55	Arlington Heights	Flooding	South of Rand Road, east of 53: includes Canterbury Ct, Roanoke Dr, Raleigh St, Suffield Ct, Waverly Ct	Street/Surface Flooding -- data from Sept. 2008 rainfall	Local	4

Reasons for Regional / Local Classifications:
1. Located on an open channel waterway with greater than 0.5 square mile drainage area
2. Roadway culvert (two-lane road)
3. Roadway culvert (greater than two-lane road)
4. Located in headwater area (less than 0.5 square mile drainage area)
5. Located within storm sewer or local drainage system (regardless of drainage area)
6. Erosion does not impact structure(s)
7. No structural/transportation damages associated with problem area

2.3 Watershed Analysis Data

2.3.1 Monitoring Data

2.3.1.1 USGS Gauge Data

The U.S. Geological Survey (USGS) owns and maintains a nationwide network of stream gauges used to record real-time measurements of the monitored stream's water surface elevations. Rating curves developed through periodic paired stage and flow measurements are used to develop rating curves for the stream, relating estimated flow to measured stage.

There are two USGS surface water data monitoring sites within the Upper Salt Creek Watershed: "05530990" at the Mainstem in Rolling Meadows at the Algonquin Road crossing and "05531044" located on the Mainstem at the Busse Woods Dam on Cook County Forest Preserve property. Table 2.3.1 summarizes the data available from these sites.

2.3.1.2 Rainfall Data

The USGS owns and maintains one rainfall gauge within the Upper Salt Creek Watershed – at the Rolling Meadows surface water station. Rainfall data is recorded continuously at 10-minute intervals, processed by the USGS to ensure quality, and available for purchase. USGS rainfall data was obtained for specific gauges and dates to support calibration of the complete Upper Salt Creek model. In addition, the Village of Palatine has recently installed 6 continuous recording gauges, located throughout the village which record on a 10-minute interval, and a real-time weather station is installed atop their Village Hall.

The District maintains a network of rain gauges; however, none are located in the Watershed.

A volunteer organization known as CoCoRahs[1] collects daily rainfall data from more than 11,000 gauges in 35 states. Within the Upper Salt Creek Watershed there are a total 7 gauges. The data from these gauges are collected daily and posted to the web. The volunteer operators receive a modicum of training such that their data is considered reliable by the USGS. Only reported data from gauges that took reliable daily readings were used for the calibration efforts.

Figure 2.3.1 shows locations where rainfall gauge data was available to support the Upper Salt Creek Watershed DWP.

[1] Community Collaborative Rain, Hail and Snow Network, http://www.cocorahs.org/

TABLE 2.3.1
USGS Gauge Data in the Upper Salt Creek Watershed

Description	USGS 5536500		USGS 05537500	
Location	Salt Creek at Rolling Meadows		Salt Creek near Elk Grove Village	
Latitude	42°03'38"		42°01'01"	
Longitude	88°01'00" NAD83		88°00'03" NAD83	
	Cook County, Hydrologic Unit 07120004: Des Plaines Watershed		Cook County, Hydrologic Unit 07120004: Des Plaines Watershed	
Contributing drainage area:	30.50 square miles		51.9 square miles	
Datum of gauge:	686.40 ft above sea level NGVD29		674.75 ft above sea level NGVD29	
Data Type	**Begin Date**	**End Date**	**Begin Date**	**End Date**
Real-time	This is a real-time site.		This is a real-time site.	
Peak stream flow	07/04/1973	05/22/2009	01/13/2005	08/24/2007
Daily Data				
Discharge, cubic feet per second (ft^3/sec)	07/12/1973	06/02/2009		
Gauge height, ft	10/1/1993	06/02/2009	06/15/1992	06/02/2009
Daily Statistics				
Discharge, ft^3/sec	07/12/1973	09/30/2007		
Gauge height, ft	10/01/1993	09/30/2007	06/15/1992	09/17/2007
Monthly Statistics				
Discharge, ft^3/sec	07/1951	09/2007		
Gauge height, ft	10/1993	09/2007	06/1992	09/2007
Annual Statistics				
Discharge, ft^3/sec	1973	2007		
Gauge height, ft	1994	2007	1992	2007
Field/lab water quality samples	10/02/1974	07/12/1989	04/27/1995	05/07/2009

2.3.1.3 Stage Data

Stage data is available at both gauges discussed in Section 2.3.1.1. In addition, stage data is taken manually at all of the District flood control structures during storm events. Figure 2.3.1 shows locations where monitoring data was available to support the Upper Salt Creek Watershed DWP. Thiessen polygons, which divide the watershed into areas closest to each available rain gauge, are also shown on Figure 2.3.1.

2.3.2 Subwatershed Delineation

The Upper Salt Creek Watershed was divided into subwatersheds representing areas tributary to the waterways in the study area. Elevation data provided by Cook County, described further in Section 2.3.4, was the principal data source used for subwatershed delineation. Drainage divides were established based upon consideration of the direction of steepest descent from local elevation maxima.

Following the definition of subwatersheds, tributaries studied in detail were divided into smaller subbasins, represented in the hydrologic model as having a unified response to rainfall. The size of subbasins varied based upon the drainage network density and proximity to the hydraulically modeled waterway. Subbasin boundaries were modified to generally encompass areas with similar development patterns. Boundaries were defined to most accurately represent the actual area tributary to specific modeled elements, such as constrictions caused by road crossings, reservoirs and larger detention basins, etc.

Figure 2.3.2 shows the subwatersheds and subbasins developed for the DWP.

2.3.3 Drainage Network

The principal waterways of the Upper Salt Creek Watershed were defined during Phase A of the watershed study. Initial identification of the stream centerline was made using planimetry data obtained from Cook County. Stream centerlines were reviewed against aerial photography and Cook County contour data at a 1:500 scale, and modified to best represent existing conditions. These streamlines were included in the topographic model of the Upper Salt Creek Watershed (see Section 2.3.4), and collect runoff from upland drainage areas. Secondary drainageways that were not modeled were identified based upon review of contour data. These secondary drainageways were used to help define flow paths in the hydrologic models for individual tributaries. Figure 2.3.3 shows the major drainageways within the Upper Salt Creek Watershed superimposed upon an elevation map of the watershed.

2.3.4 Topography and Benchmarks

Topographic data for the Upper Salt Creek watershed was developed from Cook County light detection and ranging (LiDAR) data generated from a 2003 LiDAR mission (Cook County, 2003). The LiDAR data was obtained along with break lines from Cook County. A digital elevation model (DEM) was developed for the Upper Salt Creek Watershed model based upon these elevation points. Figure 2.3.3 shows elevations within the watershed.

Stream channel cross section and stream crossing structure (such as bridge and culvert) topographic data needed to extend or supplement the existing modeling was collected during field survey work conducted primarily between November 2007 and January 2008 to support the DWP.

Rather than use an established network of benchmarks, the horizontal and vertical ground control was established by GPS technology that meets the specifications of the Federal Geodetic Control Subcommittee (FGCS) Second Order Class One and the accuracy standards specified in FEMA's *Guidelines and Specifications for Flood Hazard Mapping,* "Guidance for Aerial Mapping" (FEMA 2003).

2.3.5 Soil Classifications

NRCS soil data representative of 2002 conditions was obtained for Cook County except for unmapped areas (which include the City of Chicago and some portions of nearby communities). Peotone silty clay loam is the predominating soil type in the study area. Other types of silt loams and urban altered soils are also found in the watershed.

The NRCS soil data includes hydrologic soil group, representing the minimum infiltration rate of the soil after wetting. Table 2.3.2 summarizes the hydrologic soil groups.

TABLE 2.3.2
Hydrologic Soil Groups

Hydrologic Soil Group	Description	Texture	Infiltration Rates (in./hr)
A	Low runoff potential and high infiltration rates even when wetted	Sand, loamy sand, or sandy loam	> 0.30
B	Moderate infiltration rates when wetted	Silt loam or loam	0.15–0.30
C	Low infiltration rates when wetted	Sandy or silty clay loam	0.05–0.15
D	High runoff potential and very low infiltration when wetted	Clay loam, silty clay loam, sandy clay, silty clay, or clay	0–0.05

All data from *Technical Release 55, Urban Hydrology for Small Watersheds*, NRCS, June 1986

Soil groups with drainage characteristics affected by a high water table are classified uniformly as Group D. Table 2.3.3 summarizes the distribution of hydrologic soil type throughout the Upper Salt Creek Watershed. Figure 2.3.4 shows the distribution of soil types throughout the watershed.

TABLE 2.3.3
Hydrologic Soil Group Distribution

Hydrologic Soil Group	Acres	Acres Assumed D (% of total)	% of Upper Salt Creek Watershed
Open Water	876	231 ac. (73.64%)	2.9
A	1262	-	0
A/D	4871	2323 ac. (52.31%)	2.47
B	27213	-	3.56
B/D	11	7.7 ac. (27.40%)	13.74
C	193	-	76.74
D	1034	-	0.55

2.3.6 Land Use

Land use has a significant effect on basin hydrology, affecting the volume of runoff produced by a given area and the speed of runoff delivered to the receiving system. Impervious areas restrict infiltration and produce more runoff, which is often delivered to receiving systems more rapidly through storm sewer networks. Land use was one of two principal inputs into the calculation of CN for the Upper Salt Creek Watershed, detailed more extensively in Section 1.3.2.

A 2001 land use inventory for the Chicago metropolitan area was received from CMAP in GIS format. The data was used to characterize existing conditions land use within the Upper Salt Creek Watershed. The data include 49 land use classifications, grouped into seven general categories for summarizing land use within the DWP. Table 2.3.4 summarizes the land use distribution within the Upper Salt Creek Watershed. Figure 2.3.5 shows the distribution of general land use categories throughout the watershed.

TABLE 2.3.4
Land Use Distribution within the Upper Salt Creek Watershed

Land Use Type	Area (mi^2)	Area (%)
Residential	27	49
Forest/Open Land	11	20
Commercial/Industrial	7	12
Vacant/Under Const.	3	5
Institutional	3	5
Transportation/Utility	2	3
Water/Wetland	2	3
Industrial/Warehousing	1	1
Agricultural	1	1

2.3.7 Anticipated Development and Future Conditions

Anticipated development within the Upper Salt Creek Watershed was analyzed using population projection data. Projected future conditions land use data for the Upper Salt Creek Watershed are unavailable from CMAP or other regional agencies. Projected 2030 population data for Cook County was obtained from CMAP. Population data was overlaid upon subwatershed boundaries to identify the potential for increases in subwatershed populations. Table 2.3.5 shows subwatersheds with a projected population increase from the year 2000 population. Projected increases in population along with current subwatershed land use conditions make it possible that there will also be a corresponding increase in impervious surface area. This potential change in impervious surface area could contribute to higher flow rates and volumes of stormwater runoff drained by those tributaries.

Management of future development may be regulated through both local ordinances and the WMO as described below in Section 2.3.9. This regulation would be an effort to prevent an increase in peak flows, via the construction of site-specific stormwater controls. The impact of the modified hydrologic and hydraulic characteristics of the subwatersheds due to changing land use over time may require the recommended projects to be re-evaluated under the conditions at the time of implementation to refine the details of the final design. To accomplish this, it is recommended that at the time projects are implemented, if updated land use and topographic information is available, the H&H models be rerun incorporating this new data.

TABLE 2.3.5
Projected Population Increase by Subwatershed

Name	2000 Population	2030 Population	% Change	Population Change
Mainstem	77,800	80,200	3	2,400
West Branch	47,800	50,200	5	2,400
Arlington Heights Branch	46,200	48,700	5	2,500

While population is expected to increase in the area, the open space is limited and the projected development increase is not expected to affect hydrology.

2.3.8 Wetland and Riparian Areas

Wetland areas within the Upper Salt Creek Watershed were identified using National Wetlands Inventory (NWI) mapping. NWI data includes approximately 3.4 square miles of wetland areas in the Upper Salt Creek Watershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provide flood management, habitat, and water quality enhancement. Identified riparian areas defined as part of the DWP offer potential opportunities for restoration. Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Upper Salt Creek Watershed.

2.3.9 Management of Future Conditions through the regulations of Site Stormwater Management

The District regulates the discharge of stormwater runoff from development projects located within separate sewer areas within the District's corporate boundaries through its Sewer Permit Ordinance. Currently, development projects meeting certain thresholds must provide stormwater detention in an effort to equate the post-development flow rate to the predevelopment flow rate. A number of communities enforce standards beyond the District's currently required standards and thresholds. This DWP supports the continued regulation of future development through countywide stormwater management.

The Cook County Watershed Management Ordinance (WMO) is under development and is proposed to provide uniform, minimum, countywide standards for site stormwater runoff for events up to and including the 100-year event that are appropriate for Cook County. This effort seeks to prevent post-development flows from exceeding pre-development conditions.. The WMO is proposed to be a comprehensive ordinance addressing site runoff, floodplains, floodways, wetlands, soil erosion and sedimentation, water quality, and riparian environments.

3. Tributary Characteristics and Analysis

3.1 Upper Salt Creek Mainstem

The Mainstem of Upper Salt Creek is a natural waterway through the central part of the watershed. The creek and its tributaries are about 27.5 miles long and they drain an area of 29.3 square miles. Table 3.1.1 lists the communities draining to the Upper Salt Creek Mainstem watershed.

TABLE 3.1.1
Communities Draining to Mainstem

Community	Tributary Area (mi^2)
Unincorporated/Forest Preserve	7.47
Elk Grove Village	4.26
Inverness	4.07
Palatine	4.06
Hoffman Estates	3.23
Schaumburg	2.96
Rolling Meadows	2.61
Arlington Heights	0.64
Itasca	0.02
Wood Dale	>0.01

Between 1974 and 1984, four large flood control reservoirs were constructed in the subwatershed providing approximately 3,000 acre-feet of flood storage. Four reservoirs, Busse Woods, Plum Grove, St. Michael, and Margreth Riemer, were constructed based on a plan prepared by the NRCS and sponsored by the District.

Busse Woods Reservoir was constructed at the confluence of the Mainstem and the West Branch within the Ned Brown Preserve of the FPDCC. The reservoir is formed by an earthen dam approximately 20 feet high and about 1,000 feet long. Discharge from the reservoir is controlled by a concrete overflow structure with a crest length of 80 feet. The surface area of the reservoir at normal pool level is 590 acres.

Plum Grove Reservoir is located along Tributary C of the Mainstem in the Village of Palatine and the City of Rolling Meadows and has a tributary area of about 1,240 acres. The reservoir is formed by an earthen dam 25 feet high and approximately 2,700 feet long. Discharge from the reservoir is controlled by a hooded riser spillway of standard Soil Conservation Service (SCS) design. The spillway discharges to a 42-inch diameter culvert pipe through the embankment. Energy dissipation at the downstream end of the culvert is provided by a standard United States Bureau of Reclamation (USBR) Type VI structure. Emergency overflows are accommodated in an earthen spillway in the left abutment of the dam.

Saint Michael Reservoir is located along Tributary D of the Mainstem in the Village of Schaumburg and the City of Rolling Meadows and has a tributary area of about 2,420 acres. The reservoir is formed by an earthen dam 20 feet high and approximately 4,800 feet long. The service spillway arrangement is nearly identical to that at the Plum Grove Reservoir discussed above. The emergency spillway is located on the right abutment of the dam.

The Margreth Riemer Reservoir is located along the Mainstem in the Village of Palatine and has a tributary area of 3,400 acres. The basin is divided into two pools, the main west pool and a smaller east pool connected by a 48-inch diameter equalizer pipe. The bypass control structure has been modified from the original design to force water into the reservoir more frequently than originally designed.

TABLE 3.1.2
Land Use Distribution for Mainstem

Land Use	Acres	%
Residential	8983.6	47.9
Open Land	5046.1	26.9
Commercial	2078.5	11.1
Industrial	777.4	4.1
Water	706.4	3.8
Transportation	520.3	2.8
Meadow	282.8	1.5
Agricultural	273.1	1.5
Disturbed/ Transitional	94.4	0.5

Table 3.1.2 lists the land use breakdown by area within the Upper Salt Creek Mainstem subwatershed. Figures 3.1.1a and 3.1.1b provide an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure and are discussed in the following subsections.

3.1.1 Sources of Data

3.1.1.1 Previous Studies

Since the mid-1950's numerous public organizations have produced reports describing flooding in the Watershed and have developed possible solutions. All of the reports discussed below evaluate either the entire Upper Salt Creek Watershed (Mainstem, Arlington Heights Branch and West Branch subwatersheds) or a smaller part of it. Ultimately, all three subwatersheds join as one at the Busse Woods Reservoir so all reports are relevant for the Mainstem subwatershed.

IDNR. From about 1955 to the present, the Illinois Department of Natural Resources (IDNR) produced a number of flood control reports focused on Upper Salt Creek:

Survey Report for Flood Control – Salt Creek	1955
Report on Plan for Flood Control and Drainage – Salt Creek	1958
Survey Report – Busse Woods Forest Preserve Reservoir	1963
Report for Flood Control and Drainage Development	1965
Supplemental Report - Report for Flood Control and Drainage Development	1967
Feasibility Report on Drainage Development – West Branch	1972
Upper Salt Creek Watershed Management Plan	1979

These reports are primarily of historical interest, as land use and design rainfall amounts have changed significantly in the interim. They are available in the IDNR Office of Water Resources library in Springfield, Illinois.

USGS. The USGS has been investigating real-time flood control on Salt Creek, including Upper Salt Creek. Two papers have been produced summarizing the work performed by the USGS, including:

Modeling System for Near Real-time Flood Simulation for Salt Creek	1998
NEXRAD and Rainfall-Gauge Precipitation Inputs for Near Real-Time Flood Simulation of Salt Creek	2003

United States Department of Agriculture (USDA). During the late 1960's and early 1970's the USDA performed two studies within the Watershed, including:

Preliminary Investigation Report – Salt Creek Watershed	1968
Watershed Work Plan	1971

These documents are also of historical interest only. If needed, they are also available in the IDNR Office of Water Resources library in Springfield.

Chicago Metropolitan Agency for Planning (CMAP – formerly NIPC). CMAP has produced numerous reports over the years addressing flood control issues in Northeast Illinois. Two reports with particular applicability to Upper Salt Creek are summarized below.

"Evaluation of Stormwater Detention Effectiveness in Northeastern Illinois" (CMAP, 1989): CMAP developed LANDS and Full Equations (FEQ) models of the Watershed to evaluate the effectiveness of detention in preventing increases in instream flow rates at the watershed scale. In the study, it was concluded that detention designed using the CMAP two-year and 100-year release rates would prevent increases for typical northeastern Illinois watersheds up to at least 30 square miles.

"Investigation of Hydrologic Design Methods for Urban Development in Northeastern Illinois" (CMAP, 1991): As part of this study HSPF (successor to LANDS) was calibrated to the Upper Salt Creek (Algonquin Road gauge) and the Lower Salt Creek (Wolf Road gauge) watersheds. The calibrated model was then used to evaluate the various design storm methods used to size detention basins. In the report, it was concluded that the modified rational formula underestimates required detention volumes and that hydrograph methods such as TR-20 and ILLUDAS overpredict detention volumes under some circumstances and underpredict for others. A detention sizing chart was developed using the HSPF model and continuous rainfall-runoff simulations to provide an easy-to-use method for detention sizing. The chart (and variations for different release rates) has been included in DuPage and Lake County stormwater ordinances.

Metropolitan Water Reclamation District of Greater Chicago (District). The District, in association with NRCS, the North Cook County Soil and Water Conservation District (SWCD), the Forest Preserve District of Cook County (FPDCC), the State of Illinois, and the local municipalities and park districts, produced the "Upper Salt Creek Watershed Floodwater Management Plan" (1973). This report led to the construction of the Watershed reservoir system and the construction of the reservoirs described above.

DuPage County. DuPage County has prepared numerous reports on flood forecasting, model calibration, project evaluation, and methods of using continuous simulation and dynamic flood routing for establishing floodplain limits. Three reports that are specific to the Watershed are described below.

"Hydrologic Calibration of HSPF Model for DuPage County" (1994): This study established countywide HSPF model parameters for use in DuPage County. The Salt Creek stream gauge at Algonquin Road, which is located within the Watershed, was one of five calibration points used for the countywide calibration.

"Meteorologic Database Extension and Hydrologic Model Verification of HSPF Model for DuPage County" (1994): The countywide HSPF model was verified at seven streamflow gauges that were not used in the original 1994 calibration. The meteorologic database and runoff simulation were extended from water year 1988 through water year 1993.

"Hydraulic Evaluation of HSPF Model for Upper Salt Creek Watershed" (Conservation Design Forum, 2005): The HSPF and FEQ models were verified for simulation through water year 1996. During this effort, it was found that the 1985 land cover data within Cook County required significant adjustment to achieve an acceptable model calibration at the Algonquin Road and Busse Woods streamflow gauges. Using impervious cover as a calibration parameter for the Cook County simulation, the impervious land cover had to be increased from 17% to 36%. This suggests that the 1985 land cover in the FEQ model needs significant updating.

3.1.1.2 Water Quality Data

Water quality data for the Watershed were collected from IEPA and CMAP.

Monitoring Data. The IEPA (STOrage and RETrieval) STORET database contains water quality data collected as part of the Ambient Water Quality Monitoring Network (AWQMN) program. Two Salt Creek AWQMN segments are present within northern Cook County, segments GL and GL-10. Segment GL represents the upper portion of the Watershed between the headwaters in Inverness and Busse Woods. Segment GL-10 extends from Busse Woods downstream into DuPage County and a portion of this segment is located within the Watershed. Additionally, Busse Woods Reservoir, the 590-acre lake within the Ned Brown Preserve, contains multiple sampling locations identified in the STORET database with the prefix RGZX.

The STORET database was used to search for water quality data pertaining to dissolved oxygen, nitrite plus nitrate nitrogen, total phosphorus, ammonia nitrogen, unionized ammonia nitrogen (unionized ammonia), dissolved copper, dissolved zinc, and dissolved lead between 1990 and 2007 within the Watershed. This data search yielded no results for dissolved copper, zinc, or lead, but yielded more than 400 samples for the remaining parameters.

The mean dissolved oxygen concentration in Salt Creek was 7.38 mg/L, while in Busse Reservoir it was 8.76 mg/L. No dissolved oxygen sample from either location was below 5.00 mg/L, the Illinois Water Quality Standard.

The mean nitrite plus nitrate concentration was 8.71 mg/L in Salt Creek, with a range of 1.20 to 13.20 mg/L. Ammonia concentrations were much lower, with a mean of 0.09 mg/L and a range of 0.01 to 0.18 mg/L. Busse Reservoir had a mean nitrite plus nitrate concentration of 0.12 mg/L (range of 0.01 to 0.40 mg/L) and a mean ammonia concentration of 0.15 mg/L (range of 0.01 to 0.63 mg/L). Although no Illinois Water Quality Standard exists for nitrogen concentrations, a nitrite plus nitrate concentration exceeding 7.8 mg/L qualifies as impaired under IEPA guidelines, and Salt Creek has exceeded this limit during many collections. No samples exceeded the Illinois Water Quality Standard for ammonia (15.0 mg/L). Unionized ammonia concentrations were much lower at both sampling locations. In Salt Creek, the mean unionized ammonia concentration was 0.00093 mg/L with a range of 0.00007 to 0.00190 mg/L, while the mean concentration in Busse Reservoir was 0.01061 mg/L with a range of 0.00060 to 0.05518 mg/L.

Phosphorus samples were collected at the same locations as dissolved oxygen, nitrogen, and ammonia samples. The mean phosphorus concentration in Salt Creek was 2.58 mg/L, with a range of 0.28 to 3.9 mg/L. In Busse Reservoir, the mean concentration was 0.06 mg/L, with a range of 0.03 to 0.09 mg/L. There is an Illinois Water Quality Standard of 0.05 mg/L for phosphorus which pertains only to lakes greater than 20 acres. Multiple samples in Busse Reservoir exceeded the 0.05 mg/L limit. Although no standards exist for streams, a phosphorus concentration greater than 0.61 mg/L qualifies as an impairment under IEPA guidelines, and Salt Creek exceeded this value during the majority of the collections.

National Pollutant Discharge Elimination System (NPDES) Permit. There are no permitted point source discharges within the subwatershed.

Municipalities discharging to the Mainstem are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

Impaired Waterways. The 2006 IEPA *Illinois Integrated Water Quality Report and Section 303(d) List* was used to determine the 303(d) status of Upper Salt Creek. Upper Salt Creek was assessed under the 303(d) program at segment GL and segment GL-10; both locations are included on the impaired waterways list. Busse Woods Reservoir is also listed as an impaired waterway. The entirety of Upper Salt Creek is categorized as 'Not Supporting' for aquatic life, fish consumption, and primary contact uses. The 303(d) report lists ten impairments for segment GL and eleven for GL-10. General categories of impairments at both segments include channel alteration, high nutrient concentrations, and pollutant loading. Busse Woods Reservoir achieves 'Full Support' for aquatic life use, but does not support fish consumption use. Impairments at the lake include PCB contamination and algae growth.

Total Maximum Daily Loads (TMDLs). The Salt Creek Watershed was assessed by the EPA's TMDL program. A TMDL study was conducted for the entire Salt Creek Watershed and published in 2004. The TMDL report concluded an 8 percent reduction in chloride load, a 56 percent reduction in Carbonaceous Biochemical Oxygen Demand (CBOD) load, and a 38 percent reduction in ammonia nitrogen load are needed to meet the maximum daily load of Salt Creek. The report lists high nutrient concentrations (from runoff, wastewater treatment plant effluent, and storm sewer overflow discharges), high CBOD, and impoundments as major causes of low dissolved oxygen concentrations.

3.1.1.3 Wetland and Riparian Areas

Figures 2.3.8.1 and 2.3.8.2 contain mapping of wetland and riparian areas, respectively, in the Upper Salt Creek Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping in addition to observations made in the field during site visits. NWI data includes roughly 19,000 acres of wetland areas in the Mainstem subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.1.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated in the revised floodplains. The entire Upper Salt Creek Watershed is mapped in detail in the DFIRM mapping update. Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.1.1.5 Stormwater Problem Data

Table 3.1.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire responses provided by watershed communities to the District. Problems are classified in Table 3.1.3 as regional or local. This classification is based on a process described in Section 2.2 of this report.

3.1.1.6 Near Term Planned Projects

This subwatershed does not contain any known near-term planned projects.

TABLE 3.1.3
Community Response Data for Upper Salt Creek Mainstem

Prob. ID	Municipality	Problems as reported by local agency	Location	Problem Description	Local/ Regional	Resolution in DWP
1	Elk Grove Village	Bank Erosion & Sedimentation	Cypress Lane & Rev. Morrison Boulevard	Channels inundated with heavy vegetation, debris, silt, and bank erosion.	Local	This is a local problem because the channels are small drainage ditches.
2	Elk Grove Village	Bank Erosion & Sedimentation	Devon Avenue & Arlington Heights Road, Unincorporated Cook County	Severe erosion, slope failure and exposed tree roots along 1,200 foot-section of Salt Creek in unincorporated Elk Grove Township.	Regional	Erosion problem does not threaten structures, not addressed by DWP.
3	Hoffman Estates and Schaumburg	Flooding	Golf Road & Higgins Road	Intersection flooding at Jones and Highland. Study and design completed.	Local	Problem not located on a regional waterway. This is a local problem.
5	Palatine Township	Flooding	Plum Grove Estates Neighborhood; at Briarwood Lane	Overbank flooding	Regional	Project SCUP-05 was evaluated but did not effectively reduce flood elevations. Properties at risk of flooding are candidates for protection using nonstructural flood control measures such as floodproofing and acquisition.
7	Inverness	Flooding	Upstream of Tributary B; 2211 Palatine Rd	Overbank flooding	Local	This is located in an area draining less than 0.5 sq mi– thus it is a local problem.
8	Rolling Meadows	Streambank Erosion & Water Quality	Between Rt. 53 and Rt. 62	Erosion affects downstream water quality.	Regional	Erosion problem does not threaten structures, not addressed by DWP.
9	Rolling Meadows	Streambank Erosion	Tributary C at Kennedy Pond	Erosion	Regional	Erosion problem does not threaten structures, not addressed by DWP.
15 - 18, 23, 25 - 28, 32	IDOT	Flooding	Various	Pavement flooding	Local	Problems not located on a regional waterway. These are local problems.
43	Palatine	Flooding	South/ Central Downtown Palatine	Flooding – sewer	Local	Problem not located on a regional waterway. This is a local storm-sewer problem.
48	Elk Grove Village	Flooding	Rev. Morrison Blvd & Elk Grove Village Blvd.	Drainage ditches overtop, resulting in flooding of roadways. Village performed study in 1990's and recommended improvements completed	Local	Problem not located on a regional waterway. This is a local storm-sewer problem. Problem does not include flooding that causes regional transportation damages.
50	FPDCC	Erosion	Woodfield Rd. and Rohlwing Rd.	Erosion and sedimentation	Local	Erosion problem does not threaten structures, not addressed by DWP.

TABLE 3.1.3
Community Response Data for Upper Salt Creek Mainstem

Prob. ID	Municipal-ity	Problems as reported by local agency	Location	Problem Description	Local/ Regional	Resolution in DWP
52	FPDCC	Water Quality	Golf Rd. and I-90	Sedimentation	Local	No flooding or erosion damages to structures associated with this problem area, not addressed by DWP.
53	Rolling Meadows	Flooding	Main Stem at Algonquin Road	Street/Surface Flooding -- data from Sept. 2008 rain-fall	Regional	Model results did not confirm roadway or structure flooding due to a regional problem in this area. The observed flooding may have been the result of debris accumu-lation on the upstream side of the Algonquin Road bridge.

3.1.2 Watershed Analysis

3.1.2.1 Hydrologic Model Development

Subbasin Delineation. The Mainstem subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. Sixty-two subbasins were delineated for the area, with an average subbasin area of 302 acres (221 acres not including the two large subbasins directly tributary to the Busse Woods reservoir) and a total drainage area of 29.3 square miles.

Hydrologic Parameter Calculations. Curve Numbers were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

The time of concentration and storage coefficient were determined as discussed in Section 1.3.2.1.

3.1.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. The computer modeling used to develop the original Flood Insurance Study (FIS) flood profiles was done by FEMA using TR-20 for the hydrology and WSP-2 for the hydraulics and dates from 1972 to 1976.

In 1983, the Illinois Department of Transportation (IDOT) Office of Water Resources (now part of IDNR) developed a small, 10-branch, unsteady flow model of the Watershed upstream of the Busse Woods Reservoir. HSPF was used for the hydrology modeling and FEQ for the hydraulics modeling.

In 1988, IDNR contracted to obtain more data (e.g., cross sections and structure data) in anticipation of creating completely new models of the Watershed. By 1996 this modeling had been completed using HEC-1 for the hydrology and HEC-2 for the hydraulics. All of the main channels and tributaries were modeled. These models are the basis for the current FEMA regulatory mapping.

Subsequently in 1998, a more comprehensive FEQ model of Upper Salt Creek was constructed by DuPage County based on the data contained in the HEC-1/HEC-2 models. The stream channel coverage of the two models is identical. The purpose of this new model is to provide more accurate inflows to DuPage County's Lower Salt Creek model and to study possible modifications to the Busse Woods Dam spillway. The model is also utilized as a part of the USGS plan to provide near real-time flood simulation of Salt Creek in order to provide more accurate flood forecasts and to allow more efficient operation of the Elmhurst Quarry Flood Control Project in DuPage County.

The HEC-2 model created by the IDNR in 1996 was used as the base model for the HEC-RAS model developed as part of this DWP. The geometry of the HEC-2 model was imported into HEC-RAS and aligned over the project area using current aerial photography, available HEC-2 model documentation, and the FIS profiles as a check. Reach lengths between cross sections were adjusted proportionally where necessary based on known river lengths between bounding bridge sections to ensure that the HEC-RAS model matched the aerial photographs and known lengths determined with GIS.

Due to uncertainty of the precise location of individual cross sections, the current Digital Elevation Model (DEM) was used to identify the overbank geometry for each cross section to ensure a proper geo-spatial match between the natural topography and model. This is particularly important for mapping of the inundation boundaries. The cross sections were extended within GIS and HEC-GeoRAS was used to create a cross section profile from the 10-ft DEM for each cross section. The channel section from the HEC-2 model was retained for each section while left and right overbanks of the cross sections were replaced utilizing the Graphic Cross Section Editor tool in HEC-RAS. Interpolated sections were also added to the model within HEC-RAS to provide input locations for lateral inflow hydrographs developed within HEC-HMS and to improve the computational stability of the model.

In general, cross section spacing from the HEC-2 model was between 500- and 1,000-feet. Additional cross sections were surveyed in locations in which cross section spacing was greater than 1,000 feet. Additional cross sections and culverts/bridges were also field surveyed where required or to bring the hydraulic model to within 1 square mile of the Watershed boundary or closer.

Boundary Conditions. The downstream boundary condition at the DuPage County line was developed from the flows and stages presented in the current Cook County FIS for Upper Salt Creek.

3.1.2.3 Calibration and Verification

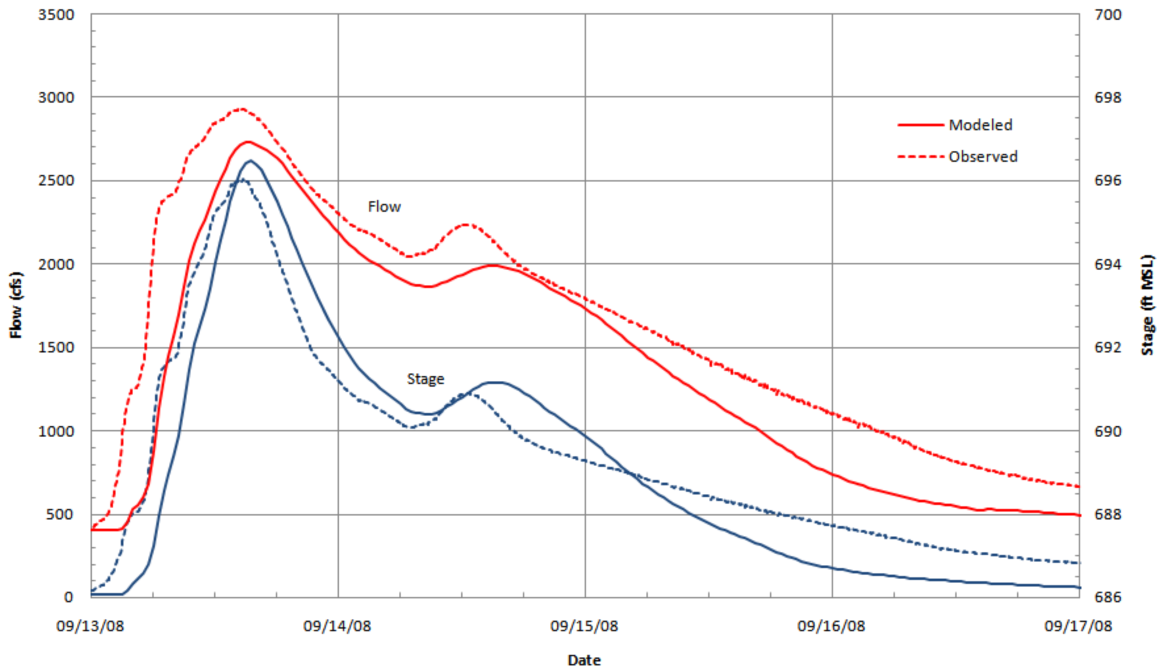
Observed Data. Two USGS stream flow gauges are located on the Upper Salt Creek Mainstem; 5536500 at Rolling Meadows located just upstream of Algonquin Road and 05537500 near Elk Grove Village located at the Busse Woods dam. Analysis of the available record for the two recording gauges shows that there are two large recent events that could be used for calibration and verification.

In August of 2007 there was a significant rainfall event resulting in two peaks; one during the early hours of August 19th and the other late on August 23rd. The total amount of rainfall was about 9 inches, with about 5 inches falling on the 19th and another 4 inches on the 23rd. Only the first rain event will be used for calibration purposes as the HEC-HMS program is not designed to model multiple events.

Another, larger event occurred in September of 2008. During this event about 9 inches of rain fell in about 30 hours. This event was selected to calibrate the model. The August 2007 event was used to validate the calibration.

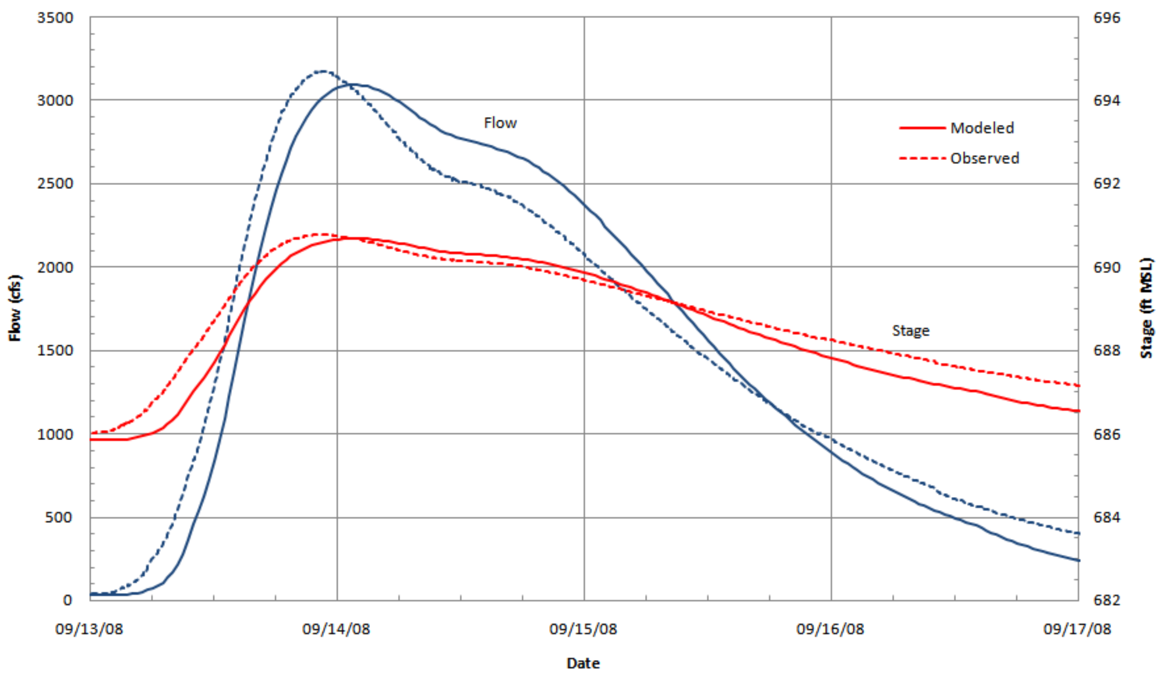
Calibration Results. A comparison of the modeled and recorded stage and flow at the Rolling Meadows gauge shows an excellent agreement for both parameters. Peak flow is within about 4%. Peak stage is about 0.7 feet low. A small change to the channel roughness factors in the area of the gauge could bring this down within the 0.5 foot calibration limit but this change would have no effect on the flows at this location and would only affect a very small reach of the stream channel so the originally estimated roughness values were left unchanged. Figure 3.1.3 shows a graphical comparison of the modeled and observed stage and flow for that event at the Rolling Meadows gauge. The shape of the flow and stage hydrographs also match the observed values except that there is some delay in the response. The recession limb is also fairly close which is unusual in a single event model. This is probably due to the relatively large volume of reservoir storage releasing back into the system as the storm dissipates.

FIGURE 3.1.4
Mainstem Calibration – Gauge 05530990 – Rolling Meadows
September 13, 2008 Storm



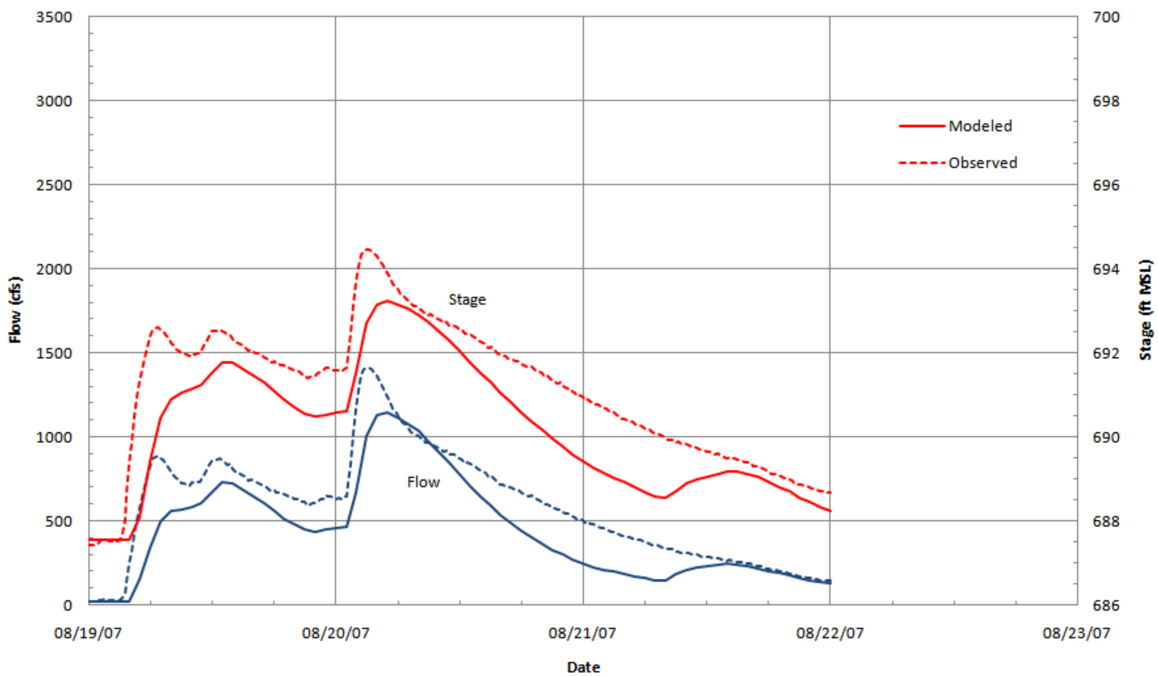
The same comparison can be done at the Busse Dam gauge. As with the Rolling Meadows gauge the modeled flow is within about 3% of the observed flow. The stage is within about 0.1 feet – which is to be expected since the flow here is controlled by a single fixed structure and not a channel reach. Figure 3.1.4 shows a graphical comparison of the modeled and observed stage and flow for the same event at the Busse Dam gauge. The shape of the flow and stage hydrographs here also matches the observed values. The recession limbs follow the observed values closely, again due to the very large storage reservoir just upstream of the gauge.

FIGURE 3.1.5
Mainstem Calibration – Gauge 05531044 – Busse Dam
September 13, 2008 Storm



Using the same parameters developed for the September 2008 event a verification run was made using the August 2007 event. This event was considerably smaller in flow but still significant when compared to the historical record. The antecedent conditions were drier for this event, but since the AMC had already been reduced to I for the calibration event (September 2008), it was not reduced further. The comparison of flows shows a difference of about 20% between the August 2007 and September 2008 events. The stage, however, shows an approximately one foot difference. Figure 3.1.5 shows a graphical comparison of the modeled and observed stage and flow for the August 2007 event at the Rolling Meadows' gauge.

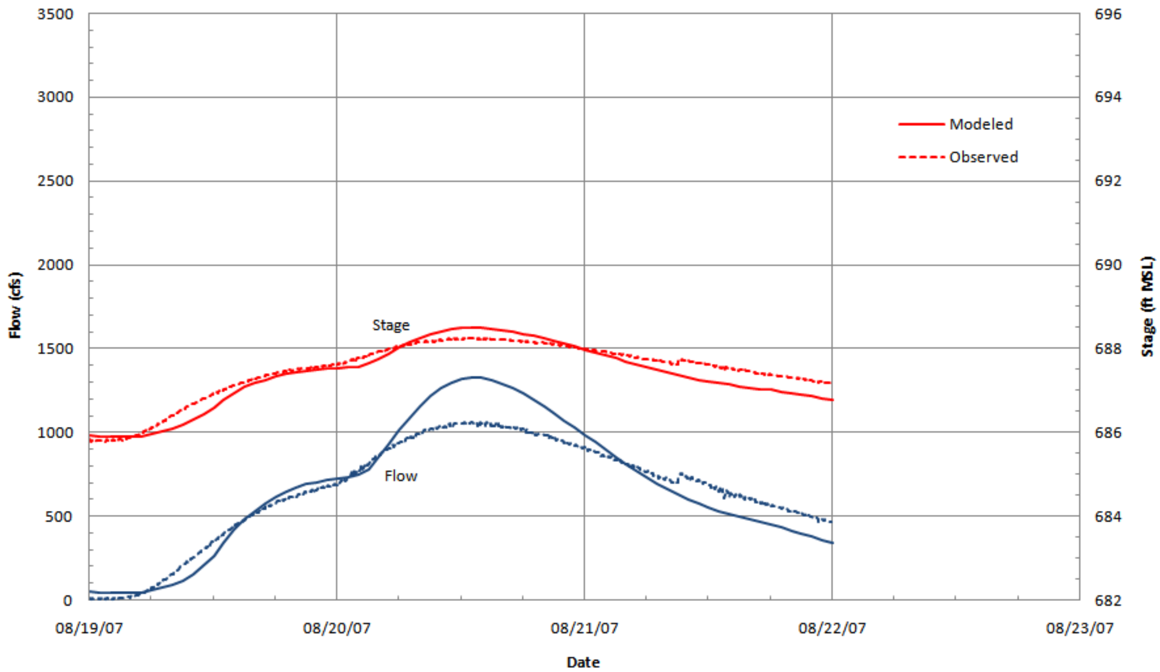
FIGURE 3.1.6
Mainstem Calibration – Gauge 05530990 – Rolling Meadows
August 19, 2007 Storm



The difference could be reduced by increasing the AMC used in the hydrologic model but this is not supported by the measured rainfall so an adjustment for this event would require a commensurate change in the AMC selected for the 2008 event. However, this would adversely impact the calibration to the 2008 event. As that event is much larger it was decided that the calibration parameters would be set by calibration to the 2008 event.

A similar comparison at the Busse Dam gauge shows a much better fit for both flow and stage. The flows are different by about 25% at the peak although they match the flow hydrograph very well for a large portion of the storm event. The peak stage is within 0.25 feet of the observed stage. Figure 3.1.6 shows a graphical comparison of the modeled and observed stage and flow for the same event at the Busse Dam gauge.

FIGURE 3.1.7
Mainstem Calibration – Gauge 05531044 – Busse Dam
August 19, 2007 Storm



Modifications to Model Input. As discussed in the previous sections the changes made to the model to effect a good calibration were limited to the AMC assumed, and thus the overall curve numbers and the storage coefficient used in the Clark unit hydrograph method. An AMC condition of I was selected as the best fit for the storms used in the calibration/verification process. Values of $R/(T_c+R)$ of 0.6 for the Mainstem and Arlington Heights Branch and 0.9 for the West Branch were used to determine the storage coefficient and time of concentration used in each area.

3.1.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figures 3.1.1a and 3.1.1b show inundation areas in the Mainstem subwatershed produced by the hydraulic model for the 100-year, 24 hour inundation boundary.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions on the watershed. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storm events.

Reservoir Operation. The existing District reservoirs within the Mainstem subwatershed were evaluated during the existing conditions analysis. In general the reservoirs operated as designed during the 100-year event. Both the St. Michaels and Plum Grove reservoirs fill to just below their overflow spillways during this event. The Margreth Reimer reservoir also fills to near capacity without backing up over the inflow weir. This reservoir, being an offline reservoir, is pumped out after the storm event. Originally, there were three pumps provided at the pumping station, two large pumps for dewatering of the reservoir and a smaller pump to drain the permanent pool for maintenance. However, during initial operations it was determined that the discharge from the dewatering pumps was causing problems in the receiving stream. Since that time only the smaller pump has been used for dewatering. This pump is operated manually from the reservoir site based on direct observation of the water levels in the channel at the station. There is no coordination required with the dewatering of the other pumped reservoir in the Upper Salt Creek Watershed as the dewatering flows are relatively small and the reservoirs are on different branches.

3.1.3 Development and Evaluation of Alternatives

3.1.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.1.4 summarizes problem areas identified through modeling of the Mainstem subwatershed.

TABLE 3.1.4
Modeled Problem Definition for the Upper Salt Creek Mainstem

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA05	Portion of the City of Rolling Meadows and Unincorporated Cook County within the Plum Grove Village neighborhood	100-, 50-, 25-, 10-, 5-, 2-	5	Previous work done by consultants hired by the Palatine Township Road District indicates that a channel improvement will not provide the required reduction in the water surface elevation. The option of adding storage to reduce flooding was also evaluated as part of the DWP but sufficient storage could not be added close enough to the project area to reduce flooding Benefits and costs were not developed for this alternative.
MPA49	Village of Palatine between Illinois Avenue and Smith Street	100-, 50-, 25-, 10-, 5-, 2-	43	Project SCUP-49 created to reduce flooding in this area.
MPA51	Village of Palatine near the intersection of Palatine and Quentin Roads upstream of Margreth Riemer Reservoir	100-, 50-, 25-, 10-, 5-	-	Project SCUP-51 created to reduce flooding in this area. This project was not recommended because the benefit-cost ratio was very low. The subject properties are candidates for protection using non-structural measures such as flood proofing or acquisition.
MPA56	In Rolling Meadows Industrial park near Intersection of New Wilke Rd. and Golf Rd.	100-, 50-, 25	-	Project SCUP-56 created to address flooding in this area.
MPA58	Village of Elk Grove Village downstream of Busse Dam	100-, 50-, 25-, 10-, 5-, 2-	-	Project SCUP-58 created to reduce flooding in this area. This project was not recommended because the benefit-cost ratio was very low. The subject properties are candidates for protection using non-structural measures such as flood proofing or acquisition.

3.1.3.2 Damage Assessment

Damages were defined following the protocol established in Chapter 6.6 of the CCSMP. No erosion damages or recreation damages due to flooding were identified for the subwatershed. Transportation damages were estimated as 15 percent of property damages plus additional site specific traffic damages computed at the intersection of Golf Road and New Wilke Road. Table 3.1.5 lists the damage assessment for existing conditions.

TABLE 3.1.5
Estimated Damages for Upper Salt Creek Mainstem

Damage Category	Estimated Damage ($)	Description
Property	$5,392,000	
Erosion	$0	
Transportation	$975,000	For most locations, assumed as 15% of property damage due to flooding, MPA56 includes a site-specific estimate

3.1.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in the subwatershed. Increased conveyance or storage were identified as the principal technologies applicable for addressing the existing stormwater problems.

3.1.3.4 Alternative Development

Flood Streambank Stabilization Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.1.6 summarizes flood control alternatives developed for the Mainstem.

Stormwater detention alternatives were modeled to address flooding problems along the Mainstem.

The flooding problems identified in the Mainstem watershed generally involve conveyance capacity issues associated with road crossings and the size of the stream channel. Solutions to these types of problems can include increasing the conveyance capacity by enlarging the culvert or bridge cross section and increasing the size of the channel. Alternatively, if the space is available, the flows in the stream channel can be reduced by providing a storage reservoir upstream of the problem location. In the Upper Mainstem there was no available undeveloped land area upstream of the problem areas to warrant investigating a storage option. Conveyance capacity was increased to lower the water level by modifying the local constrictions, such as bridges, culverts or weirs, and enlarging the channel cross section. Model runs were made to ensure that the improvements did not negatively impact the downstream areas which would necessitate the construction of a storage component to mitigate these effects. The model runs determined that this was not necessary as the scope of the improvements did not produce increased downstream flows.

TABLE 3.1.6
Flood Control Alternatives for Upper Salt Creek Mainstem

Alternative	Location	Description
SCUP-5	Portion of the City of Rolling Meadows and Unincorporated Cook County within the Plum Grove Village neighborhood	Previous work done by consultants hired by the Palatine Township Road District indicates that a channel improvement will not provide the requisite reduction in the water surface elevation. The option of adding storage to reduce flooding was also evaluated. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
SCUP-49	Village of Palatine between Illinois Avenue and Smith Street.	The channel improvements include approximately 2,800 ft of linear river channel widening requiring an estimated 28,000 yd^3 of excavation.
SCUP-51	Village of Palatine near the intersection of Palatine and Quentin Roads upstream of Margreth Riemer Reservoir	The project includes expanding the culvert under the Palatine/ Quentin Rd. intersection from three 8.1 x 6.6 foot box culverts to two 7.4 x 16.9 foot box culverts and expanding the culvert under Palatine Road upstream of this intersection from the existing two 8.3 x 5 foot box culverts with an additional four 11 x 6 foot box culverts. The channel between these culverts is expanded to a 50-ft bottom width concrete lined trapezoidal section to improve conveyance, which will require the excavation of approximately 24,000 yd^3 along 1,700 ft of channel.
SCUP-56	City of Rolling Meadows around the intersection of Golf Road and New Wilke Road.	The project includes a flap gate on the local sewer and a small levee along a local ditch to isolate the project area from the Salt Creek. Two small levees are constructed along each side of Golf Road just west of the I-90 to prevent overland flow from Salt Creek. A 50-cfs low-head pumping station is also required to handle sewer flows during times when Salt Creek is in flood.
SCUP-58	Village of Elk Grove Village downstream of Busse Dam	Major channel expansion downstream of Busse Woods including approximately 47,500 yd^3 of excavation. Two solutions were considered: SCUP-58a and SCUP-58b. SCUP-58a evaluated the option of increasing the storage capacity of the Busse Woods Reservoir by decreasing the spillway capacity of the Busse Dam. SCUP-58b evaluated channel improvements along the creek. This project would need additional modeling along the Upper Salt Creek in DuPage County to evaluate its effectiveness and to ensure no negative downstream impacts.

SCUP-5 looked at several alternative strategies for dealing with the flooding in this area. As mentioned in Table 3.1.6, previous work had been done on a pure conveyance option to lower water levels in that area. Because of the close proximity to the stream channel of a number of homes the channel improvements were necessarily limited in width and consequently provide little benefit. To significantly reduce water levels the channel improvements would need to be both wide and deep. This would require the removal of many of the closer homes, eliminating the stream meanders in the area as well as the destruction of many of the tress along the stream channel, thus effectively destroying the neighborhood. A storage option was also investigated. Approximately 1000 acre-feet of storage would be required in close proximity to the upstream end of the problem area to be effective in reducing water levels and eliminate flooding in this area. Open space upstream of this site is at a premium and at most about 200 acre-feet could be constructed close enough to have a significant impact on water levels. A program of limited buy-outs and flood proofing could be an effective solution that would preserve the neighborhood while reducing damages from the more frequent floods.

SCUP-49 includes the expansion of several culverts along the Mainstem at Pleasant Hill Avenue, Michigan Avenue, Illinois Avenue, Imperial Court and Helen Road. It also proposed channel improvements between Pleasant Hill Avenue and Illinois Avenue. Expansion of the culverts and an increase in channel conveyance capacity work together to reduce head loss along the channel and to lower the peak water surface elevation up to 3.4 feet.

SCUP-51 includes expanding the culvert capacity under the intersection of Quentin Road and Palatine Road and expanding the culvert under the second Palatine Road crossing approximately 940 feet upstream. The channel between these culverts is expanded to a concrete lined trapezoidal section to improve conveyance. Expansion of the culverts and channel improvements act together to lower the peak flood elevation approximately 3.4 feet. This project was not recommended because the benefit-cost ratio was very low. A program of property acquisition and/or flood proofing could be an alternative solution.

SCUP-56 addresses regional flooding on Golf Road near the intersection with New Wilke Road. This alternative includes a combination of both regional and local components. To isolate the project area from flooding due to high water in Salt Creek, two small levees must be constructed along both sides of Golf Road just west of I-90 to prevent overland flooding from the creek (regional). The elevation of the top of both levees is 696.0 giving three feet of freeboard. The levees extend from the embankment of I-90 west to the abutment of the Golf Road Bridge over Salt Creek, a distance of about 400 feet. The levees are approximately 4 feet high. To ensure the project area is not inundated through a local drainage ditch and storm sewer, a third levee just north of I-90 at the downstream end of the roadside drainage ditch must be constructed to an elevation of 696.2, and the storm sewer in Golf Road must be isolated from the creek by a flap gate. A pumping station with a peak capacity of 50-cfs will also be required to handle local drainage during periods when Salt Creek is high. Since this project requires regional and local components to address the problem area, the local municipality/agency with jurisdiction will be required to contribute resources for the local components while the District would contribute resources for the regional components, should this project be implemented.

SCUP-58 considered both a storage and a conveyance solution, SCUP-58a and SCUP-58b respectively. While the problem area is located just downstream of a large reservoir (Busse Woods Reservoir) the storage volume cannot be expanded without large-scale modification of the forest preserve. Alternatively, DuPage County is investigating a modification of the spillway at the dam to provide some seasonal flood control benefit. Because these benefits can only accrue during certain times of the year, they cannot be counted on when developing a flood control plan. However, as an example of what might be achieved if the spillway at the dam could be modified for year-round flood control, a sample project was developed (SCUP-58a) to maximize the storage available. The width of the spillway was decreased until the water level in the reservoir began to have a detrimental effect on water levels upstream along the West Branch and the Upper Mainstem. The width of the spillway was decreased to 52 feet raising the 100-yr water level in the reservoir 1-ft to 692.7 ft. The emergency spillway would need to be raised to or above this new peak level. The effect of this modification would reduce the peak 100-yr outflow from 4,863 cfs to 3,729 cfs and lower the 100-yr water levels downstream about 0.3 ft. This would have a minimal impact on the number of structures in the floodplain.

A channel improvement project was also developed (SCUP-58b), to provide the necessary reduction in water surface elevation of about 1.5 feet. This required an increase in the cross section of the channel by about 40% which would need to start several miles downstream of John F. Kennedy Boulevard in the vicinity of the Village of Addison, well outside the boundaries of Cook County. This is because the water surface slope in the reach downstream of the DuPage/Cook County line is very flat at about 0.5 ft per mile. Before this project could be finalized detailed modeling would need to be done along Upper Salt Creek in DuPage County. A rough cost and possible benefits for this project are included in the DWP. This project has a very low B/C ratio and is not recommended for implementation by the District. A program of property acquisition and/or flood proofing could be an alternative solution.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for this subwatershed.

3.1.3.5 Alternative Evaluation and Selection

Modeling analysis concluded that SCUP-5 could not provide effective stormwater detention resulting in flood damage reduction due to the severity of the current flooding and the lack of available open space for the construction of additional storage. Projects SCUP-49 and SCUP-56, shown in Figures 3.1.2 and 3.1.3, are recommended.

Project SCUP-49 results in reduced stage along the waterway. Table 3.1.7 provides a comparison of the modeled maximum WSEL and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.1.7
Mainstem Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		SCUP-49	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Cedar Street	62565	740.57	604	740.58	604
Rose Street	61171	733.42	604	733.09	605
Smith Street	60459	732.02	605.	729.59	607
Helen Road	59545	731.5	582	729.21	607
Imperial Court	59182	731.25	580	728.67	608
Pleasant Hill Boulevard	57746	730.28	572	727.93	612

TABLE 3.1.7
Mainstem Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		SCUP-49	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Cedar Street	62565	740.57	604	740.58	604
Michigan Avenue	56875	729.63	574	726.8	616
Illinois Avenue	56102	729.41	576	726.09	620
Euclid Avenue	53212	724.62	538	724.63	584

Project SCUP-56, although it addresses flooding in the project area, is not included in Table 3.1.7 above because it results in no impact on the water surface elevations upstream or downstream of its location. However, the flood level at the intersection of Golf Road and New Wilke Road is lowered from 693.2 to below the street level of 691.9.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Upper Salt Creek DWP.

The alternatives listed Table 3.1.6 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Table 3.1.8 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data. Alternative SCUP-5 did not produce a significant change in inundation areas and is not listed as benefits were negligible and thus costs were not calculated for this alternative.

3.1.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.1.8 lists the alternatives analyzed in detail. Figures 3.1.2 and 3.1.3 schematically show the proposed improvement as well as a comparison of the with and without project inundation mapping.

TABLE 3.1.8
Upper Salt Creek Mainstem Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Communities Involved
SCUP-49	Widen channel and increase conveyance capacity of five bridges.	0.15	1,701,000	11,030,000	61	No Impact	Yes	Palatine
SCUP-51	Widen channel and increase conveyance capacity of two bridges.	0.02	156,000	7,262,000	7	No Impact	No	Palatine
SCUP-56	Install pumping station with flap gate and construct three levees.	0.12	166,000	1,403,000*	0	No Impact	Yes	Rolling Meadows
SCUP-58	Widen Channel	0.01	87,000	5,696,000	10	No Impact	No	Elk Grove Village

Note: Net Benefits values do not include local benefits or non-economic benefits
* Includes $1,253,000 for necessary local improvements.

3.2 West Branch

The West Branch of the Upper Salt Creek is a natural waterway though the southern part of the watershed. The creek and its tributaries are about 17.0 miles long and they drain an area of 12.2 square miles. Table 3.2.1 lists the communities draining to the Upper Salt Creek West Branch subwatershed.

TABLE 3.2.1
Communities Draining to West Branch

Community/Tributary	Tributary Area (mi²)
Schaumburg	3.76
Hoffman Estates	2.57
Elk Grove Village	1.51
Unincorporated/Forest Preserve	0.13

Other than several small residential or golf course detention ponds, there are no large flood control reservoirs within the West Branch subwatershed.

Table 3.2.2 lists the land use breakdown by area within the Upper Salt Creek West Branch subwatershed. Figure 3.2.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure and are discussed in the following subsections.

3.2.1 Sources of Data

3.2.1.1 Previous Studies

Since the mid-1950's numerous public organizations have produced reports describing flooding in the Watershed and developed possible solutions. All of the reports discussed in Section 3.1.1.1 evaluate either the entire Upper Salt Creek Watershed (Mainstem, Arlington Heights Branch and West Branch subwatersheds) or a smaller part of it. Ultimately, all three subwatersheds join as one at the Busse Woods Reservoir so all reports are relevant for this analysis.

TABLE 3.2.2
Land Use Distribution for West Branch

Land Use Category	Area (acres)	%
Residential	4041	51.9
Commercial	1676	21.5
Open Land	1290	16.6
Disturbed/ Transitional	200	2.6
Meadow	180	2.3
Industrial	139	1.8
Water	100	1.3
Transportation	85	1.1
Agriculture	81	1.0

3.2.1.2 Water Quality Data

Water quality data for the Watershed were collected from IEPA and CMAP.

Monitoring Data. Section 3.1.1.2 (Monitoring Data) discusses water quality data collected in the Upper Salt Creek Watershed. The Data is collected from sites on the Mainstem only, but since the West Branch subwatershed feeds into the Mainstem upstream of the Busse Woods monitoring site, the data gives an approximation of the general conditions of the West Branch subwatershed as well.

National Pollutant Discharge Elimination System (NPDES) Permit. There is one permitted point source discharges within the subwatershed. The permitted discharge is associated with the District's Egan Water Reclamation Plant (IL0036340).

TABLE 3.2.3
Point Source Dischargers in West Branch Area

Name	NPDES	Community	Receiving Waterway
MWRDGC Egan Wastewater Treatment Plant	IL0036340	Cook County Forest Preserve	West Branch

Note: NPDES facilities were identified from the USEPA Water Discharge Permits Query Form at http://www.epa.gov/enviro/html/pcs/pcs_query_java.html.

Municipalities discharging to the West Branch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

Impaired Waterways. As stated in Section 3.1.1.2 (Impaired Waterways), the 2006 IEPA *Illinois Integrated Water Quality Report and Section 303(d) List* lists Upper Salt Creek on the impaired waterways list. The entirety of Upper Salt Creek is categorized as 'Not Supporting' for aquatic life, fish consumption, and primary contact uses.

Total Maximum Daily Loads (TMDLs). As stated in Section 3.1.1.2 (Total Maximum Daily Loads), an 8 percent reduction in chloride load, a 56 percent reduction in Carbonaceous Biochemical Oxygen Demand (CBOD) load, and a 38 percent reduction in ammonia nitrogen load are needed to meet the maximum daily load of Salt Creek. The report lists high nutrient concentrations (from runoff, wastewater treatment plant effluent, and storm sewer overflow discharges), high CBOD, and impoundments as major causes of low dissolved oxygen concentrations.

3.2.1.3 Wetland and Riparian Areas

Figures 2.3.8.1 and 2.3.8.2 contain mapping of wetland and riparian areas in the Upper Salt Creek Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping in addition to observations made in the field during site visits. NWI data includes roughly 8,000 acres of wetland areas in the West Branch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.2.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated in the revised floodplains. The entire Upper Salt Creek Watershed is mapped in detail in the DFIRM mapping update. Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.2.1.5 Stormwater Problem Data

Table 3.2.4 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities to the District. Problems are classified in Table 3.2.4 as regional or local. This classification is based on a process described in Section 2.2 of this report.

TABLE 3.2.4
Community Response Data for West Branch

Prob. ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
6	Hoffman Estates	Stream Maintenance, Streambank Erosion	Between Apple St. and Basswood St.	Streambank erosion	Regional	Erosion problem does not threaten structures, not addressed by DWP.
10	Schaumburg	Flooding	Ditch along Tower Rd. and State Parkway	Flooding	Local	Although the specific problem is local, recommended alternative Project SCWB-52 will lower peak WSEL at this location.
11	Schaumburg	Streambank Erosion	East of Schaumburg Village Hall; including parts of the West Branch and West Branch Tributaries 3 and 5	Erosion	Regional	Erosion problem does not threaten structures, not addressed by DWP.
19	IDOT	Flooding	Golf Rd. and Plum Grove Rd.	Pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
46	Schaumburg	Flooding	Ditch along Tower Rd. and State Parkway	Have study	Local	Although the specific problem is local, recommended alternative Project SCWB-52 will lower peak WSEL at this location.
47	Schaumburg	Flooding	Niagara Ave. and Sunset Dr.	Study in progress	Local	Problem not located on a regional waterway. This is a local problem.

3.2.1.6 Near-Term Planned Projects

The subwatershed has one near-term planned project that is included in the hydraulic model as part of the baseline runs. This area, discussed as problem areas 10 and 46 within the Village of Schaumburg above, currently experiences repeated flooding of the ditch along State Parkway and encroachment of floodwaters upon adjacent buildings. This project, located on the West Branch, involves moving the weir control structure for the pond in the commercial complex near the intersection of State Parkway and Tower Road. Currently, this control structure is located in the middle of the parkway between northbound and southbound traffic. The planned project moves the weir upstream of the parkway to minimize overbank flooding in the parkway and onto the roadway.

3.2.2 Watershed Analysis

3.2.2.1 Hydrologic Model Development

Subbasin Delineation. The West Branch subwatershed was delineated based upon LiDAR topographic data developed by Cook County. Thirty-two subbasins were delineated for the area, with an average subbasin area of 243 acres and a total drainage area of 12.2 square miles.

Hydrologic Parameter Calculations. Curve Numbers were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

The time of concentration and routing coefficient were determined as discussed in Section 1.3.2.1.

3.2.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. As discussed in section 3.1.2.2, several existing models were available for this watershed. The HEC-2 model created by the IDNR in 1996 was used as the base model for the HEC-RAS model. Refer to section 3.1.2.2 for additional details regarding the model development phase and general model information.

Boundary Conditions. As mentioned in Section 1.3.6.3, since the 3 subwatersheds were combined in one model, only one boundary condition was necessary for the model setup. The downstream boundary condition at the DuPage County line was developed from the flows and stages presented in the current Cook County FIS for Upper Salt Creek.

3.2.2.3 Calibration and Verification

As described in Section 3.1.2.3, the watershed models were calibrated using two USGS stream flow gauges located on the Upper Salt Creek Mainstem. Calibration and Verification was completed using data from and September 13, 2008 and August 19, 2007 rain events, respectively. The Clark Unit Hydrograph method using an AMC of 1 was selected as the best fit for the storms. Values of $R/(T_c+R)$ of 0.6 for the Mainstem and Arlington Heights Branch and 0.9 for the West Branch were used to determine the storage coefficient and time of concentration used in each area.

While no stream flow gauges were available in the Arlington Heights Branch, both USGS gauges are located downstream of the junction of the Arlington Heights Branch with the Mainstem and therefore allowed for calibration of the Arlington Heights Branch.

3.2.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.2.1 shows inundation areas in the West Branch subwatershed produced by the hydraulic model for the 100-year, 24 hour inundation boundary.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions on the watershed. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storm events.

3.2.2.5

3.2.3 Development and Evaluation of Alternatives

3.2.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.2.5 summarizes problem areas identified through modeling of the West Branch subwatershed.

TABLE 3.2.5
Modeled Problem Definition for West Branch

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA52	Village of Schaumburg at State Parkway and Tower Rd.	100-, 50-, 25-	10, 46	Project SCWB-52 created

3.2.3.2 Damage Assessment

Damages were defined following the protocol established in Chapter 6.6 of the CCSMP. No erosion damages or recreation damages due to flooding were identified for the subwatershed. Transportation damages were estimated as 15 percent of property damages. Table 3.2.6 lists the damage assessment for existing conditions.

TABLE 3.2.6
Estimated Damages for West Branch

Damage Category	Estimated Damage ($)	Description
Property	305,000	
Erosion	0	
Transportation	46,000	Assumed as 15% of property damage due to flooding

3.2.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in the subwatershed. Increased conveyance or storage were identified as the principal technologies applicable for addressing the existing stormwater problems.

3.2.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.2.7 summarizes flood control alternatives developed for the West Branch.

TABLE 3.2.7
Flood Control Alternatives for West Branch

Alternative	Location	Description
SCWB-52	Village of Schaumburg along State Parkway and Tower Road	The project involves lowering the weirs at the detention basin upstream of Woodfield Road and at Tower Rd, expanding and shortening the culvert under State Parkway at the intersection of Tower and creating an open channel ditch along State Parkway to replace the shortened culvert

SCWB-52 includes lowering the weir elevation at the detention basin upstream of Woodfield Road that will provide an additional 26 acre-feet of storage, increasing the size of the culvert at Remington Road, expanding and shortening the culvert under State Parkway and creating an open channel ditch, and lowering the weir that controls the pond in the industrial complex near the intersection of State Parkway and Tower Road. This project extends the benefits derived from the near-term project planned by the Village of Schaumburg and described in Section 3.2.1.6. The model results show that this project requires no compensatory storage to mitigate downstream effects.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for this subwatershed.

3.2.3.5 Alternative Evaluation and Selection

Alternative SCWB-52 was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The alternative resulted in reduces stage along the waterway and is recommended. Table 3.2.8 provides a comparison of the modeled maximum WSEL and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.2.8
West Branch Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		SCUP-52	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Northwest Tollway	36002	734.69	136	734.39	140
Wiley Road	35702	731.28	137	730.69	141
State Parkway Weir	33469	730.14	148	729.45	150
State Parkway Culvert	33361	729.76	146	728.69	149
Remington Road	32343	729.33	150	727.83	155
Golf Road	31403	727.51	167	726.49	176
American Lane	29659	727.15	178	725.94	189

TABLE 3.2.8
West Branch Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		SCUP-52	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Northwest Tollway	36002	734.69	136	734.39	140
Basin Outlet	27627	726.81	239	725.52	261
Woodfield Road	27385	724.26	247	724.37	269
Thacker Street	24395	720.06	539	720.09	564

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Upper Salt Creek DWP.

The alternative in Table 3.2.7 was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Table 3.2.9 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data.

3.2.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. Table 3.2.9 lists the alternatives analyzed in detail. Figure 3.2.2 schematically shows the proposed improvements as well as a comparison of the with and without project inundation mapping.

TABLE 3.2.9
West Branch Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Communities Involved
SCWB-52	Lower weirs on two detention basins, increase capacity of bridge and create ditch in place of culvert.	0.27	351,000	1,149,000	3	No Impact	Yes	Schaumburg

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.3 Arlington Heights Branch

The Arlington Heights Branch of the Upper Salt Creek is a natural waterway though the northern part of the watershed. The creek and its tributaries are about 12.6 miles long and they drain an area of 13.9 square miles. Table 3.3.1 lists the communities draining to the Upper Salt Creek Arlington Heights Branch subwatershed.

TABLE 3.3.1
Communities Draining to Arlington Heights Branch

Community	Tributary Area (mi^2)
Palatine	7.02
Unincorporated/Forest Preserve	3.08
Rolling Meadows	2.17
Arlington Heights	0.87
Inverness	0.47
Barrington	0.21
Deer Park	0.11

Between 1981 and 1986, two large flood control reservoirs were constructed in the subwatershed providing approximately 1,000 acre-feet of flood storage. The two reservoirs: Twin Lakes and Tom T. Hamilton were constructed based on a plan prepared by the NRCS and sponsored by the District.

TABLE 3.3.2
Land Use Distribution for Arlington Heights Branch

Land Use Category	Area (acres)	%
Residential	14,916	57.5
Commercial/Industrial	4,506.8	17.4
Forest/Open Land	3,971	15.3
Institutional	1,404	5.4
Transportation/Utility	889.2	3.4
Water/Wetland	180	0.7
Agricultural	69	0.3

The Twin Lakes Reservoir is located along the Arlington Heights Branch in the Village of Palatine and has a tributary area of 2,330 acres. The reservoir is formed by the embankment along Illinois Route-53. The reservoir is divided into two cells connected by twin 24-inch diameter pipes. High flows can also pass over a concrete weir that also serves as a parking lot for the recreational facilities. Flow enters the west cell of the reservoir through a culvert/weir combination and exits the same cell through a 10-foot by 12-foot box culvert under the expressway. An orifice/weir control structure limits flows through the box culvert. The emergency spillway is located on the far Southwest edge of the West pond.

The Tom T. Hamilton Reservoir is located on the Arlington Heights Branch in the Village of Palatine and has a tributary area of about 3,600 acres. The reservoir is located adjacent to the stream channel. A bypass control structure on the stream restricts the downstream flow; the remaining flow passes over a weir into the reservoir. After a storm event the reservoir is pumped down. The bypass control structure has been modified from the original design to force water into the reservoir more frequently than originally designed.

Table 3.3.2 lists the land use breakdown by area within the Upper Salt Creek Arlington Heights Branch subwatershed. Figure 3.3.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure and are discussed in the following subsections.

3.3.1 Sources of Data

3.3.1.1 Previous Studies

Since the mid-1950's numerous public organizations have produced reports describing flooding in the Watershed and developed possible solutions. All of the reports discussed in Section 3.1.1.1 evaluate either the entire Upper Salt Creek Watershed (Mainstem, Arlington Heights Branch and West Branch subwatersheds) or a smaller part of it. Ultimately, all three subwatersheds join as one at the Busse Woods Reservoir so all reports are relevant for the Arlington Heights Branch subwatershed.

3.3.1.2 Water Quality Data

Water quality data for the Watershed were collected from IEPA and CMAP.

Monitoring Data. Section 3.1.1.2 (Monitoring Data) discusses water quality data collected in the Upper Salt Creek Watershed. The Data is collected from sites on the Mainstem only, but since the Arlington Heights subwatershed feeds into the Mainstem, the data gives an approximation of the general condition of the Arlington Heights Branch subwatershed as well.

National Pollutant Discharge Elimination System (NPDES) Permit. There are two permitted point source discharges within the subwatershed. The permitted discharges are associated with Arlington International Racecourse (IL0063487) in Arlington Heights and Prairie Material Sales-Yard 35 (IL0066427) in Palatine.

TABLE 3.3.3
Point Source Dischargers in Arlington Heights Branch Area

Name	NPDES	Community	Receiving Waterway
Arlington International Racecourse	IL0063487	Arlington Heights	Arlington Heights Branch
Prairie Materials Sales – Yard 35	IL0066427	Rolling Meadows	Arlington Heights Branch

Municipalities discharging to the Arlington Heights Branch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

Impaired Waterways. As stated in Section 3.1.1.2 (Impaired Waterways), the 2006 IEPA *Illinois Integrated Water Quality Report and Section 303(d) List* lists Upper Salt Creek on the impaired waterways list. The entirety of Upper Salt Creek is categorized as 'Not Supporting' for aquatic life, fish consumption, and primary contact uses.

Total Maximum Daily Loads (TMDLs). As stated in Section 3.1.1.2 (Total Maximum Daily Loads) , an 8 percent reduction in chloride load, a 56 percent reduction in Carbonaceous Biochemical Oxygen Demand (CBOD) load, and a 38 percent reduction in ammonia nitrogen load are needed to meet the maximum daily load of Salt Creek. The report lists high nutrient concentrations (from runoff, wastewater treatment plant effluent, and storm sewer overflow discharges), high CBOD, and impoundments as major causes of low dissolved oxygen concentrations.

3.3.1.3 Wetland and Riparian Areas

Figures 2.3.8.1 and 2.3.8.2 contain mapping of wetland and riparian areas in the Upper Salt Creek Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping in addition to observations made in the field during site visits. NWI data includes roughly 9,000 acres of wetland areas in the Arlington Heights Branch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.3.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated in the revised floodplains. The entire Upper Salt Creek Watershed is mapped in detail in the DFIRM mapping update. Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.3.1.5 Stormwater Problem Data

Table 3.3.4 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities to the District. Problems are classified in Table 3.3.4 as regional or local. This classification is based on a process described in Section 2.2 of this report.

TABLE 3.3.4
Community Response Data for Arlington Heights Branch

Prob. ID	Municipali-ty	Problems as Reported by Local Agency	Location	Problem Descrip-tion	Local/ Regional	Resolution in DWP
20, 21, 22, 24, 30, 34, 35, 36	IDOT	Flooding	Various	Pavement Flood-ing	Local	Problems not lo-cated on a regional waterway. These are local problems.
41	Palatine	Flooding	Palanois Park	CSO	Local	Problem not located on a regional wa-terway. This is a local stormsewer problem.
42	Palatine	Flooding	Winston Park	Flooding – sewer	Local	Problem not located on a regional wa-terway. This is a local stormsewer problem.
44	Palatine	Flooding	Palatine Road at Wins-ton Drive	Flooding – sewer	Local	Problem not located on a regional wa-terway. This is a local stormsewer problem.
49	FPDCC	Water Quality	Lake-Cook and Quen-tin Road	Sump Pump Dis-charge into For-est Preserve	Local	No structural/ trans-portaton damages associated with problem area.
51	FPDCC	Erosion	Hillside and Ela Road	Erosion in Forest Preserve	Region-al	Erosion problem does not threaten structures, not ad-dressed in DWP.
54	Rolling Meadows	Flooding	Arlington Heights Branch north of Cen-tral Road	Street/Surface Flooding -- data from Sept. 2008 rainfall	Region-al	Model results did not confirm roadway or structure flooding due to a regional problem in this area.
55	Arlington Heights	Flooding	South of Rand Road, east of 53: includes Canterbury Ct, Roa-noke Dr, Raleigh St, Suffield Ct, Waverly Ct	Street/Surface Flooding -- data from Sept. 2008 rainfall	Local	Problem not located on a regional wa-terway. This is a local problem.

3.3.1.6 Near Term Planned Projects

This subwatershed does not contain any known near term planned projects.

3.3.2 Watershed Analysis

3.3.2.1 Hydrologic Model Development

Subbasin Delineation. The Arlington Heights Branch subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. Twenty-six subbasins were delineated for area, with an average subbasin area of 343 acres and a total drainage area of 13.9 square miles.

Hydrologic Parameter Calculations. Curve Numbers were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

The time of concentration and routing coefficient were determined as discussed in Section 1.3.2.1.

3.3.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. As discussed in section 3.1.2.2, several existing models were available for this watershed. The HEC-2 model created by the IDNR in 1996 was used as the base model for the HEC-RAS model. Refer to that section for additional details regarding the model development phase and general model information.

Boundary Conditions. As mentioned in Section 1.3.6.3, since the 3 subwatersheds were combined in one model, only one boundary condition was necessary for the model setup. The downstream boundary condition at the DuPage County line was developed from the flows and stages presented in the current Cook County FIS for Upper Salt Creek.

3.3.2.3 Calibration and Verification

As described in Section 3.1.2.3, the watershed models were calibrated using two USGS stream flow gauges located on the Upper Salt Creek Mainstem. Calibration and Verification was completed using data from and September 13, 2008 and August 19, 2007 rain events, respectively. The Clark Unit Hydrograph method using an AMC of 1 was selected as the best fit for the storms. Values of $R/(T_c+R)$ of 0.6 for the Mainstem and Arlington Heights Branch and 0.9 for the West Branch were used to determine the storage coefficient and time of concentration used in each area.

While no stream flow gauges were available in the Arlington Heights Branch, both USGS gauges are located downstream of the junction of the Arlington Heights Branch with the Mainstem and therefore allowed for calibration of the Arlington Heights Branch.

3.3.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.3.1 shows inundation areas in the Arlington Heights subwatershed produced by the hydraulic model for the 100-year, 24 hour inundation boundary.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions on the watershed. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storm events.

Reservoir Operation. The existing District reservoirs within the Arlington Heights Branch subwatershed were evaluated during the existing conditions analysis. In general the reservoirs operated as designed during the 100-year event. The Twin Lakes reservoir fills both lakes to just below the overflow spillway during this event. The Tom Hamilton reservoir also fills to near capacity without backing up over the inflow weir. This reservoir, being an offline reservoir, is pumped out after the storm event. Originally, there were three pumps provided at the pumping station, two large pumps for dewatering of the reservoir and a smaller pump to drain the permanent pool for maintenance. However, during initial operations it was determined that the discharge from the dewatering pumps was causing problems in the receiving stream. Since that time only the smaller pump has been used for dewatering. This pump is operated manually from the reservoir site based on direct observation of the water levels in the channel at the station. There is no coordination required with the dewatering of the other pumped reservoir in the Upper Salt Creek Watershed as the dewatering flows are relatively small and the reservoirs are on different branches.

3.3.3 Development and Evaluation of Alternatives

3.3.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.3.5 summarizes problem areas identified through modeling of the Arlington Heights Branch subwatershed.

TABLE 3.3.5
Modeled Problem Definition for Arlington Heights Branch

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA50	Between Dundee Rd. and Cherrywood Dr.	100-, 50-, 25-, 10-, 5-	-	Project SCAH-50 created

3.3.3.2 Damage Assessment

Damages were defined following the protocol established in Chapter 6.6 of the CCSMP. No erosion damages or recreation damages due to flooding were identified for the subwatershed. Transportation damages were estimated as 15 percent of property damages. Table 3.3.6 lists the damage assessment for existing conditions.

TABLE 3.3.6
Estimated Damages for Arlington Heights Branch

Damage Category	Estimated Damage ($)	Note
Property	1,385,000	
Erosion	0	
Transportation	208,000	Assumed as 15% of property damage due to flooding

3.3.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in the subwatershed. Increased conveyance or storage were identified as the principal technologies applicable for addressing the existing stormwater problems.

3.3.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.3.7 summarizes flood control alternatives developed for the Arlington Heights Branch.

SCAH-50 includes expanding the capacity of the culvert under Dundee Road and replacing the box culverts under Cherrywood Drive. In addition, the channel between these road crossings is widened. This project significantly reduces the peak water surface elevation in this area, removing all structures from the 100-year inundation area..

TABLE 3.3.7
Flood Control and Streambank Stabilization Alternatives for Arlington Heights Branch

Alternative Number	Location	Description
SCAH-50	Village of Palatine between Dundee Rd and Cherrywood Drive.	Expanding the capacity of the culvert under Dundee Road and Cherrywood Drive. In addition, the channel between these road crossings is widened to a 30 foot bottom depth

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for this subwatershed.

3.3.3.5 Alternative Evaluation and Selection

Alternative SCAH-50 was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The alternative resulted in reduces stage along the waterway and is recommended. Table 3.3.8 provides a comparison of the modeled maximum WSEL and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.3.8
Arlington Heights Branch Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		SCAH-50	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
1/4 Mile upstream of Dundee Road	41553	767	473.67	767.34	478
Dundee Road	40248	767	495.03	763.33	501
Cherrywood Drive	39330	761	497.83	759.31	504
1/4 Mile downstream of Cherrywood Drive	37918	756	501.72	756.23	507

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Upper Salt Creek DWP.

The alternative in Table 3.3.7 was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Table 3.3.9 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data.

3.3.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. Table 3.3.9 lists the alternative analyzed in detail. Figure 3.3.2 compares the existing 100-year inundation boundary through area with the boundary after implementation of the project and also shows the location of the suggested improvements.

TABLE 3.3.9
Arlington Heights Branch Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Communities Involved
SCAH-50	Widen channel and increase the conveyance capacity of two culverts.	0.81	1,593,000	1,707,000	18	No Impact	Yes	Palatine

Note: Net Benefits values do not include local benefits or non-economic benefits.

4. Watershed Action Plan

This section summarizes the DWP recommendations. The recommendations and supporting information will be considered by the District's Board of Commissioners in their prioritization of a countywide Stormwater Capital Improvement Program (CIP). The recommendations within the DWP consist of maintenance activities (Section 4.1) and recommended capital improvements (Section 4.2).

4.1 Watershed Maintenance Activities

Review of reported stormwater problem data indicated that certain types of maintenance activities would be helpful in preventing these stormwater problems. The District, through its maintenance activities, has been actively removing blockages such as tree limbs and woody debris from channels throughout Cook County. Local communities have reported benefits from these maintenance activities. It is recommended that the District maintenance activities be continued to address ongoing future maintenance needs.

Sedimentation is a dynamic process that is affected by soil protective measures taken in upland tributary areas as well as dynamic streambank conditions. The District's Watershed Management Ordinance will define standard practices for erosion protection on construction sites. Best management practices in upland areas should be paired with stream maintenance measures to reduce sediment delivered to waterways to reduce the need for extensive dredging programs.

Stormwater improvement projects recommended in the Upper Salt Creek DWP including culvert and bridge replacement, weir modifications and channel improvements, will require ongoing maintenance after construction. Costs associated with maintenance over a 50-year life-cycle period were included in cost estimates. It is recommended that the District develop maintenance plans for capital improvements, and where applicable, execute agreements with local governments, delegating certain maintenance responsibilities. Maintenance agreements will follow current District practice, where the District is responsible for operation and maintenance of structural, electrical, and mechanical facilities and grounds are the responsibility of partnering organizations.

4.2 Recommended Capital Improvements

Table 4.2.1 lists all recommended improvements for the Upper Salt Creek DWP. The District will use data presented here to support prioritization of a countywide stormwater CIP.

4.3 Implementation Plan

Alternatives listed in Table 4.2.1 can be constructed independently. The data presented in Table 4.2.1, along with non-economic factors, will allow the District to prioritize its CIP and to implement projects. A number of alternatives in Table 4.2.1 require the acquisition of land that currently may be unavailable. It is recommended that upon selecting an alternative for implementation, the District identify land acquisition needs and procedures.

TABLE 4.2.1
Upper Salt Creek Watershed Prioritization Matrix

Project	B/C Ratio	Total Benefits	Total Project Cost[1]	Probable Construction Cost	Relative Damage Averted 25% 50% 75%	Acreage Removed from Inundation	Wetland or Riparian Areas Impacted	Cumulative Structures Protected	Implementation[1] Time (Months)	Water Quality Benefit	Communities Involved
SCUP-49	0.15	$1,701,000	$11,030,000	$6,393,000		39.3	11.7	61	18	No Impact	Palatine
SCUP-56	0.12	$166,000	$1,403,000[2]	$956,500		11.9	0.0	0	12	No Impact	Rolling Meadows
SCAH-50	0.93	$1,593,000	$1,707,000	$975,000		2.1	2.1	18	8	No Impact	Palatine
SCWB-52	0.31	$351,000	$1,149,000	$665,000		6.8	2.2	3	6	No Impact	Schaumburg

Property Damage Erosion Transportation Recreation

1. Implementation time includes construction time, but does not include time for design, permitting or land acquisition.
2. Total Project Cost includes $1,253,000 required for necessary local improvements.

5. Summary and Conclusions

The Upper Salt Creek DWP was developed in coordination with the Upper Salt Creek WPC. The coordination focused on integrating community knowledge of stormwater problems and ideas for feasible solutions into the District's regional stormwater plan. All stormwater problem data received from stakeholders was recorded in a spatial database, and classified as local or regional according to the criteria defined in Section 1. Hydrologic and hydraulic models were developed to estimate flow and stage along regional waterways and assess the frequency and depth of flooding problems for a range of modeled recurrence intervals. Inundation mapping was developed for the 2-, 5-, 10, 25, 50, 100-year, and 500-year modeled storm events, identifying areas estimated to be at risk of flooding. Modeled water depths and inundation mapping were used to help estimate damages due to flooding within each tributary.

Stormwater improvements were developed to address regional problems throughout the Upper Salt Creek Watershed. Appropriate tributary-specific technologies were screened considering their applicability for addressing problem areas, constructability in the area required, and regulatory feasibility. Damage estimates for proposed alternatives were performed to evaluate the alternative's effectiveness at reducing regional stormwater damages. The difference in damages between existing and alternative conditions was quantified as the alternative's benefit. In addition to numeric benefits, several other criteria were noted for each alternative, such as the number of structures protected, water-quality benefit, and wetland/riparian areas affected. Conceptual level cost estimates were developed to estimate the construction and maintenance cost of proposed alternatives over a 50-year period. The estimated benefits were divided by the conceptual cost to develop a B/C ratio for each alternative.

Table 5.1 illustrates the potential of alternatives within the DWP to address regional damages throughout the watershed. As an example, the recommended the West Branch alternatives address 100 percent of estimated damages, which corresponds to a benefit of $351,000.

Recommended alternatives are estimated to reduce regional damages by $3,811,000 over a 50-year period, at an estimated cost of $15,289,000. Estimated damage reductions result from proposed stormwater improvements that increase conveyance to receiving systems, only if increased flows do not cause downstream damages. Floodproofing alternatives, though feasible for addressing isolated shallow flooding issues, are not included in the summary statistics due to the individualized way in which such measures would be implemented. All of the projects address damages at all levels of frequency up to and including the 100-year flood.   As discussed in the previous chapters the recommended projects were focused on concentrations of damaged structures to make the projects as cost effective and beneficial as possible. It was not feasible to develop individual projects to protect isolated or small groups of structures. These are more easily addressed using flood proofing or acquisition methods that are outside of the scope of this plan

TABLE 5.1
Upper Salt Creek Watershed Alternative Summary

Watershed	Existing Conditions Damages	Benefits from Recommended Alternatives	Percent of Damages Addressed	Benefit Cost Ratio
Upper Main Stem	$6,367,000	$1,867,000	29%	0.15
Arlington Heights Branch	$1,593,000	$1,593,000	100%	0.93
West Branch	$351,000	$351,000	100%	0.31
Total	$8,311,000	$3,811,000	46%	0.25

Stormwater problems, whether identified by stakeholders or identified by modeling of intercommunity waterways, indicate a need for regional stormwater management solutions throughout the Upper Salt Creek Watershed. Although problem areas are concentrated in the more intensively developed central section of the watershed, stormwater problems exist throughout the watershed. If constructed, the recommended alternatives in Table 4.2.1 are expected significantly to reduce stormwater damages, although damages are expected to persist within the watershed even following construction of those projects. However, implementation of the recommended projects should reduce the number of homes and businesses adversely affected by flooding, and also the severity of damages. Communities can continue to work toward reducing stormwater damage by ensuring that development is responsibly managed with consideration given to potential stormwater impacts and the existing stormwater problems within the watershed.

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Final Report

Detailed Watershed Plan for the Upper Salt Creek Watershed: Volume 2

Prepared for

Metropolitan Water Reclamation District of Greater Chicago

November 2009

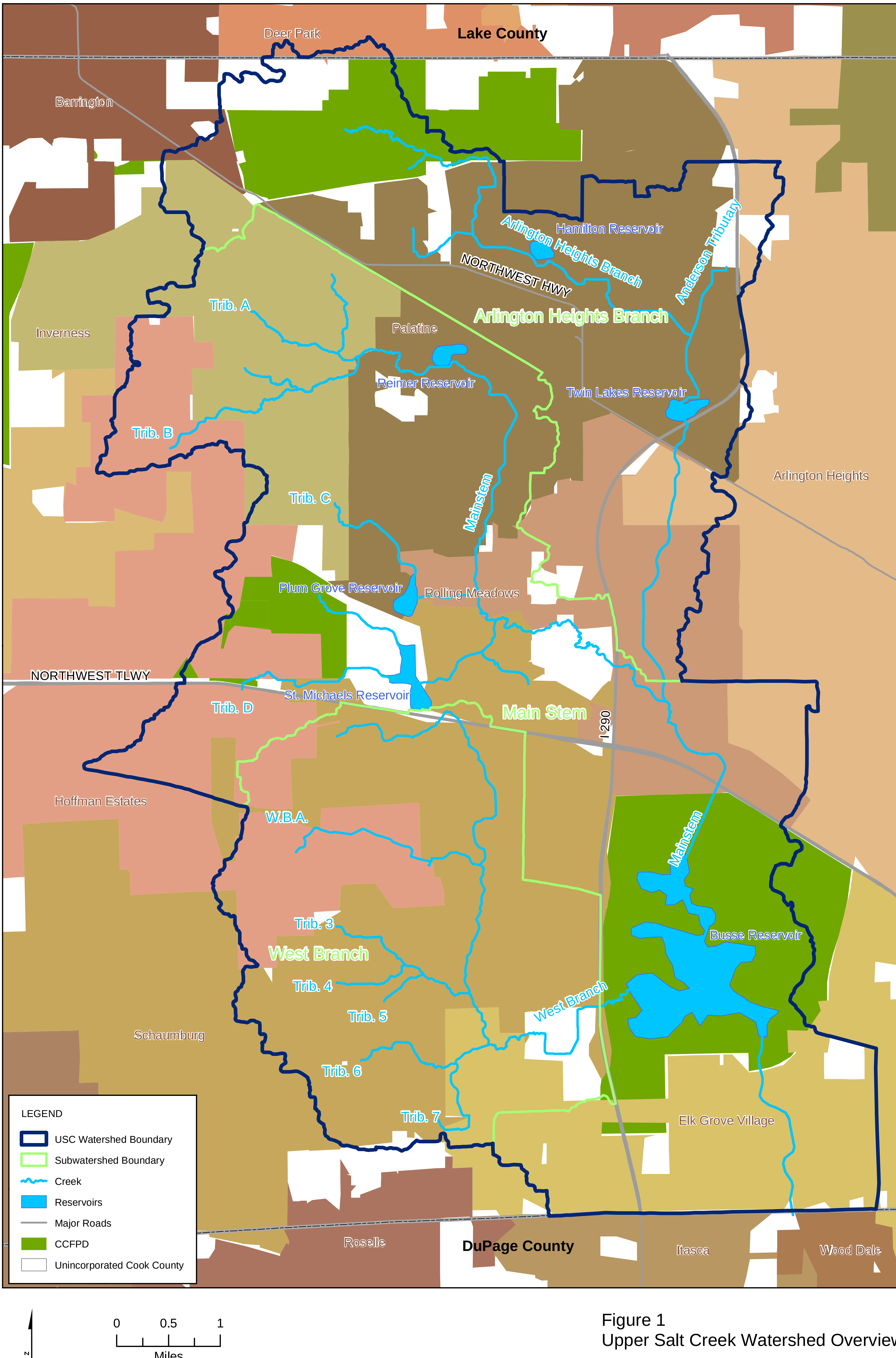

Figure 1
Upper Salt Creek Watershed Overview

MWH

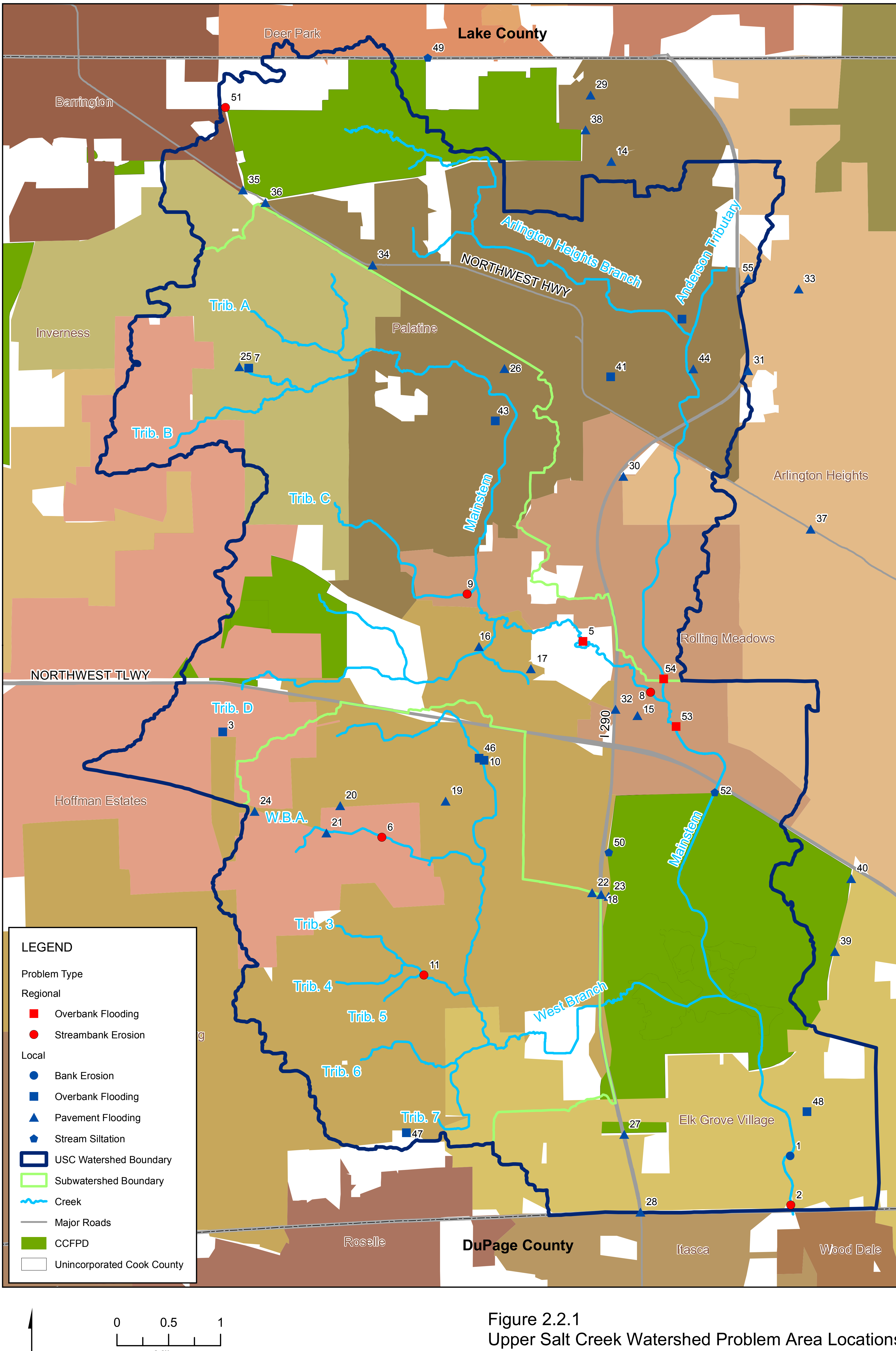

Figure 2.2.1
Upper Salt Creek Watershed Problem Area Locations

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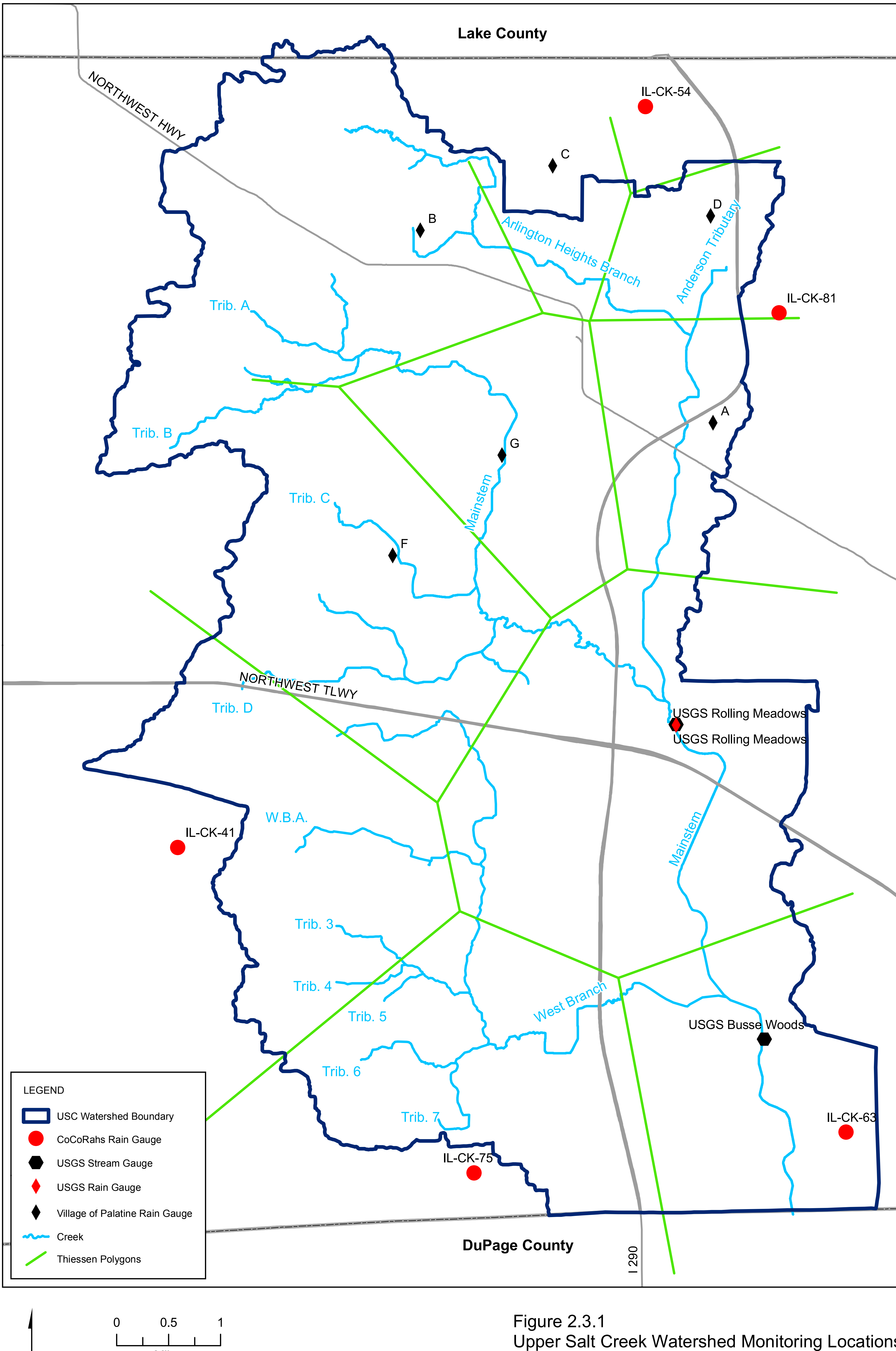

Figure 2.3.1
Upper Salt Creek Watershed Monitoring Locations

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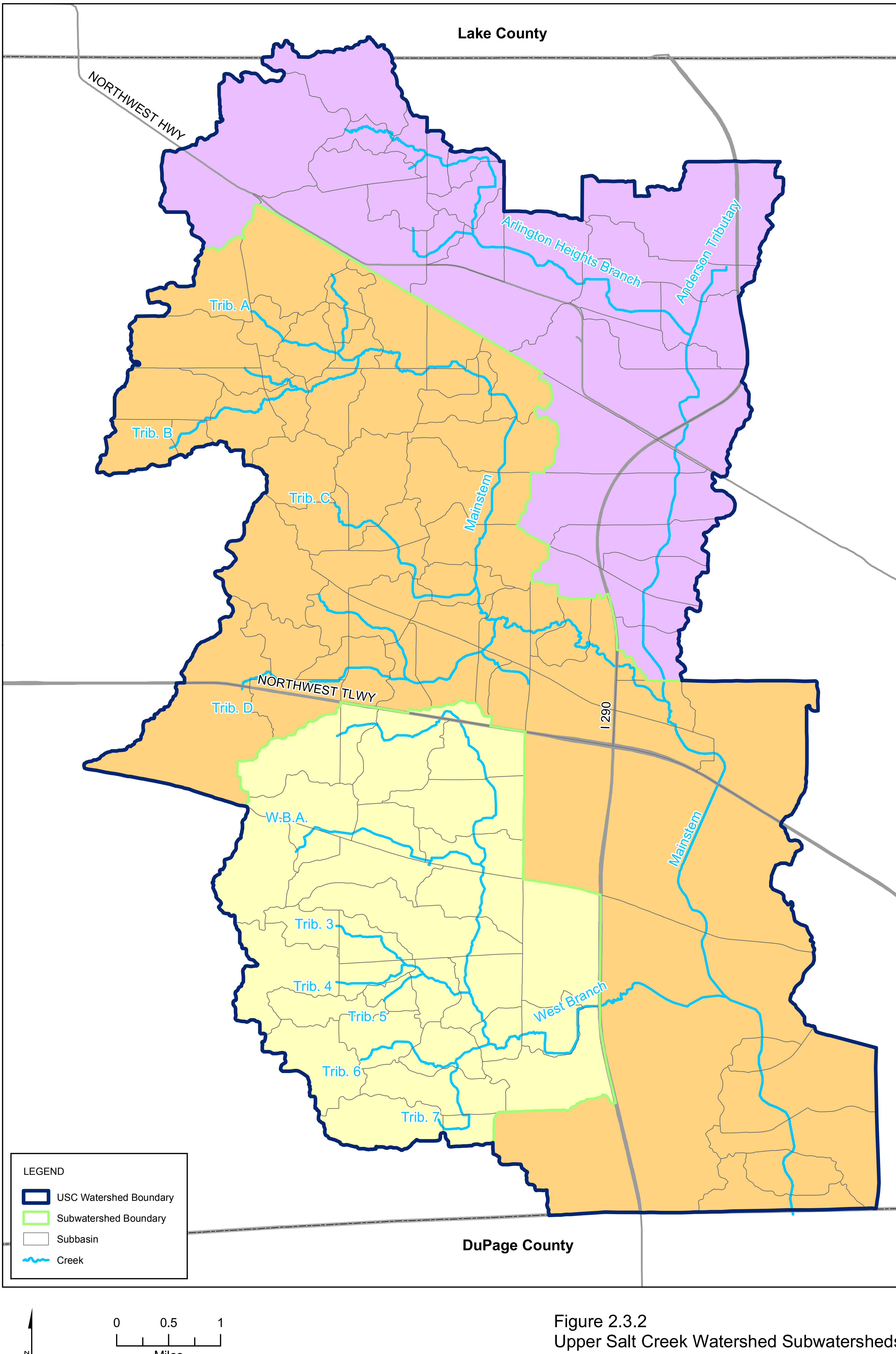

Figure 2.3.2
Upper Salt Creek Watershed Subwatersheds

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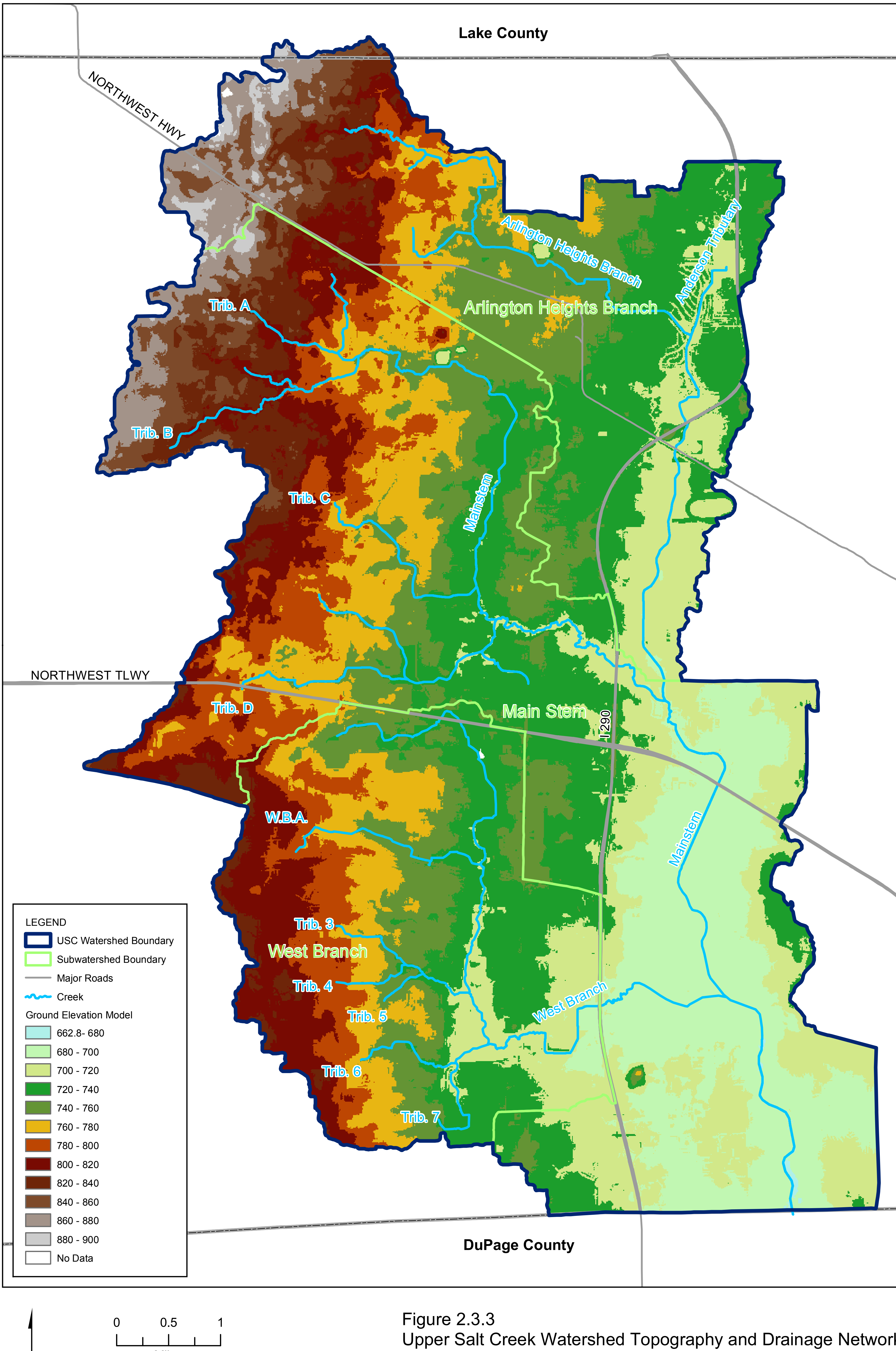

Figure 2.3.3
Upper Salt Creek Watershed Topography and Drainage Network

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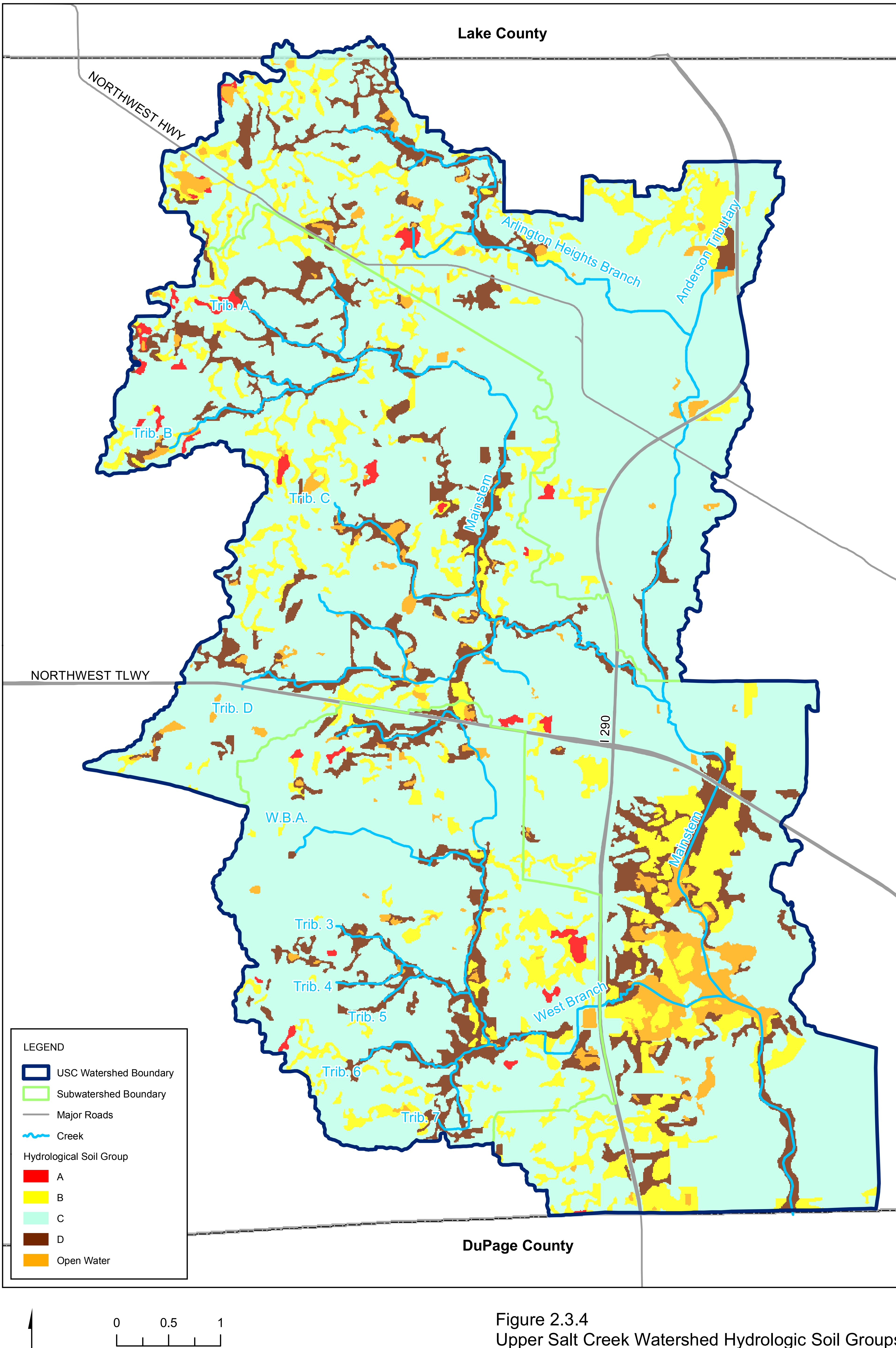

Figure 2.3.4
Upper Salt Creek Watershed Hydrologic Soil Groups

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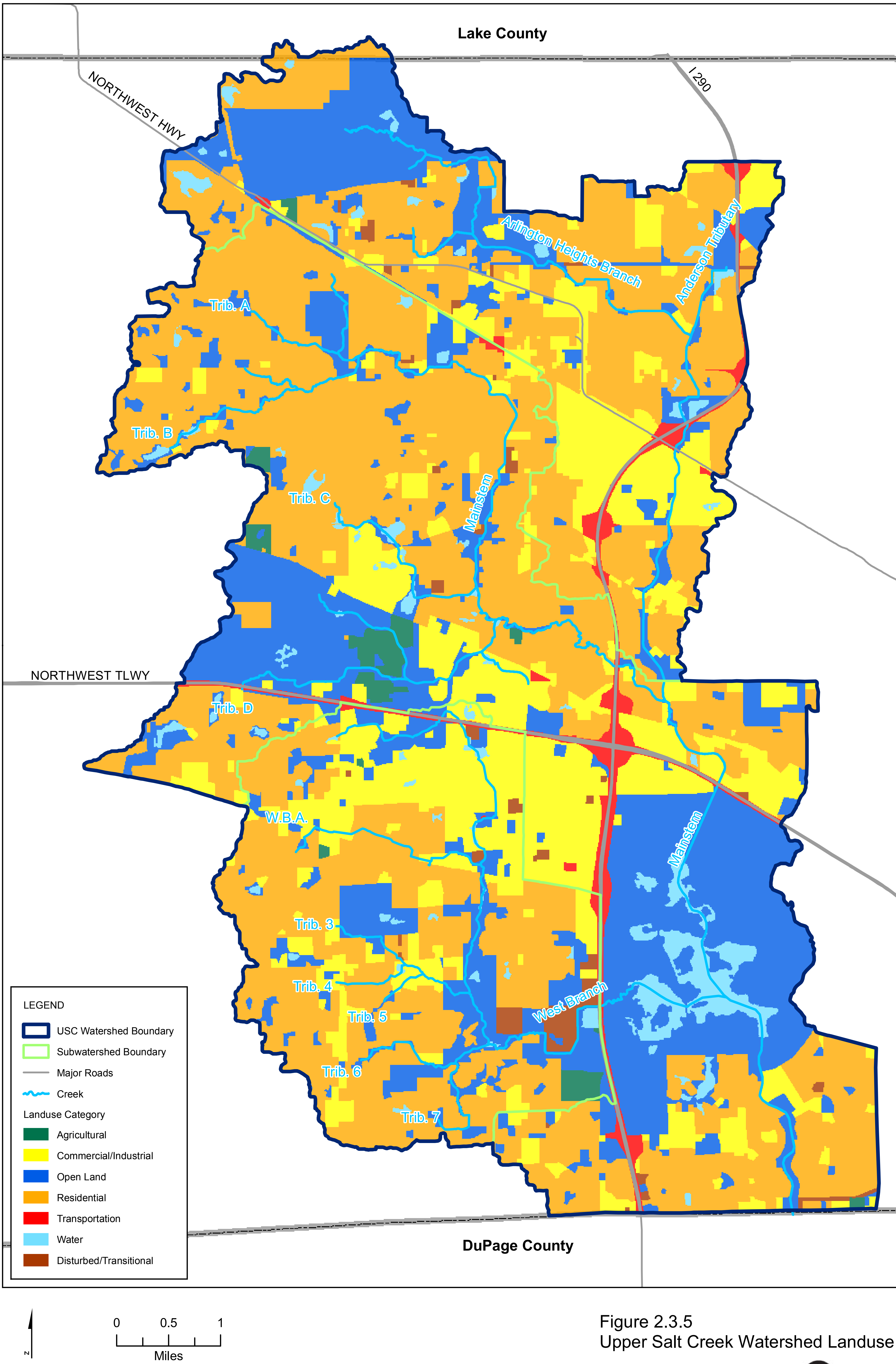

Figure 2.3.5
Upper Salt Creek Watershed Landuse

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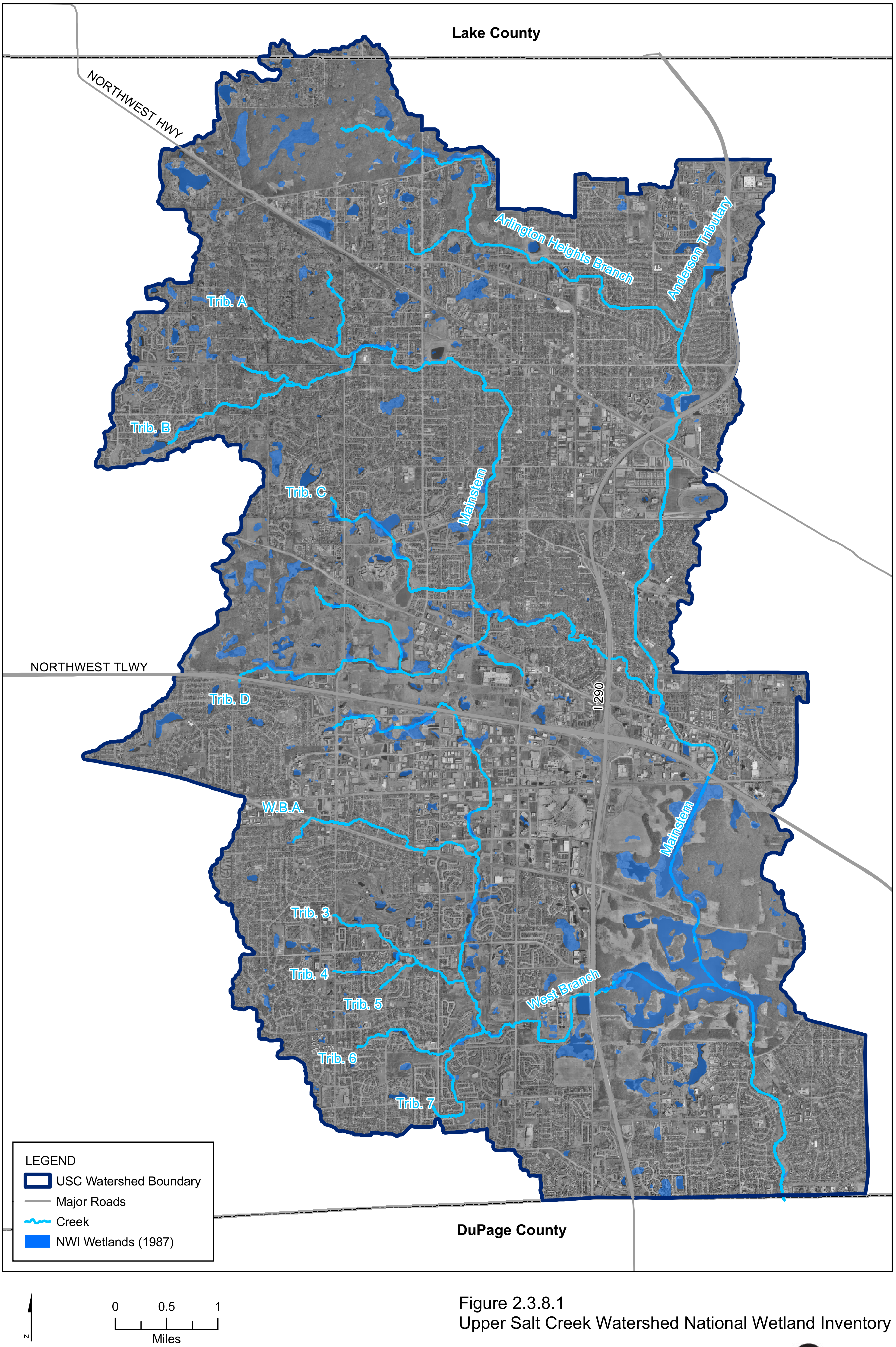

Figure 2.3.8.1
Upper Salt Creek Watershed National Wetland Inventory

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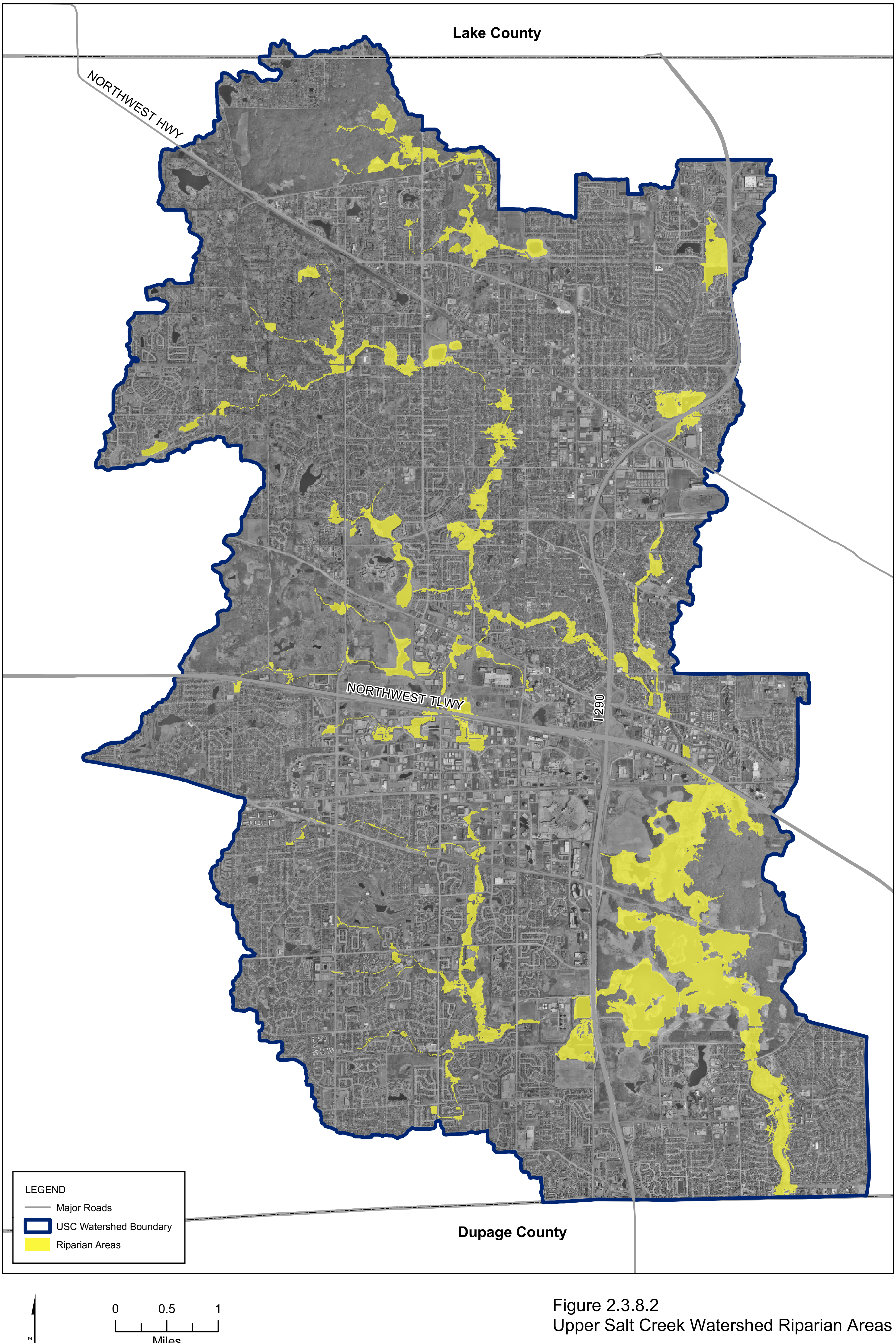

Figure 2.3.8.2
Upper Salt Creek Watershed Riparian Areas

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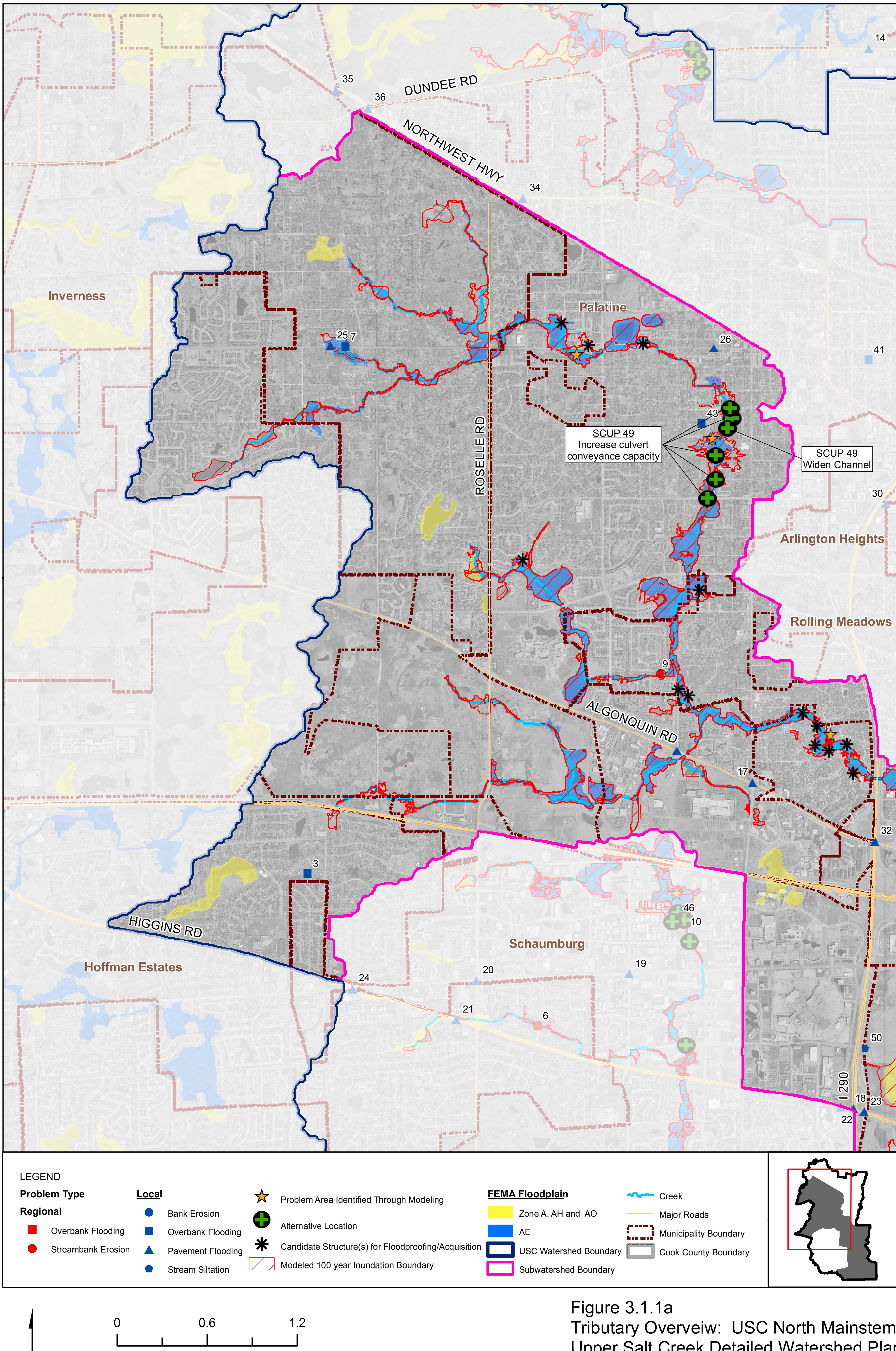

Figure 3.1.1a
Tributary Overveiw: USC North Mainstem
Upper Salt Creek Detailed Watershed Plan

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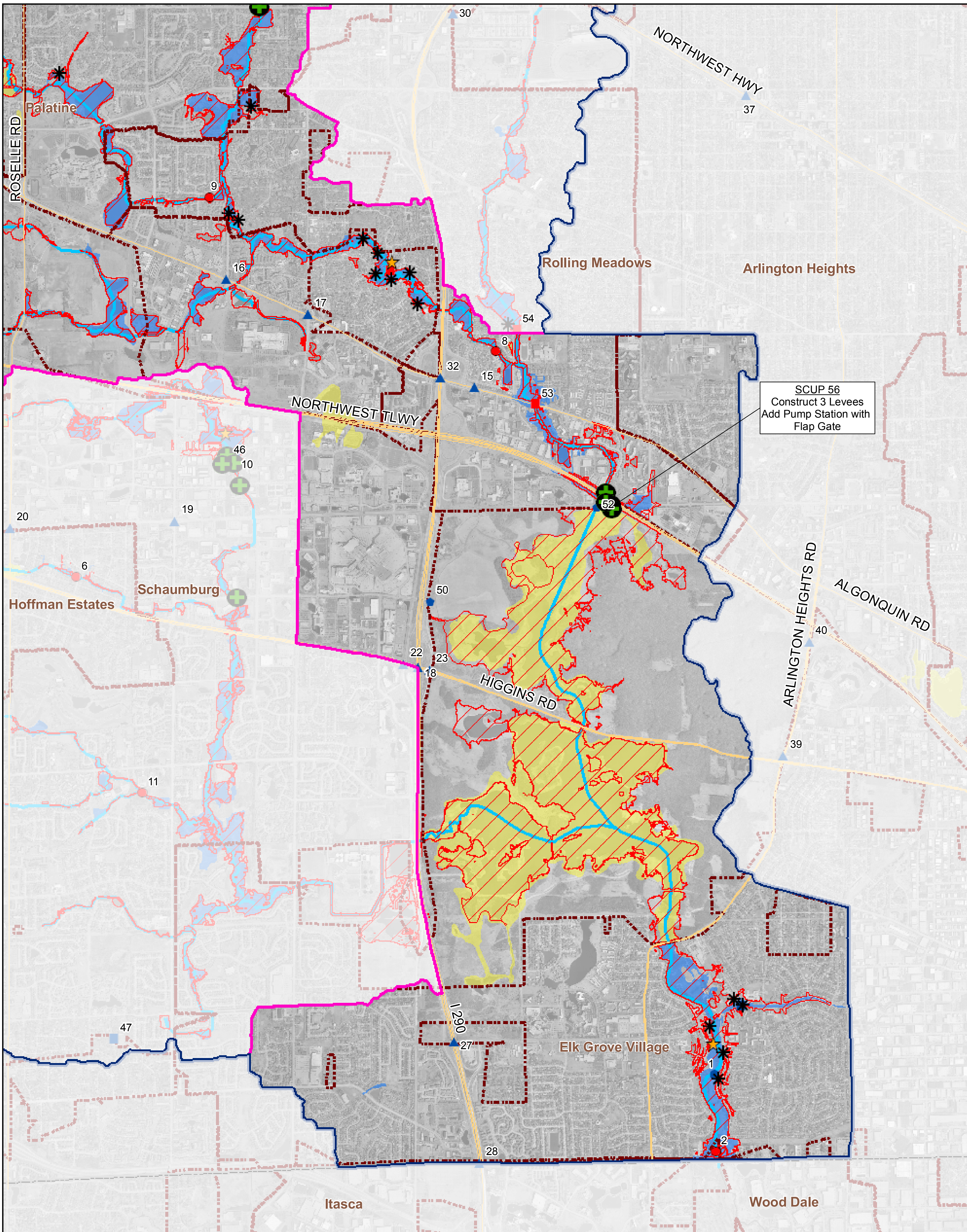


LEGEND

Problem Type

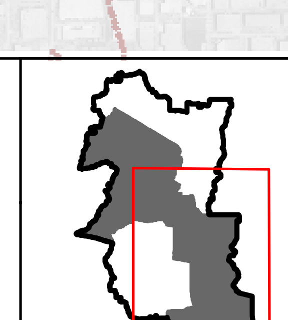
Regional
- Overbank Flooding
- Streambank Erosion

Local
- Bank Erosion
- Overbank Flooding
- Pavement Flooding
- Stream Siltation

- Problem Area Identified Through Modeling
- Alternative Location
- Candidate Structure(s) for Floodproofing/Acquisition
- Modeled 100-year Inundation Boundary

FEMA Floodplain
- Zone A, AH and AO
- AE
- USC Watershed Boundary
- Subwatershed Boundary

- Creek
- Major Roads
- Municipality Boundary
- Cook County Boundary

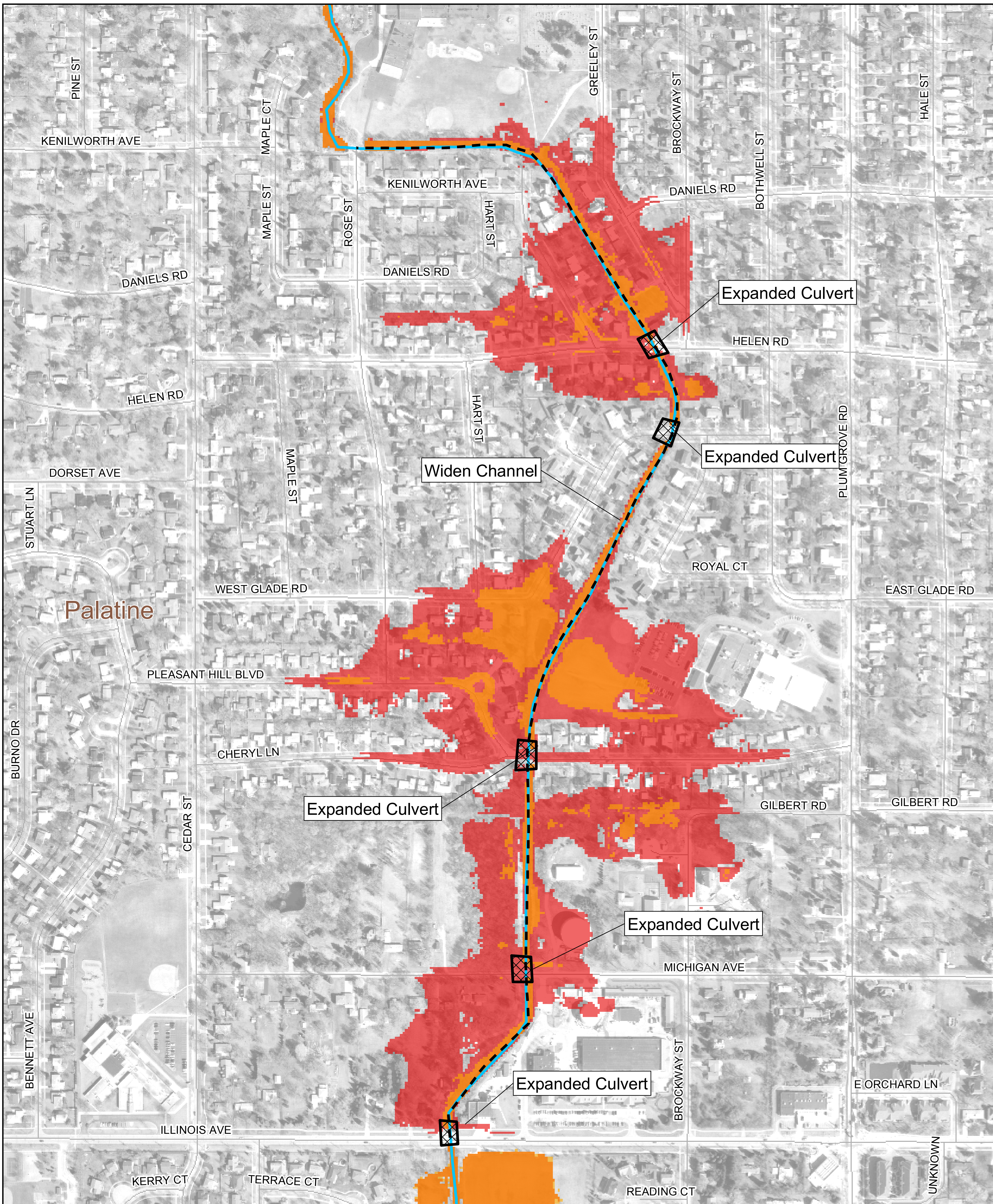


0 0.6 1.2

Miles

Figure 3.1.1b
Tributary Overveiw: USC South Main Stem
Upper Salt Creek Detailed Watershed Plan

MWH



Subwatershed: Main Stem Alternative: SCUP-49

Alternative Description:

Widen channel from Rose Street to Illinois Avenue and increase conveyance capacity of five bridges.

Conceptual Level Cost: $11,030,000 Benefits: $1,479,000

B/C Ratio: 0.13

LEGEND

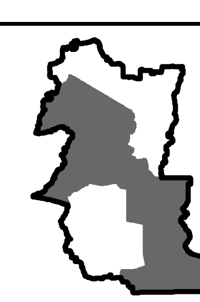
- Project Alternative Locations
- Channel Improvements
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project
- USC Watershed Boundary

Roadway

- Road
- Major Road
- Creek
- Municipality Boundary
- Cook County Boundary

0 400 800 Feet

Figure 3.1.2
USC Main Stem
Alternative SCUP-49
Existing and Alternative Inundation Areas
Upper Salt Creek Detailed Watershed Plan



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Subwatershed: Main Stem

Alternative: SCUP-56

Alternative Description:

Install pumping station with flap gate and construct three levees.

Conceptual Level Cost: $1,403,000 Benefits: $166,000

B/C Ratio: 0.12

LEGEND

- Project Alternative Locations
- Channel Improvements
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project
- USC Watershed Boundary

Roadway

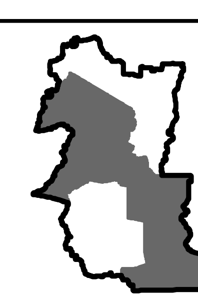
- Road
- Major Road
- Creek
- Municipality Boundary
- Cook County Boundary

0 400 800

Feet

N

Figure 3.1.3
USC Main Stem
Alternative SCUP-56
Existing and Alternative Inundation Areas
Upper Salt Creek Detailed Watershed Plan



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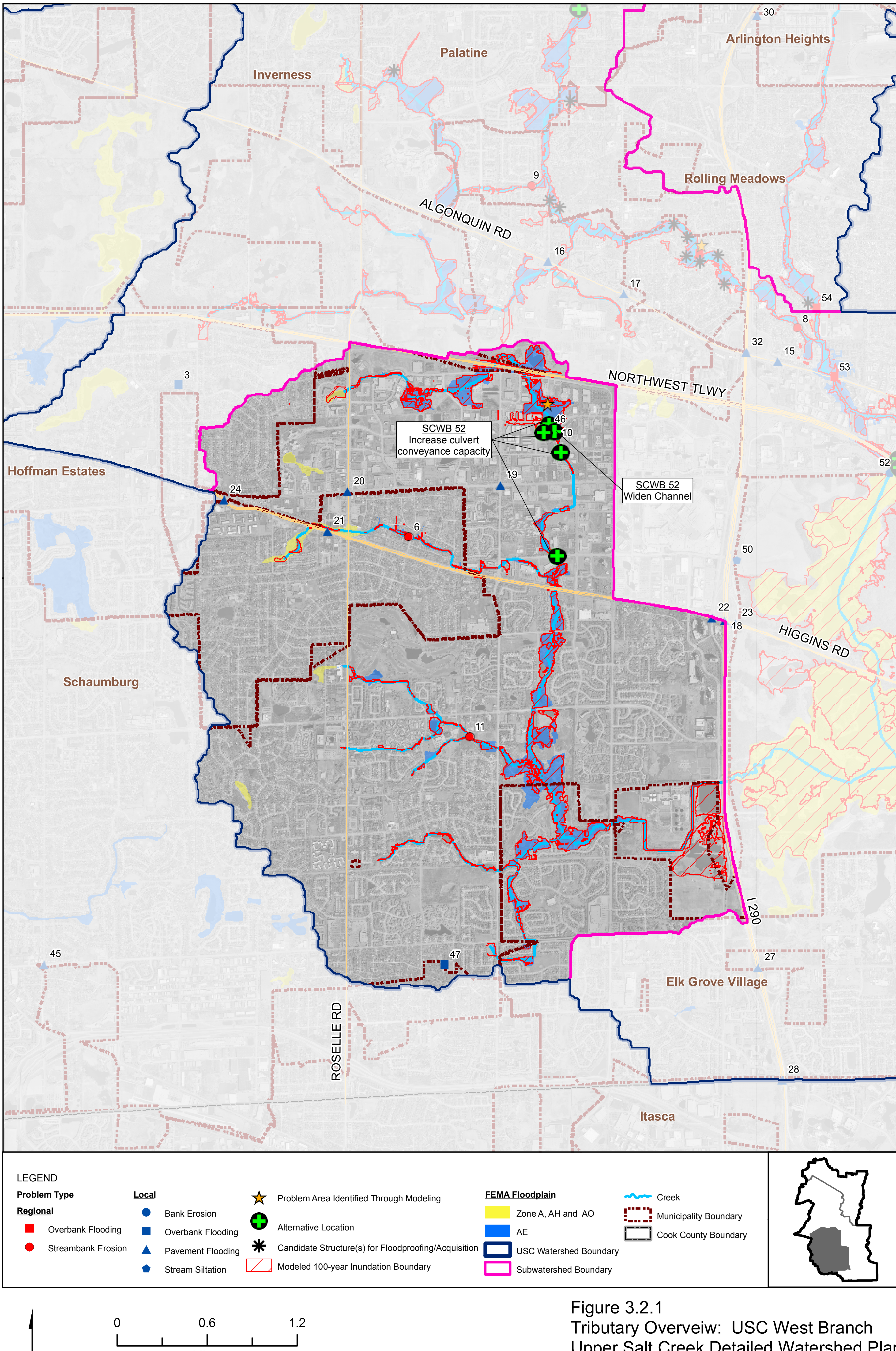
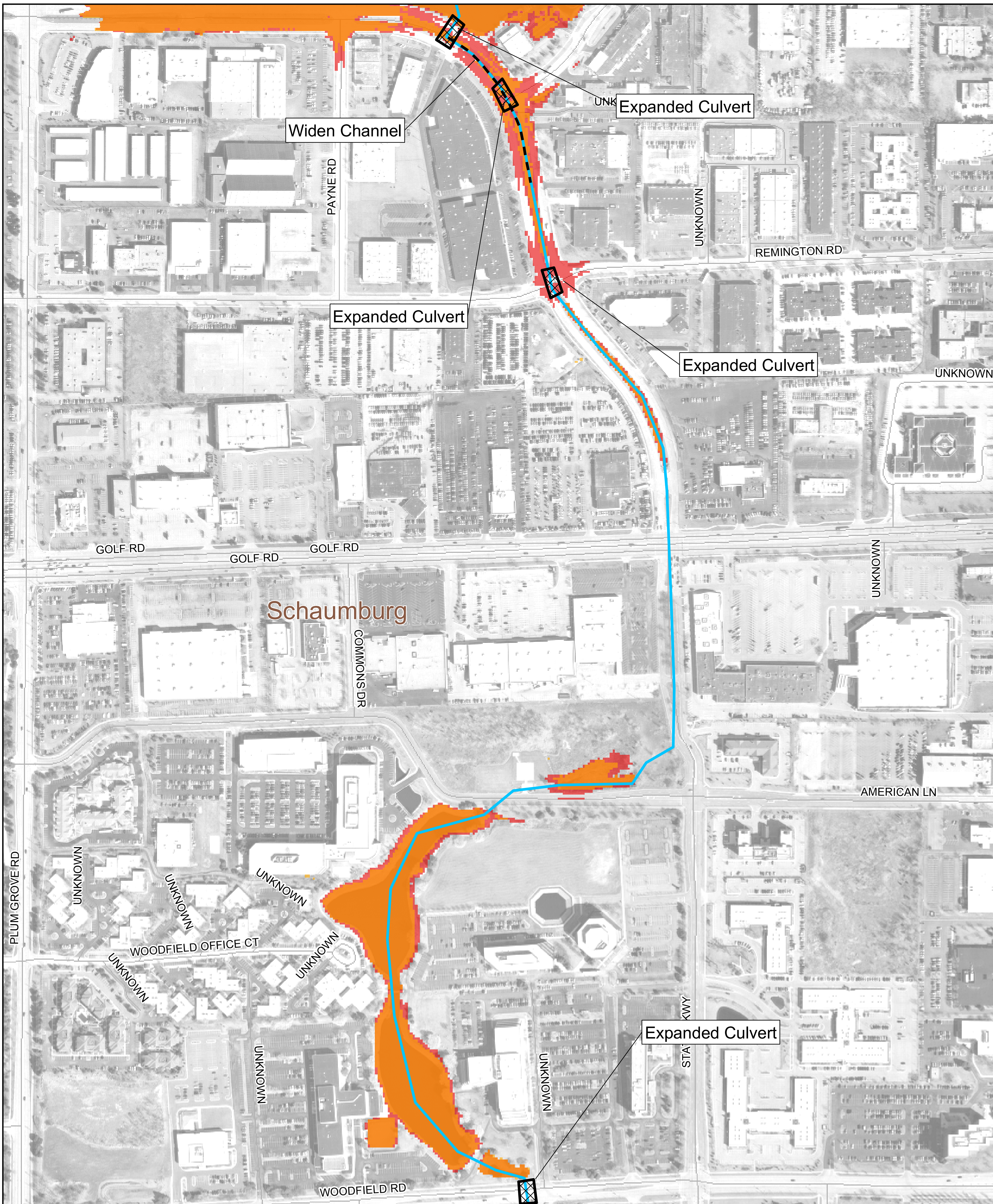


Figure 3.2.1
Tributary Overveiw: USC West Branch
Upper Salt Creek Detailed Watershed Plan

MWH



Subwatershed: West Branch

Alternative: SCWB-52

Alternative Description:

Lower weirs on two detention basins, increase capacity of bridge and create ditch in place of culvert.

Conceptual Level Cost: $1,149,000 Benefits: $305,000

B/C Ratio: 0.27

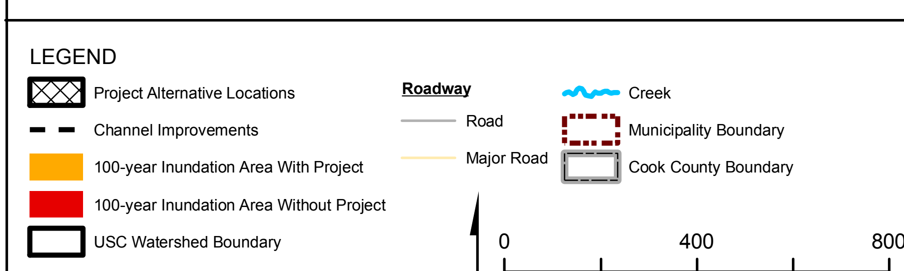
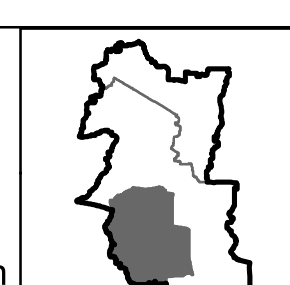


Figure 3.2.2
USC West Branch
Alternative SCWB-52
Existing and Alternative Inundation Areas
Upper Salt Creek Detailed Watershed Plan



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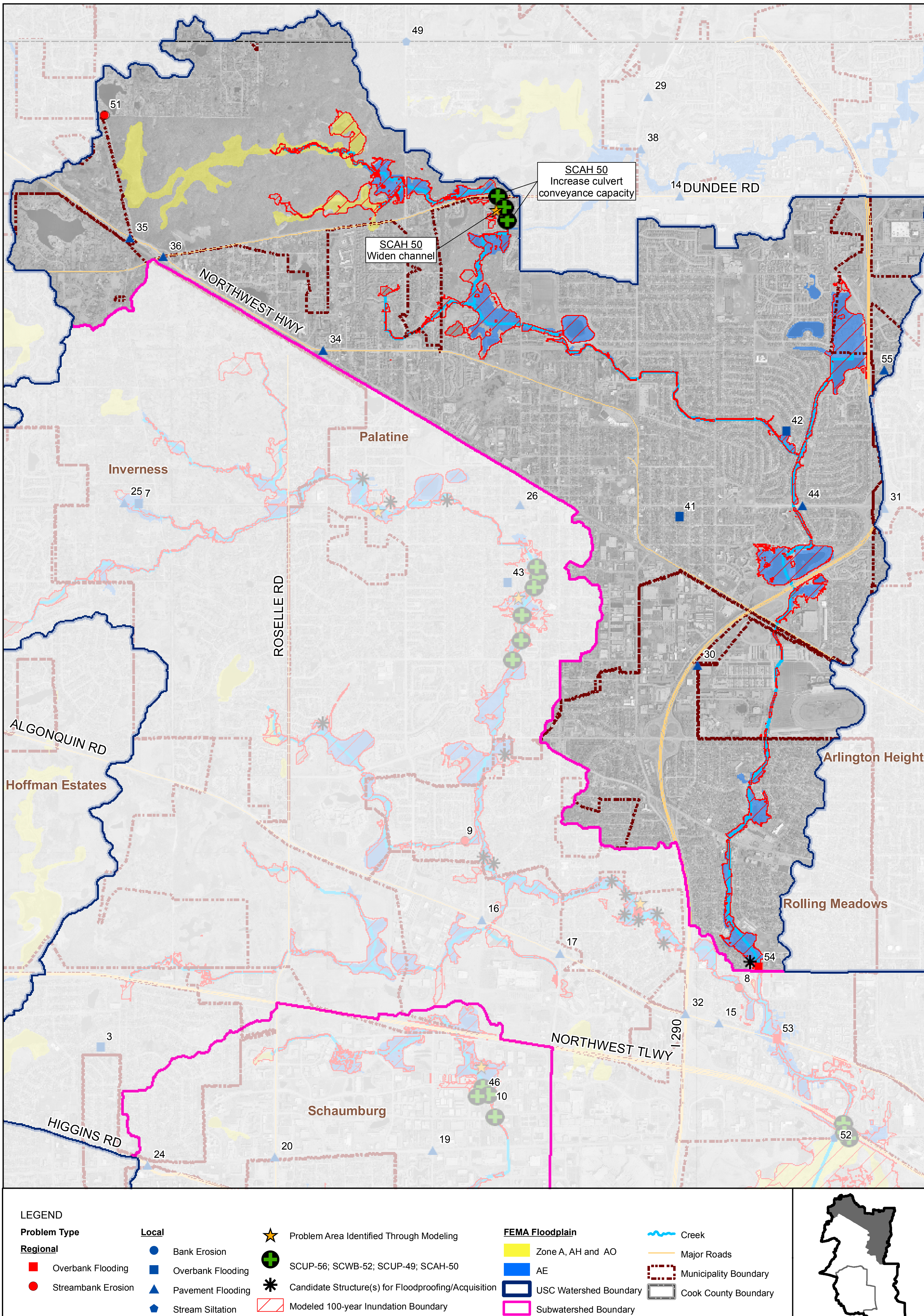
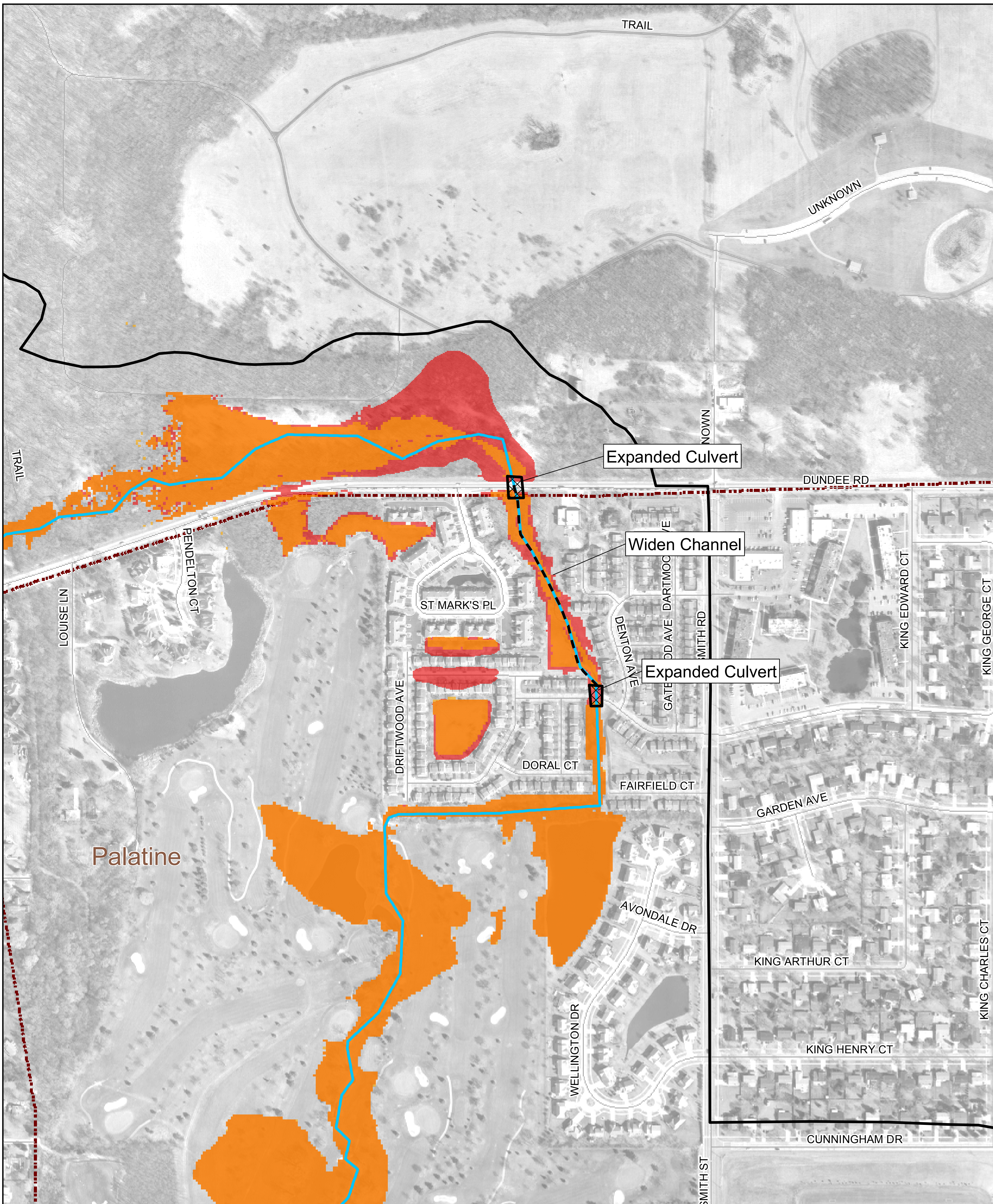


Figure 3.3.1
Tributary Overveiw: USC Arlington Heights Branch
Upper Salt Creek Detailed Watershed Plan

MWH



Subwatershed: Arlington Heights Branch

Alternative: SCAH-50

Alternative Description:

Widen channel between Dundee Road and Cherrywood Drive and increase the conveyance capacity of two culverts.

Conceptual Level Cost: $1,707,000 Benefits: $1,385,000

B/C Ratio: 0.81

LEGEND

- Project Alternative Locations
- Channel Improvements
- 100-year Inundation Area With Project
- 100-year Inundation Area Without Project
- USC Watershed Boundary

Roadway
- Road
- Major Road

- Creek
- Municipality Boundary
- Cook County Boundary

0 400 800 Feet

Figure 3.3.2
USC Arlington Heights Branch
Alternative SCAH-50
Existing and Alternative Inundation Areas
Upper Salt Creek Detailed Watershed Plan

MWH

Introduction

As part of the Upper Salt Creek DWP development, inundation mapping was produced based on hydrologic and hydraulic modeling. Tables 1 and 2 include a comparison of the inundation mapping created for this DWP to the effective FEMA floodplain mapping, revised August 19, 2008 as part of the FEMA Map Modernization program. Only detailed study Zone AE and limited detail study Zone A special flood hazard areas (SFHA) are included in the comparison. Caution should be exercised when evaluating the numbers in both tables, as some differences in inundation area may result from differences in the extent of detailed hydraulic modeling.

In some locations, discrepancies exist between this DWP inundation area maps and the FEMA floodplain maps, which may be attributed to differences in hydrologic and hydraulic modeling, as described in more detail in the following paragraphs.

Hydrologic Modeling Methodology

Hydrologic modeling methodologies utilized for the District's DWP are fundamentally different than those performed for DFIRM mapping, thus estimated peak flow rates may be significantly different. DFIRM hydrology was primarily based on regression equations and older hydrologic models (HEC-1, TR-20, etc.) while this DWP utilized a current hydrologic model (HEC-HMS). Consequently, different approaches to channel and reservoir routing may have been taken, which may result in magnitude and timing differences.

Parameters of each hydrologic model may be quite different. This DWP computed NRCS Curve Numbers based on the latest CMAP land use maps and NRCS soil maps. Contrarily, hydrologic methods, utilized by the DFIRM mapping, likely referenced older land use and soil data. Additionally, different methodologies may have been used to calculate subbasin times of concentration.

This DWP utilized current ISWS Bulletin 70 rainfall data while previous hydrologic studies used for DFIRM mapping may have used older Technical Paper-40 rainfall data. Bulletin 70 rainfall data generally yields higher rainfall depths than Technical Paper-40. For example, Technical Paper-40 specifies a 100-year, 24-hour duration rainfall depth of approximately 6.0 inches while Bulletin 70 specifies a corresponding rainfall depth of approximately 7.60 inches. Additionally, this DWP utilizes depth-area adjustments, which may not have been utilized in the DFIRM mapping.

Subbasin delineation is likely different between this DWP and the DFIRM mapping, as this DWP utilized the latest Cook County LiDAR data for topographic information to support subbasin delineation.

Differences in hydrologic modeling approaches may yield different flow rates, which will likely yield different flood surface profiles in the hydraulic model results.

Hydraulic Modeling Methodology

Hydraulic modeling methodologies utilized for this DWP are fundamentally different than those performed for DFIRM mapping, thus their associated flood surface profiles may be significantly different. Steady-state hydraulic modeling was generally performed in support of DFIRM mapping. This DWP utilized dynamic unsteady flow simulation. The difference in approaches between steady and unsteady hydraulic modeling may contribute to discrepancies between flood surface profiles.

Channel cross sections in the hydraulic models differ between this DWP and previous modeling. Cross sections developed under this DWP were generally obtained from field surveys. In a few cases, recent hydraulic models were available and modified under this DWP. If recent hydraulic models were used, several cross sections were verified with field surveying. Hydraulic models produced in support of DFIRM mapping may have used different cross section data, which may reflect outdated channel geometries. Likewise, bridge section geometries may also vary from previous modeling. Differences in model cross sections may contribute to discrepancies between flood surface profiles.

Hydraulic model calibration may also contribute to discrepancies in flood surface profiles between this DWP and DFIRM mapping. This DWP was calibrated to recent storm events that have occurred since the development of DFIRM modeling. The calibration may contribute to discrepancies between flood surface profiles.

DWP and FEMA Floodplain Area Comparison

Table 1 below lists for comparison the floodplain area within each subwatershed as determined by the Upper Salt Creek DWP and the DFIRM mapping (for both FEMA Zone AE, and FEMA Zone A).

TABLE 1
Comparison of DWP Inundation Area and FEMA Floodplain by Subwatershed

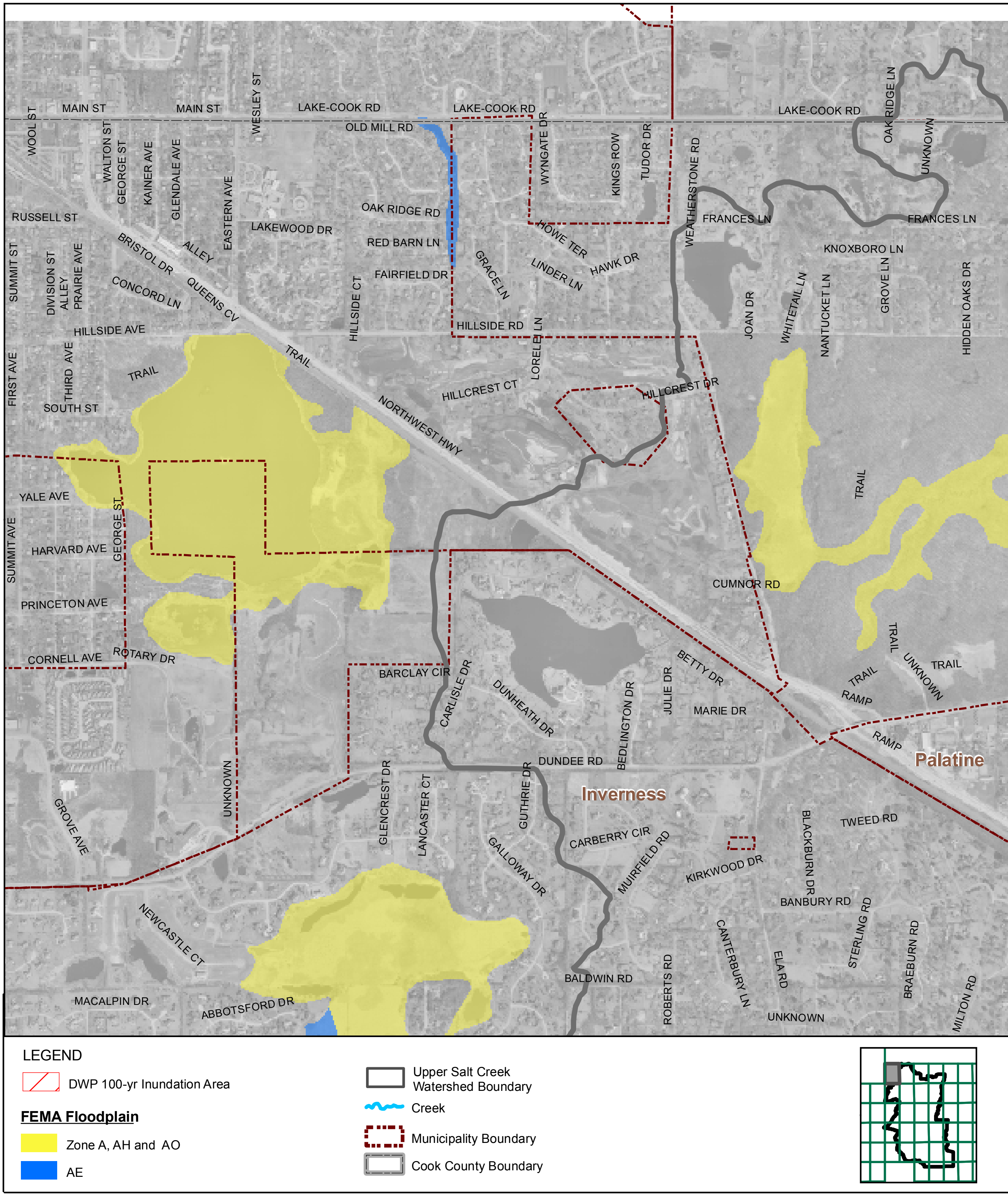
Subwatershed	DWP Floodplain Area (acres)	FEMA Zone AE Area (acres)	FEMA Zone A Area (acres)
Mainstem	1941	697	1312
West Branch	386	359	47
Arlington Heights Branch	445	391	185
Totals	2772	1447	1544

Table 2 below lists for comparison the floodplain area within each community within the Upper Salt Creek watershed as determined by the Upper Salt Creek DWP and the DFIRM mapping (for both FEMA Zone AE, and FEMA Zone A).

TABLE 2
Comparison of DWP Inundation Area and FEMA Floodplain by Community

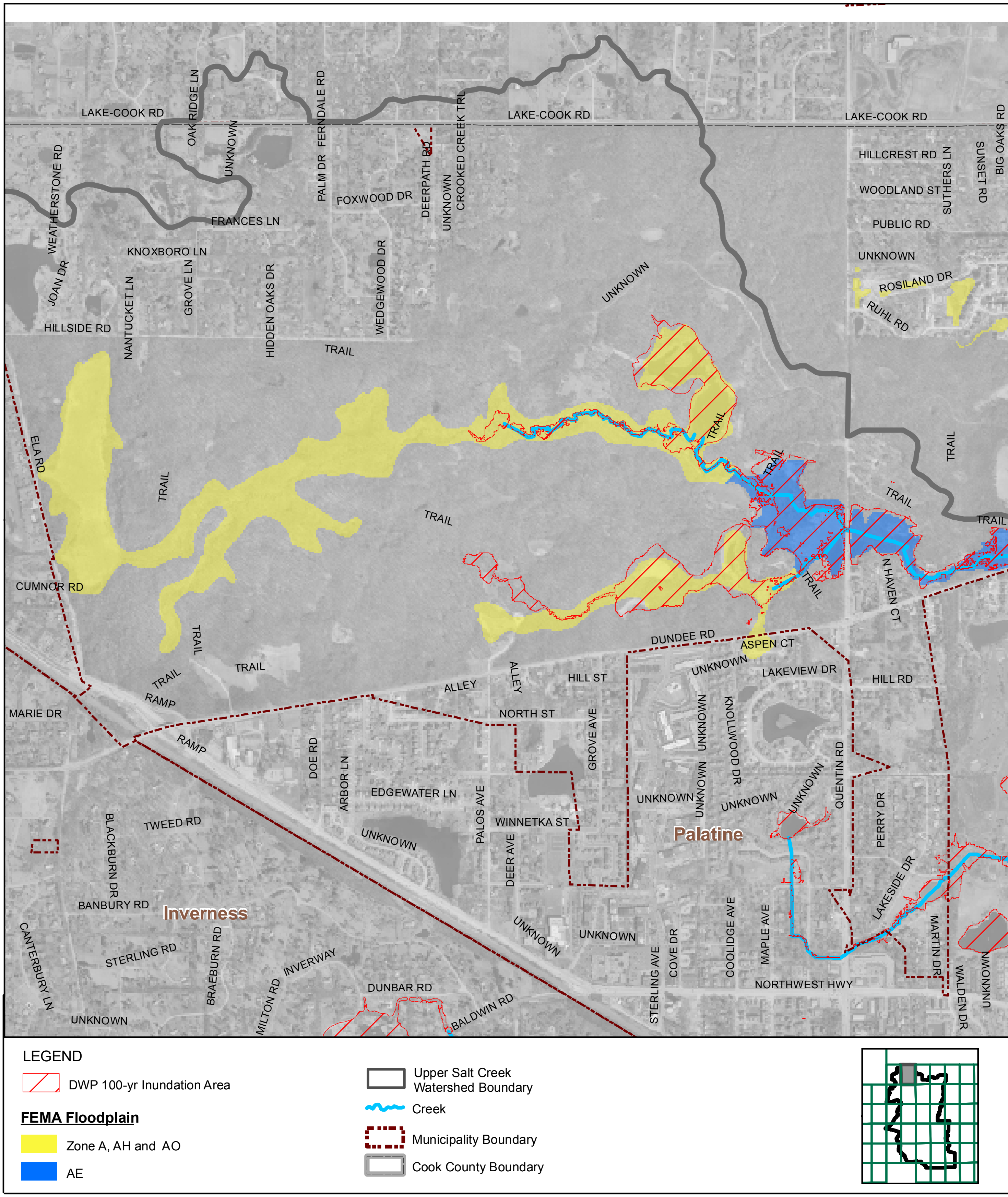
Community	DWP Floodplain Area (acres)	FEMA Zone AE Area (acres)	FEMA Zone A Area (acres)
Village of Schaumburg	312	302	56
Village of Palatine	493	451	2
FPDCC	1211	44	1357
Village of Hoffman Estates	33	10	70
Village of Elk Grove Village	221	180	0
City of Rolling Meadows	173	209	1
Village of Inverness	103	82	51
Palatine Township*	135	133	4
Village of Arlington Heights	4	4	0
Schaumburg Township*	82	27	2
Elk Grove Township*	5	5	1
Village of Barrington	0	0	0
Wheeling Township*	0	0	0
Village of Itasca	0	0	0
Village of Deer Park	0	0	0
Village of Wood Dale	0	>1	0
Total	2772	1447	1544

* Communities with no DWP inundation area mapping were omitted from the table, although some did have FEMA Zone A area. Contributing FEMA Zone A areas were included in the total.



Appendix A -
FIRM Panel: 17031C0038J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



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Feet

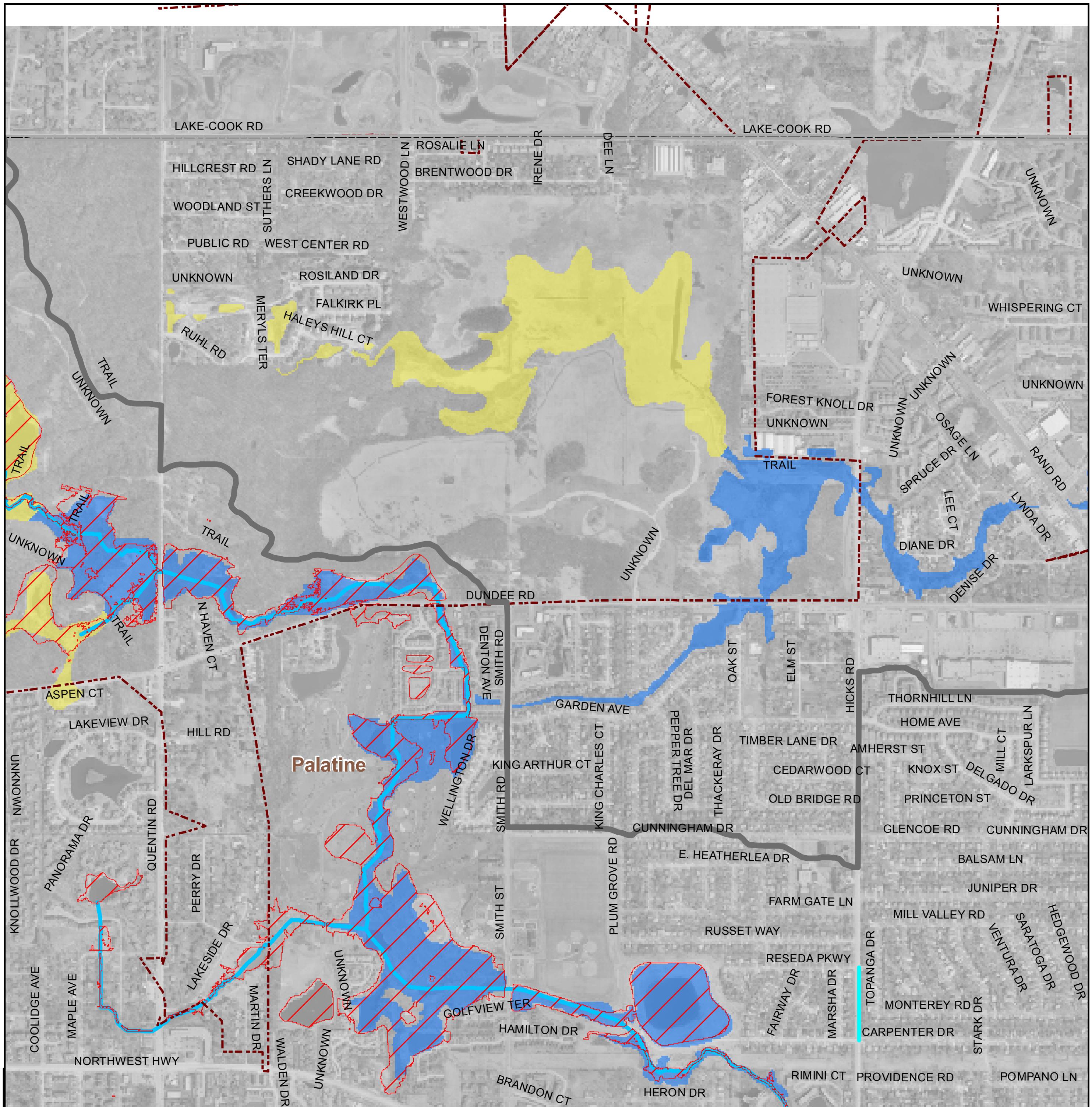
Appendix A -

FIRM Panel: 17031C0039J

Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM

Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

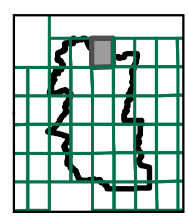
AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary



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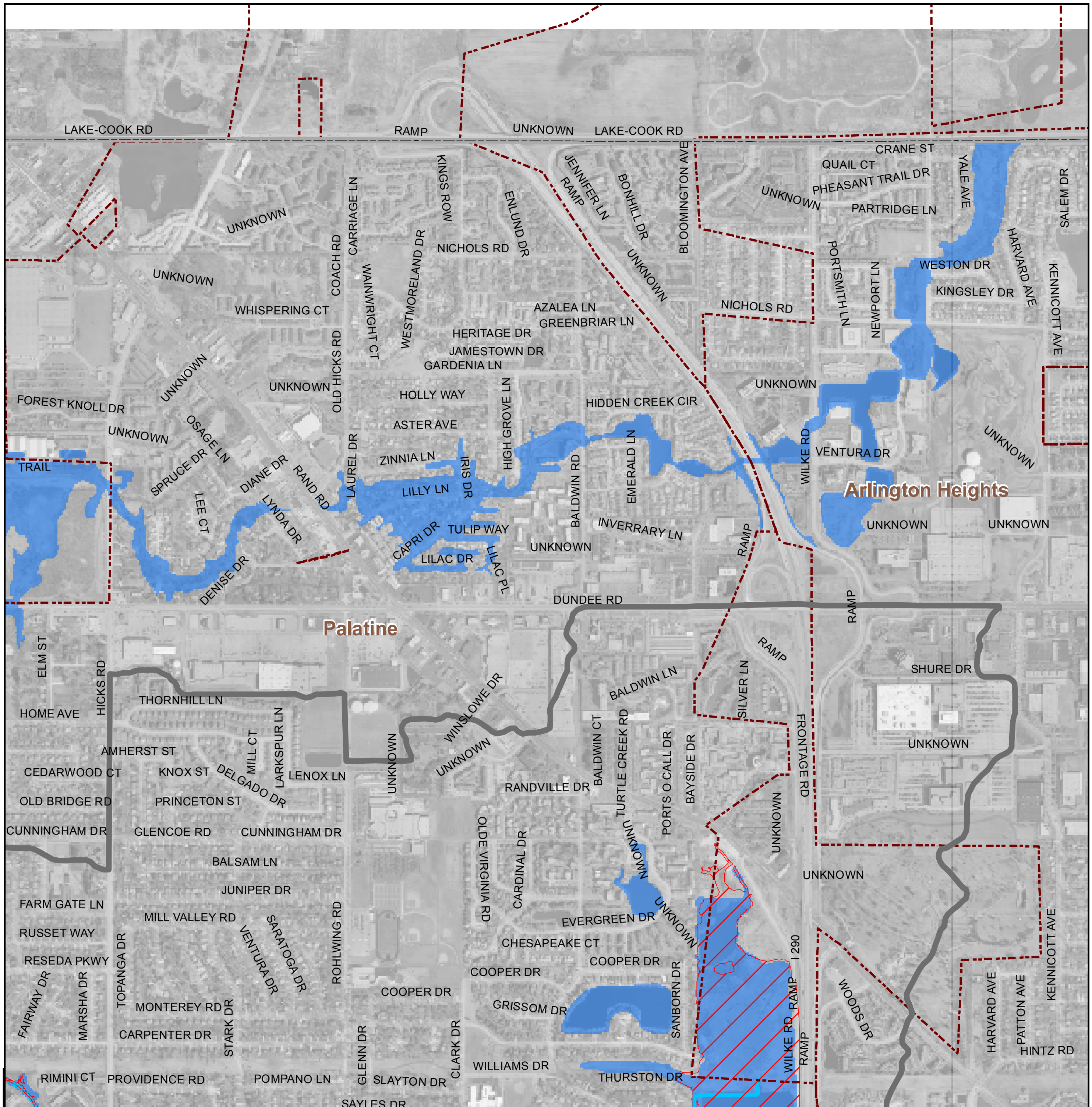
Appendix A -
FIRM Panel: 17031C0182J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

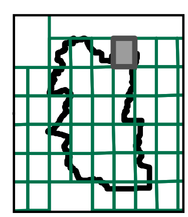
AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary



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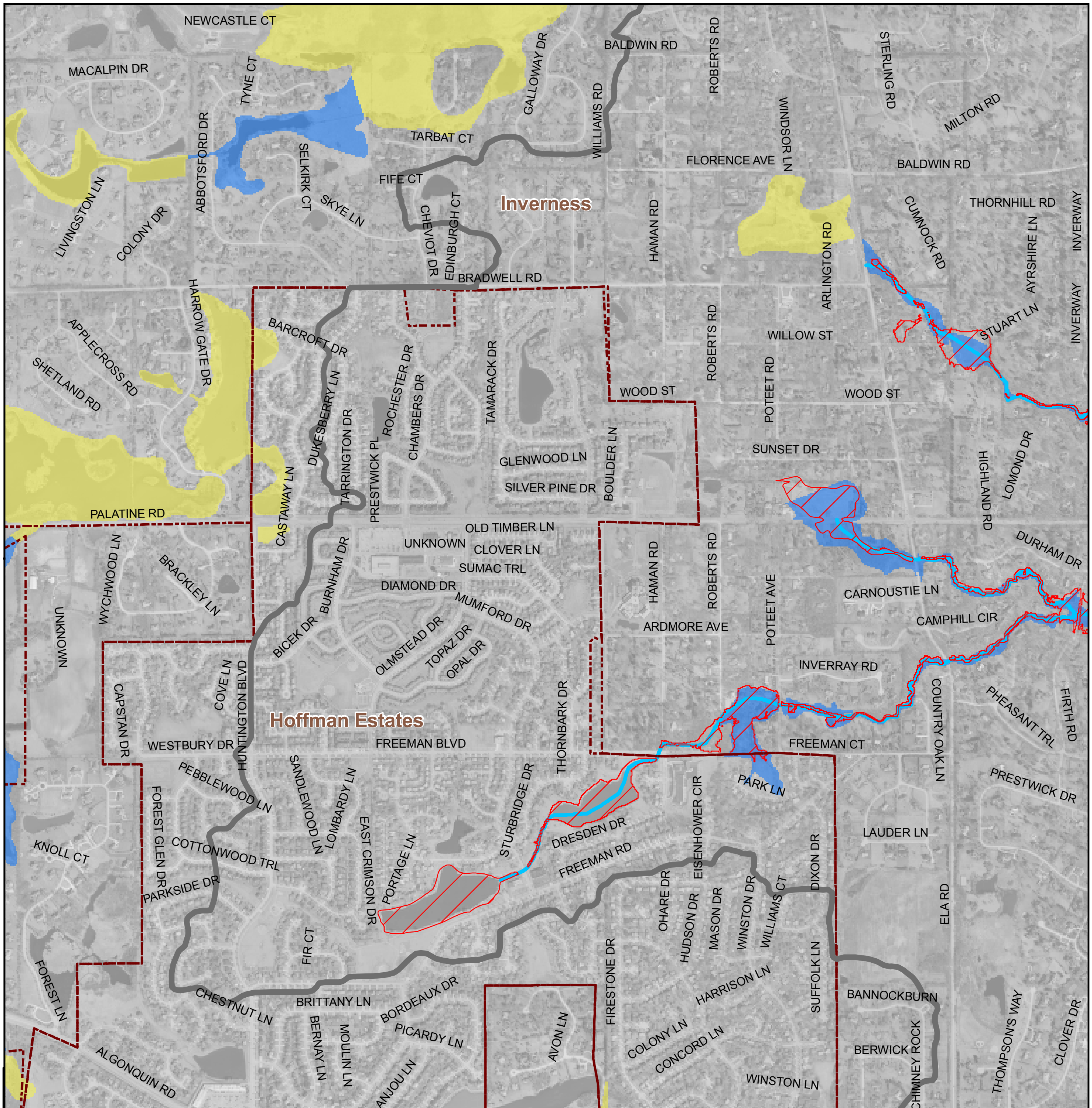
Appendix A -
FIRM Panel: 17031C0044J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

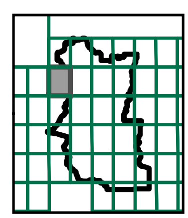
AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary



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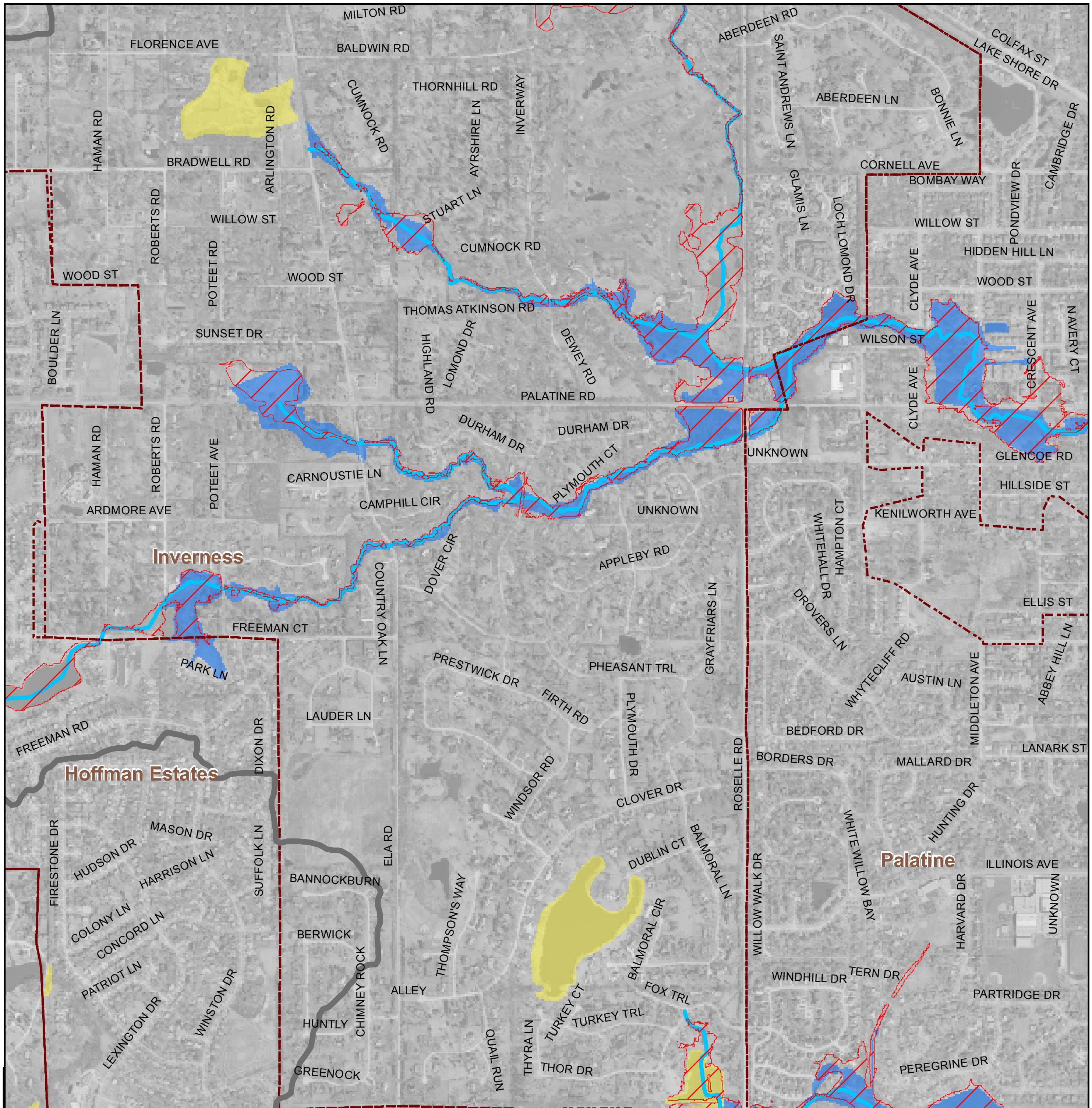
Appendix A -
FIRM Panel: 17031C0176J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

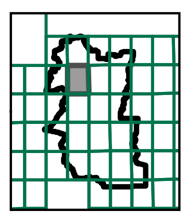
AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary



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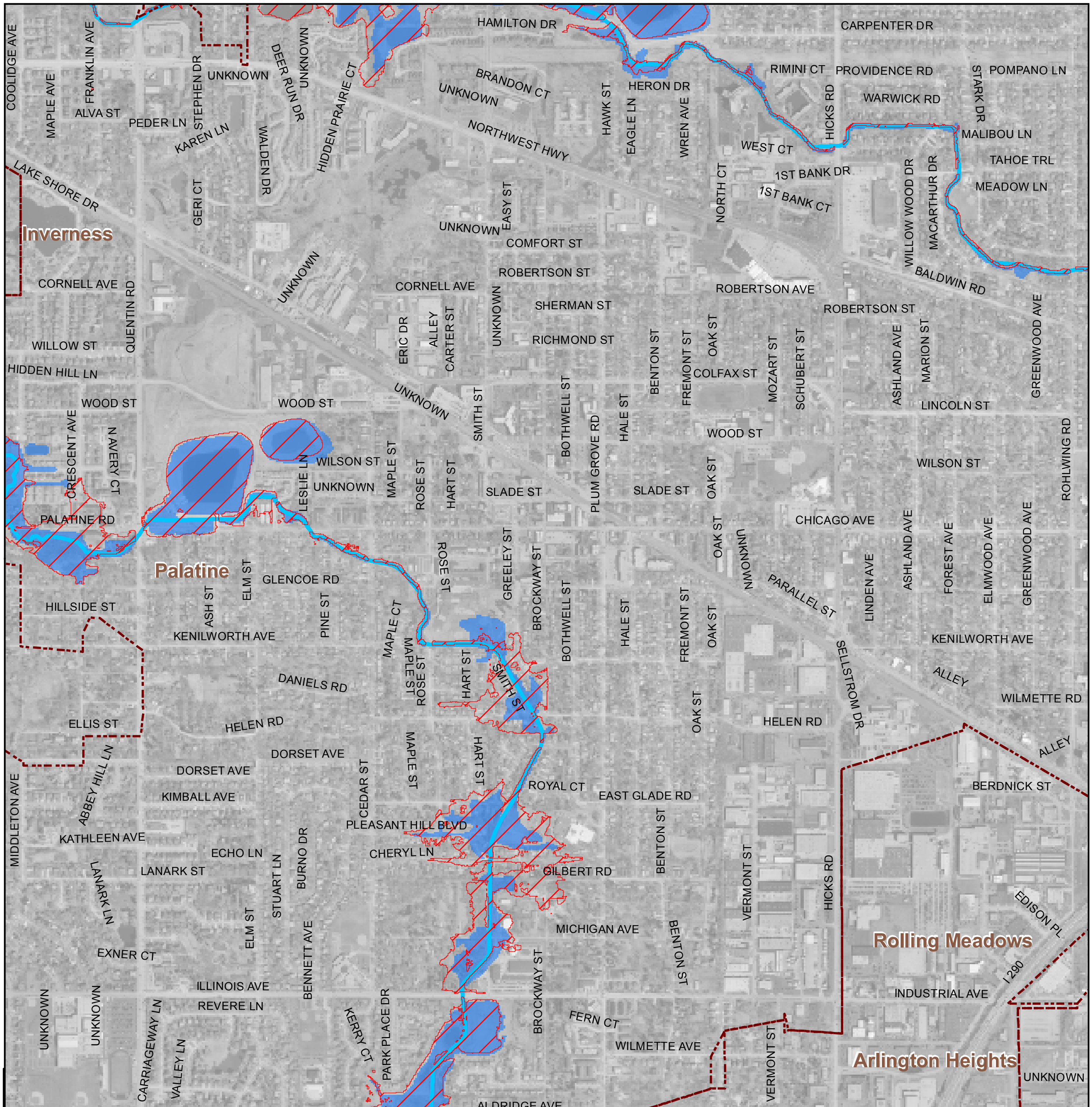
Feet

Appendix A -
FIRM Panel: 17031C0177J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

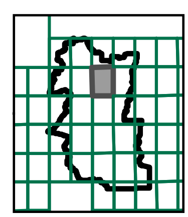
AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary



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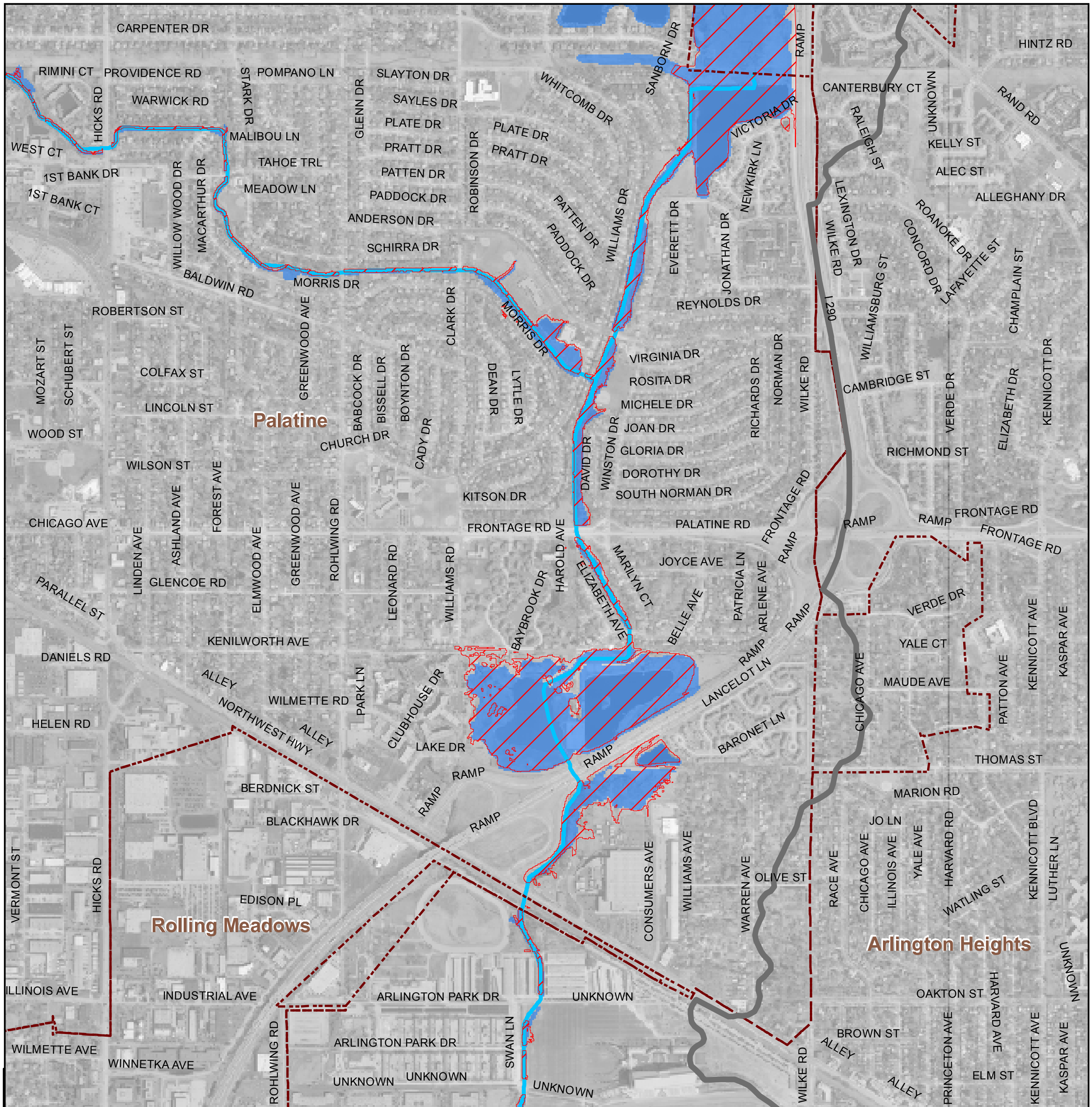
Appendix A -
FIRM Panel: 17031C0181J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary

N

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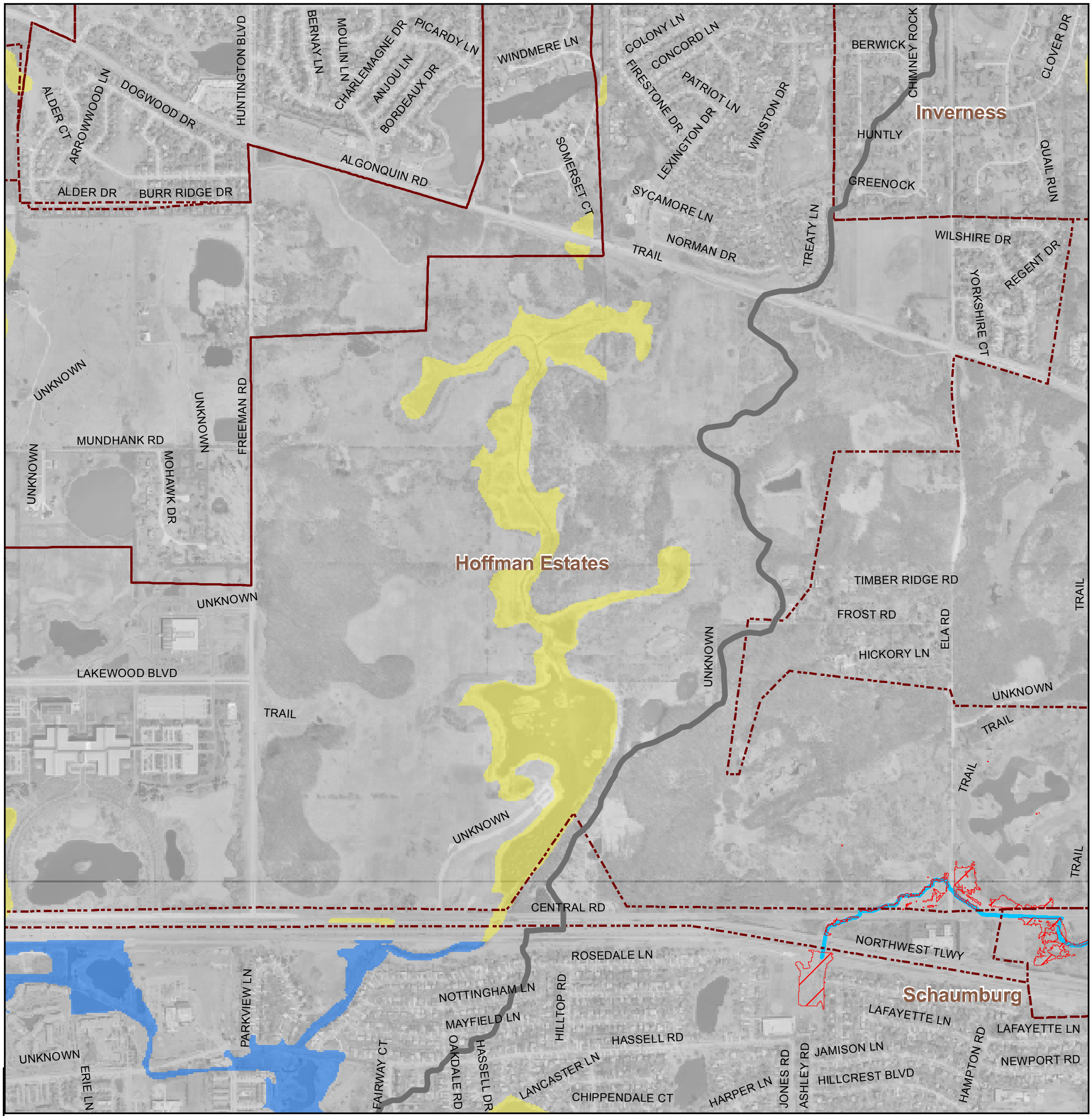
Feet

Appendix A -
FIRM Panel: 17031C0182J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

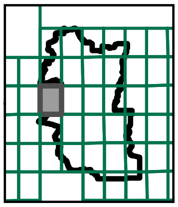
AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary



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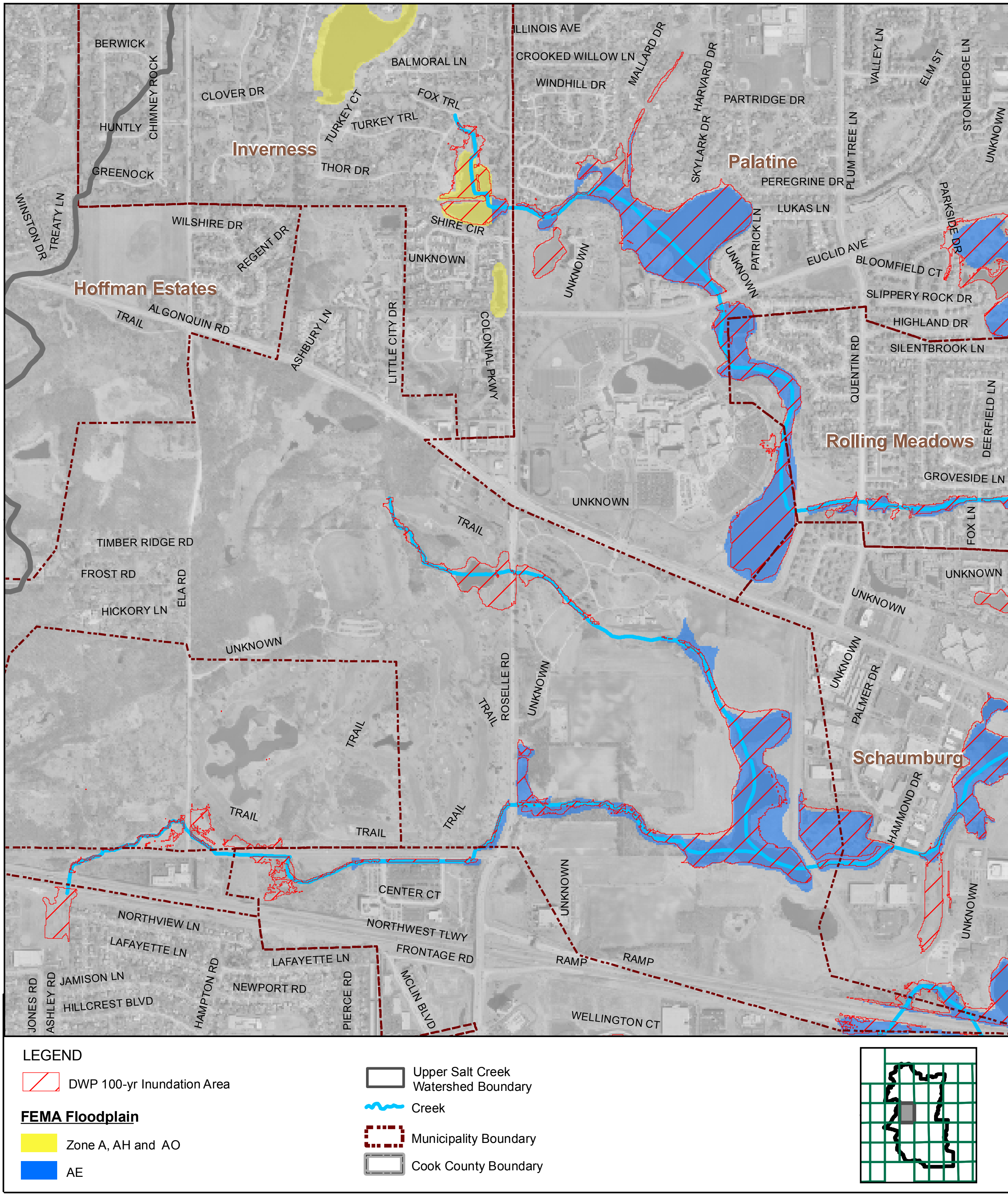
Appendix A -
FIRM Panel: 17031C0178J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



Appendix A -
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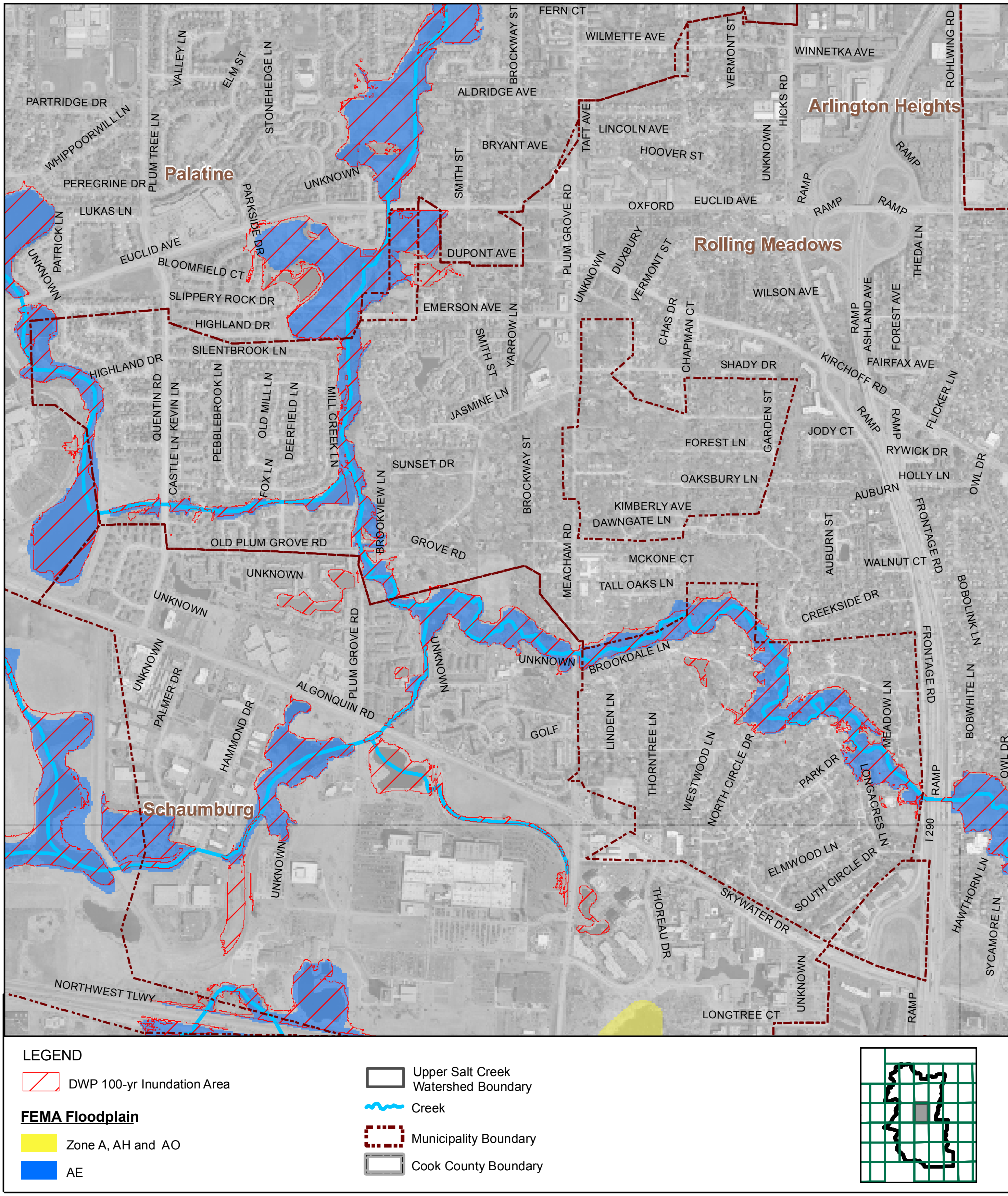
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



Appendix A -
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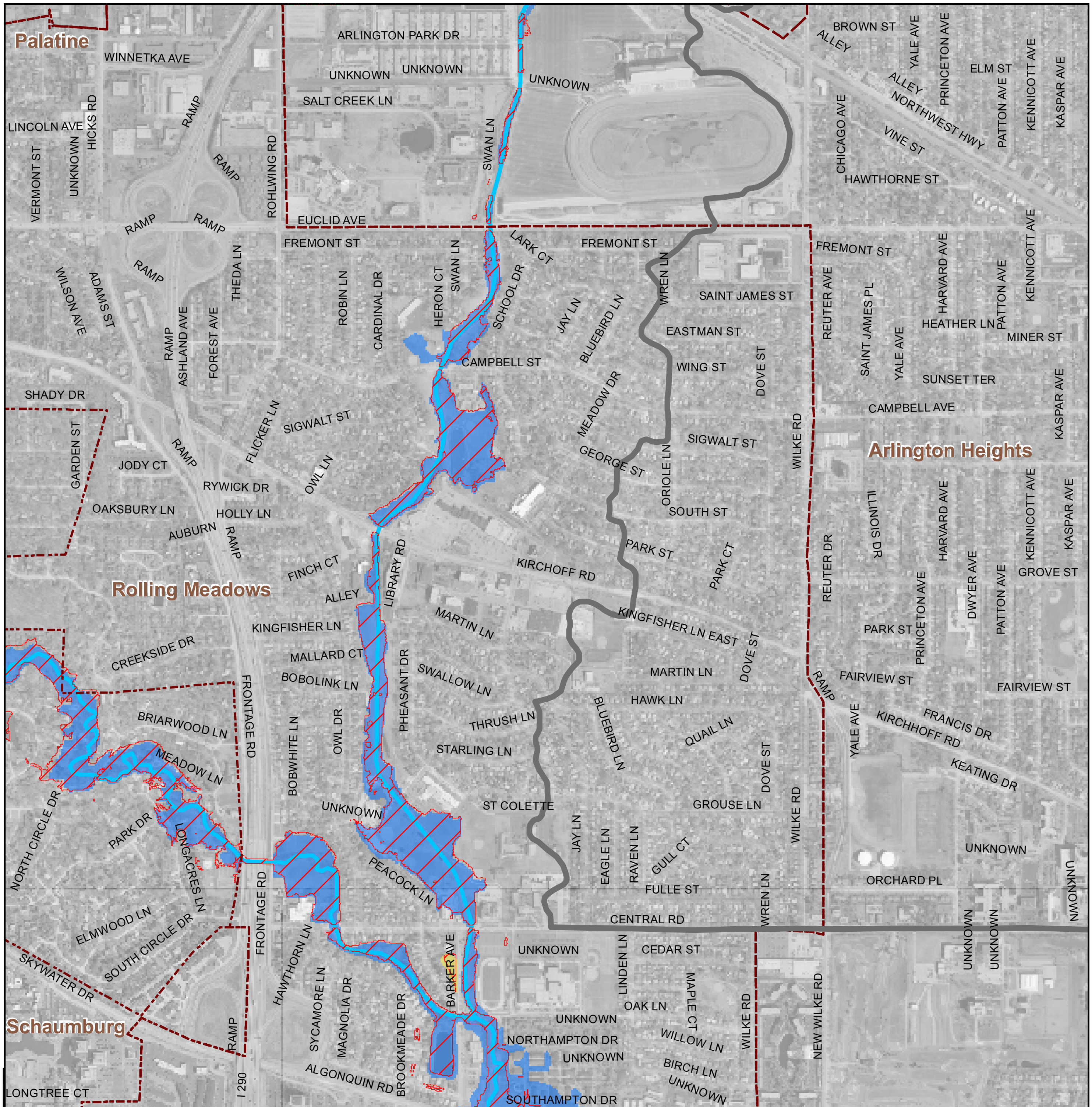
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

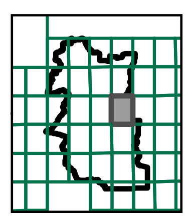
AE

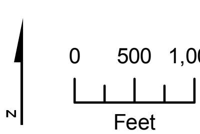
Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

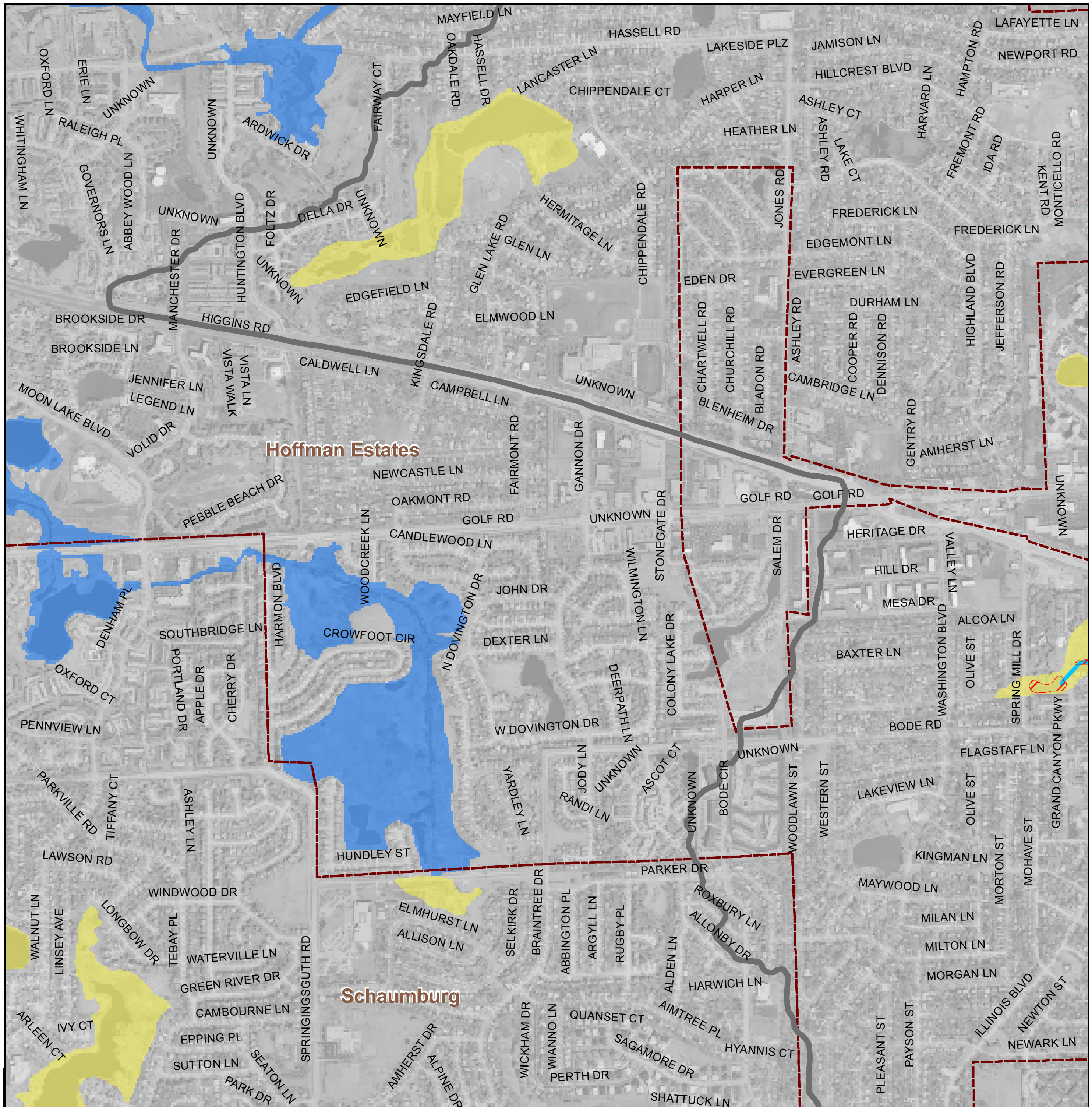
Cook County Boundary





Appendix A -
FIRM Panel: 17031C0184J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

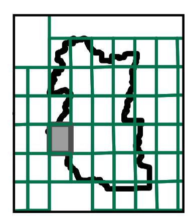
AE

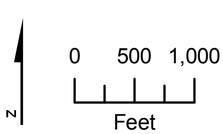
Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

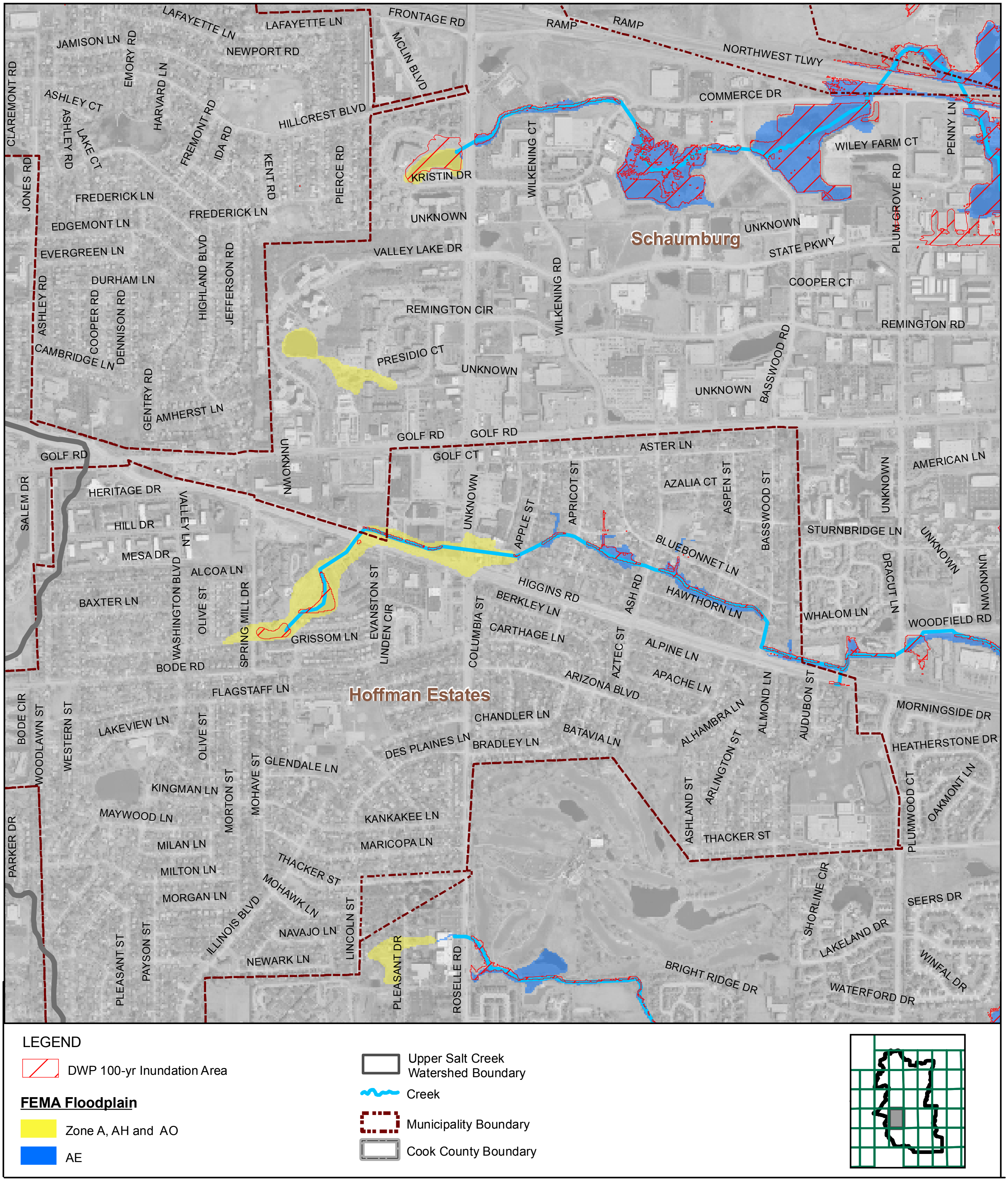
Cook County Boundary





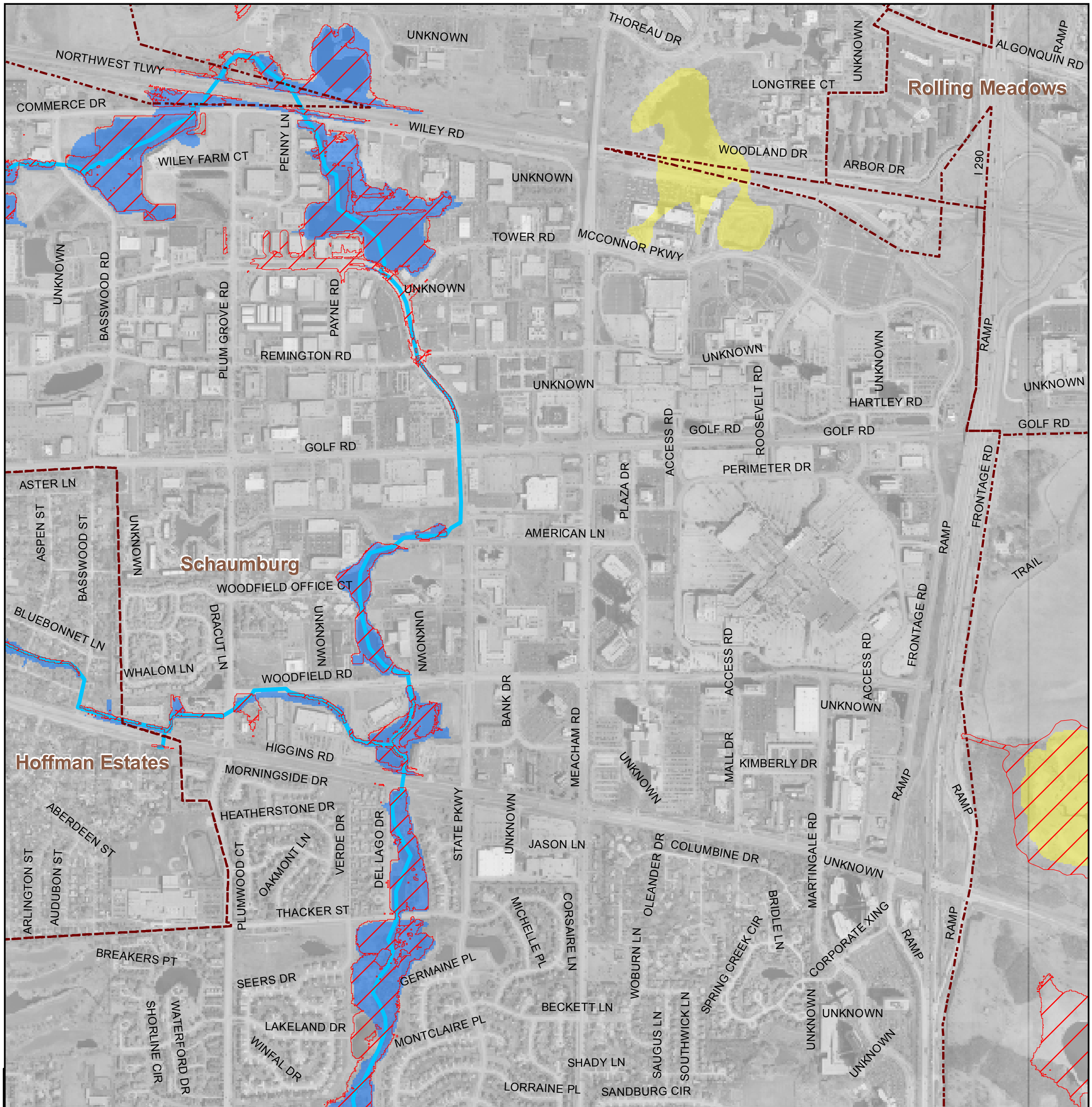
Appendix A -
FIRM Panel: 17031C0186J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



Appendix A -
FIRM Panel: 17031C0187J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

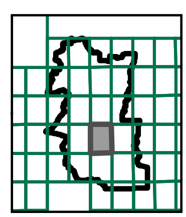
AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary



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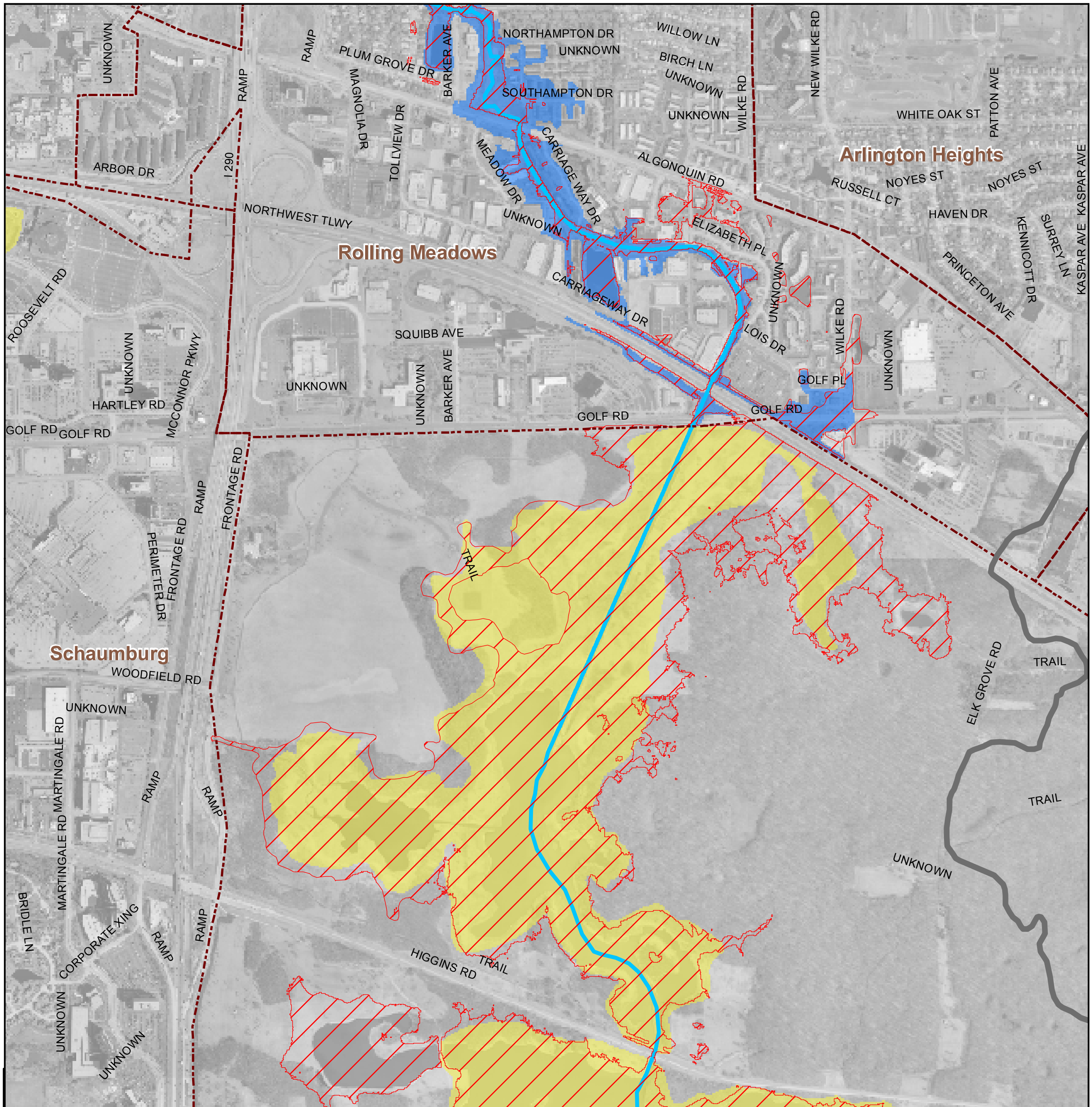
Appendix A -

FIRM Panel: 17031C0191J

Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM

Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary

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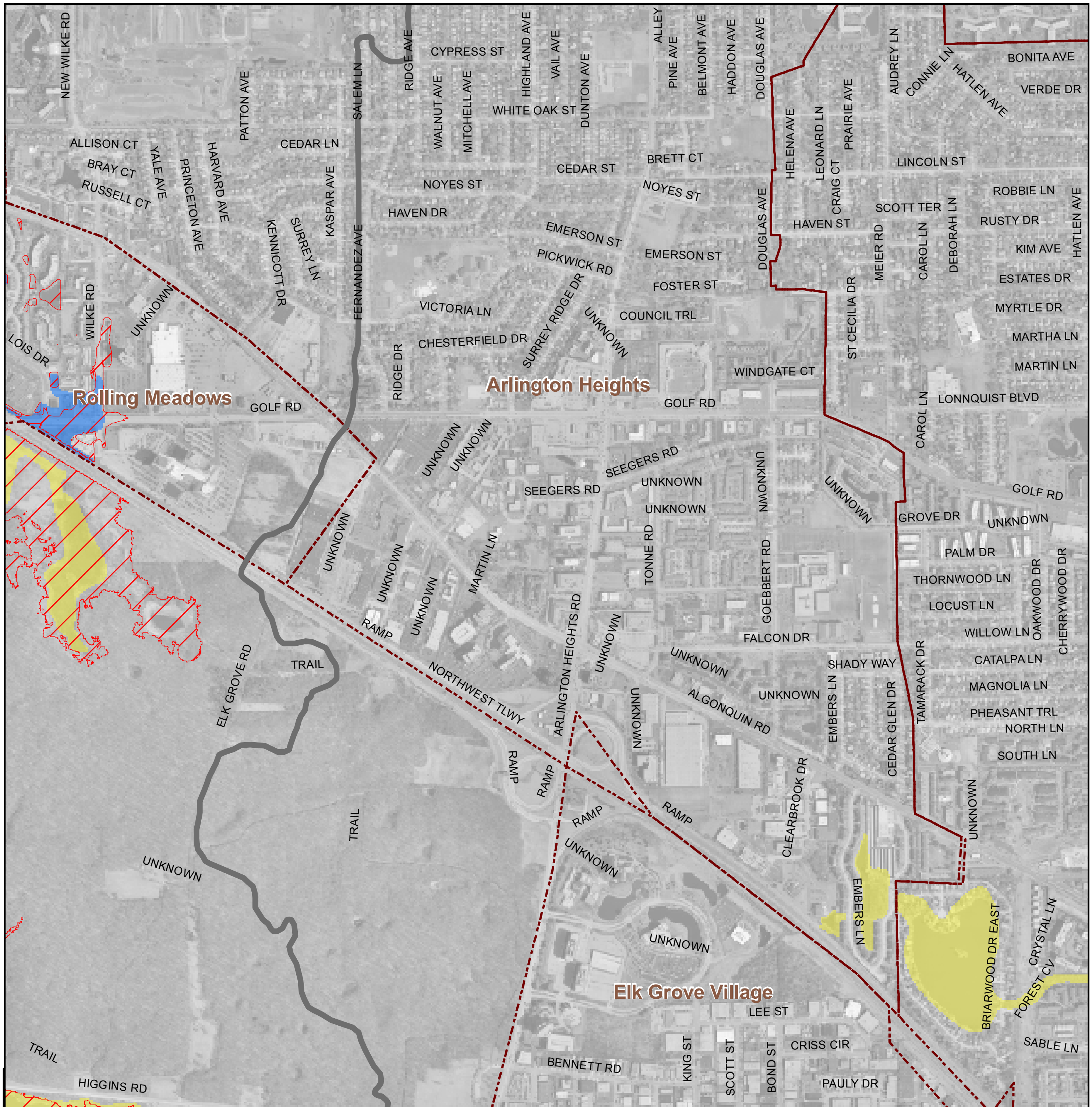
Feet

Appendix A -
FIRM Panel: 17031C0192J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



LEGEND

DWP 100-yr Inundation Area

FEMA Floodplain

Zone A, AH and AO

AE

Upper Salt Creek Watershed Boundary

Creek

Municipality Boundary

Cook County Boundary

N

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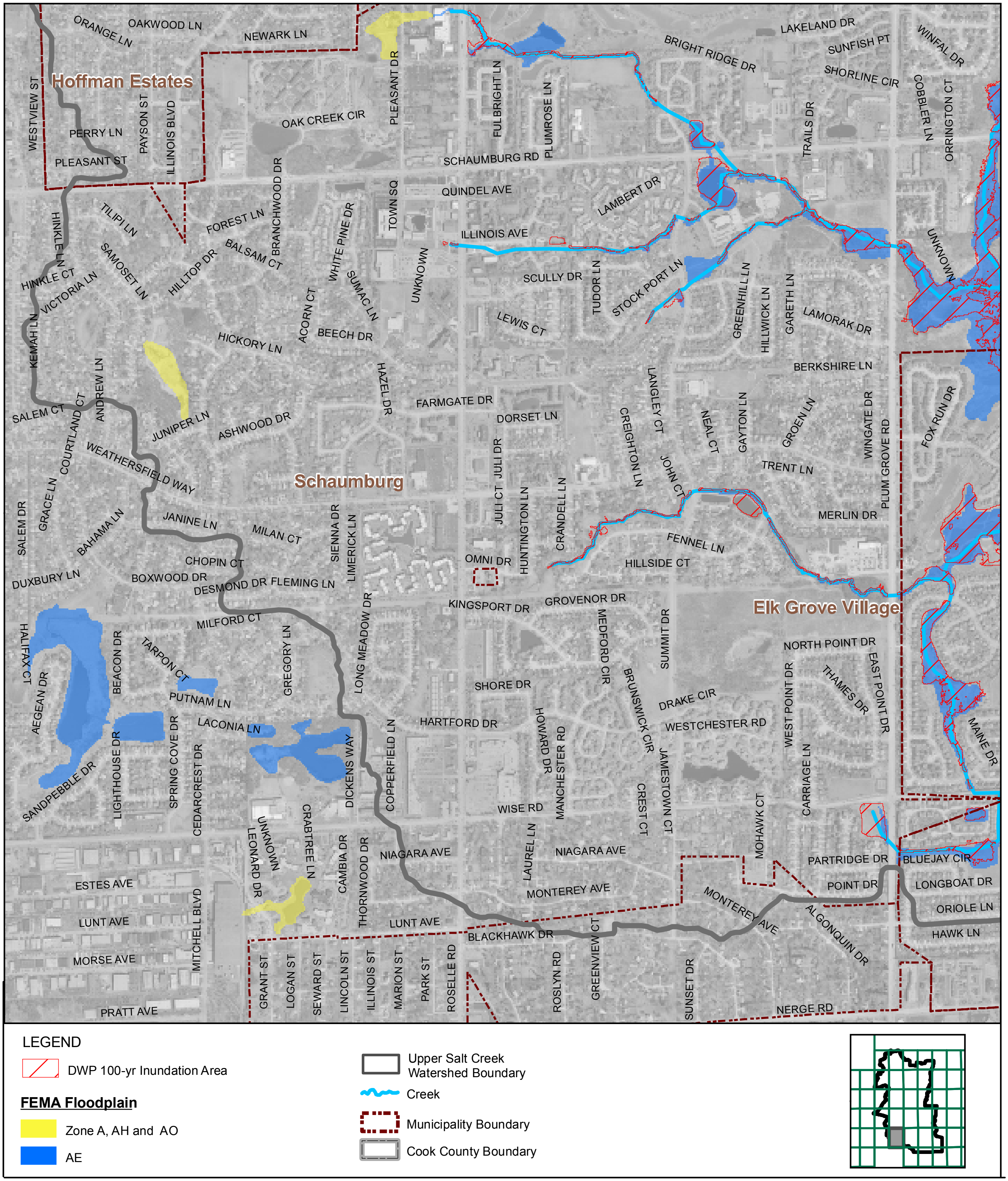
Feet

Appendix A -
FIRM Panel: 17031C0211J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



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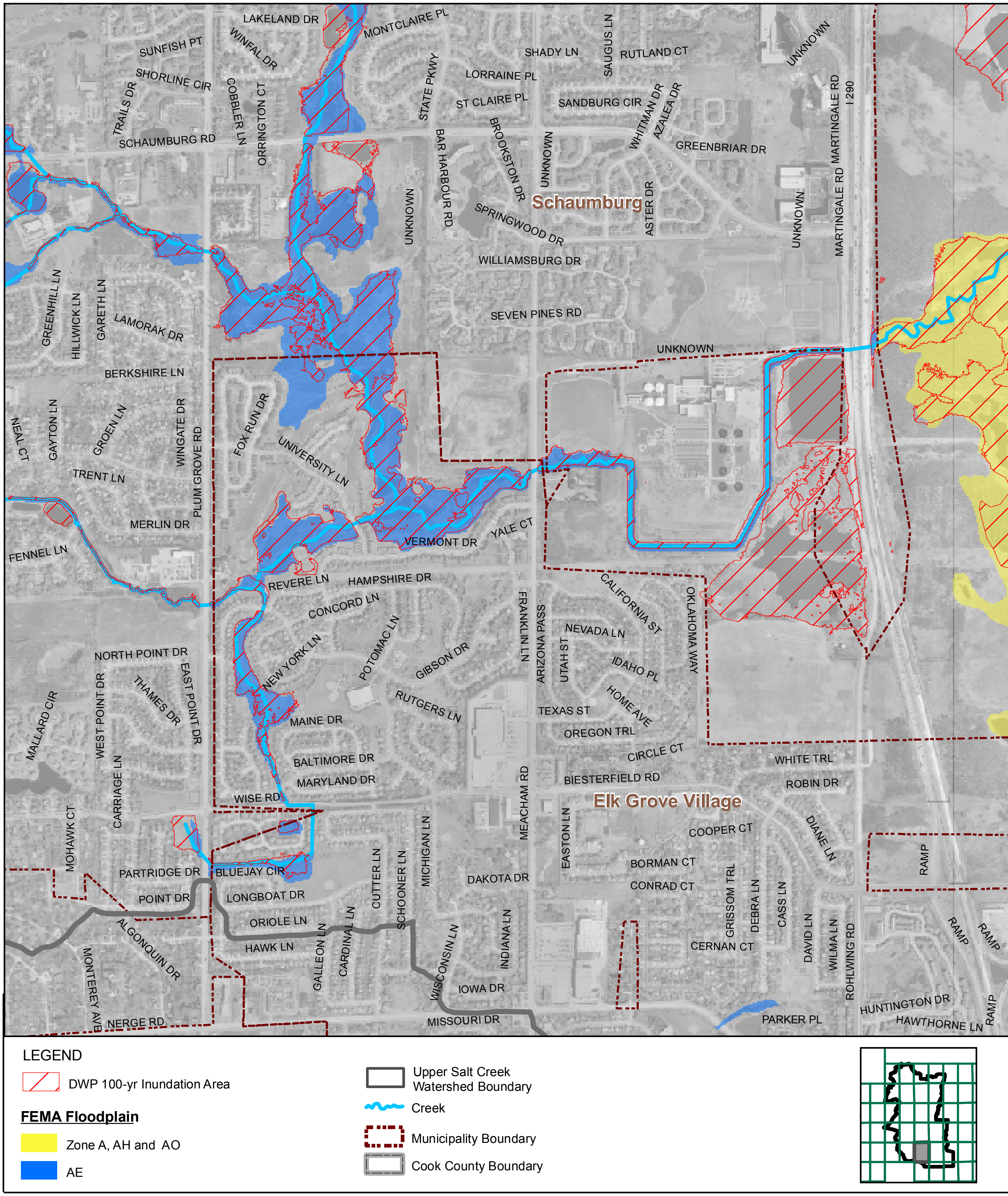
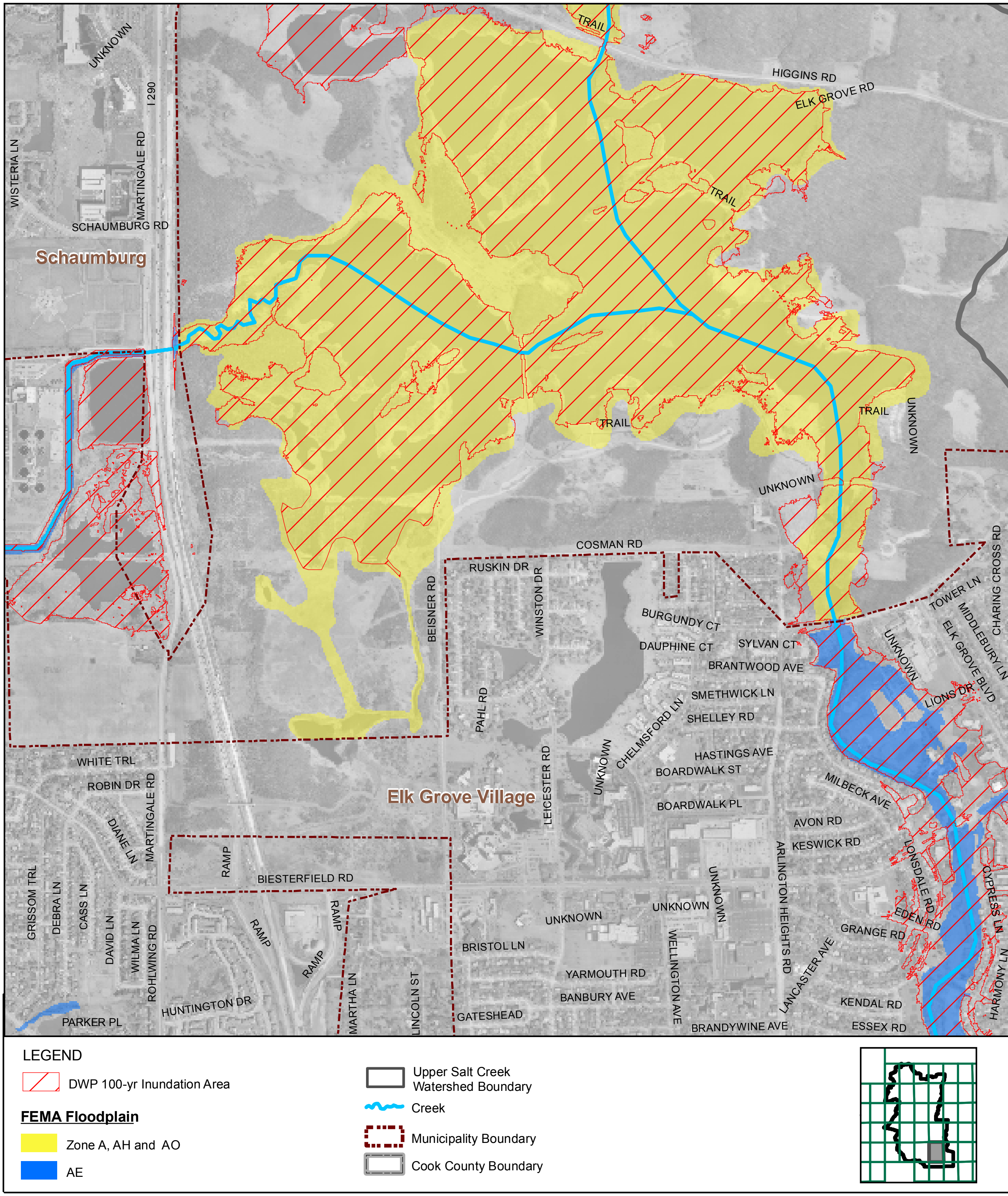
Feet

Appendix A -
FIRM Panel: 17031C0189J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan



Appendix A -
FIRM Panel: 17031C0193J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH



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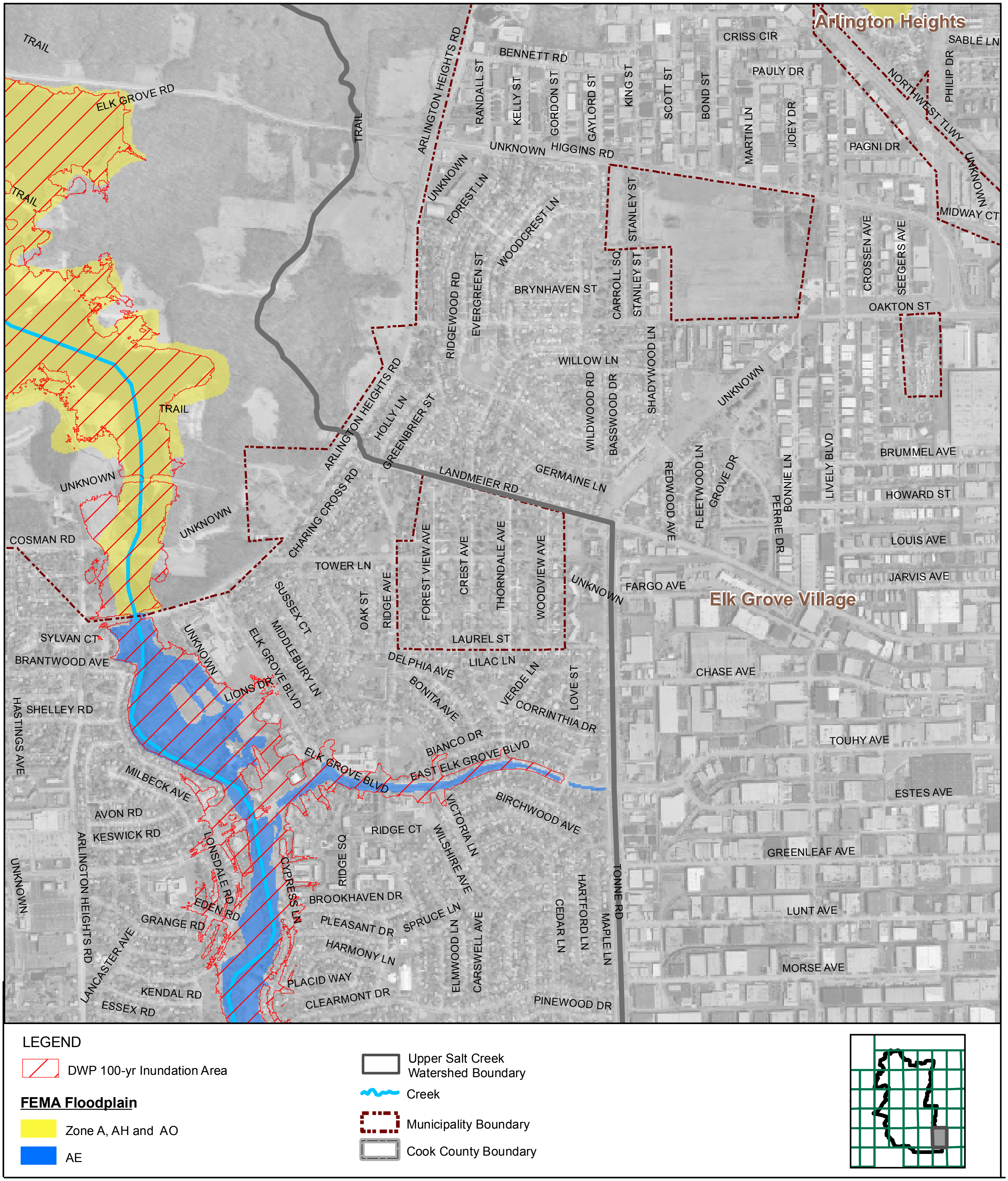
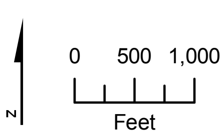
Feet

Appendix A -
FIRM Panel: 17031C0194J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH





Appendix A -
FIRM Panel: 17031C0213J
Comparison of DWP 100-yr Inundation Mapping and FEMA Effective FIRM
Upper Salt Creek Detailed Watershed Plan

MWH

Chapter 6
Watershed Planning

Acronyms used in Chapter 6:

AA_B	Average Annual Benefits
AA_C	Average Annual Costs
AA_D	Average Annual Damages
ABM	Articulated Block Mat
BC	Benefit-to-Cost
CCSMP	Cook County Stormwater Management Plan
CDSA	Critical Duration Storm Analysis
CIP	Capital Improvement Program
CMAP	Chicago Metropolitan Agency for Planning
CUDD	Calumet Union Drainage District
DTM	Digital Terrain Model
DWP	Detailed Watershed Plan
FDA	Flood Damage Assessment
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information Systems
HEC	Hydrologic Engineering Center
H&H	Hydrologic and Hydraulic
HSPF	Hydrologic Simulation Program-Fortran
IDNR-OWR	Illinois Department of Natural Resources - Office of Water Resources
IDNR-SWS	Illinois Department of Natural Resources – State Water Survey
IDOT	Illinois Department of Transportation
IEMA	Illinois Emergency Management Agency
IEPA	Illinois Environmental Protection Agency
LCSMC	Lake County Stormwater Management Commission
NB	Net Benefits
NCDC	National Climactic Data Center
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
O&M	Operation and Maintenance
PV	Present Value
PV_B	Present Value of Benefits
PV_C	Present Value of Costs
RAS	River Analysis System
SCS	Soil Conservation Service
UAA	User Attainability Analysis
UDV	Unit Day Value
UNET	Unsteady NETwork Model
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WPC	Watershed Planning Council

CHAPTER 6
WATERSHED PLANNING

6.1 Introduction

A standardized approach to watershed planning is required throughout Cook County to coordinate the District's efforts to implement its Cook County Stormwater Management Plan (CCSMP). Detailed Watershed Plans (DWPs) will be developed for all major watersheds and will serve as standardized documents to help guide the District as it develops a Capital Improvement Program (CIP). Previous planning efforts have been conducted by various organizations, and will be used in the development of DWPs where applicable. This chapter provides guidance for merging findings from previous flood remediation efforts in Cook County with new data and evaluations done to develop effective and consistent DWPs.

6.2 Status of Watershed Planning in Cook County

Local, state, and federal agencies have conducted comprehensive stormwater planning (Table 6.1) efforts as a part of their watershed planning programs for the following watersheds within Cook County: the North Branch of the Chicago River, Lower Des Plaines Tributaries, Calumet-Sag Channel, Little Calumet River, Poplar Creek and Upper Salt Creek. Where possible, previous planning information should be included and built upon in developing DWPs to take advantage of earlier efforts.

6.3 Planning Methodology

6.3.1 Organization of Detailed Watershed Plans

DWPs will serve as the supporting documentation to the District's Stormwater Management CIP. The watershed planning methodologies and standards described herein will be used to develop a DWP for each major watershed in Cook County. The objective is to supply the District with information on existing conditions, stormwater problems, alternative improvements considered to address stormwater problems, and other relevant information necessary to prioritize projects on a countywide level. Table 6.2 is a standard outline of the content to be provided within DWPs.

6.3.2 Data Collection and Review

The initial step in DWP development is the collection and review of existing data. Data that will be collected and reviewed include stormwater problem data, existing watershed studies and models, monitoring data, geographic information systems (GIS) data and other sources of useful watershed mapping.

6.3.3 Use of Existing Data for Detailed Watershed Studies

The DWP report will include a summary of existing watershed data and information. As a part of DWP development, the District will collect and review watershed data from member communities, Watershed Planning Councils (WPCs), applicable state and federal agencies, available complaint records, and other relevant watershed stakeholders. Relevant stormwater data will be compiled within the DWP report. The following subsections provide means of summarizing data regarding stormwater problems (detailed in Section 6.3.3.1) and available studies that have compiled some of the existing stormwater data (detailed in Section 6.3.3.2).

Table 6.1 Summary of Watershed Planning In Cook County

Agency	Description of Watershed Planning
Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR)	At the request of local governments, IDNR-OWR performs flood control studies to identify flooding problems, analyze alternative solutions, and determine the economic feasibility of those solutions. Plans developed by IDNR-OWR focus on structural flood control measures, but nonstructural flood mitigation alternatives are also examined. IDNR-OWR administers other funding assistance. It has a small-projects program that is often used to address local drainage problems and can fund flood related improvements up to $100,000. A less rigorous quantification of benefits is allowed under this program. Its flood mitigation program administers funds for the acquisition of flood-prone structures and flood mitigation planning. IDNR-OWR is involved in assisting FEMA with the map modernization for Cook County, as explained further in Section 2.5.1.
Illinois Environmental Protection Agency (IEPA)	IEPA collects water quality and biological data on streams and lakes throughout the state. The data are reported in the biannual *Illinois Water Quality Report,* which documents the level to which water bodies are supporting their designated uses (such as swimming, aquatic life). IEPA also maintains the Illinois Water Quality Management Plan, which offers recommendations for stormwater, soil erosion and sediment control, and stream and wetland best management practices (BMPs). IEPA also provides grants annually for implementation of nonpoint source control plans and demonstration projects. These projects can include BMPs to curtail urban runoff and also instream activities to reduce erosion, sedimentation, and degradation of water quality, as detailed in Section 319 of the Clean Water Act. On the preventive side, activities such as ordinance implementation and workshops on stormwater BMPs have been funded by IEPA. The IEPA Illinois Clean Lakes Program provides annual grants for lake remediation projects where there is a realistic opportunity for restoration and protection for high quality lakes. IEPA encourages a watershed approach in addressing lake remediation and protection.
Federal Emergency Management Agency (FEMA)	FEMA has several flood hazard mitigation funding programs, administered by the Illinois Emergency Management Agency (IEMA) and described in Section 2.5.8. Some FEMA regulatory floodplain maps for Cook County are inadequate. They do not include water surface elevations or they are out of date because of significant land use and other topographic changes. FEMA has initiated a Flood Insurance Rate Map (FIRM) Modernization Program, which compiles hydrologic and hydraulic (H&H) modeling data for selected map panels in Cook County. IDNR-OWR serves as a local sponsor for this project. The data will be included in a countywide modernization of floodplain maps.
Chicago Metropolitan Agency for Planning (CMAP)	CMAP has historically performed watershed planning, including the Area Wide Water Quality Management Plan developed for all the major watersheds in northeastern Illinois under Section 208 of the Clean Water Act. CMAP assists local governments in developing watershed planning. CMAP has produced a watershed inventory (http://www.nipc.org/environment/sustainable/water/watershed/) that includes a list of watershed plans from various sources and active watershed groups.
IDNR, State Water Survey (IDNR-SWS)	IDNR-SWS runs research centers that gather and maintain scientific data resources used in watershed planning. IDNR-SWS is also involved in planning activities for FEMA map modernization.
U.S. Army Corps of Engineers (USACE)	USACE administers a program for cost-sharing funding for the study, design, and construction of flood control projects. These projects generally are limited to structural flood control measures. If a reconnaissance level study shows that a project is likely to be cost-effective, USACE proceeds with a project analysis, which must be funded locally by 50% matching funds. For approved projects, USACE funds up to

Table 6.1 Summary of Watershed Planning In Cook County

Agency	Description of Watershed Planning
	65% of design and construction costs; the remaining costs are funded by a local or nonfederal sponsor. Sponsors must furnish all required lands, easements, rights-of-way and utility relocations, and also operate and maintain the completed project in perpetuity. Cost-sharing agreements must be negotiated individually with USACE on a project-by-project basis. USACE also provides design services for floodproofing of residences as part of an overall flood control project. This work and most USACE studies are performed with in-house staff.
U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	NRCS has planned, designed, and constructed flood control facilities to address overbank flooding in the Chicago metropolitan region with local sponsors, including the District. It also has performed floodplain management studies and updated floodplain mapping for local governments. In an effort partially funded by Section 319 of the Clean Water Act under the IEPA's direction, NRCS developed the *Illinois Urban Manual,* a technical reference for developers, planners, engineers, government officials and others involved in land use planning, building site development, and natural resource conservation. Applicable in rural, urban, and developing areas, the manual includes BMPs for soil erosion and sediment control, stormwater management, and special area protection. The manual was updated in 2002.
The District	The District designed and constructed the Tunnel And Reservoir Plan to address combined sewer overflow in the combined sewer areas of Cook County. The District has also been involved in many federal and state flood control projects, serving as the local sponsor or providing other forms of cost-sharing.
Municipalities and Townships	Most stormwater planning within a municipality is performed by the municipality itself or completed under its direction. Planning assistance on larger waterways may be initiated by state and federal agencies. Capital improvement projects that address local drainage problems are typically implemented by municipalities. Many communities within Cook County have ongoing stormwater planning efforts that could contribute to the development of DWPs.
Soil and Water Conservation Districts (SWCD)	Cook County has two Soil and Water Conservation Districts (SWCDs); the North Cook County Soil and Water Conservation District and the Will-South Cook Soil and Water Conservation District. The purpose of the SWCDs is to provide information, education and guidance on the conservation and wise use of natural resources.
Lake County Stormwater Management Commission (LCSMC)	SMC conducted a watershed assessment in conjunction with the Friends of the Chicago River. The watershed assessment pertains to the North Branch of the Chicago River within Cook County.
U.S. Geological Survey (USGS)	Through a cooperative program, in which the District participates, the USGS (Illinois Water Science Center) maintains a stream gauging network and publishes an annual report containing daily streamflow data and water quality information for selected sites around the state. The USGS administers funding for site-specific hydrologic and water quality data collection and analysis. Additionally, the USGS provides streamflow, stream elevations, and precipitation data in real-time at http://il.water.usgs.gov/nwis-w/IL/. Some mapping efforts may be fundable through the USGS. USGS funds up to 50% of a project's in-house labor and expenses. On this reimbursable basis, USGS provides technical assistance in developing watershed models and other hydrologic and water quality related assistance. In the past, the USGS has researched and completed studies on emerging technologies in the water resources field.
U.S. Environmental Protection Agency (USEPA)	USEPA provides grants for water quality related planning and demonstration projects under Section 319(h) and 104(b)(3) of the Clean Water Act, as discussed under IEPA's roles and resources in Section 2.5.7. USEPA routinely holds national conferences on stormwater-related topics.

Table 6.2 DWP Standard Outline

1. Executive Summary
2. Introduction
    - 2.1 Scope and Approach
    - 2.2 Goals and Objectives
    - 2.3 Jurisdictional Responsibilities
    - 2.4 Organization of Detailed Watershed Study
    - 2.5 Summary of Problem Areas
    - 2.6 Coordination with Watershed Planning Councils
3. Watershed Characteristics
    - 3.1 General Watershed Description
    - 3.2 Sources of Data
        - 3.2.1 Previous Studies
        - 3.2.2 Floodplain Mapping
        - 3.2.3 Wetland and Riparian Areas Data
            - 3.2.3.1 Wetland Areas
            - 3.2.3.2 Riparian Areas
        - 3.2.4 Water Quality Data
            - 3.2.4.1 Monitoring Data
            - 3.2.4.2 National Pollutant Discharge Elimination System (NPDES) Permits
            - 3.2.4.3 Impaired Waterways
            - 3.2.4.4 Nonpoint-Source Pollution
            - 3.2.4.5 Total Maximum Daily Load (TMDLs)
        - 3.2.5 Stormwater Problem Data
            - 3.2.5.1 Problem Data
            - 3.2.5.2 Watershed Planning Council Coordination
        - 3.2.6 Watershed Analysis Data
            - 3.2.6.1 Monitoring Data
            - 3.2.6.2 Sub-watershed Delineation
            - 3.2.6.3 Drainage Network
            - 3.2.6.4 Topography and Benchmarks
            - 3.2.6.5 Soil Classifications
            - 3.2.6.6 Land use
            - 3.2.6.7 Anticipated Development
        - 3.2.7 Model Selection
4. Watershed Analysis
    - 4.1 Hydrologic Model Development
        - 4.1.1 Sub-area Delineation
        - 4.1.2 Hydrologic Parameter Measurements and Calibration
        - 4.1.3 Model Setup and Unit Numbering
    - 4.2 Hydraulic Model Development
        - 4.2.1 Field Data, Investigation and Existing Modeling Data
        - 4.2.2 Physical Modeling Assumptions and Computational Settings
        - 4.2.3 Model Setup and Unit Numbering
    - 4.3 Calibration and Verification
        - 4.3.1 Gauge Data
        - 4.3.2 Modifications to Model Input Data
        - 4.3.3 Calibration Results
    - 4.4 Existing Conditions Evaluation
        - 4.4.1 Floodplain Delineation
        - 4.4.2 Hydraulic Profiles

Table 6.2 DWP Standard Outline

	4.5	Future Conditions Evaluation
5.	Development and Evaluation of Alternatives	
	5.1	Problem Definition and Damage Assessment
		5.1.1 Flood Damage Curves
		5.1.2 Erosion Damage Curves
	5.2	Technology Screening
	5.3	Alternative Development
		5.3.1 Flood Control Alternatives
		5.3.2 Erosion Control Alternatives
		5.3.3 Water Quality Improvement Alternatives
		5.3.4 Natural Resources and Environment Improvement Alternatives
		5.3.5 Alternative Cost Development Data
	5.4	Alternative Evaluation and Selection
		5.4.1 Data Required for Countywide Prioritization of Watershed Projects
6.	Action Plan	
	6.1	Recommended Improvements
	6.2	Implementation Plan
7.	Summary and Conclusions	

6.3.3.1 Stormwater Problem Data

DWPs will include a comprehensive summary of stormwater problem data within a standardized table. Table 6.3 summarizes the typical fields required within the DWP watershed problem summary table. The watershed problem summary table will include relevant stormwater problem data compiled as part of DWP development, and recommendations on the use of stormwater problem data. Table 6.4 provides descriptions of standard problem categories to be used as a part of the watershed problem summary table. Additional problem categories may arise and will be considered by the District as necessary during the watershed planning process, however problem categories will generally be consistent with those listed in Table 6.4.

Table 6.3 Structure of Watershed Problem Summary Table for DWPs

Table Field	Description
Problem Category	*Refer to Table 6.4 for list of categories.*
Source of Information	Sources of problem information such as member communities, published reports, state and federal agencies, watershed stakeholders, complaints.
Date	Date upon which data were compiled or published.
Project Planned or Underway	In some cases, efforts are planned or underway to address the problem. Identify this in the table as a consideration on the path forward.
Resolution or Action Required	Describe how the data will be acted upon. Describe resolution or planned resolution of problem.

Table 6.4 Problem Category Description

Problem Category	Description
Intercommunity (regional) flooding	Flooding problems that affect more than one community.
Intracommunity (local) flooding	Flooding problems within a community that affect only part of a single community.
Streambank erosion on intercommunity waterways	Streambank erosion along regional waterways that threatens a structure or human health and safety.
Streambank erosion on intra-community (local) waterways	Streambank erosion along local waterways that threatens a structure or human health and safety.
Stream maintenance problems	Debris jams, system failure, restrictions on waterways, etc.
Water quality problems	Observed water quality problems such as odor, spill-related pollution, aesthetically objectionable debris (such as toilet waste), etc.
Environmental degradation issues	Wetland or riparian impacts observed by watershed stakeholders.

6.3.3.2 Existing Watershed Studies

Several local, state, and federal agencies have completed watershed studies and modeling for watersheds within Cook County. Studies and the models used to support them may contain data useful to the development of DWPs. Table 6.5 summarizes some known watershed studies developed by agencies such as IDNR-OWR, USACE, IEPA, or the Illinois Department of Transportation (IDOT). These studies and others will be reviewed as a part of DWP development.

Watershed modeling has been performed for many of the studies listed in Table 6.5. The models may be useful for the development of DWPs or other watershed planning activities to be coordinated by watershed stakeholder groups. Table 6.6 summarizes some of the existing models that were identified for watersheds within Cook County.

IDNR-OWR and IDNR-SWS personnel have identified several other models that have been developed for Cook County watersheds. Many of the models include data that are not fully documented to allow for a complete evaluation of their applicability to DWP development. As a part of developing each DWP, the District will review and discuss the usefulness of existing watershed models for supporting the definition of problem areas, the development and evaluation of improvement projects and possible floodplain mapping revisions. Table 6.7 lists key criteria to be considered in defining the scope of DWP modeling activities.

Table 6.5 Existing Watershed Studies Identified

Watershed	Subwatershed	Title of Study	Agencies	Date	Summary
Calumet-Sag	Stony Creek	Stony Creek, Oak Lawn, Illinois Detailed Project Report	USACE	October 2001	Completed USACE's planning process for a project to reduce overbank flooding along Stony Creek in Oak Lawn. The recommended plan consists of flow diversion, removal of a small weir, and channel clearing downstream.
Calumet-Sag	(Report addresses tributaries)	Calumet-Sag Watershed Floodwater Management Plan Environmental Assessment	The District, NRCS, IDOT (Division of Water Resources)	June 1979	The study estimates floodwater damage in the watershed due to urbanization. It addresses erosion problems, lack of open space and recreational facilities, wetlands, and channel maintenance. Although somewhat dated, the report may be most useful in providing relevant background information.
Chicago River	Chicago River and Waterway System	Draft Use Attainability Analysis (UAA)	IEPA	November 2004	The UAA will help the IEPA understand the changing circumstances of the Chicago River and Waterway System in order to better set water quality standards for the system.
Des Plaines River	Upper Des Plaines River	Final Feasibility Report and Environmental Impact Statement	USACE	June 1999	Evaluated feasibility of, and federal interest in, implementation of a flood damage reduction plan for the Upper Des Plaines watershed located within Lake and Cook Counties. Recommended a plan consisting of the construction of two levee units, expansion of two reservoirs, construction of one lateral storage area, and modification of one earthen dam to add flood storage.
Des Plaines River	Salt Creek TMDLs	Total Maximum Daily Loads for Salt Creek, Illinois	IEPA	October 2004	Describes methods and procedures used to develop chloride and dissolved oxygen TMDLs for Salt Creek. The focus of the report is on water quality, but it contains rainfall, hydrologic, hydraulic, and stream flow information. Salt Creek and its watershed span both Cook and DuPage counties.
Des Plaines River	Farmers/Prairie Creek	Farmers/Prairie Creek Preliminary Strategic Planning Study	IDNR-OWR	October 2005	Studied alternatives for relieving flooding on Farmers/Prairie Creek, a tributary to the Des Plaines River with a watershed in areas of Des Plaines, Park Ridge, Niles, Glenview, and unincorporated Maine Township.
Des Plaines River	Addison Creek	Addison Creek Flood Control Study	IDOT (Division of Water Resources)	1993	Studied existing conditions and alternatives for relieving flooding on Addison Creek, a tributary of Lower Salt Creek. The affected area for the study includes Bellwood, Bensenville, Broadview, Elmhurst, Hillside, Maywood, Melrose Park, North Lake, North Riverside, Stone Park, and Westchester.

Table 6.5 Existing Watershed Studies Identified

Watershed	Subwatershed	Title of Study	Agencies	Date	Summary
Des Plaines River	(Report addresses tributaries)	Des Plaines River Watershed Floodwater Management Plan Environmental Assessment	The District, NRCS, IDOT (Division of Water Resources)	January 1976	The purpose of the study was to reduce flood damage, reduce erosion and sedimentation, protect wildlife habitat, improve water quality, enhance fisheries, provide additional recreation sites and open space. The study includes Lower Salt Creek, located primarily in DuPage County. Recommended flood control facilities, some of which have since been built, are described, as are anticipated impacts. The report contains useful background information.
Little Calumet River	(Report addresses tributaries)	Little Calumet River Watershed Floodwater Management Plan and Environmental Assessment	The District, NRCS, U.S. Forest Service, Illinois Department of Conservation	May 1975	The purpose of the study was to reduce flood damages, provide increased water based recreation, and provide watershed protection and environmental enhancement. Background information may be useful.
Little Calumet River	(Report addresses tributaries)	Little Calumet River Watershed Plan and Environmental Impact Statement	The District, Will-South Cook SWCD, Calumet-Union Drainage District (CUDD), Cook County Board of Commissioners, Villages, Park Districts, IDNR-OWR, NRCS, U.S. Forest Service	November 1978	This study was developed to achieve goals similar to those of the May 1975 study. Planned projects and their impacts are described. Some of the projects have been implemented. Discussion of project impacts is included. Background information is potentially useful.
Lower Des Plaines Tributaries	(Report addresses tributaries)	Lower Des Plaines Tributaries Final Watershed Plan – EIS	The District, SWCDs, NRCS, U.S. Forest Service, Municipalities	September 1987	The purpose of the study was to solve flooding and associated erosion and sedimentation problems, and to address the shortage of water-based recreation. Structural and nonstructural improvement measures are recommended, several of which have been built. Background information may be useful.
North Branch Chicago River	(Report addresses tributaries)	North Branch Chicago River Floodwater Management Plan	The District, NRCS, IDNR-OWR	October 1974	The purpose of the study was to reduce flood damages, provide increased recreational uses, and provide watershed protection and environmental enhancement. The southern limit of the study is Touhy Ave. Alternatives are suggested, including construction of flood control reservoirs that have now been built. The report may be most useful in providing relevant background information.

Table 6.5 Existing Watershed Studies Identified

Watershed	Subwatershed	Title of Study	Agencies	Date	Summary
North Branch Chicago River	(Report addresses tributaries)	North Branch Chicago River Open Space (Green Infrastructure) Plan	LCSMC, Friends of the Chicago River, IDNR-OWR	June 2005	Identifies high quality natural resources recommended for preservation, and open lands suitable for watershed improvement projects. Study is based on analysis of individual parcels. Includes listing of funding sources for land preservation and restoration.
Poplar Creek	(Report addresses tributaries)	Poplar Creek Watershed Floodwater Management Plan Environmental Assessment	The District, NRCS, IDOT (Division of Water Resources)	May 1976	The study estimates floodwater damage in the watershed due to urbanization. It addresses erosion problems, lack of open space and recreational facilities, wetlands, and channel maintenance. Some flood control measures are recommended. Although somewhat dated, the report may be most useful in providing relevant background information.
Upper Salt Creek	(Report addresses tributaries)	Upper Salt Creek Watershed Floodwater Management Plan	The District, North Cook SWCD, Forest Preserve District of Cook County, Villages, Park Districts, IDOT (Division of Water Resources)	May 1973	The purpose of the study was to reduce flood damages and create water related recreation facilities. Five flood control facilities, one multipurpose facility, and channel improvements were recommended and have been implemented. The report contains useful background information.

Table 6.6 Existing Modeling Data For Watersheds Within Cook County

Watershed	Subwatershed	Model Description
Chicago River	Chicago River and Chicago Waterway System	Unsteady flow and water quality model of entire 76-mile navigable waterway system, developed by Marquette University. More information is available at http://www.chicagoareawaterways.org/ Unsteady NETwork Model (UNET) and Hydrologic Simulation Program-Fortran (HSPF) model developed by the USACE.
Des Plaines River	Des Plaines River	Hydrologic Engineering Center-1 (HEC) and HEC-River Analysis System (RAS)
Des Plaines River	Farmers/Prairie Creek	HEC-1 and HEC-RAS
Chicago River	North Branch	HEC-1 and HEC-2
Chicago River	Middle Fork and West Fork	HEC-1 and HEC-2
Little Calumet River	Little Calumet River	HEC-1 and Unsteady-RAS; Illinois Department of Natural Resources-State Water Survey (IDNR-SWS) is updating
Little Calumet River	Stony Creek	HEC-1 and UNET

Table 6.7 Existing Model Use Criteria for DWPs

Category	Criteria for Use in DWPs
Date developed	Model must have been developed reflecting current conditions or have been updated to reflect current conditions unless otherwise accepted by the District to be used for DWPs.
Regulatory acceptance	Model must be the current regulatory model for watershed or otherwise accepted by the District to be used as a part of DWPs.
Data development requirements	Documentation of H&H model data are available and show that the data were developed to be consistent with District and IDNR-OWR minimum standards.
Calibration requirements	Must have been calibrated to a network of rainfall and stream monitoring gauges. Calibration must be documented and show that minimum District standards were met. Alternatively, radar derived precipitation could be used as approved by the District. Exceptions to the calibration requirement must be approved by the District.
Consistency with District modeling application requirements	Must have been developed using a modeling application that meets the District's minimum requirements, or is otherwise approved by the District.

Existing Monitoring Data. Rainfall, stream flow (and stage), and water quality data are available for all the major watersheds within Cook County. Some of the data may be used to support DWP modeling evaluations. Table 6.8 summarizes sources of existing monitoring data. In addition to the data listed, the District collects monitoring data that will be reviewed and utilized as appropriate as a part of DWP development.

Descriptions of USGS stream flowmeters and National Climactic Data Center (NCDC) rain gauge data are provided in Appendixes C and D, respectively.

Geographic Information Systems Data. Several sources of GIS data exist and are available to support watershed planning activities that will occur as a part of DWP development. One primary source of GIS data is Cook County. GIS data from Cook County will be obtained and used as appropriate as a part of DWP development. Section 6.4 identifies several Cook County GIS data sets to be used in DWP development.

Table 6.8 Sources of Existing Monitoring Data

Data	Owning Agency	Description
USGS Stream Flow Data	USGS	USGS stream flow data are available at http://waterdata.usgs.gov/nwis/sw. Appendix C contains a comprehensive list of gauge locations.
IDNR-OWR Stage Data	IDNR-OWR	The IDNR-OWR maintains a network of stage gauges that may have data useful for model calibration.
Rain Gauge Data	IDNR-SWS, NCDC, and USGS	The Cook County Precipitation Network is a dense rain gauge network that the IDNR-SWS has operated in Cook County since the fall of 1989 to provide accurate precipitation data for use in simulating runoff for Lake Michigan diversion accounting. The network consists of 25 rain gauges throughout Cook County, approximately every 5 to 7 miles and representative of the various watersheds within the county. The data are available in digital format at hourly increments from 1989 through 2000, and at 10-minute increments from 2001 to the present. There are 74 locations of rainfall gauges for which data are available within Cook County through the NCDC. Some gauges are no longer active, but past data are available. The time increments of the data vary from gauge to gauge. Table B-1 in Appendix D lists all gauges and information related to the type of data available. Information about obtaining data from all these gauges and associated fees can be found at the NCDC website: http://www.ncdc.noaa.gov. The USGS operates and publishes data from approximately 42 rain gauges in northeastern Illinois, of which 6 are located in Cook County. This data, almost all available in real-time, together with data from other agency rain gauges can be found at http://il.waterdata.usgs.gov/nwis/current/?type=precip&group-key=NONE.
Water Quality Monitoring Data	IEPA	Available from the IEPA Ambient Water Quality Monitoring Network of 213 monitoring sites. More information is available at: http://www.epa.state.il.us/water/surface-water/river-stream-mon.html

6.4 Watershed Data Development

New data developed for DWPs must meet the District standards and specifications described in Table 6.9.

Table 6.9 Watershed Data Development Standards And Specifications

Data Type	Standards Documentation	Summary
GIS Data	District GIS Data Development Standards	Data developed to support DWPs will be consistent with latest available District GIS Standards and Specifications.
Survey Data	District Vertical Datum	Survey data will be developed using the NAD 1983 coordinate system with the Chicago City Datum (CCD) for vertical coordinates (579.48 feet above 1925 mean sea level). DWPs will contain a survey standards document subject to District review prior to initiating any field surveys. If necessary, the District may allow changes to these standards in order to be consistent with unique conditions in watersheds such as those that have upstream or downstream boundary condition models that have been developed in a different coordinate system.
Survey Data	FEMA Guidelines	Survey standards will be consistent with FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A, "Guidance for Aerial Mapping and Surveying*," available at WWW.FEMA.GOV/FHM/DL_CGS.SHTML
DWP Data	Cook County Stormwater Management Plan	All data developed to support DWPs will be consistent with standards provided as a part of this document, or other scoping documents provided by the District.

6.4.1 Watershed Analysis and Floodplain Mapping

The District has developed the following goals for watershed analysis and floodplain mapping that will be applied to the development of DWPs. It is understood that meeting some of these goals may not be possible as a part of DWP development. These goals will be considered and applied wherever the District deems applicable:

- H&H analyses must be consistent with IDNR-OWR and FEMA map revision requirements.
- Hydrology for watershed plans will be determined by a hydrologic model that, where necessary, considers online and offline storage, infiltration, interflow, depressional storage, overland flow, nonuniform rainfall distribution, evapotranspiration, and soil moisture. The output from the hydrologic model must be compatible with the hydraulic model.
- Hydrologic analyses may require cooperative plans for water bodies that cross the District's corporate boundaries, such as the North Branch Chicago River, Little Calumet River, Des Plaines River, Poplar Creek, and Upper Salt Creek.
- Hydraulic conditions for the major watershed plans will be determined by a model that can, at a minimum, analyze the effects of floodplain encroachment, online and offline storage, diversions, channel improvements, bridges, culverts, dams, weirs, and other impediments to flow. The input to the hydraulic model will be compatible with the output from the hydrologic model. Fully dynamic models will be used when channel conditions are extremely flat (for example, slope is less than 5 feet per 1,000) and subject to backwater conditions that make it difficult to approximate storage accurately.

6.4.2 Watershed Modeling

The object of a DWP is to support the development and documentation of a countywide CIP. Understanding stormwater problems and evaluating scenarios to correct them requires the use of models and other watershed analysis tools. The following includes standards for application selection, data development, and calibration of H&H models.

Several steps are involved in applying models to the development of DWPs. First, a model of existing conditions is developed to support calibration and an understanding of existing problems. Second, a baseline conditions model is developed to reflect the conditions expected to be current when the District begins to implement the countywide CIP. This may include modifications to the existing conditions model that reflect projects that are under way and near completion. Finally, the model is modified to evaluate the effectiveness of alternative improvement projects. The guidance provided in Section 6.4.2 applies to all these steps.

6.4.2.1 Screening Considerations

Several H&H modeling applications in the public and private domain are accepted by FEMA and IDNR-OWR to determine floodplain and floodway areas for the National Flood Insurance Program. The applications are summarized in Tables 6.10 and 6.11. Table 6.12 summarizes considerations in the selection of H&H modeling applications. For DWPs, the District will specify the most appropriate H&H modeling application based on the considerations listed in Table 6.12 and specific watershed modeling requirements. In some cases, it may be acceptable to use two or more separate H&H modeling applications within the same DWP.

6.4.2.2 Hydrologic Model Data Development

Hydrologic model data developed as a part of a DWP will be consistent with minimum District standards. District standards have been developed to be consistent with the countywide stormwater management program needs and wherever possible with IDNR-OWR preferences.

Subarea Delineations. Subarea Delineations will be performed using the best available topographic mapping to a level necessary to accurately simulate hydrologic conditions within the watershed. The best available topographic data are those developed by Cook County. Cook County GIS photogrammetry data includes a digital, geospatial GIS file that depicts (through the use of a digital terrain model (DTM), and modeled by a triangulated irregular network) a general surface description for Cook County with a 300-foot buffer beyond the county boundary. The data have been made available to the District and will be used to support Subarea Delineations.

Table 6.10 Hydrologic Models Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
Single event	HEC-1 4.0.1 and upa (May 1991)	USACE	Yes
	HEC-HMS 1.1 and up (March 1998)	USACE	Yes
	MIKE 11 UHM	DHI Water and Environment	No
	PondPack v.8	Haestad Methods, Inc.	No
	SWMM (RUNOFF) 4.30 (May 1994), and 4.31 (January 1997)	USEPA and Oregon State University	Yes

Table 6.10 Hydrologic Models Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
	SWMM 5 Version 5.0.005 (May 2005)	USEPA	Yes
	TR-20 (February 1992)	USDA NRCS	Yes
	TR-20 Win 1.00.002 (Jan. 2005)	USDA NRCS	Yes
	TR-55 (June 1986)	USDA NRCS	Yes
	WinTR-55 1.0.08, (Jan. 2005)	USDA NRCS	Yes
	XP-SWMM 8.52 and up	XP Software	No
Continuous event	DR3M	USGS	Yes
	HSPF 10.10 and up	USEPA, USGS	Yes
	MIKE 11 RR	DHI Water and Environment	No
	PRMS Version 2.1	USGS	Yes
Interior drainage	HEC-IFH 1.03 and up	USACE	Yes

[a]Enhancement of these programs in editing and graphical presentation can be obtained from several private companies.

Note: FEMA periodically updates its list of approved hydrologic models.

Table 6.11 Hydraulic Modeling Applications Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
One-dimensional steady flow models	Culvert Master v.2.0	Haestad Methods, Inc.	No
	HEC-2 4.6.2a(May 1991)	USACE	Yes
	HEC-RAS 3.1.1 and up	USACE	Yes
	HY8 4.1 and up (November 1992)	U.S. Department of Transportation, Federal Highway Administration	Yes
	PondPack v.8	Haestad Methods, Inc.	No
	QUICK-2 1.0 and up (January 1995)	FEMA	Yes
	StormCAD v.4 and v.5	Haestad Methods, Inc.	No
	WSPGW 12.96 (October 2000)	Los Angeles Flood Control District and Joseph E. Bonadiman & Associates, Inc.	No
	WSPRO (June 1988 and up)	USGS, Federal Highway Administration	Yes
	XP-SWMM 8.52 and up	XP Software	No

Table 6.11 Hydraulic Modeling Applications Accepted by FEMA for the National Flood Insurance Program

Type	Program	Developer	Public Domain?
One-dimensional unsteady flow models	FEQ 9.98 and FEQUTL 5.46 (2005, both), FEQ 8.92 and FEQUTL 4.68 (1999, both)	Delbert D. Franz of Linsley, Kraeger Associates; and Charles S. Melching, USGS	Yes
	FLDWAV (November 1998)	National Weather Service	Yes
	FLO-2D v. 2003.6 (July 2003) and 2004.10 (November 2004)	Jimmy S. O'Brien	No
	HEC-RAS 3.1.1 and up	USACE	Yes
	ICPR 2.20 (October 2000) and 3.02 (November 2002)	Streamline Technologies, Inc.	No
	MIKE 11 HD	DHI Water and Environment	No
	Storm Water Management Model (SWMM) 4.30 and 4.31	USEPA and Oregon State University	Yes
	SWMM 5.0.005 (May 2005)	USEPA	Yes
	UNET 4.0	USACE	Yes
	XP-SWMM 8.52 and up	XP Software	No
Two-dimensional steady/unsteady flow models	FESWMS 2DH 1.1 and up	USGS	Yes
	FLO-2D v. 2003.6 (July 2003) and 2004.10 (November 2004)	Jimmy S. O'Brien	No
	MIKE Flood HD 2002 D and 2004	DHI Water and Environment	No
	TABS RMA2 v.4.3 RMA4 v4.5	USACE	Yes
Floodway analysis	PSUPRO	Pennsylvania State University/USACE/FEMA	Yes
	SFD	USACE/FEMA	Yes

[a] Enhancement of these programs in editing and graphical presentation can be obtained from several private companies.

Note: FEMA periodically updates its list of approved hydraulic models.

Table 6.12 H&H Modeling Application Selection Considerations

Consideration	Description
Familiarity to regulatory community	FEMA requirements for modeling to support regulatory floodplain mapping do not exclude the use of many models, but it is clear that many are more acceptable to regulatory review staff than others. The familiarity of regulatory staff at IDNR-OWR and FEMA will be considered as a part of specific H&H modeling application selection.
User base for consistent type of projects	It is common for modelers to look to a broader community of users for advice and support as a part of modeling projects. For example, a SWMM users' e-mail group is commonly used to troubleshoot problems with the application and draw upon the experience of a broad group of users. SWMM users commonly are focused on the application of SWMM to sewer system evaluations. Similar user groups exist for Hydrologic Engineering Center (HEC) modeling applications. Local, regional, and national training seminars and conferences focus on some applications more than others. The existence of an active user base will be considered in the selection of a modeling application.
History of use on floodplain mapping projects	This will be considered as part of the modeling application selection to project ease of permitting for any regulatory activities. The use of an application for projects similar to those faced by the District likely will lead to tools and support programs developed by others that will benefit the District. HEC is the most commonly used national tool for supporting flood control programs similar to the District.
Number of options for simulating open channel hydraulics	Having several options for modeling open channel hydraulics allows for a more accurate representation of field conditions. HEC applications have extensive bridge and culvert crossing options that allow users to develop confidence in results through the application of alternative hydraulic simulation approaches.
Consistency with data developed for existing regulatory models	It may be important to integrate new modeling with existing models. The ability of model output to be used between models may be important. Conversations with IDNR-OWR and experience in the area confirms that HEC software is the most commonly applied modeling application for flood control projects and regulatory floodplain mapping. This is an important consideration in the selection of any modeling application for the District's Stormwater Management Program.
Ability to perform fully dynamic unsteady flow analysis	This may be an important feature that could affect the model results and magnitude of flood control projects identified as a part of this program. Because of the flat terrain of Cook County and surrounding areas, the regulatory floodplains and floodways contain significant storage volumes. Traditional modeling applications use approaches that simulate this storage in a simplified and typically conservative manner. Fully dynamic unsteady flow modeling applications allow for a more explicit simulation of this storage that often leads to results showing more accurate lower floodway elevations.
Availability of vendor provided proprietary interface applications that enhance usability of product	Some models include proprietary modules to increase the functionality of the model. This may be useful as modeling exercises become more complex.
GIS interface capabilities	An important component of watershed modeling will be to integrate the application with GIS software. Most modeling applications listed in Tables 6.10 and 6.11 have GIS interfaces that have been developed to support data development and visualization.

Subarea boundaries will be developed as closed polygons with attribute data that at a minimum include their watershed designation, model name, total area and source of data used for delineation and any other fields specified by the District. Subarea delineation data will be in a format compatible with the District's stormwater GIS. The overall watershed delineation developed as a part of DWPs will be used as the District's official watershed delineation for administrative as well as technical purposes.

Rainfall Data. Observed and design event rainfall data may be used to support H&H modeling performed as a part of a DWP. Observed rainfall data are used as a part of hydrologic model data calibration. Two approaches are typically used to define observed rainfall data. These are the use of rain gauge data or rainfall data developed using radar technology. Both approaches are acceptable and will be used where appropriate as a part of DWPs developed by the District. Table 6.13 specifies how observed rainfall data will be used. Design event rainfall data are used to define flood damages, evaluate alternative improvement projects, and recommend capital improvements. Observed and design event rainfall data developed and used as a part of a DWP will be organized in a database format. Fields required in the table where rainfall data are stored will include year, month, day, hour, minute, and depth (inches).

GIS applications will be used to determine influence areas for rainfall data. For rain gauges, GIS applications will be used to develop Theissen polygon areas that can be intersected with subarea delineations to assign rainfall data for hydrologic modeling. Theissen polygon areas will be created in a GIS format consistent with District standards. If radar derived rainfall data are used, influence areas of rainfall data sets will be provided to the District in a GIS format consistent with District standards.

Table 6.13 Observed Rainfall Data Utilization Criteria

Source of Observed Rainfall Data	Criteria for Application
Rain gauges	Rain gauges that log rainfall data on a 10- to 15-minute increment will be used to support hydrologic model data calibration during storms where spatial distribution of rainfall appears to be adequately captured by the rain gauge network in place. The Cook County Precipitation Network operated by IDNR-SWS records data at 10-minute increments at 25 rain gauges (see Table 6.8). Research was developed to determine the appropriate minimum spacing and coverage requirements, which determined the locations of the rain gauges.
Radar-derived rainfall data	Radar derived rainfall data may be used in large watersheds where the rain gauge network in place is unlikely to sufficiently define the spatial distribution of rainfall occurring over the watershed. The District will review the existing and proposed rain gauge network and historic spatial rainfall distribution patterns to provide justification for the use of radar derived rainfall data.

Design Event Rainfall Data. Design event rainfall data are used as a part of the H&H modeling that is performed to support the identification of flooding problem areas, flood damage curves and the development and evaluation of alternative improvement projects. The standard source of rainfall depth and distribution data for H&H model evaluations will be the sectional frequency distribution of rainfall for given recurrence intervals as listed in Bulletin 70 or Bulletin 71 with Huff Distribution or the data most recently adopted by IDNR-OWR for use in hydrologic modeling. Bulletin 71 provides guidance on which Huff distribution will be used (1st, 2nd, 3rd, or 4th quartiles) with storms of various durations.

To determine the critical or most extreme duration storm for each recurrence interval storm considered as a part of DWP development, a critical duration analysis will be conducted. To be consistent with IDNR-OWR requirements, the critical duration analysis must include at least the simulations of 1-, 3-, 6-, 12- and 24-hour duration storms.

Infiltration Rates and Capacities. The most common method used to determine loss rates and runoff volumes in Cook County has been the Soil Conservation Service (SCS) Curve Number method. The method is acceptable for the hydrologic modeling that is performed as part of a DWP. Other methods may be used when appropriate at the discretion of the District. When using the SCS Curve Number method, the modeler will follow guidance contained in Urban Hydrology for Small Watersheds (USDA NRCS, TR-55, June 1986) or as approved by the District.

Runoff and Overland Flow Parameters (Existing and Future). Impervious area coverage, aerial photography, topographic mapping, soils groups mapping and other soils data, land use mapping, and other land use data all will be used to determine watershed areas, flow paths, slopes, lengths, time of concentration, and any other parameters necessary to support developing stormwater runoff hydrographs consistent with the guidance within USDA NRCS TR-55 or as approved by the District.

Unit Hydrograph/Routing. Unit hydrographs acceptable for routing runoff include SCS dimensionless, Clark, or Snyder. A user-specified unit hydrograph may be used for a watershed if enough quality data are available for it to be properly derived from observed rainfall and runoff.

6.4.2.3 Hydraulic Model Data Development

Channel Cross Section Data. Channel cross sections used within hydraulic modeling applications will be obtained through field surveys that meet survey standards described in Table 6.9. Field survey efforts will include the determination of the appropriate Manning's roughness parameters based on observations of characteristics that include surface roughness, vegetation, channel size, channel shape, channel alignment, and obstructions. If observed water surface profile information is available in the form of gauge data, calibration of Manning's "n" values is possible and desirable.

Open Channel Hydraulics by V. T. Chow (McGraw-Hill 1959; reissued 1988) contains excellent guidance for determining Manning's "n" values for a wide range of rivers and streams. The USGS Illinois Water Science Center has computed Manning's "n" values at many representative urban and rural sites in Illinois, available at http://il.water.usgs.gov/proj/nvalues/. Figure E-1 in Appendix E is an example of the type of form to be used to document Manning's "n" values in the field. Separate Manning's "n" values are generally appropriate to be used for the channel and the overbanks. The typical channel cross section template form in Figure E-2 in Appendix E is an example of the type of form that will be used to gather cross-sectional data during a survey.

Bridge and Culvert Crossings. Bridges and culverts generally will be modeled as existing. For the baseline conditions model, bridge or culvert replacement projects that are under construction or in the late stages of the planning process and unlikely to be revised may be modeled as proposed. The model must account for bridge deck, piers, abutments, and embankment side slopes.

Storage Areas. Storage areas that are simulated as a part of hydraulic modeling will be represented with stage-area or stage-volume relationships developed from best available topographic information and discharge rating curves developed according to hydraulic properties of the controlling device.

Downstream Boundary Conditions. Downstream boundary conditions for hydraulic analysis will be based on known water surface elevations when available. If the water surface elevation is unknown at the downstream end of the study reach, normal depth will be used at a location further downstream so as not to have influence on the profile. To test whether the starting cross section is sufficiently downstream for a given discharge, the distance is varied until the water elevation at the project boundary does not change appreciably, which indicates that the profile will not be affected by the starting elevation.

6.4.2.4 Steady State vs. Unsteady Flow Analysis

If there is reason to believe that a steady-state model would inadequately represent actual hydraulic conditions, such as extremely flat slopes (Froude number < 0.1) or flow restrictions that may cause significant storage within the channel or situations with reverse flow, then unsteady-state modeling will be considered and used where necessary.

6.4.2.5 Critical Duration Storm Analysis

A critical duration storm analysis (CDSA) will be performed and documented as a part of design event simulations performed to develop flood damage curves. A CDSA is performed for each problem area to identify the duration storm that produces the critical water surface elevation and level of damage. CDSA involves running a range of duration storm events for a given recurrence interval to determine which duration storm is critical. Generally, this duration is somewhere near the time of concentration of the watershed tributary to a given point. The IDNR-OWR generally requires a CDSA as a part of the regulatory map revision process.

6.4.2.6 Model Calibration and Verification

Calibration must be performed in developing defensible H&H models representative of actual conditions. High water marks, historic floods, or other stream gauge data will be used to compare with model results and adjust model parameters, typically the roughness coefficients. The final calibrated model must not contain model parameters outside their "reasonable" bounds, although it may be permitted when performing model sensitivity analyses. If enough data exist, the model will be validated by comparing calibrated model results to a set of data that was not included in the calibration.

H&H model data will be calibrated to a point where the runoff volume and stream flow rates are within roughly 30 percent of the data recorded at stream gauges. Water surface elevations will match within 6 inches. In some cases, where rain gauge data are used to support calibration, it is not possible to adjust H&H model data with confidence when the spatial distribution of rainfall appears to be inadequately captured and reflected in the model.

6.4.3 Floodplain Mapping

To ensure that H&H modeling performed as a part of a DWP can be utilized for future FEMA FIRM remapping efforts, the District will require that all modeling performed be consistent with current IDNR-OWR and FEMA standards. Both agencies have published standards that will be followed: *Floodplain Map Revision Manual* (March 1996) published by IDNR-OWR and *Guidelines and Specifications for Flood Hazard Mapping Partners* published by FEMA, available at http://www.fema.gov/fhm/gs_main.shtm. It is not a specific goal of the DWPs to replace or revise the current FEMA FIRM maps. However, if a substantial error in the current regulatory maps is identified during a DWP, the District may consider requesting a map revision from FEMA. As the CIP progresses, a decision will be made as to whether the District or the benefiting local government entity will pursue map revisions necessary to reflect the implementation of future flood control projects.

6.5 Problem Area Identification

Stormwater problem areas will be identified through stakeholder involvement, such as WPC meetings, discussion with other agencies, and logs of complaints. They will also be identified and confirmed as a part of the DWP. DWP reports will summarize relevant and known stormwater problem areas and also watershed analyses to confirm the magnitude of flooding problems.

6.5.1 Flooding Problem Areas

Flooding problems are defined as flooding of residential, commercial, industrial and public buildings, or transportation facilities that are critical to the economy and emergency services. H&H models will be the primary method for evaluating flooding problem areas. H&H models will be used to define water surface elevations for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms. These elevations will be compared with top of foundation and first floor elevations for properties within the floodplain to develop flood damage curves. The methodology for developing flood damage curves and data required to support them are described in Section 6.6.

In some instances flooding may result from non-riverine sources, such as depressions in the ground surface that are inundated by the water table. The majority of such depressional flooding instances are expected to be confined to a single community, and therefore will not be addressed in a DWP. However, cases where depressional inundation results in inter-community flooding will be addressed with the DWP, in conjunction with the District, on a case by case basis.

6.5.2 Erosion Problem Areas

Erosion problems are defined as streambank erosion along waterways that could result in property damage or a risk to human health and safety. As part of a DWP, the District will require an evaluation of streambank conditions to generally identify areas where erosion appears to meet these criteria. Special attention will be paid to areas where the District or other stakeholders have received complaints about erosion problems that are threatening structures or posing a risk to human health and safety. The District will visit the erosion problem areas identified and document existing conditions to support the evaluation of alternatives. Site visits will include the collection of survey data that is necessary to prepare conceptual level plans and cost estimates for alternative improvement scenarios.

6.5.3 Maintenance Problem Areas

Maintenance problems are defined as restrictions on drainage caused by accumulation of debris. They will be identified through field visits by District staff or through stakeholder identification. Further information on maintenance can be found in Section 5.4. Efforts to identify the agencies responsible for maintenance within the watershed will be undertaken in the DWPs.

6.5.4 Water Quality Problem Areas
Water quality problem areas are identified in the IEPA's 303d Report. As discussed in Chapter 4, the report provides a comprehensive summary of waterways within the state of Illinois where water quality standards or listing criteria are not met. Water quality benefits provided by projects planned as a part of DWPs will be shown in qualitative terms as a part of the documentation of improvement projects identified. During development of the draft CCSMP, the District went to great lengths to identify methods accepted by other agencies, such as the USACE and the IDNR-OWR, for determining the economic value of ecosystem impacts and water quality improvement to no avail. Therefore, until an acceptable method is identified and approved by the District, the water quality improvement and ecosystem impact facets of a project will be considered as non-economic factors.

6.5.5 Wetlands, Floodplains, and Riparian Environment at Risk
Wetland, floodplain, and riparian areas will be identified as a part of a DWP. Wetland areas are identified on National Wetland Inventory (NWI) mapping. GIS data for NWI mapping are available on the Web (http://www.fws.gov/nwi/) for download and incorporation into DWPs. Floodplain areas are delineated for many of the Cook County regional waterways and will be summarized as a part of a DWP.

Riparian zones generally are not delineated for Cook County waterways and will be defined as a part of a DWP. Wherever possible, a desktop evaluation of aerial photography or other available field data will be the method for identifying riparian zones. Riparian zones generally are defined as the interfaces between terrestrial and aquatic ecosystems. For the purpose of DWP development, riparian areas will be defined as any vegetated area adjacent to a waterbody that is occasionally inundated by floodwaters resulting in periodic hydric soil conditions. The frequency of inundation impacts the nutrient loads of riparian areas, as well as the soil conditions and plant community composition. The 10-yr delineated floodplain will be used to characterize inundation. For stream reaches where flood frequency data is not available, riparian delineation will attempt to capture the functional relationship between periodic inundation and species diversity in the floodplain.

6.6 Estimates of Existing Damage

Estimating existing damages is the first step in defining the extent of problem areas. Damage estimates defined as a part of a DWP will focus on the economic damages caused by flooding and streambank erosion. Economic damages are estimated by summing damages from four categories:

- Property damage resulting from flooding (residential and commercial)
- Streambank erosion damage
- Transportation damage
- Recreation damage

The following subsections provide guidance on the economic valuation of damages and benefits that will be included as a part of DWP development.

6.6.1 Property Damage
Property damage caused by flooding includes structural damage to buildings (residential, commercial, industrial, and public) and loss of building contents (equipment, furnishings, raw materials, and inventory). The extent of property damage depends on the severity of the

flood. For riverine flooding typical of Cook County, severity is dictated primarily by flooding levels and by high flow velocities and the duration of flooding. A floodplain inventory is necessary to understand the assets that are at risk. H&H modeling is used to define water surface elevations for several storm events of varying probability of occurrence and to understand the impact on properties within the floodplain.

Table 6.14 summarizes data requirements for this analysis and suggested data sources. Several public domain applications are available to support the development of average annual damages (AA_D) curves using the data listed in Table 6.14 and consistent with the USACE's National Economic Development (NED) methodology.

Table 6.14 Property Damage Calculations

Data Requirement	Source
Flood stage elevations for 2-, 5-, 10-, 25-, 50-, and 100-year storms.	H&H modeling based on guidance contained in Section 6.4. For DWPs, flood stage elevation (floodplain boundaries) will be developed consistent with GIS standards and specifications provided by the District.
Surveyed property and structure Locations	Based on surveys performed during DWP development or acceptable estimates based on topographic data and visual inspections.
Zero-damage elevations for each structure	Based on surveys performed during DWP development or acceptable estimates based on topographic data and visual inspections.
Assessed value of each asset	Cook County tax parcel data.
Valuation of contents of structures	Recommended assumptions: For residential structures, contents are 50% of the replacement value of the structure. For commercial, industrial, or public facilities, contents are 90% of the replacement value of the structure. More specific information can be substituted, if it can be easily obtained through interviews or additional data gathering.

In general, based on the flood stage calculated using H&H models, damages are calculated for six storm events: 2-, 5-, 10-, 25-, 50-, and 100-year. Once the damages are calculated, a damage curve is developed by plotting the value of damages versus the exceedance probability. The AA_D value, which can be determined by calculating the area under the damage curve, is essentially the sum of all the damages weighted by their probability of occurrence.

Appendix F contains a more detailed description of the NED methodology for determining property damages including the development of damage curves and performing benefit-to-cost (BC) analysis.

6.6.2 Streambank Erosion Damage

Streambank erosion damage will be calculated in a manner similar to property damage calculations. Surveys performed by the District will determine where streambank erosion is likely to cause property damage. In such cases, the valuation of the structure and the contents of structures deemed to be at imminent risk will be included. Therefore, frequency determinations are unnecessary, and evaluations will focus on effectiveness for the full range of expected flows, particularly bank full-flow ranges. Only actual property damage to structures will be included in the damage calculation. Loss of land will not be considered.

6.6.3 Transportation Damage

The following damages in the transportation category will be quantified for the purposes of damage assessment:

- Physical damages to roads, bridges, traffic signal installations, and sewers
- Emergency response costs
- Traffic delay or disruption

Transportation damages will be calculated using the following tiered approach:

Tier 1—If avoided transportation damages are not expected to be a significant component of the project, then a 15 percent markup of total property damage should be used to account for indirect damages. This methodology is consistent with the IDNR-OWR's common approach to damage assessment, which includes physical damages, emergency response costs, and traffic delays or disruptions, and is intended to cover such costs as public works staff time, lost wages for residents, and other associated damages.

Tier 2—If the traffic delay component of the project is expected to be more significant, then a more detailed traffic delay analysis will be performed and included as an addition to the 15 percent markup. The methodology used for this analysis will be site-specific and will be approved by the District.

Tier 3—If historic information obtained during DWP preparation shows that flooding in the area has been known to cause significant transportation damage, then project-specific transportation damage curves will be developed in place of the 15 percent markup. An example of this may be that bridges in a particular project area are of high value and vulnerable to flood damages; therefore, the 15 percent markup would not be high enough to account for the damage expected to these bridges. These project-specific damages will be calculated using the formula

$$D_x = F_x Q_x$$

where:

D_x = the monetary damages derived from a particular flood event; e.g., damages for a 2-year flood

F_x = multiplication factor incorporating cost; e.g., cost of project-specific bridge replacement

Q_x = the quantity of the particular facility affected by the flood event; e.g., number of bridges affected by the flood

Specific cost factors and inputs to be used to calculate damages for each transportation cost component will be developed using historic information. As with property damages, transportation damages will be calculated for each flooding event, developed into a damage curve, and then converted into an AA_D. The AA_D is determined by calculating the area under the damage curve. Appendix F contains a detailed explanation of this procedure.

6.6.4 Recreation Damages and Benefits

Recreation damages are incurred through the loss of the use of parks, forest preserves, or other recreational facilities. Recreation benefits can accrue from damages avoided and by the creation of recreation areas as part of a flood control project. Several methods have been developed to calculate recreational damage/benefit. The unit day value (UDV) method will be used for recreational damage or benefit calculation as a part of DWPs. The UDV method relies on annually published studies by the USACE that estimate dollar damages per day ($ person-day) that are accrued based on a point rating. The point rating system includes five criteria related to: available activities, facilities, relative scarcity, ease of access, and aesthetics. Appendix G contains USACE's 2006 published study, which is updated annually. The general formula for calculating damages is:

$$D_x = F_x V_x L_x$$

where:

D_x = the monetary damages derived from a particular flood
F_x = multiplication factor incorporating the UDV
V_x = the average number of daily visitors to a recreational facility
L_x = Length of impact in days

Unless site-specific information can be readily developed, the values contained in Appendix H (Table H-1) will be used to calculate recreational damages or benefits. This table will be evaluated annually to determine if updates are required.

Similar to property and transportation damages, recreation damages must be calculated for each flood event, developed into a damage curve, and then converted into an AA_D for recreation facilities. The AA_D can be determined by calculating the area under the damage curve. Appendix F contains a detailed explanation of the procedure.

6.6.5 Final Calculation

Once damages are calculated for each flood event, a damage curve will be developed for the sum of all damages from each category, and then converted into an overall AA_D. The AA_D can be determined by calculating the area under the damage curve. Appendix F contains a more detailed explanation of this procedure. Table 6.15 summarizes the valuation of damages and benefits proposed in the sections above.

Table 6.15 Summary Recommendation for Economic Valuation

Type of Damage and Benefit	Description	Valuation Method
Property Damage from Flooding		
Residential property —structural damage	Avoided structural damage to residences.	Follow USACE NED guidance. Use HEC-Flood Damage Assessment (FDA) or IDNR-OWR's damages model. Property valuation will be based on assessed value obtained from Cook County tax records.
Residential property—contents	Avoided damage to contents within residences.	Assume 50% of structural damage to account for residential contents.
Industrial commercial property—structural damage	Avoided structural damage to industrial/commercial property.	Follow USACE NED guidance. Use HEC-FDA software or IDNR-OWR's damages. Research individual building types through interviews and other data collection.
Industrial/ commercial property—contents	Avoided damage to contents within industrial/commercial property.	Assume 90% of structural damage unless information can be obtained through interviews and other data collection.

Table 6.15 Summary Recommendation for Economic Valuation

Type of Damage and Benefit	Description	Valuation Method
Streambank Erosion Damage		
Erosion damage	Damages from erosion.	Similar to structural damage, except include damage in areas where erosion is the cause of structural damage rather than flooding. Only structural damage will be included in the valuation, loss of land will not be considered.
Transportation Damage		
Transportation—physical damage and emergency response costs	Physical damage to roads, bridges, and utilities, as well as damages resulting from police, fire and emergency rescue costs.	Assume 15% of property damages (structural plus contents) for indirect transportation damages (this includes both physical damage and emergency response costs).
Transportation damage—operation and delay costs	Damage from additional vehicle operation, and loss of productivity.	Operational delay is considered when the flood elevation reaches 0.5 foot above the low roadway elevation. If significant, estimate damages based on estimated cost of delay.
Transportation damage—vehicles	Damage to vehicles.	Not included for District transportation damage calculations. Assume most vehicles will be removed from flooded areas before damage can occur.
Other damages—income loss	Damage from lost wages of workers that cannot be transferred out of a flooded area.	Not included. Assume that work can be transferred out of the flooded area. (*Note:* The likelihood of an event extreme enough to cause income loss is small.)
Other damages — relocation costs	Damages from additional living expenses of residences required to temporarily relocate.	Not included for District transportation damage calculations. Assume that living expenses are small relative to property damage.
Recreation Damage and Benefit		
Parks and forest preserves	Damage incurred from the loss of use of parks, forest preserves, or other recreation areas. Benefits accrued from the development of new recreation areas created by an alternative will be valued (see Section 6.6.4)	USACE Economics Guidance Memorandum, 07-03 dated November 20, 2006, unit day values for recreation, fiscal year 2007, which estimates $/person-recreation day. This calculation can be used to calculate damages in recreation areas as well as benefit from recreation area created.
Wetland and Riparian Areas		
Wetlands and riparian habitat	Existing damage to wetlands and riparian habitats will not be included in the baseline damages valuation. Damage caused by an alternative will be mitigated and included in the overall cost of an alternative. Benefit from additional wetlands or riparian habitat created by an alternative will be valued (see Section 6.7.3.1).	Not included in damage calculation. For benefit calculations use the market rate of wetlands and riparian habitat from a wetland bank in the appropriate watershed.
Water Quality		
Water quality	Damages from impaired water quality, both ecological and regulatory.	Not included until an acceptable method is developed.

6.7 Alternative Development and Evaluation

Once problem areas are defined (Section 6.5) and damages quantified (Section 6.6), then alternatives to reduce the damages associated with the problems will be developed and evaluated. Several alternatives will be developed and evaluated for each problem area. For flooding problem areas, alternatives will provide a varying level of protection. In other words, some alternatives will address lower recurrence interval storms such as the 15-year storm, and others will address higher recurrence interval storms such as the 100-year storm. Once alternatives are developed, they will be evaluated based on their BC ratio or net benefit.

The enacting legislation, Public Act 93-1049, in which authority was granted to the District for the responsibilities of stormwater management for Cook County, stipulates that BC analysis is required during deliberations for capital project selection. However, the District's Board of Commissioners is not required to select projects solely on BC analysis. They may also decide to consider noneconomic criteria in the selection of alternatives for each problem areas. Information about noneconomic criteria will be summarized for each project so that it can be included as a consideration in the countywide prioritization of stormwater improvement projects. The ultimate decision for funding of any capital project is at the discretion of the District's Board of Commissioners.

Section 6.7 is generally organized according to the steps to be followed as a part of alternative development and evaluation. Alternative development and evaluation will be performed as a part of DWPs. Table 6.16 summarizes the general steps for development and evaluation of alternatives.

Table 6.16 Summary of Alternative Development Sections

CCSMP Section Number	Alternative Development and Evaluation Step	General Overview
6.5	Define problem areas	Use guidance in Section 6.5 to identify and define the magnitude of problem areas.
6.7.1	Identify alternatives	Use technology guidance provided in Section 6.7.1 and information on watershed to identify alternatives that can help resolve problems in problem areas.
6.7.2	Evaluate alternatives	Evaluate alternatives for effectiveness addressing problem areas. This will primarily focus on the evaluation of the effectiveness of flood control alternatives using H&H modeling consistent with protocol established in Section 6.4. Streambank erosion control alternatives will focus on bank-full conditions.
6.7.3	Estimate conceptual cost of alternatives	Use unit costs, markups, and other guidance provided by the District to estimate the conceptual cost of alternatives.
6.7.3	Evaluate cost-effectiveness of alternatives	Use the damages defined in Section 6.6 and the conceptual cost estimates to determine the BC ratio for each alternative. Use the BC ratio to determine whether alternatives address problem areas cost-effectively.
6.8	Summarize recommended projects for each problem area and define noneconomic criteria	Develop lists of projects recommended throughout the watershed for each problem area. Alternatives that have the highest BC ratio (net benefit) generally will be recommended for each problem area. Also summarize noneconomic data for each problem area to be used as a part of District's countywide prioritization of improvement projects.

6.7.1 Technology Guidance and Alternative Identification

Many acceptable technologies can be used alone or in combination to form project alternatives to remediate existing stormwater problems. Where opportunities exist, projects funded by the District will incorporate BMPs that provide secondary water quality benefits. Section 6.7.1 provides guidance on the use of technologies in developing alternatives to remediate flooding and erosion problems.

6.7.1.1 Flood Control Technologies

As described in Section 6.5, flooding problems occur when flood waters reach structures, transportation facilities, utilities, critical facilities, or recreation areas. Damages arise from the effects on the facilities and their contents, as well as the consequences of loss of service. Table 6.17 contains descriptions of technologies that can remediate flooding problems and also general guidance on their use for the development of alternatives. The technologies will be used as appropriate for the development of flood control alternatives as a part of a DWP.

Technologies listed in Table 6.17 are summarized in terms of their ability to remediate flooding problems. It is assumed that these technologies would be implemented along with a regulatory program that requires measures to prevent future flooding problems. Without measures to prevent future flooding problems, such as site discharge restrictions, the technologies may not prove as effective in the future as when they originally were designed and implemented.

Table 6.17 Summary of Flood Control Options

Flood Control Option	Description
Detention/Retention	
Detention facilities	Impoundments to temporarily store stormwater. This centralized technology includes wet basins, stormwater wetlands, regional facilities, and flood control reservoirs.
Retention facilities (Wet basins)	Impoundments to permanently store stormwater and remove it through infiltration and evaporation. Retention facilities generally have an outfall to the receiving waterway that is located at an elevation above the permanent pool.
Underground detention	A specialized form of storage where stormwater is detained in underground facilities such as vaults or tunnels.
Bioretention	Decentralized microbasins distributed throughout a site or watershed to control runoff close to where it is generated. Runoff is detained in the bioretention facilities and infiltrated into the soil and removed through evapotranspiration.
Conveyance Improvement	
Culvert/bridge re-placement	Enhancement of the hydraulic capacity of culverts or bridges serving as stream crossings through size increase, roughness reduction, and removal of obstacles (for example, piers).
Channel improvement	Enhancement of the hydraulic capacity of channels by enlarging cross sections (for example, floodplain enhancement), reducing roughness (for example, lining), or channel realignment.
Flood Barriers	
Levees	Earth embankments built along rivers and streams to keep flood waters within the channel.
Floodwalls	Vertical walls typically made of concrete or other hard materials built along rivers and streams to keep flood waters within the channel.
Relocation	
Buyouts	Acquisition and demolition of properties in the floodplain to eliminate flood damages.
Building relocation	Relocation of buildings (typically houses) to higher ground to remove them from the floodplain. This technology requires purchasing new land and transporting buildings to new locations.
Elevation	Modification of a structure's foundation to elevate the building above a given flood level. Typically applied to houses.
Floodproofing	
Dry floodproofing	Installation of impermeable barriers and flood gates along the perimeter of a building to keep flood waters out. Typically deployed around commercial and industrial build-ings that cannot be elevated or relocated.
Wet floodproofing	Implementation of measures that do not prevent water from entering a building but minimize damages; for example, utility relocation and installation of water resistant materials.

Note that sometimes applications of flood control technologies to address problems in one location may aggravate problems in another location (for example, conveyance improve-ments reduce flooding upstream but may worsen conditions downstream). Therefore, the potential applications of flood control technologies to address problems will not be analyzed in isolation. No alternative recommended as a part of a DWP may create negative impacts within the watershed or outside of the watershed, including areas lying outside of Cook County.

6.7.1.2 Erosion Control Technologies

As described in Section 6.5, streambank erosion can result in property damage or a risk to human health and safety. Damages arise from the effects on the facilities and their contents, as well as the consequences of loss of service. A description of appropriate technologies that can remediate existing streambank erosion problems and general guidance on their utilization for the development of alternatives, is presented in Table 6.18.

Table 6.18 Streambank Erosion Control Options

Control Option	Description
Natural (vegetated or bioengineered) stabilization	The stabilization and protection of eroding overland flow areas or streambanks with selected vegetation using bioengineering techniques. The practice applies to natural or excavated channels where the streambanks are susceptible to erosion from the action of water, ice, or debris and the problem can be solved using vegetation. Vegetative stabilization is generally applicable where bankfull flow velocity does not exceed 5 ft/sec and soils are more erosion resistant, such as clayey soils. Combinations of the stabilization methods listed below and others may be used.
Vegetating by sodding, seeding or planting	Establishing permanent vegetative cover to stabilize disturbed or exposed areas. Required in open areas to prevent erosion and provide runoff control. This stabilization method often includes the use of geotextile materials to provide stability until the vegetation is established and able to resist scour and shear forces.
Vegetated armoring (joint planting)	The insertion of live stakes, trees, shrubs and other vegetation in the openings or joints between rocks in a riprap or articulated block mat (ABM). The object is to reinforce riprap or ABM by establishing roots into the soil. Drainage may also be improved through extracting soil moisture.
Vegetated cellular grid (erosion blanket)	Lattice-like network of structural material installed with planted vegetation to facilitate the establishment of the vegetation, but not strong enough to armor the slope. Typically involves the use of coconut or plastic mesh fiber (erosion blanket) that may disintegrate over time after the vegetation is established.
Reinforced grass systems	Similar to the vegetated cellular grid, but the structural coverage is designed to be permanent. The technology can include the use of mats, meshes, interlocking concrete blocks, or the use of geocells containing fill material.
Live cribwall	Installation of a regular framework of logs, timbers, rock, and woody cuttings to protect an eroding channel bank with structural components consisting of live wood.
Structural stabilization	Stabilization of eroding streambanks or other areas by use of designed structural measures. Structural stabilization is generally applicable where flow velocities exceed 5 ft/sec or where vegetative streambank protection is inappropriate.
Riprap	A section of rock placed in the channel or on the channel banks to prevent erosion. Riprap typically is underlain by a sand and geotextile base to provide a foundation for the rock, and to prevent scour behind the rock.
Interlocking concrete	Interlocking concrete may include A-Jacks®, ABM, or similar structural controls that form a grid or matrix to protect the channel from erosion. A-Jacks armor units may be assembled into a continuous, flexible matrix that provides channel toe protection against high velocity flow. The matrix of A-Jacks can be backfilled with topsoil and vegetated to increase system stability and to provide in-stream habitat. ABM can be used with or without joint planting with vegetation. ABM is available in several sizes and configurations from several manufacturers. The size and configuration of the ABM is determined by the shear forces and site conditions of the channel.

Table 6.18 Streambank Erosion Control Options

Control Option	Description
Gabions	Gabions are wire mesh baskets filled with river stone of specific size to meet the shear forces in a channel. The gabions are used more often in urban areas where space is not available for other stabilization techniques. Gabions can provide stability when designed and installed correctly.
Grade Control	Grade control measures may be used to prevent stream incision into the channel bed or upstream nickpoint migration. Grade control measures involve some means of stabilizing the channel bed at a desired elevation with natural materials such as rocks or logs, or in some situations concrete. Rock vortex weirs, rock cross vanes, and log drops are means of grade control that impede channel incision and often result in scour pools developing downstream of the grade control measure.
Concrete channels	A constructed concrete channel designed to convey flow at a high velocity (greater than 5 ft/sec) where other stabilization methods cannot be used. May be suitable in situations where downstream areas can handle the increase in peak flows and there is limited space available for conveyance.
Outlet stabilization	Prevent streambank erosion from excessive discharge velocities where stormwater flows out of a pipe. Outlet stabilization may include any method discussed above.

USDA NRCS and IEPA. *Illinois Urban Manual.* 2002

Sometimes applications of streambank erosion control technologies to address problems in one location may aggravate problems in another location (for example, lining a channel in one location may exacerbate streambank erosion at another location). Therefore, application of streambank erosion or grade control technologies to address problems must not be analyzed in isolation. As stated previously, no alternative recommended as a part of a DWP may create negative impacts in the watershed or outside of the watershed including areas outside of Cook County.

Bioengineering techniques for stabilizing water body shorelines provide more natural solutions than hard armoring. Hard armoring, which protects the bank with concrete, riprap, or other nonnatural materials, is sometimes necessary when a bioengineered solution will not provide the necessary level of protection or cannot withstand flow velocities. In preparing a DWP, consideration will be made to allow only the minimum necessary amount of hard armoring. The DWP will consider the use of bioengineering techniques where appropriate. A combination of treatments will likely be suggested to maximize durability.

6.7.2 Alternative Evaluation

Alternatives developed to address flooding will be evaluated using H&H modeling consistent with methodologies described in Section 6.4. Modeling will determine the avoided damages or benefit for each alternative. The avoided damage or benefit will be used to calculate the BC ratio for each alternative.

Frequency determinations are unnecessary in evaluating alternatives developed to address erosions problems. Evaluations will focus on effectiveness for the full range of expected flows, particularly the bank full flow ranges. Costs will be considered, but not using the multistorm approach applied for flood damages.

6.7.3 Evaluating Cost Effectiveness of Alternatives

BC ratio is determined by calculating the benefit of a project in terms of avoided damages or benefit added, and the construction and operation and maintenance (O&M) costs associated with a project. Section 6.6 provides a description of the process to be followed to determine the benefit or damages for problem areas. Benefits are then divided by the cost to obtain an indicator of the cost effectiveness of each project. Net benefit can also be calculated by subtracting the cost from the benefit.

6.7.3.1 Benefit Calculation

In economic terms, benefit is the dollar value of the damages avoided because of implementation of an alternative (flood control project, soil stabilization project, buyouts). Benefits are calculated by determining damages without a project minus damages with a project; that is, damages avoided. Benefits can include the added value of recreation facilities, wetlands, or riparian areas. As explained in Appendix F, benefits can be expressed as a present value, PV_B, or can be annualized to obtain the average annual benefits AA_B.

Recreation Areas. If the project creates recreation areas, the value will be included as a benefit to the project using the economic valuation method described in Section 6.6.4. Recreation benefit, once created, can be assumed to accrue annually over the life of the project.

Wetlands and Riparian Areas. If the project creates wetlands or riparian areas, their value will be included as an economic benefit of the project. The value of wetlands and riparian areas is calculated based on the market rate of wetlands in the watershed. Appendix H provides the 2006 market rate for wetlands by watershed (Table H-2). The values are variable and will be confirmed annually.

6.7.3.2 Costing Assumptions

Project costs involve all expenditures necessary for implementation. For traditional flood control projects such as levees or reservoirs, they include study, design, land acquisition, construction, and O&M costs. For a residential buyout, there is a one-time cost to purchase structures in the floodplain, including demolition of the structures, restoration of the land, relocation and closing costs. Floodproofing costs may be represented by one-time costs of utility relocation and the occasional complete replacement of flood shields.

Flood protection projects provide benefits throughout a defined period of time that depends on the useful life of a project. A levee may have a useful life of 50 years, whereas relocation of a house outside the floodplain is a permanent solution. Every year that the project performs its functions, it provides benefits and, in principle, requires some expenditure, although most of the cost is incurred during construction. Therefore, the concept of annualizing is applied to compare these unevenly distributed benefits and costs.

Annualizing benefits and costs is a basic concept of engineering economics that accounts for the time value of money. To calculate the annual payment, benefits accrued and the costs incurred every year are discounted using compound interest procedures. The typical discount rate is set by the federal government and is also used by IDNR-OWR. Recently it has varied between 3 and 7 percent. In 2005, the value used by IDNR-OWR for discounting was 5.375 percent. The District will validate the discount rate annually. If the life expectancy of facilities is less than the period for which benefits are calculated, then replacement costs must be incorporated to account for the total cost of facilities for the entire time period.

Standard engineering economics textbooks provide formulas for converting a present value or a future value into a uniform series of “payments.” For example, a capital expenditure can be converted into an annual payment using the formula

$$AAc = PV \frac{i(1+i)^n}{(1+i)^n - 1}$$

where:

AAc = annual cost
n = useful life of the project in years
PV = total cost or benefit in the present
i = discount rate

To calculate costs accurately, it is necessary to have an assumption of the life expectancy of a project. Table 6.19 lists the standard assumptions to be used to estimate project life for purposes of alternative evaluation.

Table 6.19 Life Expectancy and O&M Requirements for Alternative Evaluation

Project	Life Expectancy (yr)	Inspection and Routine O&M (yr)	Additional O&M (YR)
Flood Control Projects			
Detention pond	50	Every 2-3	Every 10
Underground detention	50	Every 2-3	Every 5
Levee with detention	100	Every 3	Every 15
Channel enlargement with detention	50	Every 2-3	Every 5
Floodproofing	20	Every 1	Every 2
Buyouts	Permanent		
Detention pond	50	Every 2-3	Every 10
Underground detention	50	Every 2-3	Every 5
Soil Stabilization Projects			
Natural stabilization	30	Every 1	Every 2
Riprap	30	Every 2-3	Every 5
Reno gabions	30	Every 1	Every 5
Basket gabions	30	Every 1	Every 5
Sloped vertical concrete wall	30	Every 2-3	Every 5
Rectangular concrete channel	50	Every 2-3	Every 5
Trapezoidal concrete channel	50	Every 2-3	Every 5

6.7.3.3 Unit Costs for Alternative Development

The District will develop a current list of unit costs to use as part of alternative cost estimation. Unit cost items will be developed by the District and evaluated annually to determine if updates are required. In addition to the list of unit costs, the District will also establish consistent markups for items such as mobilization, engineering, and contingencies. Unless a customized or site-specific approach to include these costs is approved by the District, standard unit cost items and markups will be used for DWP alternative development to provide for consistency during the countywide prioritization of projects.

6.7.3.4 Calculating Benefit-to-Cost Ratio

Once the average annual benefits (AA_B) and average annual cost (AA_C) have been estimated, the BC ratio is computed using the formula:

$$BC = \frac{AA_B}{AA_C}$$

where:

AA_B = the average annual benefit
AA_C = the average annual costs

Note that the BC ratio can also be computed using benefits and costs expressed as present values:

$$BC = \frac{PV_B}{PV_C}$$

where:

PV_B = the present value of the benefits
PV_C = the present value of the costs

The BC ratio will be used to evaluate whether a project is cost-effective. If the BC ratio is greater than one, the project benefits exceed the costs and the project can be considered cost-effective. Other factors may be considered that would favor a project that did not have a BC ratio greater than one.

Similarly, the net benefits of the project are equal to:

$$NB = PV_B - PV_C$$

If the net benefits are positive, the project is cost-effective and the BC ratio greater than one.

6.7.4 Alternative Selection for Problem Area

As stated previously, the District is required to consider the BC ratio when selecting projects for implementation. In addition the District will consider noneconomic criteria in selecting alternatives. All projects which meet the District's absolute requirements for capital project funding will be prioritized on a countywide basis, with final decision for funding made at the discretion of the District's Board of Commissioners.

6.8 Summary of Recommended Alternatives

Recommended projects will be summarized to describe the economic and noneconomic data to be used as a part of the District's countywide prioritization of improvements. The economic data will focus on the BC ratio defined for each problem area, consistent with the documentation provided in Sections 6.6 and 6.7. Noneconomic data to be developed for each project are summarized in Section 6.8.1.

Exhibit 6.1 depicts the documentation that will be prepared as a part of each DWP to support the countywide prioritization of projects. Only alternatives that meet the District's minimum criteria for funding (see Chapter 1) will be developed and evaluated. For each project that meets the minimum criteria, a BC analysis will be developed, as will information on the development of noneconomic data. That information will be summarized in a manner consistent with what is shown in Exhibit 6.1 for incorporation into the District's countywide prioritization of improvement projects. Note that all costs and net benefits shown in Exhibit 6.1 shall be expressed as present values.

6.8.1 Other Noneconomic Evaluation Criteria

In addition to the BC ratio, the following information will be compiled for the District to use as a part of the countywide prioritization of projects:

- Total cost to the District
- Area (in acres) removed from the floodplain
- Number of structures protected
- Probability that funding will be provided by outside agencies (identify funding source, and percent of project to be funded, if known)
- Implementation time (in months)
- Water quality benefit, based on the qualitative scale described in Section 6.8.2
- Cook County communities involved
- Wetland or riparian area protected (ac)

6.8.2 Water Quality Benefit

To determine the water quality benefit of a flood control or erosion control project, the following questions must be addressed:

- Does the project contribute to the implementation of a TMDL established for the watershed?
- Does the project improve water quality concerns identified as a part of an NPDES Phase II Stormwater Permit?
- Does the project improve water quality related to a pollutant or pollution identified in the state's 303(d) Report?
- Does the project have an effect on habitat?

Once these questions are addressed, water quality benefit will be evaluated qualitatively using the scale in Table 6.20.

Table 6.20 Water Quality Benefit Evaluation Scale

Rating	Description
No Impact	No notable impact on water quality.
Slightly Positive	Project partly addresses or affects an NPDES Phase II Stormwater Permit, a TMDL established for the watershed, violations in water quality standards or listing criteria, or habitat.
Positive	Project fully addresses or impacts an NPDES Phase II Stormwater Permit, a TMDL established for the watershed, violations in water quality standards or listing criteria, or habitat.

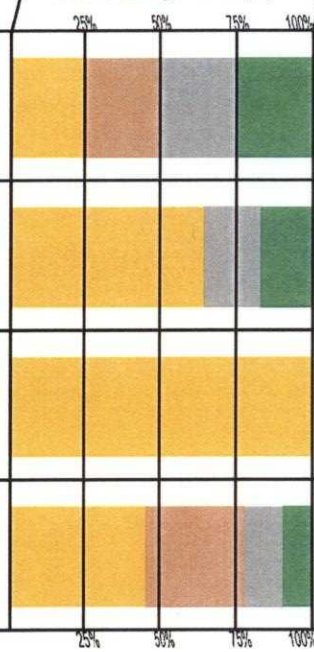
6.9 Implementation Plan

Each DWP will include an implementation plan that identifies issues critical to implementation of watershed recommendations. The recommendations will include stormwater improvement projects to address watershed problems, data management needs and responsibilities, special coordination requirements identified as a part of DWP development, scheduled updates to DWPs, and any other issues identified as critical to the District.

Exhibit 6-1 Example CIP Prioritization Matrix

Metropolitan Water Reclamation District of Greater Chicago
Example Prioritization Matrix

	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Total Cost To MWRDGC ($)	Relative Damage Averted (%)	Area Removed from Floodplain (ac)	Wetland or Riparian Area Protected (ac)	Number of Structures Protected	Possibility of Funding Provided by Outside Agencies	Implementation Time (months)	Water Quality Benefit	Communities Involved
Project A	1.25	5.0 M	4.0 M	3.2 M		5.0	40	6	Very Likely	6	Positive	Oak Park Berwyn Cicero
Project B	2.5	7.5 M	3.0 M	3.0 M		2.6	8	10	Not Likely	28	Slightly Positive	Park Ridge Des Plaines Mount Prospect
Project C	1.2	12.0 M	10.0 M	7.8 M		13.0	0	50	Somewhat Likely	3	No Impact	Oak Lawn Chicago Ridge
Project D	1.0	15.0 M	15.0 M	14.0 M		3.9	15	25	Not Likely	24	Slightly Postive	Buffalo Grove Wheeling Des Plaines Mount Prospect Prospect Heights



Note: This prioritization matrix may be expanded to include additional non-economic criteria. All values are hypothetical and for demonstration purposes only.

Calumet-Sag Watershed SCS Curve Number Generation

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DATE: August 14, 2007

SCS hydrology uses the empirical curve number (CN) parameter as a part of calculating runoff volumes based on landscape characteristics such as soil type, land cover, imperviousness, and land-use development. Areas characterized by saturated or poorly infiltrating soils, or impervious development, have higher CN values, converting a greater portion of rainfall volume into runoff. The principle data sources used to develop CN values for the Calumet-Sag watershed are the Natural Resource Conversation Service (NRCS) soil data for Cook County and the 2001 Northeast Illinois Planning Commission (NIPC) land-use mapping for Cook County. This technical memorandum documents the procedure used to develop a CN grid for use in hydrologic modeling for the Calumet-Sag watershed and the assumptions inherent in this procedure.

Approach

CN values are dependent on a number of factors, including the soil infiltration characteristics and condition, as well as land cover characteristics such as directly connected impervious area and cover type. Therefore both soil data and land-use data are required to estimate CN. The best available soil and land-use data for Cook County are the NRCS soil data and NIPC land-use data. Table 1 lists curve numbers based on combinations of land-use data and soil data for small urban watersheds.

Table A.1 Curve Number Generation for Small Urban Watersheds

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area 2/	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) 3/:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) 4/		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) 5/		77	86	91	94

Table excerpted from Technical Release 55, Urban Hydrology for Small Watersheds, June 1986

A slightly modified version of this table will be used for curve number generation in the Calumet-Sag watershed, shown in table A.2. Both the NRCS soil data and the land use data require preprocessing before generating curve numbers using the lookup table.

Table A.2 Modified Curve Number Generation for Calumet-sag Watershed.

Description	Average % Impervious	Curve Number by Hydrologic Soil Group				Typical Land Uses
		A	B	C	D	
Residential (High Density)	65	77	85	90	92	Multi-family, Apartments, Condos, Trailer Parks
Residential (Med. Density)	30	57	72	81	86	Single-Family, Lot Size ¼ to 1 acre
Residential (Low Density)	15	48	66	78	83	Single-Family, Lot Size 1 acre and Greater
Commercial	85	89	92	94	95	Strip Commercial, Shopping Ctrs, Convenience Stores
Industrial	72	81	88	91	93	Light Industrial, Schools, Prisons, Treatment Plants
Disturbed/Transitional	5	76	85	89	91	Gravel Parking, Quarries, Land Under Development
Agricultural	5	67	77	83	87	Cultivated Land, Row crops, Broadcast Legumes
Open Land – Good	5	39	61	74	80	Parks, Golf Courses, Greenways, Grazed Pasture
Meadow	5	30	58	71	78	Hay Fields, Tall Grass, Ungrazed Pasture
Woods (Thick Cover)	5	30	55	70	77	Forest Litter and Brush adequately cover soil
Woods (Thin Cover)	5	43	65	76	82	Light Woods, Woods-Grass combination, Tree Farms
Impervious	95	98	98	98	98	Paved Parking, Shopping Malls, Major Roadways
Water	100	100	100	100	100	Water Bodies, Lakes, Ponds, Wetlands

Data from
http://gis2.esri.com/library/userconf/proc00/professional/papers/PAP657/p657.htm

Data is for average antecedent moisture condition II- dormant season (5-day) rainfall averaging from 0.5 to 1.1 inches and growing season rainfall from 1.4 to 2.1 inches

NRCS Soil data

Soil mapping for Cook County was downloaded from the NRCS website at http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/, representing 2002 conditions. The data downloaded includes a GIS shapefile of the soil groups and numerous text files that can be imported into an Access database and linked to the GIS data via a field called 'Mapunit Key.' The data field most relevant for SCS hydrology is the 'Hydrologic Group.' The hydrologic soil group (HSG) indicates the minimum infiltration of a specific soil group following wetting, and represented by four soil groups, shown in Table A.3.

TABLE A.3. HYDROLOGIC SOIL GROUPS

Hydrologic Soil Group	Description	Texture	Infiltration Rates (in/hr)
A	Low runoff potential and high infiltration rates even when wetted	Sand, loamy sand, or sandy loam	> 0.30
B	Moderate infiltration rates when wetted	Silt loam or loam	0.15 – 0.30
C	Low infiltration rates when wetted	Sandy clay loam	0.05 – 0.15
D	High runoff potential and very low infiltration when wetted	Clay loam, silty clay loam, sandy clay, silty clay, or clay	0 – 0.05
		clay, or clay	

All data from Technical Release 55, Urban Hydrology for Small Watersheds, June 1986

Soil groups with drainage characteristics impacted by a high water table are indicated with a '/D' designation, where the letter preceding the slash indicates the hydrologic group of the soil under drained conditions. Thus an 'A/D' indicates that the soil has characteristics of the A soil group if drained, but the D soil group if not drained. 'A/D', 'B/D', or 'C/D', occur throughout the Calumet-Sag study area and represent a cumulative area of 9.11 mi^2 of the 152 square-mile watershed. Due to the difficulty of establishing the extent of drainage of these soils for each mapped soil polygon, it was assumed that 50% (by area) of these soil types were drained.

The City of Chicago is not mapped within the NRCS data set and thus does not have an assigned HSG. Based on previous studies, a minimum infiltration rate of 0.1 in/hr is reasonable in much of Chicago which corresponds to a 'C' HSG. In addition, a number of other soil features lacked HSG data, however these were generally open water or unmapped areas, for which CN values would not be stratified by HSG. When intersected with land-use data, the CN values are averaged across A, B , C and D values for the specified land-use type to estimate CN.

NIPC Land Use Data

NIPC land-use data contains delineation of land-use categories at an average scale of 0.10 acres for features in the Calumet-Sag watershed. To generate CN values, these land-use categories must be converted to analogous land-use categories for which CN data has previously been developed. Table A.4 demonstrates the field mapping used to convert NIPC land-use categories into categories for which CN data exists.

Table A.4. NIPC field mapping to land use field.

NIPC Code	NIPC Land USE	SCS Land Use	A	B	C	D	A/D	B/D	C/D	NULL
1110	1110 RES/SF	Residential (High Density)	77	85	90	92	84.5	88.5	91	86
1120	1120 RES/FARM	Residential (Low Density)	48	66	78	83	65.5	74.5	80.5	68.75
1130	1130 RES/MF	Residential (Med. Density)	57	72	81	86	71.5	79	83.5	74
1140	1140 RES/MOBILE HM	Residential (High Density)	77	85	90	92	84.5	88.5	91	86
1211	1211 MALL	Commercial	89	92	94	95	92	93.5	94.5	92.5
1212	1212 RETAIL CNTR	Commercial	89	92	94	95	92	93.5	94.5	92.5
1221	1221 OFFICE CMPS	Commercial	89	92	94	95	92	93.5	94.5	92.5
1222	1222 SINGL OFFICE	Commercial	89	92	94	95	92	93.5	94.5	92.5
1223	1223 BUS. PARK	Commercial	89	92	94	95	92	93.5	94.5	92.5
1231	1231 URB MX W/PRKNG	Commercial	89	92	94	95	92	93.5	94.5	92.5
1232	1232 URB MX NO PRKNG	Industrial	81	88	91	93	87	90.5	92	88.25
1240	1240 CULT/ENT	Commercial	89	92	94	95	92	93.5	94.5	92.5
1250	1250 HOTEL/MOTEL	Commercial	89	92	94	95	92	93.5	94.5	92.5
1310	1310 MEDICAL	Industrial	81	88	91	93	87	90.5	92	88.25
1320	1320 EDUCATION	Industrial	81	88	91	93	87	90.5	92	88.25
1330	1330 GOVT	Commercial	89	92	94	95	92	93.5	94.5	92.5
1340	1340 PRISON	Industrial	81	88	91	93	87	90.5	92	88.25
1350	1350 RELIGOUS	Commercial	89	92	94	95	92	93.5	94.5	92.5
1360	1360 CEMETERY	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
1370	1370 INST/OTHER	Residential (Low Density)	48	66	78	83	65.5	74.5	80.5	68.75
1410	1410 MINERAL EXT	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
1420	1420 MANUF/PROC	Industrial	81	88	91	93	87	90.5	92	88.25
1430	1430 WAREH/DIST/WHOL	Industrial	81	88	91	93	87	90.5	92	88.25
1440	1440 INDUST PK	Industrial	81	88	91	93	87	90.5	92	88.25

NIPC Code	NIPC Land USE	SCS Land Use	A	B	C	D	A/D	B/D	C/D	NULL
1511	1511 INTERSTATE/TOLL	75 % Impervious/25 % Open Land	83.25	88.75	92.00	93.50	88.38	91.13	92.75	89.38
1512	1512 OTHER ROADWY	75 % Impervious/25 % Open Land	83.25	88.75	92.00	93.50	88.38	91.13	92.75	89.38
1520	1520 OTH LINEAR TRAN	I75 % Impervious/25 % Open Land	83.25	88.75	92.00	93.50	88.38	91.13	92.75	89.38
1530	1530 AIR TRANSPORT	50 % Impervious/ 50% Open Lands	68.50	79.50	86.00	89.00	78.75	84.25	87.50	80.75
1540	1540 INDEP AUTO PRK	Commercial	89	92	94	95	92	93.5	94.5	92.5
1550	1550 COMMUNICATION	Agricultural	67	77	83	87	77	82	85	78.5
1560	1560 UTILITIES/WASTE	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
2100	2100 CROP/GRAIN/GRAZ	Agricultural	67	77	83	87	77	82	85	78.5
2200	2200 NRSRY/GRNHS/ORC	Agricultural	67	77	83	87	77	82	85	78.5
2300	2300 AG/OTHER	Agricultural	67	77	83	87	77	82	85	78.5
3100	3100 OPENSP REC	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3200	3200 GOLF COURSE	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3300	3300 OPENSP CONS	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3400	3400 OPENSP PRIVATE	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3500	3500 OPENSP LINEAR	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
3600	3600 OPENSP OTHER	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
4110	4110 VAC FOR/GRASS	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
4120	4120 WETLAND	Meadow	30	58	71	78	54	68	74.5	59.25
4210	4210 CONST RES	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
4220	4220 CONST NONRES	Disturbed/Transitional	76	85	89	91	83.5	88	90	85.25
4300	4300 OTHER VACANT	Open Land – Good	39	61	74	80	59.5	70.5	77	63.5
5100	5100 RIVERS/CANALS	Water	100	100	100	100	100	100	100	100
5200	5200 LAKE/RES/LAGOON	Water	100	100	100	100	100	100	100	100
5300	5300 LAKE MICHIGAN	Water	100	100	100	100	100	100	100	100
9999	9999 OUT OF REGION	Water	100	100	100	100	100	100	100	100

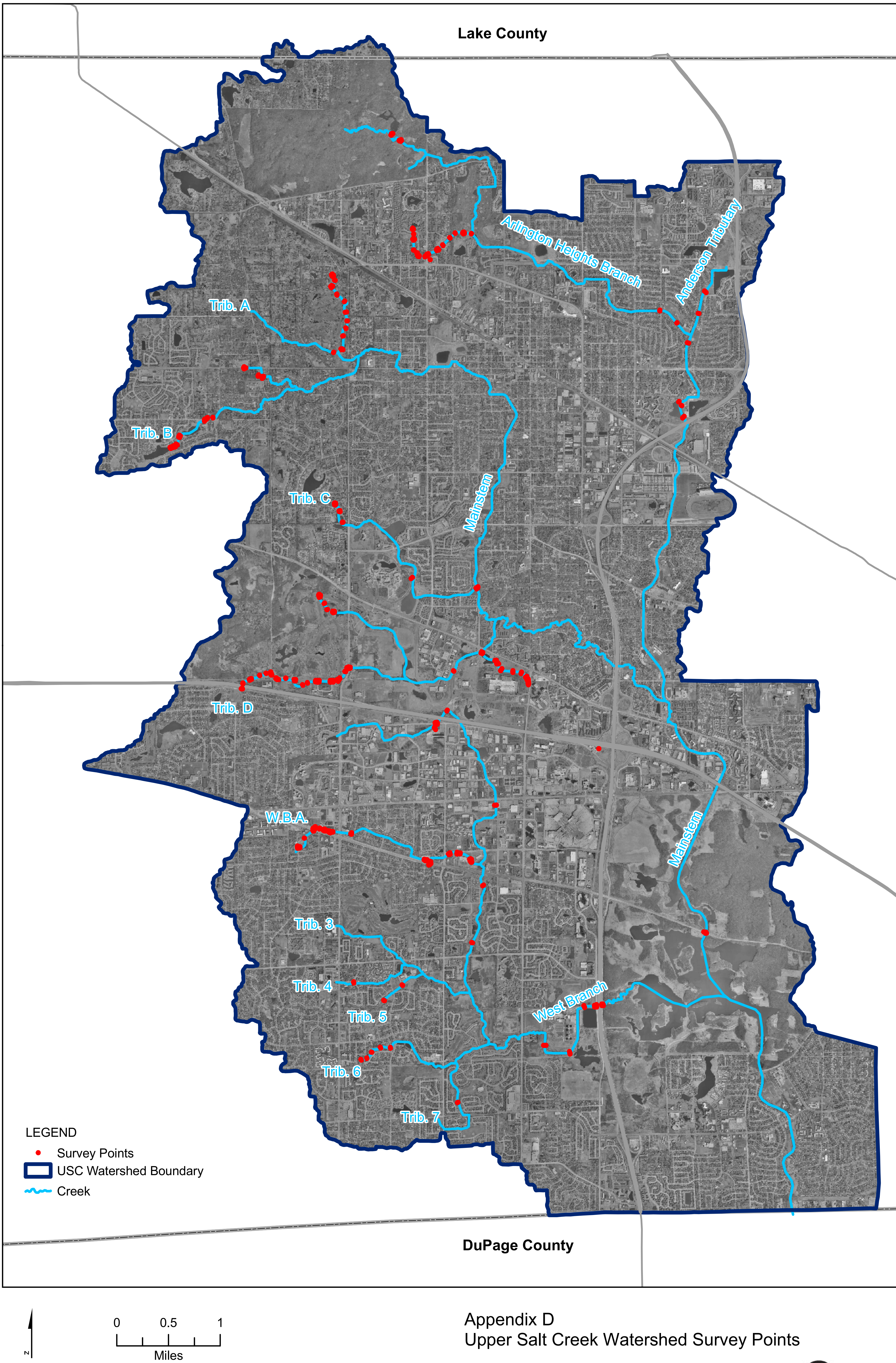
Note: not all NIPC land use types exist within the Calumet-Sag watershed.

Steps for Generating Curve Number Grid

Following the preparation of the land-use and soil data is described in the preceding two sections, three steps are followed to generate the CN Grid

1) Perform an intersection of the NRCS soil mapping polygon feature class with the NIPC land use polygon feature class. This produces a polygon feature class that has both land-use type and HSG. This feature class was output into a personal geodatabase so that Access queries could be performed on it.
2) Add a field called CurveNumber to the intersected feature class
3) Assign a CN value to each intersected polygon feature based upon HSG and land use. This was performed using an Access update query on the CurveNumber field. The soil groups impacted by high water table (e.g. 'A/D') were estimated to be 50% drained, using the average of the D CN and the drained (e.g. A) CN.
4) Use the "feature to raster" function in ArcToolbox to create a CN grid based on the CurveNumber value at the center of each grid pixel. A 20 ft x 20 ft grid, the same resolution as digital terrain model uses for watershed delineation, was used for this purpose.

The included figure shows the final CN grid for the Calumet-Sag watershed.



Appendix D
Upper Salt Creek Watershed Survey Points

Appendix F - Depth Damage Curves

TABLE 1.
Residential, One Story with Basement.

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-8	0%	0	-8	0.10%	1.6
-7	0.70%	1.34	-7	0.80%	1.16
-6	0.80%	1.06	-6	2.10%	0.92
-5	2.40%	0.94	-5	3.70%	0.81
-4	5.20%	0.91	-4	5.70%	0.78
-3	9.00%	0.88	-3	8.00%	0.76
-2	13.80%	0.85	-2	10.50%	0.74
-1	19.40%	0.83	-1	13.20%	0.72
0	25.50%	0.85	0	16.00%	0.74
1	32.00%	0.96	1	18.90%	0.83
2	38.70%	1.14	2	21.80%	0.98
3	45.50%	1.37	3	24.70%	1.17
4	52.20%	1.63	4	27.40%	1.39
5	58.60%	1.89	5	30.00%	1.6
6	64.50%	2.14	6	32.40%	1.81
7	69.80%	2.35	7	34.50%	1.99
8	74.20%	2.52	8	36.30%	2.13
9	77.70%	2.66	9	37.70%	2.25
10	80.10%	2.77	10	38.60%	2.35
11	81.10%	2.88	11	39.10%	2.45
12	81.10%	2.88	12	39.10%	2.45
13	81.10%	2.88	13	39.10%	2.45
14	81.10%	2.88	14	39.10%	2.45
15	81.10%	2.88	15	39.10%	2.45

TABLE 1.
Residential, One Story with Basement.

Structure			Content		
16	81.10%	2.88	16	39.10%	2.45

TABLE 2.
Residential, Two or More Stories, With Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-8	1.70%	2.7	-8	0%	0
-7	1.70%	2.7	-7	1.00%	2.27
-6	1.90%	2.11	-6	2.30%	1.76
-5	2.90%	1.8	-5	3.70%	1.49
-4	4.70%	1.66	-4	5.20%	1.37
-3	7.20%	1.56	-3	6.80%	1.29
-2	10.20%	1.47	-2	8.40%	1.21
-1	13.90%	1.37	-1	10.10%	1.13
0	17.90%	1.32	0	11.90%	1.09
1	22.30%	1.35	1	13.80%	1.11
2	27.00%	1.5	2	15.70%	1.23
3	31.90%	1.75	3	17.70%	1.43
4	36.90%	2.04	4	19.80%	1.67
5	41.90%	2.34	5	22.00%	1.92
6	46.90%	2.63	6	24.30%	2.15
7	51.80%	2.89	7	26.70%	2.36
8	56.40%	3.13	8	29.10%	2.56
9	60.80%	3.38	9	31.70%	2.76
10	64.80%	3.71	10	34.40%	3.04
11	68.40%	4.22	11	37.20%	3.46
12	71.40%	5.02	12	40.00%	4.12
13	73.70%	6.19	13	43.00%	5.08
14	75.40%	7.79	14	46.10%	6.39
15	76.40%	9.84	15	49.30%	8.08
16	76.40%	12.36	16	52.60%	10.15

TABLE 3.
Residential, Split Level, With Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-8			-8	0.60%	2.09
-7			-7	0.70%	1.49
-6	2.50%	1.80%	-6	1.40%	1.14
-5	3.10%	1.60%	-5	2.40%	1.01
-4	4.70%	1.50%	-4	3.80%	1
-3	7.20%	1.60%	-3	5.40%	1.02
-2	10.40%	1.60%	-2	7.30%	1.03
-1	14.20%	1.60%	-1	9.40%	1.04
0	18.50%	1.60%	0	11.60%	1.06
1	23.20%	1.70%	1	13.80%	1.12
2	28.20%	1.90%	2	16.10%	1.23
3	33.40%	2.10%	3	18.20%	1.38
4	38.60%	2.40%	4	20.20%	1.57
5	43.80%	2.60%	5	22.10%	1.76
6	48.80%	2.90%	6	23.60%	1.95
7	53.50%	3.20%	7	24.90%	2.13
8	57.80%	3.40%	8	25.80%	2.28
9	61.60%	3.60%	9	26.30%	2.44
10	64.80%	3.90%	10	26.30%	2.44
11	67.20%	4.20%	11	26.30%	2.44
12	68.80%	4.80%	12	26.30%	2.44
13	69.30%	5.70%	13	26.30%	2.44
14	69.30%	5.70%	14	26.30%	2.44
15	69.30%	5.70%	15	26.30%	2.44
16	69.30%	5.70%	16	26.30%	2.44

TABLE 4.
Residential, One Story, No Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%	-2	0%	0%
-1	2.50%	2.70%	-1	2.40%	2.10%
0	13.40%	2.00%	0	8.10%	1.50%
1	23.30%	1.60%	1	13.30%	1.20%
2	32.10%	1.60%	2	17.90%	1.20%
3	40.10%	1.80%	3	22.00%	1.40%
4	47.10%	1.90%	4	25.70%	1.50%
5	53.20%	2.00%	5	28.80%	1.60%
6	58.60%	2.10%	6	31.50%	1.60%
7	63.20%	2.20%	7	33.80%	1.70%
8	67.20%	2.30%	8	35.70%	1.80%
9	70.50%	2.40%	9	37.20%	1.90%
10	73.20%	2.70%	10	38.40%	2.10%
11	75.40%	3.00%	11	39.20%	2.30%
12	77.20%	3.30%	12	39.70%	2.60%
13	78.50%	3.70%	13	40.00%	2.90%
14	79.50%	4.10%	14	40.00%	3.20%
15	80.20%	4.50%	15	40.00%	3.50%
16	80.70%	4.90%	16	40.00%	3.80%

TABLE 5.
Residential, Two of More Stories, No Basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%	-2	0%	0%
-1	3.00%	4.10%	-1	1.00%	3.50%
0	9.30%	3.40%	0	5.00%	2.90%
1	15.20%	3.00%	1	8.70%	2.60%
2	20.90%	2.80%	2	12.20%	2.50%
3	26.30%	2.90%	3	15.50%	2.50%
4	31.40%	3.20%	4	18.50%	2.70%
5	36.20%	3.40%	5	21.30%	3.00%
6	40.70%	3.70%	6	23.90%	3.20%
7	44.90%	3.90%	7	26.30%	3.30%
8	48.80%	4.00%	8	28.40%	3.40%
9	52.40%	4.10%	9	30.30%	3.50%
10	55.70%	4.20%	10	32.00%	3.50%
11	58.70%	4.20%	11	33.40%	3.50%
12	61.40%	4.20%	12	34.70%	3.50%
13	63.80%	4.20%	13	35.60%	3.50%
14	65.90%	4.30%	14	36.40%	3.60%
15	67.70%	4.60%	15	36.90%	3.80%
16	69.20%	5.00%	16	37.20%	4.20%

TABLE 6.
Residential, Split Level, No basement

Structure			Content		
Depth	Mean of Damage	Standard Deviation of Damage	Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%	-2	0%	0%
-1	6.40%	2.90%	-1	2.20%	2.20%
0	7.20%	2.10%	0	2.90%	1.50%
1	9.40%	1.90%	1	4.70%	1.20%
2	12.90%	1.90%	2	7.50%	1.30%
3	17.40%	2.00%	3	11.10%	1.40%
4	22.80%	2.20%	4	15.30%	1.50%
5	28.90%	2.40%	5	20.10%	1.60%
6	35.50%	2.70%	6	25.20%	1.80%
7	42.30%	3.20%	7	30.50%	2.10%
8	49.20%	3.80%	8	35.70%	2.50%
9	56.10%	4.50%	9	40.90%	3.00%
10	62.60%	5.30%	10	45.80%	3.50%
11	68.60%	6.00%	11	50.20%	4.10%
12	73.90%	6.70%	12	54.10%	4.60%
13	78.40%	7.40%	13	57.20%	5.00%
14	81.70%	7.90%	14	59.40%	5.40%
15	83.80%	8.30%	15	60.50%	5.70%
16	84.40%	8.70%	16	60.50%	6.00%

TABLE 7.
Non-residential, Commercial and Industry

Structure		Contents	
Depth	Combined Commercial Industrial	Depth	Combined Commercial Industrial
-8		-8	
-7		-7	
-6		-6	
-5		-5	
-4	0.00%	-4	0.00%
-3	0.00%	-3	0.00%
-2	0.00%	-2	0.00%
-1	0.00%	-1	0.00%
0	0.68%	0	2.75%
1	10.21%	1	19.50%
2	14.21%	2	33.73%
3	17.46%	3	45.16%
4	20.92%	4	55.26%
5	24.02%	5	62.08%
6	27.35%	6	66.93%
7	30.50%	7	70.34%
8	33.72%	8	73.19%
9	36.89%	9	75.46%
10	39.86%	10	77.21%
11	43.52%	11	79.60%
12	46.85%	12	81.10%
13	49.45%	13	82.40%
14	51.85%	14	83.64%
15	54.31%	15	84.28%
16	56.53%	16	84.82%

Note: This curve was created by USACE, Galveston District

References:

Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements.

United States Army Corp of Engineers, Galveston District, HAZUS application.

CECW-PG 10 October 2003

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements.

1. Purpose. The purpose of this memorandum is to release, and provide guidance for the use of, generic depth-damage curves for use in U.S. Army Corps of Engineers flood damage reduction studies.

2. Background. Proper planning and evaluation of flood damage reduction projects require knowledge of actual damage caused to various types of properties. The primary purpose of the Flood Damage Data Collection Program is to meet that requirement by providing Corps district offices with standardized relationships for estimating flood damage and other costs of flooding, based on actual losses from flood events. Under this program, data have been collected from major flooding that occurred in various parts of the United States from 1996 through 2001. Damage data collected are based on comprehensive accounting of losses from flood victims' records. The generic functions developed and provided in this EGM represent a substantive improvement over other generalized depth-damage functions such as the Flood Insurance Administration (FIA) Rate Reviews.

3. Results. Generic damage functions are attached for one-story homes with basement, two or more story homes with basement, and split-level homes with basement. Generic damage functions for similar structures without basements were published in 2000 and are included as enclosure 1 for ready reference.

a. Regression analysis was used to create the damage functions. While several independent variables, such as flood duration and flood warning lead-time, were examined in building the models, the models that were most efficient in explaining the percent damage to structure and contents were quadratic and cubic forms with depth as the only independent variable.

b. Content damage was modeled with the dependent variable being content damage as a percentage of structure value. This differs from the previous technique of first developing content valuations and then content damage relationships as a function of content valuations. The generic content damage models are statistically significant and their use eliminates the need to establish content-to-structure ratios through surveys.

c. While the data collected include information on all aspects of National Economic Development (NED) losses, only results and recommendations related to the structure and content damages for homes with basements are included in this EGM.

Direct costs for cleanup expenses, unpaid hours for cleanup and repair, emergency damage prevention actions, and other flood-related costs are not included in these damage functions. Information on other residential flood costs, beyond those included in these damage functions will found the summary report, discussed in paragraph 5. These costs should be developed using site-specific historical information.

4. Application. The following paragraphs provide information on the application of the generic curves within the HEC-FDA damage calculation program.

a. The economic section of HEC-FDA divides the quantification of flood damages into a direct method and an indirect method. The direct method allows the user to directly enter a stage-damage relationship for any structure. This approach is commonly used for large or unique properties such as industrial or pubic buildings. The indirect method quantifies the stage-damage relationship for a group of structures that have significant commonality. Typically damage to residential structures is calculated using the indirect method. The procedures described in the following paragraphs apply only when using the indirect method to determine the stage-damage relationship.

b. The traditional approach to quantifying damage to contents by the indirect method relies on three pieces of information: 1) structure value; 2) content-to-structure value ratio; and 3) the content depth-damage relationship. The content-to-structure value ratio and content depth-damage relationship are unique to the structure occupancy type to which a structure is assigned. The content depth-damage relationship provides the estimate of content flood damage as a percentage of content value. Thus, to calculate a content stage-damage function for an individual structure, the structure value for an individual structure is first multiplied by the content-to-structure value ratio to provide an estimate of the content value. This content value is then multiplied by each percent damage value of the content depth-damage relationship.

c. The new content depth-damage functions provided herein are different from those used by the Corps in the past in one important aspect. The new functions calculate content damage as a percent of structure value rather than content value. Using these functions within HEC-FDA requires care in specifying a content-to-structure value ratio. To understand the requirements for using the new content depth-damage functions requires a basic understanding of how HEC-FDA calculates content damage.

(1). To calculate damages by the indirect method, each structure must be assigned to a structure occupancy type. For each structure occupancy type a content-to-structure value ratio and content depth-damage relationship are defined. These data for calculating content damage within HEC-FDA is entered on the “Study Structure Occupancy Type” screen. As long as a content value is not entered for a structure in the Structure Inventory Data, HEC-FDA calculates the content stage-damage by first calculating content using the structure value multiplied by the content-to-structure value ratio.

In some instances, however, analysts develop unique estimates of content values for a structure, which are entered for the individual structure on the Structure Inventory Data screen. For each structure that has a content value entered, calculating a content value by using the content-to-structure value ratio is ignored and the user entered content value is used to calculate content damage.

(2). The new content depth-damage functions do not require this intermediate step of calculating content values. Therefore, the content-to-structure value ratio for each structure occupancy type using the new content depth-damage relationships must be set to one hundred percent (100). This forces the content depth-damage function to be multiplied by the structure value as required. Also, the "Error Associated with Content/Structure Value" on the "Study Structure Occupancy Type" screen should be left blank. This implies that the error in content-to-structure value ratio is part of the new content depth-damage relationship.

(3). Because entering a content value on the Structure Inventory Data window overrides the content-to-structure value ratio, the new content depth-damage relationships should not be used for structures that have separately entered content values.

(4). Questions concerning the use of the generic curves within the HEC-FDA model can be addressed to Dr. David Moser, Institute of Water Resources (IWR), (703) 428-8066.

5. Report. A report summarizing the data collection effort and analyses performed to derive these curves will shortly be available on the IWR website. More information may be obtained by contacting the program's principal investigator, Stuart Davis, (703) 428-7086.

6. Waiver to Policy. These curves are developed for nation-wide applicability in flood damage reduction studies. When using these curves, the requirement to develop site-specific depth-damage curves contained in ER 1105-2-100, E-19q.(2) is waived. Additionally, the requirement to develop content valuations and content-to-structure ratios based on site-specific or comparable floodplain information, ER 1005-2-100, E-19q.(1)(a), is also waived. Note these waivers currently apply only to single-family homes with and without basements for which generic curves have been published, and not other categories of flood inundation damages for which no generic curves exist. Feasibility reports must state the generic curves are being used in the flood damage analysis for residential structures with and/or without basements. Use of these curves is optional and analysts should always endeavor to use the best available information to accurately quantify the damages and benefits in inundation reduction studies.

7. Point of Contact. Administrators of the Flood Damage Data Collection Program continue to collect and analyze flood-related damages to both residential and commercial properties. The HQUSACE program monitor is Lillian Almodovar, (202) 761-4233, who can address any questions concerning the program.

FOR THE COMMANDER:

/s/

Encl

WILLIAM R. DAWSON, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

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DAMAGE FUNCTIONS
FOR SINGLE FAMILY RESIDENTIAL
STRUCTURES WITH BASEMENTS

Structure Depth-Damage

Table 1 Structure One Story, With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8	0%	0
-7	0.7%	1.34
-6	0.8%	1.06
-5	2.4%	0.94
-4	5.2%	0.91
-3	9.0%	0.88
-2	13.8%	0.85
-1	19.4%	0.83
0	25.5%	0.85
1	32.0%	0.96
2	38.7%	1.14
3	45.5%	1.37
4	52.2%	1.63
5	58.6%	1.89
6	64.5%	2.14
7	69.8%	2.35
8	74.2%	2.52
9	77.7%	2.66
10	80.1%	2.77
11	81.1%	2.88
12	81.1%	2.88
13	81.1%	2.88
14	81.1%	2.88
15	81.1%	2.88
16	81.1%	2.88

Table 2 Structure Two or More Stories, With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8	1.7%	2.70
-7	1.7%	2.70
-6	1.9%	2.11
-5	2.9%	1.80
-4	4.7%	1.66
-3	7.2%	1.56
-2	10.2%	1.47
-1	13.9%	1.37
0	17.9%	1.32
1	22.3%	1.35
2	27.0%	1.50
3	31.9%	1.75
4	36.9%	2.04
5	41.9%	2.34
6	46.9%	2.63
7	51.8%	2.89
8	56.4%	3.13
9	60.8%	3.38
10	64.8%	3.71
11	68.4%	4.22
12	71.4%	5.02
13	73.7%	6.19
14	75.4%	7.79
15	76.4%	9.84
16	76.4%	12.36

Table 3 Structure Split Level, With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8		
-7		
-6	2.5%	1.8%
-5	3.1%	1.6%
-4	4.7%	1.5%
-3	7.2%	1.6%
-2	10.4%	1.6%
-1	14.2%	1.6%
0	18.5%	1.6%
1	23.2%	1.7%
2	28.2%	1.9%
3	33.4%	2.1%
4	38.6%	2.4%
5	43.8%	2.6%
6	48.8%	2.9%
7	53.5%	3.2%
8	57.8%	3.4%
9	61.6%	3.6%
10	64.8%	3.9%
11	67.2%	4.2%
12	68.8%	4.8%
13	69.3%	5.7%
14	69.3%	5.7%
15	69.3%	5.7%
16	69.3%	5.7%

Content Depth-Damage

Table 4 Content One Story, With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8	0.1%	1.60
-7	0.8%	1.16
-6	2.1%	0.92
-5	3.7%	0.81
-4	5.7%	0.78
-3	8.0%	0.76
-2	10.5%	0.74
-1	13.2%	0.72
0	16.0%	0.74
1	18.9%	0.83
2	21.8%	0.98
3	24.7%	1.17
4	27.4%	1.39
5	30.0%	1.60
6	32.4%	1.81
7	34.5%	1.99
8	36.3%	2.13
9	37.7%	2.25
10	38.6%	2.35
11	39.1%	2.45
12	39.1%	2.45
13	39.1%	2.45
14	39.1%	2.45
15	39.1%	2.45
16	39.1%	2.45

Table 5
Content
Two or More Stories-With Basement

Depth	Mean of Damage	Standard Deviation of Damage
-8	0%	0
-7	1.0%	2.27
-6	2.3%	1.76
-5	3.7%	1.49
-4	5.2%	1.37
-3	6.8%	1.29
-2	8.4%	1.21
-1	10.1%	1.13
0	11.9%	1.09
1	13.8%	1.11
2	15.7%	1.23
3	17.7%	1.43
4	19.8%	1.67
5	22.0%	1.92
6	24.3%	2.15
7	26.7%	2.36
8	29.1%	2.56
9	31.7%	2.76
10	34.4%	3.04
11	37.2%	3.46
12	40.0%	4.12
13	43.0%	5.08
14	46.1%	6.39
15	49.3%	8.08
16	52.6%	10.15

Table 6 Content Split-Level-With Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-8	0.6%	2.09
-7	0.7%	1.49
-6	1.4%	1.14
-5	2.4%	1.01
-4	3.8%	1.00
-3	5.4%	1.02
-2	7.3%	1.03
-1	9.4%	1.04
0	11.6%	1.06
1	13.8%	1.12
2	16.1%	1.23
3	18.2%	1.38
4	20.2%	1.57
5	22.1%	1.76
6	23.6%	1.95
7	24.9%	2.13
8	25.8%	2.28
9	26.3%	2.44
10	26.3%	2.44
11	26.3%	2.44
12	26.3%	2.44
13	26.3%	2.44
14	26.3%	2.44
15	26.3%	2.44
16	26.3%	2.44

ENCLOSURE
DAMAGE FUNCTIONS
FOR SINGLE FAMILY RESIDENTIAL

STRUCTURES WITHOUT BASEMENTS

Structure One Story, No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	2.5%	2.7%
0	13.4%	2.0%
1	23.3%	1.6%
2	32.1%	1.6%
3	40.1%	1.8%
4	47.1%	1.9%
5	53.2%	2.0%
6	58.6%	2.1%
7	63.2%	2.2%
8	67.2%	2.3%
9	70.5%	2.4%
10	73.2%	2.7%
11	75.4%	3.0%
12	77.2%	3.3%
13	78.5%	3.7%
14	79.5%	4.1%
15	80.2%	4.5%
16	80.7%	4.9%

Structure Two or More Stories-No Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%
-1	3.0%	4.1%
0	9.3%	3.4%
1	15.2%	3.0%
2	20.9%	2.8%
3	26.3%	2.9%
4	31.4%	3.2%
5	36.2%	3.4%
6	40.7%	3.7%
7	44.9%	3.9%
8	48.8%	4.0%
9	52.4%	4.1%
10	55.7%	4.2%
11	58.7%	4.2%
12	61.4%	4.2%
13	63.8%	4.2%
14	65.9%	4.3%
15	67.7%	4.6%
16	69.2%	5.0%

Structure Split-Level-No Basement		
Depth	Mean of Damage	Standard Deviation of Damage
-2	0%	0%
-1	6.4%	2.9%
0	7.2%	2.1%
1	9.4%	1.9%
2	12.9%	1.9%
3	17.4%	2.0%
4	22.8%	2.2%
5	28.9%	2.4%
6	35.5%	2.7%
7	42.3%	3.2%
8	49.2%	3.8%
9	56.1%	4.5%
10	62.6%	5.3%
11	68.6%	6.0%
12	73.9%	6.7%
13	78.4%	7.4%
14	81.7%	7.9%
15	83.8%	8.3%
16	84.4%	8.7%

Content One Story, No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	2.4%	2.1%
0	8.1%	1.5%
1	13.3%	1.2%
2	17.9%	1.2%
3	22.0%	1.4%
4	25.7%	1.5%
5	28.8%	1.6%
6	31.5%	1.6%
7	33.8%	1.7%
8	35.7%	1.8%
9	37.2%	1.9%
10	38.4%	2.1%
11	39.2%	2.3%
12	39.7%	2.6%
13	40.0%	2.9%
14	40.0%	3.2%
15	40.0%	3.5%
16	40.0%	3.8%

Content Two or More Stories-No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	1.0%	3.5%
0	5.0%	2.9%
1	8.7%	2.6%
2	12.2%	2.5%
3	15.5%	2.5%
4	18.5%	2.7%
5	21.3%	3.0%
6	23.9%	3.2%
7	26.3%	3.3%
8	28.4%	3.4%
9	30.3%	3.5%
10	32.0%	3.5%
11	33.4%	3.5%
12	34.7%	3.5%
13	35.6%	3.5%
14	36.4%	3.6%
15	36.9%	3.8%
16	37.2%	4.2%

Content Split-Level-No Basement		
Depth	**Mean of Damage**	**Standard Deviation of Damage**
-2	0%	0%
-1	2.2%	2.2%
0	2.9%	1.5%
1	4.7%	1.2%
2	7.5%	1.3%
3	11.1%	1.4%
4	15.3%	1.5%
5	20.1%	1.6%
6	25.2%	1.8%
7	30.5%	2.1%
8	35.7%	2.5%
9	40.9%	3.0%
10	45.8%	3.5%
11	50.2%	4.1%
12	54.1%	4.6%
13	57.2%	5.0%
14	59.4%	5.4%
15	60.5%	5.7%
16	60.5%	6.0%

Tributary	Subbasin	Area (sq. mi)	Curve Number	Time of concentration (hr)	Storage Coefficient (hr)
Arlington Heights	AH01	1.6938	64.4	0.98	5.55
Arlington Heights	AH02	0.6643	66.8	0.64	3.62
Arlington Heights	AH03	0.14061	57.4	0.17	0.96
Arlington Heights	AH04	0.14029	58.1	0.26	1.47
Arlington Heights	AH05	0.32278	53.4	0.49	2.79
Arlington Heights	AH06	0.2473	71.3	0.38	2.16
Arlington Heights	AH07	0.79381	70.2	3.41	19.31
Arlington Heights	AH08	0.12295	68.3	0.28	1.6
Arlington Heights	AH09	0.10442	64.4	0.4	2.26
Arlington Heights	AH10	0.23564	66.4	0.33	1.88
Arlington Heights	AH11	0.12446	66.8	0.26	1.46
Arlington Heights	AH12	0.28086	66.1	2.32	13.16
Arlington Heights	AH13	1.272	71.9	1.12	6.36
Arlington Heights	AH14	1.3088	69.4	1.4	7.96
Arlington Heights	AH15	0.54935	75.8	0.84	4.78
Arlington Heights	AH16	0.35309	77.2	0.18	1.04
Arlington Heights	AH17	0.47087	76.2	0.49	2.8
Arlington Heights	AH18	0.32435	78	0.84	4.78
Arlington Heights	AH19	1.1792	76.1	0.97	5.49
Arlington Heights	AH20	0.35566	77.2	0.43	2.44
Arlington Heights	AH21	0.7256	80.7	0.87	4.91
Arlington Heights	AH22	0.97432	79.3	0.96	5.45
Arlington Heights	AH23	0.48158	77.8	0.55	3.1
Arlington Heights	AH24	0.31815	75.4	0.55	3.1
Arlington Heights	AH25	0.48817	77.2	0.63	3.58
Arlington Heights	AH26	0.2645	70.8	0.31	1.75

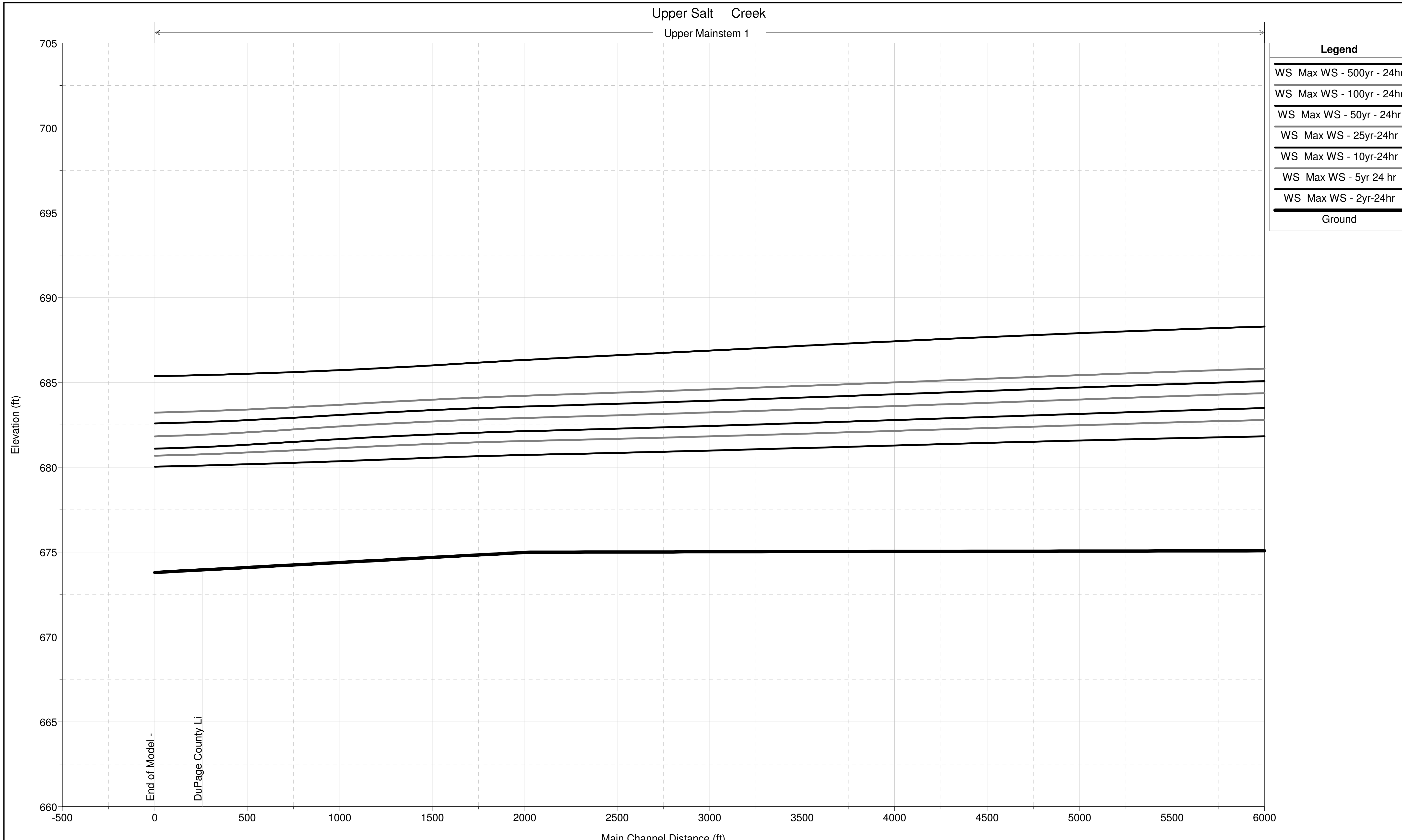
Tributary	Subbasin	Area (sq. mi)	Curve Number	Time of concentration (hr)	Storage Coefficient (hr)
Mainstem	MS01	0.30927	73.7	0.61	3.46
Mainstem	MS02	0.10385	74.6	0.44	2.47
Mainstem	MS03	0.44777	76.2	0.79	4.45
Mainstem	MS04	0.33946	74.5	0.34	1.92
Mainstem	MS05	0.57226	73	0.71	4.05
Mainstem	MS06	0.11536	77.2	0.45	2.55
Mainstem	MS07	0.0694656	79.3	0.13	0.76
Mainstem	MS08	0.15892	77.4	0.25	1.44
Mainstem	MS09	0.31056	75.1	0.37	2.11
Mainstem	MS10	0.43523	69.4	0.75	4.23
Mainstem	MS11	0.18877	77.5	0.22	1.26
Mainstem	MS12	0.27719	71.4	0.22	1.23
Mainstem	MS13	0.67911	75	0.54	3.06
Mainstem	MS14	0.13214	73.8	0.32	1.8
Mainstem	MS15	0.1022	63.6	0.27	1.51
Mainstem	MS16	0.14677	70.5	0.16	0.91
Mainstem	MS17	0.43155	76.7	0.59	3.33
Mainstem	MS18	0.40578	74.5	0.57	3.25
Mainstem	MS19	0.23145	65.4	0.31	1.75
Mainstem	MS20	0.1318	76.7	0.21	1.2
Mainstem	MS21	0.2322	78.2	0.38	2.18
Mainstem	MS22	0.31977	78.4	0.64	3.65
Mainstem	MS23	0.56227	77	0.41	2.32
Mainstem	MS24	0.65361	71.4	0.49	2.78
Mainstem	MS25	0.54246	73.8	0.6	3.39
Mainstem	MS26	0.45491	71.4	0.35	1.96
Mainstem	MS27	0.27881	73.7	0.3	1.7
Mainstem	MS28	0.51747	76.4	0.61	3.48
Mainstem	MS29	0.20488	78.2	0.4	2.25
Mainstem	MS30	0.33203	76.2	0.48	2.72
Mainstem	MS31	0.20144	76.4	0.47	2.68
Mainstem	MS32	0.25211	75.4	0.18	1.04
Mainstem	MS33	0.20385	73.8	0.49	2.78
Mainstem	MS34	0.71831	59.8	0.44	2.5
Mainstem	MS35	0.19061	57.4	0.42	2.36
Mainstem	MS36	0.16947	61.7	0.21	1.2
Mainstem	MS37	1.1548	75.4	5.67	32.11
Mainstem	MS38	0.40792	60.1	0.72	4.05
Mainstem	MS39	0.31741	60.2	1.98	11.22
Mainstem	MS40	0.36349	70.3	0.67	3.78
Mainstem	MS41	0.10521	56.4	0.49	2.8
Mainstem	MS42	0.27123	65.1	0.26	1.5

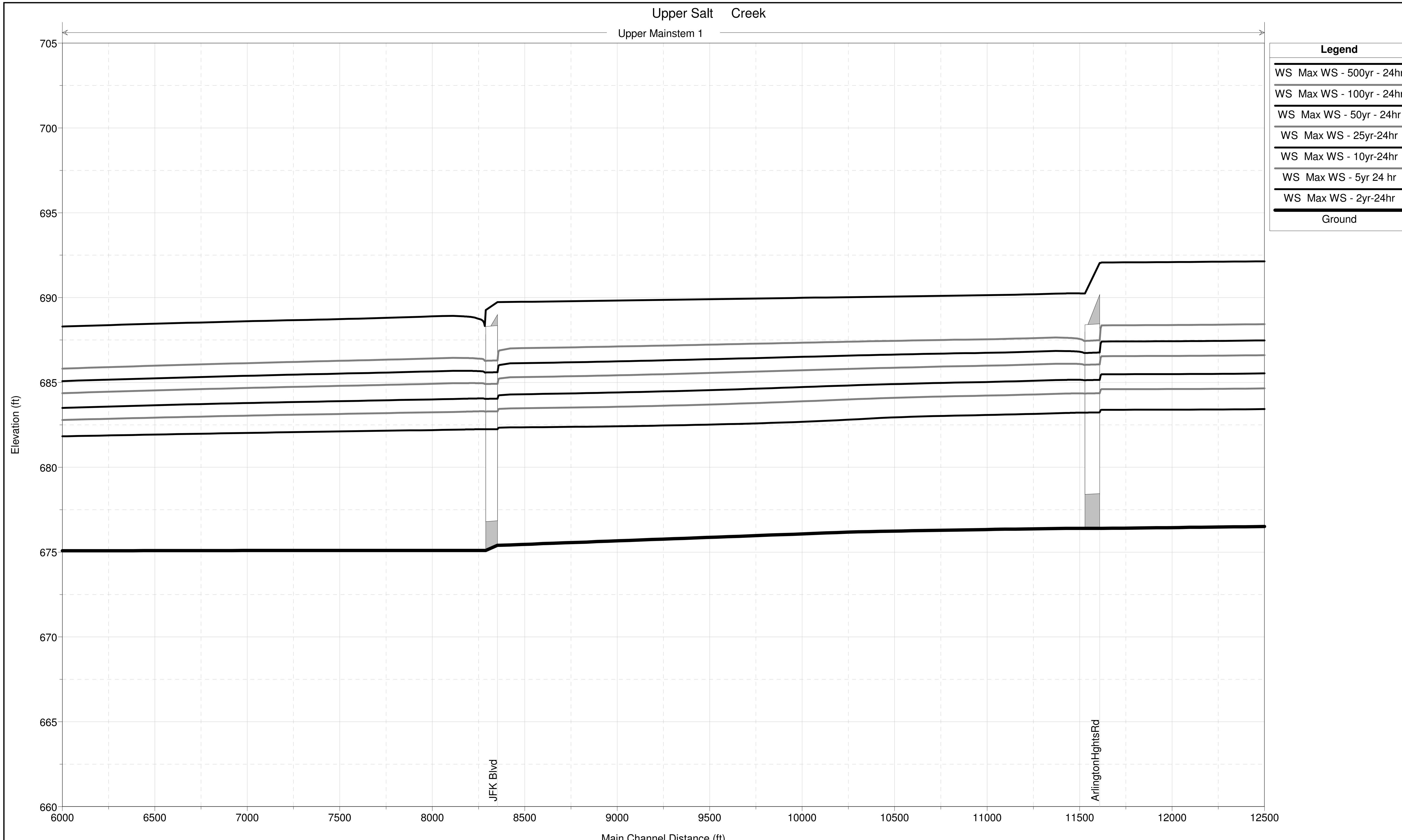
Tributary	Subbasin	Area (sq. mi)	Curve Number	Time of concentration (hr)	Storage Coefficient (hr)
Mainstem	MS43	0.22698	63.1	0.55	3.14
Mainstem	MS44	0.37859	74.3	0.44	2.48
Mainstem	MS45	0.38605	67.2	1.35	7.64
Mainstem	MS46	0.22643	83.6	0.48	2.74
Mainstem	MS47	0.0926152	82.5	0.67	3.81
Mainstem	MS48	0.29336	70.5	0.19	1.08
Mainstem	MS49	0.15349	76.7	0.28	1.61
Mainstem	MS50	0.23281	77.5	0.23	1.28
Mainstem	MS51	0.39309	80	0.39	2.22
Mainstem	MS52	0.0527419	75.9	0.09	0.53
Mainstem	MS53	0.27406	74.5	0.17	0.95
Mainstem	MS54	0.31252	81.4	0.36	2.06
Mainstem	MS55	1.2303	73.7	1.12	6.36
Mainstem	MS56	3.6846	65.1	1.16	6.55
Mainstem	MS57	4.8299	66.4	1.13	6.38
Mainstem	MS58	0.16458	54.7	0.16	0.89
Mainstem	MS59	0.95229	76.1	1.18	6.69
Mainstem	MS60	0.7008	74.5	1.15	6.52
Mainstem	MS61	0.32503	75.3	0.37	2.08
Mainstem	MS62	0.36299	71.3	0.85	4.79

Tributary	Subbasin	Area (sq. mi)	Curve Number	Time of concentration (hr)	Storage Coefficient (hr)
West Branch	WB01	0.48661	70.5	8.5	6.8
West Branch	WB02	0.1853	76.6	5.75	4.6
West Branch	WB03	0.55704	74.6	10.21	8.17
West Branch	WB04	0.09691	80	8.84	7.07
West Branch	WB05	0.43982	83.2	7.07	5.66
West Branch	WB06	0.59493	80.7	9.32	7.46
West Branch	WB07	0.59358	75.3	13.21	10.57
West Branch	WB08	0.13991	73.8	5.62	4.5
West Branch	WB09	0.39748	77.4	13.24	10.59
West Branch	WB10	0.44799	76.9	16.43	13.14
West Branch	WB11	0.27486	78.2	4.25	3.4
West Branch	WB12	0.33792	76.1	5.8	4.64
West Branch	WB13	0.45394	74.8	6.18	4.95
West Branch	WB14	0.74381	68.6	15.45	12.36
West Branch	WB15	0.21668	78.9	12.17	9.73
West Branch	WB16	0.22918	70.3	3.37	2.69
West Branch	WB17	0.61918	75.3	26.87	21.49
West Branch	WB18	0.17354	81.4	4.06	3.25
West Branch	WB19	0.25667	75.9	28.64	22.91
West Branch	WB20	0.12469	79.1	5.34	4.27
West Branch	WB21	0.23149	76.6	1.97	1.58
West Branch	WB22	0.40366	65.7	11.4	9.12
West Branch	WB23	0.49773	73.2	8.98	7.18
West Branch	WB24	0.32981	74	7.31	5.85
West Branch	WB25	0.28483	72.1	5.08	4.07
West Branch	WB26	0.48086	76.9	10.99	8.79
West Branch	WB27	0.14125	74.8	24.84	19.87
West Branch	WB28	0.46394	69.4	9.54	7.63
West Branch	WB29	0.2009	69.4	3.85	3.08
West Branch	WB30	0.26235	64.7	5.11	4.08
West Branch	WB31	0.65108	69.9	17.12	13.7
West Branch	WB32	0.85322	67.8	17.75	14.2

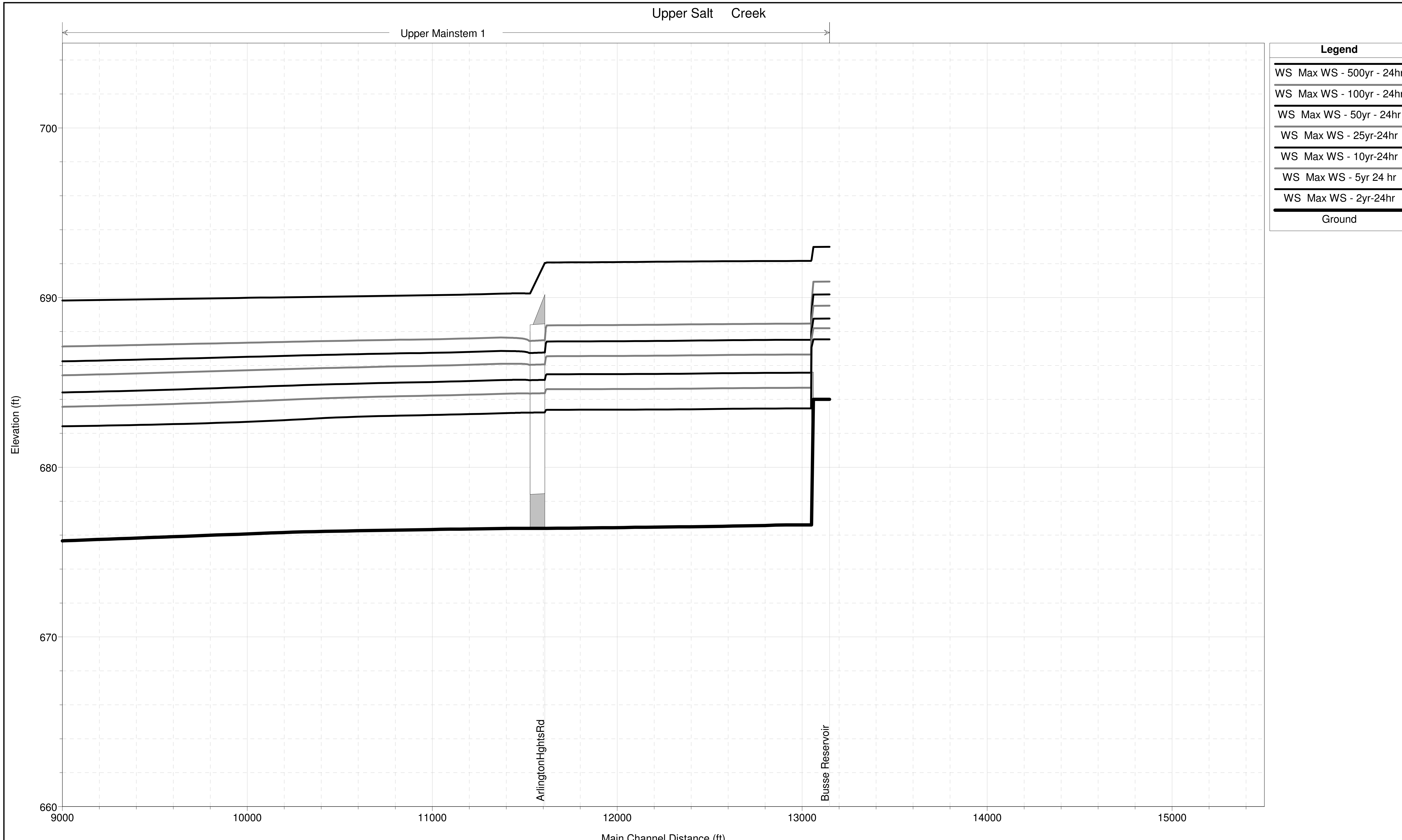
Detailed Watershed Plan for the Upper Salt Creek
Appendix H: Hydraulic Profiles for Existing Conditions

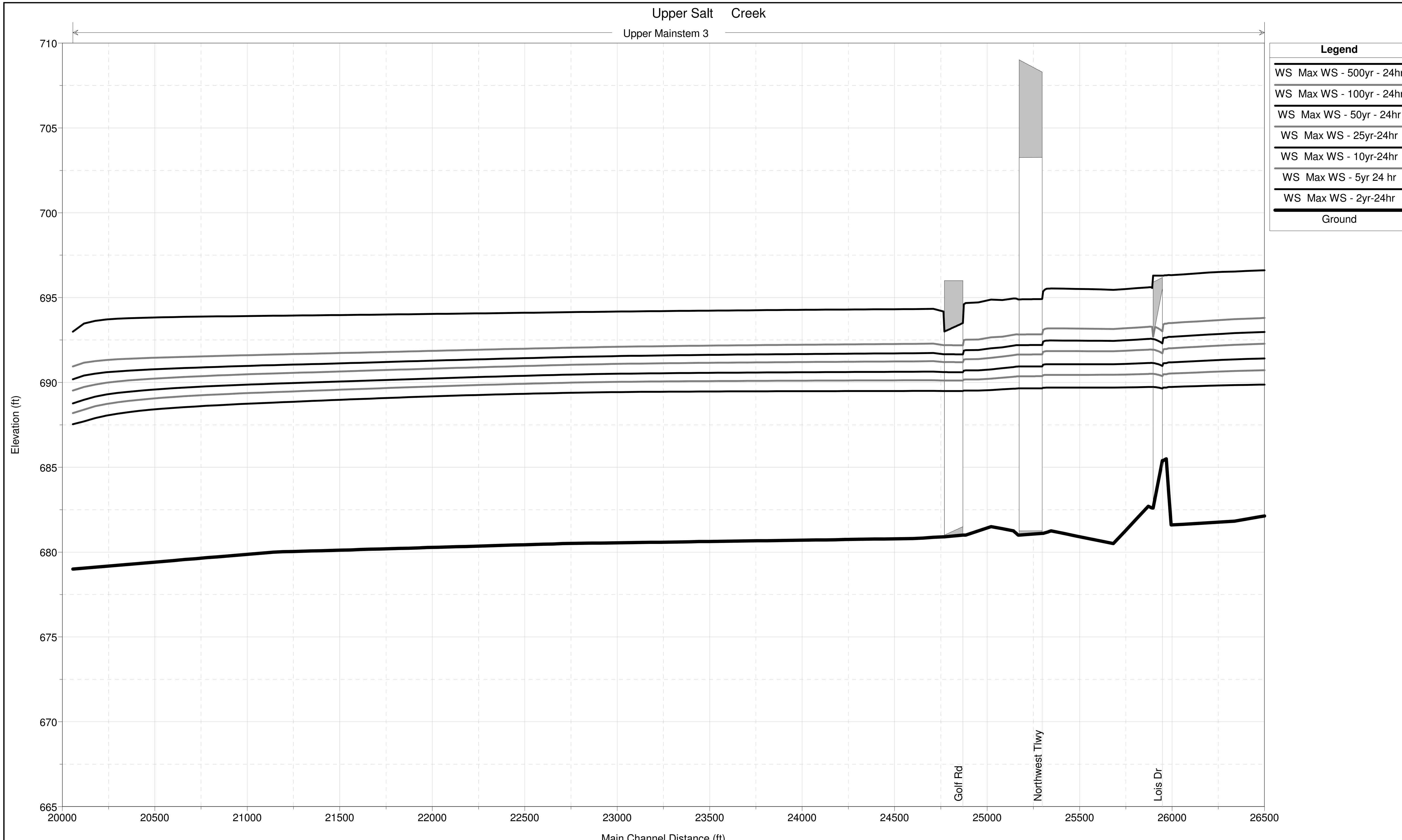
Mainstem


Upper Salt Creek
Upper Mainstem 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
705
700
695
690
685
680
675
670
665
660
End of Model -
DuPage County Li
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
Main Channel Distance (ft)

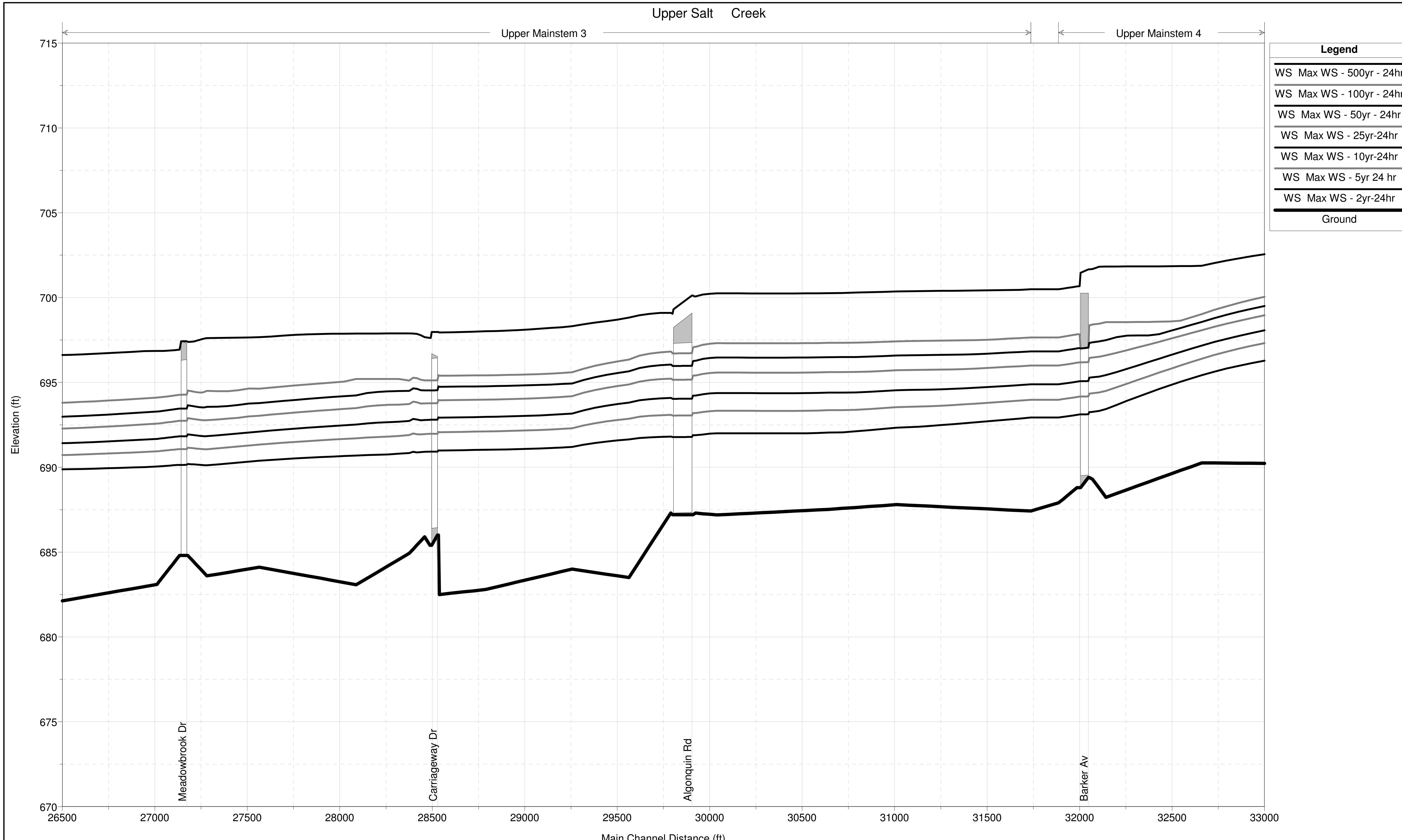


Upper Salt Creek
Upper Mainstem 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
705
700
695
690
685
680
675
670
665
660
JFK Blvd
ArlingtonHghtsRd
6000
6500
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
12000
12500
Main Channel Distance (ft)

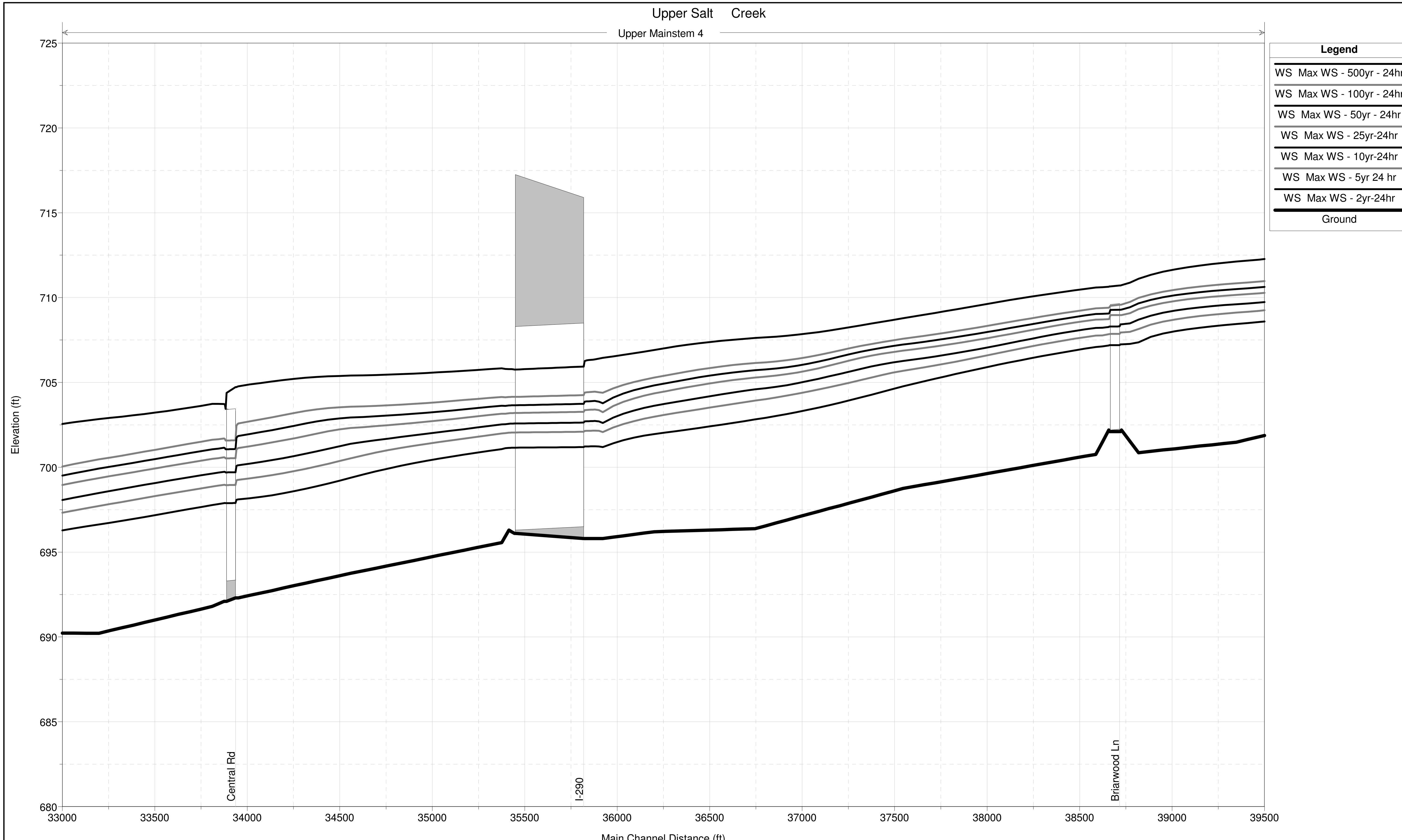

Upper Salt Creek
Upper Mainstem 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
700
690
680
670
660
ArlingtonHghtsRd
Busse Reservoir
9000
10000
11000
12000
13000
14000
15000
Main Channel Distance (ft)

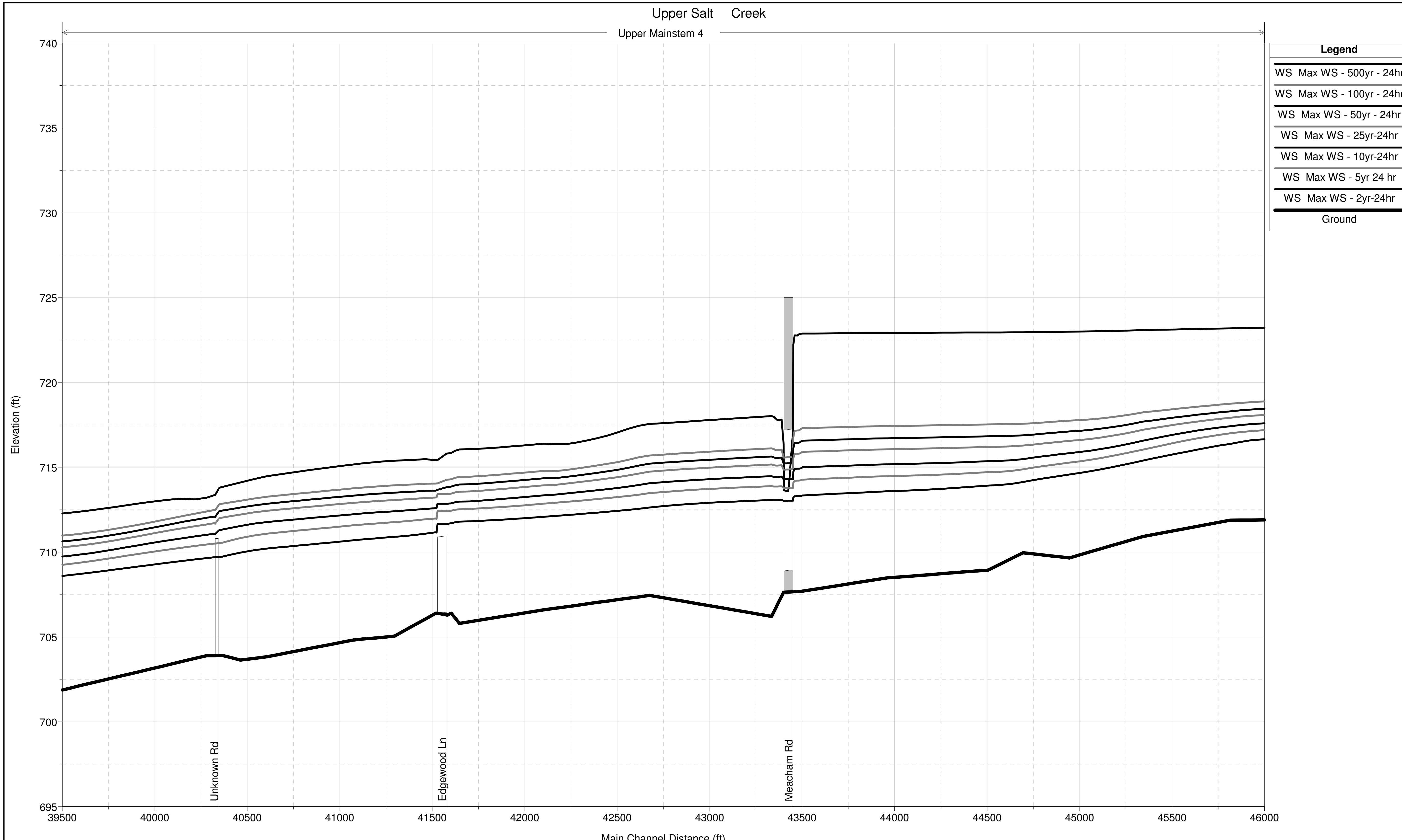


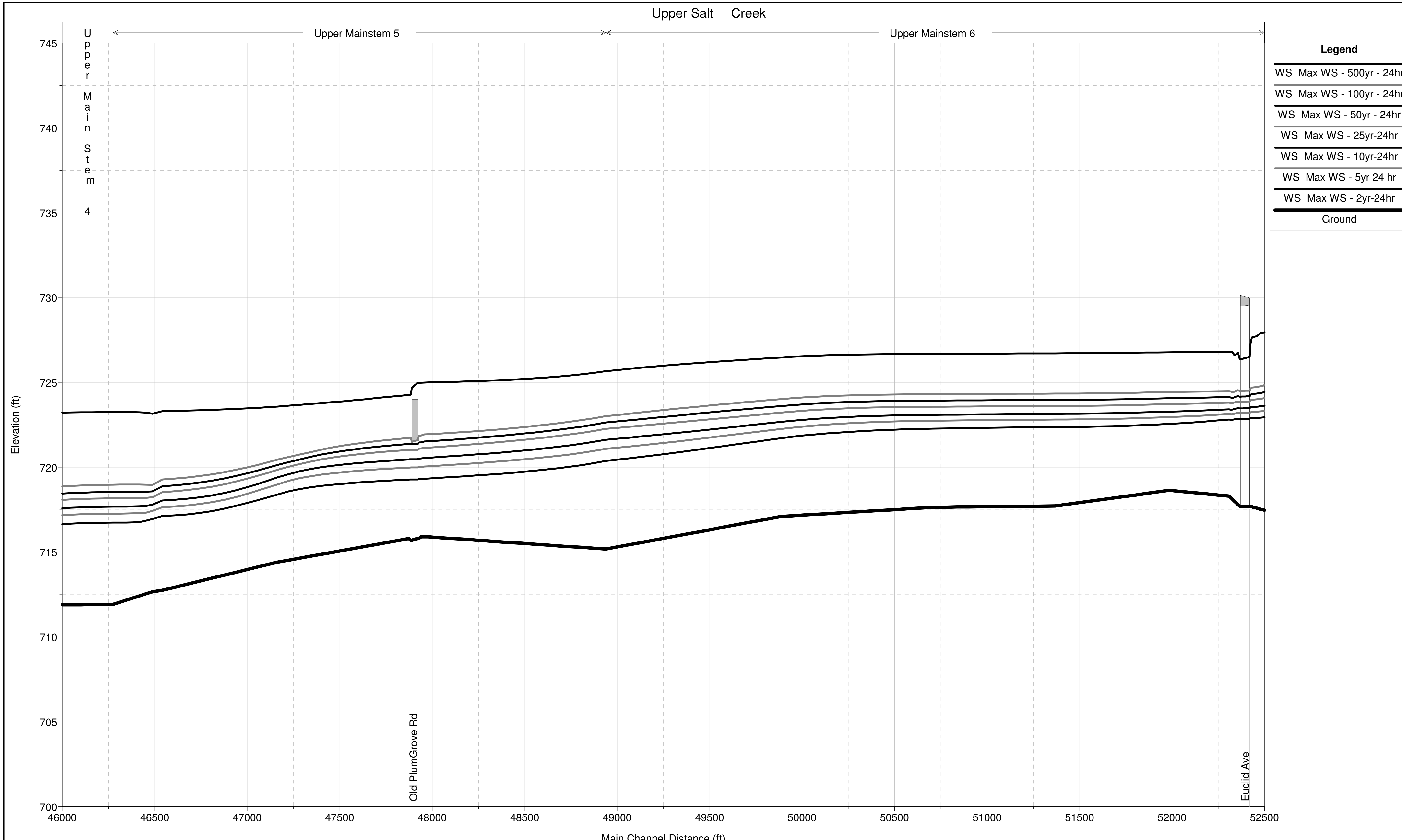
Upper Salt Creek
Upper Mainstem 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Golf Rd
Northwest Tlwy
Lois Dr
Elevation (ft)
Main Channel Distance (ft)
710
705
700
695
690
685
680
675
670
665
20000
20500
21000
21500
22000
22500
23000
23500
24000
24500
25000
25500
26000
26500



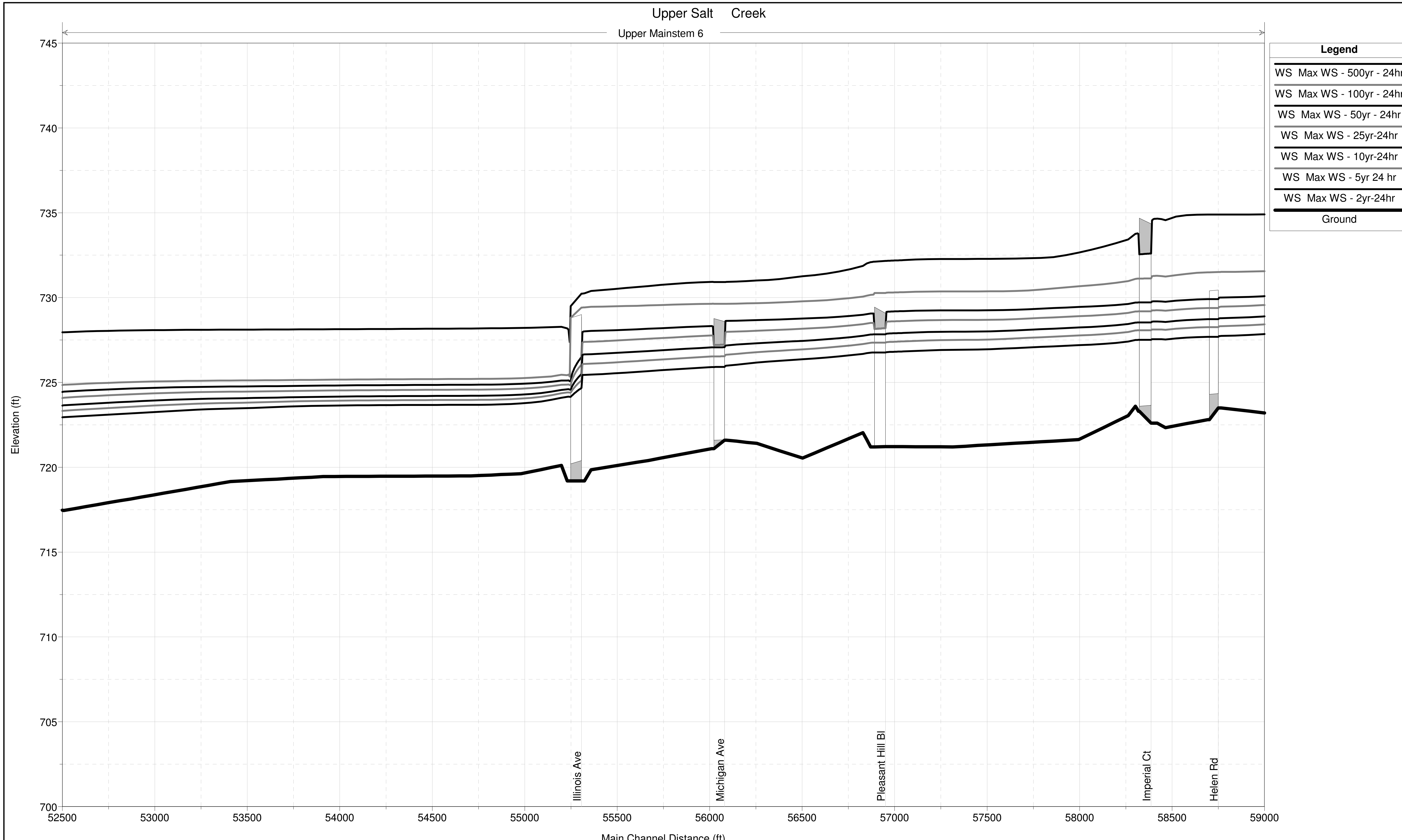
Upper Salt Creek
Upper Mainstem 3
Upper Mainstem 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
715
710
705
700
695
690
685
680
675
670
Meadowbrook Dr
Carriageway Dr
Algonquin Rd
Barker Av
26500
27000
27500
28000
28500
29000
29500
30000
30500
31000
31500
32000
32500
33000
Main Channel Distance (ft)


Upper Salt Creek
Upper Mainstem 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
725
720
715
710
705
700
695
690
685
680
Central Rd
I-290
Briarwood Ln
33000
33500
34000
34500
35000
35500
36000
36500
37000
37500
38000
38500
39000
39500
Main Channel Distance (ft)

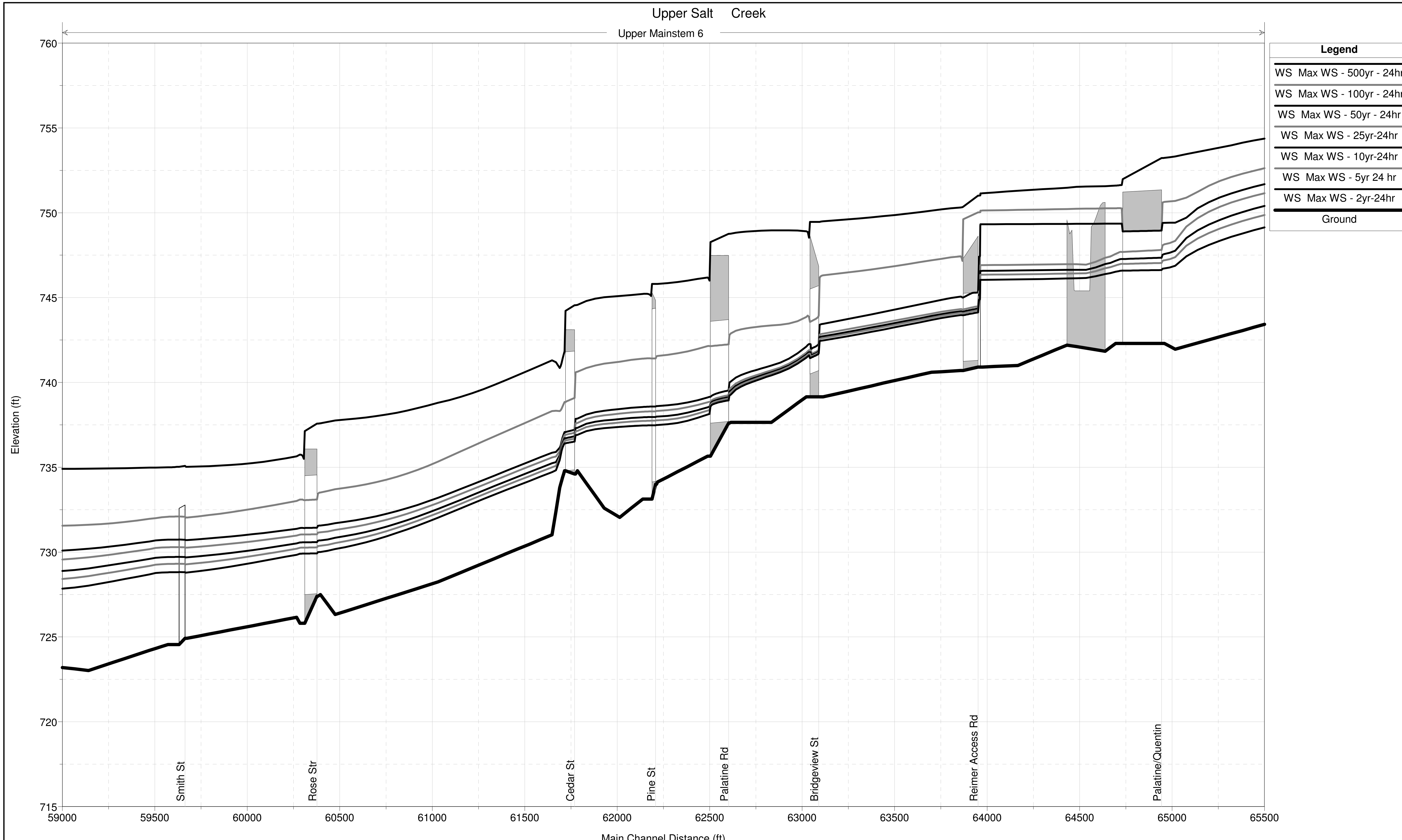

Upper Salt Creek
Upper Mainstem 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
740
735
730
725
720
715
710
705
700
695
Unknown Rd
Edgewood Ln
Meacham Rd
39500
40000
40500
41000
41500
42000
42500
43000
43500
44000
44500
45000
45500
46000
Main Channel Distance (ft)



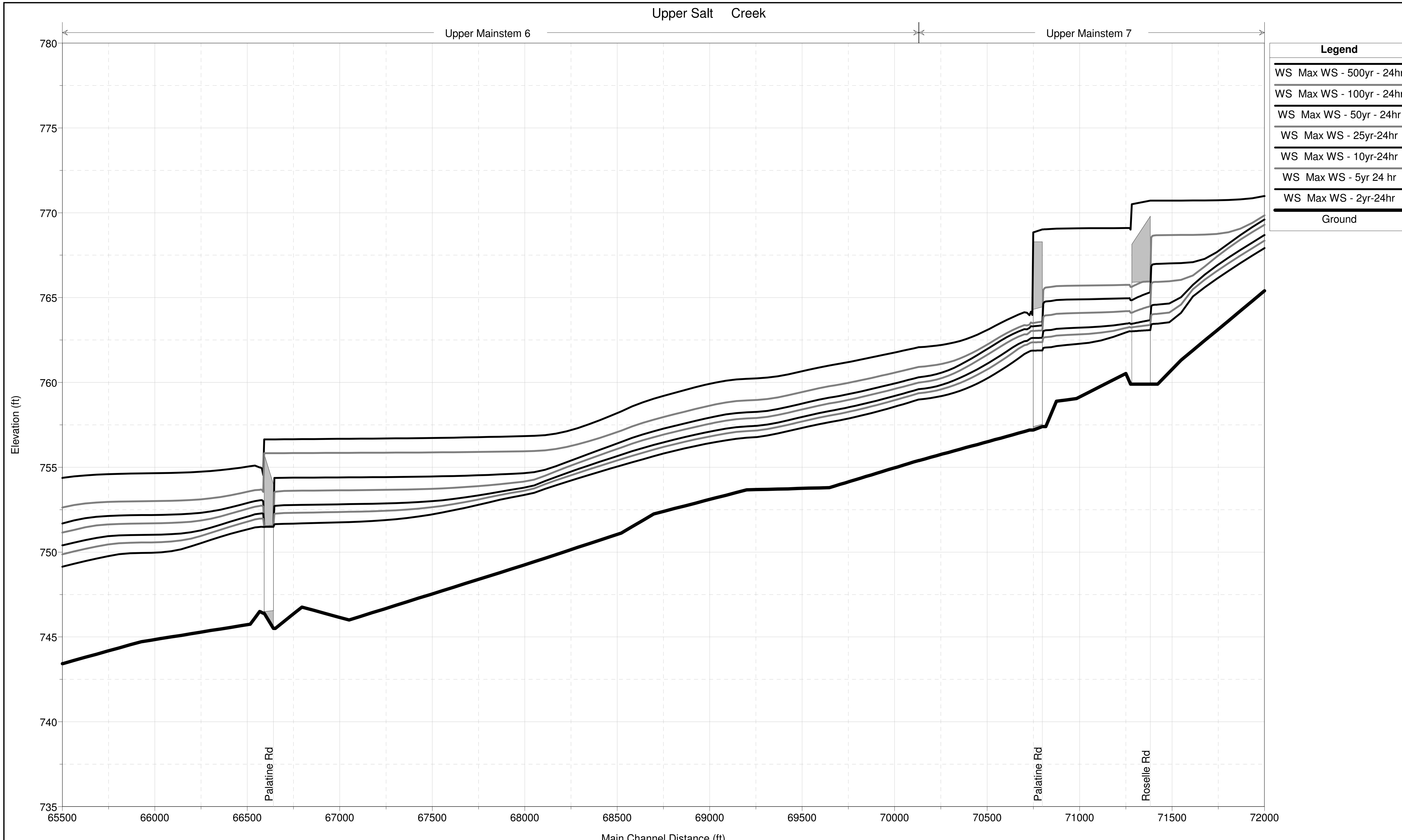
Upper Salt Creek
Upper Mainstem 5
Upper Mainstem 6
Upper Main Stem 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Old PlumGrove Rd
Euclid Ave
Elevation (ft)
Main Channel Distance (ft)
745
740
735
730
725
720
715
710
705
700
46000
46500
47000
47500
48000
48500
49000
49500
50000
50500
51000
51500
52000
52500



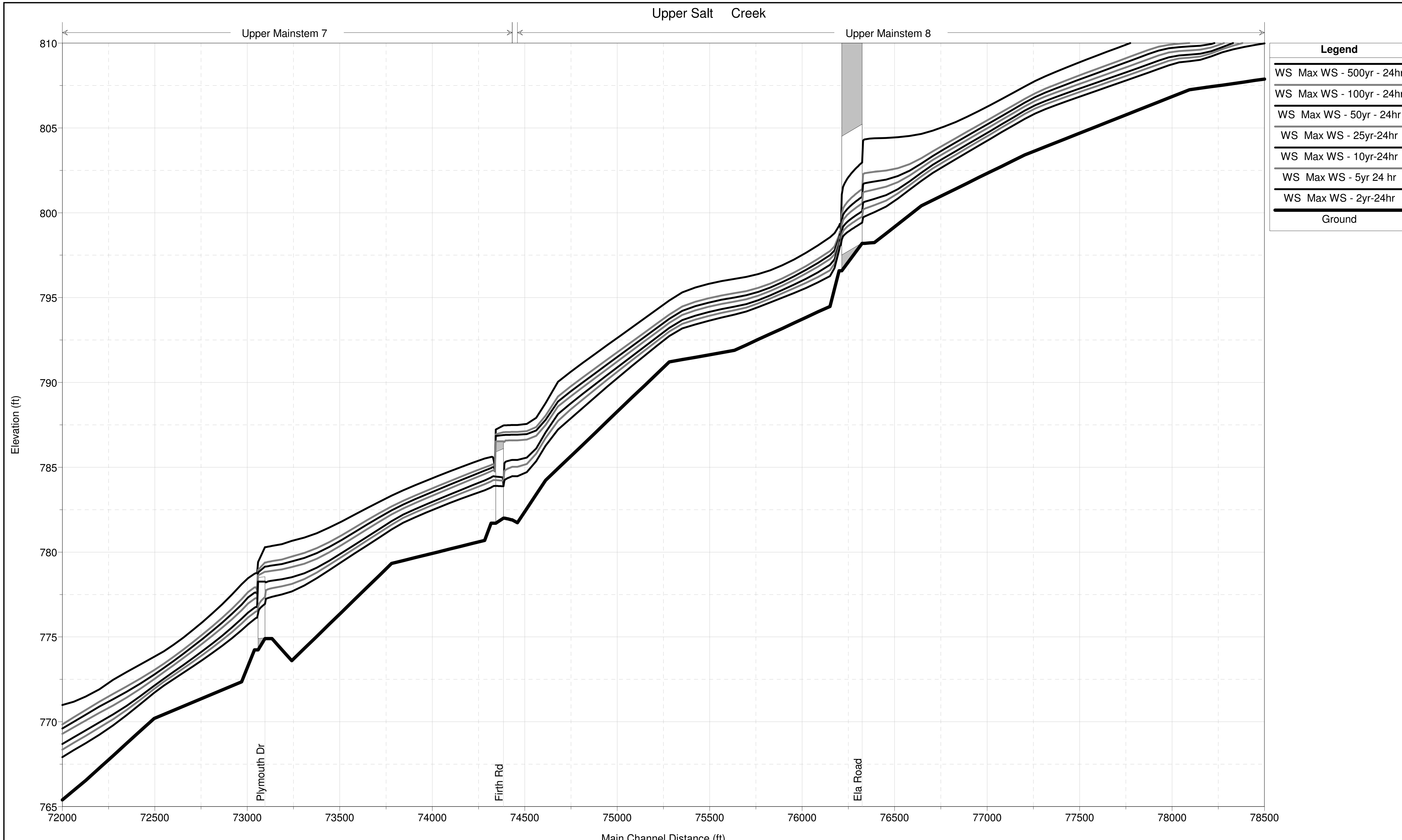
Upper Salt Creek
Upper Mainstem 6
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
745
740
735
730
725
720
715
710
705
700
Illinois Ave
Michigan Ave
Pleasant Hill Bl
Imperial Ct
Helen Rd
52500
53000
53500
54000
54500
55000
55500
56000
56500
57000
57500
58000
58500
59000
Main Channel Distance (ft)



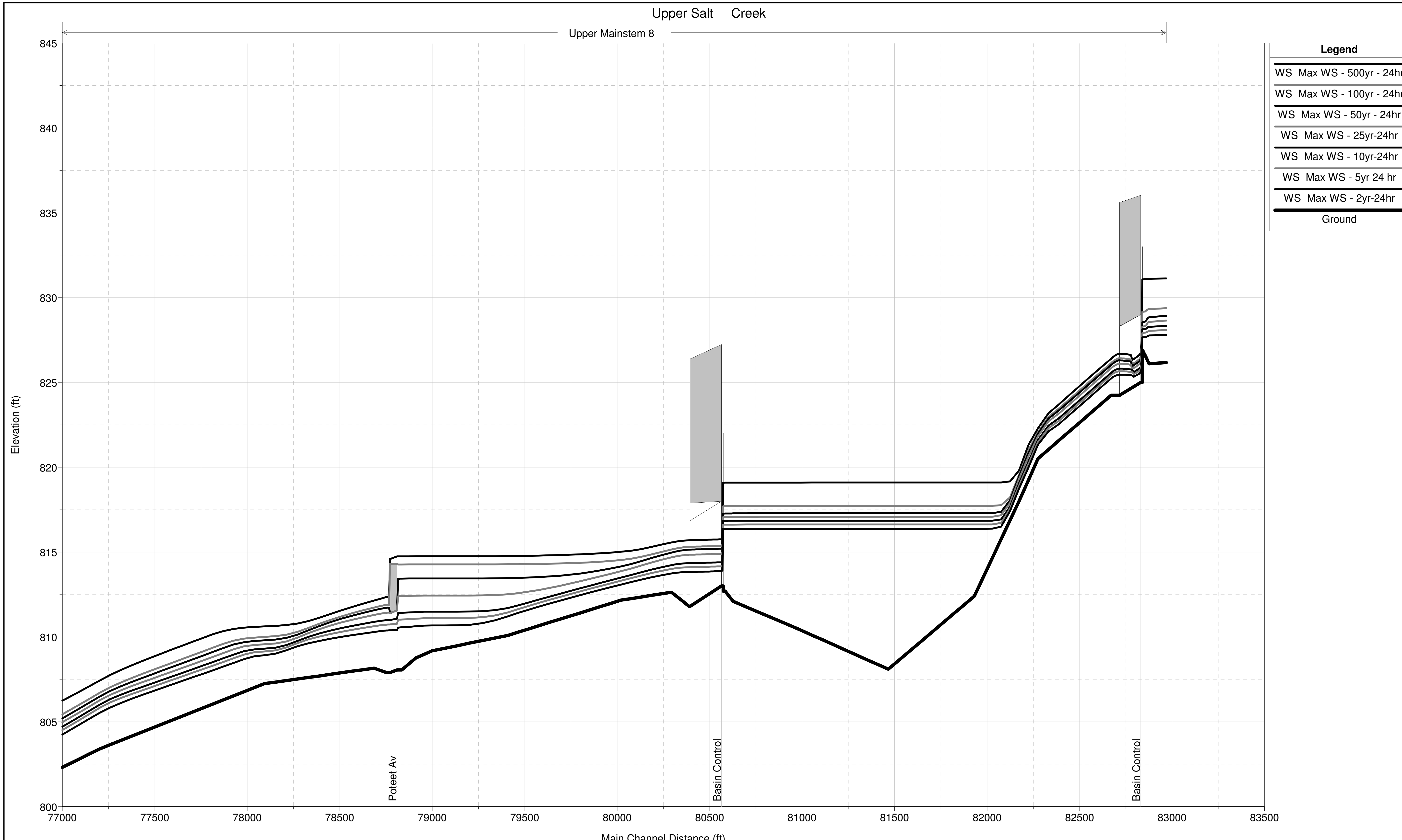
Upper Salt Creek
Upper Mainstem 6
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
Smith St
Rose Str
Cedar St
Pine St
Palatine Rd
Bridgeview St
Reimer Access Rd
Palatine/Quentin
760
755
750
745
740
735
730
725
720
715
59000
59500
60000
60500
61000
61500
62000
62500
63000
63500
64000
64500
65000
65500



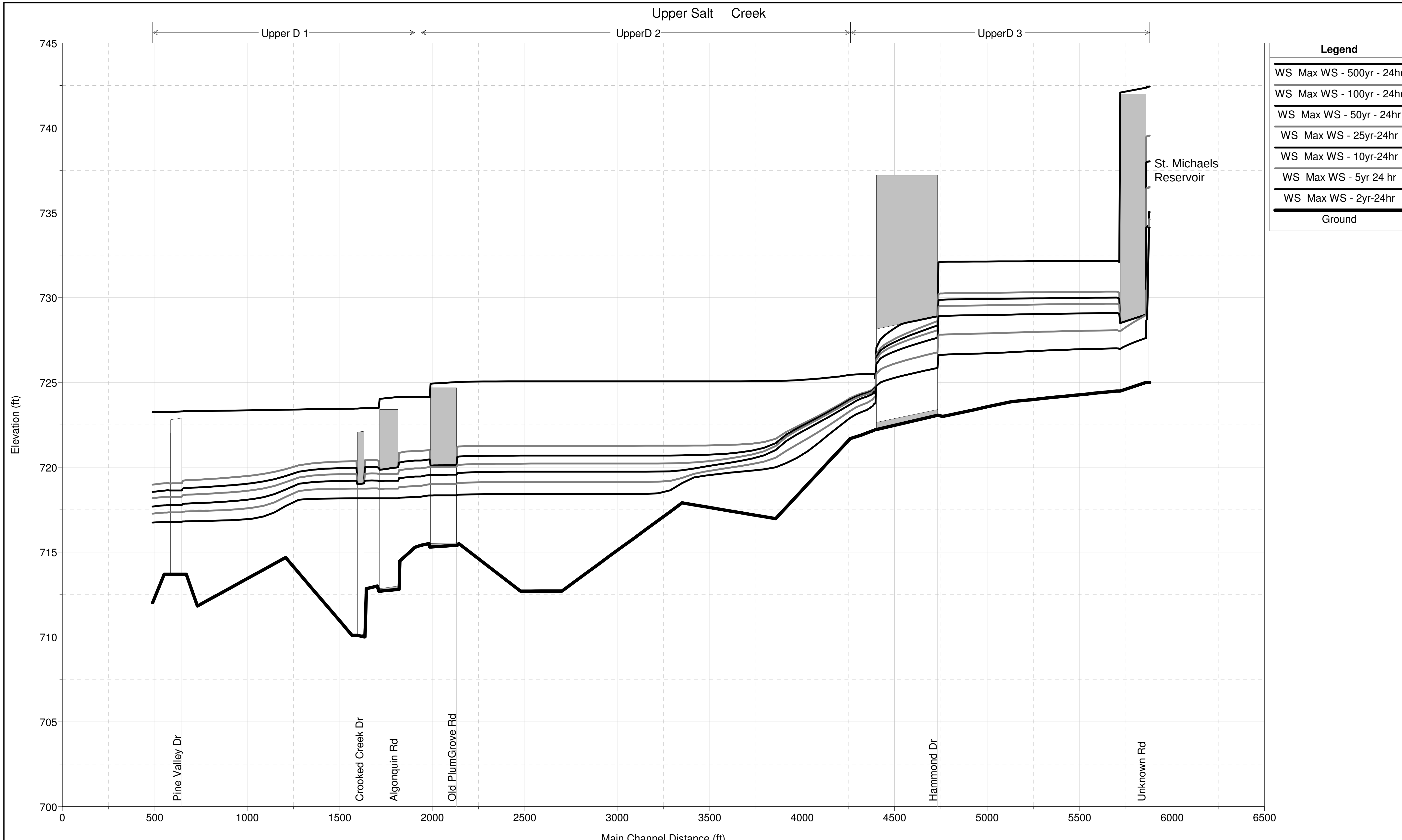
Upper Salt Creek
Upper Mainstem 6
Upper Mainstem 7
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
780
775
770
765
760
755
750
745
740
735
Palatine Rd
Palatine Rd
Roselle Rd
65500
66000
66500
67000
67500
68000
68500
69000
69500
70000
70500
71000
71500
72000
Main Channel Distance (ft)



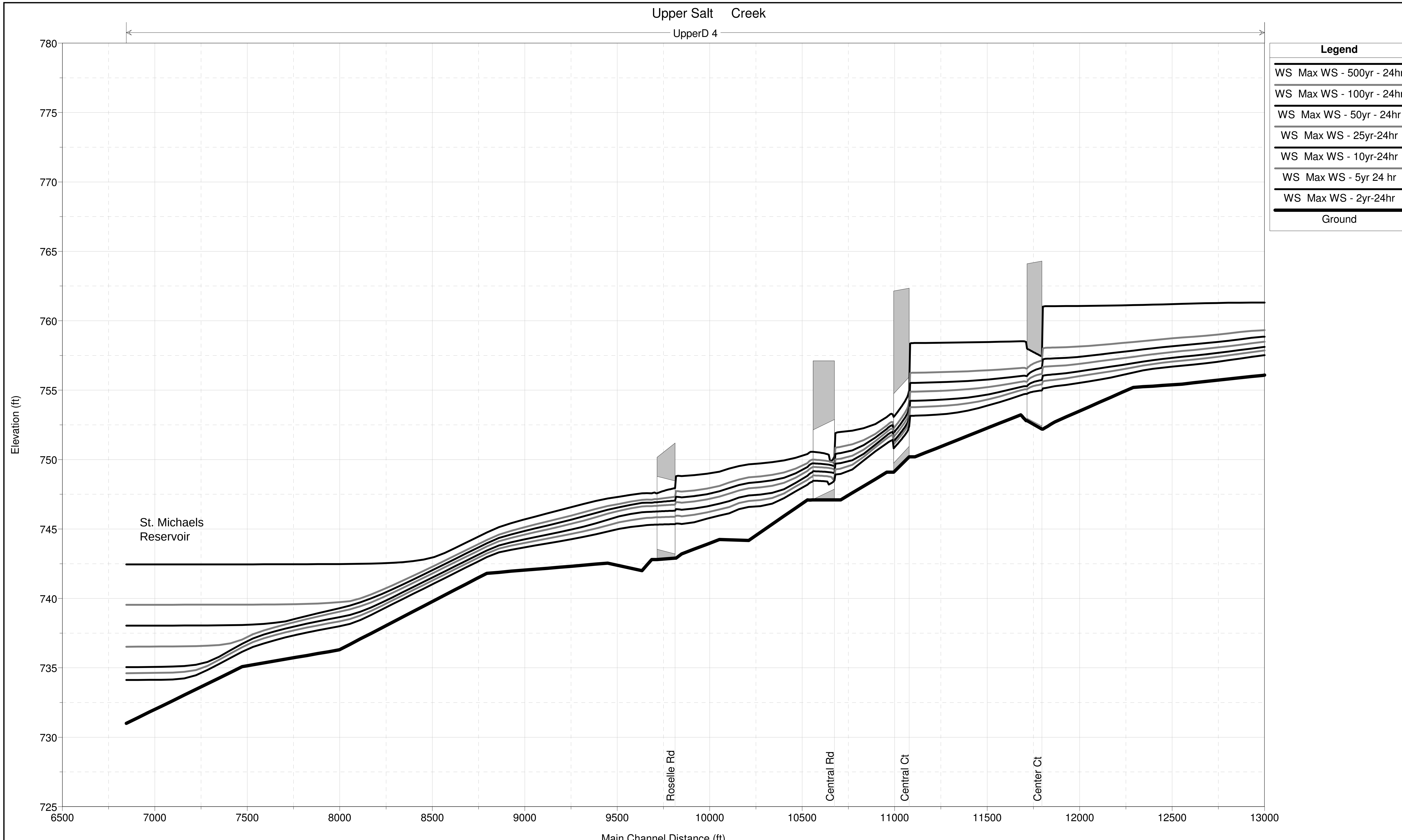
Upper Salt Creek
Upper Mainstem 7
Upper Mainstem 8
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
810
805
800
795
790
785
780
775
770
765
Plymouth Dr
Firth Rd
Ela Road
72000
72500
73000
73500
74000
74500
75000
75500
76000
76500
77000
77500
78000
78500
Main Channel Distance (ft)



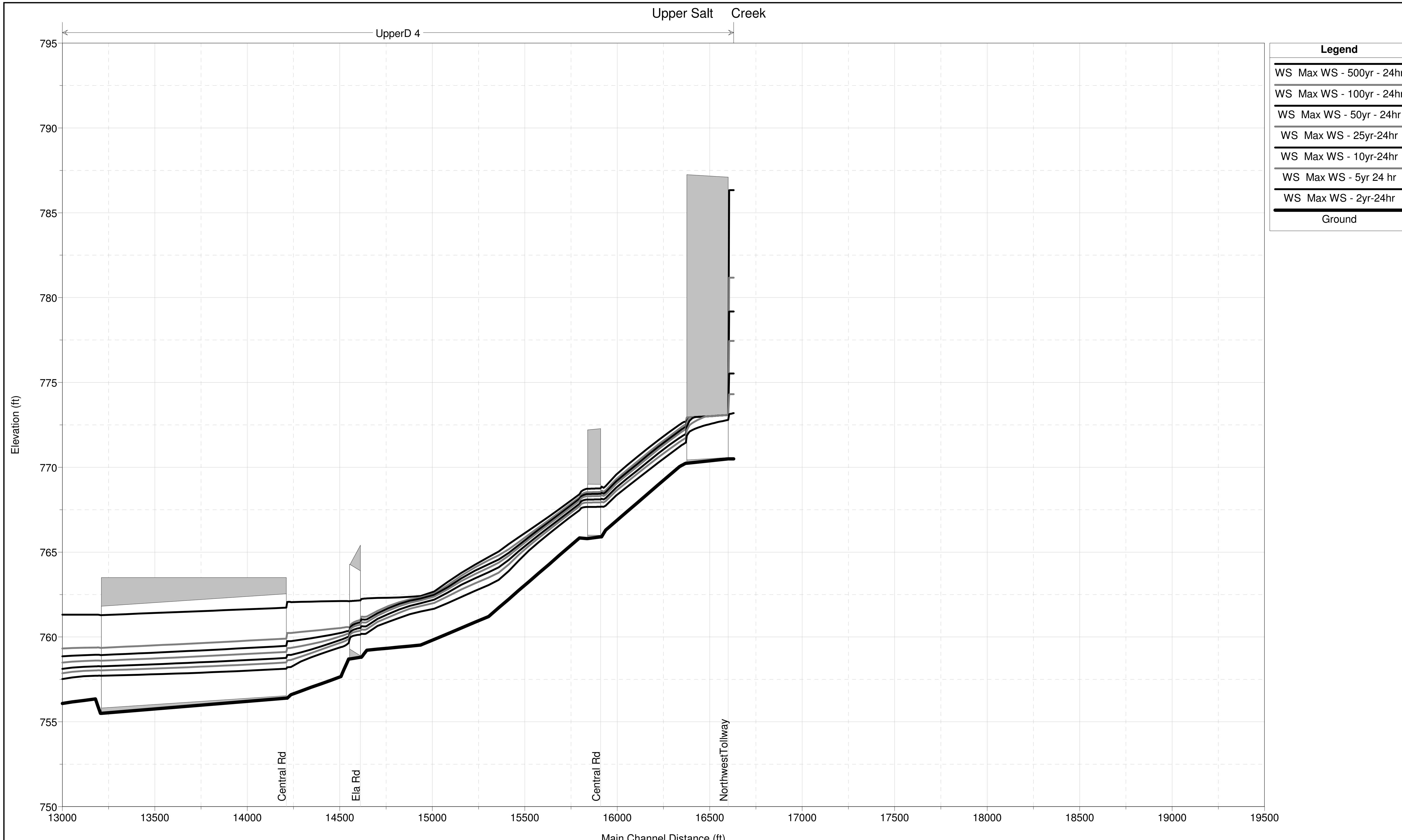
Upper Salt Creek
Upper Mainstem 8
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
845
840
835
830
825
820
815
810
805
800
Poteet Av
Basin Control
Basin Control
77000
77500
78000
78500
79000
79500
80000
80500
81000
81500
82000
82500
83000
83500
Main Channel Distance (ft)

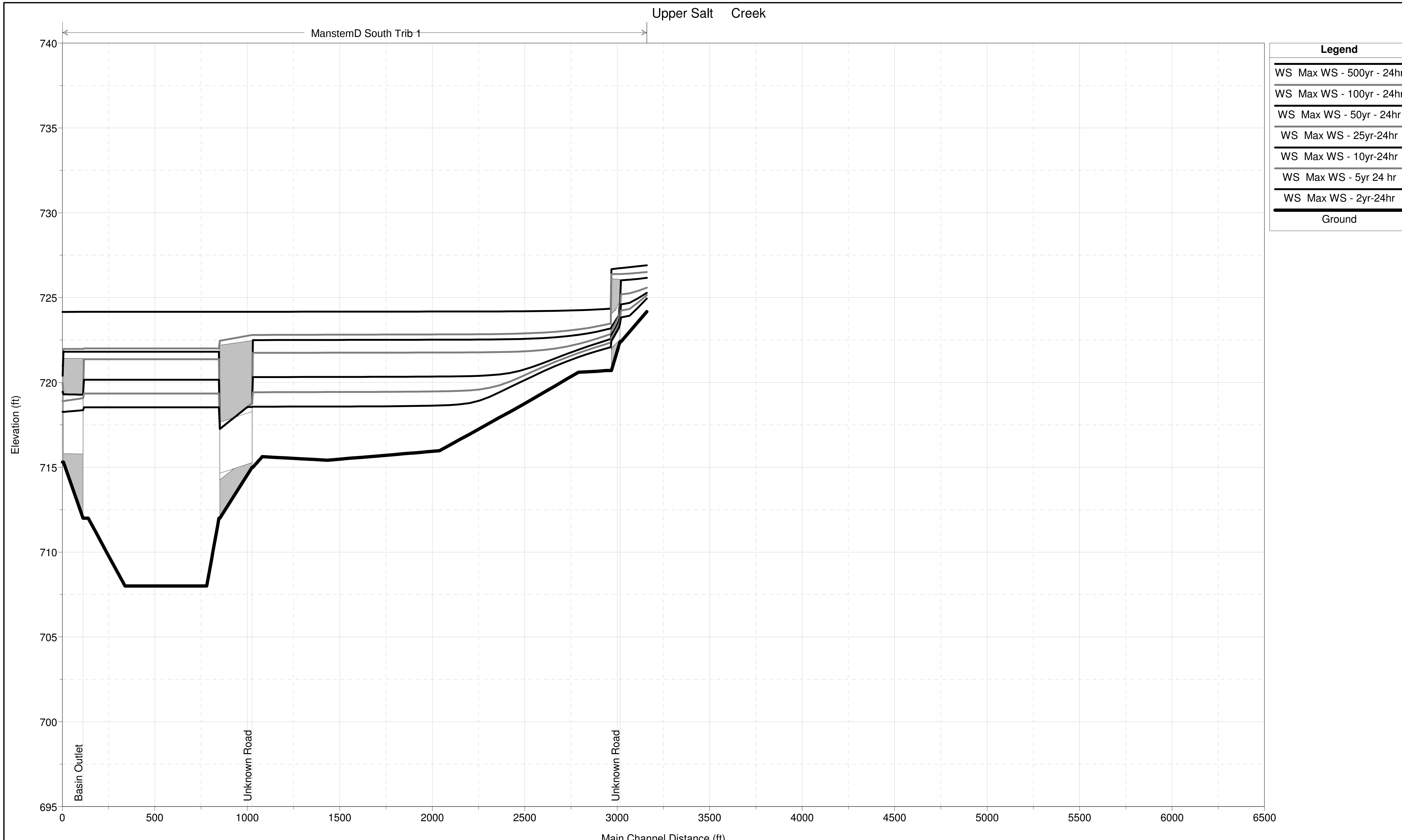


Upper Salt Creek
Upper D 1
UpperD 2
UpperD 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
St. Michaels Reservoir
Elevation (ft)
745
740
735
730
725
720
715
710
705
700
Pine Valley Dr
Crooked Creek Dr
Algonquin Rd
Old PlumGrove Rd
Hammond Dr
Unknown Rd
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)

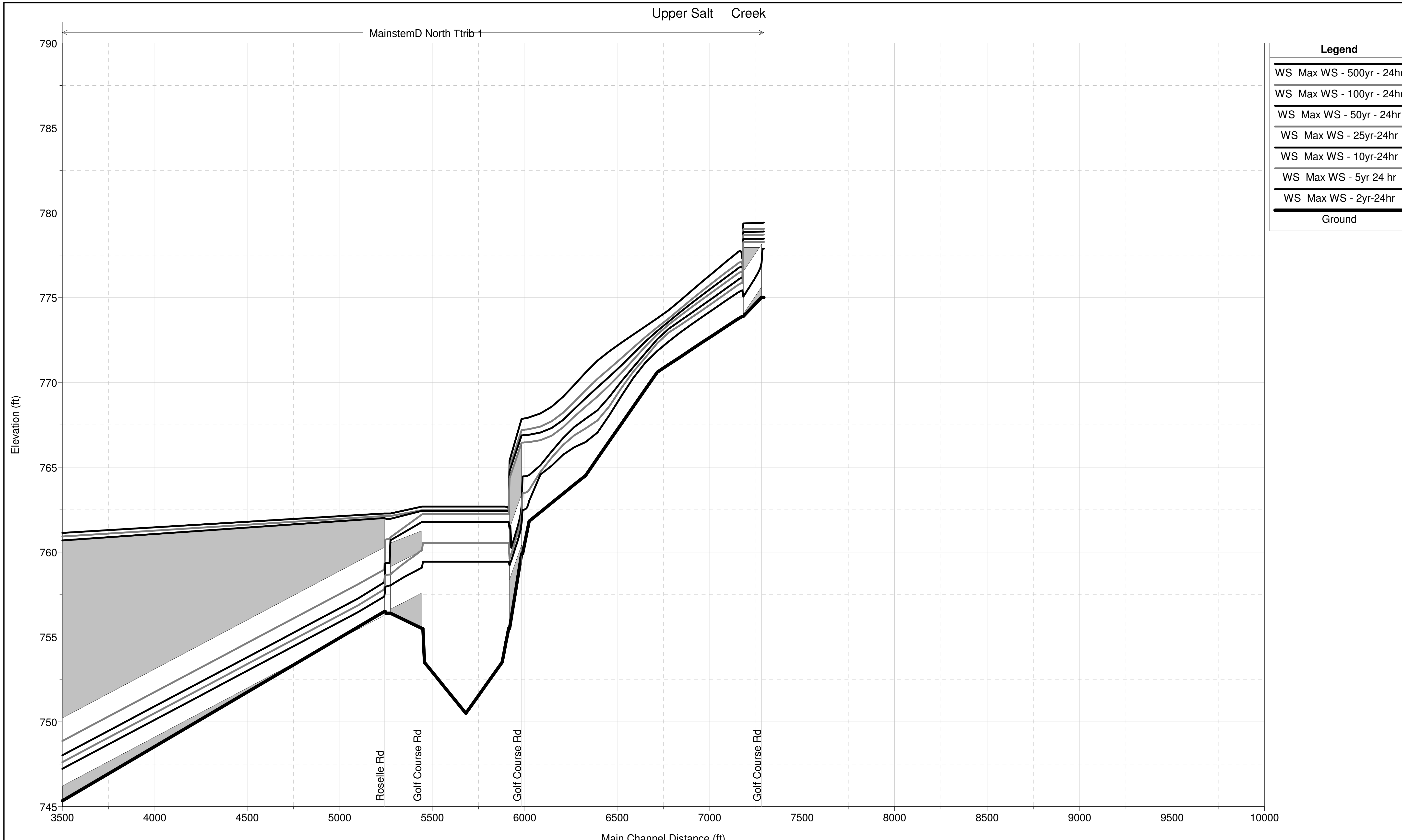


Upper Salt Creek
UpperD 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
St. Michaels Reservoir
Roselle Rd
Central Rd
Central Ct
Center Ct
780
775
770
765
760
755
750
745
740
735
730
725
6500
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
12000
12500
13000

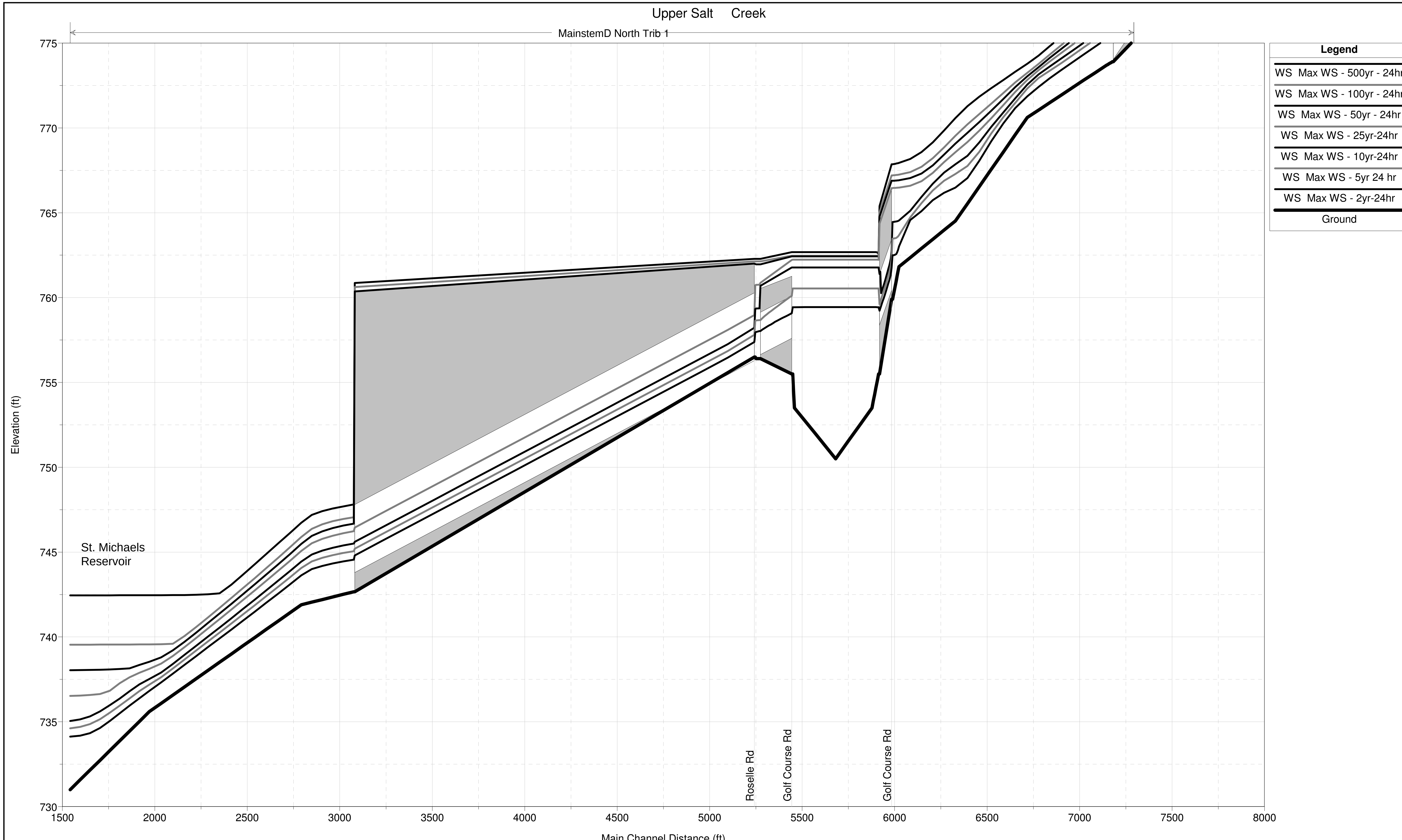

Upper Salt Creek
UpperD 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Central Rd
Ela Rd
Central Rd
NorthwestTollway
Elevation (ft)
Main Channel Distance (ft)
795
790
785
780
775
770
765
760
755
750
13000
13500
14000
14500
15000
15500
16000
16500
17000
17500
18000
18500
19000
19500



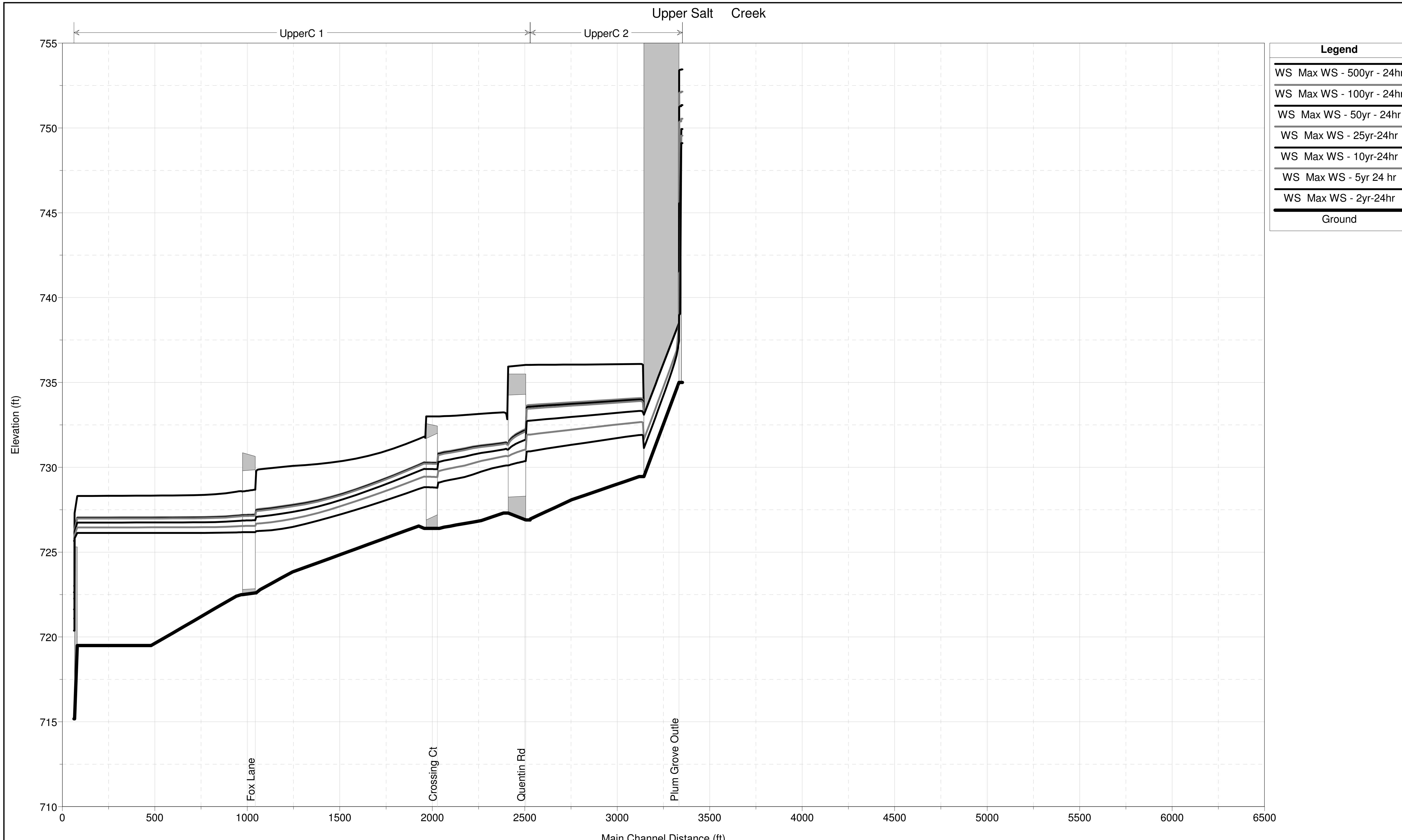
Upper Salt Creek
ManstemD South Trib 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
740
735
730
725
720
715
710
705
700
695
Basin Outlet
Unknown Road
Unknown Road
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)

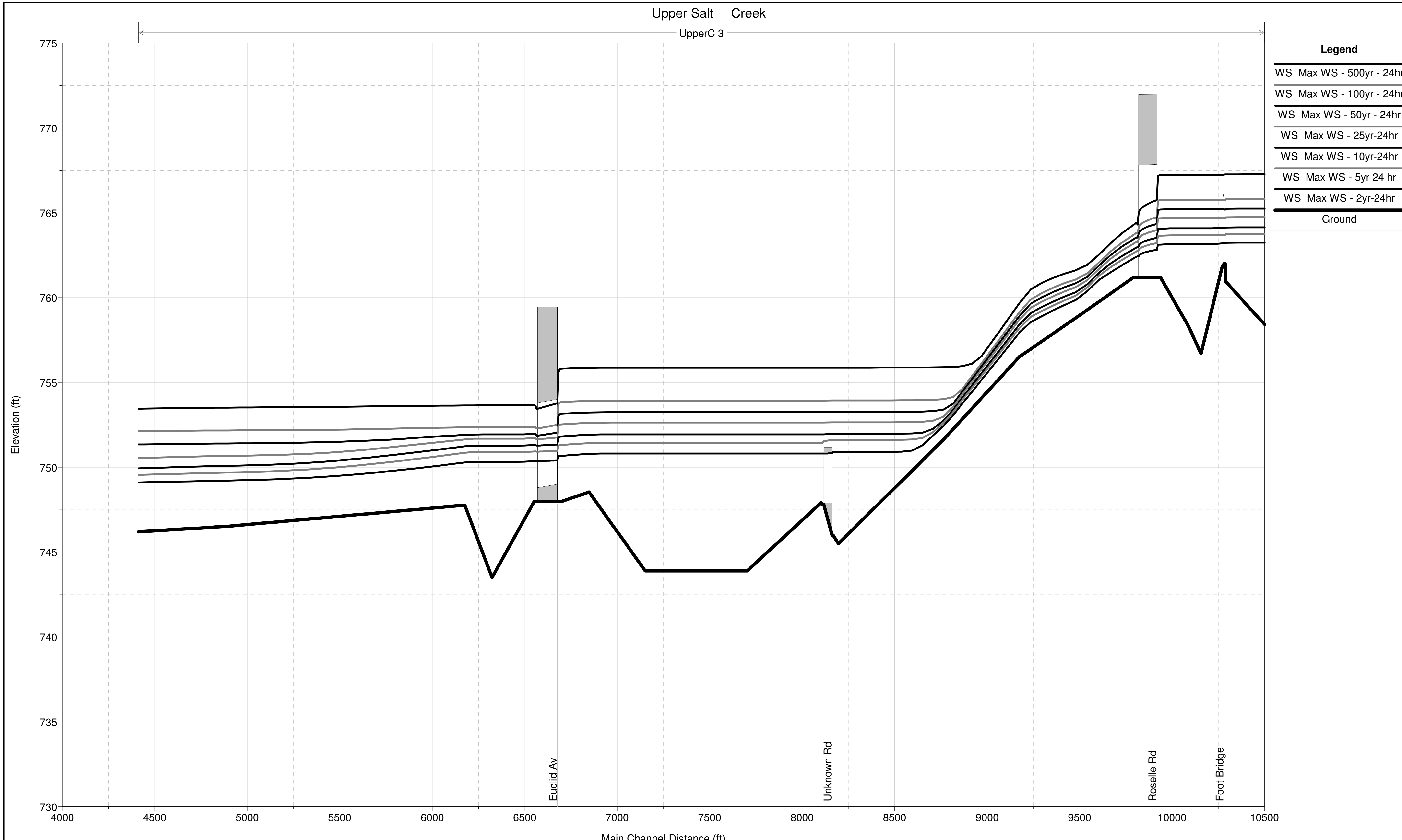


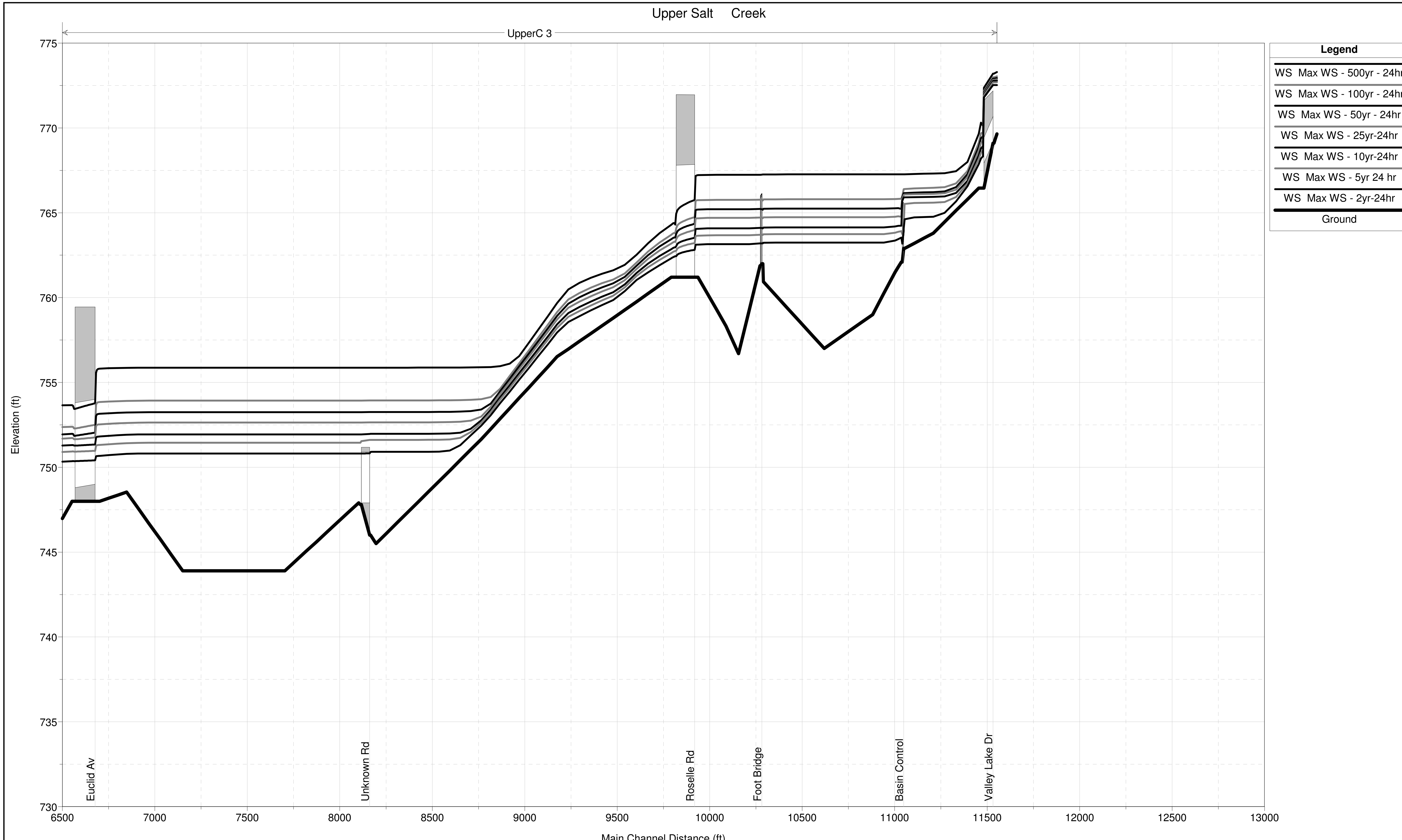
Upper Salt Creek
MainstemD North Ttrib 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
790
785
780
775
770
765
760
755
750
745
Roselle Rd
Golf Course Rd
Golf Course Rd
Golf Course Rd
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
10000
Main Channel Distance (ft)



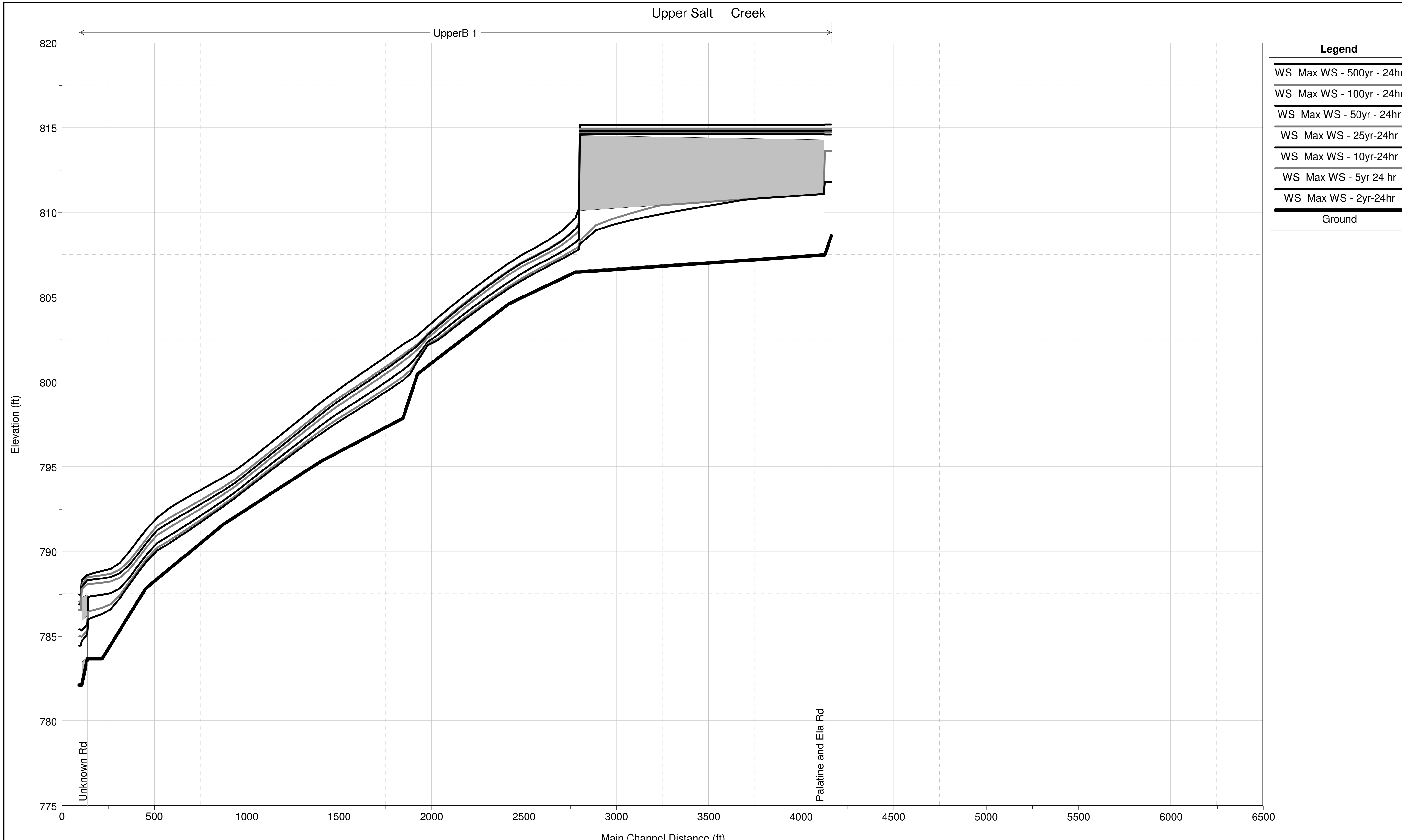
Upper Salt Creek
MainstemD North Trib 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
St. Michaels Reservoir
Roselle Rd
Golf Course Rd
Golf Course Rd
Elevation (ft)
Main Channel Distance (ft)
775
770
765
760
755
750
745
740
735
730
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000


Upper Salt Creek
UpperC 1
UpperC 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
755
750
745
740
735
730
725
720
715
710
Fox Lane
Crossing Ct
Quentin Rd
Plum Grove Outle
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)

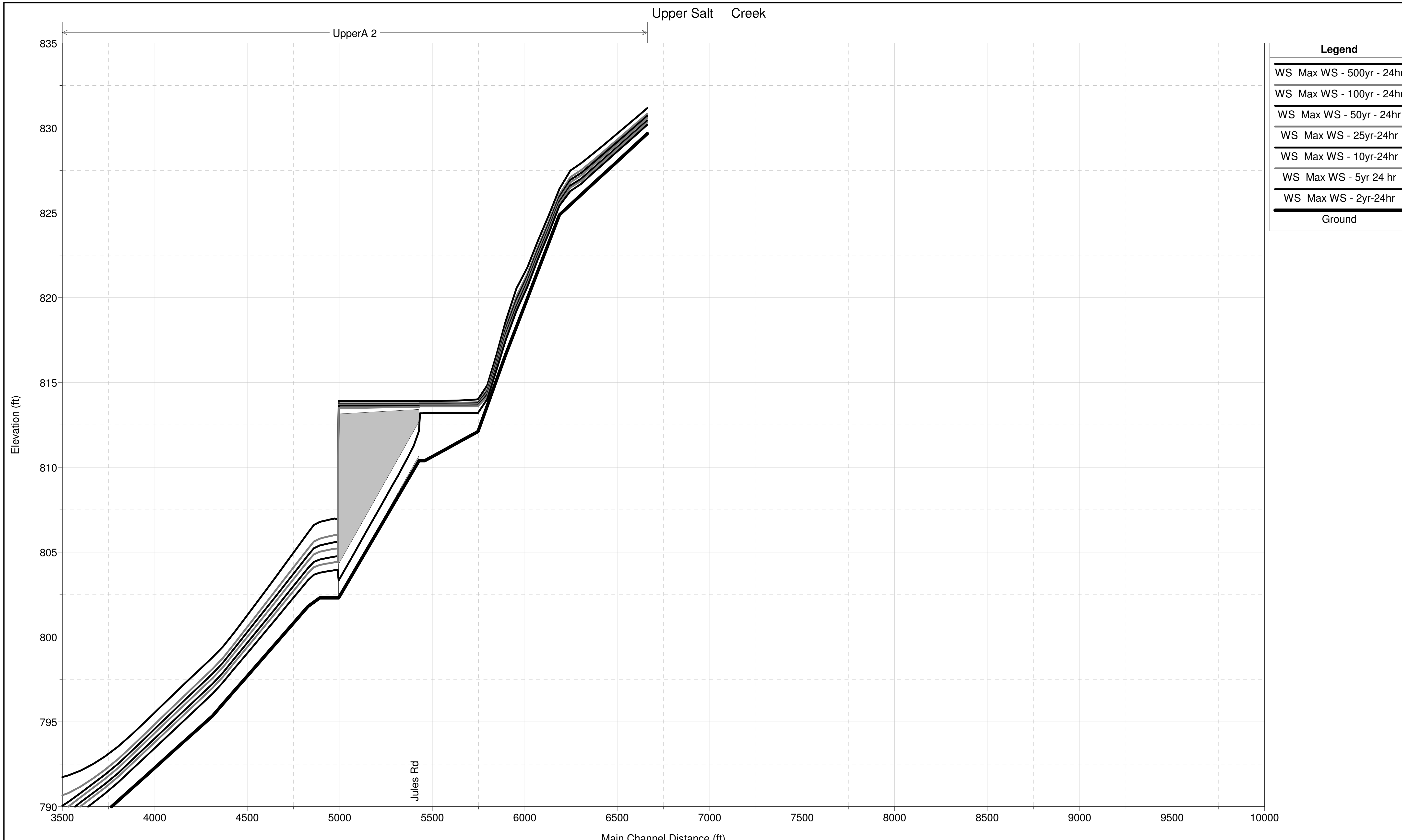

Upper Salt Creek
UpperC 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
775
770
765
760
755
750
745
740
735
730
Main Channel Distance (ft)
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
10000
10500
Euclid Av
Unknown Rd
Roselle Rd
Foot Bridge



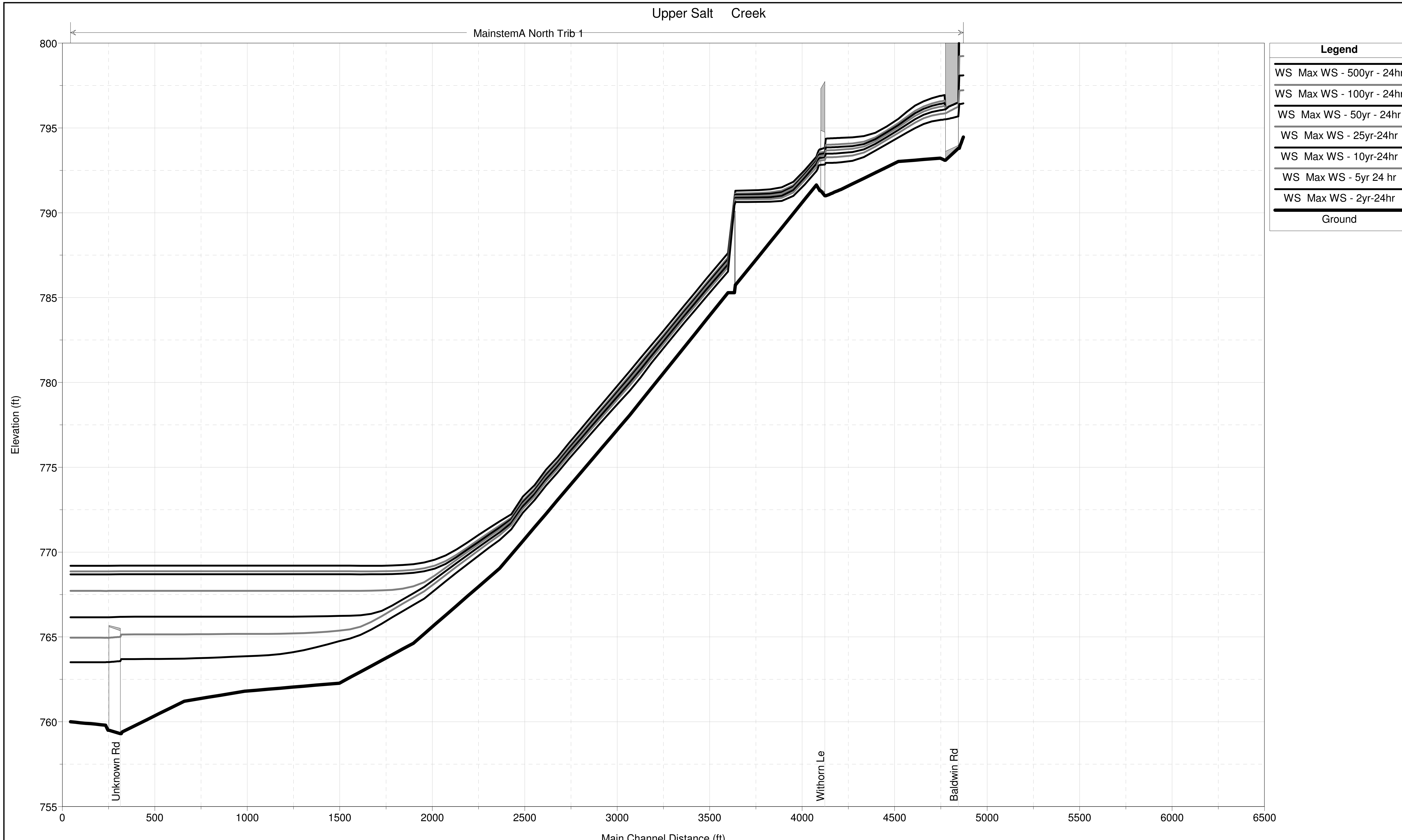
Upper Salt Creek
UpperC 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
Euclid Av
Unknown Rd
Roselle Rd
Foot Bridge
Basin Control
Valley Lake Dr
775
770
765
760
755
750
745
740
735
730
6500
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
12000
12500
13000

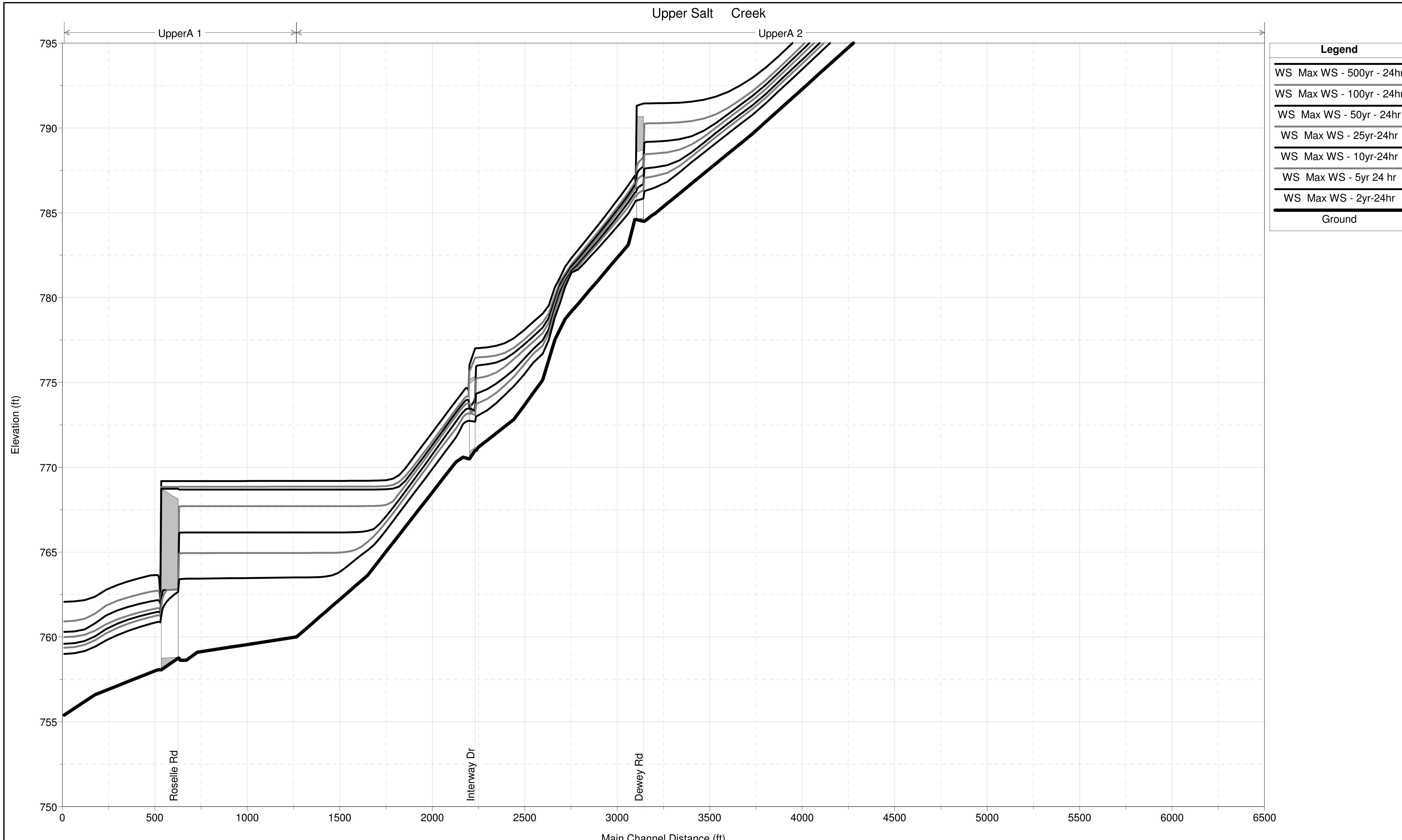


Upper Salt Creek
UpperB 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
Unknown Rd
Palatine and Ela Rd
820
815
810
805
800
795
790
785
780
775
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500



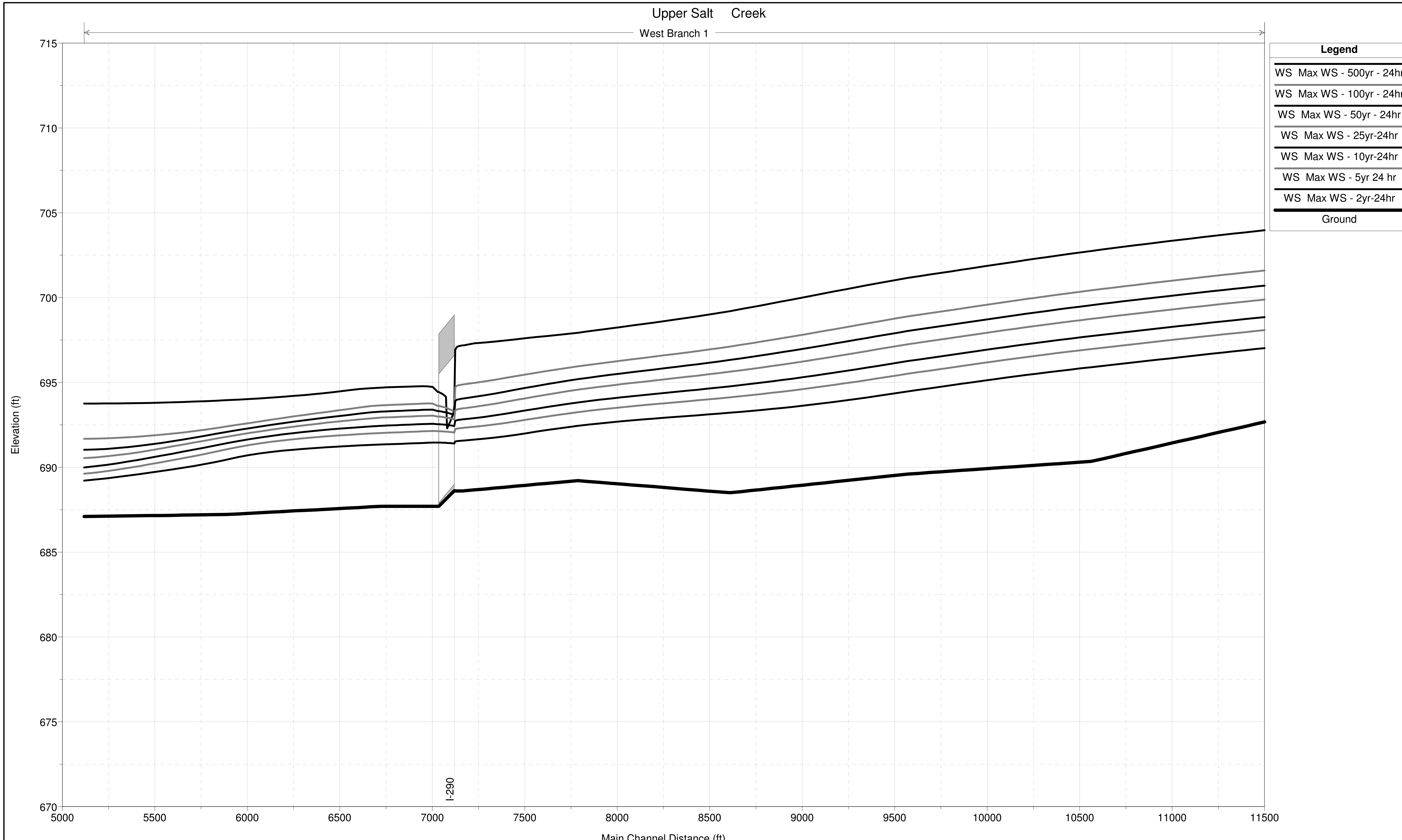
Upper Salt Creek
UpperA 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Jules Rd
Elevation (ft)
Main Channel Distance (ft)
835
830
825
820
815
810
805
800
795
790
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
10000


Upper Salt Creek
MainstemA North Trib 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
Unknown Rd
Withorn Le
Baldwin Rd
755
760
765
770
775
780
785
790
795
800
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500

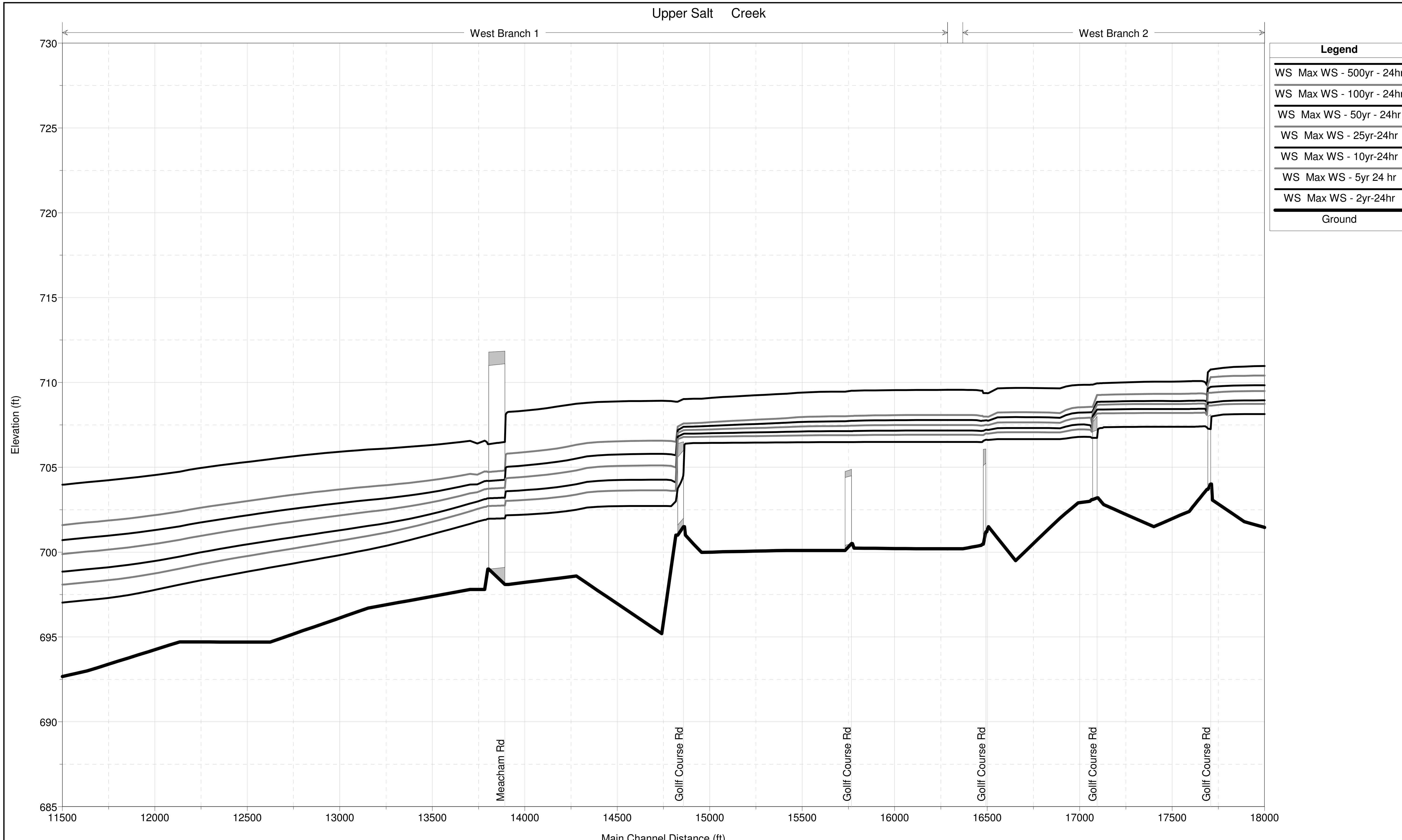


Upper Salt Creek
UpperA 1
UpperA 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
795
790
785
780
775
770
765
760
755
750
Roselle Rd
Interway Dr
Dewey Rd
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)

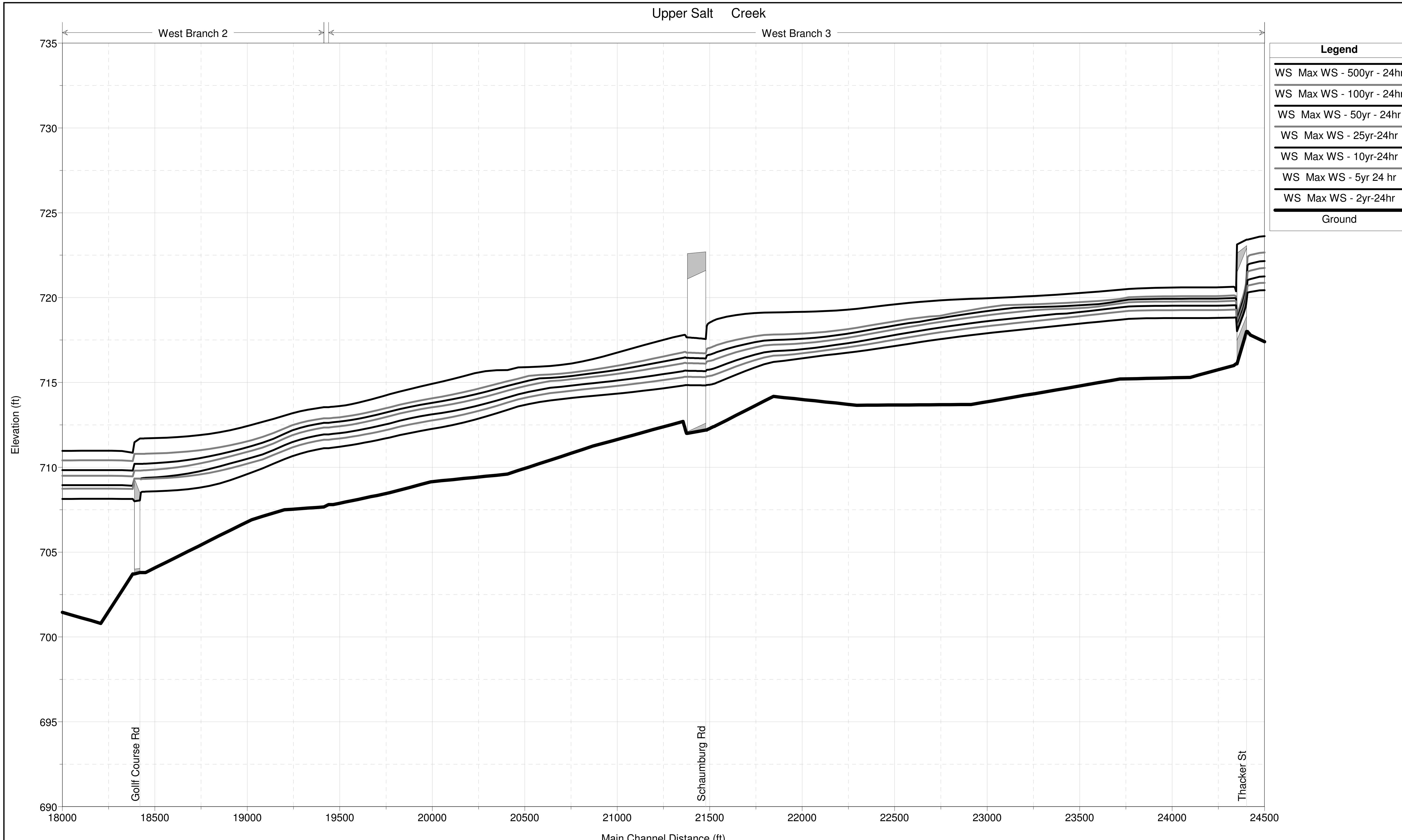
West Branch



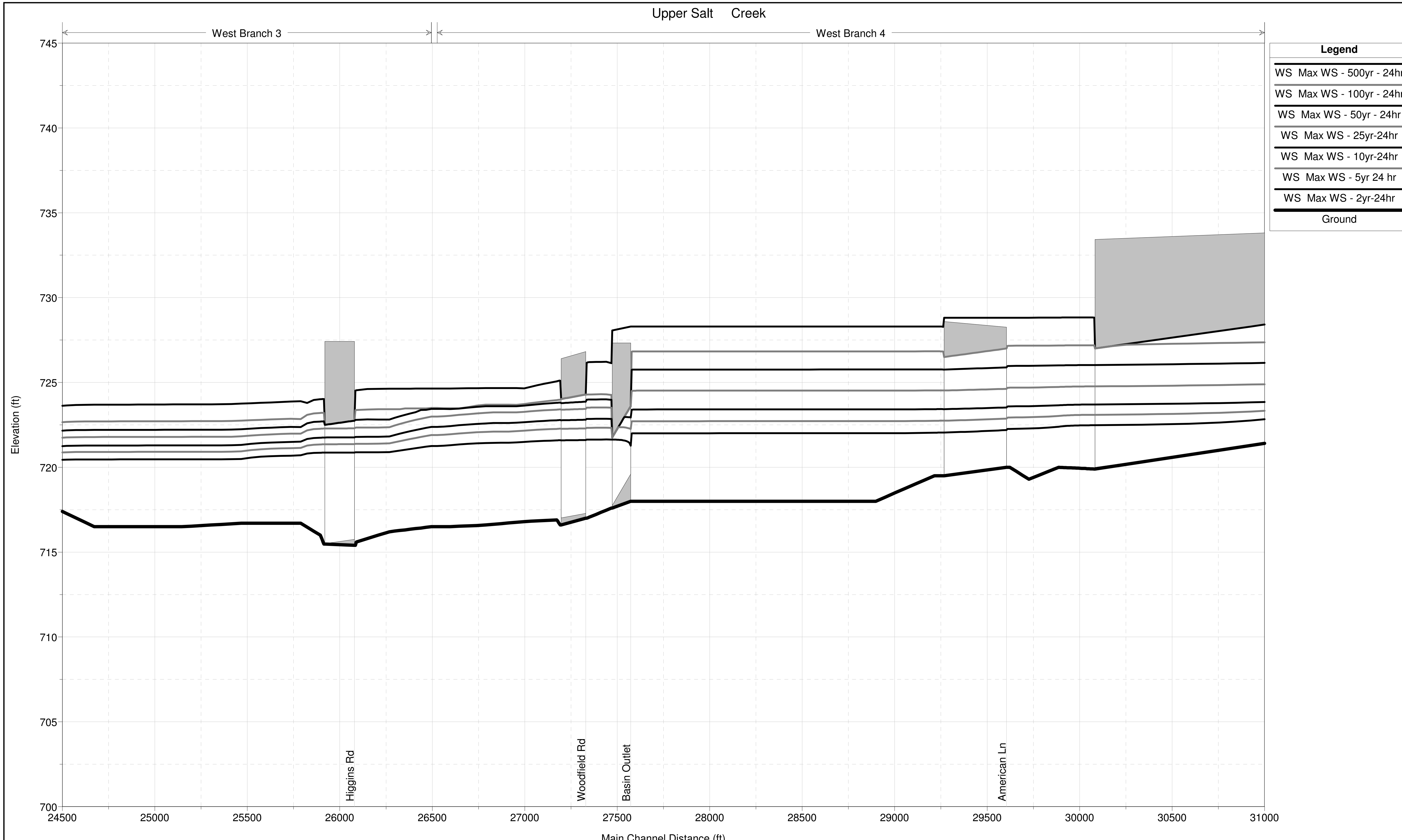
Upper Salt Creek
West Branch 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
715
710
705
700
695
690
685
680
675
670
I-290
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
Main Channel Distance (ft)



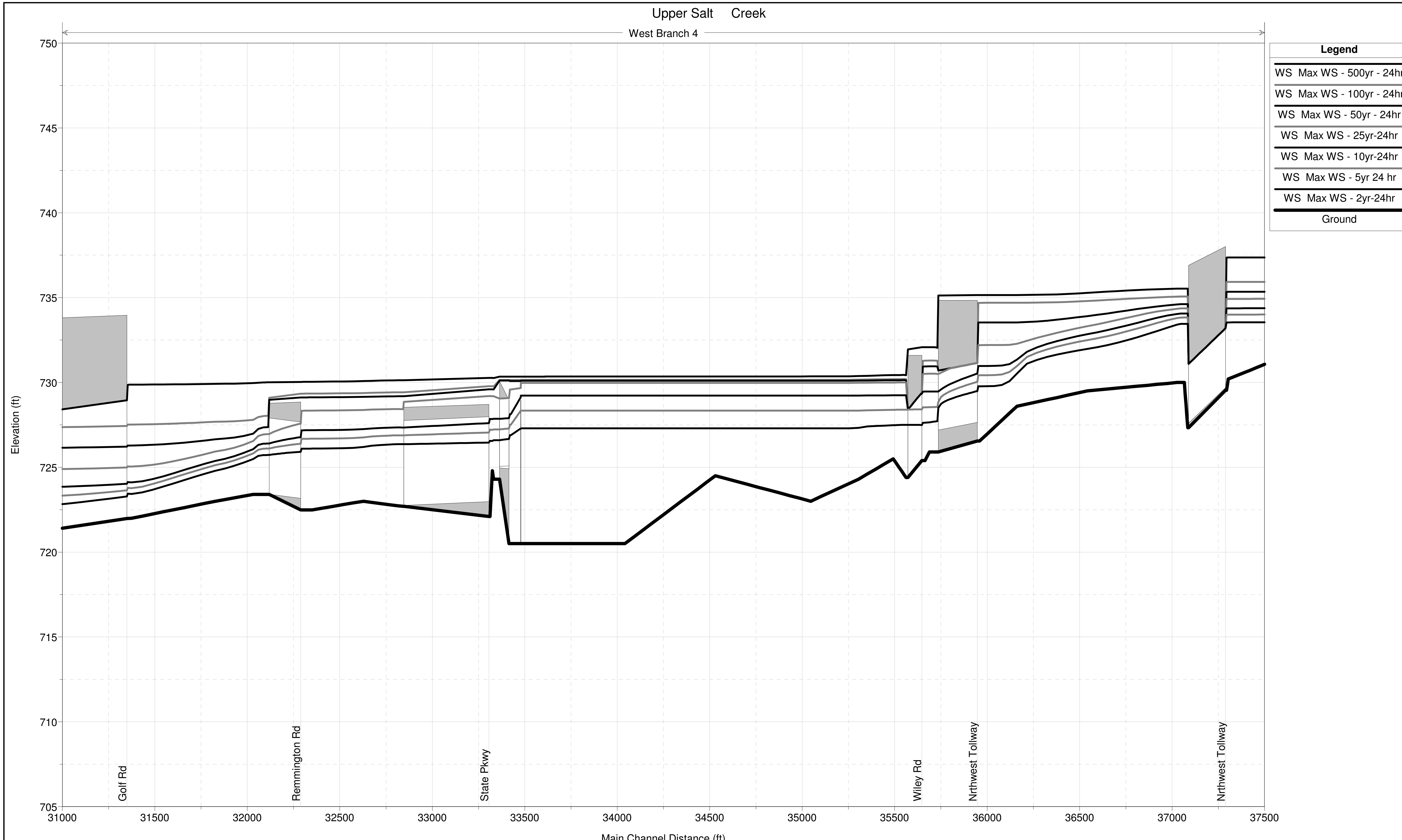
Upper Salt Creek
West Branch 1
West Branch 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
730
725
720
715
710
705
700
695
690
685
Meacham Rd
Golf Course Rd
Golf Course Rd
Golf Course Rd
Golf Course Rd
Golf Course Rd
11500
12000
12500
13000
13500
14000
14500
15000
15500
16000
16500
17000
17500
18000
Main Channel Distance (ft)



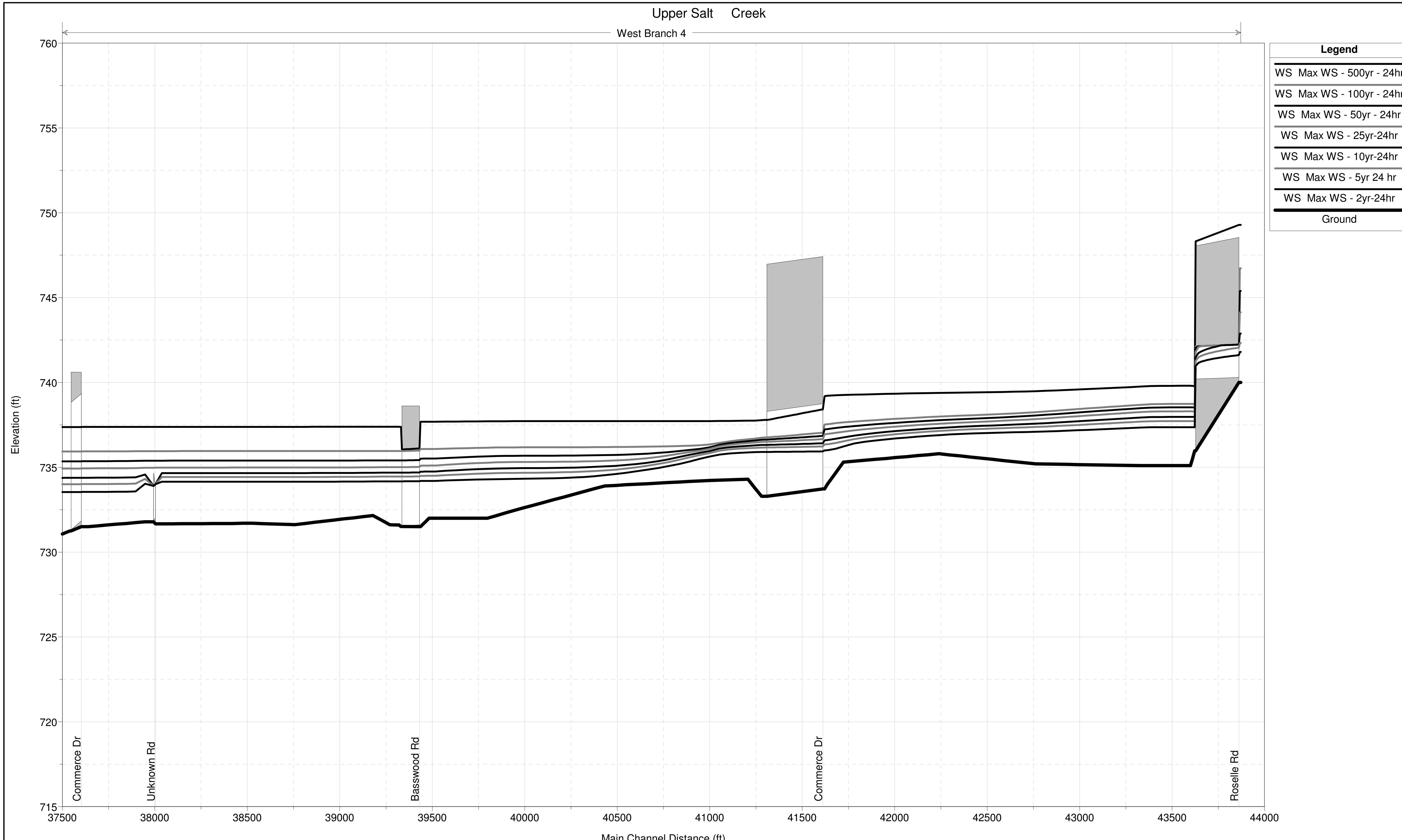
Upper Salt Creek
West Branch 2
West Branch 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
735
730
725
720
715
710
705
700
695
690
Golf Course Rd
Schaumburg Rd
Thacker St
18000
18500
19000
19500
20000
20500
21000
21500
22000
22500
23000
23500
24000
24500
Main Channel Distance (ft)



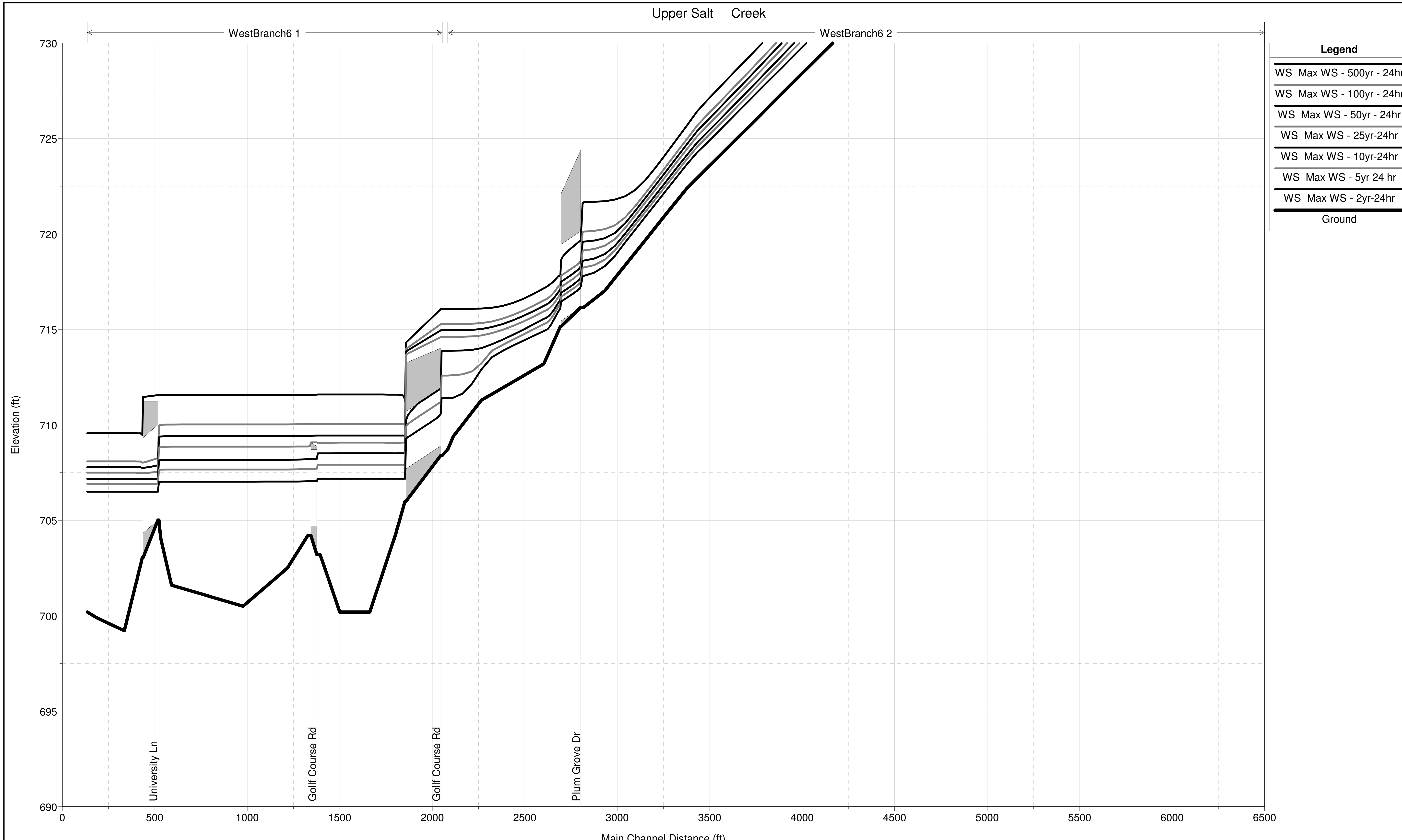
Upper Salt Creek
West Branch 3
West Branch 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
745
740
735
730
725
720
715
710
705
700
Higgins Rd
Woodfield Rd
Basin Outlet
American Ln
24500
25000
25500
26000
26500
27000
27500
28000
28500
29000
29500
30000
30500
31000
Main Channel Distance (ft)



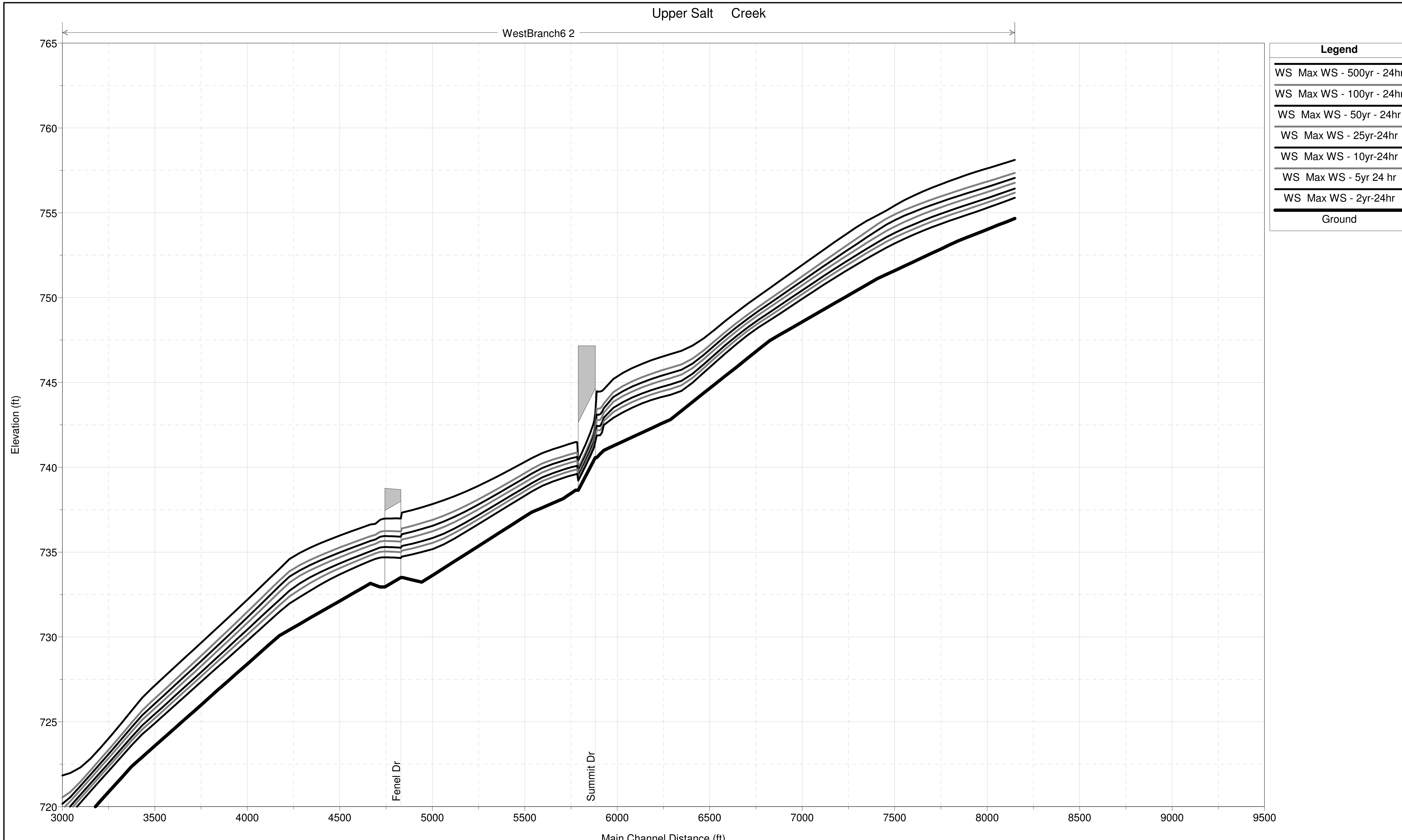
Upper Salt Creek
West Branch 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
750
745
740
735
730
725
720
715
710
705
Golf Rd
Remmington Rd
State Pkwy
Wiley Rd
Nrthwest Tollway
Nrthwest Tollway
31000
31500
32000
32500
33000
33500
34000
34500
35000
35500
36000
36500
37000
37500
Main Channel Distance (ft)



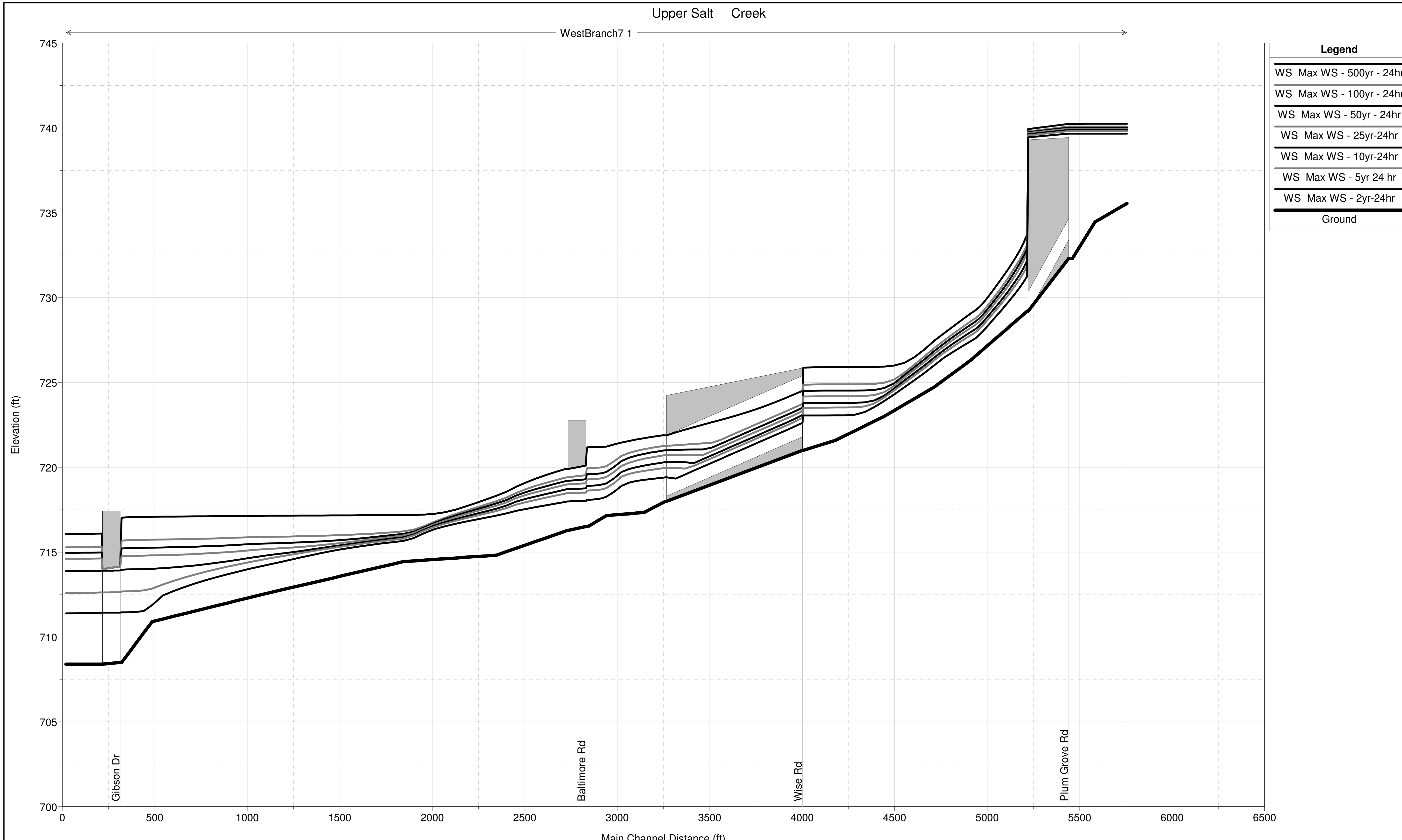
Upper Salt Creek
West Branch 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
760
755
750
745
740
735
730
725
720
715
Commerce Dr
Unknown Rd
Basswood Rd
Commerce Dr
Roselle Rd
37500
38000
38500
39000
39500
40000
40500
41000
41500
42000
42500
43000
43500
44000
Main Channel Distance (ft)



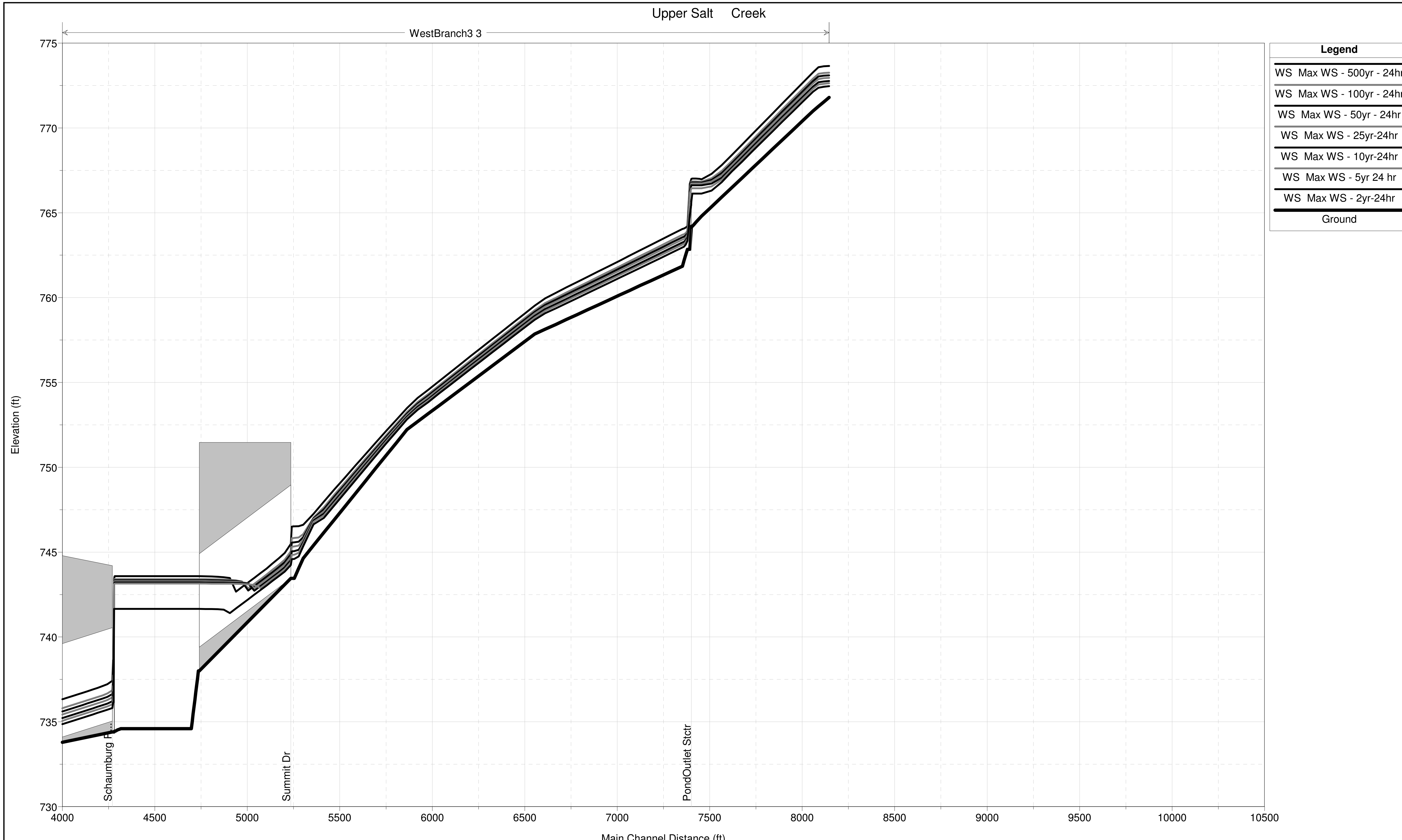
Upper Salt Creek
WestBranch6 1
WestBranch6 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
730
725
720
715
710
705
700
695
690
University Ln
Golf Course Rd
Golf Course Rd
Plum Grove Dr
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)

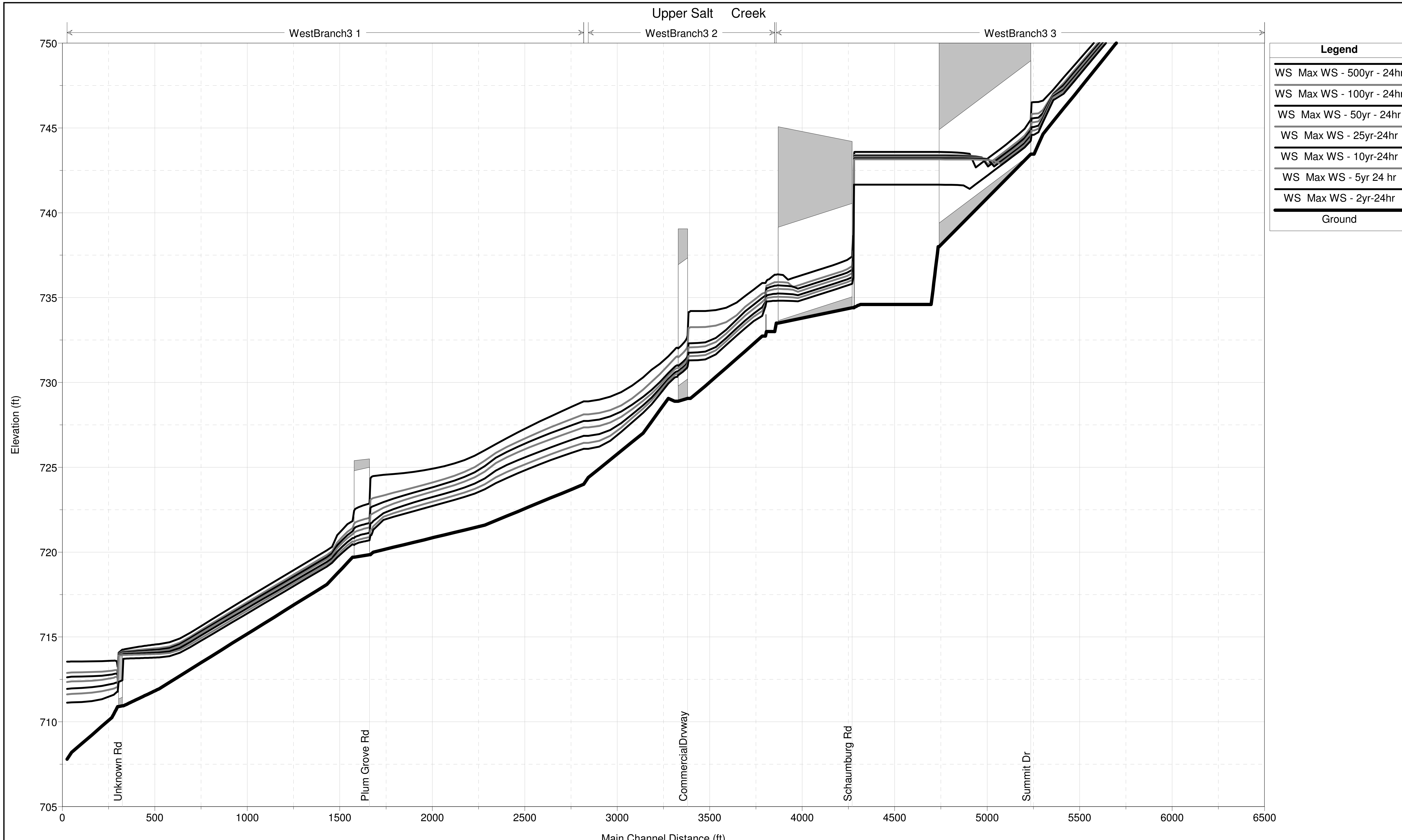


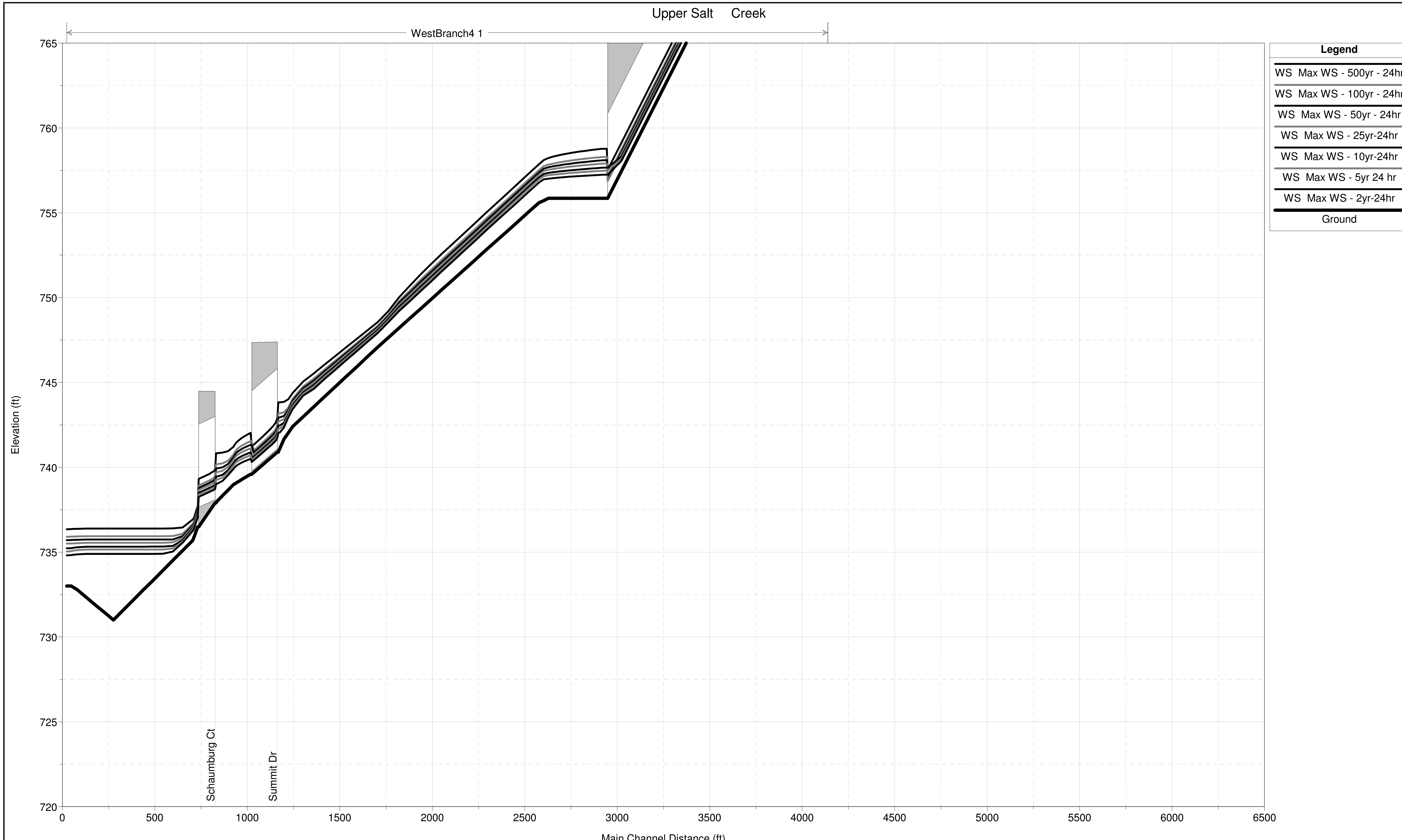
Upper Salt Creek
WestBranch6 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
765
760
755
750
745
740
735
730
725
720
Fenel Dr
Summit Dr
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
Main Channel Distance (ft)



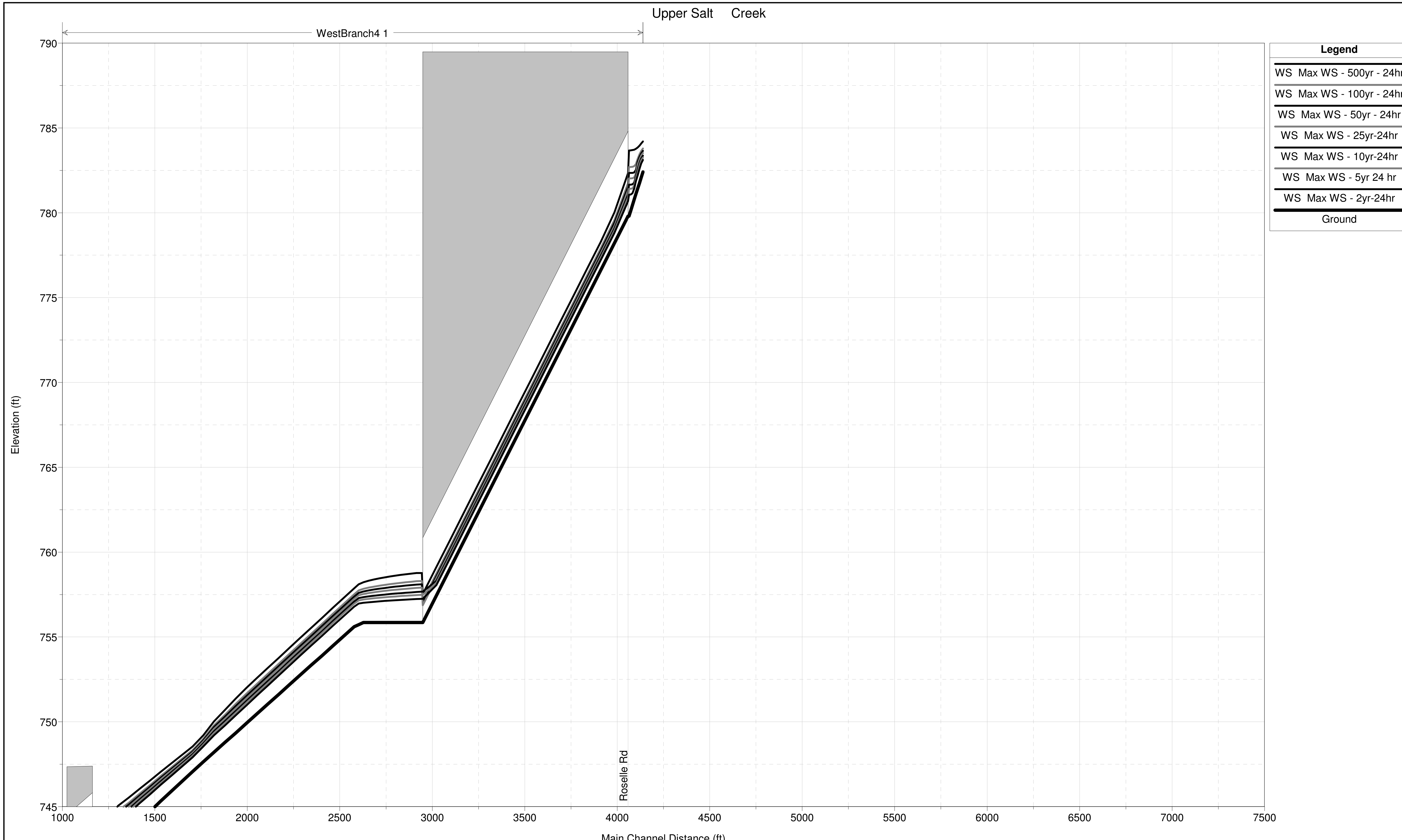
Upper Salt Creek
WestBranch7 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
Gibson Dr
Baltimore Rd
Wise Rd
Plum Grove Rd
745
740
735
730
725
720
715
710
705
700
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500


Upper Salt Creek
WestBranch3 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
Schaumburg R...
Summit Dr
PondOutlet Stctr
775
770
765
760
755
750
745
740
735
730
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
10000
10500

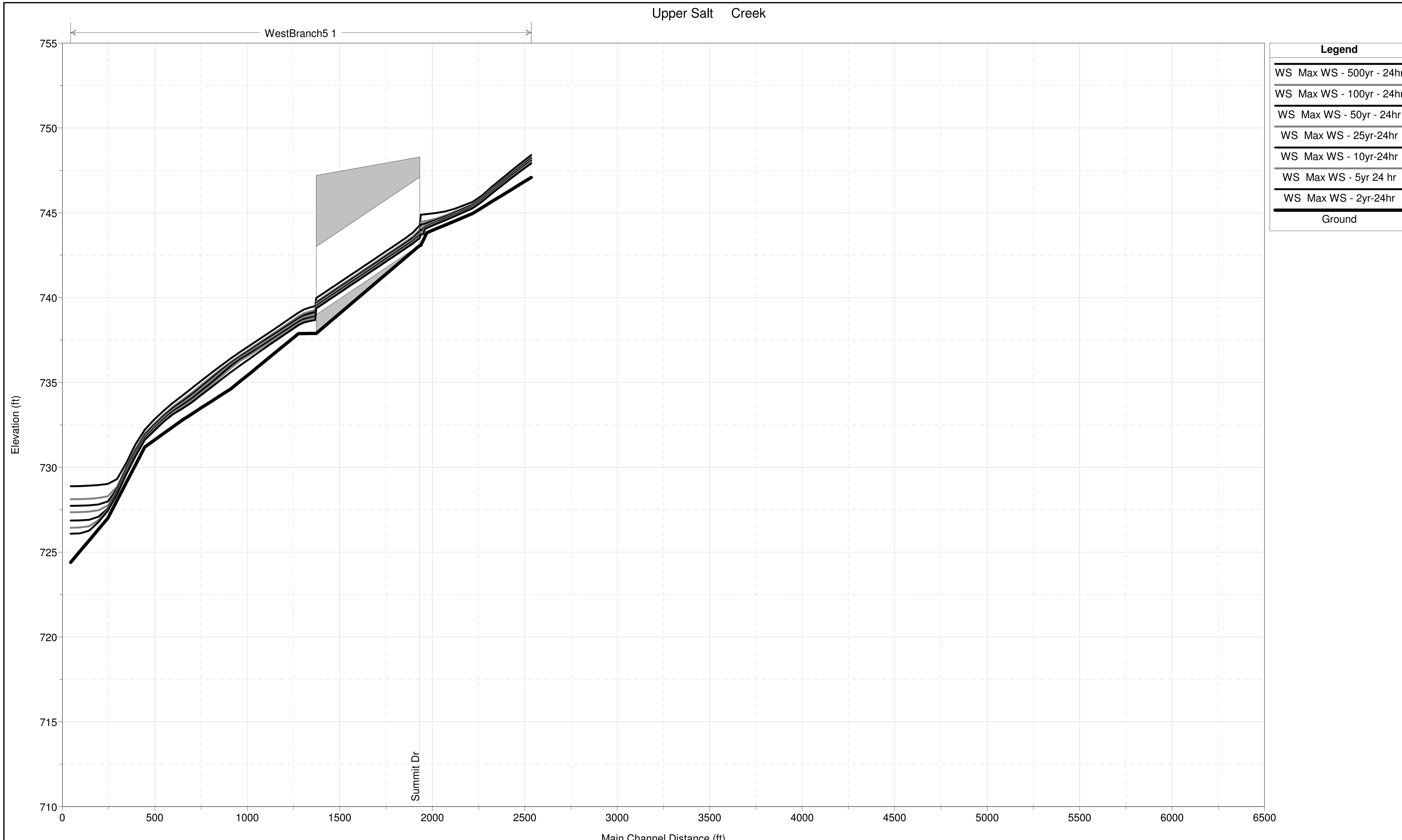

Upper Salt Creek
WestBranch3 1
WestBranch3 2
WestBranch3 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
750
745
740
735
730
725
720
715
710
705
Unknown Rd
Plum Grove Rd
CommercialDrvway
Schaumburg Rd
Summit Dr
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)



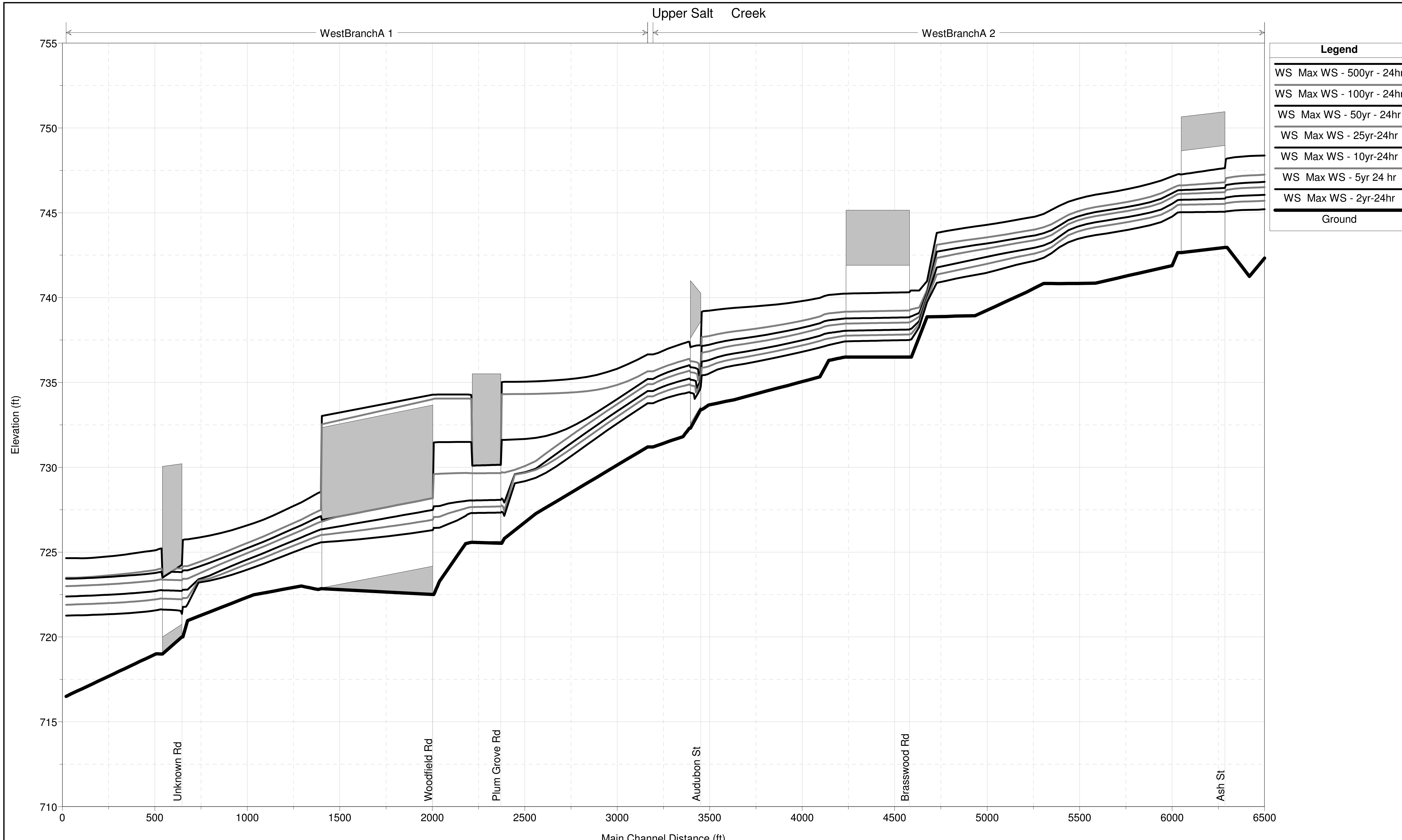
Upper Salt Creek
WestBranch4 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
765
760
755
750
745
740
735
730
725
720
Schaumburg Ct
Summit Dr
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)



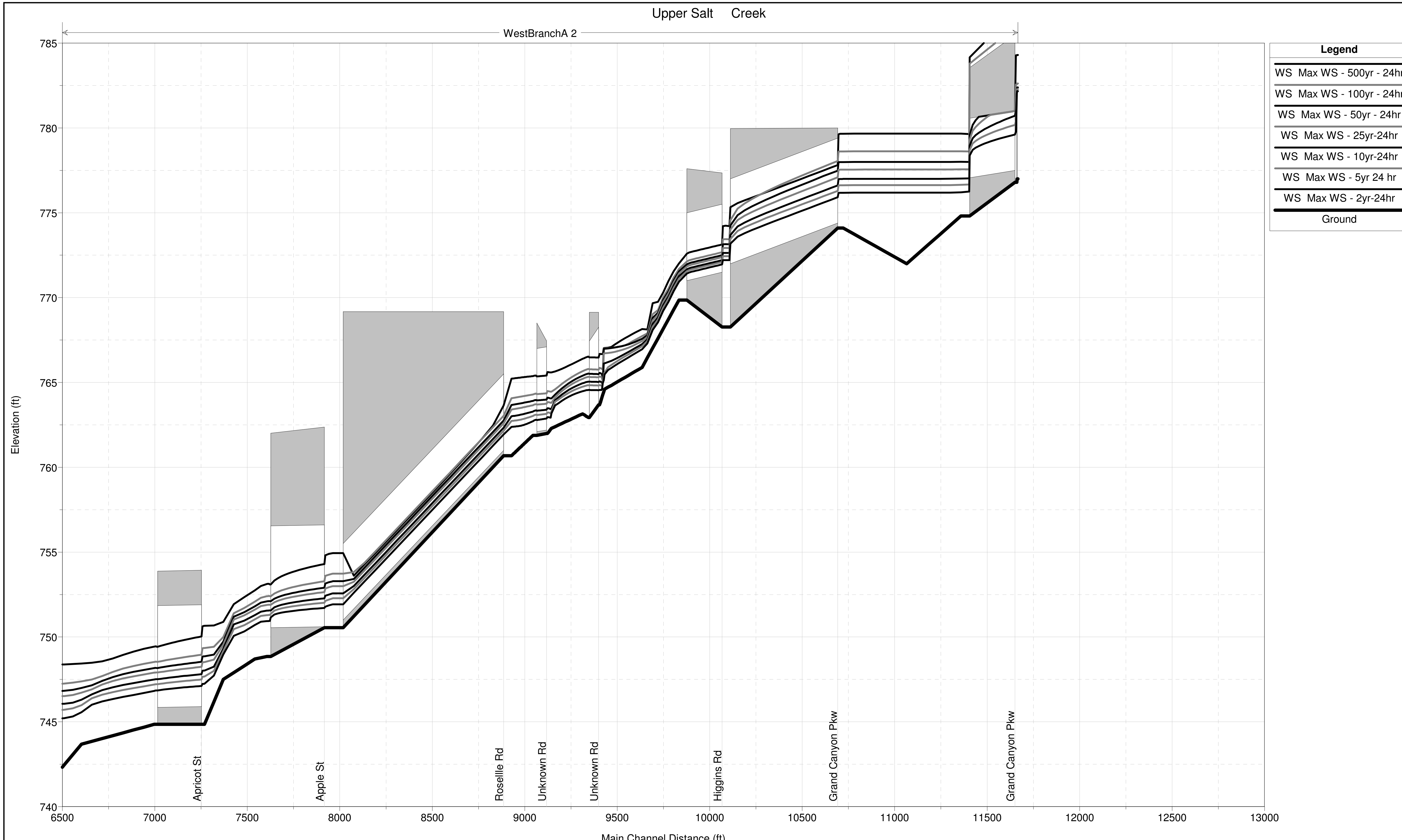
Upper Salt Creek
WestBranch4 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
790
785
780
775
770
765
760
755
750
745
Roselle Rd
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
Main Channel Distance (ft)



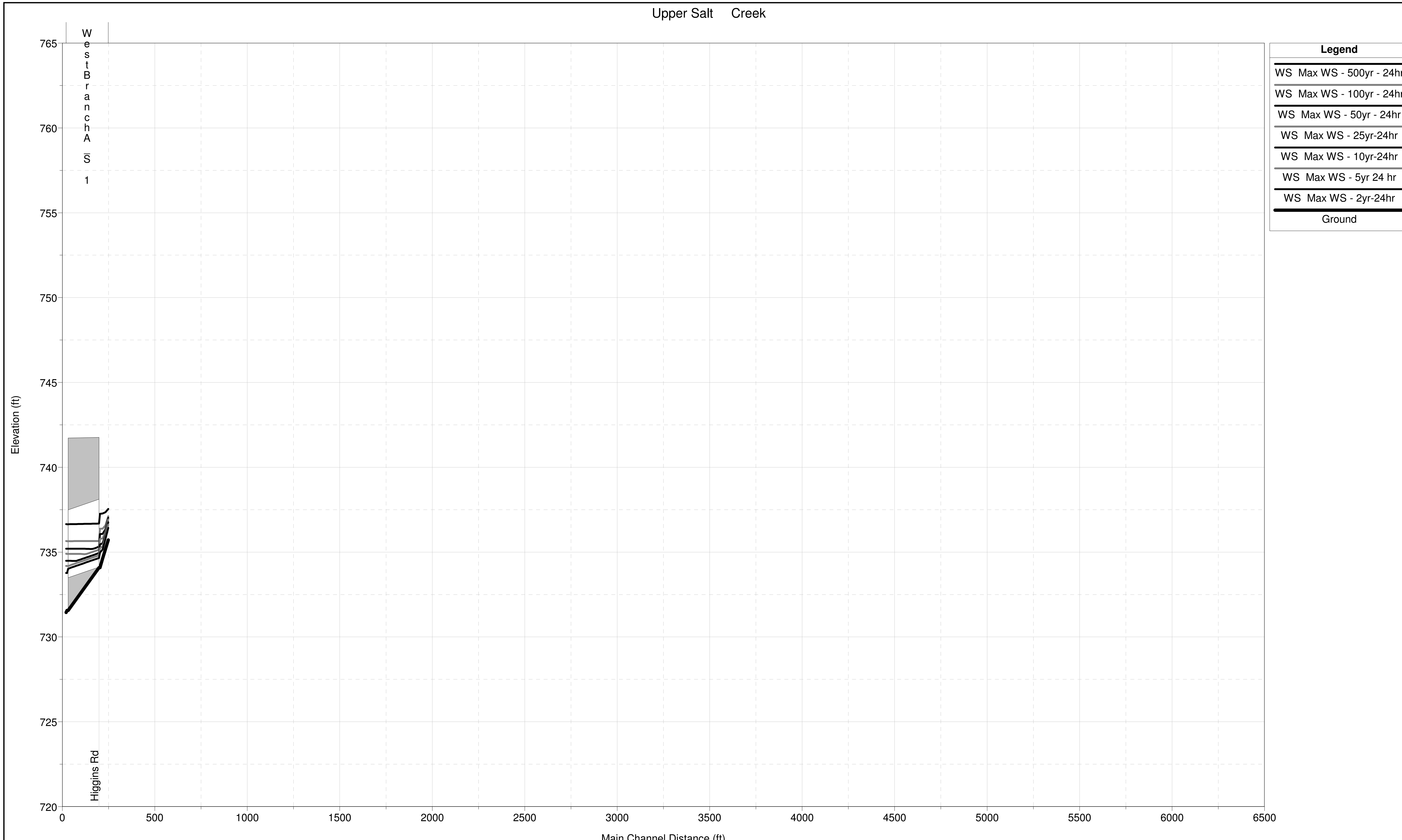
Upper Salt Creek
WestBranch5 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
755
750
745
740
735
730
725
720
715
710
Summit Dr
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)



Upper Salt Creek
WestBranchA 1
WestBranchA 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
755
750
745
740
735
730
725
720
715
710
Unknown Rd
Woodfield Rd
Plum Grove Rd
Audubon St
Brasswood Rd
Ash St
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)

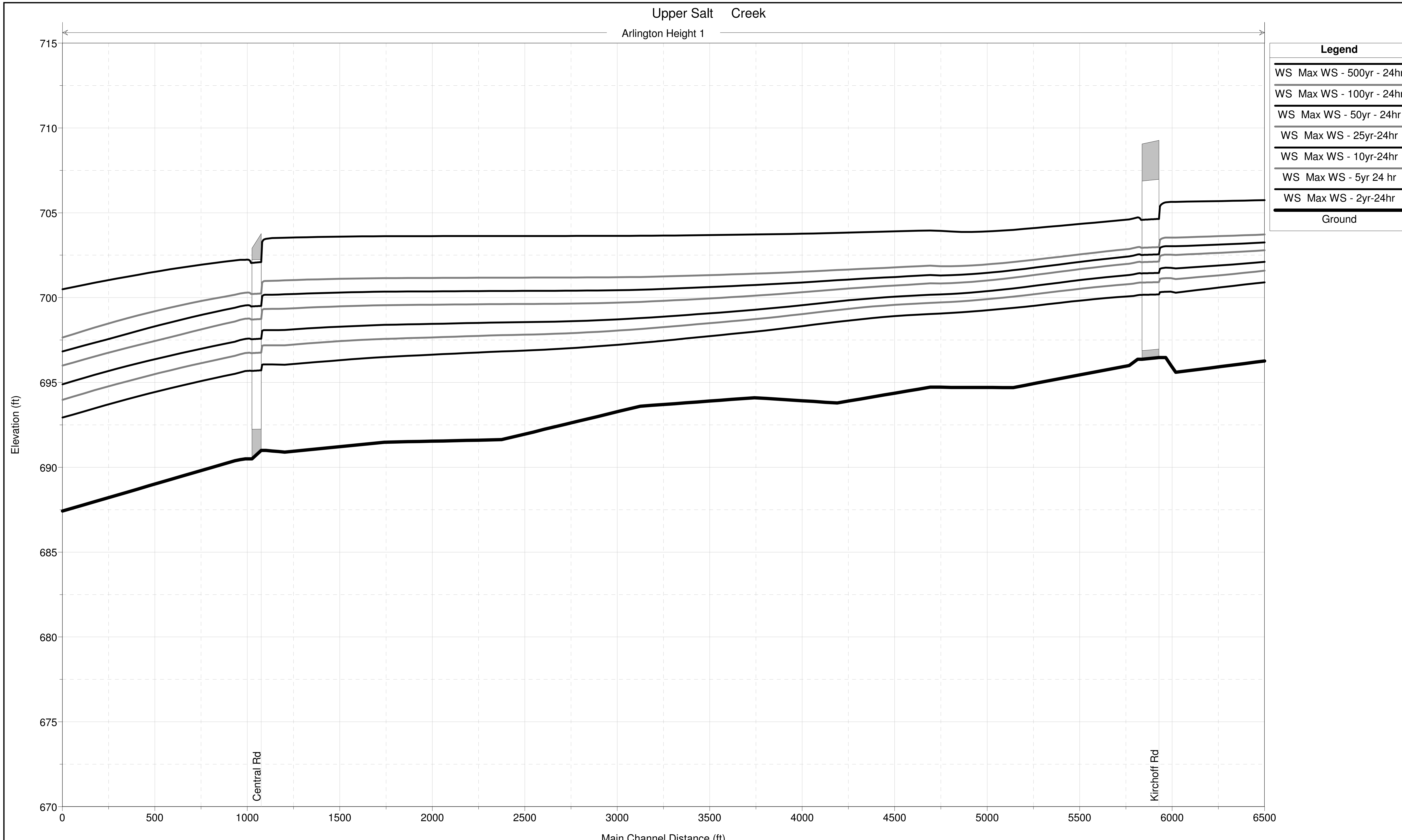


Upper Salt Creek
WestBranchA 2
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
Main Channel Distance (ft)
Apricot St
Apple St
Roselle Rd
Unknown Rd
Unknown Rd
Higgins Rd
Grand Canyon Pkw
Grand Canyon Pkw
785
780
775
770
765
760
755
750
745
740
6500
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
12000
12500
13000

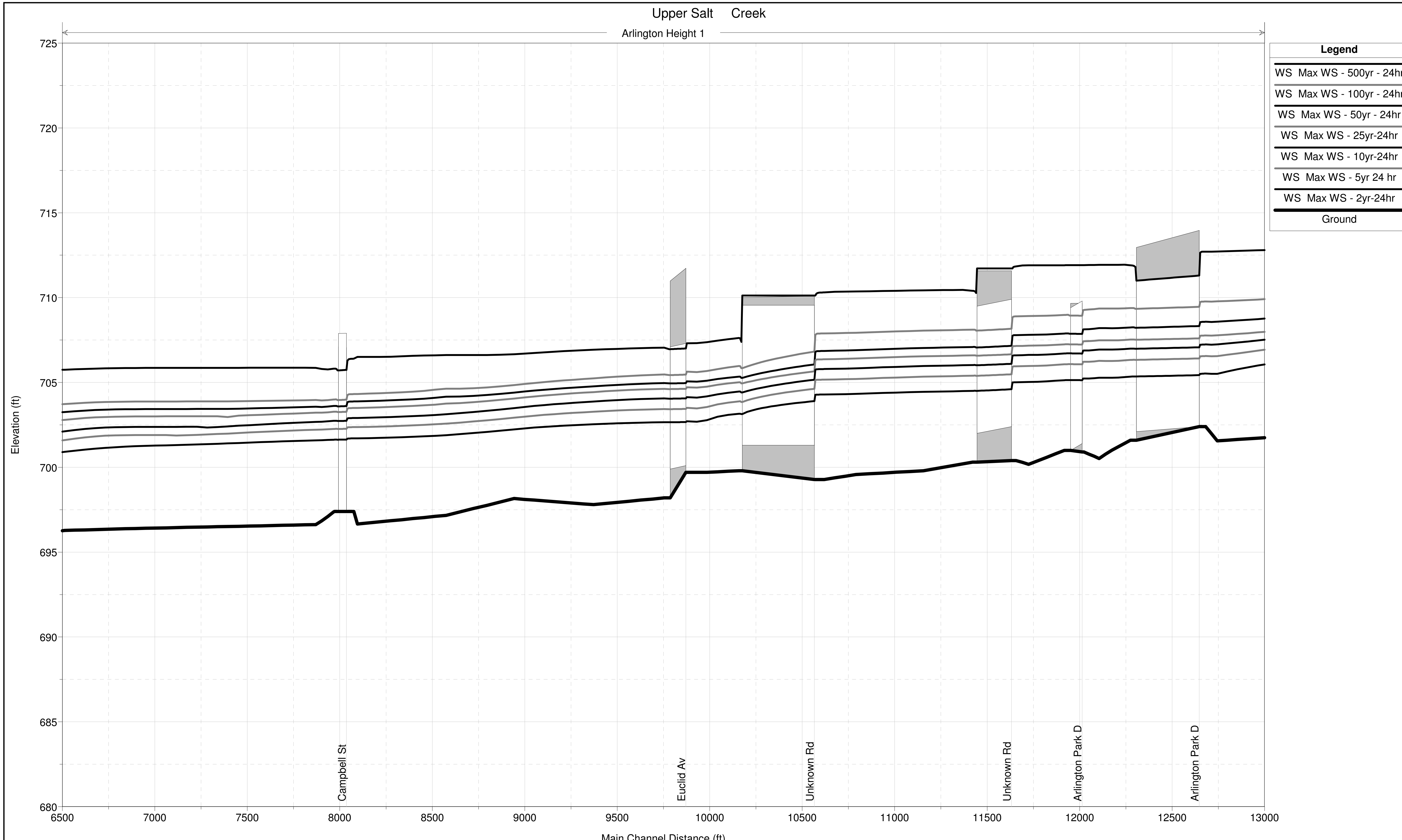


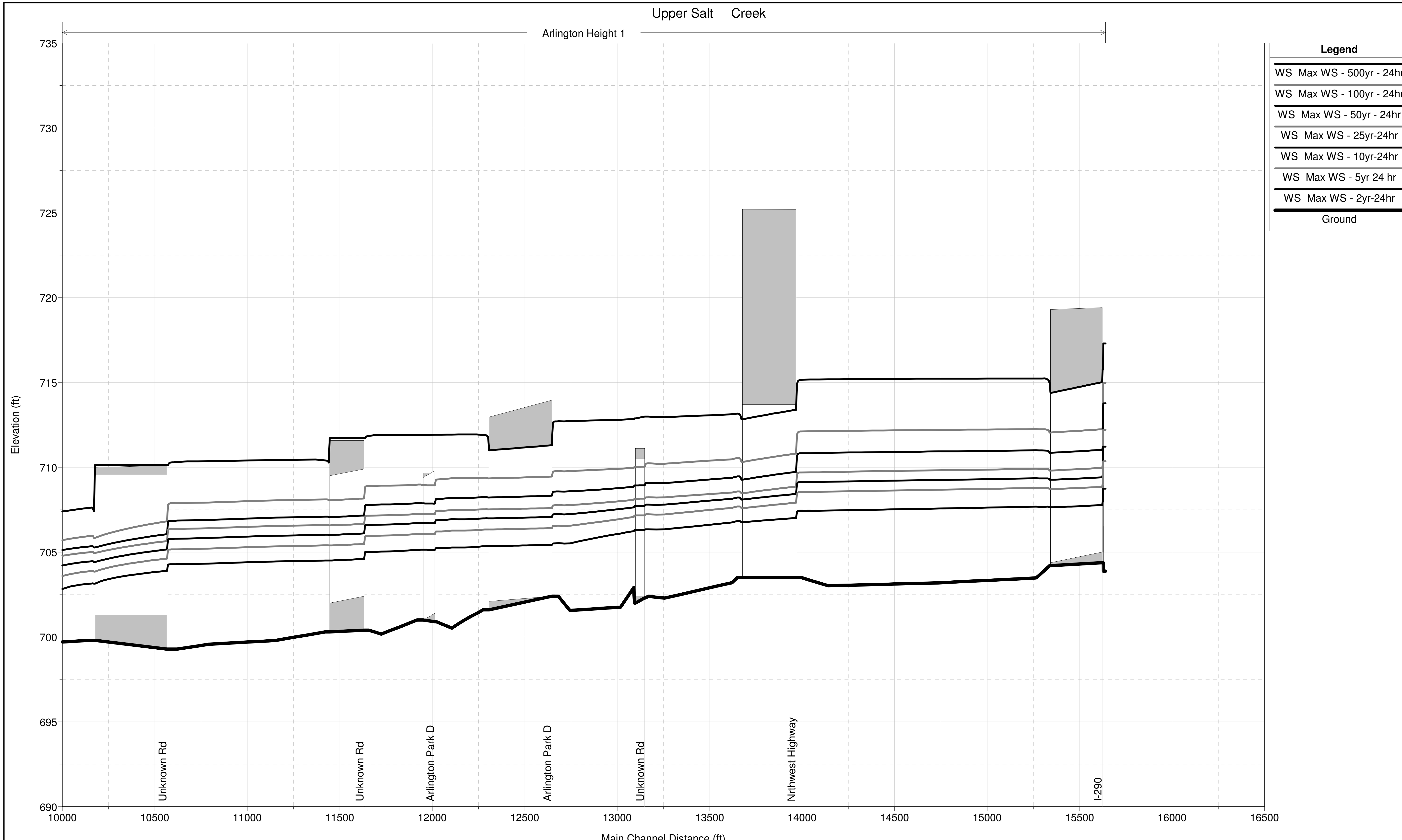
Upper Salt Creek
West Branch A_S 1
Higgins Rd
Elevation (ft)
765
760
755
750
745
740
735
730
725
720
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Main Channel Distance (ft)
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground

Arlington Heights Branch

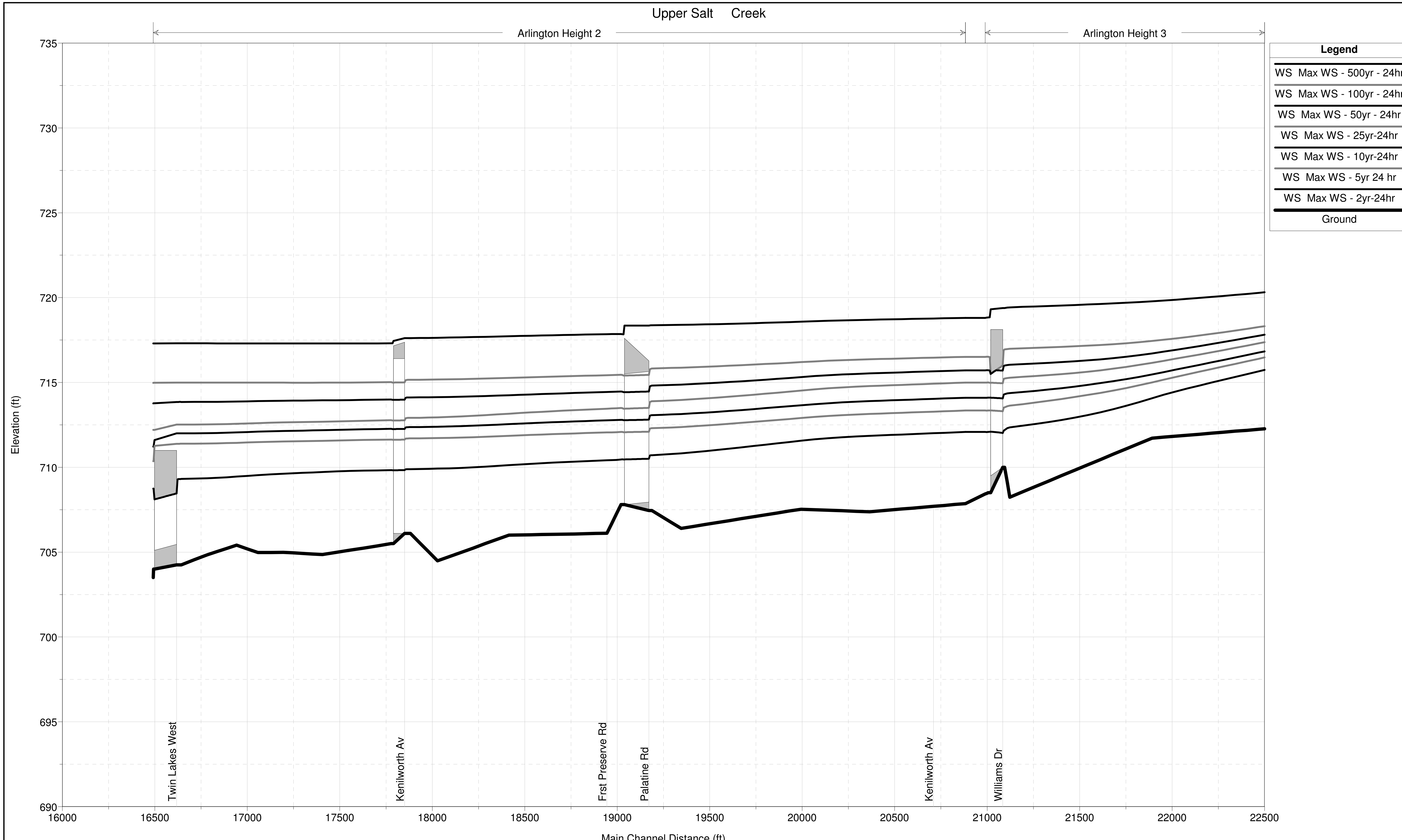


Upper Salt Creek
Arlington Height 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Central Rd
Kirchoff Rd
Elevation (ft)
Main Channel Distance (ft)
715
710
705
700
695
690
685
680
675
670
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500

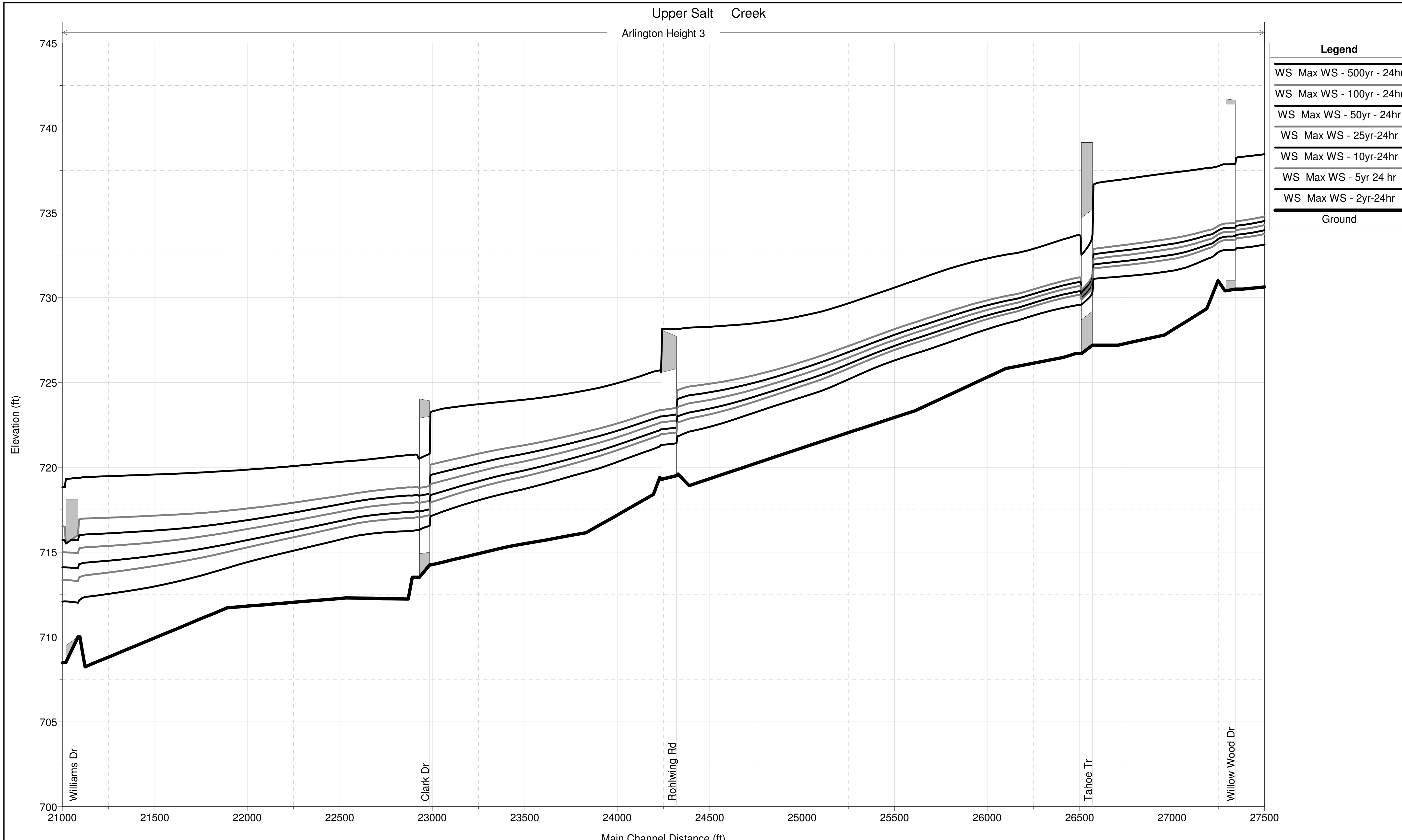

Upper Salt Creek
Arlington Height 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
725
720
715
710
705
700
695
690
685
680
6500
7000
7500
8000
8500
9000
9500
10000
10500
11000
11500
12000
12500
13000
Main Channel Distance (ft)
Campbell St
Euclid Av
Unknown Rd
Unknown Rd
Arlington Park D
Arlington Park D



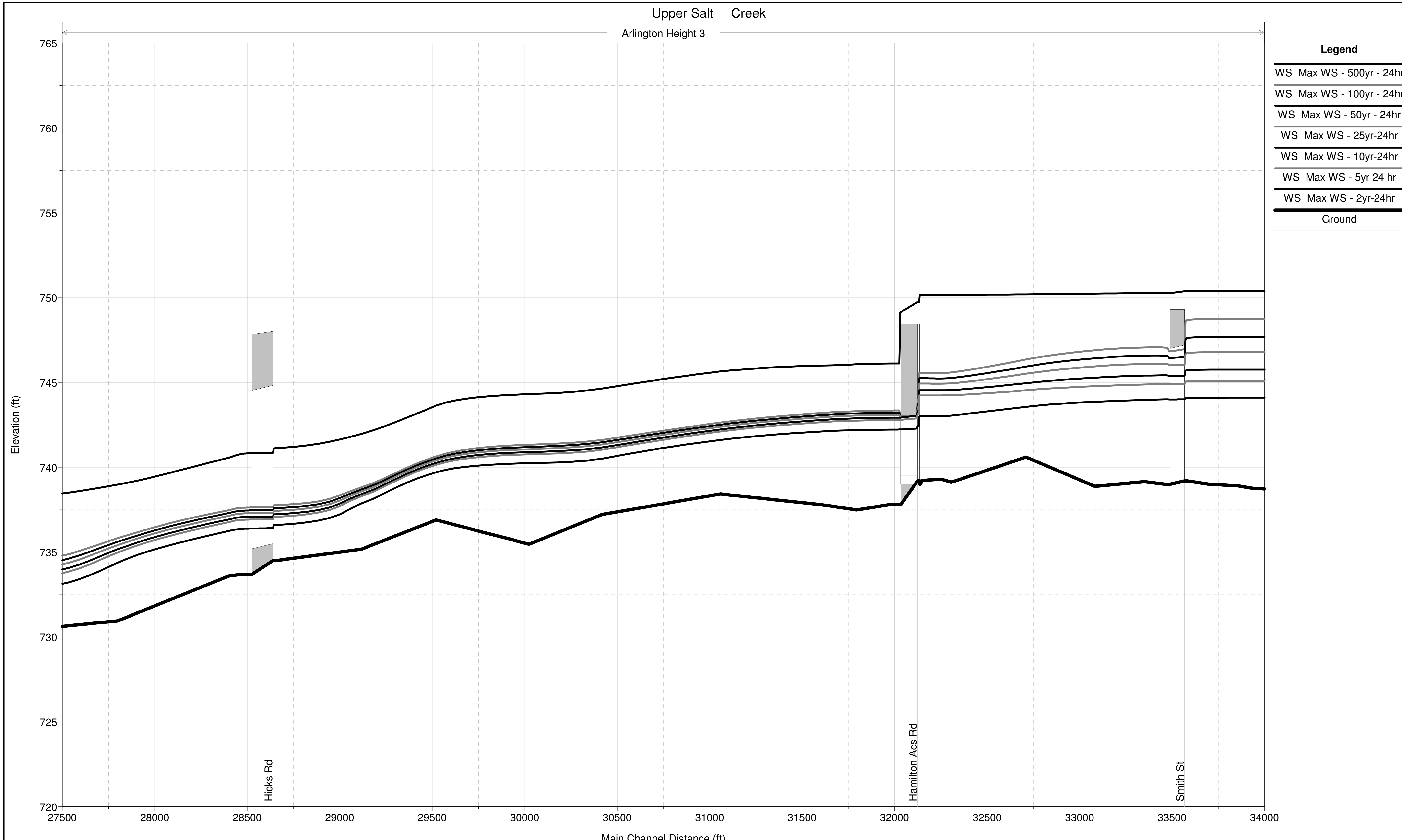
Upper Salt Creek
Arlington Height 1
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
735
730
725
720
715
710
705
700
695
690
Unknown Rd
Unknown Rd
Arlington Park D
Arlington Park D
Unknown Rd
Nrthwest Highway
I-290
10000
10500
11000
11500
12000
12500
13000
13500
14000
14500
15000
15500
16000
16500
Main Channel Distance (ft)



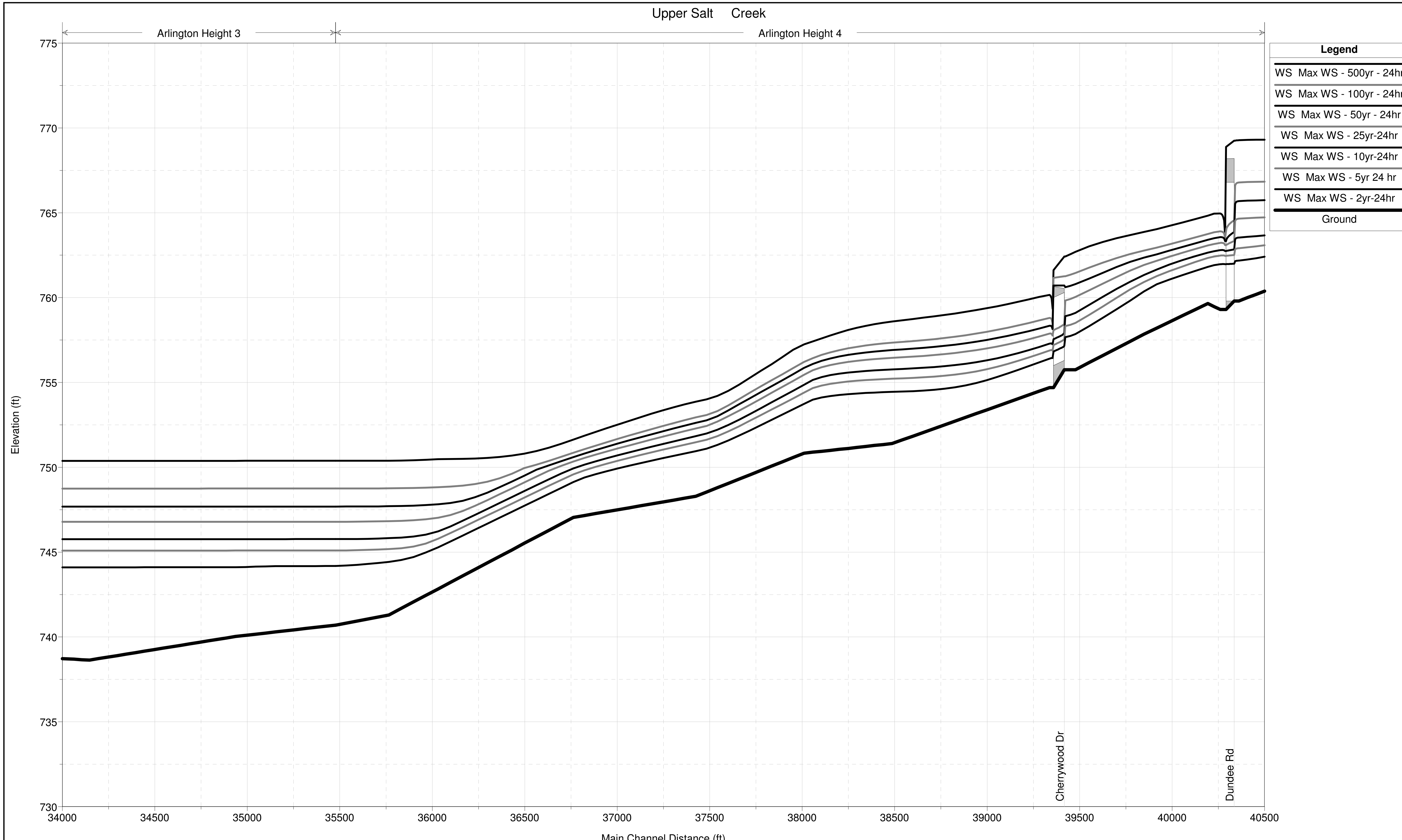
Upper Salt Creek
Arlington Height 2
Arlington Height 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
735
730
725
720
715
710
705
700
695
690
Twin Lakes West
Kenilworth Av
Frst Preserve Rd
Palatine Rd
Kenilworth Av
Williams Dr
16000
16500
17000
17500
18000
18500
19000
19500
20000
20500
21000
21500
22000
22500
Main Channel Distance (ft)

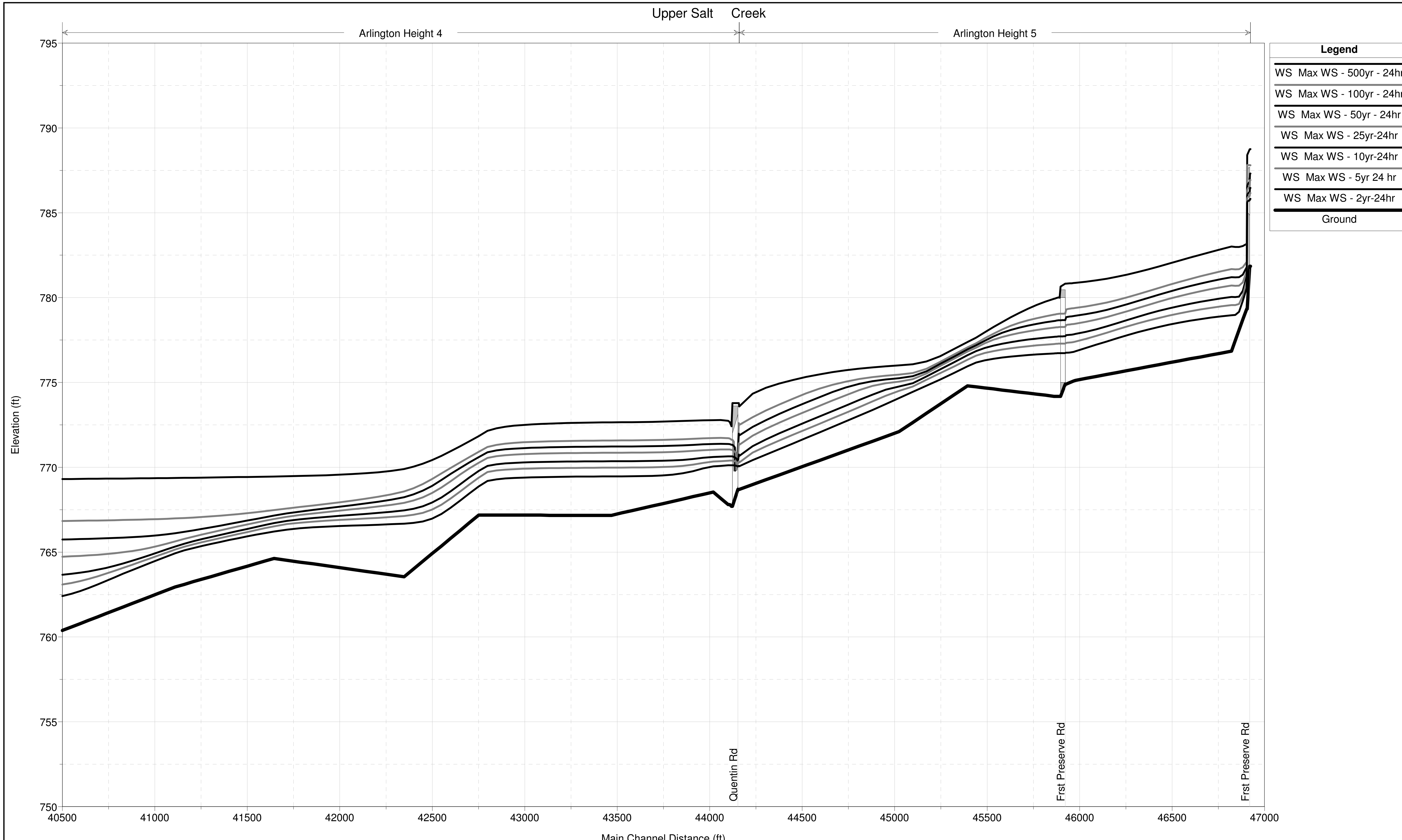


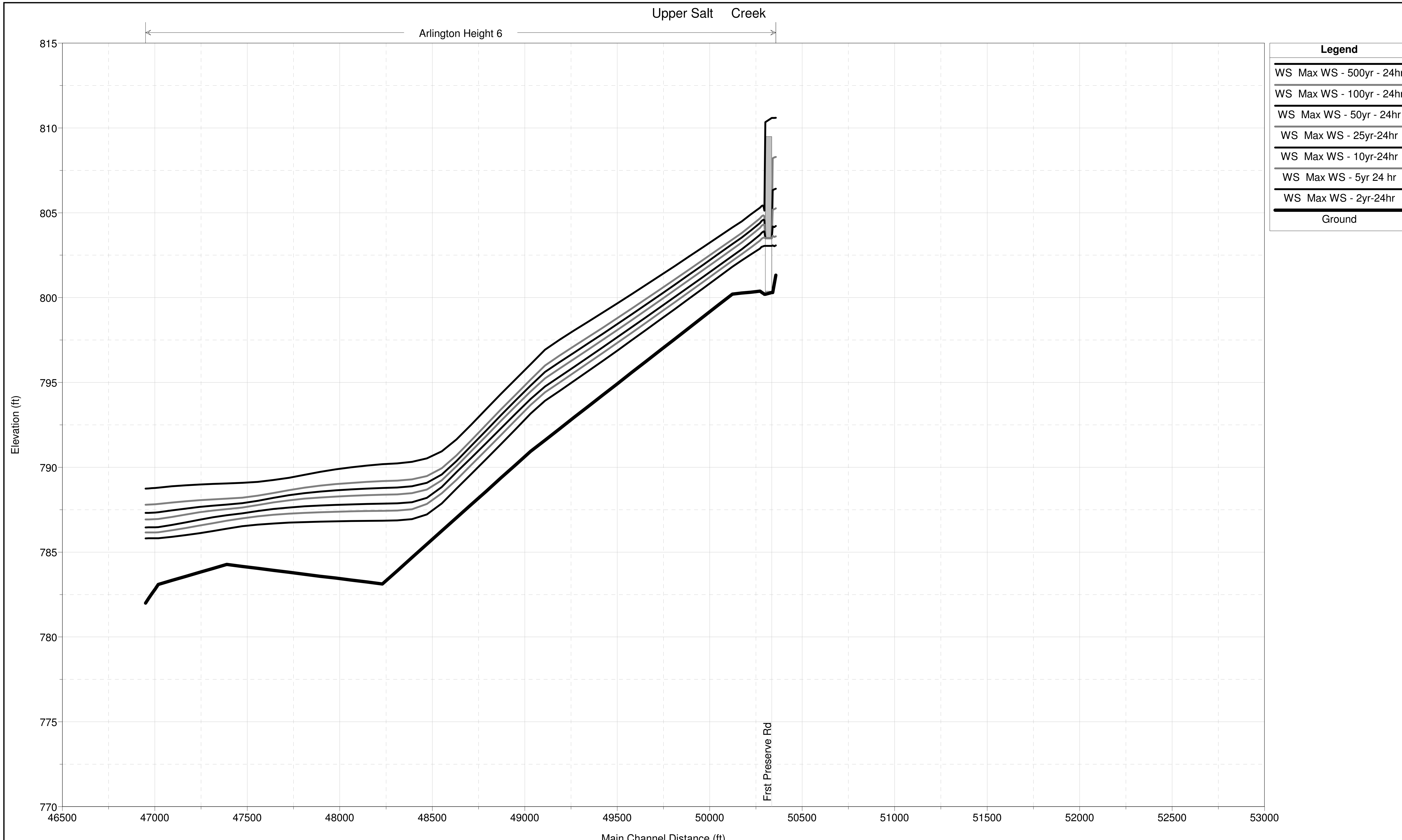
Upper Salt Creek
Arlington Height 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
745
740
735
730
725
720
715
710
705
700
Williams Dr
Clark Dr
Rohlwing Rd
Tahoe Tr
Willow Wood Dr
21000
21500
22000
22500
23000
23500
24000
24500
25000
25500
26000
26500
27000
27500
Main Channel Distance (ft)



Upper Salt Creek
Arlington Height 3
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
765
760
755
750
745
740
735
730
725
720
Hicks Rd
Hamilton Acs Rd
Smith St
27500
28000
28500
29000
29500
30000
30500
31000
31500
32000
32500
33000
33500
34000
Main Channel Distance (ft)


Upper Salt Creek
Arlington Height 3
Arlington Height 4
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
775
770
765
760
755
750
745
740
735
730
Cherrywood Dr
Dundee Rd
34000
34500
35000
35500
36000
36500
37000
37500
38000
38500
39000
39500
40000
40500
Main Channel Distance (ft)


Upper Salt Creek
Arlington Height 4
Arlington Height 5
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
795
790
785
780
775
770
765
760
755
750
Quentin Rd
Frst Preserve Rd
Frst Preserve Rd
40500
41000
41500
42000
42500
43000
43500
44000
44500
45000
45500
46000
46500
47000
Main Channel Distance (ft)



Upper Salt Creek
Arlington Height 6
Legend
WS Max WS - 500yr - 24hr
WS Max WS - 100yr - 24hr
WS Max WS - 50yr - 24hr
WS Max WS - 25yr-24hr
WS Max WS - 10yr-24hr
WS Max WS - 5yr 24 hr
WS Max WS - 2yr-24hr
Ground
Elevation (ft)
815
810
805
800
795
790
785
780
775
770
Frst Preserve Rd
46500
47000
47500
48000
48500
49000
49500
50000
50500
51000
51500
52000
52500
53000
Main Channel Distance (ft)

Metropolitan Water Reclamation District of Greater Chicago
Upper Salt Creek Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name	SCAH-50
Problem Description	Project 2 addresses flooding issues of several homes along the Arlington Heights branch
Strategy	The project includes expanding the culverts under Dundee Road from a 10.5 x 7 foot box culvert to two 10 x 7
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Pipe under pavement (city): 72 to 84 inches / box culvert (28 to 38 ft2)	lf	266	$425	$113,225	$105,298	$0	Dundee Road
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	177	$609	$107,557	$100,027	$0	Cherrywood Drive
Channel treatment: Excavation	yd3	2980	$11	$31,826	$0	$0	
Channel treatment: Material to be hauled offsite	yd3	2980	$12	$35,015	$0	$0	
Channel treatment: Biostabilization	yd2	5736	$64	$367,506	$341,775	$88,000	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$655,130**	**$547,099**	**$88,000**
Utility Relocation	4 %	$26,205		
Mobilization \ General Conditions	5%	$32,756		
Subtotal with Percent Allowances		**$714,091**		
Contingency	30%	$214,227		
Profit	5%	$46,416		
Probable Construction Cost Estimate		**$974,734**		
Design Engineering, Geotechnical, and Construction Management	10%	$97,473		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate		**$1,707,307**		

Additional Comments

Metropolitan Water Reclamation District of Greater Chicago
Upper Salt Creek Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name SCUP-5

Problem Description Within the Plum Grove Village neighborhood there are a number of structures that are

Strategy Previous work done by consultants hired by the Village of Rolling Meadows indicates that a channel

District Minimum Criteria for Funding: Not Met

Recommended No

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Buyout: Property *	dollar	4683514	$1	$4,683,514	$0	$0	02351001000000 02353010080000 02353010150000 02353010160000 02353010300000 02353010310000 02353010320000 02354030020000 02354030180000 02354030190000 02354030360000 02354030380000 02354030540000

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$0**	**$0**	**$0**
Utility Relocation	4 %	$0		
Mobilization \ General Conditions	5%	$0		
Subtotal with Percent Allowances		**$0**		
Contingency	30%	$0		
Profit	5%	$0		
Probable Construction Cost Estimate		**$0**		
Design Engineering, Geotechnical, and Construction Management	10%	$0		
Property Acquisition Cost:		$4,683,514		
Total Conceptual Cost Estimate		**$4,683,514**		

Additional Comments

Metropolitan Water Reclamation District of Greater Chicago
Upper Salt Creek Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name	SCUP-49
Problem Description	Project 1 addresses flooding issues, which include several homes, on the mainstem of the
Strategy	The channel improvements include approximately 2,800 ft of linear river channel and require an estimated
District Minimum Criteria for Funding:	Met
Recommended	Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	216	$609	$131,479	$122,274	$0	Helen Road
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	338	$661	$223,164	$207,539	$0	Imperial Court
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	356	$609	$216,941	$201,752	$0	Pleasant Hill Boulevard
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	348	$609	$211,828	$196,996	$0	Michigan Avenue
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	347	$609	$211,462	$196,657	$0	Illinois Avenue
Channel treatment: Excavation	yd3	30100	$11	$321,468	$0	$0	
Channel treatment: Material to be hauled offsite	yd3	30100	$12	$353,675	$0	$0	
Channel treatment: Biostabilization	yd2	41000	$64	$2,626,870	$2,442,949	$629,011	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$4,296,887**	**$3,368,166**	**$629,011**
Utility Relocation	4 %	$171,875		
Mobilization \ General Conditions	5%	$214,844		
Subtotal with Percent Allowances		**$4,683,606**		
Contingency	30%	$1,405,082		
Profit	5%	$304,434		
Probable Construction Cost Estimate		**$6,393,123**		
Design Engineering, Geotechnical, and Construction Management	10%	$639,312		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate		**$11,029,612**		

Additional Comments

Metropolitan Water Reclamation District of Greater Chicago
Upper Salt Creek Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name SCUP-51

Problem Description Project 3 will act to protect several structres upstream of the Margareth Reimer Reservoir

Strategy The project includes expanding the culvert under this intersection from three 8.1 x 6.6 foot box culverts to two

District Minimum Criteria for Funding: Not Met

Recommended No

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	299	$661	$197,912	$184,055	$0	Palatine Road
Pipe under pavement (city): Box culvert (51 to 60 ft2)	lf	1050	$661	$694,082	$645,485	$0	Quentin / Palatine Roads
Channel treatment: Excavation	yd3	24000	$11	$256,320	$0	$0	
Channel treatment: Material to be hauled offsite	yd3	24000	$12	$282,000	$0	$0	
Channel treatment: Biostabilization	yd2	22760	$64	$1,458,233	$1,356,135	$349,178	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$2,888,547**	**$2,185,675**	**$349,178**
Utility Relocation	4 %	$115,542		
Mobilization \ General Conditions	5%	$144,427		
Subtotal with Percent Allowances		**$3,148,516**		
Contingency	30%	$944,555		
Profit	5%	$204,654		
Probable Construction Cost Estimate		**$4,297,725**		
Design Engineering, Geotechnical, and Construction Management	10%	$429,772		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate		**$7,262,350**		

Additional Comments

Metropolitan Water Reclamation District of Greater Chicago
Upper Salt Creek Watershed Detailed Watershed Plan
Table X-X Total Conceptual Cost Report

Alternative Name	SCUP-56
Problem Description	SCUP-56
Strategy	SCUP-56
District Minimum Criteria for Funding:	Not Met
Recommended	No

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Pump Station: Small Pump Station with Flap Gate	each	1	$650,000	$650,000	$362,694	$0	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$650,000**	**$362,694**	**$0**
Utility Relocation	4 %	$26,000		
Mobilization \ General Conditions	5%	$32,500		
Subtotal with Percent Allowances		**$708,500**		
Contingency	30%	$212,550		
Profit	5%	$46,053		
Probable Construction Cost Estimate		**$967,103**		
Design Engineering, Geotechnical, and Construction Management	10%	$96,710		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate		**$1,426,507**		

Additional Comments

Metropolitan Water Reclamation District of Greater Chicago
Upper Salt Creek Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name SCUP-58

Problem Description Fill in with text.

Strategy Fill in with text.

District Minimum Criteria for Funding: Not Met

Recommended No

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Channel treatment: Excavation	yd3	47407	$11	$506,307	$0	$0	
Channel treatment: Material to be hauled offsite	yd3	47407	$12	$557,032	$0	$0	
Channel treatment: Biostabilization	yd2	22000	$64	$1,409,540	$1,310,851	$337,518	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$2,472,879**	**$1,310,851**	**$337,518**
Utility Relocation	4 %	$98,915		
Mobilization \ General Conditions	5%	$123,644		
Subtotal with Percent Allowances		**$2,695,438**		
Contingency	30%	$808,631		
Profit	5%	$175,203		
Probable Construction Cost Estimate		**$3,679,273**		
Design Engineering, Geotechnical, and Construction Management	10%	$367,927		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate		**$5,695,569**		

Additional Comments

Metropolitan Water Reclamation District of Greater Chicago
Upper Salt Creek Watershed Detailed Watershed Plan
Total Conceptual Cost Report

Alternative Name SCWB-52

Problem Description Project 4 addresses the flooding issues of several commercial buildings along State

Strategy Overbank flooding is caused by channel backwater effects starting at on online detention basin between

District Minimum Criteria for Funding: Met

Recommended Yes

	Unit	Quantity	Unit Cost	Base Cost	Maint. Cost	Replacement Cost	Notes/Issues
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	340	$609	$206,958	$192,468	$0	Remmington Road
Pipe under pavement (city): 90 to 96 inches / box culvert (39 to 50 ft2)	lf	120	$609	$73,044	$67,930	$0	State Parkway
Channel treatment: Excavation	yd3	1435	$11	$15,328	$0	$0	
Channel treatment: Material to be hauled offsite	yd3	1435	$12	$16,863	$0	$0	
Channel treatment: Biostabilization	yd2	2101	$64	$134,617	$125,192	$32,235	

* Indicates item excluded from subtotal (e.g. land acquisition, buyouts)

Subtotal (direct costs)		**$446,811**	**$385,590**	**$32,235**
Utility Relocation	4 %	$17,872		
Mobilization \ General Conditions	5%	$22,341		
Subtotal with Percent Allowances		**$487,024**		
Contingency	30%	$146,107		
Profit	5%	$31,657		
Probable Construction Cost Estimate		**$664,787**		
Design Engineering, Geotechnical, and Construction Management	10%	$66,479		
Property Acquisition Cost:		$0		
Total Conceptual Cost Estimate		**$1,149,091**		

Additional Comments