HYDROLOGIC AND HYDRAULIC ANALYSES
OF SWIFT CREEK

CLAYTON BYPASS

JOHNSTON AND WAKE COUNTY,
NORTH CAROLINA
(R-2552)

Prepared for:

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
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EXECUTIVE SUMMARY

Watershed analyses were performed on behalf of the N.C. Department of Transportation (DOT) for an area surrounding the proposed Clayton Bypass (Bypass) (R-2552) for Current Condition and two future scenarios that consider no project versus project levels of development. The analyses conducted as part of this study include comparative modeling of current and future stormwater flows considering complex hydraulic variables that may affect the stream ecosystem. The purpose of the study is to estimate the percentage difference in these complex hydraulic variables between the "with project" and "without project" scenarios. This study is required by the N.C. Division of Water Quality (DWQ) and the U.S. Fish and Wildlife Service (FWS) in an effort to address direct, indirect, and cumulative impacts for consideration during Section 404 permit review and Section 401 Water Quality Certification review. These analyses were completed using techniques that utilize the strengths of two different modeling approaches: 1) hydrologic modeling on the entire Site using sub-watersheds in the Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) model developed by the U.S. Army Corps of Engineers (USACE) coupled with 2) hydraulic modeling of Swift Creek using the Hydrologic Engineering Center – River Analysis System (HEC-RAS) model developed by the U.S. Army Corps of Engineers. These models provided quantitative evaluations of the hydrologic and hydraulic conditions within the Swift Creek system. This information was further used to evaluate stormwater attenuation in the DOT Mitigation Site and to infer potential effects on the mussel population in the stream.

Two future scenarios were evaluated including: 1) Scenario 1 - Year 2025 projected growth without the Bypass and 2) Scenario 2 - Year 2025 projected growth with the Bypass and proposed induced development specifically attributable to the Bypass. The Current Scenario was evaluated to provide a baseline with similar model assumptions and parameters to facilitate a comparative analysis without verification from field data.

By Year 2025, modeling of land use derived from predicted growth indicates that the Bypass and associated induced development will result in an increase in stormwater runoff ranging from 6.5 percent to over 18 percent. The DOT Swift Creek Mitigation Site, proposed as compensatory mitigation for Bypass related impacts to waters of the U.S., has been shown by HEC-HMS to provide water attenuation benefits resulting from detention of stormwater runoff passing through the Mitigation Site. The attenuation is shown in a reduction in flow-rates from Scenario 1 to Scenario 2 of 1.5-percent for the 10-year event, 2.8-percent for the 25-year event, 2.6-percent for the 50-year event, and 1.1-percent for the 100-year event.

This analysis also shows the preferred locations for mussel habitat in Swift creek at several return period events. The length of the modeled stream suitable for mussel habitat, based primarily on shear stress values, range from 24 percent (for the 100-year return period event) to 33 percent (for the 10-year return period event) of the total 25,000-foot reach of Swift Creek. These areas were consistently determined to be suitable habitat locations regardless of future growth trends.

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WAKE AND JOHNSTON COUNTIES, NORTH CAROLINA

1.0 INTRODUCTION

EcoScience Corporation (ESC) has been retained by the N.C. Department of Transportation (DOT) to perform watershed-based and instream analyses for hydrologic and hydraulic changes within the vicinity of the proposed Clayton Bypass (R-2552) (Bypass) in Johnston County, North Carolina (Figure 1, Appendix A). The 13.2-square mile region of study (hereafter referred to as the "Site") is composed of several watersheds draining to Swift Creek that are proposed to be traversed by the Bypass. These watersheds will be the focus of the hydrologic portion of this study. A 25,000-foot reach of Swift Creek is also contained within the Site, and this reach is the focus of the hydraulic portion of this study. The Site completely encompasses a proposed Mitigation Site, which is the NCDOT-defined compensatory mitigation project to offset unavoidable jurisdictional area impacts from the Bypass. It is not the focus of this study to evaluate the Mitigation Site alone, but to present the changes in the watershed and in Swift Creek relevant to the Bypass development.

The proposed alignment of the Bypass extends from the intersection of US 70 and US 70-Bypass westward to a proposed interchange with I-40. The 9-mile corridor is proposed as a multi-lane, divided, controlled-access facility on new location. Additional interchanges are planned at SR 1560 (JJ Ranch Road) and NC 42. The Bypass will relieve traffic congestion, improve commuting time, and generate improved access to employment centers like Raleigh, Durham, and the Research Triangle Park (RTP) for rural areas located in eastern Johnston County.

Streams within the vicinity of the Bypass contain populations of an aquatic species federally listed as Endangered and several species identified as Federal Species of Concern (FSC). These rare species receive consideration under the Endangered Species Act of 1973, as amended (16 USC 1531 *et seq.)*, and may be threatened by water quantity degradation. These hydrologic and hydraulic analyses provide an evaluation of how the potential water quantity changes resulting from induced secondary and cumulative development associated with the Bypass affect the potential habitat of endangered mussels within Swift Creek. In addition, the study provides regulatory agencies with supporting documentation to determine whether additional Best Management Practices (BMPs) may be required in order to protect and maintain the integrity of existing federally protected aquatic species populations.

This effort has been requested by the N.C. Division of Water Quality (DWQ) as part of the review process for issuance of Section 401 Water Quality Certification. In addition, the U.S. Fish and Wildlife Service (FWS) is interested in these analyses in order to comment on the potential for the Bypass to affect the federally Endangered dwarf wedge mussel (*Alasmidonta heterodon*), as well as four FSC-listed species and seven state listed species with known occurrences within the Site.

Results of the hydrologic and hydraulic analyses will be used to quantify changes in hydrology and mussel habitat, from the Current Scenario (Current), for two future scenarios: 1) Scenario 1 - projected growth without the Bypass and 2) Scenario 2 - projected growth with the Bypass and development induced by the project. An analysis of Current was conducted to provide a baseline for comparison that uses similar assumptions as the future scenarios.

Currently, individual segments of streams within the region are primarily degraded by excessive erosion due to increased stormwater runoff. In order to estimate mussel habitat changes for each scenario, long-term, time-series measurements of stream flow, shear stress, channel velocities, and other complex hydraulic variables (turbidity, depth, temperature, substrate, groundwater inflow) for various stream stages in the growing and non-growing seasons would be required. A detailed field study is prohibitive for the current effort due to the large size of the Site (13.2 square miles, including 25,000 linear feet of Swift Creek); therefore, predictive modeling efforts have been employed to determine future flow-rate trends.

Two models developed by the United States Army Corps of Engineers (USACE) Hydrologic Enginering Center (HEC) will be used for the hydrologic and hydraulic analyses for this study. HEC Hydrologic Model Simulation (HMS) is a watershed-based model that incorporates topography, land use, soil cover, simulated precipitation, and spatial routing relationships to produce hydrograph flows at many locations throughout a studied watershed, and a cumulative hydrograph showing how the hydrology of the watershed affects the flows at the outlet of the studied watershed.

HEC-River Analsys System (RAS) is a stream-channel-simulating model that incorporates channel geometry, floodplain topography, input flow data, and the presence of any bridges, culverts or other hydraulic structures to determine a wide variety of output information. The channel geometry and floodplain topography are identical to that used for HEC-HMS, and the HEC-HMS output hydrographs can be used for the input flow data. Output includes flow rates, velocity, Froude Number, water surface elevation, shear stress, among other values. Due to information found in recent literature for mussels, the variable with highest correlation to mussel habitat is channel shear stress. This output variable will be the focus of the HEC-RAS output.

A previous study was completed to analyze the nutrient and sediment impacts of the development associated with the Bypass (EcoScience, 2004). This study used several pollutant models to predict pollutant yields and trends for future land use scenarios associated with and without the Bypass. The results of the sediment and nutrient analyses show that pollutant yields increase as impervious area increases, and that a small increase in pollutant loading is attributable to the Bypass. In addition, the preservation of the Mitigation Site is predicted to prevent overland loadings of nutrients and sediment to Swift Creek, therefore having a positive impact on the rare aquatic species in Swift Creek.

2.0 METHODS

This study was heavily dependent upon the utilization of data from several available sources in order to produce an accurate representation of the detailed area to be studied. Land use and topographical data were obtained as described in the following paragraphs. The models run for hydrologic and hydraulic analyses include HEC-HMS, HEC-GeoHMS, and HEC-RAS with HEC-DSS used as a data transfer utility. The following sections describe the assumptions and variables associated with these models and their use for this analysis.

2.1 Site Definition

The Site is defined as a subwatershed of the Swift Creek watershed with an upstream boundary approximately 11,000 feet downstream of the dam at Lake Benson in Wake County, and a downstream boundary approximately 1500 feet upstream of the Swift Creek crossing of Cornwallis Road in Johnston County. Land use was generated by DOT consultants for all three scenarios (Current, Future with Bypass, Future without Bypass) (URS, 2003), and topographic information was obtained by the use of LIght Detection and Ranging (LIDAR)-based elevation data (FMP 2000) with a reported vertical accuracy of 25 centimeters.

The Site incorporates the lower portion of the 14-digit Hydrologic Unit 03020201110030, one of several hydrologic units likely to be traversed by the Bypass. Figure 2 (Appendix A) depicts the boundaries of the sub-watersheds within the Site boundary, which were modeled using HEC-HMS. Additionally, the Swift Creek Mitigation Site is contained completely within the Site boundary.

2.2 Land-use Generation

Twelve land-use categories are utilized by the HEC-HMS model matching the 12 categories used for the Sediment and Nutrient Model (EcoScience 2004). The categories are defined by the amount of impervious area and vegetation cover within a tax parcel unit (Table 1). All land-use information was digitized and provided in ArcView 3.x shapefile format. Figures depicting land use for all scenarios are provided in Figure 3 (Appendix A).

Table 1. Land-use categories used in HEC-HMS. Site land use was categorized using tax parcels as land-use units.

Land-use Category
COMM: Business, Commercial, 85% impervious
CROPLAND: Fallow, Row Crops, Small Grain
HOUSE20: Housing, 1-acre lots, 20% impervious
HOUSE25: Housing, 0.5-acre lots, 25% impervious
HOUSE30: Housing, 0.3-acre lots, 30% impervious
HOUSE38: Housing, 0.25-acre lots, 38% impervious
HOUSE65: Housing, 0.125-acre lots, 65% impervious
INDUST: Business, Industrial, 72% Impervious
PASTURE: Pasture, Grassland, or Range
WATER: Lakes, Ponds, Reservoirs
WOODG: Woods-Grass Combination
WOODS: Woodland or Forest

2.2.1 Current Condition

Current Condition serves as the baseline against which future land-use scenarios were developed. In addition to land-use mapping, Year 1998 U.S. Geological Survey (USGS) National Aerial Photography Program (NAPP) color infra-red digital aerial photography, Year 1999 Wake County color aerial photography, Year 2000 Johnston County color aerial photography, and Year 1993 DOT black-and-white aerial photography were use to generate figures and as sources of reference for selecting appropriate model parameters for specific land uses. N.C. Floodplain Mapping Program (FMP) LIDAR data were used to generate landscape surface features for this study. Several resolutions of Digital Elevation Models (DEM) were created from the LIDAR data. The availability of these data sets allowed for the flexibility to use the appropriate resolution in relation to size for each area modeled. Data obtained from the CGIA for inclusion into the mapping database include Site hydrology (Neuse River basin), county lines, and 14-digit hydrologic unit boundaries for inclusion in the mapping database. Digital data obtained from the DOT include roadway networks and the alignment for the Bypass. For clarity in mapping, each land-use category was color coded.

2.2.2 Year 2025 Predicted Condition: Scenarios 1 and 2

New development within the Site was projected to Year 2025 for Scenario 1 and Scenario 2. Scenarios 1 and 2 are based upon estimated secondary and cumulative growth. These estimates were generated based on the following assumptions (URS 2004).

1. The Site will likely experience considerable development regardless of the project.
2. Growth generated by the project will mainly be limited to new interchange catchment areas within the Site. However, the region south and east of the Site may also experience development pressure due to increased accessibility to regional employment centers.

New development in both scenarios is dominated by the low-density residential category in previously rural areas of forest and cropland. Increases in commercial and industrial categories are centered along major transportation corridors for both scenarios.

The main difference between Scenarios 1 and 2, in terms of land use, is the noticeable increase in commercial land in Scenario 2, though Scenario 1 shows greater residential development. It is clear in all scenarios that the Swift Creek floodplain is maintained as forested land.

Table 2. Summary of Hydrologic Soil Group (HSG) Classifications for Project Area

Soil Series	Soil Description	Hydrologic Soil Group[1]
Altavista	Fine sandy loam, clay loam, or coarse sandy loam	C
Appling	Sandy loam, gravelly sandy loam, clay loam, or sandy clay loam	B
Cecil	Sandy loam, gravelly sandy loam, clay loam or loam	B
Cowarts	Sandy loam, sandy clay loam, sandy clay or clay loam	C
Enon	Fine sandy loam, clay or clay loam	C
Faceville	Sandy loam or clay loam	B
Lloyd	Loam, clay loam, or silty clay loam	B
Louisburg	Loamy sand or coarse sandy loam	B
Norfolk	Loamy sand or coarse sandy loam	B
Orangeburg	Loamy sand, or sandy clay or sandy loam	B
Uchee	Loamy coarse sand, sandy clay loam or sandy clay	A
Vance	Coarse sandy loam, sandy clay or clay loam	C
Varina	Loamy sand, sandy clay or clay loam	C
Wagram	Loamy sand or sand clay loam	A
Wedowee	Sandy loam, sandy clay or clay loam	B

[1] Reference: Exhibit A-1, *Urban Hydrology For Small Watersheds*, Technical Release No. 55 (2nd Edition), Soil Conservation Service, United States Department of Agriculture, June 1986.

SCS Hydrologic Soil Groups:

A. Lowest runoff potential. Includes deep sands with very little silt and clay; also, deep, rapidly permeable gravel.

B. Moderately low runoff potential. Mostly sandy soils less deep and less aggregated than Group A, but the group, as a whole, has above average infiltration after thorough wetting.

C. Moderately high runoff potential. Comprises shallow soils and soils containing considerable clay and colloids, though less than those of Group D. The group has below- average infiltration after saturation.

D. Highest runoff potential. Includes mostly clays of high swelling percentage, but the group also includes some shallow soils with nearly impermeable subhorizons near the surface.

3.1.2 Meteorology

Meteorological data analysis is performed in the meteorologic component and includes precipitation and evapotranspiration methods. Four different methods for producing synthetic precipitation were used. Hypothetical frequency storm events are statistically derived and are based on the analysis of long term, historical rain gage data for specific regions. The events have a specific probability of occurrence in a given area, expressed as an x-percent chance of exceedance (exceedance probability) in any given year. They are balanced with a consistent depth-frequency relationship for each incremental duration throughout the storm event.

The National Weather Service (NWS) has published technical papers (TP) and other publications with atlases of the United States illustrating isohyetal frequency rainfall intensity lines for specific storm durations. The NWS TP-40, entitled Rainfall frequency atlas for 1- through 100-year return interval precipitation depths for durations ranging from 30 minutes to 24 hours for the eastern United States (Hershenfield, 1961), was used for this analysis.

The frequency storm uses statistical data to produce balanced storms with a specific exceedance probability. The SCS hypothetical storm implements the primary precipitation distributions for design analysis using NRCS criteria.

Meteorological data for this analysis used a Type II (24-hour) SCS Storm event with overall rainfall at the following values for each return period:

10-year = 5.7 inches
25-year = 6.6 inches
50-year = 7.3 inches
100-year = 8.2 inches

The objective of the frequency-based hypothetical storm that is included in HEC-HMS is to define an event for which the precipitation depths for various durations within the storm have a consistent exceedance probability.

3.1.3 Control Specifications

The time span of a simulation is proscribed by control specifications. Control specifications include a starting date and time, an ending date and time, and a computation time step. A computation run is created by combining a basin model, meteorologic model, and control specifications. Computation results are viewed from the basin model schematic. Global and element summary tables include information on peak flow and total volume. Time-series tables and graphs are available for elements. The control parameters for all of the scenario models were set for one 24-hour event with data processed and output provided every 30 minutes. The simulation does not rely on actual precipitation or stream-flow data.

3.1.4 HEC-GeoHMS

The Geospatial Hydrologic Modeling Extension (HEC-GeoHMS) is a software package for use with the ArcView Geographic Information System. GeoHMS uses ArcView and Spatial Analyst to develop a number of hydrologic modeling inputs. Analyzing digital terrain information, HEC-

GeoHMS transforms the drainage paths and watershed boundaries into a hydrologic data structure that represents the watershed response to precipitation (Figure 5, Appendix A).

The program also features terrain-preprocessing capabilities. Additional interactive capabilities allow users to construct a hydrologic schematic of the watershed at stream gages, hydraulic structures, and other control points. The hydrologic results from HEC-GeoHMS are then imported by HEC-HMS, where simulation is performed. Each reach and subwatershed is numerically identified and represented so that reaches within subwatersheds share the same identification information (Figure 6, Appendix A).

3.2 HEC-DSS Model

HEC-Data Storage System (DSS) is a visual utilities program that allows users to plot, tabulate, edit, and manipulate data in a HEC-DSS database file. HEC-DSS was developed to meet the specific needs of applications in water resources studies. In order to efficiently manage large amounts of related data for practical applications, routines have been developed which organize and transfer data in blocks of continuous data. For example, each block of data for time series applications consists of a record of a time-dependent variable for a day or month or year. By storing data in this manner, an entire year of daily flows (or block of data) can be handled as a single element and accessed by one "search" of the database. Other routines deal with tables of paired data, such as stage-discharge, stage-damage or discharge-frequency relationships.

To account for changes in flow due to entering tributaries and upstream subwatersheds the HEC-DSS program was used to incorporate the hydrographs produced by HEC-HMS at the appropriate locations along Swift Creek. The flow and water-surface elevation at each cross-section could then be modeled at each 30-minute interval over the course of the 24-hour storm event period.

3.3 HEC-RAS Model

HEC-RAS was created by USACE in order to perform hydraulic calculations for a channel or network of channels on a one-dimensional basis. For the purpose of this study, all Scenarios were modeled as steady flow in the channel of Swift Creek. Channel geometry and channel flow are the two main components of this HEC-RAS model.

The HEC-RAS model is intended for calculating water surface profiles for steady gradually varied flow. The model can handle a full network of channels, a dendritic system, or a single river reach. The steady flow component is capable of modeling subcritical, supercritical, and mixed flow regimes water surface profiles.

The basic computational procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is utilized in situations where the water-surface profile is rapidly varied. These situations include mixed flow regime calculations (i.e. hydraulic jumps), hydraulics of bridges, and evaluating profiles at river confluences (stream junctions).

The effects of various obstructions such as bridges, culverts, weirs, and structures in the floodplain may be considered in the computations. The steady-flow system is designed for application in floodplain management and flood insurance studies to evaluate floodway encroachments.

Using ArcView 3.1, in conjunction with the HEC-GeoRAS utility, a channel and cross sections were drawn over a three-dimensional terrain model for this study. Cross sections were created in order to define the geometry of the channel and adjoining floodplain accurately. These cross sections were then supplemented with field cross-section data taken at 1000-foot intervals along the studied reach of Swift Creek. Adjustments were made to the computer-produced cross sections to accommodate the actual channel geometry observed in the field. In addition to channel geometry, two large bridges for I-40 and NC42 were incorporated into the model using construction plan dimensions for those bridges.

The output tables from HEC-RAS contain several variables with relevance to mussel habitat within Swift Creek. These variables include, among others, flow (Q, in cubic feet per second), velocity (V, in feet per second), and shear stress (in pounds force per foot squared). The model was then applied to evaluate habitat conditions at one particular flow of interest.

To analyze the persistence of habitat, we investigated the locations of suitable habitat at flows associated with the 10-, 25, 50-, and 100-year storm events. Habitat was designated as suitable at very low and moderate flows, and suitable habitat is defined further in Sections 4.2 and 4.3. This criterion might seem very strict, but this analysis aims to identify the colonies that could be particularly sensitive to flow reductions.

4.0 RESULTS AND DISCUSSION

It was necessary to establish a basis of comparison to evaluate the land-use changes in the Scenarios 1 and 2. Changes in land-use patterns were particularly relevant for use in the HEC-HMS model due to the direct correlation between land use, curve number, and runoff. The results of the HEC-RAS modeling effort indicate that of the approximately 25,000 linear feet of stream modeled the following lengths are suitable for mussel habitat: 8,100 feet at 10-year flows, 7,800 feet at 25-year flows, 7,450 feet at 50-year flows, and 6,050 feet at 100-year flows. The 10-year length is only 32 percent of the overall stream length, but it must be recognized that this suitability is based solely on channel shear stress. The following sections will provide more detail as to why comparisons were made in this way, and how the condition changes in the future scenarios.

4.1 Land Use induced Changes

4.1.1 Current Condition

An analysis of Current Condition was necessary to establish baseline parameters for development of future scenarios. Changes in land-use patterns were particularly relevant for use in the HEC-HMS model due to the direct correlation between land use and stormwater runoff.

Table 3. Summary of Increase in Flow Rate for Future Site Land Use Scenarios

RETURN PERIOD	FLOWRATE			PERCENT INCREASE		FUTURE SCENARIO DIFFERENCE
	C	1	2	1	2	
10	5749	6787	6703	18.1	16.6	1.5
25	7625	8831	8619	15.8	13.0	2.8
50	8913	10392	10163	16.6	14.0	2.6
100	11541	12416	12293	7.6	6.5	1.1

C=Current
1=Scenario 1
2-Scenario 2

4.1.2 Scenario 1 (without Bypass)

Site land use is projected to change considerably by Year 2025, even without additional growth associated with the Bypass. By Year 2025, non-Bypass related ambient growth is expected to result in increases of residential, industrial and commercial land uses. Residential growth will be scattered and located primarily in an unnamed tributary to Swift Creek watershed in between White Oak and Little Creeks, while non-residential growth will be concentrated along the NC 42 corridor and along US 70. The results of the modeling effort indicate that 6787 cubic feet per second of stormwater runoff will be conveyed from the Site for the 10-year event, 8831 cubic feet per second for the 25-year event, 10,392 cubic feet per second for the 50-year event, and

12,416 cubic feet per second for the 100-year event (Table 3). Stormwater runoff in Year 2025 will increase in response to increased development. Increases, over the current condition, of 18.1-percent are excepted for the 10-year event, 15.8-percent for the 25-year event, 16.6-percent for the 50-year event and 7.6-percent for the 100-year event, will result from the predicted growth relative to Current (Table 3). For additional information, see Appendices B and D.

4.1.3 Scenario 2 (with Bypass)

Bypass construction and associated new development will be dominated by residential growth. The improved access to rural areas previously subject to unreasonable commute times is expected to stimulate new-home construction, as well as the industry, commerce, and improved transportation infrastructure necessary to support the new residential development. Land use changes implemented in this scenario include all development predicted in Scenario 1 as well as increases of 1.7 square mile of residential growth and 2.2 square miles of non-residential growth. All induced growth in this scenario is considered to be attributable to the Bypass. Residential growth will predominantly be located in unincorporated areas of Wake and Johnston Counties that may receive water and sewer utilities by Year 2025. Commercial and industrial growth is anticipated to occur adjacent to the Bypass and be focused at interchanges and major arterial roadways.

Scenario 2 results of the modeling effort indicate that 6703 cubic feet per second of stormwater runoff will be conveyed from the Site for the 10-year event, 8619 cubic feet per second for the 25-year event, 10163 cubic feet per second for the 50-year event, and 12293 cubic feet per second for the 100-year event (Table 4). The flowrate increase of 16.6 percent is expected for the 10-Year event, 13.0 percent for the 25-year event, 14.0 percent for the 50-year event, and 6.5 percent for the 100-year event, from the current conditions (Table 4). For additional information, see Appendices B and D.

4.1.4 Mitigation Site

HEC-HMS runs produced hydrographs for each subwatershed outlet showing the overall peak flow and volume. A summary of these values is provided for the outlet of the total watershed in Appendix B. In general, peak flows at the outlet increased from Current to Scenario 1 and increased again to Scenario 2. Higher peaks with shorter concentration times are to be expected with increases in urbanization throughout the watershed. The lower peaks observed for Scenario 2 are due to the preservation of the Mitigation Site. Keeping the areas nearest the stream channel preserved reduces the rate of flow into the channel, and, therefore, reduces the peak at points downstream of the preserved area.

The Mitigation Site has been evaluated for water attenuation benefits resulting from detention of stormwater runoff passing through the Mitigation Site. The outcome of this attenuation is a reduction in flowrates from Scenario 1 to Scenario 2 of 1.5-percent for the 10-year event, 2.8 percent for the 25-year event, 2.6 percent for the 50-year event and 1.1 percent for the 100-year event (Table 3). Within the Mitigation Site, the land is primarily made up of floodplain wetlands and not conducive to heavy development. The difference in land use between Scenario 1 and

Scenario 2 inside the Mitigation Site is the small amount of development in the upland areas. These areas are rarely, if ever, inundated by floodwaters, and therefore do not have a large influence on the attenuation of stormwater within the Mitigation Site. For additional information, see Appendix B.

4.2 Establishing a Reference

Researchers have been studying complex hydraulic variables such as substrate texture, discharge, velocity, shear stress, turbidity, temperature, Reynolds number, Froude number, and even the presence of dams in an attempt to correlate the values of these variables with mussel habitat suitability (Michaelson and Neves, 1995; Hardison and Layzer, 2001; Strayer, 1999; Salmon and Green, 1982). Chemical factors such as dissolved oxygen, pH, and the presence of various nutrients also plays a key role in establishing which of these factors, or combination of factors, dictates the most suitable habitat for freshwater mussels. The presence of host fish is also a requirement for suitable mussel habitat, and one that is greatly affected by the presence of dams.

When looking at the research presented, some studies appear to contradict one another, though some subjects are common to many authors. One theory supported by the research of several groups is that mussel beds tend to be located in areas with low shear stress. Both Strayer, from the Institute of Ecosystem Studies, and the team of Layzer and Madison, of the National Biological Service, Tennessee Technological University, show the relationship between mussel populations and relative shear stress in their work. Strayer (1999) suggests that mussel beds are present in areas where low shear stresses are present, even in return period flows between 3- and 30-years (shear stress was not quantitatively defined). Layzer and Madison (1995) studied the relationship between mussel density and shear stress. They positively correlated low shear stress with high mussel density at low discharges, but were unable to determine a relationship at higher discharges.

Another subject in agreement between multiple authors is the importance of stability in mussel habitat. Hardison and Layzer (2001) present the argument that hydrological stability is a major factor in mussel distribution, though they stress that factors affecting mussel distribution at low discharges may not be the same at higher discharges. This is due, in part, to the fact that many factors (such as Reynolds' number and Froude number) do not account for the flow conditions most near the substrate. This subject is also approached by Strayer (1999) in the flow refuges. These areas have lower shear stress, even in higher flows, and it would logically follow that these locations are areas of more stable substrate. Michaelson and Neves (1995) quantify a velocity of 0.33 feet per second as a velocity for high mussel suitability, though other researchers specify "low" velocities rather than provide a specific value. Johnson and Brown (2000) observed that mussels were more likely to be found in the shallow stable areas of streams with higher currents than in deeper pools with silt bottoms. Several authors recognize differences in substrate to be a possible reason for mussels to choose a particular location, though Salmon and Green (1982) mention that substrate seems to be a secondary factor to current. Because both shear stress and flow have been shown in the research documented here to be strongly related to mussel habitat, these two variables were the main focus of the HEC-RAS analysis.

Even in areas where physical aspects of a stream bed seem to be optimal for mussel habitat, chemical properties in the water may be a deterrent. The properties discussed above (shear stress and channel stability) are hydraulic and physical characteristics that have been shown to provide a reasonable idea of where mussel beds can be found within a stream or river.

4.3 HEC-RAS Results

The output hydrographs produced by HEC-HMS at locations along Swift Creek were used as flow input to the HEC-RAS model. There are three main variables of interest with regards to mussels in the HEC-RAS output: flow, velocity, and shear stress. The amount of flow and velocity present at each cross section at each return interval, in combination with the geometry of the channel, dictate the shear stress in the channel. In general, greater values of shear stress are observed at higher flows and velocities. For additional information, see Appendices B and D.

The results of the modeling effort indicate that 5,749 cubic feet per second of stormwater runoff are currently being conveyed from the Site for the 10-year event, 7,625 cubic feet per second for the 25-year event, 8,913 cubic feet per second for the 50-year event, and 11,541 cubic feet per second for the 100-year event (Table 3). These values are in line with those published in the Flood Insurance Study Report for Johnston County, Sept., 2003. (Appendix C)

4.3.1 Establishing a Threshold

In order to define what constitutes a reasonable reference for preferred habitat for mussels in Swift Creek, the conditions at locations where mussels have been located were observed (Natural Heritage Program). By evaluating the flowrates, velocities, and shear stresses at these locations, we determined the maximum shear stress reference to be the maximum shear stress in the channel at the 100-year peak flow. In two cross-sections along the studied reach of Swift Creek, the maximum shear stress observed at the 100-year event was 0.16 pound force per square foot and 0.12 pound force per square foot, respectively. The value of 0.16 pound force per square foot was chosen as the maximum shear stress threshold, and this threshold was used to compare the shear stresses at the other cross sections for each time-step interval.

4.3.2 Velocity and Shear Stress

Velocity and shear stress have been shown to be correlated and can be represented by a polynomial expression for each scenario. Figure 7 (Appendix A) shows plots of this relationship and the associated equation for each scenario. The relationships show very little difference between the three scenarios.

Figure 7 (Appendix A) also shows the shear stress threshold of 0.16 pound force per square foot and the velocity associated with the shear stress threshold is 2.4 feet per second. Higher shear stresses have been observed at velocities of 2.4 feet per second and slower, and low shear stresses have been observed at velocities higher than 2.4 feet per second. In general, the area shown in Figure 8 (Appendix A) with shear stress below 0.16 pound force per square foot and velocity below 2.4 feet per second is determined to be preferred habitat for mussels.

4.3.3 Preferred Habitat Areas Based on Shear Stress

Using the shear-stress threshold, several details about the stream channel and its suitability for mussel habitat were observed. Areas of preferred habitat for the Current scenario were consistently areas of preferred habitat for the same return periods in both future scenarios. Areas that were preferred habitat at more frequent return periods are not necessarily preferred at less frequent return periods. This can be observed in the overall length of stream found preferred at each return period. At the 10-year return period, about 8100 linear feet of stream were found to be suitable for mussel habitat based on the shear-stress threshold. At the 25-year event, this value was reduced to about 7840 linear feet, and the value was reduced further to 7450 at the 50-year event and 6050 at the 100-year event. In terms of the overall length of stream modeled, 32 percent of the stream is suitable at the 10-year event, 31 percent at the 25-year event, 30 percent at the 50-year event, and 24 percent for the 100-year return period event. Each of these lengths and their location along Swift Creek can be seen in Figure 8 (Appendix A).

4.3.4 Floodplain Area

The area of the 100-year floodplain modeled using HEC-RAS falls on an area very similar to the NCDOT-proposed Mitigation Site (Figure 9, Appendix A). This shows the area to be preserved encompasses the vast majority of floodplain affected by frequent and infrequent storm events. The preservation of this floodplain has also been shown to produce water quality benefits (ESC, 2004) in addition to the attenuation benefits. Again, Scenario1 and 2 have very similar land use in the Mitigation Site, and the additional development in the upland areas has negligible effects on the 100-year floodplain.

5.0 CONCLUSIONS

The Swift Creek invertebrate community includes 10 species of fresh-water mussels, including three state Endangered species and the Federally Endangered dwarf wedgemussel. The unusual richness of the mussel fauna in Swift Creek is a good indication that, despite historic use of the creek for water supply, the native ecosystem is substantially intact. However, growing demand for future water use may alter the timing, duration, and intensity of flow and the related biological and water-quality characteristics of the stream.

With the exception of flood events, the Swift Creek system seems to be relatively stable. This stability potentially indicates strong surface-subsurface water interactions. It is reasonable to conclude from this information that there is good retention in the system. Apparently, the Swift Creek floodplain acts like a sponge, storing excess water and metering it out at a later time (the significant amount of wetlands in the Swift Creek floodplain are likely a reason for this).

At the macro scale, all of these factors point toward the preference for moderate and stable conditions for mussels, a logical result for relatively immobile organisms. The model predictions matched well with the documented abundance of mussels and also indicate that habitat suitability is highly sensitive to flow changes.

The quantity of suitable habitat for mussels changed dramatically with flow fluctuations. It is evident that in the majority of cases, many locations are only suitable habitat at specific flows. The stability of Swift Creek flows is consequently very beneficial for mussel populations. Due to the limited mobility of mussel species, locations with consistently present habitat under relatively stable flows can be critically important.

Scenario 1 predicts that 19.6 % growth will occur by the Year 2025 relative to the baseline (current) condition land use. Scenario 2 predicts that an additional 5.1 % of land will be converted to developed land-use categories in Year 2025 relative to Scenario 1. The overall results of the additional impervious area, due to development, are an increase in overall stormwater volume.

Land use changes implemented in Scenario 2 include all development predicted in Scenario 1 as well as increases of 1.7 square mile of residential growth and 2.2 square miles of non-residential growth. All induced growth in this scenario is considered to be attributable to the Bypass.

The Mitigation Site demonstrates water quantity benefits resulting from attenuation of stormwater runoff passing through the Mitigation Site. The outcome of this attenuation is a reduction in flow rates from Scenario 1(no Bypass) to Scenario 2(with Bypass) of 1.5-percent for the 10-year event, 2.8 percent for the 25-year event, 2.6 percent for the 50-year event and 1.1 percent for the 100-year event.

Summarizing the conclusions of this part of the study we find that:

1) The habitat conditions for freshwater mussels are relatively good in Swift Creek.

2) Large and stable habitat clusters are necessary for sustainable freshwater mussel colonies.
3) Habitat availability is a function of flow.
4) The largest colony of freshwater mussels can be strongly affected by present and future water withdrawals.
5) Flow patterns in the Swift Creek are stable due to complex interactions with adjacent wetlands and subsurface flows.
6) There are indications that human-induced flow fluctuations occur which could negatively impact mussel populations.
7) The proposed Mitigation Site attenuates stormwater runoff passing through the area at rates ranging from 1.1 percent to 2.8 percent.

The combination of conclusions 2 and 5 suggests a relationship between the presence of freshwater mussels and a high abundance of wetlands in the Swift Creek watershed; this may indicate that undeveloped watersheds are a precondition for mussel presence. These conclusions are not final as more effort needs to be invested in understanding the Swift Creek hydrology, as well as habitat conditions of other members of the aquatic community. Our database is not of adequate size and structure to allow us to make definitive conclusions at this time.

5.1 Alternative

Site land-use controls are currently mandated by regulation including Neuse River Riparian Buffer rules and Phase I storm water controls. By Year 2025, municipalities within the Site may be subject to Phase II stormwater requirements. Modeled land-use controls contribute to the protection of water quality and minimize water quantity stream degradation as the Site develops. It is well known that site-specific runoff impacts can largely be managed through land-use restrictions, controls over the amount of allowable impervious surface thresholds, implementation of riparian buffers, utilization of storm water catchment facilities (basins and treatment wetlands), and effective use of other structural BMPs (silt fencing, grassy swales, biorention areas, *etc.*) during and after construction.

Benefits associated with land-use restrictions imposed by current stream buffer regulations should be fully considered in these future analyses. No additional development should be considered within riparian stream buffers. Both future scenarios could be modeled with consideration for constraints resulting from current and anticipated BMPs such as Neuse River riparian buffers and stormwater ponds resulting from Phase I and II Stormwater Controls.

Efficiencies associated with runoff attenuation by stormwater ponds and riparian buffers can be quantified in future analyses within the modeled sub-watersheds using HEC-HMS and other routing software. The benefits of such measures are significant. The reduction efficiencies of these BMPs, and stormwater ponds to primarily store water and sediment, and nutrient particles that have been bound to sediment, are not being erroneously released. Modeled BMPs will predict reductions in Site stream volumes and velocities, and can prevent failures in stream banks within a rapidly urbanizing watershed.

6.0 REFERENCES

Ackerman, C. T. 2002. HEC-GeoRAS An Extension for Support of HEC-RAS using ArcView (Version 3.1). United States Army Corps of Engineer, Hydrologic Engineering Center. Davis, California.

Amoroso, J.L. 2002. Natural Heritage Program List of the Rare Plant Species of North Carolina. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health and Natural Resources, Raleigh. 85 pp.

Arcadis G&M, Incorporated. 2004. Simulated flow data for Swift Creek used in Instream Flow Study for Dempsey E. Benton Water Treatment Plant. Unpublished.

Bruner, G. W. 2002. HEC-RAS River Analysis System Hydraulic Reference Manual (Version 3.1). United State Army Corps of Engineers, Hydrologic Engineering Center. Davis, California.

Division of Water Quality (DWQ). 2002. Neuse River Basinwide Water Quality Management Plan. N.C. Department of Environment and Natural Resources, Water Quality Section, Raleigh, NC.

Doan, J. H. 2000. Geospatial Hydrologic Modeling Extension HEC-GeoHMS User's Manual. United States Army Corps of Engineers, Hydrologic Engineering Center. Davis, California.

EcoScience Corporation. 2004. Secondary and Cumulative Impact Report, Nutrient and Sediment Analyses, Clayton Bypass. Unpublished.

Floodplain Mapping Program (FMP). 2000. Neuse River Basin Light Detection and Ranging Data: Bare Earth Resolution. Website citation: www.ncfloodmaps.com

Hardison, B. S. and J.B. Layzer. 2001. Relations Between Complex Hydraulics and the Localized Distribution of Mussels in Three Regulated Rivers. Regulated Rivers: Research and Management 17: 77-84.

Herschfield, D.M. (1961) Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. Technical Paper 40. Weather Bureau, U.S. Department of Commerce, Washington, DC.

Johnson, P. D. and K. M. Brown. 2000. The Importance of Microhabitat Factors and Habitat Stability to the Threatened Louisiana Pearl Shell, *Margaritifera hembeli* (Conrad). Canadian Journal of Zoology 78: 271-277.

Layzer, J. B. and L.M. Madison. 1995. Microhabitat Use by Freshwater Mussles and Recommendations for Determining Their Instream Flow Needs. Regulated Rivers: Research and Management 10: 329-345.

LeGrand, H.E., Jr. and S.P. Hall. 2001. Natural Heritage Program List of the Rare Animal Species of North Carolina. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health and Natural Resources, Raleigh. 67 pp.

Michaelson, D. L. and R. J. Neves. 1995. Life History and Habitat of the Endangered Dwarf Wedgemussel *Alasmidonta heterdon* (Bivalvia:Unionidae). Journal of the North American Benthological Society 14(2):324-240.

Salmon, A. and R. H. Green. 1982. Environmental Determinants of Unionid Clam Distribution in the Middle Thames River, Ontario. Canadian Journal of Zoology 61: 832-838.

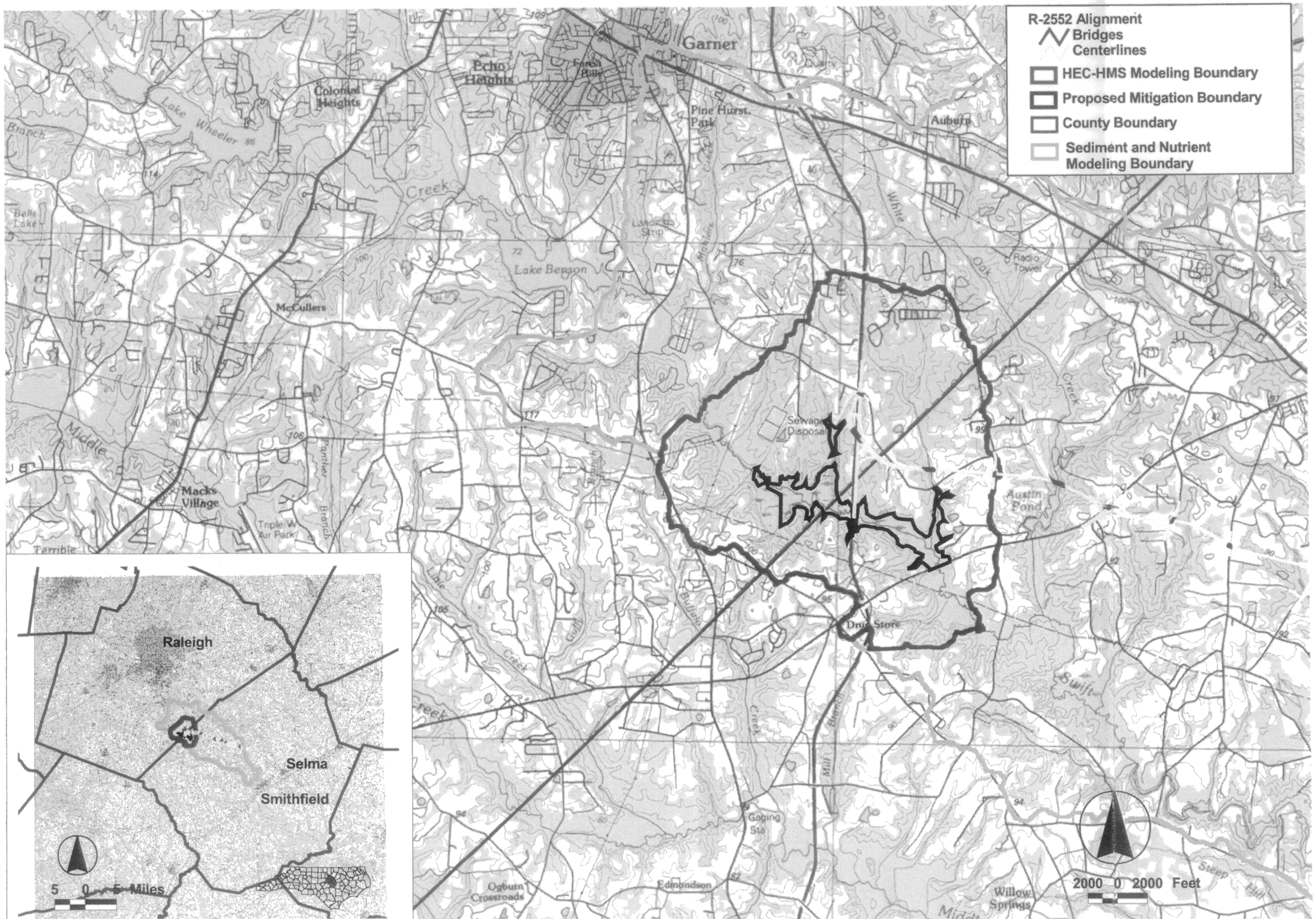
Sharffenberg, W. A. 2001. Hydrologic Modeling System HEC-HMS (Version 2.1) User's Manual. United States Army Corps of Engineers, Hydrologic Engineering Center. Davis, California.

Soil Conservation Service (SCS). 1986. Urban Hydrology for Small Watersheds (2nd Edition). Technical Release No. 55. U.S. Department of Agriculture.

Strayer, D. L. 1999. Use of Flow Refuges by Unionid Mussels in Rivers. Journal of the North American Bethological Society 18(4): 468-476.

URS Corporation. 2004. Clayton Bypass: Indirect and Cumulative Effects Assessment. Submitted to North Carolina Department of Transportation.

APPENDIX A:
FIGURES



EcoScience Corporation

CLIENT:

PROJECT:

HYDROLOGIC AND HYDRAULIC ANALYSIS

CLAYTON BYPASS (R-2552)

Johnston and Wake Counties, North Carolina

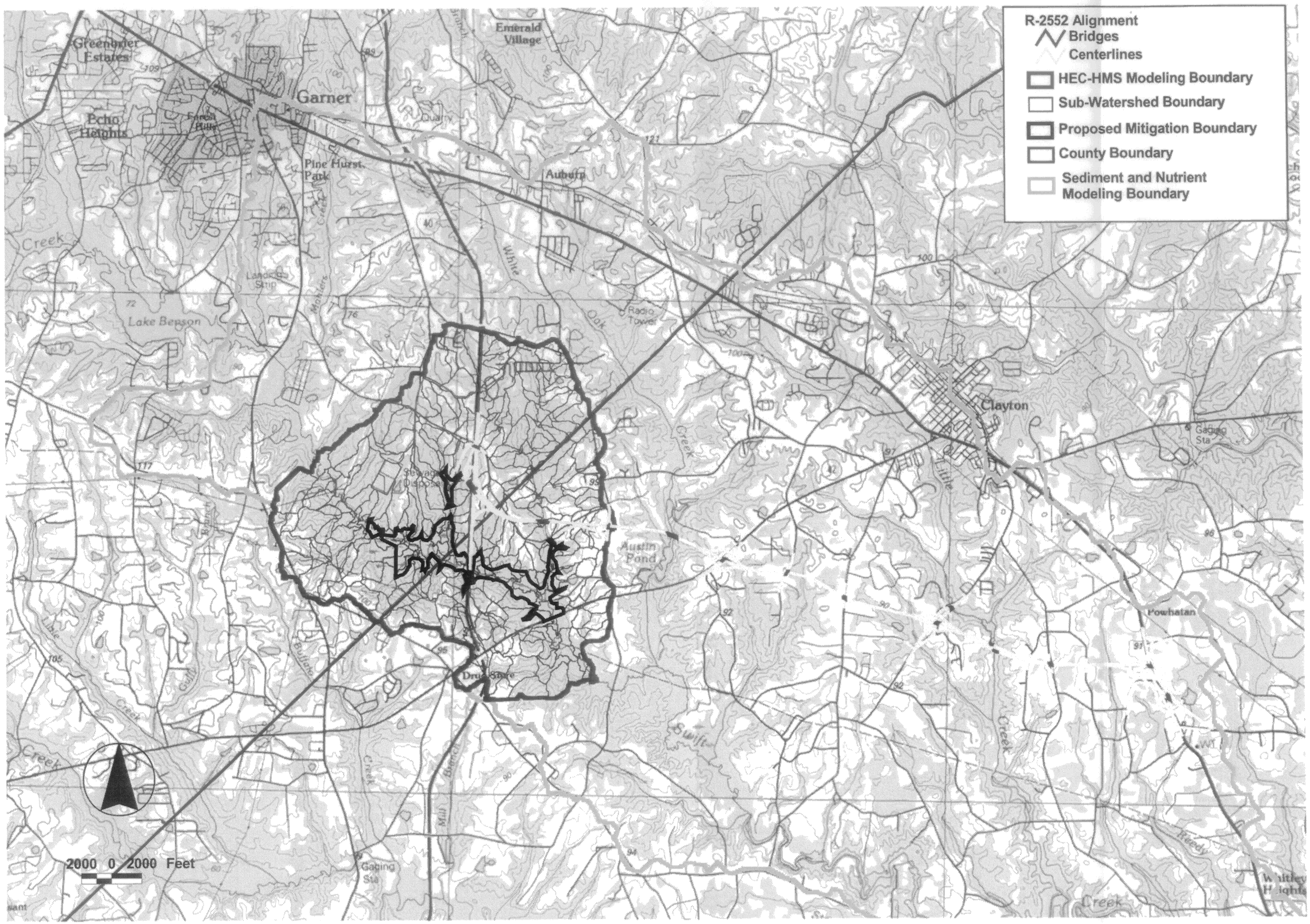
TITLE:

STUDY AREA LOCATION

Dwn By: MAF	Ckd By: JD
Date: SEPT 2004	Scale: AS SHOWN
ESC Project No.: 02-113.40	

FIGURE

1



EcoScience Corporation

CLIENT:

PROJECT:

HYDROLOGIC AND HYDRAULIC ANALYSIS

CLAYTON BYPASS (R-2552)

Johnston and Wake Counties, North Carolina

TITLE:

MODELING BOUNDARIES

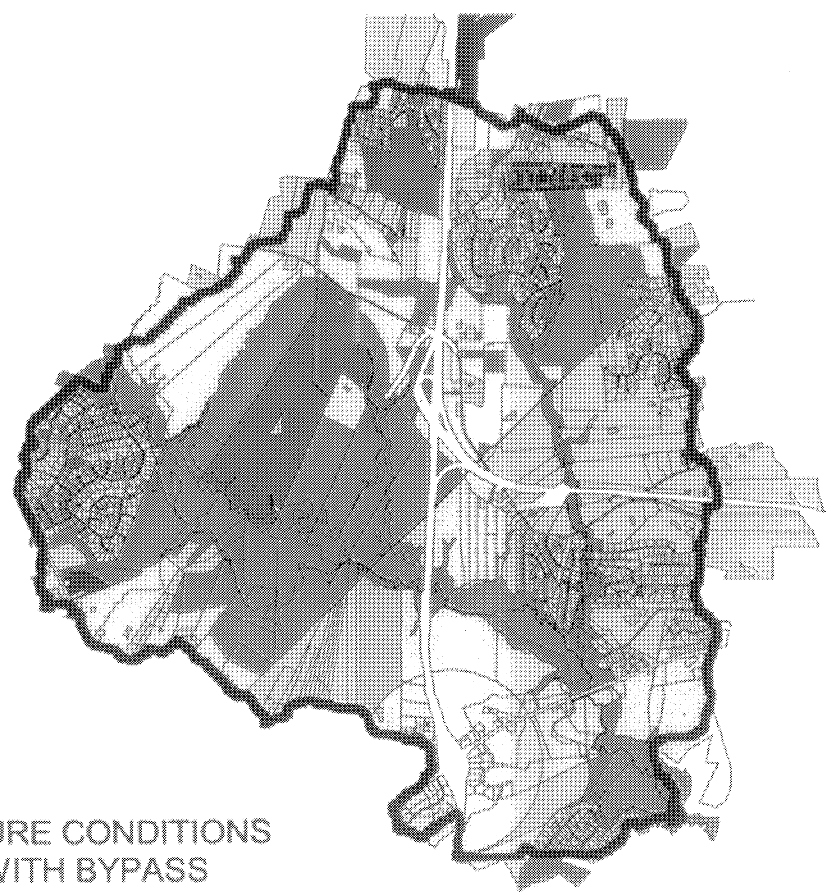
Dwn By:	Ckd By:
MAF	JD
Date:	Scale:
SEPT 2004	AS SHOWN
ESC Project No.:	
02-113.40	

FIGURE

2

CURRENT CONDITIONS

FUTURE CONDITIONS
WITHOUT BYPASS



FUTURE CONDITIONS
WITH BYPASS

HEC-HMS Modeling Boundary

- COMM
- CROPLAND
- HOUSE20
- HOUSE25
- HOUSE30
- HOUSE38
- HOUSE65
- INDUST
- PASTURE
- ROAD
- WATER
- WOODG
- WOODS

EcoScience Corporation

CLIENT:

PROJECT:

HYDROLOGIC AND HYDRAULIC ANALYSIS

CLAYTON BYPASS (R-2552)

Johnston and Wake Counties, North Carolina

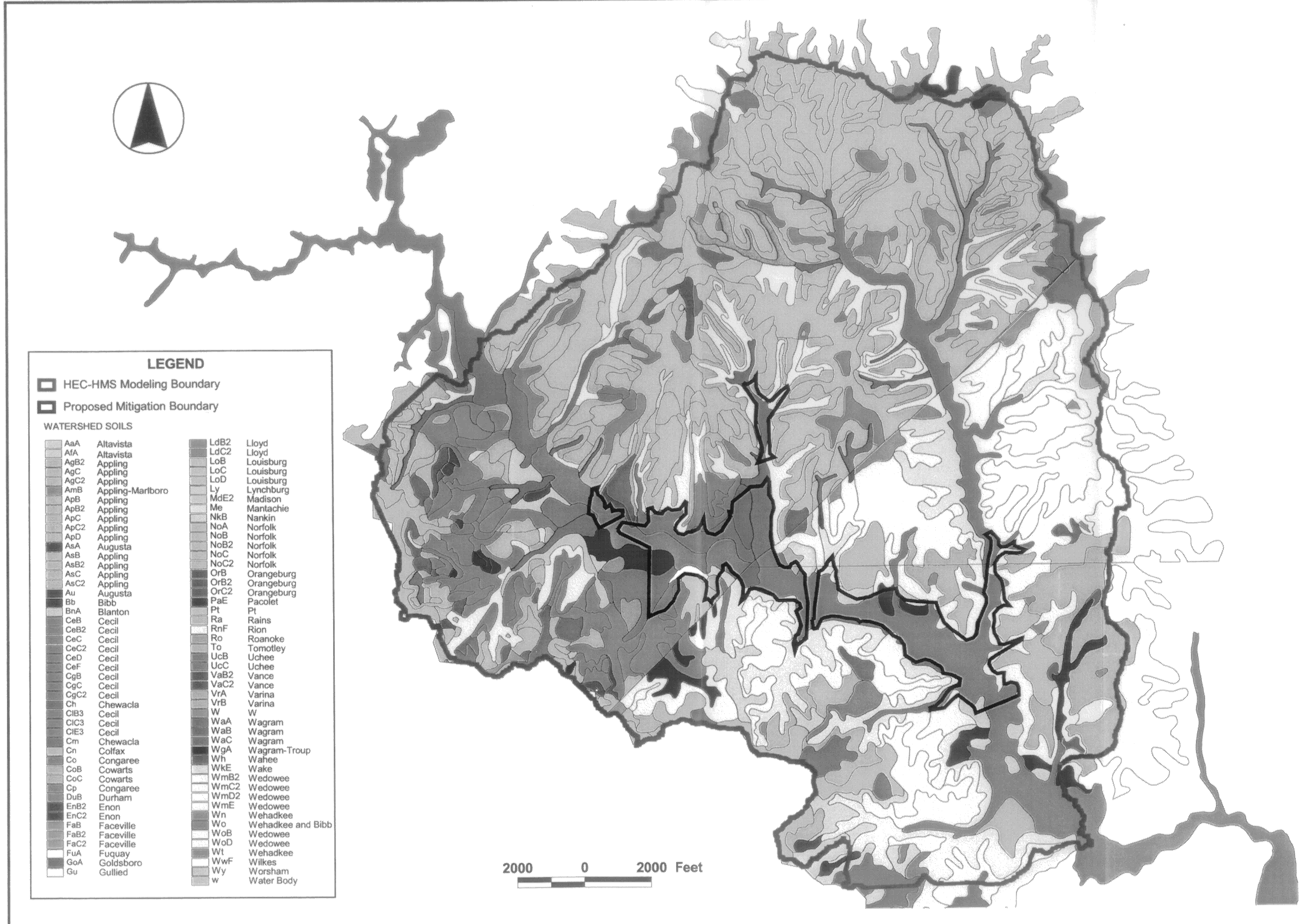
TITLE:

LAND USE FOR THREE MODELED SCENARIOS

Dwn By: MAF	Ckd By: JD
Date: SEPT 2004	Scale: AS SHOWN
ESC Project No.: 02-113.40	

FIGURE

3



EcoScience Corporation

CLIENT:

PROJECT:

HYDROLOGIC AND HYDRAULIC ANALYSIS

CLAYTON BYPASS (R-2552)

Johnston and Wake Counties, North Carolina

TITLE:

SOIL INFORMATION

Dwn By:	Ckd By:
MAF	JD
Date:	Scale:
SEPT 2004	AS SHOWN
ESC Project No.:	
02-113.40	

FIGURE

4

EcoScience Corporation

CLIENT:

PROJECT:

HYDROLOGIC AND HYDRAULIC ANALYSIS

CLAYTON BYPASS (R-2552)

Johnston and Wake Counties, North Carolina

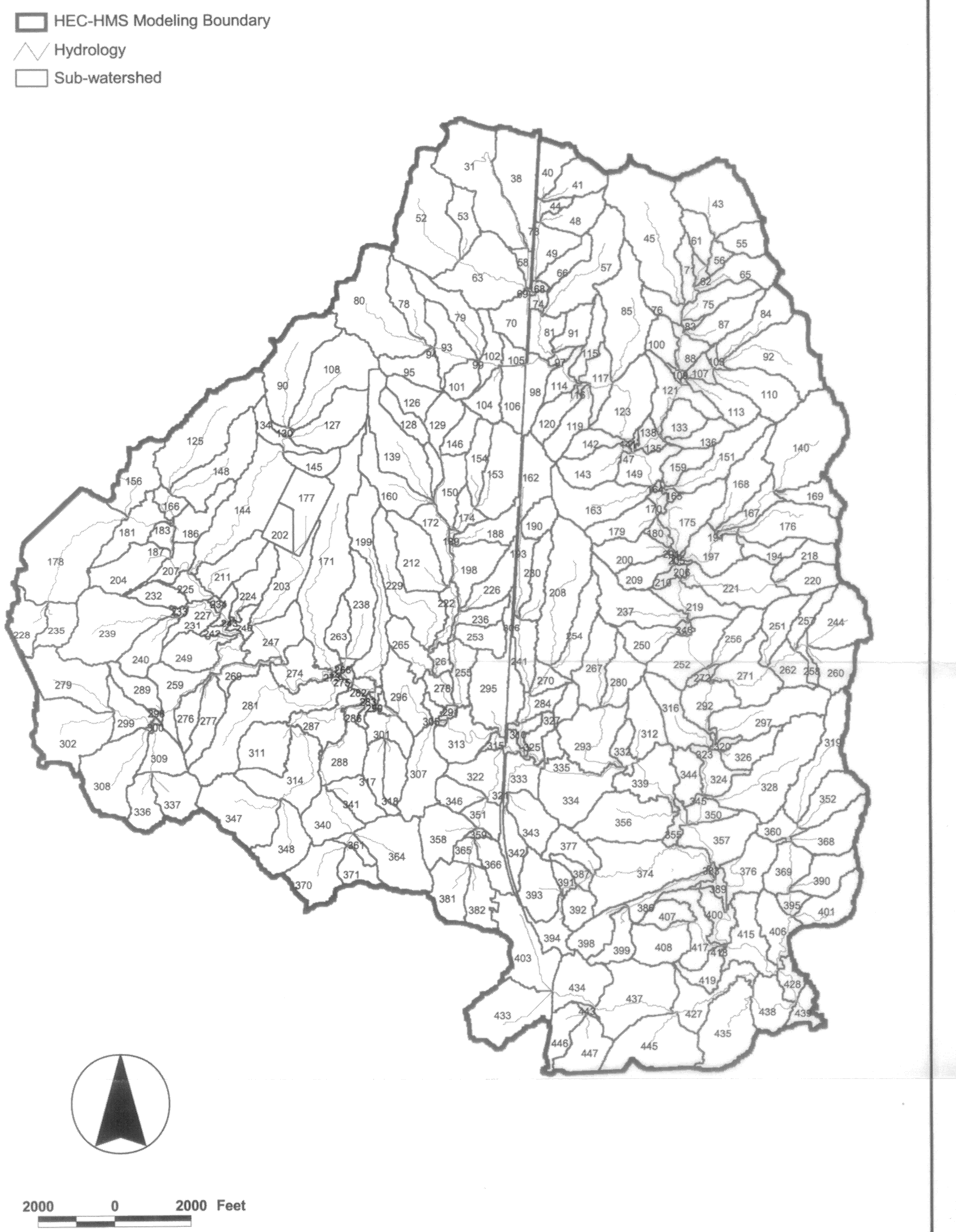
TITLE:

HEC/HMS SUB-WATERSHEDS AND STREAM NETWORK

Dwn By: MAF	Ckd By: JD
Date: SEPT 2004	Scale: AS SHOWN
ESC Project No.: 02-113.40	

FIGURE

5



EcoScience Corporation

CLIENT:

PROJECT:

SUB-WATERSHED LOCATION IDENTIFICATION
HYDROLOGIC AND HYDRAULIC ANALYSIS
CLAYTON BYPASS (R-2552)

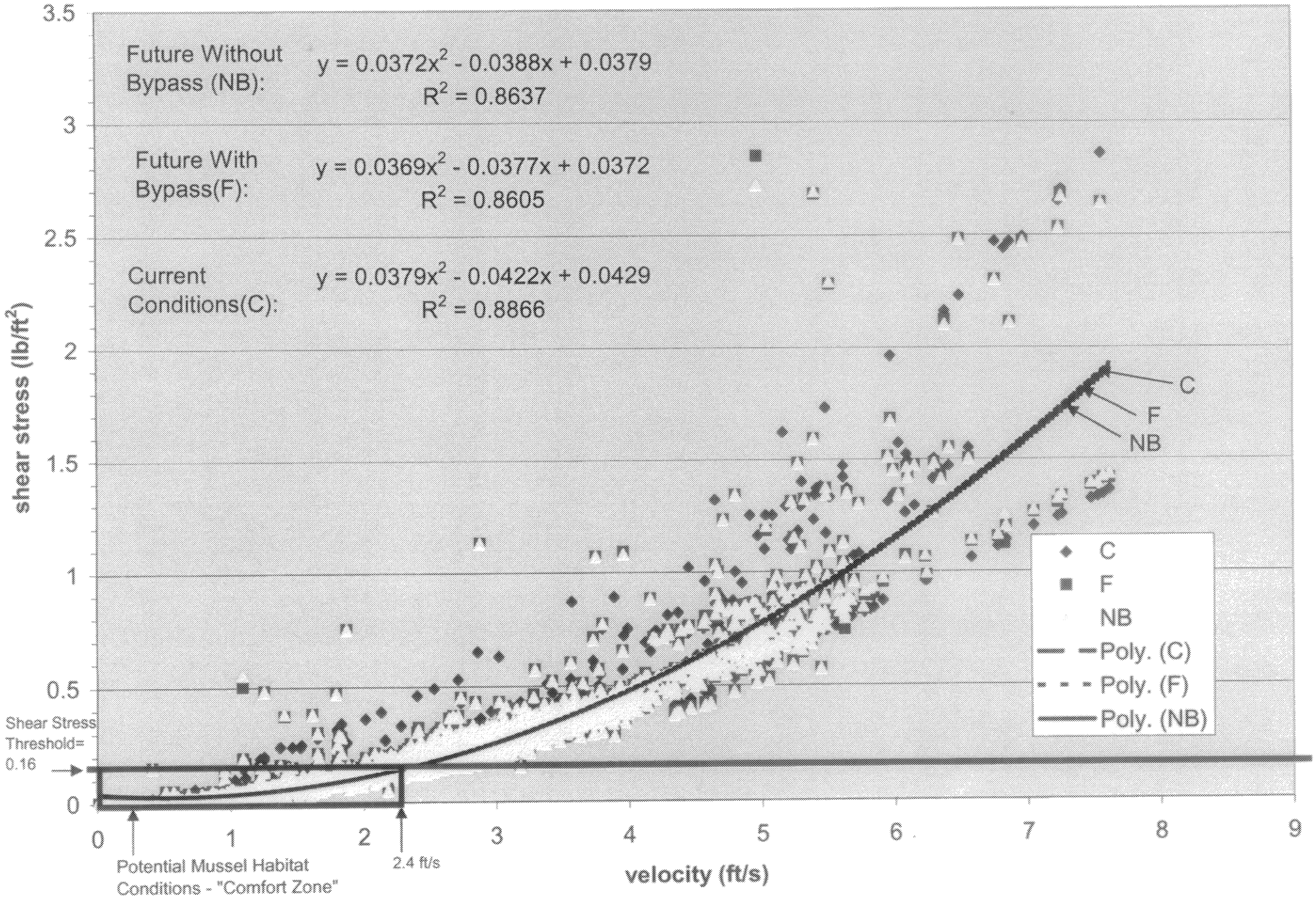
Johnston and Wake Counties,
North Carolina

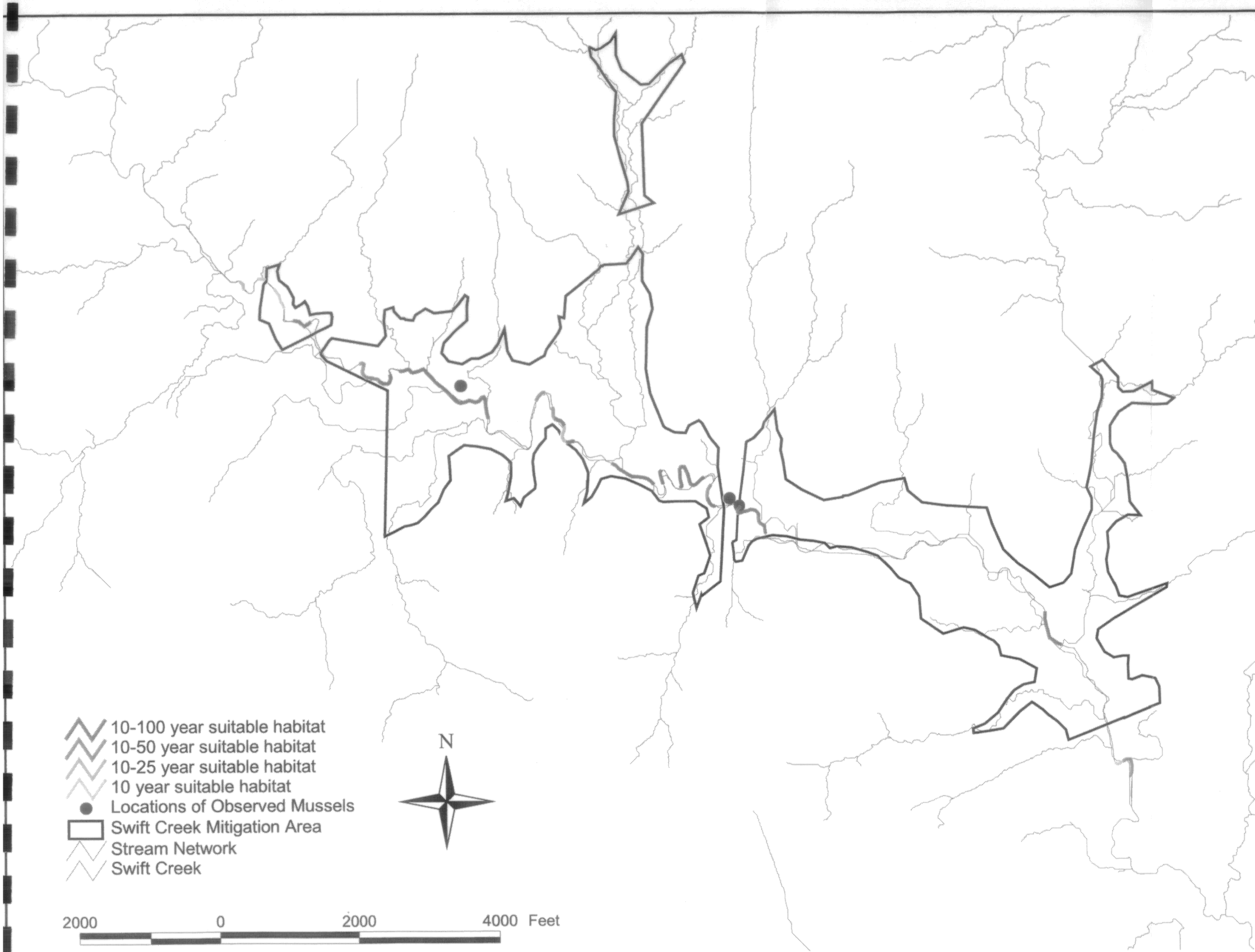
Dwn By:	Ckd By:
MAF	JD
Date:	Scale:
SEPT 2004	AS SHOWN
ESC Project No.:	
02-113.40	

FIGURE

6

Figure 7: Velocity Versus Channel Shear Stress





EcoScience Corporation

Client:

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

HYDROLOGIC AND HYDRAULIC ANALYSIS

Clayton Bypass (R-2552)

Johnston and Wake Counties, North Carolina

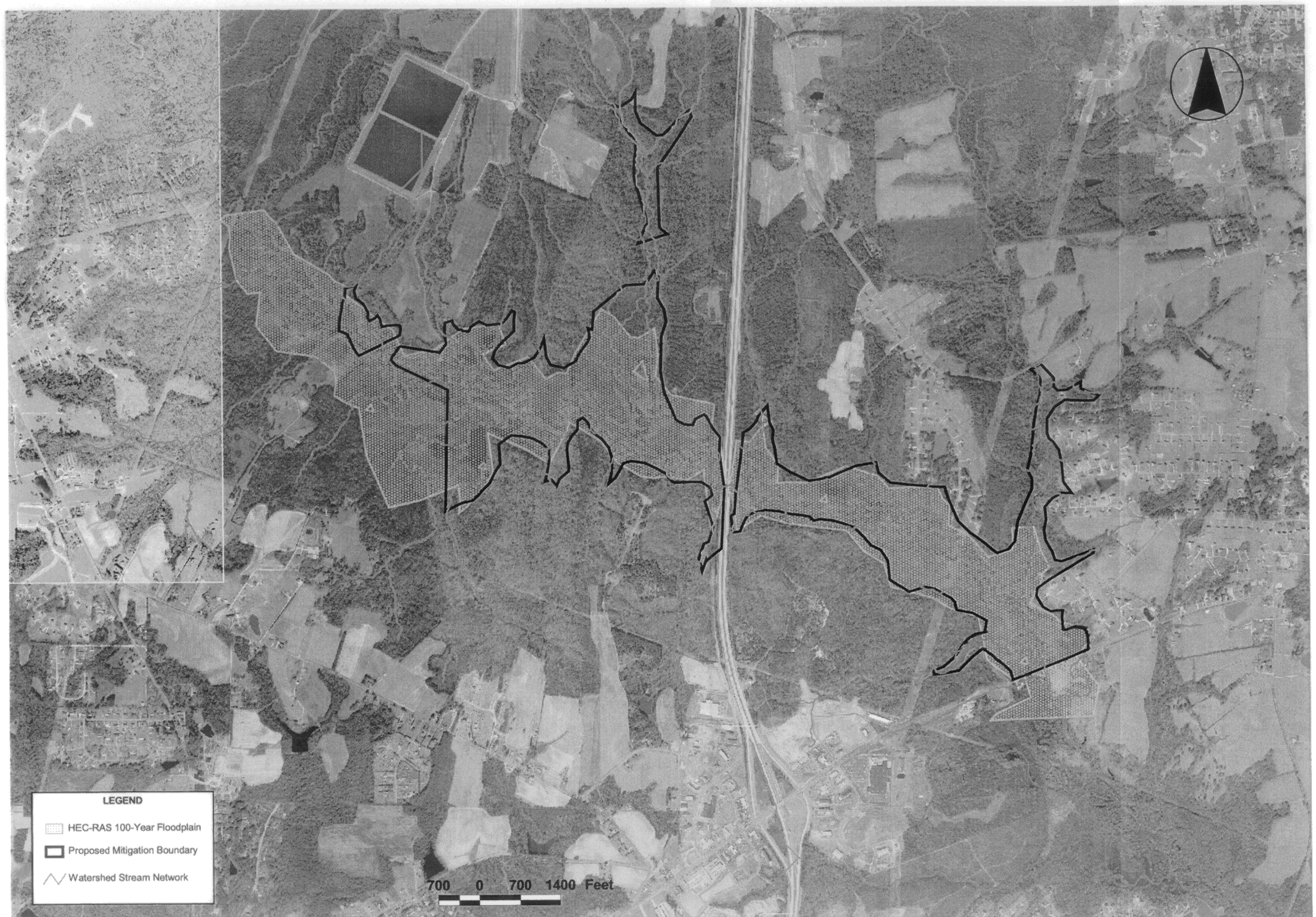
FIGURE

8

Drawn By: JCD	Date: Sep. 2004
Checked By: MTC	Scale: As Shown
ESC Project No.: 02-113.40	

Title:

Model-Indicated Areas for Possible Mussel Habitat



EcoScience Corporation

CLIENT:

PROJECT:

HYDROLOGIC AND HYDRAULIC ANALYSIS

CLAYTON BYPASS (R-2552)

Johnston and Wake Counties, North Carolina

TITLE:

HEC-RAS 100-YEAR FLOODPLAIN BOUNDARY

Dwn By:	Ckd By:
MAF	JD
Date:	Scale:
SEPT 2004	AS SHOWN
ESC Project No.:	
02-113.40	

FIGURE

9

EXISTING CONDITIONS

HMS * Summary of Results for Outlet

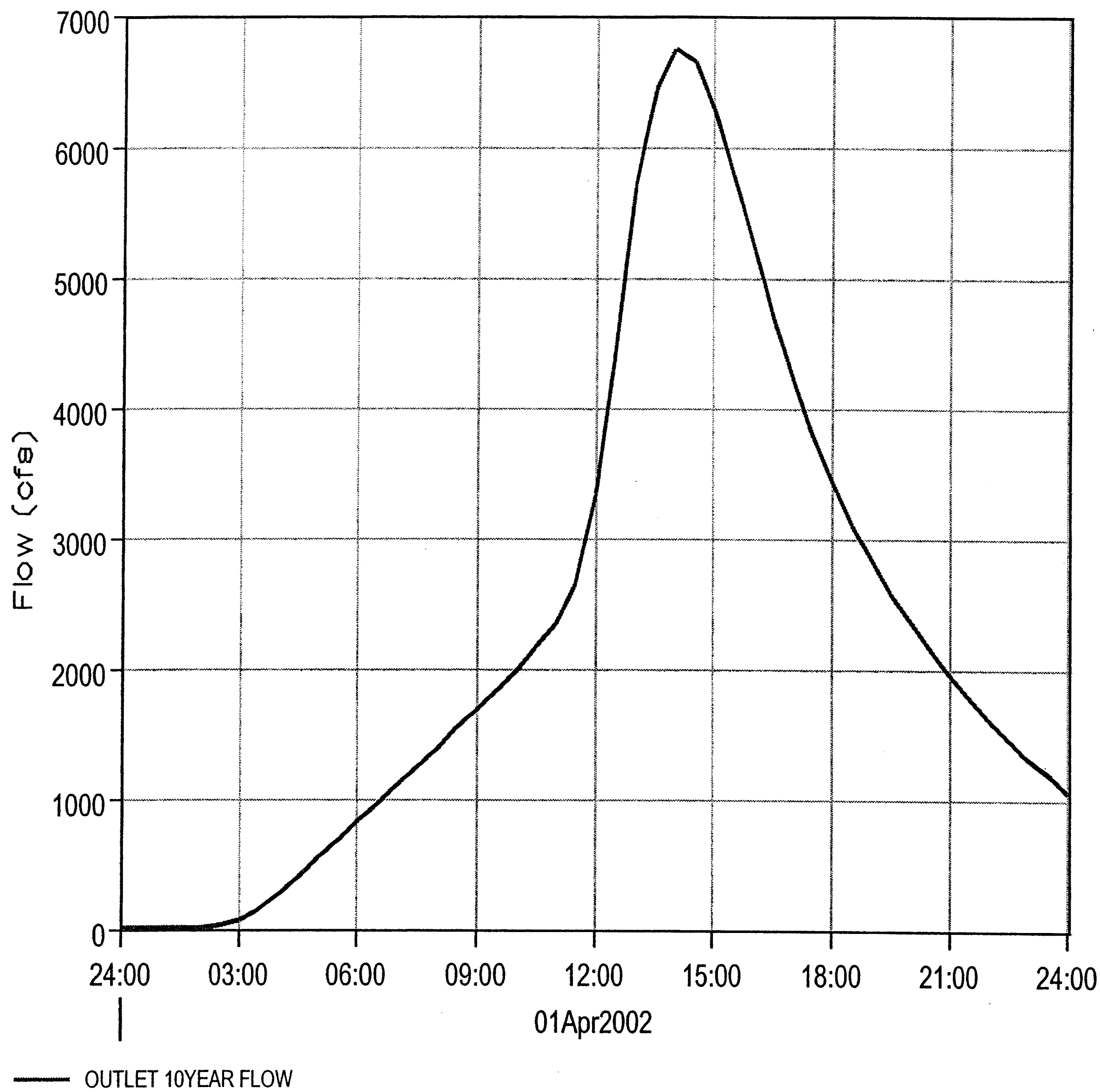
Project : swifttest   Run Name : 10year

Start of Run	: 01Apr02 0000	Basin Model	: swift10year
End of Run	: 01Apr02 2400	Met. Model	: Met 1
Execution Time	: 31Aug04 1334	Control Specs	: Control 1

Computed Results

Peak Outflow : 5749.7 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 4185.9 (ac-ft)



7000
6000
5000
4000
3000
2000
1000
0
Flow (cfs)
24:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 10YEAR FLOW

HMS * Summary of Results for Outlet

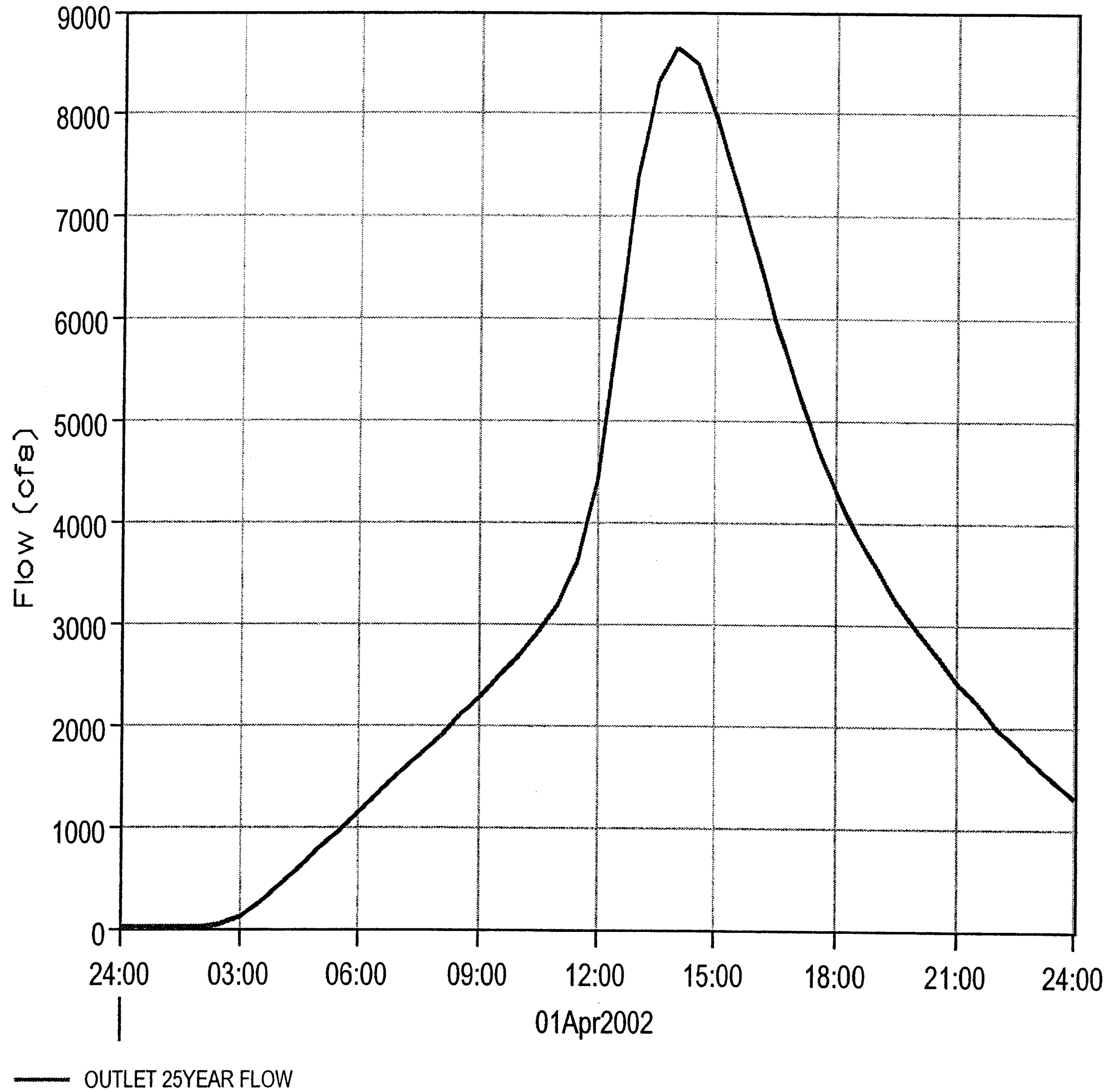
Project : swifttest   Run Name : 25year

Start of Run	: 01Apr02 0000	Basin Model	: swift25year
End of Run	: 01Apr02 2400	Met. Model	: Met 2
Execution Time	: 31Aug04 1337	Control Specs	: Control 1

Computed Results

Peak Outflow : 7625.0 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 5583.3 (ac-ft)



9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Flow (cfs)
24:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 25YEAR FLOW

HMS * Summary of Results for Outlet

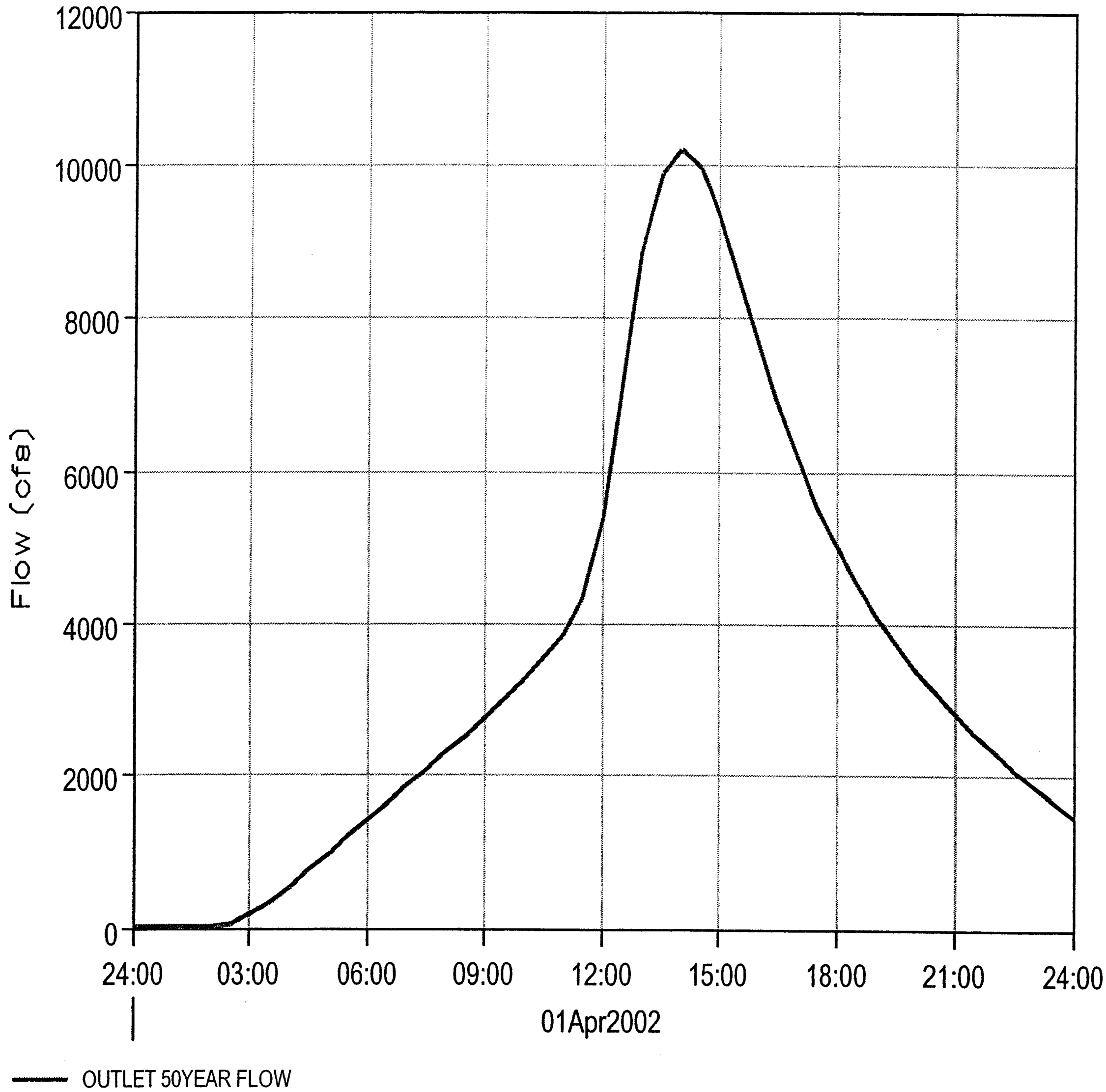
Project : swifttest   Run Name : 50year

Start of Run	: 01Apr02 0000	Basin Model	: swift50year
End of Run	: 01Apr02 2400	Met. Model	: Met 3
Execution Time	: 31Aug04 1339	Control Specs	: Control 1

Computed Results

Peak Outflow : 8913.4 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 6386.4 (ac-ft)



12000
10000
8000
6000
4000
2000
0
Flow (cfs)
24:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 50YEAR FLOW

HMS * Summary of Results for Outlet

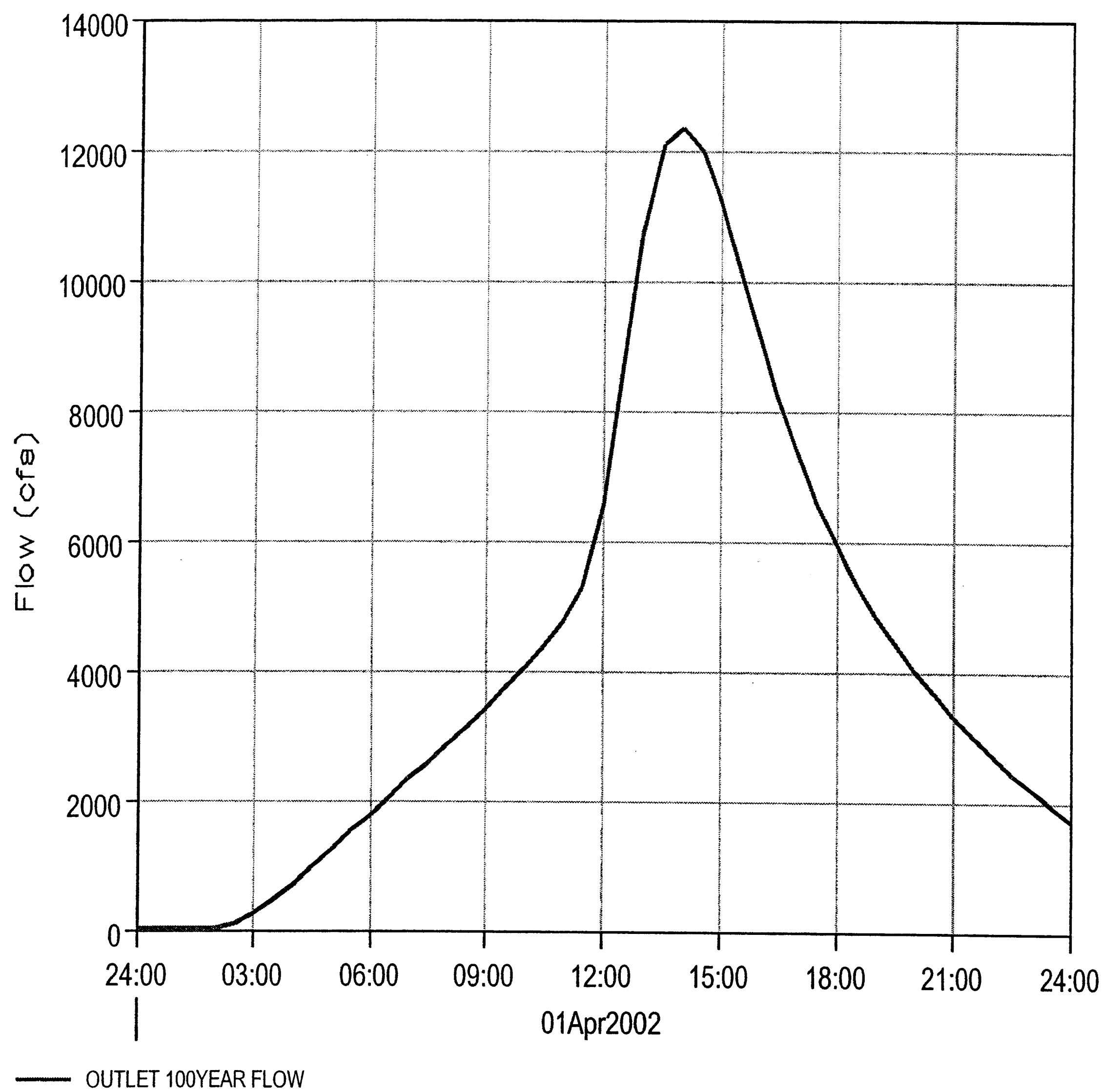
Project : swifttest   Run Name : 100year

Start of Run	: 01Apr02 0000	Basin Model	: swift100year
End of Run	: 01Apr02 2400	Met. Model	: Met 4
Execution Time	: 31Aug04 1341	Control Specs	: Control 1

Computed Results

Peak Outflow : 11541 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 8570.3 (ac-ft)



14000
12000
10000
8000
6000
4000
2000
0
Flow (cfs)
24:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 100YEAR FLOW

HMS * Summary of Results

Project : swifttest   Run Name : 10year

Start of Run : 01Apr02 0000   Basin Model : swift10year
End of Run : 01Apr02 2400   Met. Model : Met 1
Execution Time : 17Sep04 0853   Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R4330W4330	72.787	01 Apr 02 1330	24.063	0.095
R4030W4030	79.028	01 Apr 02 1300	24.003	0.088
JR4340	146.77	01 Apr 02 1300	48.067	0.183
R4340	146.19	01 Apr 02 1330	48.059	0.183
R4460W4460	34.064	01 Apr 02 1300	8.7508	0.035
R4470W4470	38.175	01 Apr 02 1300	9.8558	0.051
JR4430	72.239	01 Apr 02 1300	18.607	0.086
R4430	72.032	01 Apr 02 1300	18.610	0.086
R4340W4340	58.792	01 Apr 02 1300	15.349	0.060
R4430W4430	7.3976	01 Apr 02 1200	1.0313	0.004
JR4370	276.84	01 Apr 02 1300	83.050	0.333
R4370	267.93	01 Apr 02 1300	82.991	0.333
R4370W4370	88.256	01 Apr 02 1300	23.629	0.110
R4450W4450	29.108	01 Apr 02 1400	11.977	0.100
JR4270	374.01	01 Apr 02 1300	118.60	0.543
R4270	359.54	01 Apr 02 1330	118.36	0.543
R4270W4270	26.116	01 Apr 02 1330	8.4428	0.058
R4350W4350	25.629	01 Apr 02 1500	12.118	0.093
JR4380	402.49	01 Apr 02 1330	138.92	0.694
R4380	396.17	01 Apr 02 1330	138.44	0.694
R4080W4080	60.627	01 Apr 02 1230	12.689	0.053
R4070W4070	22.634	01 Apr 02 1230	5.3300	0.026
JR4170	83.260	01 Apr 02 1230	18.019	0.079
R4170	69.066	01 Apr 02 1230	17.859	0.079
R4170W4170	29.371	01 Apr 02 1300	8.4218	0.045
R4190W4190	14.311	01 Apr 02 1300	3.8020	0.025
JR4180	112.51	01 Apr 02 1300	30.083	0.149
R4180	112.45	01 Apr 02 1300	30.084	0.149
R3980W3980	48.946	01 Apr 02 1230	9.5362	0.037
R3990W3990	41.653	01 Apr 02 1230	8.0569	0.032
JR3860	90.600	01 Apr 02 1230	17.593	0.069
R3860	85.160	01 Apr 02 1230	17.606	0.069
R3930W3930	70.900	01 Apr 02 1230	13.620	0.054
R3940W3940	41.752	01 Apr 02 1200	8.1170	0.030
JR3910	110.54	01 Apr 02 1230	21.737	0.084
R3910	110.35	01 Apr 02 1230	21.752	0.084
R3910W3910	14.019	01 Apr 02 1230	2.7112	0.011
R3920W3920	34.112	01 Apr 02 1230	6.9481	0.027
JR3870	158.48	01 Apr 02 1230	31.412	0.122
R3870	157.57	01 Apr 02 1230	31.441	0.122
R3770W3770	44.048	01 Apr 02 1230	8.3702	0.034

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R3870W3870	19.433	01 Apr 02 1230	3.6927	0.015
JR3740	221.05	01 Apr 02 1230	43.504	0.171
R3740	207.51	01 Apr 02 1230	43.457	0.171
R3420W3420	34.672	01 Apr 02 1230	7.0092	0.026
R3430W3430	57.530	01 Apr 02 1230	11.811	0.047
JR3330	92.202	01 Apr 02 1230	18.820	0.073
R3330	88.081	01 Apr 02 1230	18.834	0.073
R3810W3810	39.232	01 Apr 02 1300	9.7539	0.049
R3820W3820	38.810	01 Apr 02 1300	9.9888	0.039
JR3650	78.043	01 Apr 02 1300	19.743	0.088
R3650	77.866	01 Apr 02 1300	19.746	0.088
R3650W3650	8.4061	01 Apr 02 1300	2.0714	0.014
R3660W3660	32.566	01 Apr 02 1230	7.8754	0.030
JR3590	116.65	01 Apr 02 1300	29.693	0.132
R3590	116.56	01 Apr 02 1300	29.699	0.132
R3580W3580	24.414	01 Apr 02 1330	7.6456	0.056
R3590W3590	4.4694	01 Apr 02 1230	0.84636	0.004
JR3510	142.61	01 Apr 02 1300	38.191	0.192
R3510	141.81	01 Apr 02 1300	38.196	0.192
R3460W3460	12.755	01 Apr 02 1300	3.7036	0.027
R3510W3510	26.303	01 Apr 02 1230	5.4697	0.024
JR3220	175.42	01 Apr 02 1300	47.369	0.243
R3220	173.51	01 Apr 02 1300	47.358	0.243
R3470W3470	20.758	01 Apr 02 1430	8.9031	0.095
R3480W3480	14.070	01 Apr 02 1400	5.7979	0.059
JR3140	34.598	01 Apr 02 1430	14.701	0.154
R3140	34.564	01 Apr 02 1430	14.572	0.154
R3110W3110	11.974	01 Apr 02 1430	5.5363	0.055
R3140W3140	27.471	01 Apr 02 1400	11.092	0.086
JR2870	73.542	01 Apr 02 1430	31.200	0.295
R2870	71.312	01 Apr 02 1430	30.726	0.295
R3700W3700	23.839	01 Apr 02 1330	8.2451	0.063
R3710W3710	7.3515	01 Apr 02 1400	2.7972	0.026
JR3610	30.784	01 Apr 02 1330	11.042	0.089
R3610	30.613	01 Apr 02 1330	11.039	0.089
R3610W3610	4.3300	01 Apr 02 1330	1.4631	0.012
R3640W3640	21.362	01 Apr 02 1430	9.3496	0.096
JR3400	54.861	01 Apr 02 1400	21.852	0.197
R3400	54.455	01 Apr 02 1400	21.813	0.197
R3400W3400	13.225	01 Apr 02 1400	5.0379	0.053
R3410W3410	9.3892	01 Apr 02 1400	3.5252	0.037
JR2880	77.069	01 Apr 02 1400	30.376	0.287
R2880	74.991	01 Apr 02 1400	30.140	0.287
R2870W2870	23.210	01 Apr 02 1300	5.9197	0.046
R2880W2880	16.533	01 Apr 02 1330	5.5192	0.055
JR2860	165.84	01 Apr 02 1430	72.305	0.683
R2860	165.73	01 Apr 02 1430	72.211	0.683
R2760W2760	7.6716	01 Apr 02 1430	3.3256	0.028
R2770W2770	11.787	01 Apr 02 1400	4.6768	0.042
JR2690	19.063	01 Apr 02 1400	8.0024	0.070
R2690	19.044	01 Apr 02 1430	7.9483	0.070

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2390W2390	28.951	01 Apr 02 1500	14.650	0.127
R2400W2400	10.371	01 Apr 02 1430	4.3925	0.043
JR2330	38.494	01 Apr 02 1500	19.042	0.170
R2330	38.441	01 Apr 02 1500	19.028	0.170
R2320W2320	12.159	01 Apr 02 1330	3.7740	0.025
R2330W2330	2.0281	01 Apr 02 1230	0.45985	0.003
JR2310	45.293	01 Apr 02 1430	23.261	0.198
R2310	44.960	01 Apr 02 1430	23.172	0.198
R2280W2280	12.803	01 Apr 02 1400	5.0479	0.042
R2350W2350	13.173	01 Apr 02 1330	4.7326	0.035
JR1780	25.903	01 Apr 02 1400	9.7805	0.077
R1780	25.454	01 Apr 02 1400	9.7248	0.077
Source	2735.0	01 Apr 02 1130	2656.2	75.000
R1560	2671.1	01 Apr 02 1130	2631.2	75.000
R1780W1780	44.078	01 Apr 02 1530	22.317	0.180
R1560W1560	20.518	01 Apr 02 1330	7.0735	0.056
JR1810	2672.6	01 Apr 02 1130	2670.4	75.313
R1810	2639.8	01 Apr 02 1130	2662.3	75.313
R1250W1250	54.829	01 Apr 02 1330	18.073	0.133
R1480W1480	31.908	01 Apr 02 1330	10.748	0.082
JR1660	86.737	01 Apr 02 1330	28.821	0.215
R1660	85.075	01 Apr 02 1330	28.787	0.215
R1810W1810	18.865	01 Apr 02 1400	7.0953	0.051
R1660W1660	5.5540	01 Apr 02 1330	1.7513	0.016
JR1830	2643.1	01 Apr 02 1130	2699.9	75.595
R1830	2642.4	01 Apr 02 1130	2699.3	75.595
R1830W1830	0.11854	01 Apr 02 1230	0.026653	0.000
R1860W1860	20.354	01 Apr 02 1230	5.0372	0.039
JR1870	2643.4	01 Apr 02 1130	2704.4	75.634
R1870	2633.4	01 Apr 02 1130	2703.0	75.634
R2040W2040	17.742	01 Apr 02 1430	8.0208	0.061
R1870W1870	6.3665	01 Apr 02 1400	2.2982	0.014
JR2070	2634.2	01 Apr 02 1130	2713.3	75.709
R2070	2626.6	01 Apr 02 1130	2712.7	75.709
R900W900	41.951	01 Apr 02 1330	13.576	0.107
R1080W1080	27.176	01 Apr 02 1330	9.7534	0.102
JR1300	69.128	01 Apr 02 1330	23.329	0.209
R1300	68.774	01 Apr 02 1330	23.323	0.209
R1300W1300	1.9175	01 Apr 02 1230	0.46251	0.004
R1270W1270	18.918	01 Apr 02 1300	5.2915	0.072
JR1340	84.194	01 Apr 02 1330	29.077	0.285
R1340	83.983	01 Apr 02 1330	29.067	0.285
R1340W1340	10.701	01 Apr 02 1300	2.7667	0.025
R1450W1450	5.8040	01 Apr 02 1300	1.7085	0.026
JR1440	96.711	01 Apr 02 1330	33.542	0.336
R1440	95.919	01 Apr 02 1330	33.223	0.336
R2070W2070	12.214	01 Apr 02 1330	3.9127	0.026
R1440W1440	31.244	01 Apr 02 1430	13.396	0.137
JR2250	2647.4	01 Apr 02 1300	2763.2	76.208
R2250	2624.5	01 Apr 02 1300	2744.5	76.208
R2250W2250	8.0642	01 Apr 02 1300	2.3832	0.018

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2110W2110	8.5841	01 Apr 02 1430	3.8962	0.053
JR2270	2636.9	01 Apr 02 1300	2750.8	76.279
R2270	2630.9	01 Apr 02 1300	2747.9	76.279
R2310W2310	8.2186	01 Apr 02 1330	2.7856	0.029
R2270W2270	1.3244	01 Apr 02 1300	0.38843	0.004
JR2340	2665.5	01 Apr 02 1300	2774.3	76.510
R2340	2661.0	01 Apr 02 1300	2771.9	76.510
R2790W2790	18.039	01 Apr 02 1430	8.0882	0.087
R3020W3020	30.394	01 Apr 02 1430	13.154	0.103
JR2990	48.433	01 Apr 02 1430	21.242	0.190
R2990	48.087	01 Apr 02 1430	21.202	0.190
R3360W3360	15.369	01 Apr 02 1330	5.2866	0.039
R3370W3370	15.646	01 Apr 02 1400	5.7775	0.046
JR3090	30.523	01 Apr 02 1330	11.064	0.085
R3090	30.451	01 Apr 02 1400	11.050	0.085
R3080W3080	33.158	01 Apr 02 1400	12.351	0.095
R3090W3090	14.111	01 Apr 02 1330	4.9681	0.038
JR3000	77.426	01 Apr 02 1400	28.370	0.218
R3000	77.375	01 Apr 02 1400	28.362	0.218
R2990W2990	7.3519	01 Apr 02 1430	3.2172	0.036
R3000W3000	0.36474	01 Apr 02 1300	0.10156	0.001
JR2980	129.31	01 Apr 02 1400	52.883	0.445
R2980	129.04	01 Apr 02 1400	52.868	0.445
R2890W2890	5.6835	01 Apr 02 1430	2.4544	0.030
R2980W2980	0.61489	01 Apr 02 1300	0.17027	0.002
JR2590	135.07	01 Apr 02 1400	55.493	0.477
R2590	132.40	01 Apr 02 1430	55.147	0.477
R2490W2490	19.674	01 Apr 02 1330	6.6488	0.049
R2590W2590	15.457	01 Apr 02 1400	5.8413	0.067
JR2420	164.33	01 Apr 02 1400	67.637	0.593
R2420	161.45	01 Apr 02 1400	67.453	0.593
R2420W2420	2.9843	01 Apr 02 1300	0.80406	0.009
R2340W2340	3.0058	01 Apr 02 1300	0.93088	0.011
JR2430	2783.9	01 Apr 02 1330	2841.1	77.123
R2430	2782.9	01 Apr 02 1330	2840.7	77.123
R2430W2430	0.24791	01 Apr 02 1230	0.069873	0.001
R2240W2240	9.4229	01 Apr 02 1330	3.3472	0.042
JR2460	2792.5	01 Apr 02 1330	2844.1	77.166
R2460	2788.3	01 Apr 02 1330	2839.0	77.166
R2020W2020	6.1591	01 Apr 02 1300	2.0244	0.025
R1770W1770	9.6209	01 Apr 02 1400	4.1576	0.059
JR2030	13.882	01 Apr 02 1330	6.1820	0.084
R2030	13.770	01 Apr 02 1400	6.1472	0.084
R2460W2460	2.8381	01 Apr 02 1400	1.1251	0.013
R2030W2030	14.663	01 Apr 02 1330	5.1084	0.061
JR2470	2818.9	01 Apr 02 1330	2851.4	77.324
R2470	2804.4	01 Apr 02 1330	2845.0	77.324
R2690W2690	7.3301	01 Apr 02 1400	2.6963	0.020
R2470W2470	4.3399	01 Apr 02 1430	2.2488	0.058
JR2740	2829.2	01 Apr 02 1330	2857.9	77.472
R2740	2815.1	01 Apr 02 1330	2853.0	77.472

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2740W2740	5.9296	01 Apr 02 1400	2.4397	0.043
R1710W1710	40.071	01 Apr 02 1400	15.238	0.175
JR2730	2860.3	01 Apr 02 1330	2870.6	77.690
R2730	2858.7	01 Apr 02 1330	2870.1	77.690
R2630W2630	4.8739	01 Apr 02 1330	1.8619	0.026
R2380W2380	12.835	01 Apr 02 1300	4.0760	0.059
JR2660	16.820	01 Apr 02 1330	5.9380	0.085
R2660	16.813	01 Apr 02 1330	5.9323	0.085
R2730W2730	1.5043	01 Apr 02 1230	0.33662	0.002
R2660W2660	1.5444	01 Apr 02 1230	0.39249	0.004
JR2750	2877.4	01 Apr 02 1330	2876.8	77.781
R2750	2873.5	01 Apr 02 1330	2875.3	77.781
R2810W2810	35.846	01 Apr 02 1430	15.274	0.156
R2750W2750	2.7511	01 Apr 02 1230	0.59430	0.004
JR2820	2905.4	01 Apr 02 1330	2891.2	77.941
R2820	2901.2	01 Apr 02 1330	2889.8	77.941
R2820W2820	2.7771	01 Apr 02 1230	0.68639	0.008
R1990W1990	16.855	01 Apr 02 1430	7.3874	0.095
JR2830	2917.0	01 Apr 02 1330	2897.9	78.044
R2830	2906.3	01 Apr 02 1330	2890.2	78.044
R2860W2860	3.7621	01 Apr 02 1230	0.81172	0.007
R2830W2830	2.6212	01 Apr 02 1230	0.50677	0.003
JR2900	3056.7	01 Apr 02 1400	2963.7	78.737
R2900	3053.0	01 Apr 02 1400	2961.3	78.737
R3170W3170	6.4772	01 Apr 02 1400	2.7001	0.030
R3180W3180	4.9279	01 Apr 02 1430	2.2396	0.029
JR3010	11.307	01 Apr 02 1430	4.9397	0.059
R3010	11.282	01 Apr 02 1430	4.9279	0.059
R2900W2900	3.3140	01 Apr 02 1230	0.74223	0.005
R3010W3010	6.7170	01 Apr 02 1430	2.8727	0.032
JR2960	3071.8	01 Apr 02 1400	2969.9	78.833
R2960	3053.4	01 Apr 02 1400	2960.7	78.833
R2960W2960	14.124	01 Apr 02 1430	5.9792	0.061
R3070W3070	18.671	01 Apr 02 1400	7.4563	0.067
JR3050	3086.1	01 Apr 02 1400	2974.2	78.961
R3050	3082.6	01 Apr 02 1400	2972.8	78.961
R1600W1600	19.307	01 Apr 02 1330	6.6853	0.057
R1390W1390	18.797	01 Apr 02 1330	6.9132	0.087
JR1720	38.104	01 Apr 02 1330	13.598	0.144
R1720	37.170	01 Apr 02 1400	13.535	0.144
R2120W2120	15.835	01 Apr 02 1330	5.9322	0.068
R1720W1720	14.170	01 Apr 02 1400	5.2862	0.049
JR2220	67.083	01 Apr 02 1400	24.753	0.261
R2220	66.678	01 Apr 02 1400	24.631	0.261
R2290W2290	15.887	01 Apr 02 1430	7.0816	0.096
R2220W2220	6.8462	01 Apr 02 1400	2.5950	0.020
JR2610	88.974	01 Apr 02 1400	34.308	0.377
R2610	87.896	01 Apr 02 1400	34.244	0.377
R2650W2650	8.0855	01 Apr 02 1400	3.2941	0.040
R2610W2610	7.3588	01 Apr 02 1300	1.9762	0.013
JR2780	100.56	01 Apr 02 1400	39.514	0.430

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2780	97.793	01 Apr 02 1400	39.266	0.430
R1280W1280	7.4856	01 Apr 02 1300	2.1251	0.025
R1260W1260	8.6362	01 Apr 02 1330	2.8243	0.032
JR1290	15.722	01 Apr 02 1300	4.9494	0.057
R1290	15.063	01 Apr 02 1300	4.9438	0.057
R1290W1290	9.4911	01 Apr 02 1400	3.5267	0.034
R1460W1460	7.6165	01 Apr 02 1400	2.9056	0.025
JR1500	31.574	01 Apr 02 1330	11.376	0.116
R1500	30.688	01 Apr 02 1330	11.338	0.116
R1540W1540	11.929	01 Apr 02 1330	4.1391	0.034
R1530W1530	20.486	01 Apr 02 1400	8.1287	0.073
JR1740	31.988	01 Apr 02 1400	12.268	0.107
R1740	31.813	01 Apr 02 1400	12.253	0.107
R1500W1500	7.4067	01 Apr 02 1430	3.2464	0.038
R1740W1740	3.8427	01 Apr 02 1400	1.5653	0.019
JR1890	72.751	01 Apr 02 1400	28.403	0.280
R1890	72.531	01 Apr 02 1400	28.377	0.280
R1890W1890	0.32408	01 Apr 02 1400	0.14086	0.002
R1880W1880	14.565	01 Apr 02 1330	5.1431	0.038
JR1980	87.164	01 Apr 02 1400	33.661	0.320
R1980	86.342	01 Apr 02 1400	33.554	0.320
R1980W1980	11.361	01 Apr 02 1400	4.5788	0.053
R2260W2260	9.6140	01 Apr 02 1400	3.8442	0.039
JR2360	107.32	01 Apr 02 1400	41.977	0.412
R2360	106.37	01 Apr 02 1400	41.921	0.412
R2360W2360	4.7345	01 Apr 02 1400	1.8890	0.024
R2530W2530	6.0461	01 Apr 02 1400	2.4647	0.033
JR2550	117.15	01 Apr 02 1400	46.274	0.469
R2550	114.05	01 Apr 02 1400	46.069	0.469
R2780W2780	9.0736	01 Apr 02 1330	3.0030	0.020
R2550W2550	11.228	01 Apr 02 1400	4.2942	0.032
JR2910	231.54	01 Apr 02 1400	92.632	0.951
R2910	225.92	01 Apr 02 1430	92.246	0.951
R3050W3050	3.3382	01 Apr 02 1400	1.2307	0.008
R2910W2910	1.7183	01 Apr 02 1400	0.63484	0.004
JR3130	3313.3	01 Apr 02 1400	3066.9	79.924
R3130	3266.0	01 Apr 02 1400	3048.9	79.924
R3130W3130	19.862	01 Apr 02 1400	7.6076	0.053
R2950W2950	22.920	01 Apr 02 1400	9.4419	0.076
JR3150	3308.8	01 Apr 02 1400	3065.9	80.053
R3150	3292.2	01 Apr 02 1400	3059.3	80.053
R3150W3150	3.9217	01 Apr 02 1330	1.2456	0.006
R3220W3220	29.949	01 Apr 02 1330	9.4999	0.047
JR3210	3425.1	01 Apr 02 1400	3117.4	80.349
R3210	3405.9	01 Apr 02 1400	3112.4	80.349
R1620W1620	21.889	01 Apr 02 1330	7.5037	0.047
R1900W1900	9.7851	01 Apr 02 1330	3.5155	0.026
JR1930	31.674	01 Apr 02 1330	11.019	0.073
R1930	31.048	01 Apr 02 1400	10.985	0.073
R1930W1930	12.141	01 Apr 02 1330	4.0664	0.028
R2300W2300	8.7145	01 Apr 02 1400	3.5865	0.035

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
JR2410	51.211	01 Apr 02 1400	18.638	0.136
R2410	50.988	01 Apr 02 1400	18.597	0.136
R2080W2080	40.478	01 Apr 02 1430	16.790	0.126
R2540W2540	19.503	01 Apr 02 1330	6.4582	0.051
JR2700	58.453	01 Apr 02 1400	23.248	0.177
R2700	58.115	01 Apr 02 1400	23.224	0.177
R2410W2410	11.863	01 Apr 02 1400	4.5364	0.035
R2700W2700	8.0974	01 Apr 02 1300	2.2611	0.019
JR2840	126.27	01 Apr 02 1400	48.619	0.367
R2840	125.62	01 Apr 02 1400	48.569	0.367
R3060W3060	22.776	01 Apr 02 1300	6.7016	0.029
R2840W2840	8.3874	01 Apr 02 1330	2.6053	0.022
JR3100	148.74	01 Apr 02 1400	57.876	0.418
R3100	141.71	01 Apr 02 1400	57.111	0.418
R3210W3210	20.126	01 Apr 02 1230	4.6211	0.018
R3100W3100	7.4572	01 Apr 02 1300	2.0618	0.012
JR3250	3559.6	01 Apr 02 1400	3176.2	80.797
R3250	3550.3	01 Apr 02 1400	3172.1	80.797
R3330W3330	42.374	01 Apr 02 1200	7.7069	0.032
R3250W3250	7.8255	01 Apr 02 1400	2.9185	0.019
JR3350	3590.5	01 Apr 02 1400	3201.6	80.921
R3350	3590.1	01 Apr 02 1400	3201.5	80.921
R3350W3350	0.17283	01 Apr 02 1230	0.033201	0.000
R3270W3270	12.386	01 Apr 02 1330	3.9520	0.029
JR3340	3601.1	01 Apr 02 1400	3205.5	80.951
R3340	3578.0	01 Apr 02 1400	3194.1	80.951
R2670W2670	25.056	01 Apr 02 1300	7.6571	0.060
R2800W2800	18.029	01 Apr 02 1400	6.6182	0.043
JR2930	42.402	01 Apr 02 1330	14.275	0.103
R2930	41.007	01 Apr 02 1330	14.191	0.103
R3340W3340	59.311	01 Apr 02 1330	18.961	0.089
R2930W2930	26.861	01 Apr 02 1430	11.163	0.081
JR3320	3696.6	01 Apr 02 1400	3238.4	81.224
R3320	3688.9	01 Apr 02 1400	3236.0	81.224
R3320W3320	11.233	01 Apr 02 1300	3.1338	0.020
R3120W3120	21.743	01 Apr 02 1400	8.6342	0.050
JR3390	3718.2	01 Apr 02 1400	3247.7	81.294
R3390	3706.8	01 Apr 02 1400	3241.4	81.294
R3560W3560	71.120	01 Apr 02 1300	19.542	0.096
R3390W3390	25.140	01 Apr 02 1400	9.0976	0.059
JR3550	3777.6	01 Apr 02 1400	3270.1	81.449
R3550	3760.2	01 Apr 02 1400	3263.4	81.449
R800W800	45.057	01 Apr 02 1400	17.470	0.135
R950W950	14.182	01 Apr 02 1400	5.2920	0.038
JR940	59.239	01 Apr 02 1400	22.762	0.173
R940	59.235	01 Apr 02 1400	22.761	0.173
R780W780	19.068	01 Apr 02 1330	6.4227	0.049
R940W940	0.034550	01 Apr 02 1400	0.012988	0.000
JR930	77.268	01 Apr 02 1400	29.197	0.222
R930	76.815	01 Apr 02 1400	29.158	0.222
R930W930	23.798	01 Apr 02 1300	6.9682	0.046

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R810W810	12.004	01 Apr 02 1400	4.4653	0.031
R910W910	7.4077	01 Apr 02 1400	3.0909	0.029
JR970	282.80	01 Apr 02 1400	118.71	0.911
R970	281.83	01 Apr 02 1400	118.56	0.911
R980W980	17.350	01 Apr 02 1400	6.2730	0.036
R970W970	1.5455	01 Apr 02 1400	0.60654	0.007
JR1140	454.59	01 Apr 02 1400	184.39	1.404
R1140	453.44	01 Apr 02 1400	184.19	1.404
R1140W1140	8.2600	01 Apr 02 1400	3.0011	0.023
R1150W1150	10.818	01 Apr 02 1330	3.4327	0.028
JR1180	471.03	01 Apr 02 1400	190.62	1.455
R1180	470.50	01 Apr 02 1400	190.57	1.455
R1200W1200	13.742	01 Apr 02 1330	4.3730	0.030
R1180W1180	0.028254	01 Apr 02 1300	0.0090654	0.000
JR1160	482.75	01 Apr 02 1400	194.95	1.485
R1160	480.01	01 Apr 02 1400	194.64	1.485
R1190W1190	11.819	01 Apr 02 1400	4.7722	0.037
R1160W1160	0.45407	01 Apr 02 1400	0.17396	0.002
JR1170	492.29	01 Apr 02 1400	199.59	1.524
R1170	491.19	01 Apr 02 1400	199.46	1.524
R1170W1170	6.7790	01 Apr 02 1430	3.0639	0.033
R850W850	31.121	01 Apr 02 1430	14.069	0.107
JR1230	526.12	01 Apr 02 1400	216.59	1.664
R1230	519.79	01 Apr 02 1400	215.91	1.664
R1420W1420	9.5277	01 Apr 02 1330	3.1749	0.027
R1230W1230	20.240	01 Apr 02 1400	8.3236	0.078
JR1410	548.88	01 Apr 02 1400	227.41	1.769
R1410	547.15	01 Apr 02 1400	227.28	1.769
R430W430	25.480	01 Apr 02 1430	10.829	0.098
R550W550	8.7497	01 Apr 02 1400	3.4539	0.031
JR560	33.883	01 Apr 02 1430	14.283	0.129
R560	33.857	01 Apr 02 1430	14.265	0.129
R610W610	7.3010	01 Apr 02 1430	3.2010	0.027
R560W560	5.9218	01 Apr 02 1330	1.8655	0.012
JR620	45.221	01 Apr 02 1400	19.332	0.168
R620	45.076	01 Apr 02 1430	19.316	0.168
R620W620	1.8740	01 Apr 02 1300	0.58341	0.008
R650W650	19.948	01 Apr 02 1300	5.8285	0.044
JR710	60.646	01 Apr 02 1400	25.728	0.220
R710	60.605	01 Apr 02 1400	25.715	0.220
R450W450	33.437	01 Apr 02 1530	17.100	0.167
R710W710	4.2045	01 Apr 02 1400	1.7304	0.022
JR760	91.732	01 Apr 02 1430	44.545	0.409
R760	91.675	01 Apr 02 1430	44.516	0.409
R760W760	7.3979	01 Apr 02 1400	2.7825	0.020
R750W750	11.292	01 Apr 02 1330	4.0941	0.035
JR830	108.65	01 Apr 02 1400	51.392	0.464
R830	108.33	01 Apr 02 1400	51.366	0.464
R830W830	1.3394	01 Apr 02 1330	0.45231	0.004
R870W870	11.453	01 Apr 02 1400	4.7137	0.046
JR880	121.04	01 Apr 02 1400	56.532	0.514

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R880	120.60	01 Apr 02 1430	56.419	0.514
R1000W1000	8.2389	01 Apr 02 1430	3.4650	0.027
R880W880	5.7791	01 Apr 02 1400	2.1846	0.022
JR1090	134.06	01 Apr 02 1430	62.068	0.563
R1090	134.03	01 Apr 02 1430	62.029	0.563
R840W840	10.991	01 Apr 02 1400	4.1796	0.048
R920W920	18.890	01 Apr 02 1430	8.3803	0.103
JR1030	29.181	01 Apr 02 1400	12.560	0.151
R1030	29.070	01 Apr 02 1400	12.553	0.151
R1030W1030	1.4852	01 Apr 02 1300	0.41854	0.006
R1100W1100	13.985	01 Apr 02 1430	5.9979	0.064
JR1070	43.641	01 Apr 02 1400	18.970	0.221
R1070	43.180	01 Apr 02 1430	18.940	0.221
R1070W1070	2.8274	01 Apr 02 1300	0.89800	0.013
R1130W1130	7.9530	01 Apr 02 1330	2.9470	0.039
JR1120	52.858	01 Apr 02 1400	22.785	0.273
R1120	52.743	01 Apr 02 1400	22.778	0.273
R1090W1090	1.0249	01 Apr 02 1330	0.32787	0.003
R1120W1120	0.22259	01 Apr 02 1300	0.069160	0.001
JR1210	186.53	01 Apr 02 1400	85.203	0.840
R1210	186.02	01 Apr 02 1430	84.961	0.840
R1210W1210	7.6091	01 Apr 02 1500	3.8721	0.049
R1330W1330	11.785	01 Apr 02 1300	3.0611	0.030
JR1350	197.72	01 Apr 02 1430	91.894	0.919
R1350	197.70	01 Apr 02 1430	91.886	0.919
R1350W1350	0.0048651	01 Apr 02 1230	0.0013152	0.000
R1360W1360	4.8773	01 Apr 02 1330	1.7961	0.025
JR1380	201.48	01 Apr 02 1430	93.683	0.944
R1380	201.28	01 Apr 02 1430	93.534	0.944
R1410W1410	0.63569	01 Apr 02 1330	0.21716	0.003
R1380W1380	3.1702	01 Apr 02 1430	1.3705	0.016
JR1470	748.57	01 Apr 02 1400	322.40	2.732
R1470	748.28	01 Apr 02 1400	322.39	2.732
R1430W1430	17.267	01 Apr 02 1330	5.6529	0.048
R1470W1470	0.026136	01 Apr 02 1230	0.0053965	0.000
JR1490	763.93	01 Apr 02 1400	328.05	2.781
R1490	755.38	01 Apr 02 1400	327.46	2.781
R1630W1630	33.275	01 Apr 02 1330	11.099	0.079
R1490W1490	17.113	01 Apr 02 1330	5.4027	0.041
JR1640	801.43	01 Apr 02 1400	343.96	2.901
R1640	798.06	01 Apr 02 1400	343.76	2.901
R1590W1590	7.7384	01 Apr 02 1300	2.2899	0.027
R1510W1510	18.925	01 Apr 02 1400	7.3437	0.061
JR1650	24.302	01 Apr 02 1330	9.6336	0.088
R1650	24.221	01 Apr 02 1330	9.6315	0.088
R1640W1640	0.64276	01 Apr 02 1300	0.17113	0.002
R1650W1650	1.7571	01 Apr 02 1300	0.47668	0.004
JR1700	823.59	01 Apr 02 1400	354.04	2.995
R1700	818.26	01 Apr 02 1400	353.69	2.995
R1790W1790	21.415	01 Apr 02 1330	6.5555	0.042
R1700W1700	3.0663	01 Apr 02 1330	0.95614	0.007

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
JR1800	838.27	01 Apr 02 1400	361.20	3.044
R1800	830.04	01 Apr 02 1400	360.70	3.044
R2000W2000	17.815	01 Apr 02 1330	5.4849	0.043
R1800W1800	6.2739	01 Apr 02 1300	1.5722	0.011
JR2010	847.48	01 Apr 02 1400	367.76	3.098
R2010	845.39	01 Apr 02 1400	367.65	3.098
R2010W2010	0.86843	01 Apr 02 1230	0.16405	0.001
R1750W1750	31.259	01 Apr 02 1300	8.2497	0.062
JR2050	864.07	01 Apr 02 1400	376.06	3.161
R2050	861.63	01 Apr 02 1400	375.75	3.161
R1690W1690	15.469	01 Apr 02 1330	4.8216	0.030
R1400W1400	43.928	01 Apr 02 1430	19.091	0.135
JR1670	54.512	01 Apr 02 1400	23.912	0.165
R1670	53.935	01 Apr 02 1430	23.853	0.165
R1680W1680	24.026	01 Apr 02 1330	7.8589	0.062
R1670W1670	14.812	01 Apr 02 1300	4.3914	0.029
JR1920	86.764	01 Apr 02 1400	36.103	0.256
R1920	86.726	01 Apr 02 1400	36.094	0.256
R1940W1940	15.735	01 Apr 02 1230	3.3702	0.026
R1760W1760	34.907	01 Apr 02 1300	10.199	0.077
JR1910	47.871	01 Apr 02 1300	13.570	0.103
R1910	47.441	01 Apr 02 1300	13.568	0.103
R1920W1920	0.49211	01 Apr 02 1200	0.092756	0.000
R1910W1910	2.2543	01 Apr 02 1230	0.46100	0.003
JR1970	128.51	01 Apr 02 1330	50.216	0.362
R1970	126.81	01 Apr 02 1330	50.123	0.362
R2050W2050	0.95909	01 Apr 02 1230	0.18446	0.001
R1970W1970	25.321	01 Apr 02 1300	7.0535	0.048
JR2060	999.51	01 Apr 02 1400	433.11	3.572
R2060	997.76	01 Apr 02 1400	432.96	3.572
R2090W2090	16.487	01 Apr 02 1230	3.6230	0.029
R2060W2060	1.5310	01 Apr 02 1230	0.33675	0.002
JR2100	1004.4	01 Apr 02 1400	436.92	3.603
R2100	1000.6	01 Apr 02 1400	436.62	3.603
R2180W2180	14.264	01 Apr 02 1300	3.9537	0.032
R2200W2200	16.502	01 Apr 02 1300	4.5159	0.034
JR2210	30.766	01 Apr 02 1300	8.4696	0.066
R2210	28.588	01 Apr 02 1330	8.4375	0.066
R2100W2100	5.7804	01 Apr 02 1300	1.5654	0.011
R2210W2210	42.274	01 Apr 02 1230	10.462	0.081
JR2190	1046.5	01 Apr 02 1400	457.09	3.761
R2190	1036.0	01 Apr 02 1400	455.99	3.761
R2370W2370	31.016	01 Apr 02 1330	9.7935	0.077
R2190W2190	19.368	01 Apr 02 1330	6.0129	0.044
JR2480	1078.8	01 Apr 02 1400	471.80	3.882
R2480	1075.6	01 Apr 02 1400	471.51	3.882
R2500W2500	19.349	01 Apr 02 1300	5.0797	0.041
R2480W2480	4.2345	01 Apr 02 1230	0.79552	0.005
JR2520	1087.8	01 Apr 02 1400	477.38	3.928
R2520	1075.7	01 Apr 02 1400	476.07	3.928
R2520W2520	29.072	01 Apr 02 1400	10.656	0.079

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2560W2560	21.479	01 Apr 02 1300	5.3441	0.040
JR2720	1115.5	01 Apr 02 1400	492.07	4.047
R2720	1111.9	01 Apr 02 1400	491.81	4.047
R2600W2600	23.262	01 Apr 02 1300	5.8575	0.041
R2440W2440	38.170	01 Apr 02 1300	10.187	0.074
JR2580	61.432	01 Apr 02 1300	16.044	0.115
R2580	61.011	01 Apr 02 1300	16.045	0.115
R2570W2570	14.552	01 Apr 02 1300	3.5981	0.026
R2580W2580	4.3668	01 Apr 02 1300	1.1243	0.011
JR2620	79.930	01 Apr 02 1300	20.768	0.152
R2620	78.707	01 Apr 02 1300	20.765	0.152
R2510W2510	25.833	01 Apr 02 1230	5.8991	0.044
R2620W2620	13.522	01 Apr 02 1300	3.5380	0.032
JR2710	115.89	01 Apr 02 1300	30.202	0.228
R2710	112.63	01 Apr 02 1300	30.165	0.228
R2720W2720	3.7016	01 Apr 02 1330	1.1672	0.008
R2710W2710	29.134	01 Apr 02 1330	9.3032	0.066
JR2920	1212.8	01 Apr 02 1400	532.44	4.349
R2920	1198.8	01 Apr 02 1400	530.19	4.349
R2920W2920	15.778	01 Apr 02 1430	6.7413	0.046
R2970W2970	34.539	01 Apr 02 1400	13.039	0.085
JR3200	1248.4	01 Apr 02 1400	549.97	4.480
R3200	1244.3	01 Apr 02 1400	549.57	4.480
R3160W3160	19.176	01 Apr 02 1430	8.0465	0.053
R3200W3200	3.4410	01 Apr 02 1300	0.99353	0.007
JR3230	1265.5	01 Apr 02 1400	558.61	4.540
R3230	1265.4	01 Apr 02 1400	558.59	4.540
R3230W3230	0.080787	01 Apr 02 1230	0.018406	0.000
R3260W3260	14.122	01 Apr 02 1400	5.3824	0.033
JR3240	1279.6	01 Apr 02 1400	563.99	4.573
R3240	1266.8	01 Apr 02 1400	563.00	4.573
R3440W3440	12.564	01 Apr 02 1400	4.8886	0.033
R3240W3240	9.3547	01 Apr 02 1430	4.0408	0.034
JR3450	1288.3	01 Apr 02 1400	571.93	4.640
R3450	1287.1	01 Apr 02 1400	571.84	4.640
R3450W3450	0.056677	01 Apr 02 1230	0.011851	0.000
R3280W3280	47.959	01 Apr 02 1400	19.231	0.126
JR3500	1335.0	01 Apr 02 1400	591.08	4.766
R3500	1324.0	01 Apr 02 1430	589.64	4.766
R3550W3550	12.561	01 Apr 02 1230	2.3345	0.013
R3500W3500	10.153	01 Apr 02 1330	3.2421	0.023
JR3570	5090.3	01 Apr 02 1400	3858.6	86.251
R3570	5069.5	01 Apr 02 1400	3854.1	86.251
R3740W3740	91.270	01 Apr 02 1330	31.395	0.137
R3570W3570	27.769	01 Apr 02 1330	9.5867	0.064
JR3830	5238.6	01 Apr 02 1400	3938.6	86.623
R3830	5218.1	01 Apr 02 1400	3935.1	86.623
R3860W3860	22.074	01 Apr 02 1300	5.8796	0.026
R3830W3830	1.9749	01 Apr 02 1230	0.42184	0.002
JR3890	5254.1	01 Apr 02 1400	3959.0	86.720
R3890	5214.3	01 Apr 02 1400	3948.4	86.720

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R3890W3890	7.6614	01 Apr 02 1300	2.0077	0.011
R3760W3760	26.048	01 Apr 02 1330	8.6372	0.054
JR4000	5243.2	01 Apr 02 1400	3959.0	86.785
R4000	5190.2	01 Apr 02 1400	3947.1	86.785
R4000W4000	17.889	01 Apr 02 1330	5.6243	0.032
R4180W4180	0.24880	01 Apr 02 1230	0.047083	0.000
JR4150	5269.8	01 Apr 02 1400	3982.8	86.966
R4150	5199.1	01 Apr 02 1430	3967.6	86.966
R3190W3190	39.545	01 Apr 02 1400	14.393	0.078
R3520W3520	34.437	01 Apr 02 1300	10.082	0.051
JR3600	72.243	01 Apr 02 1330	24.475	0.129
R3600	71.955	01 Apr 02 1330	24.470	0.129
R3600W3600	11.399	01 Apr 02 1330	3.5374	0.022
R3680W3680	41.841	01 Apr 02 1300	11.599	0.057
JR3690	121.52	01 Apr 02 1330	39.606	0.208
R3690	121.07	01 Apr 02 1330	39.581	0.208
R3690W3690	29.273	01 Apr 02 1230	6.8928	0.041
R3900W3900	28.201	01 Apr 02 1230	6.7364	0.044
JR3950	169.09	01 Apr 02 1300	53.210	0.293
R3950	166.79	01 Apr 02 1300	53.204	0.293
R3950W3950	6.6684	01 Apr 02 1300	1.7313	0.013
R4010W4010	42.721	01 Apr 02 1230	8.3508	0.048
JR4060	204.03	01 Apr 02 1300	63.286	0.354
R4060	198.53	01 Apr 02 1300	63.207	0.354
R4150W4150	32.314	01 Apr 02 1300	9.5375	0.061
R4060W4060	22.079	01 Apr 02 1330	7.0730	0.047
JR4280	5396.5	01 Apr 02 1400	4047.4	87.428
R4280	5375.6	01 Apr 02 1400	4038.0	87.428
R4380W4380	18.878	01 Apr 02 1400	6.8647	0.046
R4280W4280	19.904	01 Apr 02 1230	3.7667	0.021
JR4390	5757.3	01 Apr 02 1400	4187.0	88.189
R4390	5740.0	01 Apr 02 1400	4182.3	88.189
R4390W4390	11.625	01 Apr 02 1330	3.5867	0.023
Outlet	5749.7	01 Apr 02 1400	4185.9	88.212

FUTURE CONDITIONS WITH BYPASS

HMS * Summary of Results for Outlet

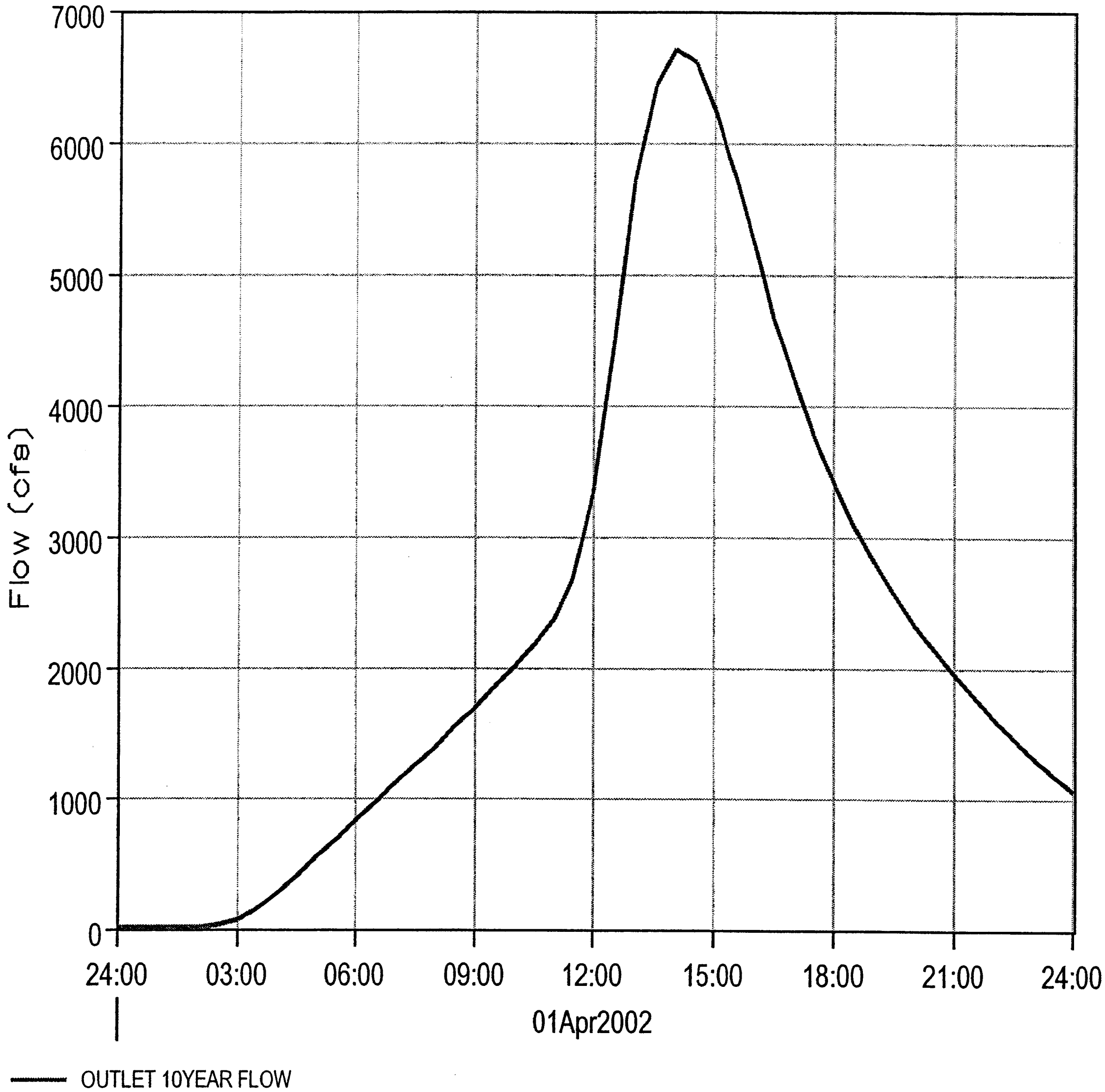
Project : future_swift   Run Name : 10year

Start of Run	: 01Apr02 0000	Basin Model	: swift future 10year
End of Run	: 01Apr02 2400	Met. Model	: Met 1
Execution Time	: 31Aug04 1522	Control Specs	: Control 1

Computed Results

Peak Outflow : 6703.6 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 4599.1 (ac-ft)



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3000
2000
1000
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Flow (cfs)
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03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 10YEAR FLOW

HMS * Summary of Results for Outlet

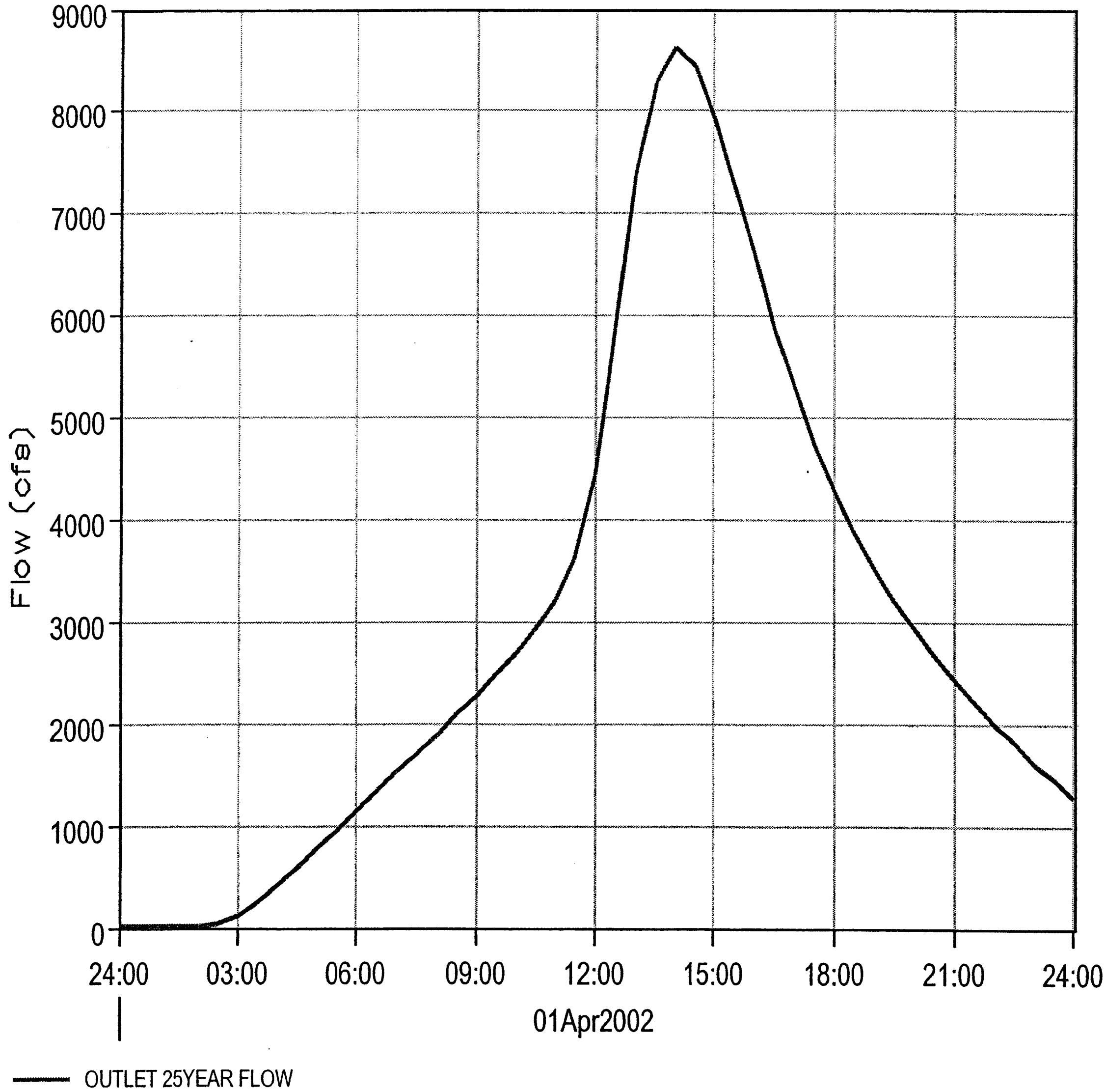
Project : future_swift   Run Name : 25year

Start of Run	: 01Apr02 0000	Basin Model	: swift future 25year
End of Run	: 01Apr02 2400	Met. Model	: Met 2
Execution Time	: 31Aug04 1518	Control Specs	: Control 1

Computed Results

Peak Outflow : 8619.2 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 5941.6 (ac-ft)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5000
4000
3000
2000
1000
0
Flow (cfs)
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03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 25YEAR FLOW

HMS * Summary of Results for Outlet

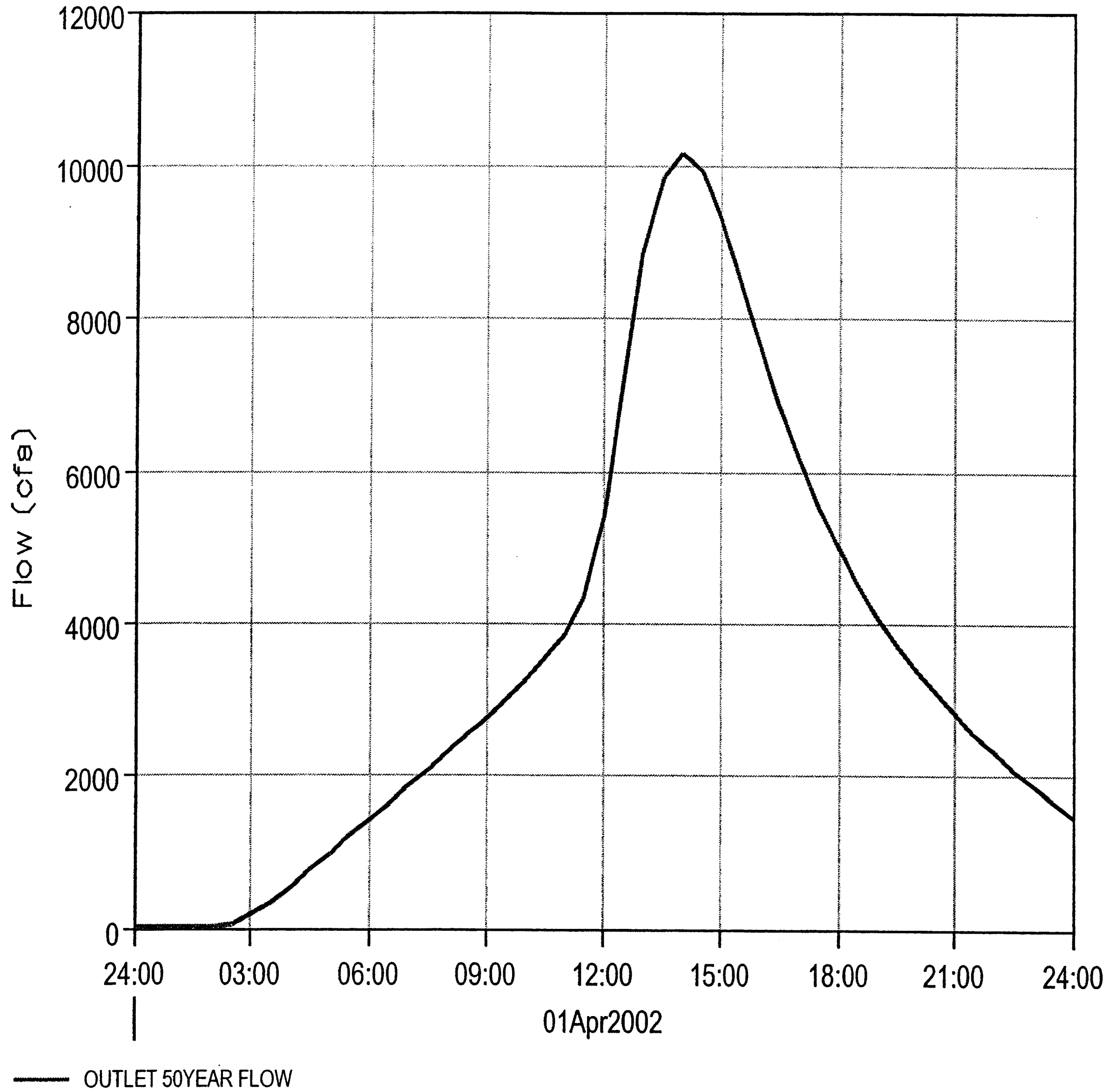
Project : future_swift   Run Name : 50year

Start of Run	: 01Apr02 0000	Basin Model	: swift future 50year
End of Run	: 01Apr02 2400	Met. Model	: Met 3
Execution Time	: 31Aug04 1516	Control Specs	: Control 1

Computed Results

Peak Outflow : 10163 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 7023.9 (ac-ft)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09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 50YEAR FLOW

HMS * Summary of Results for Outlet

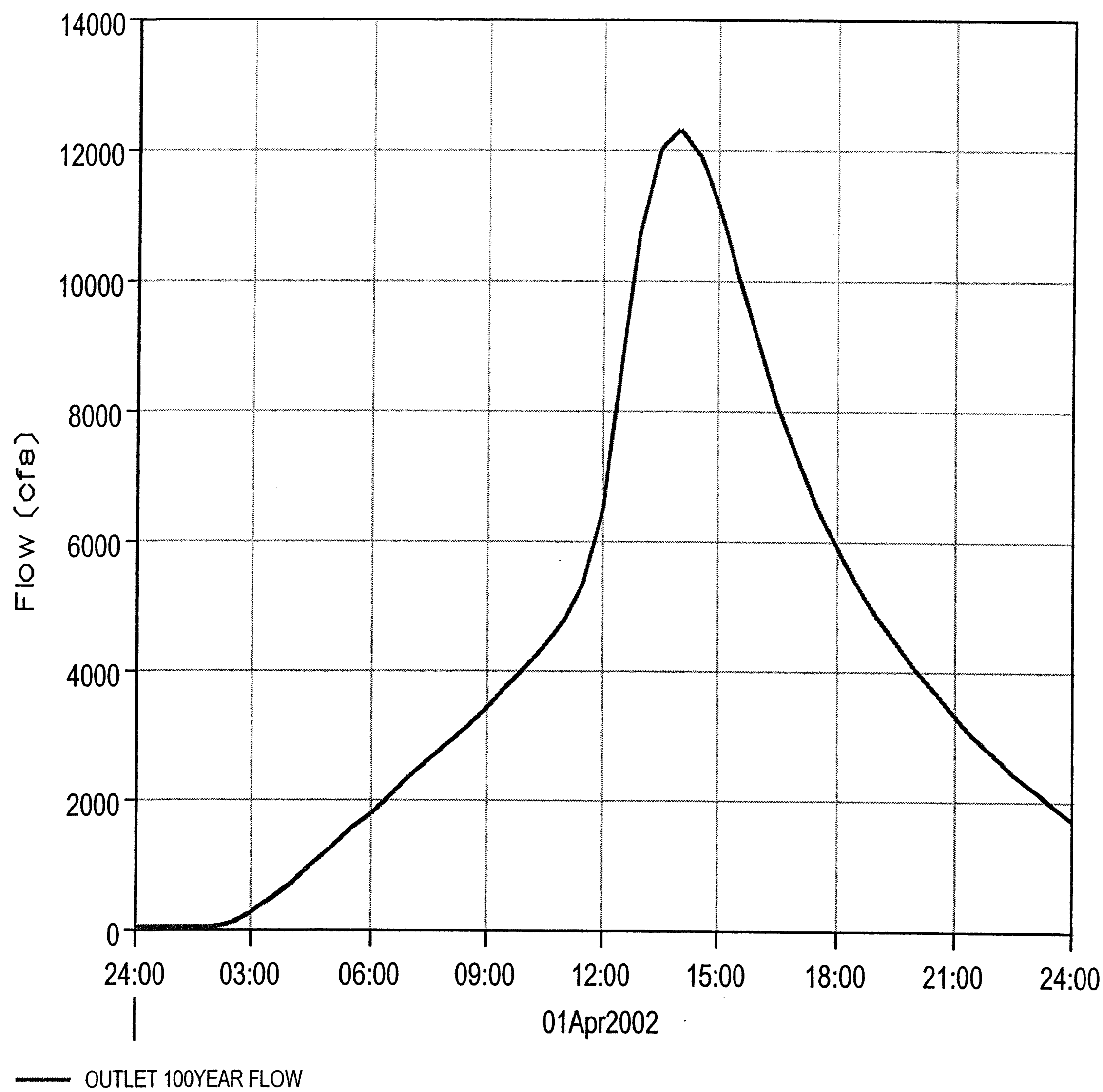
Project : future_swift   Run Name : 100year

Start of Run	: 01Apr02 0000	Basin Model	: swift future 100year
End of Run	: 01Apr02 2400	Met. Model	: Met 4
Execution Time	: 31Aug04 1511	Control Specs	: Control 1

Computed Results

Peak Outflow : 12293 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 8464.7 (ac-ft)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12000
10000
8000
6000
4000
2000
0
Flow (cfs)
24:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 100YEAR FLOW

HMS * Summary of Results

Project : future_swift   Run Name : 10year

Start of Run   : 01Apr02 0000   Basin Model   : swift future 10year
End of Run   : 01Apr02 2400   Met. Model   : Met 1
Execution Time   : 17Sep04 0859   Control Specs   : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R4330W4330	72.908	01 Apr 02 1330	24.121	0.095
R4030W4030	78.836	01 Apr 02 1300	23.894	0.088
JR4340	146.71	01 Apr 02 1300	48.014	0.183
R4340	146.15	01 Apr 02 1330	48.007	0.183
R4460W4460	33.946	01 Apr 02 1300	8.7069	0.035
R4470W4470	42.320	01 Apr 02 1300	10.969	0.051
JR4430	76.267	01 Apr 02 1300	19.676	0.086
R4430	76.057	01 Apr 02 1300	19.679	0.086
R4340W4340	58.882	01 Apr 02 1300	15.382	0.060
R4430W4430	7.3079	01 Apr 02 1200	1.0172	0.004
JR4370	280.87	01 Apr 02 1300	84.086	0.333
R4370	271.94	01 Apr 02 1300	84.028	0.333
R4370W4370	89.109	01 Apr 02 1300	23.873	0.110
R4450W4450	35.663	01 Apr 02 1400	14.304	0.100
JR4270	383.79	01 Apr 02 1300	122.21	0.543
R4270	369.49	01 Apr 02 1330	121.96	0.543
R4270W4270	25.367	01 Apr 02 1330	8.2248	0.058
R4350W4350	21.475	01 Apr 02 1500	10.321	0.093
JR4380	408.45	01 Apr 02 1330	140.51	0.694
R4380	402.19	01 Apr 02 1330	140.03	0.694
R4080W4080	63.206	01 Apr 02 1230	13.374	0.053
R4070W4070	27.859	01 Apr 02 1230	6.7001	0.026
JR4170	91.064	01 Apr 02 1230	20.074	0.079
R4170	75.156	01 Apr 02 1300	19.834	0.079
R4170W4170	37.151	01 Apr 02 1300	10.743	0.045
R4190W4190	16.901	01 Apr 02 1300	4.4347	0.025
JR4180	129.21	01 Apr 02 1300	35.012	0.149
R4180	129.13	01 Apr 02 1300	35.013	0.149
R3980W3980	48.870	01 Apr 02 1230	9.5137	0.037
R3990W3990	41.653	01 Apr 02 1230	8.0567	0.032
JR3860	90.523	01 Apr 02 1230	17.570	0.069
R3860	85.085	01 Apr 02 1230	17.583	0.069
R3930W3930	70.785	01 Apr 02 1230	13.589	0.054
R3940W3940	41.635	01 Apr 02 1200	8.0800	0.030
JR3910	110.33	01 Apr 02 1230	21.669	0.084
R3910	110.15	01 Apr 02 1230	21.684	0.084
R3910W3910	13.995	01 Apr 02 1230	2.7049	0.011
R3920W3920	34.054	01 Apr 02 1230	6.9288	0.027
JR3870	158.19	01 Apr 02 1230	31.318	0.122
R3870	157.27	01 Apr 02 1230	31.346	0.122
R3770W3770	43.968	01 Apr 02 1230	8.3489	0.034

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R3870W3870	19.501	01 Apr 02 1230	3.7104	0.015
JR3740	220.74	01 Apr 02 1230	43.406	0.171
R3740	207.19	01 Apr 02 1230	43.359	0.171
R3420W3420	34.758	01 Apr 02 1230	7.0407	0.026
R3430W3430	57.633	01 Apr 02 1230	11.840	0.047
JR3330	92.391	01 Apr 02 1230	18.881	0.073
R3330	88.278	01 Apr 02 1230	18.896	0.073
R3810W3810	36.019	01 Apr 02 1300	8.9407	0.049
R3820W3820	38.750	01 Apr 02 1300	9.9651	0.039
JR3650	74.769	01 Apr 02 1300	18.906	0.088
R3650	74.586	01 Apr 02 1300	18.909	0.088
R3650W3650	8.3217	01 Apr 02 1300	2.0522	0.014
R3660W3660	32.360	01 Apr 02 1230	7.8042	0.030
JR3590	113.12	01 Apr 02 1300	28.765	0.132
R3590	113.03	01 Apr 02 1300	28.771	0.132
R3580W3580	24.320	01 Apr 02 1330	7.6189	0.056
R3590W3590	4.5236	01 Apr 02 1230	0.85729	0.004
JR3510	139.01	01 Apr 02 1300	37.248	0.192
R3510	138.20	01 Apr 02 1300	37.252	0.192
R3460W3460	13.010	01 Apr 02 1300	3.7668	0.027
R3510W3510	26.540	01 Apr 02 1230	5.5250	0.024
JR3220	172.24	01 Apr 02 1300	46.544	0.243
R3220	170.36	01 Apr 02 1300	46.532	0.243
R3470W3470	32.742	01 Apr 02 1400	13.263	0.095
R3480W3480	20.361	01 Apr 02 1400	7.9538	0.059
JR3140	53.104	01 Apr 02 1400	21.217	0.154
R3140	52.341	01 Apr 02 1430	21.087	0.154
R3110W3110	15.598	01 Apr 02 1430	6.9654	0.055
R3140W3140	34.282	01 Apr 02 1400	13.525	0.086
JR2870	101.19	01 Apr 02 1430	41.577	0.295
R2870	99.675	01 Apr 02 1430	41.064	0.295
R3700W3700	23.823	01 Apr 02 1330	8.2401	0.063
R3710W3710	7.5591	01 Apr 02 1400	2.8653	0.026
JR3610	30.979	01 Apr 02 1330	11.105	0.089
R3610	30.807	01 Apr 02 1330	11.103	0.089
R3610W3610	4.3303	01 Apr 02 1330	1.4632	0.012
R3640W3640	28.916	01 Apr 02 1430	12.217	0.096
JR3400	62.796	01 Apr 02 1400	24.783	0.197
R3400	62.305	01 Apr 02 1400	24.742	0.197
R3400W3400	14.697	01 Apr 02 1400	5.5132	0.053
R3410W3410	10.708	01 Apr 02 1400	3.9497	0.037
JR2880	87.710	01 Apr 02 1400	34.205	0.287
R2880	85.410	01 Apr 02 1400	33.965	0.287
R2870W2870	28.447	01 Apr 02 1300	7.1123	0.046
R2880W2880	21.159	01 Apr 02 1330	6.8045	0.055
JR2860	209.22	01 Apr 02 1400	88.946	0.683
R2860	208.51	01 Apr 02 1430	88.842	0.683
R2760W2760	7.4493	01 Apr 02 1430	3.2401	0.028
R2770W2770	12.941	01 Apr 02 1400	5.0678	0.042
JR2690	19.993	01 Apr 02 1400	8.3079	0.070
R2690	19.902	01 Apr 02 1430	8.2541	0.070

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2390W2390	30.599	01 Apr 02 1500	15.389	0.127
R2400W2400	14.037	01 Apr 02 1400	5.7226	0.043
JR2330	43.165	01 Apr 02 1500	21.111	0.170
R2330	43.133	01 Apr 02 1500	21.097	0.170
R2320W2320	12.757	01 Apr 02 1330	3.9483	0.025
R2330W2330	2.4095	01 Apr 02 1230	0.53575	0.003
JR2310	50.822	01 Apr 02 1430	25.581	0.198
R2310	50.546	01 Apr 02 1430	25.491	0.198
R2280W2280	11.859	01 Apr 02 1400	4.7269	0.042
R2350W2350	13.275	01 Apr 02 1330	4.7640	0.035
JR1780	25.053	01 Apr 02 1400	9.4910	0.077
R1780	24.616	01 Apr 02 1400	9.4357	0.077
Source	2816.6	01 Apr 02 1200	2735.4	75.000
R1560	2751.1	01 Apr 02 1200	2707.6	75.000
R1780W1780	46.809	01 Apr 02 1530	23.618	0.180
R1560W1560	30.166	01 Apr 02 1330	10.010	0.056
JR1810	2763.0	01 Apr 02 1200	2750.7	75.313
R1810	2721.6	01 Apr 02 1200	2741.9	75.313
R1250W1250	88.205	01 Apr 02 1330	28.458	0.133
R1480W1480	53.330	01 Apr 02 1330	17.443	0.082
JR1660	141.54	01 Apr 02 1330	45.900	0.215
R1660	139.85	01 Apr 02 1330	45.872	0.215
R1810W1810	20.726	01 Apr 02 1400	7.7366	0.051
R1660W1660	8.2069	01 Apr 02 1300	2.4835	0.016
JR1830	2774.6	01 Apr 02 1230	2798.0	75.595
R1830	2773.7	01 Apr 02 1230	2797.4	75.595
R1830W1830	0.16424	01 Apr 02 1230	0.034215	0.000
R1860W1860	34.343	01 Apr 02 1230	7.9562	0.039
JR1870	2808.2	01 Apr 02 1230	2805.3	75.634
R1870	2802.6	01 Apr 02 1230	2803.4	75.634
R2040W2040	18.870	01 Apr 02 1430	8.4774	0.061
R1870W1870	7.1409	01 Apr 02 1330	2.5646	0.014
JR2070	2810.6	01 Apr 02 1230	2814.4	75.709
R2070	2806.8	01 Apr 02 1230	2813.4	75.709
R900W900	66.476	01 Apr 02 1330	20.894	0.107
R1080W1080	44.625	01 Apr 02 1330	14.823	0.102
JR1300	111.10	01 Apr 02 1330	35.717	0.209
R1300	110.75	01 Apr 02 1330	35.712	0.209
R1300W1300	3.1308	01 Apr 02 1230	0.69775	0.004
R1270W1270	26.289	01 Apr 02 1300	6.8657	0.072
JR1340	131.42	01 Apr 02 1330	43.276	0.285
R1340	131.30	01 Apr 02 1330	43.270	0.285
R1340W1340	17.109	01 Apr 02 1300	4.2192	0.025
R1450W1450	8.4754	01 Apr 02 1300	2.2810	0.026
JR1440	152.71	01 Apr 02 1300	49.770	0.336
R1440	151.23	01 Apr 02 1330	49.432	0.336
R2070W2070	14.355	01 Apr 02 1330	4.5535	0.026
R1440W1440	47.812	01 Apr 02 1400	19.572	0.137
JR2250	2970.7	01 Apr 02 1300	2886.9	76.208
R2250	2939.6	01 Apr 02 1300	2866.2	76.208
R2250W2250	9.5115	01 Apr 02 1300	2.7470	0.018

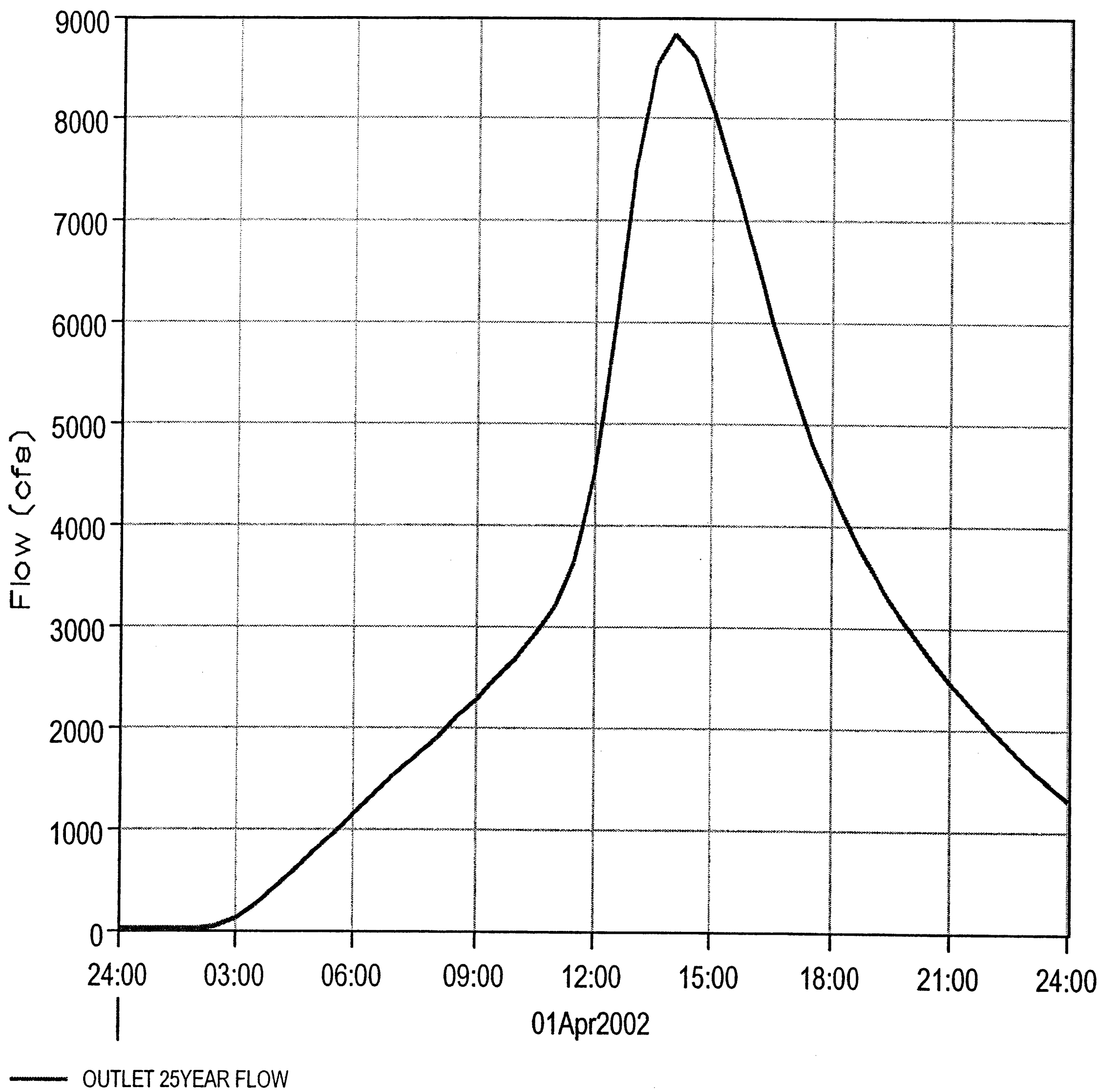
Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2110W2110	11.297	01 Apr 02 1430	4.9131	0.053
JR2270	2955.2	01 Apr 02 1300	2873.8	76.279
R2270	2947.6	01 Apr 02 1300	2870.7	76.279
R2310W2310	10.825	01 Apr 02 1330	3.5102	0.029
R2270W2270	1.7040	01 Apr 02 1300	0.47587	0.004
JR2340	2989.3	01 Apr 02 1300	2900.2	76.510
R2340	2982.2	01 Apr 02 1300	2897.7	76.510
R2790W2790	23.439	01 Apr 02 1430	10.149	0.087
R3020W3020	38.598	01 Apr 02 1430	16.406	0.103
JR2990	62.037	01 Apr 02 1430	26.555	0.190
R2990	61.727	01 Apr 02 1430	26.514	0.190
R3360W3360	21.522	01 Apr 02 1330	7.1899	0.039
R3370W3370	28.665	01 Apr 02 1330	10.383	0.046
JR3090	50.187	01 Apr 02 1330	17.573	0.085
R3090	49.345	01 Apr 02 1330	17.559	0.085
R3080W3080	52.264	01 Apr 02 1400	19.149	0.095
R3090W3090	21.907	01 Apr 02 1330	7.4242	0.038
JR3000	122.94	01 Apr 02 1330	44.133	0.218
R3000	122.46	01 Apr 02 1330	44.128	0.218
R2990W2990	10.233	01 Apr 02 1430	4.2984	0.036
R3000W3000	0.60775	01 Apr 02 1300	0.15724	0.001
JR2980	190.40	01 Apr 02 1400	75.097	0.445
R2980	190.17	01 Apr 02 1400	75.084	0.445
R2890W2890	7.8393	01 Apr 02 1400	3.2011	0.030
R2980W2980	0.90323	01 Apr 02 1300	0.23279	0.002
JR2590	198.50	01 Apr 02 1400	78.518	0.477
R2590	194.40	01 Apr 02 1400	78.159	0.477
R2490W2490	23.634	01 Apr 02 1330	7.8366	0.049
R2590W2590	18.550	01 Apr 02 1330	6.7607	0.067
JR2420	234.84	01 Apr 02 1400	92.756	0.593
R2420	231.93	01 Apr 02 1400	92.580	0.593
R2420W2420	3.8955	01 Apr 02 1300	1.0003	0.009
R2340W2340	3.9854	01 Apr 02 1300	1.1580	0.011
JR2430	3184.6	01 Apr 02 1330	2992.4	77.123
R2430	3183.0	01 Apr 02 1330	2991.4	77.123
R2430W2430	0.35574	01 Apr 02 1230	0.089828	0.001
R2240W2240	13.648	01 Apr 02 1330	4.5178	0.042
JR2460	3196.9	01 Apr 02 1330	2996.0	77.166
R2460	3178.3	01 Apr 02 1330	2989.7	77.166
R2020W2020	8.7799	01 Apr 02 1300	2.6032	0.025
R1770W1770	14.108	01 Apr 02 1400	5.6696	0.059
JR2030	20.156	01 Apr 02 1330	8.2728	0.084
R2030	19.688	01 Apr 02 1400	8.2389	0.084
R2460W2460	3.7600	01 Apr 02 1400	1.4263	0.013
R2030W2030	20.818	01 Apr 02 1330	6.8076	0.061
JR2470	3222.2	01 Apr 02 1330	3006.2	77.324
R2470	3197.1	01 Apr 02 1330	2998.4	77.324
R2690W2690	8.8086	01 Apr 02 1400	3.2016	0.020
R2470W2470	7.9723	01 Apr 02 1430	3.6675	0.058
JR2740	3227.5	01 Apr 02 1330	3013.5	77.472
R2740	3204.8	01 Apr 02 1330	3007.2	77.472

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2740W2740	9.3886	01 Apr 02 1330	3.5140	0.043
R1710W1710	65.719	01 Apr 02 1330	23.278	0.175
JR2730	3279.9	01 Apr 02 1330	3034.0	77.690
R2730	3276.7	01 Apr 02 1330	3033.3	77.690
R2630W2630	6.7907	01 Apr 02 1330	2.4117	0.026
R2380W2380	18.641	01 Apr 02 1300	5.3923	0.059
JR2660	24.278	01 Apr 02 1300	7.8039	0.085
R2660	23.679	01 Apr 02 1300	7.7992	0.085
R2730W2730	1.7490	01 Apr 02 1230	0.38664	0.002
R2660W2660	2.0315	01 Apr 02 1230	0.48404	0.004
JR2750	3302.5	01 Apr 02 1330	3042.0	77.781
R2750	3294.2	01 Apr 02 1330	3040.1	77.781
R2810W2810	46.042	01 Apr 02 1400	19.025	0.156
R2750W2750	3.2690	01 Apr 02 1230	0.69235	0.004
JR2820	3336.1	01 Apr 02 1330	3059.9	77.941
R2820	3327.4	01 Apr 02 1330	3058.0	77.941
R2820W2820	3.7171	01 Apr 02 1230	0.85189	0.008
R1990W1990	22.568	01 Apr 02 1400	9.4751	0.095
JR2830	3349.1	01 Apr 02 1330	3068.4	78.044
R2830	3336.6	01 Apr 02 1330	3060.0	78.044
R2860W2860	4.7068	01 Apr 02 1230	0.97680	0.007
R2830W2830	3.0136	01 Apr 02 1230	0.57898	0.003
JR2900	3536.7	01 Apr 02 1400	3150.4	78.737
R2900	3532.2	01 Apr 02 1400	3147.6	78.737
R3170W3170	8.0512	01 Apr 02 1400	3.2338	0.030
R3180W3180	7.6167	01 Apr 02 1430	3.2523	0.029
JR3010	15.437	01 Apr 02 1430	6.4861	0.059
R3010	15.436	01 Apr 02 1430	6.4749	0.059
R2900W2900	4.0096	01 Apr 02 1230	0.87802	0.005
R3010W3010	8.6520	01 Apr 02 1400	3.5553	0.032
JR2960	3557.5	01 Apr 02 1400	3158.5	78.833
R2960	3531.6	01 Apr 02 1400	3147.6	78.833
R2960W2960	18.129	01 Apr 02 1400	7.3914	0.061
R3070W3070	22.500	01 Apr 02 1400	8.7637	0.067
JR3050	3572.2	01 Apr 02 1400	3163.8	78.961
R3050	3566.7	01 Apr 02 1400	3162.0	78.961
R1600W1600	27.582	01 Apr 02 1330	9.1433	0.057
R1390W1390	27.673	01 Apr 02 1330	9.4240	0.087
JR1720	55.255	01 Apr 02 1330	18.567	0.144
R1720	53.127	01 Apr 02 1330	18.501	0.144
R2120W2120	24.260	01 Apr 02 1330	8.3967	0.068
R1720W1720	18.842	01 Apr 02 1400	6.8268	0.049
JR2220	96.146	01 Apr 02 1330	33.724	0.261
R2220	95.290	01 Apr 02 1400	33.594	0.261
R2290W2290	22.259	01 Apr 02 1430	9.4476	0.096
R2220W2220	6.7328	01 Apr 02 1400	2.5567	0.020
JR2610	124.13	01 Apr 02 1400	45.599	0.377
R2610	123.15	01 Apr 02 1400	45.533	0.377
R2650W2650	10.747	01 Apr 02 1400	4.1725	0.040
R2610W2610	8.8798	01 Apr 02 1300	2.3518	0.013
JR2780	139.25	01 Apr 02 1400	52.057	0.430

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2780	136.39	01 Apr 02 1400	51.790	0.430
R1280W1280	10.395	01 Apr 02 1300	2.7622	0.025
R1260W1260	13.142	01 Apr 02 1330	4.0496	0.032
JR1290	23.455	01 Apr 02 1300	6.8118	0.057
R1290	22.680	01 Apr 02 1300	6.8082	0.057
R1290W1290	14.860	01 Apr 02 1330	5.2022	0.034
R1460W1460	12.125	01 Apr 02 1400	4.4623	0.025
JR1500	48.461	01 Apr 02 1330	16.473	0.116
R1500	47.583	01 Apr 02 1330	16.434	0.116
R1540W1540	20.962	01 Apr 02 1330	6.9447	0.034
R1530W1530	38.003	01 Apr 02 1400	14.347	0.073
JR1740	57.402	01 Apr 02 1400	21.292	0.107
R1740	57.337	01 Apr 02 1400	21.279	0.107
R1500W1500	10.239	01 Apr 02 1430	4.3047	0.038
R1740W1740	7.0126	01 Apr 02 1400	2.6193	0.019
JR1890	119.35	01 Apr 02 1400	44.637	0.280
R1890	119.25	01 Apr 02 1400	44.609	0.280
R1890W1890	0.44805	01 Apr 02 1400	0.18289	0.002
R1880W1880	20.522	01 Apr 02 1330	7.0183	0.038
JR1980	139.37	01 Apr 02 1400	51.810	0.320
R1980	139.14	01 Apr 02 1400	51.703	0.320
R1980W1980	15.023	01 Apr 02 1400	5.7870	0.053
R2260W2260	12.118	01 Apr 02 1400	4.6825	0.039
JR2360	166.28	01 Apr 02 1400	62.173	0.412
R2360	165.52	01 Apr 02 1400	62.122	0.412
R2360W2360	6.1805	01 Apr 02 1400	2.3576	0.024
R2530W2530	8.0758	01 Apr 02 1400	3.1272	0.033
JR2550	179.78	01 Apr 02 1400	67.607	0.469
R2550	177.01	01 Apr 02 1400	67.406	0.469
R2780W2780	10.784	01 Apr 02 1330	3.5249	0.020
R2550W2550	13.411	01 Apr 02 1400	5.0524	0.032
JR2910	336.75	01 Apr 02 1400	127.77	0.951
R2910	330.81	01 Apr 02 1400	127.42	0.951
R3050W3050	3.9080	01 Apr 02 1400	1.4331	0.008
R2910W2910	1.9924	01 Apr 02 1400	0.73336	0.004
JR3130	3903.4	01 Apr 02 1400	3291.6	79.924
R3130	3826.5	01 Apr 02 1400	3271.5	79.924
R3130W3130	22.448	01 Apr 02 1400	8.5167	0.053
R2950W2950	24.108	01 Apr 02 1400	9.8643	0.076
JR3150	3873.1	01 Apr 02 1400	3289.9	80.053
R3150	3848.9	01 Apr 02 1400	3282.4	80.053
R3150W3150	4.5755	01 Apr 02 1330	1.4926	0.006
R3220W3220	31.859	01 Apr 02 1330	10.148	0.047
JR3210	3982.3	01 Apr 02 1400	3340.5	80.349
R3210	3958.1	01 Apr 02 1400	3334.5	80.349
R1620W1620	32.226	01 Apr 02 1330	11.043	0.047
R1900W1900	15.686	01 Apr 02 1330	5.4325	0.026
JR1930	47.912	01 Apr 02 1330	16.476	0.073
R1930	46.426	01 Apr 02 1330	16.441	0.073
R1930W1930	18.988	01 Apr 02 1330	6.2833	0.028
R2300W2300	18.081	01 Apr 02 1400	6.9431	0.035

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
JR2410	82.209	01 Apr 02 1330	29.667	0.136
R2410	81.430	01 Apr 02 1400	29.625	0.136
R2080W2080	70.233	01 Apr 02 1400	28.474	0.126
R2540W2540	33.989	01 Apr 02 1330	10.919	0.051
JR2700	100.46	01 Apr 02 1400	39.393	0.177
R2700	100.28	01 Apr 02 1400	39.371	0.177
R2410W2410	20.502	01 Apr 02 1400	7.7182	0.035
R2700W2700	16.345	01 Apr 02 1300	4.3619	0.019
JR2840	211.64	01 Apr 02 1400	81.076	0.367
R2840	211.48	01 Apr 02 1400	81.031	0.367
R3060W3060	25.712	01 Apr 02 1300	7.8732	0.029
R2840W2840	16.694	01 Apr 02 1300	4.8967	0.022
JR3100	246.67	01 Apr 02 1330	93.800	0.418
R3100	233.39	01 Apr 02 1400	93.036	0.418
R3210W3210	20.941	01 Apr 02 1230	4.9164	0.018
R3100W3100	9.6303	01 Apr 02 1300	2.6561	0.012
JR3250	4204.8	01 Apr 02 1400	3435.1	80.797
R3250	4194.0	01 Apr 02 1400	3430.5	80.797
R3330W3330	45.339	01 Apr 02 1200	8.3885	0.032
R3250W3250	10.848	01 Apr 02 1400	4.0422	0.019
JR3350	4237.5	01 Apr 02 1400	3461.9	80.921
R3350	4237.0	01 Apr 02 1400	3461.7	80.921
R3350W3350	0.18421	01 Apr 02 1230	0.035467	0.000
R3270W3270	20.805	01 Apr 02 1330	6.5956	0.029
JR3340	4254.7	01 Apr 02 1400	3468.3	80.951
R3340	4215.0	01 Apr 02 1400	3454.7	80.951
R2670W2670	48.882	01 Apr 02 1300	14.283	0.060
R2800W2800	20.971	01 Apr 02 1400	7.6600	0.043
JR2930	66.424	01 Apr 02 1330	21.943	0.103
R2930	66.056	01 Apr 02 1330	21.866	0.103
R3340W3340	61.855	01 Apr 02 1330	19.864	0.089
R2930W2930	36.464	01 Apr 02 1400	14.879	0.081
JR3320	4365.2	01 Apr 02 1400	3511.3	81.224
R3320	4353.0	01 Apr 02 1400	3508.1	81.224
R3320W3320	12.264	01 Apr 02 1300	3.3939	0.020
R3120W3120	21.468	01 Apr 02 1400	8.5307	0.050
JR3390	4382.6	01 Apr 02 1400	3520.0	81.294
R3390	4364.2	01 Apr 02 1400	3512.6	81.294
R3560W3560	76.664	01 Apr 02 1300	21.132	0.096
R3390W3390	27.340	01 Apr 02 1400	9.8650	0.059
JR3550	4440.1	01 Apr 02 1400	3543.6	81.449
R3550	4414.2	01 Apr 02 1400	3536.2	81.449
R800W800	51.511	01 Apr 02 1400	19.697	0.135
R950W950	20.367	01 Apr 02 1400	7.5073	0.038
JR940	71.878	01 Apr 02 1400	27.204	0.173
R940	71.874	01 Apr 02 1400	27.204	0.173
R780W780	28.523	01 Apr 02 1330	9.3032	0.049
R940W940	0.057069	01 Apr 02 1400	0.021125	0.000
JR930	98.075	01 Apr 02 1400	36.529	0.222
R930	97.807	01 Apr 02 1400	36.490	0.222
R930W930	35.528	01 Apr 02 1300	10.190	0.046

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R790W790	25.054	01 Apr 02 1330	8.3587	0.051
JR990	151.78	01 Apr 02 1330	55.039	0.319
R990	151.65	01 Apr 02 1330	55.036	0.319
R1010W1010	17.023	01 Apr 02 1300	4.7890	0.027
R990W990	0.041736	01 Apr 02 1230	0.0084162	0.000
JR1020	167.56	01 Apr 02 1330	59.834	0.346
R1020	166.35	01 Apr 02 1330	59.812	0.346
R1040W1040	14.757	01 Apr 02 1330	4.7466	0.029
R1020W1020	11.971	01 Apr 02 1330	3.9142	0.027
JR1050	193.08	01 Apr 02 1330	68.473	0.402
R1050	185.17	01 Apr 02 1330	67.633	0.402
R1050W1050	10.433	01 Apr 02 1300	2.8774	0.013
R1060W1060	15.599	01 Apr 02 1330	5.4098	0.035
JR980	210.11	01 Apr 02 1330	75.920	0.450
R980	208.38	01 Apr 02 1330	75.880	0.450
R520W520	43.409	01 Apr 02 1430	18.388	0.143
R530W530	9.9281	01 Apr 02 1330	3.3422	0.032
JR630	51.267	01 Apr 02 1400	21.730	0.175
R630	50.748	01 Apr 02 1430	21.662	0.175
R310W310	38.282	01 Apr 02 1430	16.668	0.133
R380W380	36.541	01 Apr 02 1400	13.861	0.086
JR580	72.606	01 Apr 02 1430	30.529	0.219
R580	72.601	01 Apr 02 1430	30.489	0.219
R630W630	34.900	01 Apr 02 1400	13.346	0.103
R580W580	7.2993	01 Apr 02 1300	1.9928	0.011
JR690	161.24	01 Apr 02 1400	67.490	0.508
R690	161.07	01 Apr 02 1400	67.438	0.508
R700W700	26.318	01 Apr 02 1330	8.3313	0.037
R690W690	0.16486	01 Apr 02 1300	0.042591	0.000
JR730	183.59	01 Apr 02 1400	75.812	0.545
R730	183.39	01 Apr 02 1400	75.801	0.545
R400W400	28.034	01 Apr 02 1300	7.2828	0.033
R410W410	33.109	01 Apr 02 1300	8.5790	0.041
JR440	61.143	01 Apr 02 1300	15.862	0.074
R440	60.576	01 Apr 02 1300	15.864	0.074
R440W440	9.7715	01 Apr 02 1300	2.7832	0.012
R480W480	20.393	01 Apr 02 1330	6.4216	0.041
JR490	89.275	01 Apr 02 1300	25.069	0.127
R490	86.699	01 Apr 02 1300	25.060	0.127
R490W490	20.337	01 Apr 02 1300	5.8299	0.036
R660W660	10.188	01 Apr 02 1400	3.7978	0.027
JR680	114.52	01 Apr 02 1300	34.688	0.190
R680	113.61	01 Apr 02 1300	34.688	0.190
R730W730	15.032	01 Apr 02 1200	2.0294	0.007
R680W680	2.9479	01 Apr 02 1300	0.81001	0.004
JR740	283.50	01 Apr 02 1330	113.33	0.746
R740	281.04	01 Apr 02 1330	113.25	0.746
R740W740	7.1333	01 Apr 02 1300	2.0168	0.010
R570W570	29.061	01 Apr 02 1430	13.070	0.095
JR810	309.22	01 Apr 02 1330	128.34	0.851
R810	306.79	01 Apr 02 1400	128.20	0.851


9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Flow (cfs)
24:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
24:00
01Apr2002
OUTLET 25YEAR FLOW

HMS * Summary of Results for Outlet

Project : Future_wo_bypass   Run Name : 50year

Start of Run	: 01Apr02 0000	Basin Model	: no bypass 50year
End of Run	: 01Apr02 2400	Met. Model	: Met 3
Execution Time	: 31Aug04 1804	Control Specs	: Control 1

Computed Results

Peak Outflow : 10392 (cfs)   Date/Time of Peak Outflow : 01 Apr 02 1400

Total Outflow : 7084.6 (ac-ft)

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R810W810	13.538	01 Apr 02 1400	4.9979	0.031
R910W910	10.334	01 Apr 02 1400	4.1197	0.029
JR970	339.29	01 Apr 02 1400	140.89	0.911
R970	338.73	01 Apr 02 1400	140.73	0.911
R980W980	22.484	01 Apr 02 1330	8.1456	0.036
R970W970	3.0210	01 Apr 02 1400	1.0955	0.007
JR1140	578.35	01 Apr 02 1330	230.65	1.404
R1140	577.35	01 Apr 02 1400	230.43	1.404
R1140W1140	10.031	01 Apr 02 1330	3.5640	0.023
R1150W1150	13.145	01 Apr 02 1330	4.0903	0.028
JR1180	598.44	01 Apr 02 1400	238.08	1.455
R1180	598.20	01 Apr 02 1400	238.07	1.455
R1200W1200	22.253	01 Apr 02 1330	7.1329	0.030
R1180W1180	0.039634	01 Apr 02 1300	0.011668	0.000
JR1160	617.29	01 Apr 02 1400	245.21	1.485
R1160	614.71	01 Apr 02 1400	244.85	1.485
R1190W1190	15.294	01 Apr 02 1400	6.0174	0.037
R1160W1160	1.1666	01 Apr 02 1330	0.40136	0.002
JR1170	631.12	01 Apr 02 1400	251.27	1.524
R1170	630.55	01 Apr 02 1400	251.15	1.524
R1170W1170	9.7333	01 Apr 02 1430	4.1993	0.033
R850W850	33.216	01 Apr 02 1430	14.917	0.107
JR1230	670.48	01 Apr 02 1400	270.26	1.664
R1230	666.24	01 Apr 02 1400	269.55	1.664
R1420W1420	14.455	01 Apr 02 1330	4.6145	0.027
R1230W1230	27.689	01 Apr 02 1400	10.913	0.078
JR1410	706.93	01 Apr 02 1400	285.08	1.769
R1410	705.56	01 Apr 02 1400	284.98	1.769
R430W430	37.729	01 Apr 02 1400	15.554	0.098
R550W550	14.938	01 Apr 02 1400	5.6160	0.031
JR560	52.667	01 Apr 02 1400	21.170	0.129
R560	52.200	01 Apr 02 1400	21.151	0.129
R610W610	10.609	01 Apr 02 1430	4.5158	0.027
R560W560	7.5866	01 Apr 02 1330	2.3767	0.012
JR620	68.916	01 Apr 02 1400	28.044	0.168
R620	68.530	01 Apr 02 1400	28.027	0.168
R620W620	3.9316	01 Apr 02 1300	1.0489	0.008
R650W650	32.308	01 Apr 02 1300	9.0457	0.044
JR710	94.386	01 Apr 02 1330	38.122	0.220
R710	93.835	01 Apr 02 1330	38.110	0.220
R450W450	54.349	01 Apr 02 1500	26.684	0.167
R710W710	8.8937	01 Apr 02 1400	3.2980	0.022
JR760	145.91	01 Apr 02 1400	68.092	0.409
R760	145.53	01 Apr 02 1400	68.060	0.409
R760W760	7.8191	01 Apr 02 1400	2.9271	0.020
R750W750	16.882	01 Apr 02 1330	5.8128	0.035
JR830	169.67	01 Apr 02 1400	76.800	0.464
R830	169.34	01 Apr 02 1400	76.771	0.464
R830W830	1.9822	01 Apr 02 1330	0.63876	0.004
R870W870	17.317	01 Apr 02 1400	6.7450	0.046
JR880	188.46	01 Apr 02 1400	84.155	0.514

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R880	187.01	01 Apr 02 1400	84.039	0.514
R1000W1000	8.7610	01 Apr 02 1430	3.6663	0.027
R880W880	8.2690	01 Apr 02 1400	3.0011	0.022
JR1090	203.88	01 Apr 02 1400	90.706	0.563
R1090	203.23	01 Apr 02 1400	90.664	0.563
R840W840	24.898	01 Apr 02 1330	8.4681	0.048
R920W920	26.356	01 Apr 02 1430	11.170	0.103
JR1030	49.710	01 Apr 02 1400	19.638	0.151
R1030	49.630	01 Apr 02 1400	19.632	0.151
R1030W1030	2.0436	01 Apr 02 1300	0.53811	0.006
R1100W1100	22.065	01 Apr 02 1400	8.9377	0.064
JR1070	72.707	01 Apr 02 1400	29.108	0.221
R1070	72.267	01 Apr 02 1400	29.079	0.221
R1070W1070	3.9633	01 Apr 02 1300	1.1559	0.013
R1130W1130	15.637	01 Apr 02 1330	5.1203	0.039
JR1120	89.268	01 Apr 02 1400	35.355	0.273
R1120	89.186	01 Apr 02 1400	35.347	0.273
R1090W1090	1.2063	01 Apr 02 1330	0.37792	0.003
R1120W1120	0.31140	01 Apr 02 1300	0.089008	0.001
JR1210	293.62	01 Apr 02 1400	126.48	0.840
R1210	290.35	01 Apr 02 1400	126.24	0.840
R1210W1210	14.134	01 Apr 02 1500	6.6952	0.049
R1330W1330	14.789	01 Apr 02 1300	3.7148	0.030
JR1350	309.93	01 Apr 02 1400	136.65	0.919
R1350	309.90	01 Apr 02 1400	136.64	0.919
R1350W1350	0.0069666	01 Apr 02 1230	0.0016906	0.000
R1360W1360	8.4796	01 Apr 02 1330	2.8004	0.025
JR1380	317.62	01 Apr 02 1400	139.44	0.944
R1380	315.15	01 Apr 02 1400	139.28	0.944
R1410W1410	1.1782	01 Apr 02 1330	0.36378	0.003
R1380W1380	4.8583	01 Apr 02 1400	1.9749	0.016
JR1470	1026.5	01 Apr 02 1400	426.60	2.732
R1470	1026.1	01 Apr 02 1400	426.57	2.732
R1430W1430	29.021	01 Apr 02 1330	9.1177	0.048
R1470W1470	0.025308	01 Apr 02 1230	0.0052493	0.000
JR1490	1051.4	01 Apr 02 1400	435.70	2.781
R1490	1044.0	01 Apr 02 1400	435.14	2.781
R1630W1630	45.475	01 Apr 02 1330	14.835	0.079
R1490W1490	22.773	01 Apr 02 1330	7.0483	0.041
JR1640	1105.0	01 Apr 02 1400	457.03	2.901
R1640	1102.0	01 Apr 02 1400	456.82	2.901
R1590W1590	12.463	01 Apr 02 1300	3.3550	0.027
R1510W1510	20.475	01 Apr 02 1400	7.8691	0.061
JR1650	29.580	01 Apr 02 1330	11.224	0.088
R1650	29.513	01 Apr 02 1330	11.222	0.088
R1640W1640	1.7290	01 Apr 02 1230	0.38884	0.002
R1650W1650	2.3607	01 Apr 02 1300	0.61672	0.004
JR1700	1132.1	01 Apr 02 1400	469.04	2.995
R1700	1127.3	01 Apr 02 1400	468.66	2.995
R1790W1790	29.751	01 Apr 02 1300	9.0090	0.042
R1700W1700	4.5691	01 Apr 02 1330	1.4082	0.007

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
JR1800	1154.3	01 Apr 02 1400	479.08	3.044
R1800	1146.6	01 Apr 02 1400	478.56	3.044
R2000W2000	28.301	01 Apr 02 1300	8.2926	0.043
R1800W1800	7.2308	01 Apr 02 1300	1.7937	0.011
JR2010	1171.3	01 Apr 02 1400	488.65	3.098
R2010	1169.3	01 Apr 02 1400	488.49	3.098
R2010W2010	0.69669	01 Apr 02 1230	0.13471	0.001
R1750W1750	36.366	01 Apr 02 1300	9.4371	0.062
JR2050	1190.4	01 Apr 02 1400	498.07	3.161
R2050	1187.4	01 Apr 02 1400	497.65	3.161
R1690W1690	13.600	01 Apr 02 1330	4.2781	0.030
R1400W1400	41.040	01 Apr 02 1430	17.946	0.135
JR1670	50.144	01 Apr 02 1400	22.224	0.165
R1670	49.943	01 Apr 02 1430	22.165	0.165
R1680W1680	24.934	01 Apr 02 1330	8.1179	0.062
R1670W1670	15.260	01 Apr 02 1300	4.5079	0.029
JR1920	83.417	01 Apr 02 1400	34.791	0.256
R1920	83.381	01 Apr 02 1400	34.781	0.256
R1940W1940	15.928	01 Apr 02 1230	3.4044	0.026
R1760W1760	41.745	01 Apr 02 1300	11.906	0.077
JR1910	54.849	01 Apr 02 1300	15.311	0.103
R1910	54.364	01 Apr 02 1300	15.309	0.103
R1920W1920	0.62659	01 Apr 02 1200	0.12214	0.000
R1910W1910	3.0031	01 Apr 02 1230	0.60221	0.003
JR1970	131.83	01 Apr 02 1330	50.815	0.362
R1970	130.45	01 Apr 02 1330	50.722	0.362
R2050W2050	1.0184	01 Apr 02 1230	0.19563	0.001
R1970W1970	23.886	01 Apr 02 1300	6.7035	0.048
JR2060	1325.9	01 Apr 02 1400	555.27	3.572
R2060	1324.8	01 Apr 02 1400	555.13	3.572
R2090W2090	19.523	01 Apr 02 1230	4.1719	0.029
R2060W2060	1.5053	01 Apr 02 1230	0.33171	0.002
JR2100	1332.1	01 Apr 02 1400	559.63	3.603
R2100	1328.8	01 Apr 02 1400	559.30	3.603
R2180W2180	15.734	01 Apr 02 1300	4.2979	0.032
R2200W2200	18.753	01 Apr 02 1300	5.0499	0.034
JR2210	34.487	01 Apr 02 1300	9.3479	0.066
R2210	32.007	01 Apr 02 1300	9.3173	0.066
R2100W2100	6.4954	01 Apr 02 1300	1.7372	0.011
R2210W2210	41.507	01 Apr 02 1230	10.310	0.081
JR2190	1377.0	01 Apr 02 1400	580.66	3.761
R2190	1367.1	01 Apr 02 1400	579.40	3.761
R2370W2370	42.283	01 Apr 02 1330	13.047	0.077
R2190W2190	21.138	01 Apr 02 1330	6.5170	0.044
JR2480	1420.1	01 Apr 02 1400	598.96	3.882
R2480	1416.6	01 Apr 02 1400	598.62	3.882
R2500W2500	23.244	01 Apr 02 1300	5.9680	0.041
R2480W2480	4.5958	01 Apr 02 1230	0.85871	0.005
JR2520	1430.6	01 Apr 02 1400	605.45	3.928
R2520	1420.4	01 Apr 02 1400	604.23	3.928
R2520W2520	31.967	01 Apr 02 1400	11.634	0.079

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R2560W2560	24.948	01 Apr 02 1300	6.1319	0.040
JR2720	1464.4	01 Apr 02 1400	622.00	4.047
R2720	1461.2	01 Apr 02 1400	621.70	4.047
R2600W2600	24.907	01 Apr 02 1300	6.2349	0.041
R2440W2440	42.104	01 Apr 02 1300	11.111	0.074
JR2580	67.011	01 Apr 02 1300	17.346	0.115
R2580	66.580	01 Apr 02 1300	17.348	0.115
R2570W2570	16.372	01 Apr 02 1300	4.0138	0.026
R2580W2580	6.1754	01 Apr 02 1300	1.5236	0.011
JR2620	89.127	01 Apr 02 1300	22.886	0.152
R2620	87.919	01 Apr 02 1300	22.883	0.152
R2510W2510	28.280	01 Apr 02 1230	6.3629	0.044
R2620W2620	16.423	01 Apr 02 1300	4.1801	0.032
JR2710	129.99	01 Apr 02 1300	33.426	0.228
R2710	126.82	01 Apr 02 1300	33.392	0.228
R2720W2720	4.6349	01 Apr 02 1330	1.4450	0.008
R2710W2710	31.219	01 Apr 02 1330	9.9071	0.066
JR2920	1571.5	01 Apr 02 1400	666.44	4.349
R2920	1555.9	01 Apr 02 1400	664.09	4.349
R2920W2920	19.160	01 Apr 02 1430	8.1181	0.046
R2970W2970	40.039	01 Apr 02 1400	15.004	0.085
JR3200	1614.5	01 Apr 02 1400	687.21	4.480
R3200	1609.4	01 Apr 02 1400	686.86	4.480
R3160W3160	22.975	01 Apr 02 1430	9.5983	0.053
R3200W3200	4.7439	01 Apr 02 1300	1.3296	0.007
JR3230	1635.3	01 Apr 02 1400	697.79	4.540
R3230	1635.2	01 Apr 02 1400	697.76	4.540
R3230W3230	0.094555	01 Apr 02 1230	0.021264	0.000
R3260W3260	15.787	01 Apr 02 1400	5.9901	0.033
JR3240	1651.0	01 Apr 02 1400	703.78	4.573
R3240	1638.9	01 Apr 02 1400	702.89	4.573
R3440W3440	17.060	01 Apr 02 1400	6.5528	0.033
R3240W3240	14.731	01 Apr 02 1430	6.1899	0.034
JR3450	1670.4	01 Apr 02 1400	715.63	4.640
R3450	1669.0	01 Apr 02 1400	715.50	4.640
R3450W3450	0.067060	01 Apr 02 1230	0.013879	0.000
R3280W3280	57.904	01 Apr 02 1400	22.940	0.126
JR3500	1726.9	01 Apr 02 1400	738.45	4.766
R3500	1707.3	01 Apr 02 1400	737.01	4.766
R3550W3550	15.748	01 Apr 02 1230	2.9578	0.013
R3500W3500	13.598	01 Apr 02 1330	4.2717	0.023
JR3570	6159.7	01 Apr 02 1400	4290.7	86.251
R3570	6135.4	01 Apr 02 1400	4285.8	86.251
R3740W3740	97.736	01 Apr 02 1330	34.105	0.137
R3570W3570	40.629	01 Apr 02 1330	13.801	0.064
JR3830	6322.2	01 Apr 02 1400	4378.9	86.623
R3830	6305.6	01 Apr 02 1400	4374.4	86.623
R3860W3860	23.744	01 Apr 02 1300	6.4192	0.026
R3830W3830	2.2929	01 Apr 02 1230	0.49855	0.002
JR3890	6342.3	01 Apr 02 1400	4398.8	86.720
R3890	6284.5	01 Apr 02 1400	4389.0	86.720

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
R3890W3890	9.6776	01 Apr 02 1300	2.5639	0.011
R3760W3760	36.039	01 Apr 02 1330	11.905	0.054
JR4000	6322.8	01 Apr 02 1400	4403.4	86.785
R4000	6253.3	01 Apr 02 1400	4390.2	86.785
R4000W4000	24.581	01 Apr 02 1330	7.9639	0.032
R4180W4180	0.33191	01 Apr 02 1230	0.064048	0.000
JR4150	6350.0	01 Apr 02 1400	4435.8	86.966
R4150	6255.3	01 Apr 02 1430	4418.7	86.966
R3190W3190	40.870	01 Apr 02 1400	14.885	0.078
R3520W3520	36.167	01 Apr 02 1300	10.583	0.051
JR3600	75.169	01 Apr 02 1330	25.468	0.129
R3600	74.887	01 Apr 02 1330	25.463	0.129
R3600W3600	14.626	01 Apr 02 1330	4.5425	0.022
R3680W3680	43.831	01 Apr 02 1300	12.167	0.057
JR3690	129.32	01 Apr 02 1330	42.172	0.208
R3690	128.94	01 Apr 02 1330	42.148	0.208
R3690W3690	36.786	01 Apr 02 1230	8.5179	0.041
R3900W3900	35.951	01 Apr 02 1230	8.3586	0.044
JR3950	190.40	01 Apr 02 1300	59.024	0.293
R3950	188.19	01 Apr 02 1300	59.020	0.293
R3950W3950	9.7822	01 Apr 02 1300	2.4740	0.013
R4010W4010	55.151	01 Apr 02 1230	10.791	0.048
JR4060	236.20	01 Apr 02 1300	72.286	0.354
R4060	231.73	01 Apr 02 1300	72.224	0.354
R4150W4150	44.100	01 Apr 02 1300	12.763	0.061
R4060W4060	28.698	01 Apr 02 1330	9.0922	0.047
JR4280	6476.5	01 Apr 02 1400	4512.8	87.428
R4280	6414.3	01 Apr 02 1400	4503.4	87.428
R4380W4380	17.842	01 Apr 02 1400	6.5126	0.046
R4280W4280	26.941	01 Apr 02 1230	5.2233	0.021
JR4390	6797.9	01 Apr 02 1400	4652.2	88.189
R4390	6777.2	01 Apr 02 1400	4647.1	88.189
R4390W4390	12.607	01 Apr 02 1330	3.8771	0.023
Outlet	6787.6	01 Apr 02 1400	4650.9	88.212

HEC-HMS

CURVE NUMBER AND INITIAL ABSTRACTION VALUES

Curve Numbers and Initial Abstractions for All Scenarios

	Current		Future		No-Bypass	
Subbasin	CN	Ia	CN	Ia	CN	Ia
R520W520	70.1	0.854	70.1	0.854	72.4	0.763
R400W400	76	0.631	87	0.299	91.5	0.186
R410W410	69	0.8986	85.5	0.399	85	0.352
R430W430	66	1.03	69.4	0.88	76.3	0.62
R380W380	74	0.703	76.6	0.611	70	0.857
R480W480	69	0.898	75.2	0.659	76.8	0.603
R660W660	67	0.985	72.3	0.767	73	0.739
R440W440	78	0.564	89.1	0.244	87.8	0.277
R580W580	78	0.564	79.8	0.507	75.8	0.637
R310W310	67	0.985	69.5	0.878	72.7	0.753
R530W530	63	1.175	64	1.126	67.8	0.952
R560W560	75	0.67	88.3	0.265	83.2	0.403
R610W610	68	0.941	77.5	0.579	78.2	0.557
R550W550	66	1.03	75.5	0.569	80.5	0.485
R620W620	56	1.571	60.6	1.302	69.6	0.874
R490W490	72	0.7778	76.1	0.629	75.6	0.646
R690W690	70	0.857	92.8	0.156	84.7	0.362
R680W680	84	0.381	83.8	0.386	82.1	0.435
R450W450	65	1.077	73.5	0.721	77.5	0.582
R710W710	58	1.44	64.7	1.089	74.2	0.694
R630W630	66	1.03	70	0.858	73.6	0.719
R570W570	66	1.03	72.3	0.766	73.3	0.73
R780W780	70	0.857	81.8	0.446	80	0.5
R700W700	76	0.6316	88.1	0.27	85	0.353
R1230W1230	65	1.077	73.5	0.722	72.3	0.766
R970W970	60	1.3334	72.2	0.769	75.5	0.651
R810W810	73	0.7397	80.7	0.469	76.5	0.614
R800W800	70	0.857	73.5	0.722	78.1	0.56
R1050W1050	73	0.7397	87.2	0.293	72.9	0.745
R790W790	71	0.8169	76.8	0.604	78.7	0.542
R910W910	65	1.077	73	0.738	72.8	0.749
R870W870	64	1.125	66.3	1.016	73.7	0.715
R830W830	66	1.03	71.4	0.802	75.9	0.636
R760W760	72	0.7778	72.8	0.747	73.5	0.72
R750W750	67	0.985	72.1	0.773	77.3	0.588
R650W650	70	0.857	84.1	0.377	84.4	0.37
R730W730	98	0.0408	98	0.041	98	0.041
R740W740	80	0.5	83.7	0.39	80.6	0.48
R1000W1000	70	0.857	72.6	0.753	71.6	0.793
R880W880	63	1.174	67.7	0.952	71.3	0.807
R1030W1030	55	1.636	60	1.333	60	1.333
R850W850	71	0.817	73	0.739	72.7	0.752
R1130W1130	57	1.509	61.2	1.265	70	0.858
R990W990	68	0.941	68	0.941	68	0.941
R930W930	74	0.703	87.3	0.292	86.3	0.317
R950W950	72	0.7778	83.5	0.396	85.6	0.337
R1010W1010	70	0.857	79.1	0.528	82.8	0.415
R1040W1040	67	0.985	76.7	0.609	82	0.44
R1060W1060	71	0.817	75	0.668	83	0.409
R980W980	79	0.532	85.2	0.348	88.6	0.258
R940W940	70	0.857	86	0.326	86	0.326

HEC-RAS
CROSS-SECTIONS
AND
SHEAR STRESS VALUES
AT
SECTION 9441

Curve Numbers and Initial Abstractions for All Scenarios

	Current		Future		No-Bypass	
Subbasin	CN	Ia	CN	Ia	CN	Ia
R520W520	70.1	0.854	70.1	0.854	72.4	0.763
R400W400	76	0.631	87	0.299	91.5	0.186
R410W410	69	0.8986	85.5	0.399	85	0.352
R430W430	66	1.03	69.4	0.88	76.3	0.62
R380W380	74	0.703	76.6	0.611	70	0.857
R480W480	69	0.898	75.2	0.659	76.8	0.603
R660W660	67	0.985	72.3	0.767	73	0.739
R440W440	78	0.564	89.1	0.244	87.8	0.277
R580W580	78	0.564	79.8	0.507	75.8	0.637
R310W310	67	0.985	69.5	0.878	72.7	0.753
R530W530	63	1.175	64	1.126	67.8	0.952
R560W560	75	0.67	88.3	0.265	83.2	0.403
R610W610	68	0.941	77.5	0.579	78.2	0.557
R550W550	66	1.03	75.5	0.569	80.5	0.485
R620W620	56	1.571	60.6	1.302	69.6	0.874
R490W490	72	0.7778	76.1	0.629	75.6	0.646
R690W690	70	0.857	92.8	0.156	84.7	0.362
R680W680	84	0.381	83.8	0.386	82.1	0.435
R450W450	65	1.077	73.5	0.721	77.5	0.582
R710W710	58	1.44	64.7	1.089	74.2	0.694
R630W630	66	1.03	70	0.858	73.6	0.719
R570W570	66	1.03	72.3	0.766	73.3	0.73
R780W780	70	0.857	81.8	0.446	80	0.5
R700W700	76	0.6316	88.1	0.27	85	0.353
R1230W1230	65	1.077	73.5	0.722	72.3	0.766
R970W970	60	1.3334	72.2	0.769	75.5	0.651
R810W810	73	0.7397	80.7	0.469	76.5	0.614
R800W800	70	0.857	73.5	0.722	78.1	0.56
R1050W1050	73	0.7397	87.2	0.293	72.9	0.745
R790W790	71	0.8169	76.8	0.604	78.7	0.542
R910W910	65	1.077	73	0.738	72.8	0.749
R870W870	64	1.125	66.3	1.016	73.7	0.715
R830W830	66	1.03	71.4	0.802	75.9	0.636
R760W760	72	0.7778	72.8	0.747	73.5	0.72
R750W750	67	0.985	72.1	0.773	77.3	0.588
R650W650	70	0.857	84.1	0.377	84.4	0.37
R730W730	98	0.0408	98	0.041	98	0.041
R740W740	80	0.5	83.7	0.39	80.6	0.48
R1000W1000	70	0.857	72.6	0.753	71.6	0.793
R880W880	63	1.174	67.7	0.952	71.3	0.807
R1030W1030	55	1.636	60	1.333	60	1.333
R850W850	71	0.817	73	0.739	72.7	0.752
R1130W1130	57	1.509	61.2	1.265	70	0.858
R990W990	68	0.941	68	0.941	68	0.941
R930W930	74	0.703	87.3	0.292	86.3	0.317
R950W950	72	0.7778	83.5	0.396	85.6	0.337
R1010W1010	70	0.857	79.1	0.528	82.8	0.415
R1040W1040	67	0.985	76.7	0.609	82	0.44
R1060W1060	71	0.817	75	0.668	83	0.409
R980W980	79	0.532	85.2	0.348	88.6	0.258
R940W940	70	0.857	86	0.326	86	0.326

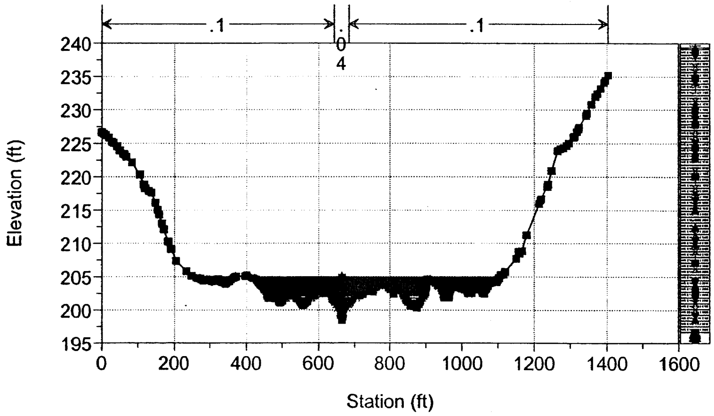
R1020W1020	67	0.985	72.9	0.743	72.1	0.775
R1140W1140	70	0.857	81.4	0.456	75.1	0.662
R1200W1200	73	0.7397	87.2	0.292	90.3	0.214
R1160W1160	60	1.333	65.8	1.041	83.9	0.383
R1180W1180	55	1.636	60	1.333	60	1.333
R1190W1190	70	0.857	81	0.469	77	0.599
R1290W1290	64	1.125	74.7	0.679	71.9	0.781
R1460W1460	67	0.985	79.9	0.504	78.6	0.544
R1540W1540	68	0.9412	84.5	0.368	81	0.469
R1530W1530	66	1.03	83.4	0.397	73.9	0.706
R1620W1620	76	0.6316	90	0.223	77.5	0.582
R1500W1500	60	1.333	66.6	1.004	71.5	0.797
R1720W1720	65	1.077	71.9	0.782	67.9	0.946
R1740W1740	59	1.389	71.7	0.789	61.8	1.235
R1880W1880	71	0.817	80.9	0.472	79.7	0.511
R1900W1900	71	0.817	85.6	0.355	80	0.502
R1890W1890	56	1.571	61.3	1.262	66.1	1.025
R1980W1980	60	1.333	65.4	1.057	69.1	0.895
R1930W1930	73	0.7397	88.1	0.271	87.2	0.294
R2260W2260	63	1.175	67.9	0.944	72.5	0.759
R2300W2300	64	1.125	83.8	0.387	73.7	0.714
R2080W2080	71	0.8169	88.9	0.25	77.6	0.576
R2360W2360	58	1.448	62.8	1.187	70.3	0.846
R2220W2220	70	0.857	69.6	0.875	70.4	0.843
R3060W3060	89	0.247	95.8	0.087	90.9	0.199
R2540W2540	69	0.8985	86.2	0.32	72.1	0.776
R2530W2530	57	1.509	62	1.228	74.4	0.689
R2410W2410	70	0.857	87.7	0.279	74.3	0.691
R2650W2650	59	1.39	64.3	1.112	66.6	1.002
R2610W2610	74	0.7027	79.7	0.509	81.2	0.463
R2950W2950	69	0.8986	70.2	0.848	82.9	0.411
R2550W2550	71	0.817	75.9	0.634	78.6	0.544
R2700W2700	67	0.985	88.6	0.257	67.6	0.958
R2780W2780	74	0.7027	79.2	0.526	81.7	0.447
R2840W2840	67	0.9851	87.5	0.285	80.8	0.477
R3050W3050	75	0.6667	80	0.5	84.2	0.374
R2910W2910	76	0.6316	80.8	0.473	82.5	0.423
R3270W3270	71	0.8169	88.5	0.26	84.5	0.368
R3100W3100	78	0.5641	87.2	0.293	88.6	0.258
R3130W3130	73	0.7397	76.5	0.614	86.5	0.311
R3250W3250	75	0.667	86.3	0.318	90.1	0.219
R3150W3150	85	0.3529	92.2	0.168	94.9	0.108
R3070W3070	66	1.03	70.3	0.843	70.9	0.819
R3220W3220	84	0.381	86.5	0.312	83.9	0.385
R3330W3330	90	0.2222	93.6	0.137	84	0.38
R3350W3350	83	0.4096	85.5	0.34	91.7	0.182
R3020W3020	70	0.857	76.6	0.611	78.8	0.538
R2790W2790	62	1.226	67.5	0.962	70.1	0.854
R2890W2890	59	1.39	65	1.079	68.7	0.913
R2990W2990	61	1.2787	68	0.942	67.1	0.978
R2760W2760	68	0.9412	67.3	0.97	71.3	0.807
R2770W2770	66	1.03	68.1	0.938	67.6	0.96
R3080W3080	70	0.8571	84.2	0.375	82.4	0.428
R3000W3000	63	1.175	75	0.666	70	0.856

R2980W2980	59	1.39	66.3	1.017	80.1	0.498
R3090W3090	70	0.8571	82.9	0.413	81.8	0.446
R3370W3370	69	0.8985	88.5	0.26	75.7	0.641
R3360W3360	71	0.8169	80.8	0.476	81.7	0.448
R3470W3470	62	1.226	72.3	0.766	73.8	0.711
R3110W3110	64	1.125	69.9	0.862	74.6	0.682
R3140W3140	70	0.8571	75.9	0.634	69.8	0.866
R3410W3410	62	1.226	64.7	1.093	66.7	0.997
R3400W3400	62	1.226	64.1	1.119	69.2	0.889
R3480W3480	63	1.175	71.2	0.81	75.2	0.661
R3610W3610	68	0.9412	68	0.941	68	0.941
R3640W3640	63	1.175	69.8	0.867	70.5	0.836
R3710W3710	65	1.077	65.6	1.049	68.4	0.924
R3700W3700	70	0.8571	70	0.859	69.5	0.877
R3170W3170	61	1.279	65.2	1.067	66.1	1.026
R3180W3180	58	1.448	66.4	1.011	66.2	1.022
R3010W3010	61	1.279	66	1.028	65.6	1.047
R3580W3580	71	0.8169	70.9	0.821	74.9	0.67
R3460W3460	71	0.8169	71.5	0.798	82.9	0.414
R3340W3340	86	0.3256	87.8	0.277	90.3	0.215
R3390W3390	75	0.6667	77.6	0.577	84.7	0.361
R3560W3560	84	0.3809	87	0.3	92.8	0.156
R3550W3550	79	0.5316	84.3	0.373	87.8	0.278
R3740W3740	89	0.2472	90.9	0.2	92.4	0.165
R3770W3770	91	0.1978	90.9	0.201	94.2	0.124
R3870W3870	91	0.1978	91.2	0.193	94.2	0.124
R3930W3930	92	0.1739	91.9	0.176	94	0.128
R3910W3910	91	0.1978	90.9	0.2	94.6	0.115
R3920W3920	93	0.1505	92.9	0.155	93.6	0.136
R3940W3940	95	0.1053	94.8	0.11	93.7	0.135
R4030W4030	96	0.0833	95.8	0.088	92.4	0.164
R3980W3980	93	0.1505	92.9	0.153	93.5	0.14
R3990W3990	92	0.1739	92	0.174	91	0.197
R4080W4080	90	0.2222	92.2	0.169	93.2	0.147
R4070W4070	84	0.3809	93.2	0.146	94.5	0.116
R3860W3860	88	0.2727	90.1	0.219	91.6	0.185
R4340W4340	93	0.1505	93.1	0.149	92.1	0.171
R4370W4370	86	0.3256	86.4	0.315	86.6	0.308
R4430W4430	93	0.1739	92.2	0.169	91	0.197
R4330W4330	93	0.1505	93.1	0.148	93	0.152
R4460W4460	92	0.1739	91.8	0.18	75.7	0.64
R4470W4470	82	0.439	86	0.326	80.1	0.497
R4450W4450	68	0.9412	73	0.739	74.4	0.686
R4350W4350	71	0.8169	66.7	0.999	68.6	0.917
R4270W4270	73	0.7397	72.2	0.768	80.1	0.495
R4190W4190	74	0.7027	79	0.53	86.4	0.316
R4170W4170	81	0.4691	90.3	0.215	94.3	0.12
R4000W4000	79	0.5316	91.6	0.184	92.2	0.169
R3890W3890	80	0.5	94.7	0.112	89.2	0.242
R4150W4150	75	0.6667	82.5	0.424	85.1	0.35
R4060W4060	74	0.7027	87.1	0.296	82.4	0.428
R3950W3950	70	0.8571	93.2	0.145	81.4	0.456
R3900W3900	74	0.7027	92.8	0.156	81.2	0.463
R4010W4010	78	0.5641	93.5	0.139	87.4	0.288

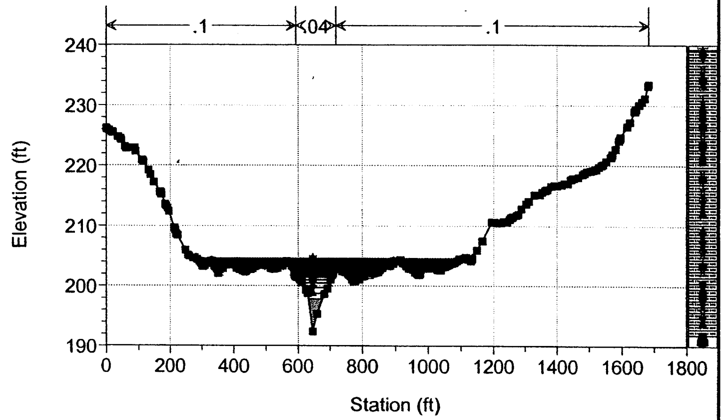
R4390W4390	75	0.6667	79.3	0.521	77.5	0.579
R4280W4280	79	0.5316	83.2	0.405	91.5	0.186
R3690W3690	77	0.5974	93	0.15	84.5	0.368
R3600W3600	76	0.6316	76.4	0.617	84.7	0.36
R3680W3680	84	0.3809	88.9	0.249	85.8	0.33
R3520W3520	83	0.4096	83.4	0.397	84.8	0.358
R3830W3830	85	0.3529	91.1	0.196	91.7	0.18
R3760W3760	76	0.6316	88.4	0.262	87.4	0.289
R3570W3570	74	0.7027	76.8	0.604	86.6	0.31
R3500W3500	72	0.77778	74.7	0.678	80.9	0.471
R3450W3450	77	0.5974	82.3	0.43	82.5	0.424
R3190W3190	81	0.4691	80.7	0.478	82.2	0.434
R3280W3280	75	0.6667	74.8	0.673	80.8	0.474
R3260W3260	77	0.5974	75.1	0.663	80.6	0.482
R3240W3240	68	0.9412	70.4	0.841	81	0.468
R3230W3230	77	0.5974	82	0.439	82	0.439
R3200W3200	72	0.7778	76	0.632	81.5	0.454
R2970W2970	75	0.6667	75.4	0.653	79.6	0.514
R2920W2920	74	0.7027	75.3	0.657	80	0.501
R3160W3160	75	0.6667	76.1	0.628	80.8	0.476
R3440W3440	74	0.7027	75.6	0.647	83.8	0.383
R3320W3320	75	0.6667	77.6	0.579	85.9	0.329
R2930W2930	72	0.7778	81.2	0.463	82.1	0.437
R3120W3120	79	0.5316	78.6	0.545	78	0.563
R2800W2800	75	0.6667	79.8	0.507	73.1	0.735
R2710W2710	72	0.7778	72	0.778	73.9	0.707
R2720W2720	73	0.7397	75.3	0.657	79.9	0.502
R2670W2670	69	0.8985	90.2	0.218	76.9	0.6
R2500W2500	68	0.9412	81.8	0.446	72.6	0.755
R2520W2520	71	0.8169	75.4	0.652	73.6	0.718
R2560W2560	70	0.8571	74.7	0.677	74.1	0.7
R2600W2600	72	0.7778	70.7	0.829	73.9	0.707
R2580W2580	63	1.1746	64.8	1.086	71	0.817
R2620W2620	65	1.077	64.7	1.09	69.4	0.88
R2510W2510	70	0.8571	74.2	0.695	72.2	0.769
R2570W2570	71	0.8169	75.1	0.663	74.3	0.692
R2480W2480	75	0.6667	92.9	0.152	77.5	0.581
R2190W2190	71	0.8169	72.8	0.749	73.4	0.726
R2440W2440	71	0.8169	76.5	0.614	73.6	0.718
R2200W2200	70	0.8571	69.6	0.875	73.3	0.73
R2210W2210	69	0.8985	69.7	0.87	68.6	0.916
R2060W2060	77	0.5974	80.7	0.479	76.5	0.614
R2090W2090	68	0.9412	68.4	0.926	72	0.776
R2370W2370	69	0.8985	75.9	0.633	77.7	0.574
R2000W2000	69	0.8985	71.2	0.808	82.1	0.436
R1750W1750	70	0.8571	70.6	0.834	74	0.704
R1650W1650	67	0.9851	70.6	0.834	74.4	0.688
R1640W1640	59	1.3898	66.8	0.996	82	0.438
R1630W1630	72	0.7778	83.5	0.397	81.4	0.457
R1430W1430	67	0.9851	77.9	0.566	81.7	0.447
R1490W1490	70	0.8571	78.1	0.562	78.2	0.558
R1470W1470	72	0.7778	77.4	0.583	71.2	0.811
R1590W1590	59	1.3898	66	1.032	68.1	0.935
R1510W1510	68	0.9412	68.7	0.911	69.9	0.863

R1680W1680	69	0.8985	69.4	0.881	69.9	0.861
R1690W1690	76	0.6316	76.3	0.62	72.3	0.766
R1760W1760	70	0.8571	69	0.898	74.6	0.68
R1670W1670	74	0.7027	73.6	0.718	74.8	0.672
R1940W1940	69	0.8985	68.8	0.908	69.3	0.888
R2180W2180	68	0.9412	68.1	0.937	70.3	0.843
R1970W1970	73	0.7397	73.4	0.725	71.5	0.799
R2010W2010	76	0.6316	80.6	0.483	70	0.858
R1400W1400	73	0.7397	72.5	0.757	71.2	0.809
R1920W1920	84	0.3809	80.3	0.492	95.3	0.099
R1790W1790	75	0.66667	84.5	0.367	86.1	0.322
R1800W1800	72	0.7778	74.8	0.675	76.1	0.629
R1700W1700	71	0.8169	77.1	0.595	83.7	0.388
R2100W2100	72	0.7778	75.8	0.637	75.2	0.66
R1360W1360	56	1.5714	60.6	1.301	65.7	1.043
R1100W1100	62	1.226	63.9	1.129	72.3	0.765
R920W920	59	1.39	64.1	1.12	65.5	1.053
R1330W1330	63	1.175	68.4	0.925	67.9	0.946
R1420W1420	67	0.9851	80.1	0.498	78.1	0.561
R1150W1150	68	0.9412	71.6	0.795	73	0.74
R2120W2120	60	1.3333	68.4	0.926	73.2	0.732
R2960W2960	63	1.175	68.3	0.929	73.7	0.715
R2290W2290	57	1.509	63.1	1.169	72.3	0.765
R2250W2250	70	0.8571	74.2	0.694	70.3	0.847
R2070W2070	74	0.7027	78.9	0.534	76.6	0.61
R2030W2030	59	1.3898	65.6	1.05	65.6	1.05
R2020W2020	56	1.5714	61.7	1.24	61.9	1.232
R1440W1440	63	1.1746	73	0.738	65.2	1.067
R2390W2390	68	0.9412	69.3	0.885	70.6	0.835
R1660W1660	65	1.077	74.8	0.674	80.6	0.481
R1450W1450	54	1.7037	59.6	1.356	61.9	1.233
R1300W1300	66	1.03	78.2	0.558	81.3	0.46
R1270W1270	56	1.571	61.4	1.258	61.8	1.237
R1080W1080	62	1.2258	73	0.739	75.3	0.657
R1560W1560	69	0.89855	79.7	0.509	78.3	0.555
R900W900	69	0.89855	82.7	0.418	85.8	0.33
R1260W1260	60	1.3333	68.8	0.909	76.7	0.608
R1340W1340	65	1.077	77.2	0.59	81.6	0.452
R1860W1860	69	0.89855	83.8	0.386	82.8	0.414
R1390W1390	58	1.448	64.9	1.079	72.2	0.772
R1600W1600	67	0.9851	76.1	0.629	78.2	0.557
R1710W1710	60	1.3333	74.3	1.11	72.7	0.752
R1990W1990	58	1.4483	63.4	1.156	70.7	0.828
R2380W2380	55	1.636	60.6	1.3	61.1	1.271
R1280W1280	59	1.3898	65	1.076	69.5	0.878
R1780W1780	70	0.8571	71.6	0.795	73.5	0.721
R1810W1810	72	0.77778	74.6	0.68	78	0.563
R2280W2280	68	0.9412	66.3	1.018	71.7	0.789
R2350W2350	71	0.8169	71.2	0.81	71.2	0.809
R2110W2110	57	1.5087	61.8	1.235	67.2	0.975
R2400W2400	64	1.125	70.9	0.819	70.7	0.83
R2320W2320	74	0.7027	75.4	0.651	76.4	0.617
R2340W2340	59	1.3898	63.9	1.128	61.2	1.267
R2330W2330	74	0.7027	79	0.532	74.3	0.692

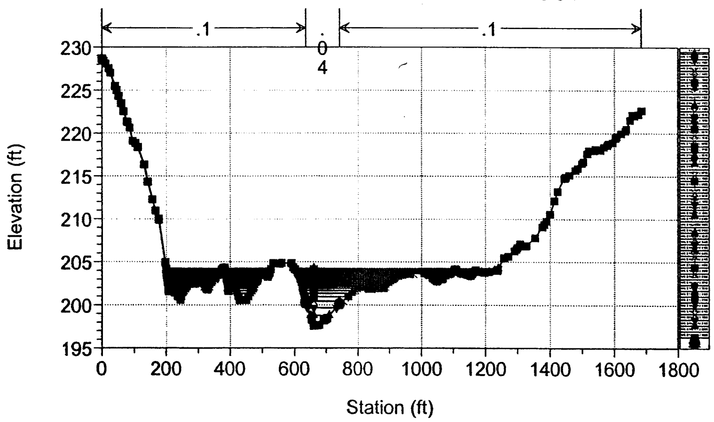
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 24885.54



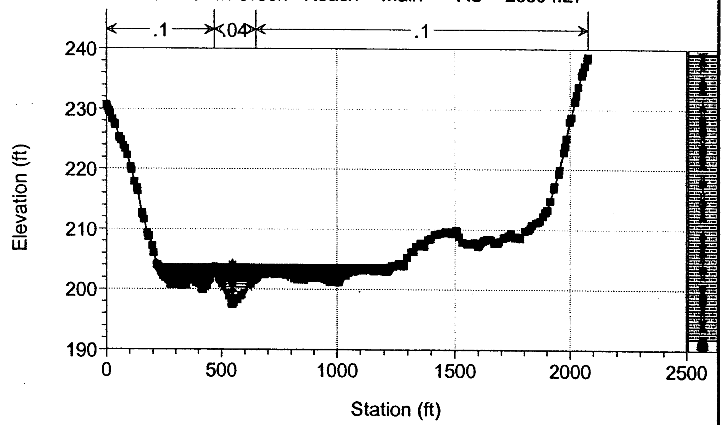
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 24497.86



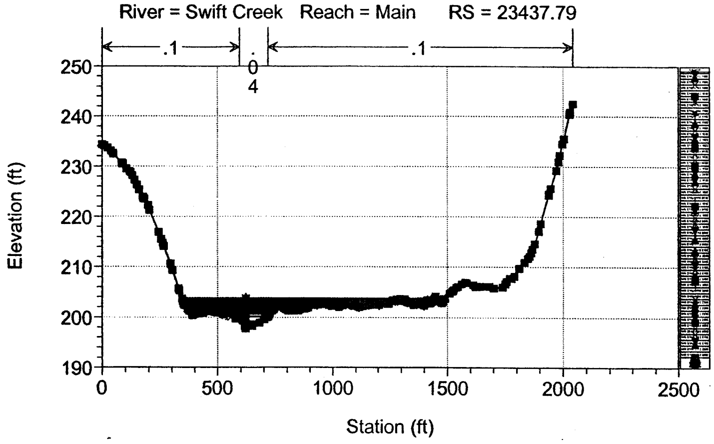
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 24115.82



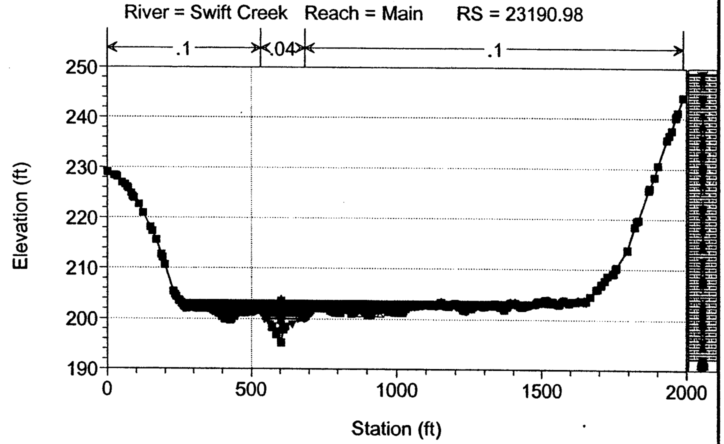
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 23894.27



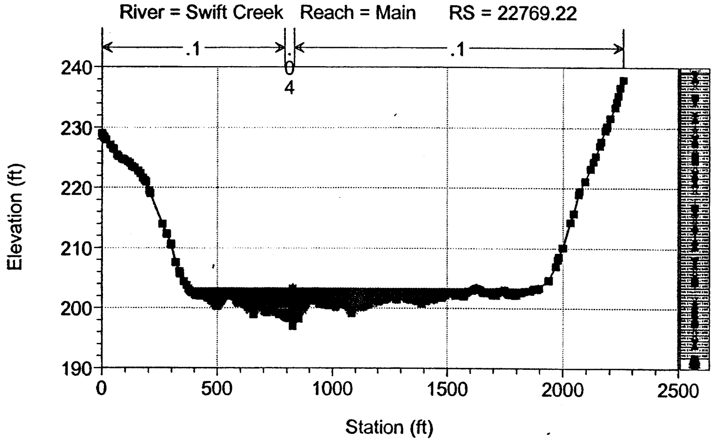
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 23437.79



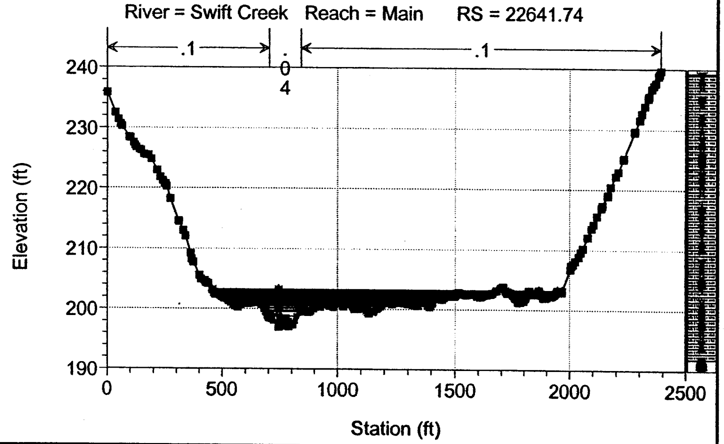
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 23190.98

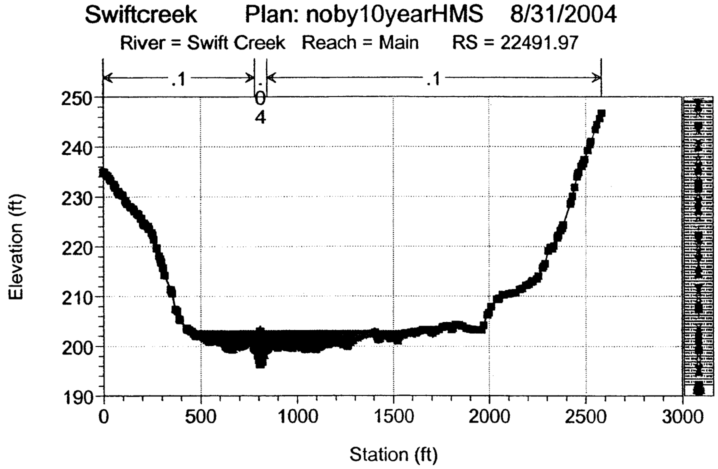


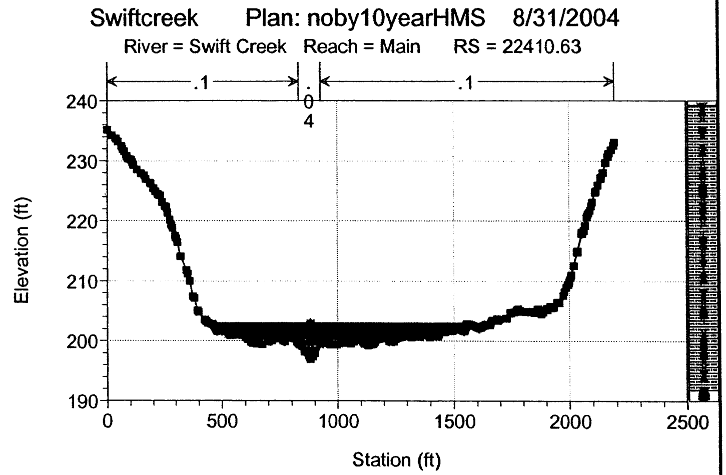
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 22769.22

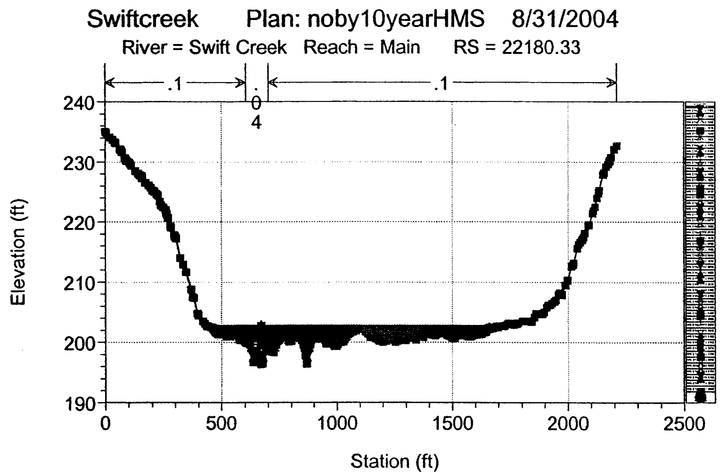


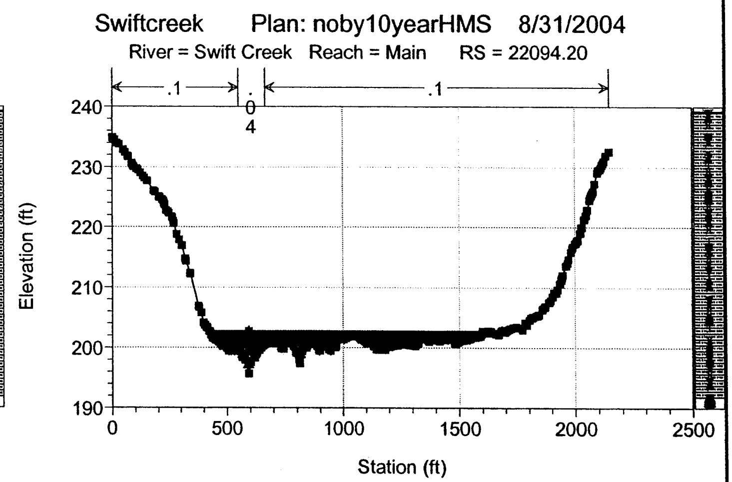
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 22641.74

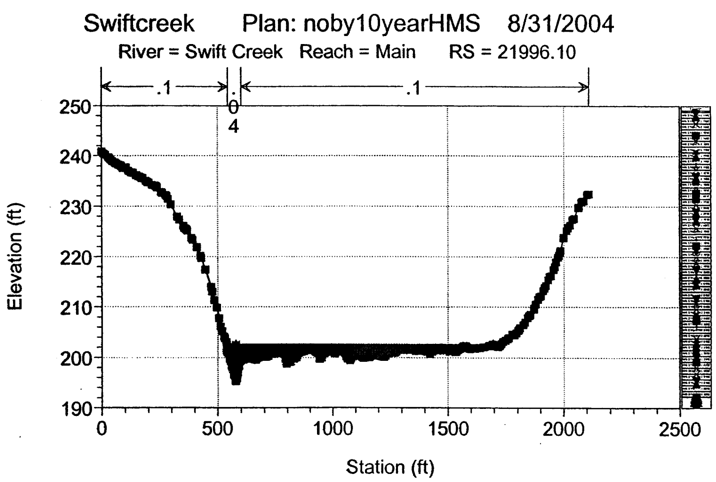


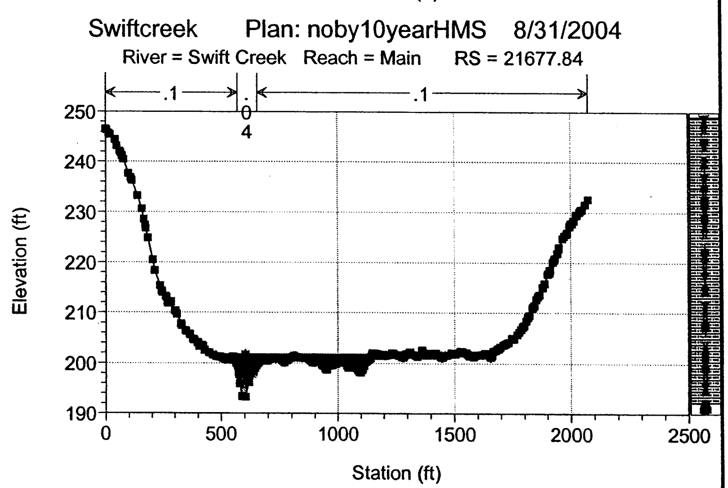

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 22491.97
.1
.04
.1
Elevation (ft)
Station (ft)

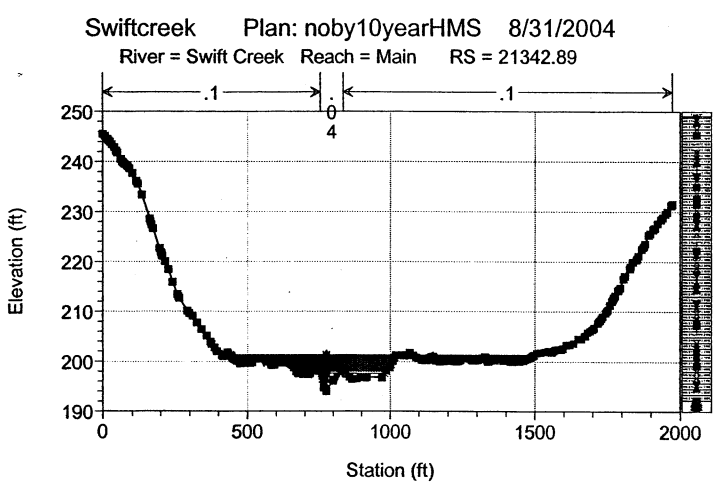

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 22410.63
.1
.04
.1
Elevation (ft)
Station (ft)

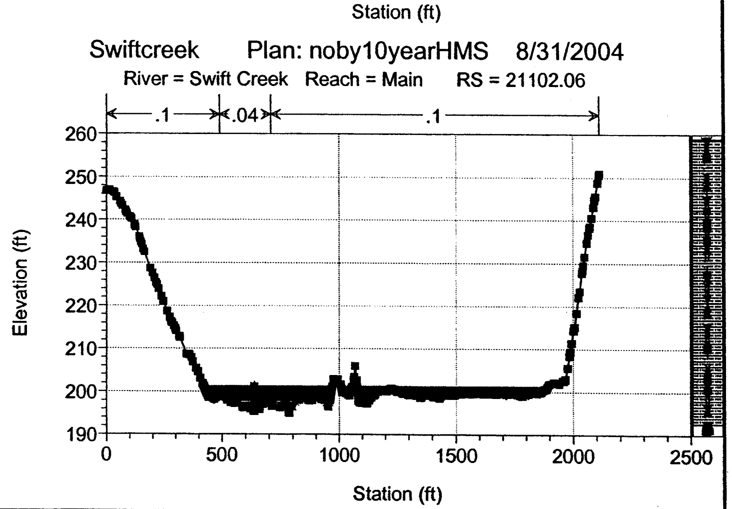

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 22180.33
.1
.04
.1
Elevation (ft)
Station (ft)

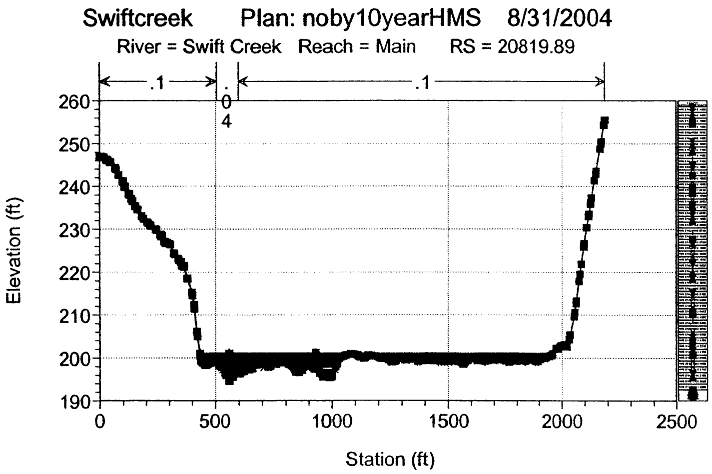

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 22094.20
.1
.04
.1
Elevation (ft)
Station (ft)

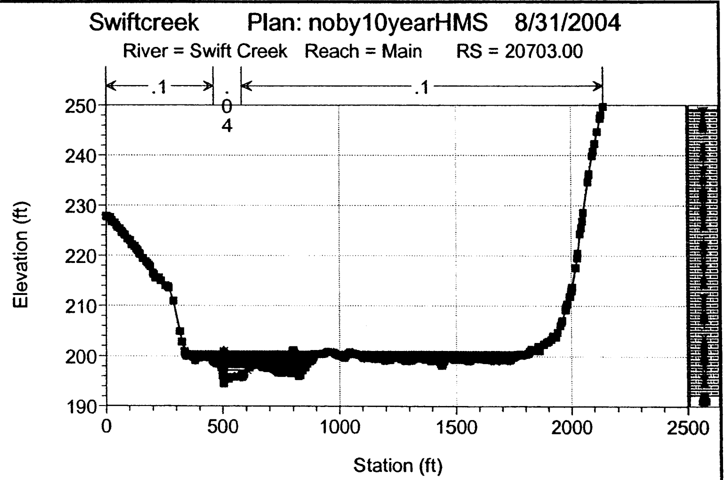

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 21996.10
.1
.04
.1
Elevation (ft)
Station (ft)

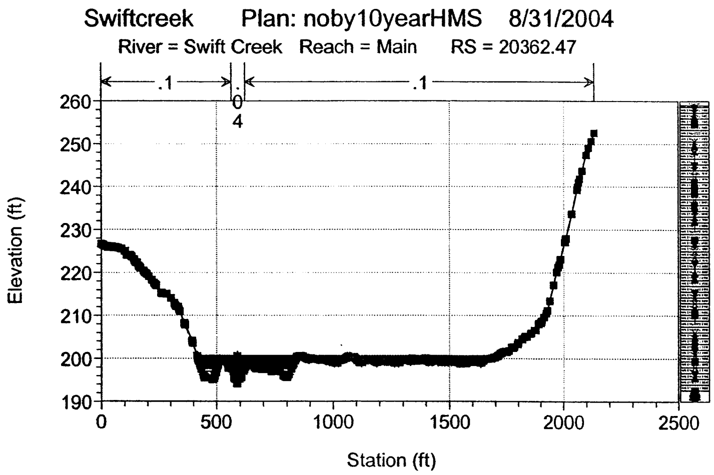

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 21677.84
.1
.04
.1
Elevation (ft)
Station (ft)


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 21342.89
.1
.04
.1
Elevation (ft)
Station (ft)


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 21102.06
.1
.04
.1
Elevation (ft)
Station (ft)


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 20819.89
.1
.04
.1
Elevation (ft)
Station (ft)


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 20703.00
.1
.04
.1
Elevation (ft)
Station (ft)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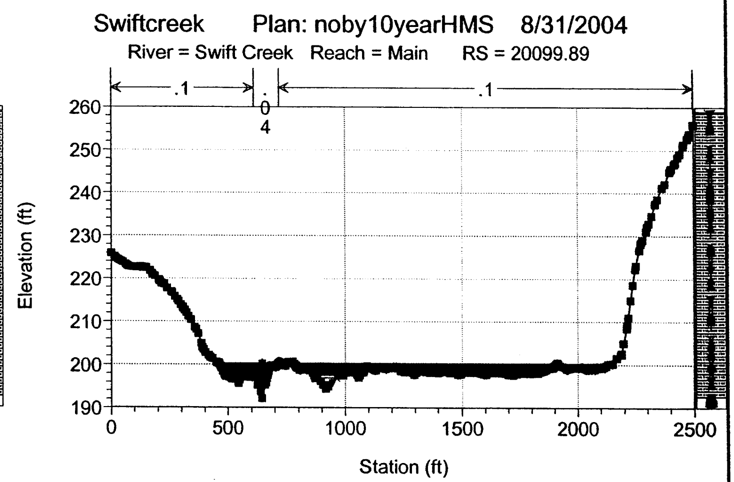
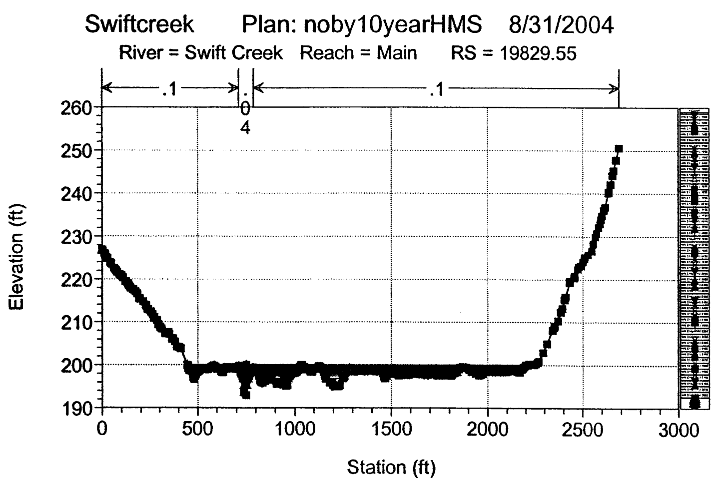
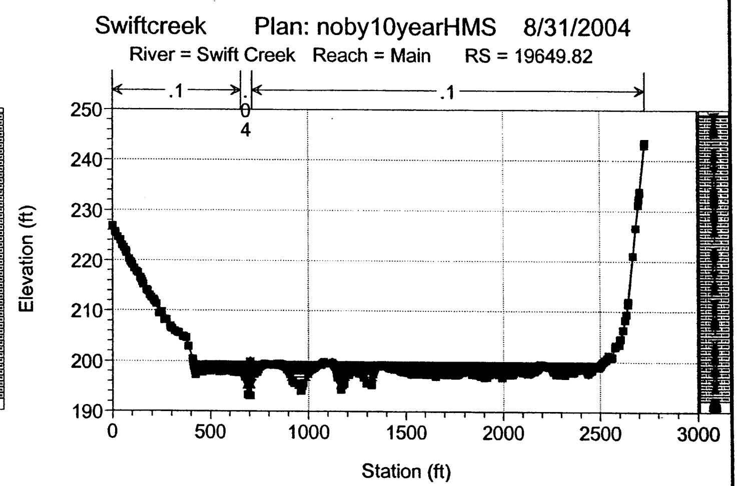
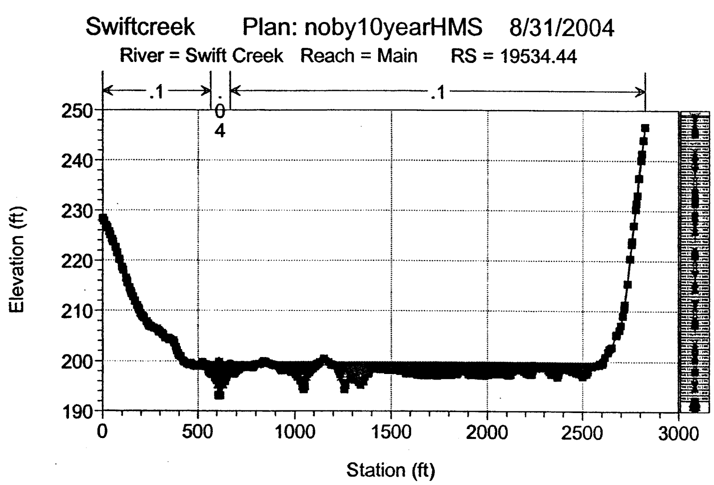
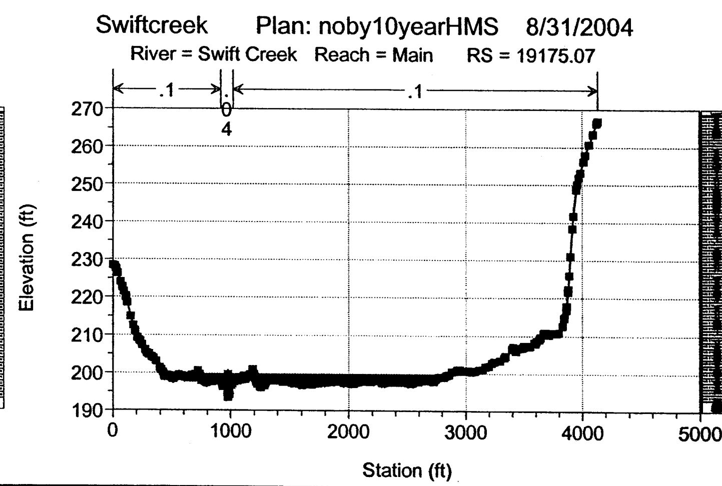
River = Swift Creek Reach = Main RS = 20362.47
.1
.04
.1
Elevation (ft)
Station (ft)

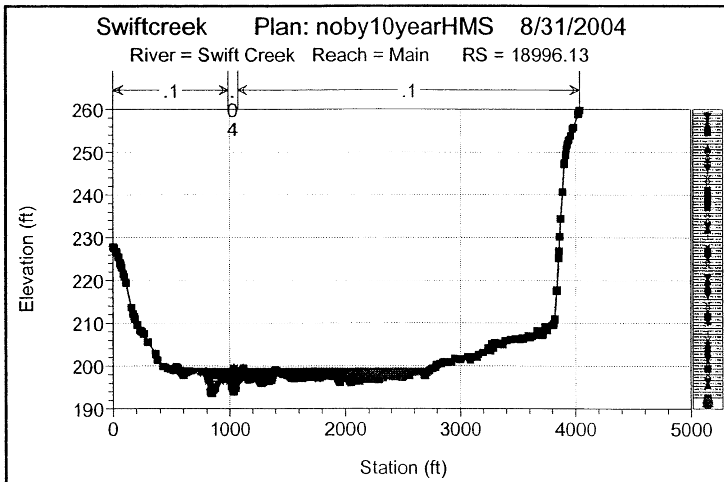

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 20099.89
.1
.04
.1
Elevation (ft)
Station (ft)

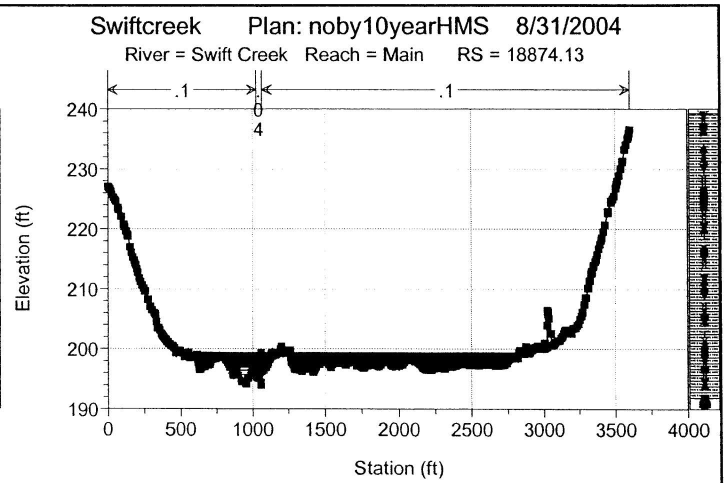

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 19829.55
.1
.04
.1
Elevation (ft)
Station (ft)

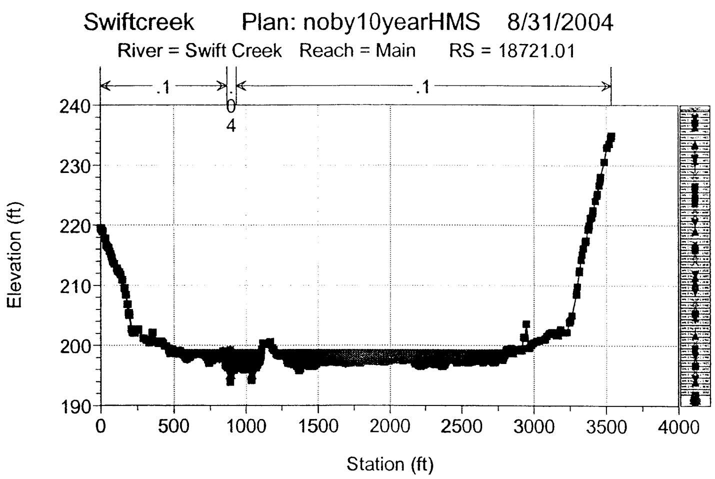

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 19649.82
.1
.04
.1
Elevation (ft)
Station (ft)

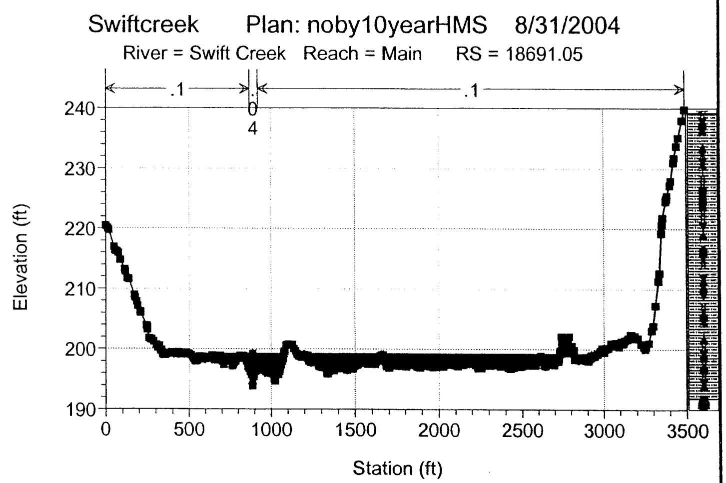

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 19534.44
.1
.04
.1
Elevation (ft)
Station (ft)

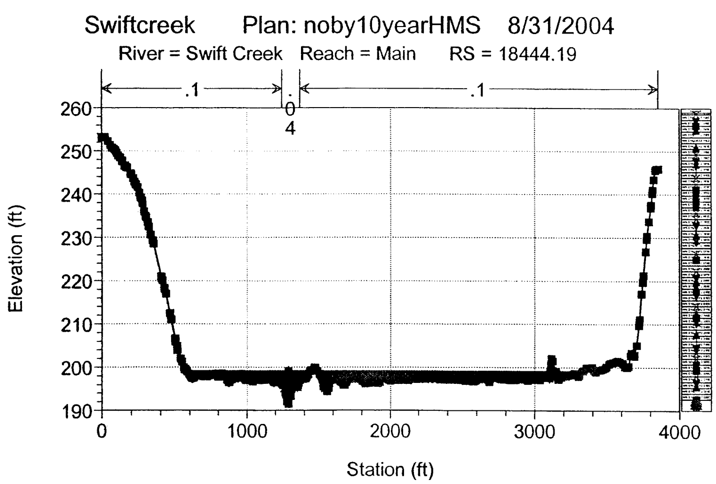

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 19175.07
.1
.04
.1
Elevation (ft)
Station (ft)

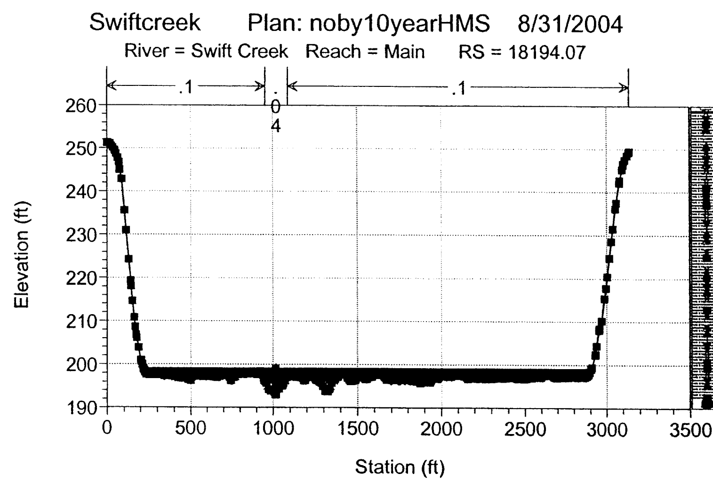

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 18996.13
.1
.04
.1
Elevation (ft)
Station (ft)

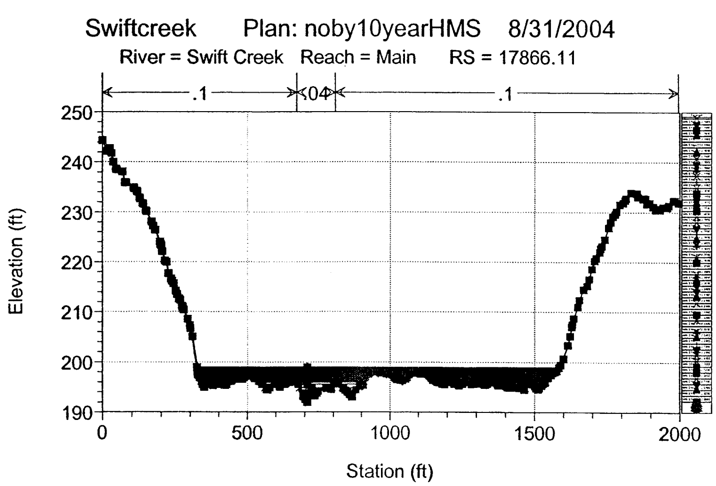

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 18874.13
.1
.04
.1
Elevation (ft)
Station (ft)

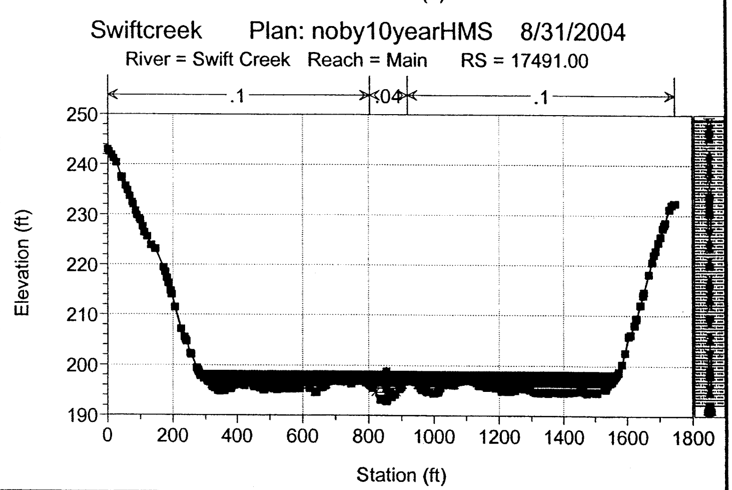

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 18721.01
.1
.04
.1
Elevation (ft)
Station (ft)


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 18691.05
.1
.04
.1
Elevation (ft)
Station (ft)

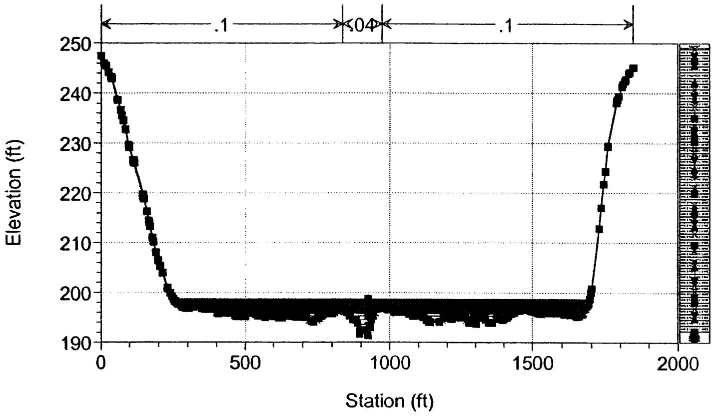

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 18444.19
.1
.04
.1
Elevation (ft)
Station (ft)


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 18194.07
.1
.04
.1
Elevation (ft)
Station (ft)

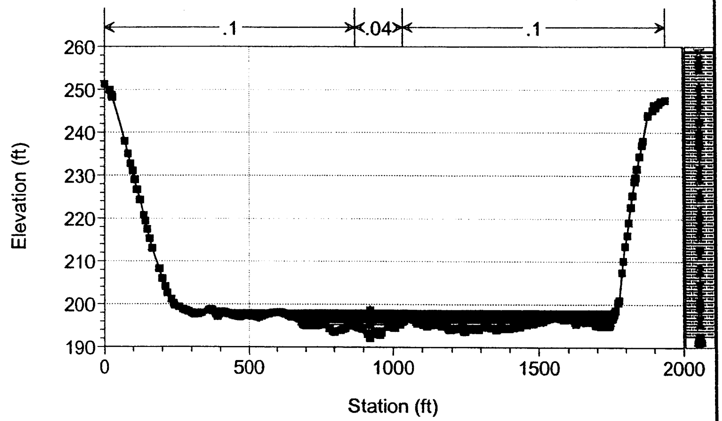

Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 17866.11
.1
.04
.1
Elevation (ft)
Station (ft)


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 17491.00
.1
.04
.1
Elevation (ft)
Station (ft)

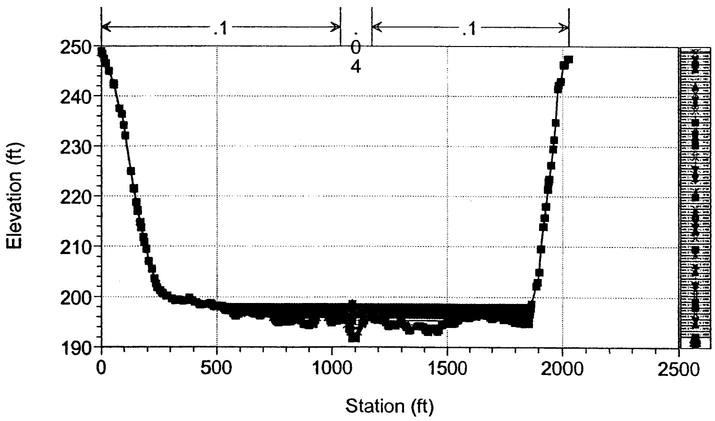
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 17220.71



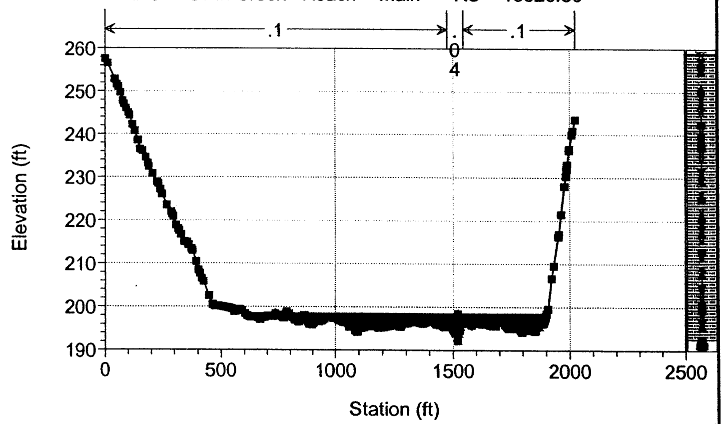
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 17100.03



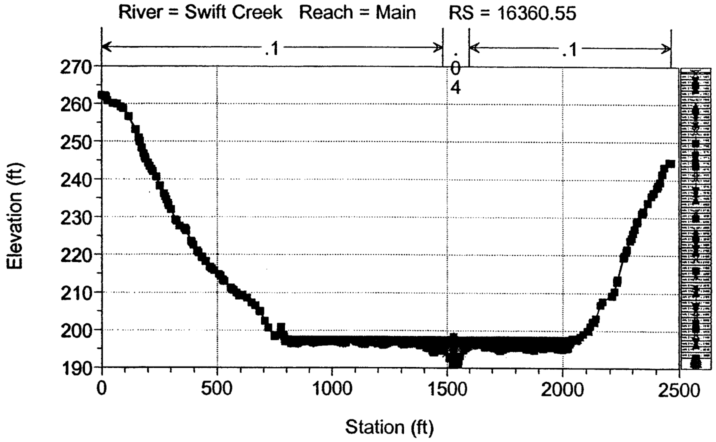
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 16941.30



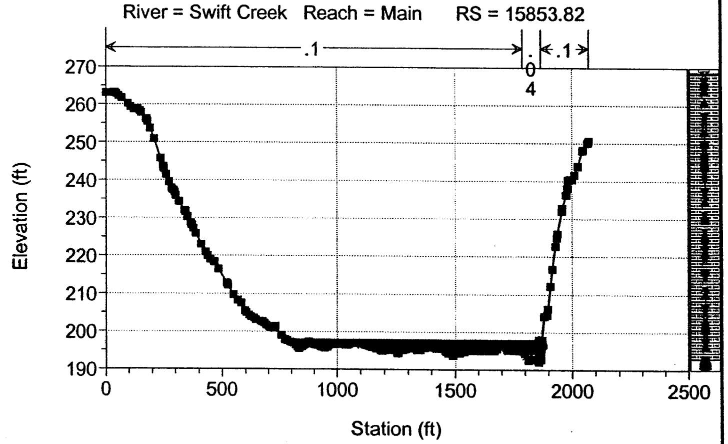
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 16523.56



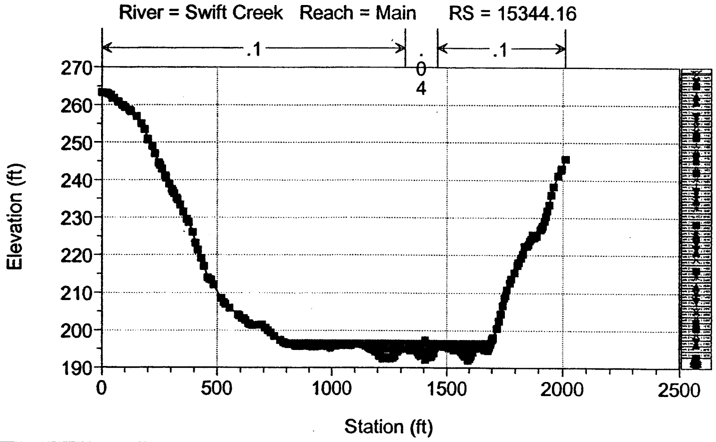
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 16360.55



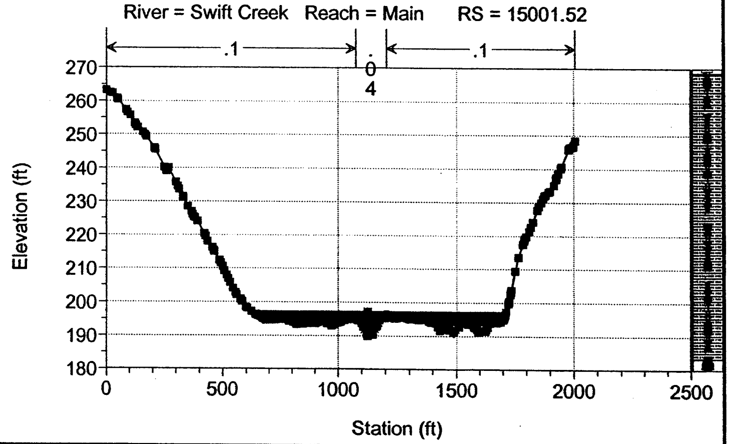
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 15853.82

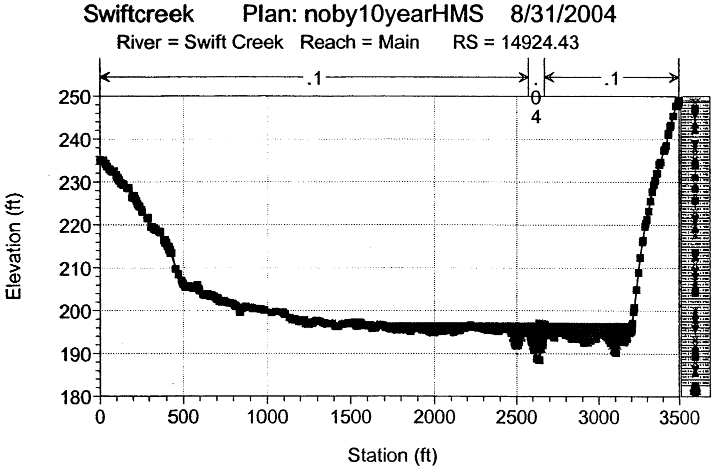


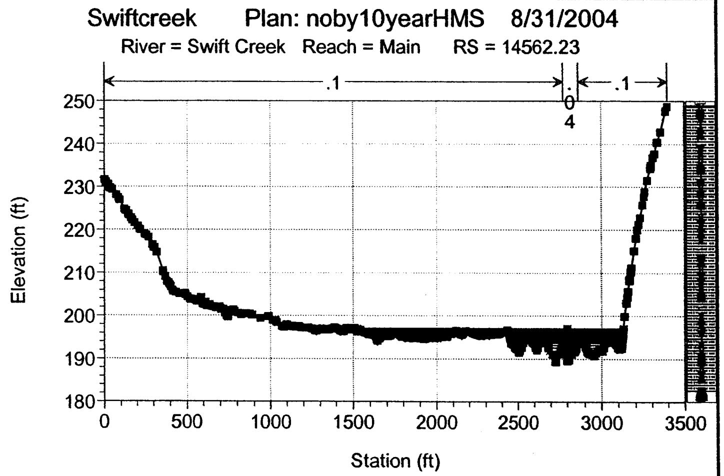
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 15344.16

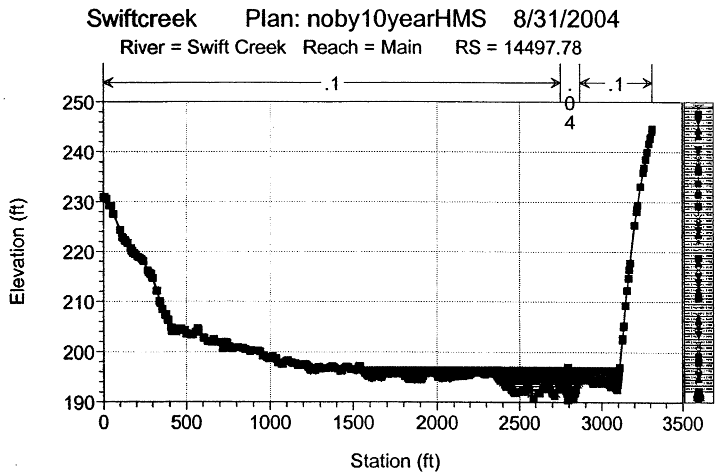


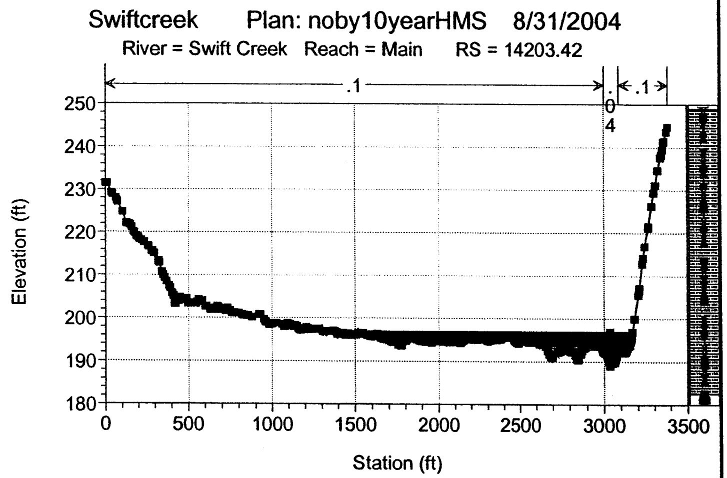
Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 15001.52




Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 14924.43
.1
.04
.1
Elevation (ft)
Station (ft)
250
240
230
220
210
200
190
180
0
500
1000
1500
2000
2500
3000
3500


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 14562.23
.1
.04
.1
Elevation (ft)
Station (ft)
250
240
230
220
210
200
190
180
0
500
1000
1500
2000
2500
3000
3500


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 14497.78
.1
.04
.1
Elevation (ft)
Station (ft)
250
240
230
220
210
200
190
0
500
1000
1500
2000
2500
3000
3500


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 14203.42
.1
.04
.1
Elevation (ft)
Station (ft)
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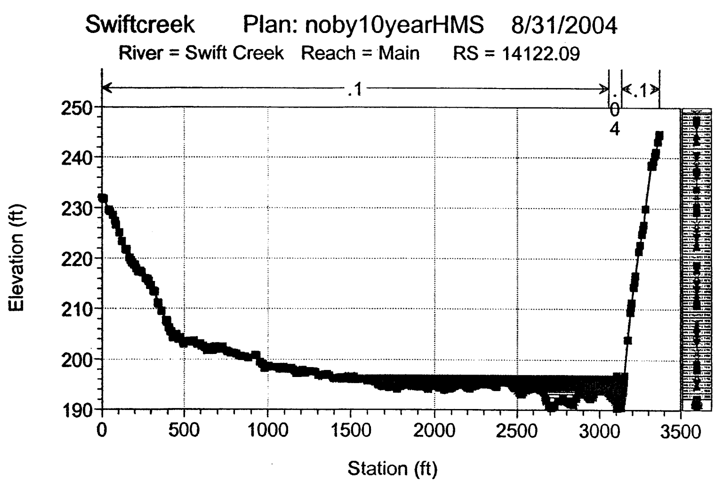
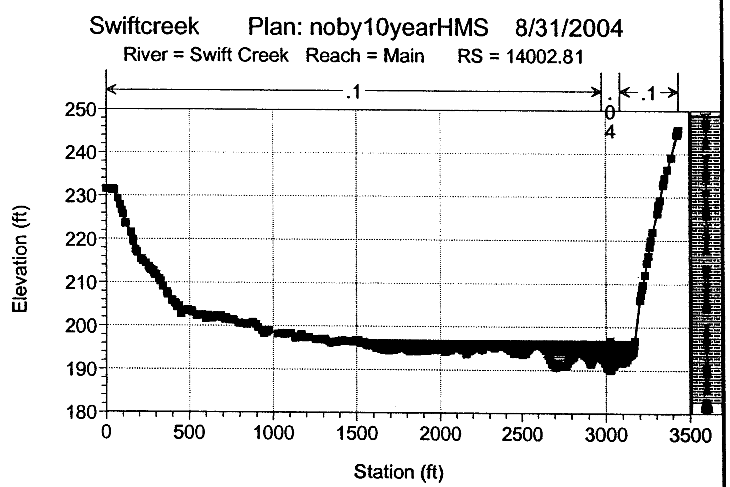
240
230
220
210
200
190
180
0
500
1000
1500
2000
2500
3000
3500


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 14122.09
.1
.04
.1
Elevation (ft)
Station (ft)
250
240
230
220
210
200
190
0
500
1000
1500
2000
2500
3000
3500


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 14002.81
.1
.04
.1
Elevation (ft)
Station (ft)
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240
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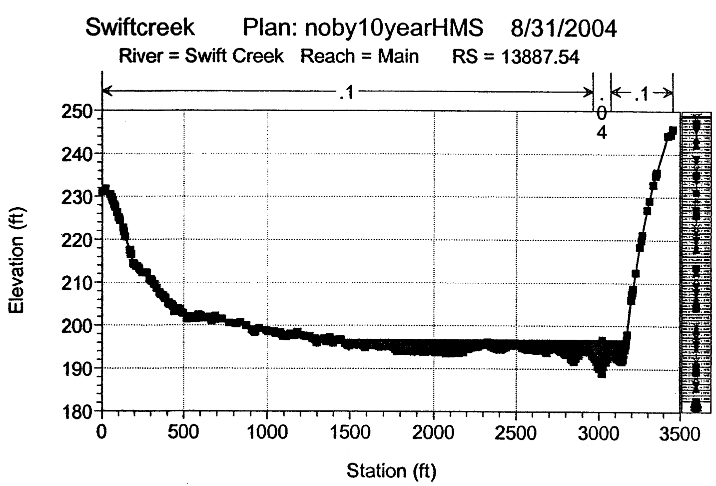
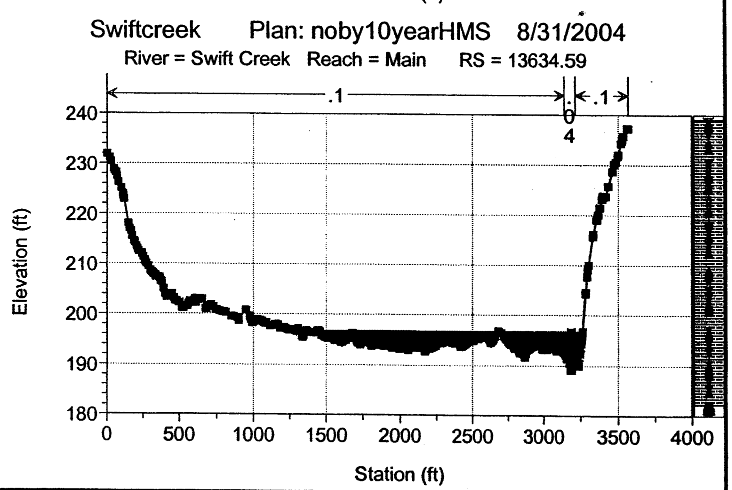
210
200
190
180
0
500
1000
1500
2000
2500
3000
3500


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 13887.54
.1
.04
.1
Elevation (ft)
Station (ft)
250
240
230
220
210
200
190
180
0
500
1000
1500
2000
2500
3000
3500


Swiftcreek Plan: noby10yearHMS 8/31/2004
River = Swift Creek Reach = Main RS = 13634.59
.1
.04
.1
Elevation (ft)
Station (ft)
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230
220
210
200
190
180
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1000
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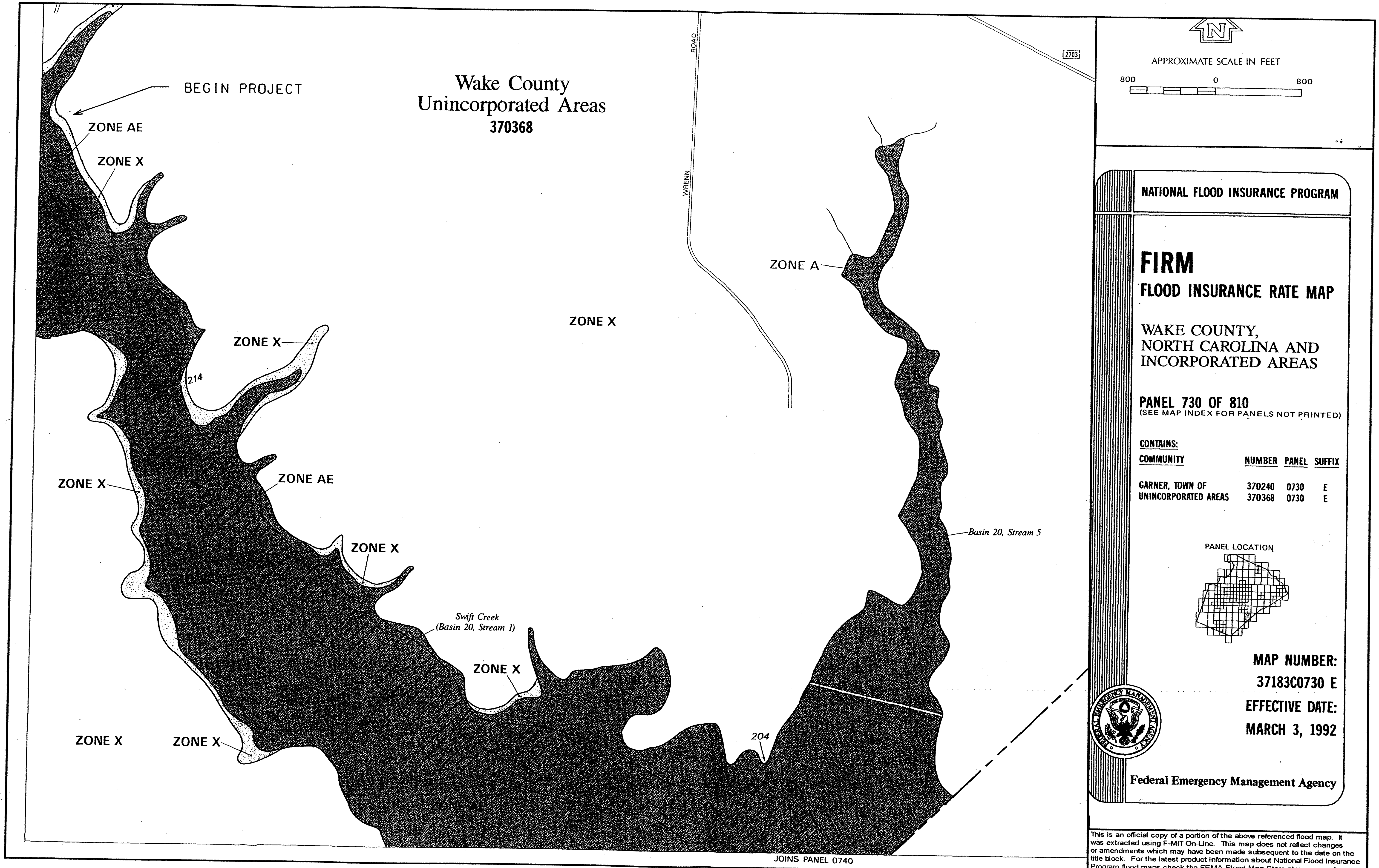
2500
3000
3500
4000



BEGIN PROJECT
Wake County
Unincorporated Areas
370368
ZONE AE
ZONE X
ZONE A
WRENN ROAD
2703
214
Swift Creek
(Basin 20, Stream 1)
Basin 20, Stream 5
204
JOINS PANEL 0740
APPROXIMATE SCALE IN FEET
800
0
800
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
WAKE COUNTY,
NORTH CAROLINA AND
INCORPORATED AREAS
PANEL 730 OF 810
(SEE MAP INDEX FOR PANELS NOT PRINTED)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
GARNER, TOWN OF 370240 0730 E
UNINCORPORATED AREAS 370368 0730 E
PANEL LOCATION
MAP NUMBER:
37183C0730 E
EFFECTIVE DATE:
MARCH 3, 1992
Federal Emergency Management Agency
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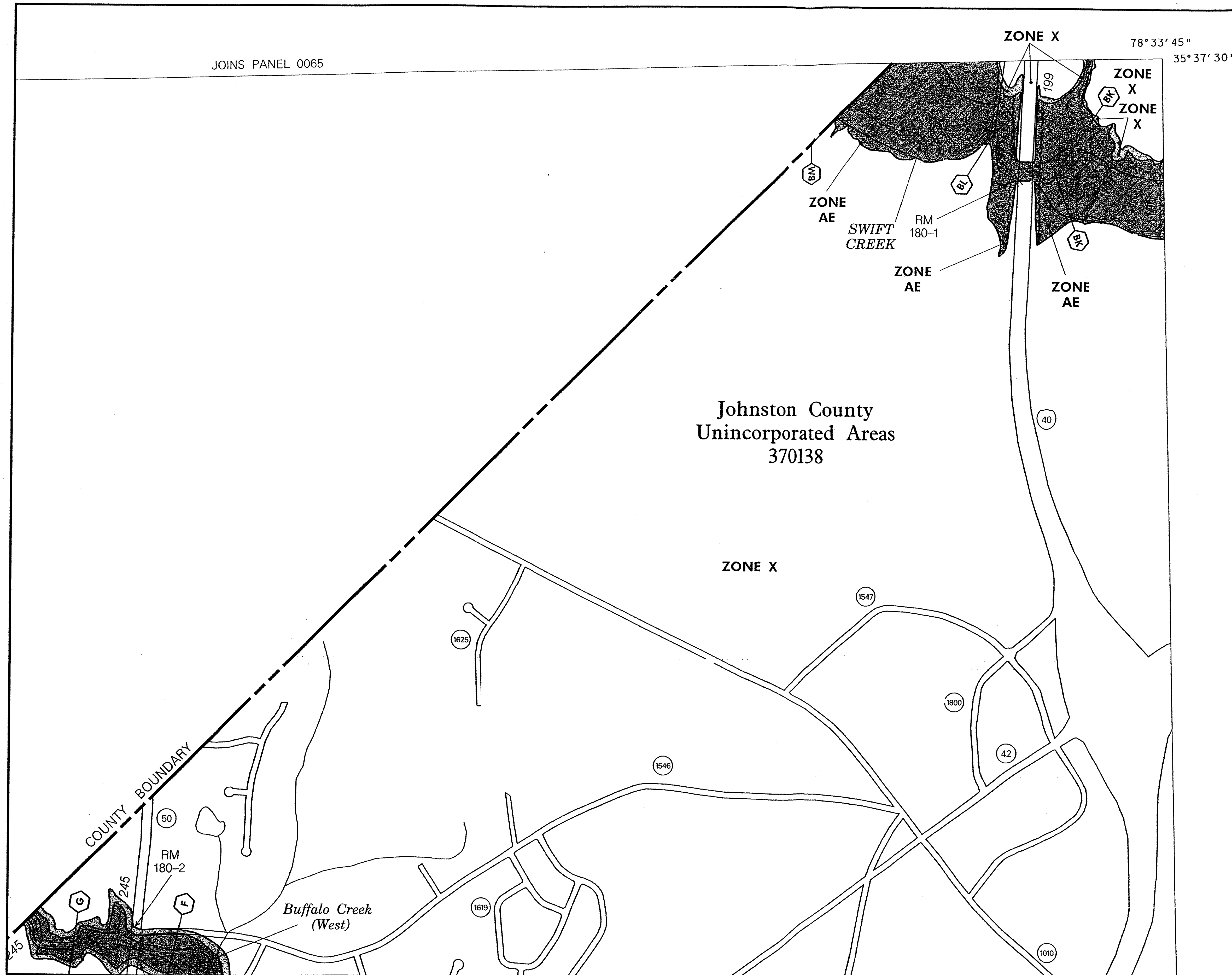

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
JOHNSTON COUNTY,
NORTH CAROLINA
AND INCORPORATED AREAS

PANEL 180 OF 535

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
JOHNSTON COUNTY	370138	0180	D

Notice to User: The MAP NUMBER shown below should be used when placing map orders; the COMMUNITY NUMBER shown above should be used on insurance applications for the subject community.

MAP NUMBER
37101C0180 D

EFFECTIVE DATE:
OCTOBER 20, 2000

Federal Emergency Management Agency

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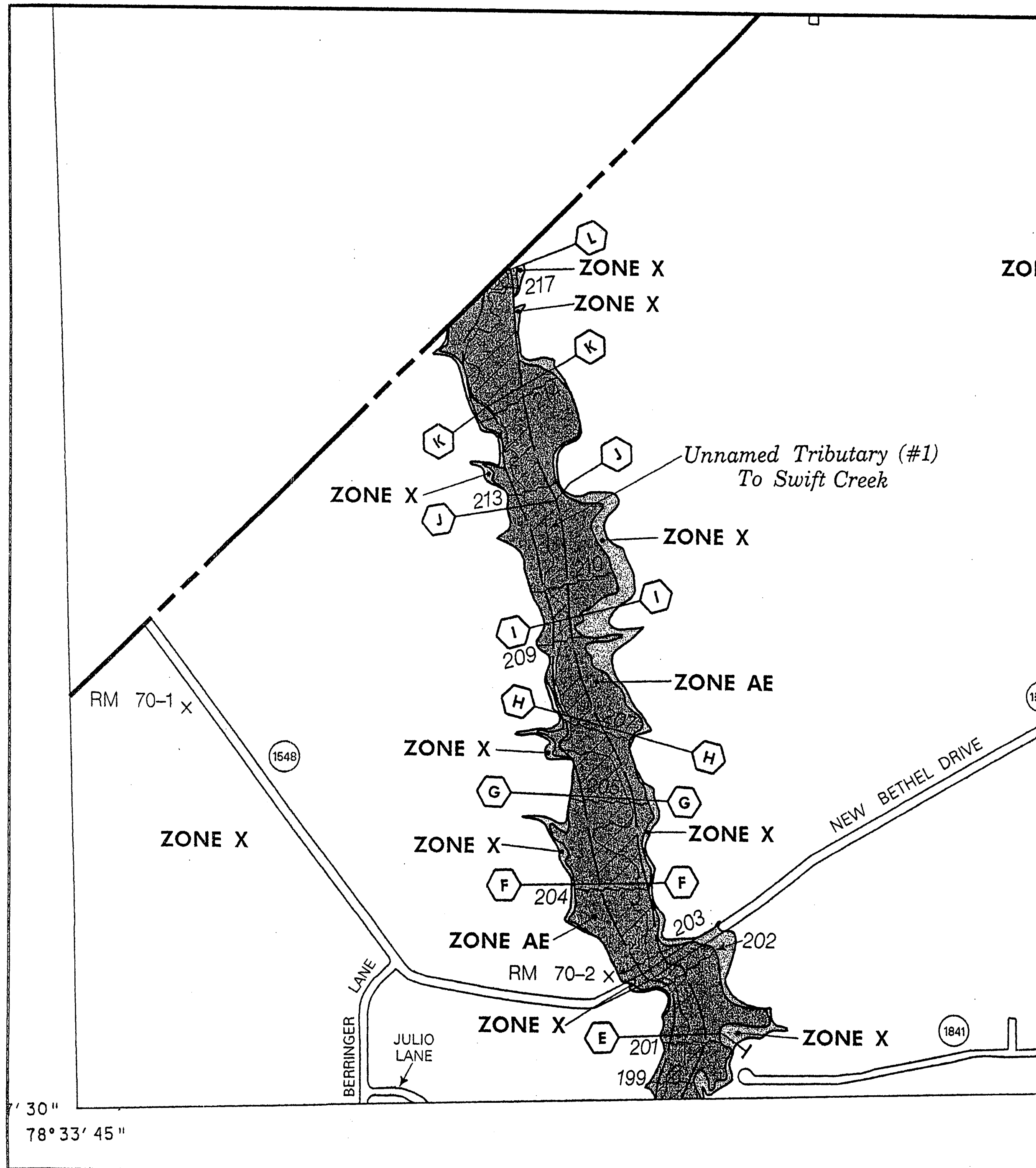

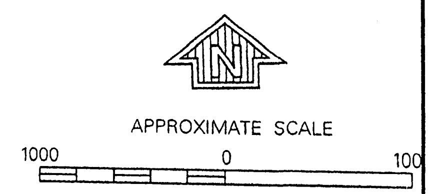

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
JOHNSTON COUNTY, NORTH CAROLINA AND INCORPORATED AREAS

PANEL 70 OF 535

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLAYTON, TOWN OF	370139	0070	D
JOHNSTON COUNTY	370138	0070	D

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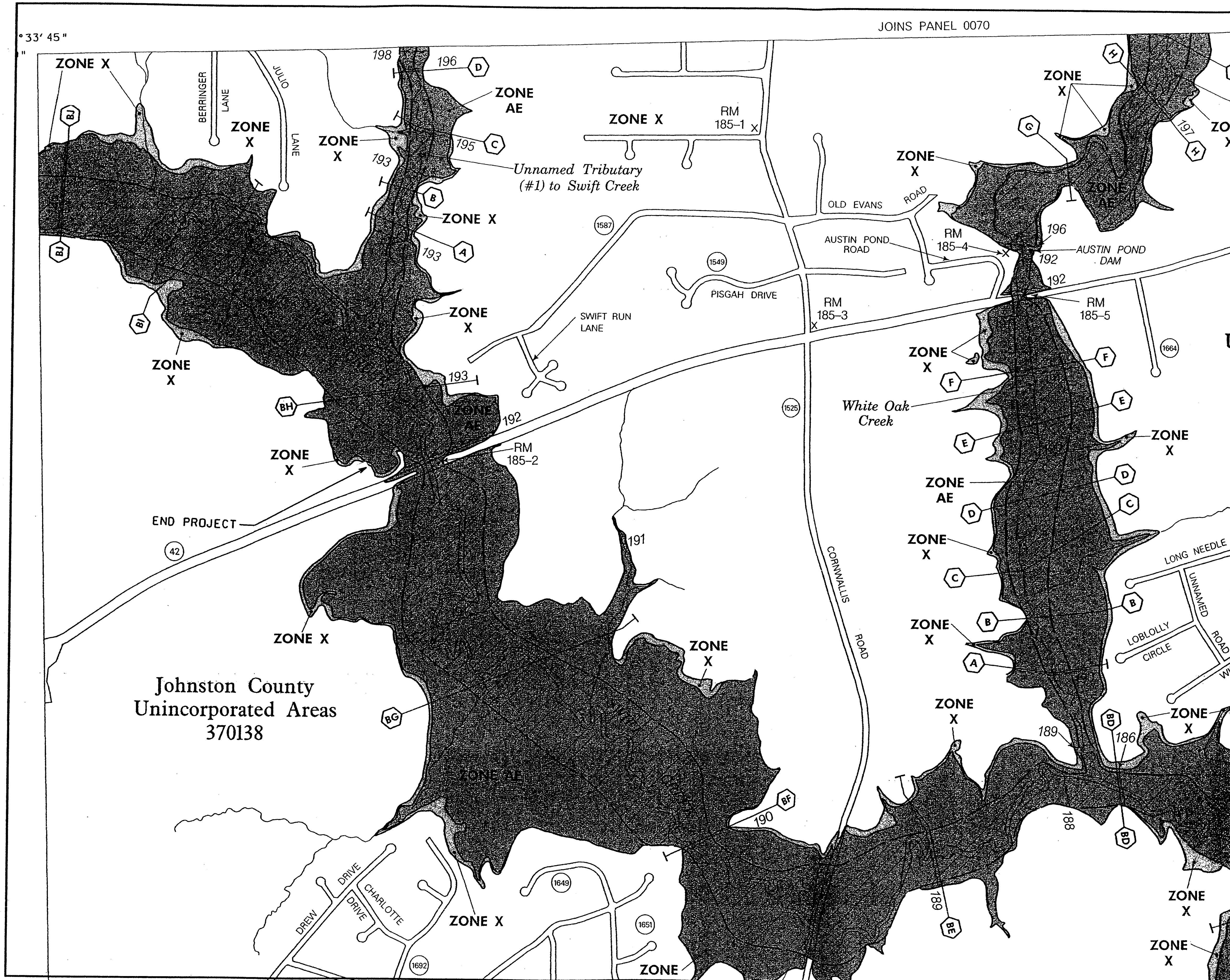

APPROXIMATE SCALE

0 1000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

JOHNSTON COUNTY, NORTH CAROLINA AND INCORPORATED AREAS

PANEL 185 OF 535

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
JOHNSTON COUNTY	370138	0185	D

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MAP NUMBER 37101C0185 D

EFFECTIVE DATE: OCTOBER 20, 2000

Federal Emergency Management Agency

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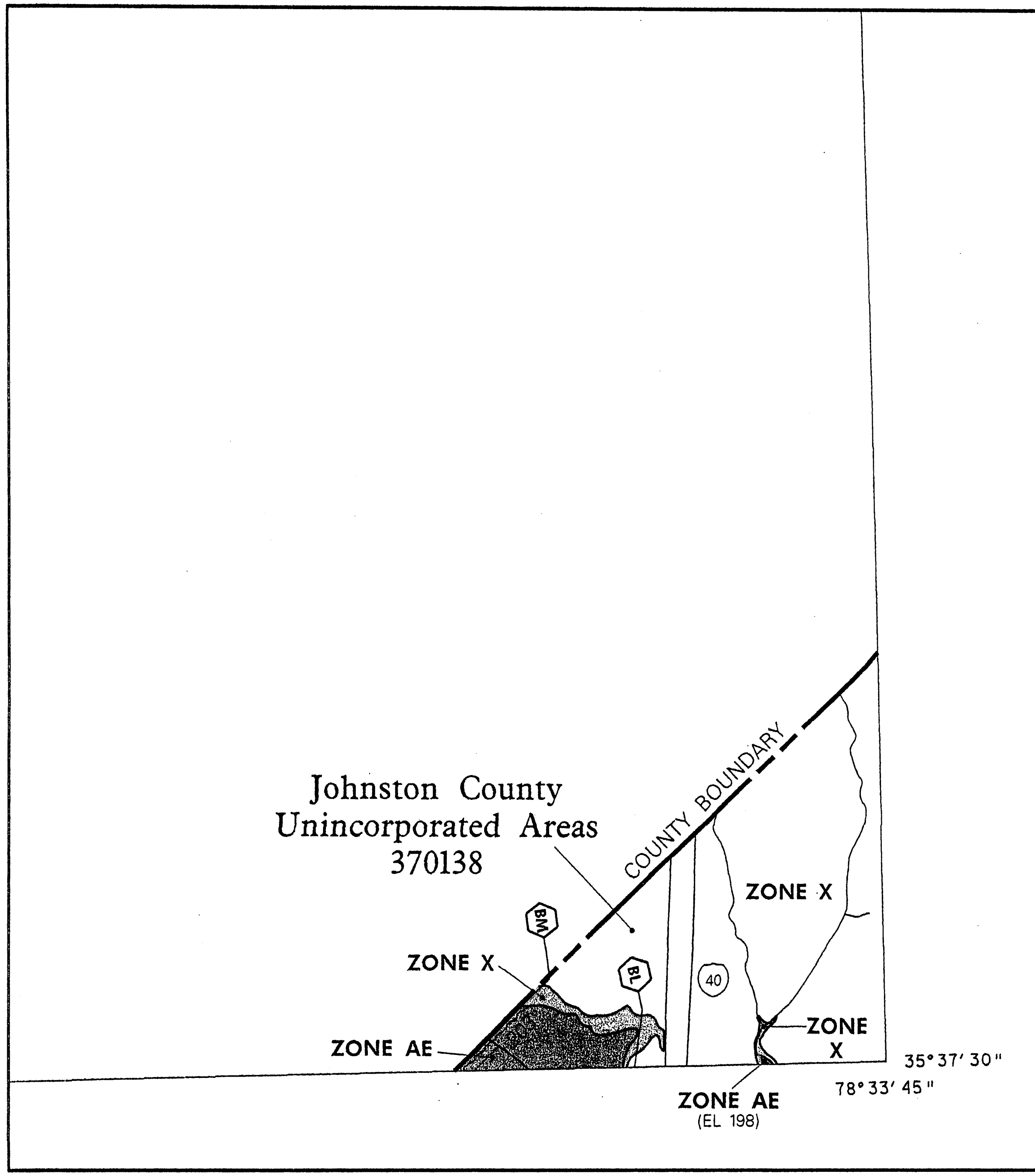

APPROXIMATE SCALE

1000 0 1000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

JOHNSTON COUNTY,
NORTH CAROLINA
AND INCORPORATED AREAS

PANEL 65 OF 535

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
JOHNSTON COUNTY	370138	0065	D

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MAP NUMBER
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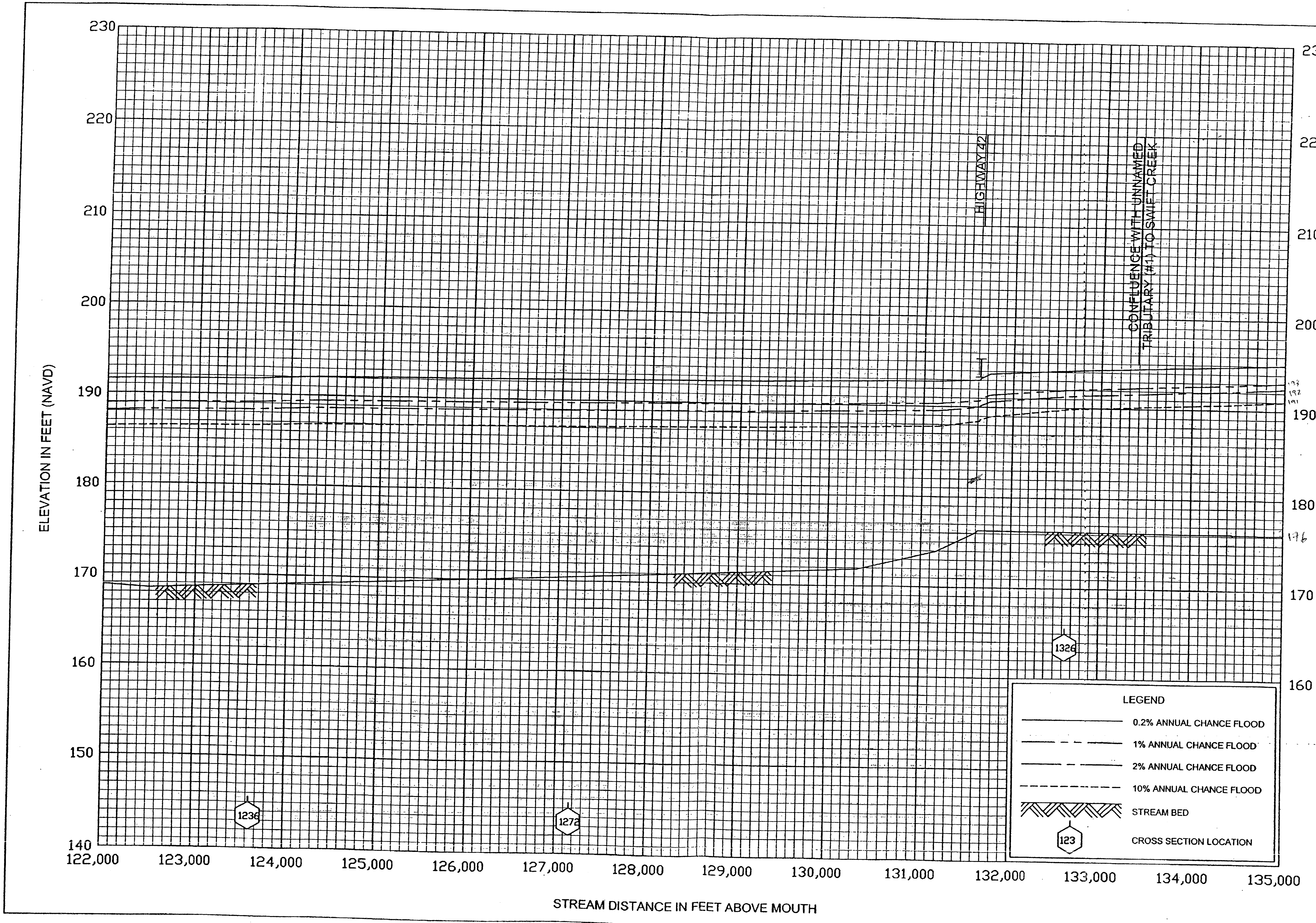
EFFECTIVE DATE:
OCTOBER 20, 2000

Federal Emergency Management Agency

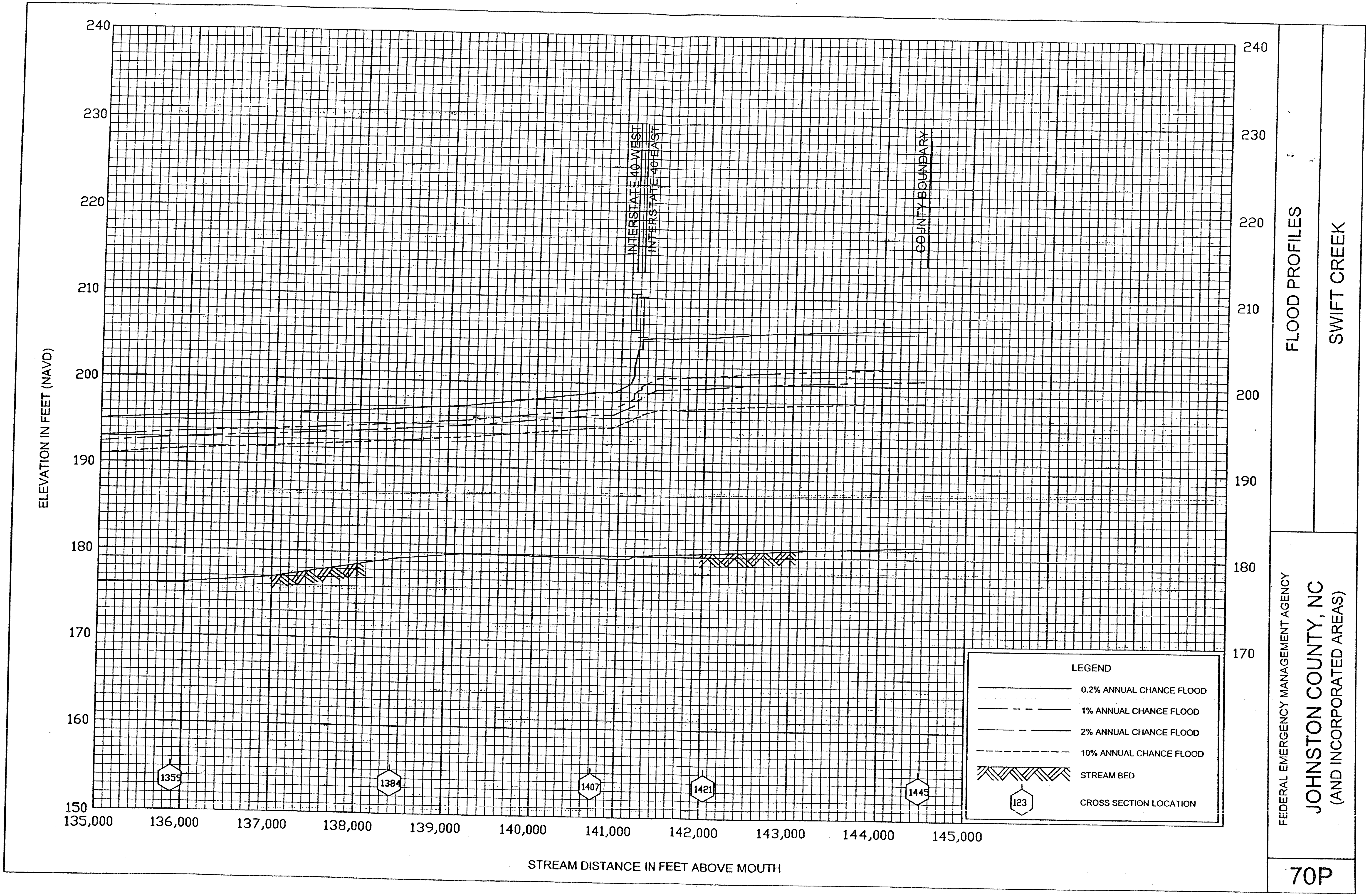


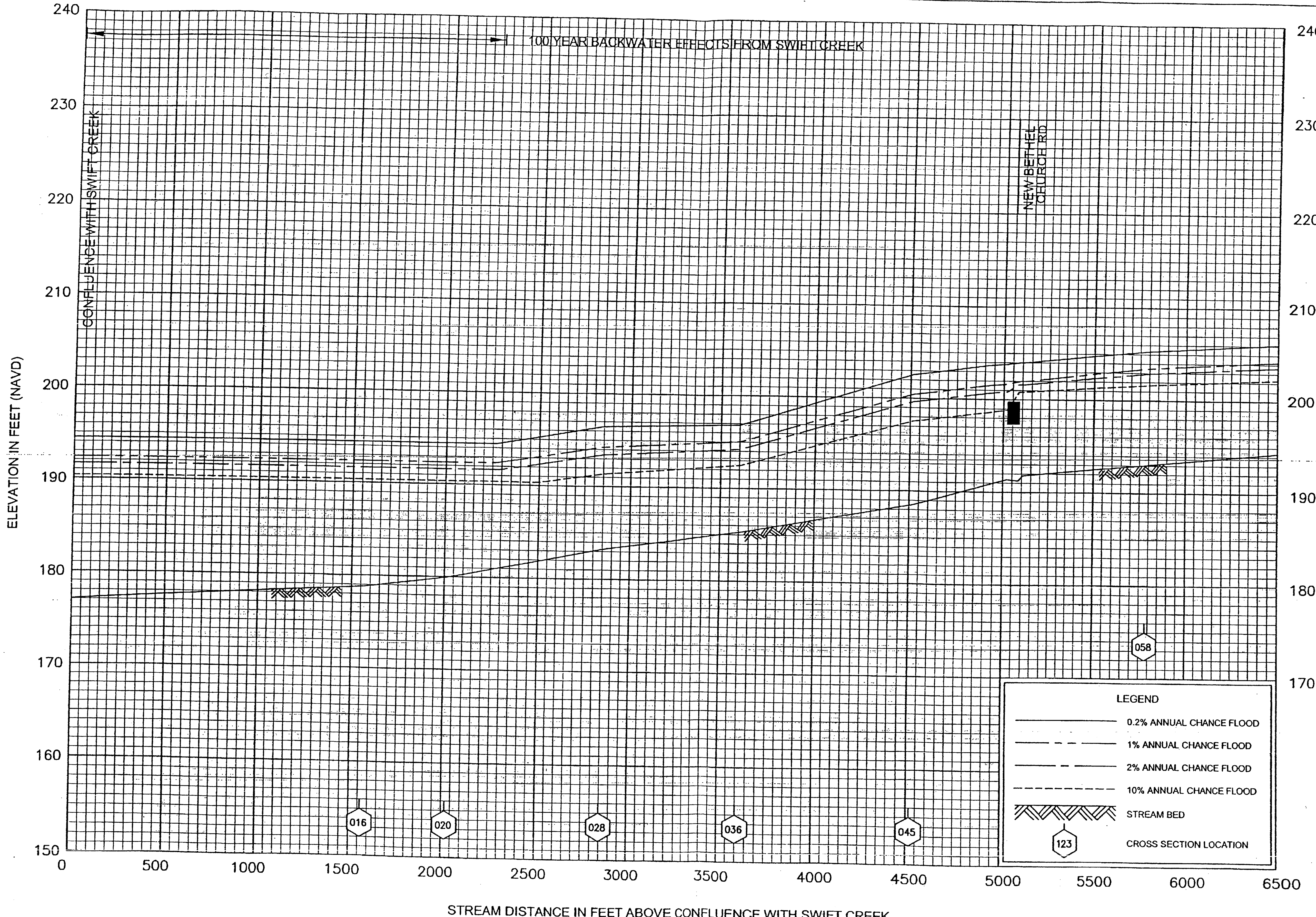
FLOOD PROFILES

SWIFT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC
(AND INCORPORATED AREAS)


240
230
220
210
200
190
180
170
160
150
ELEVATION IN FEET (NAVD)
INTERSTATE 40 WEST
INTERSTATE 40 EAST
COUNTY BOUNDARY
1359
1384
1407
1421
1445
135,000
136,000
137,000
138,000
139,000
140,000
141,000
142,000
143,000
144,000
145,000
STREAM DISTANCE IN FEET ABOVE MOUTH
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
123
CROSS SECTION LOCATION
FLOOD PROFILES
SWIFT CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
JOHNSTON COUNTY, NC
(AND INCORPORATED AREAS)
70P



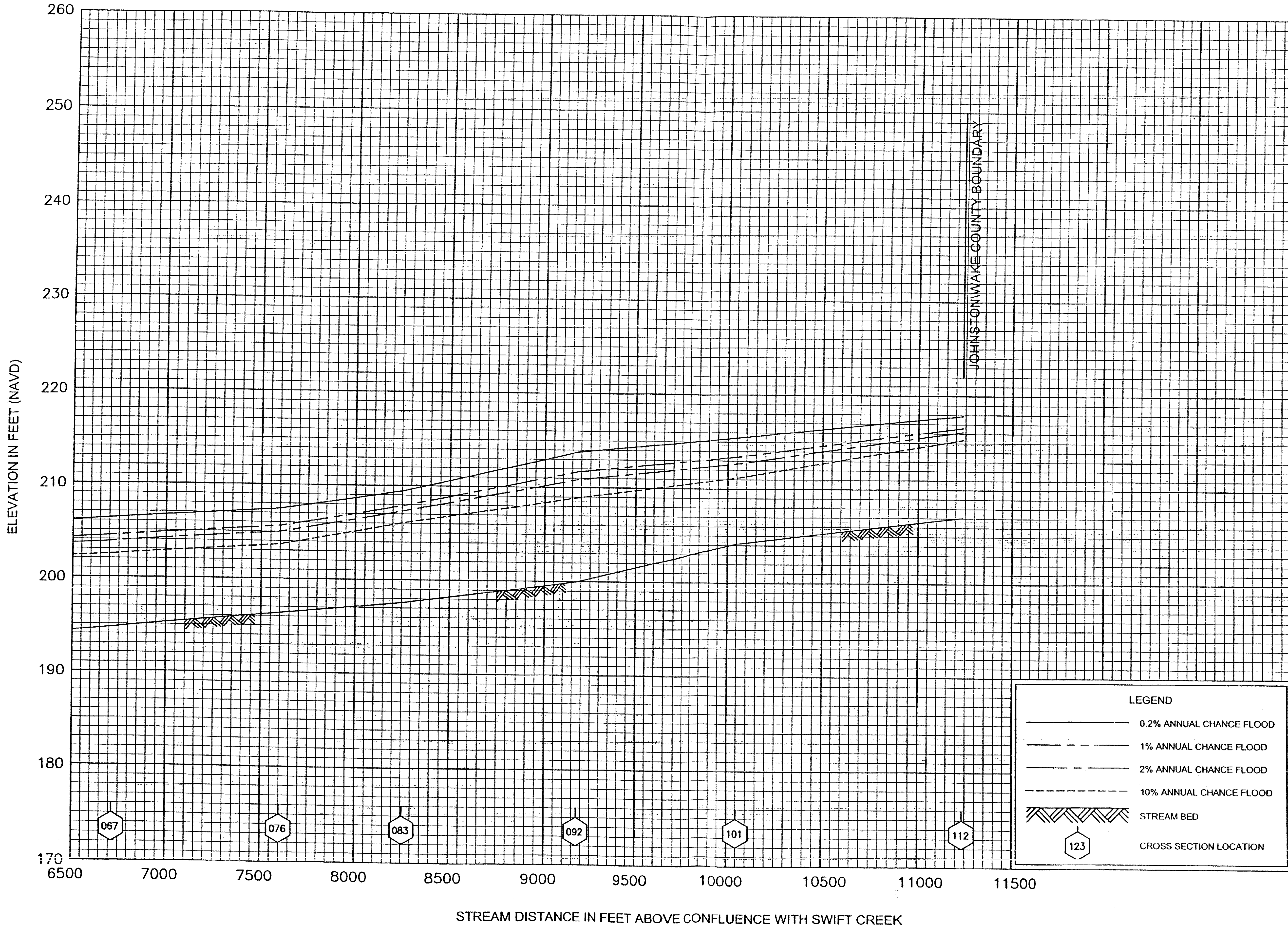
FLOOD PROFILES

UNNAMED TRIBUTARY (#1) TO SWIFT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC
(AND INCORPORATED AREAS)

71P



FLOOD PROFILES

UNNAMED TRIBUTARY (#1) TO SWIFT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC
(AND INCORPORATED AREAS)

72P

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Flood Profiles

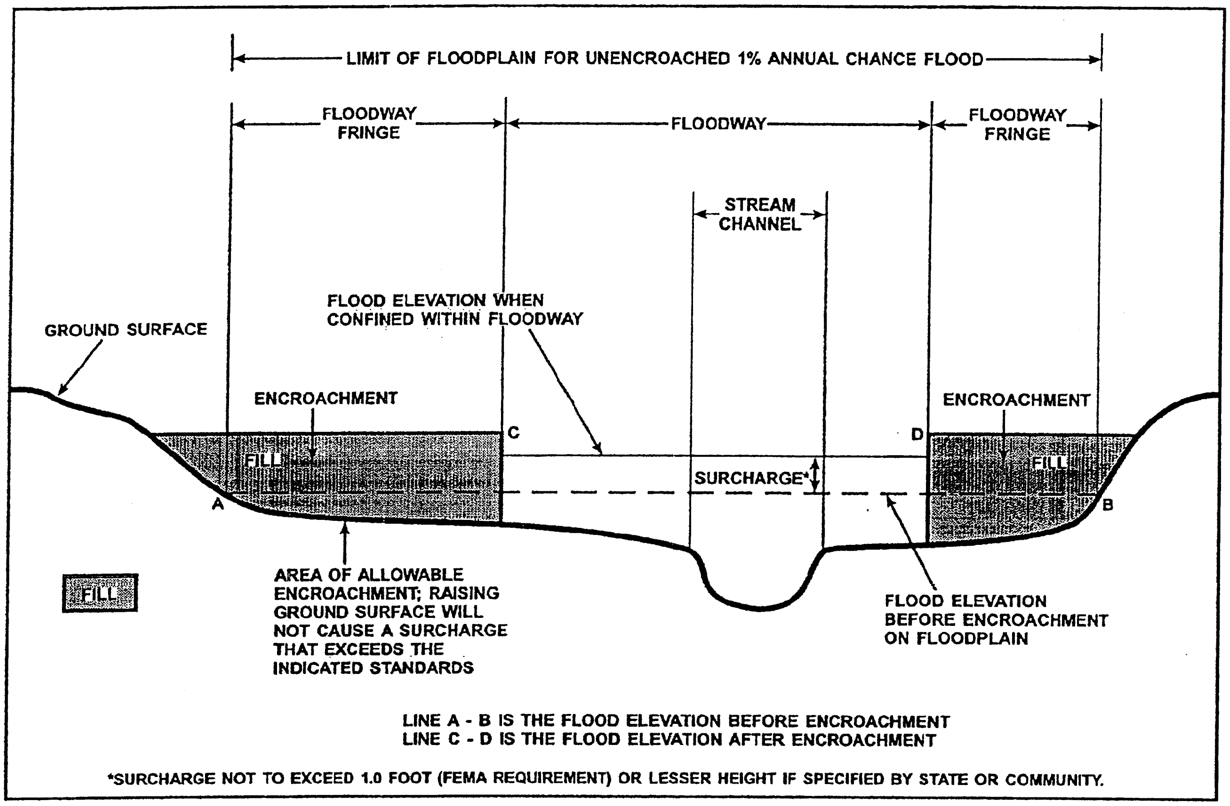

Figure 1—Floodway Schematic

2.3 Base Flood Elevations

Base Flood Elevations (BFEs) are shown on the FIRM and represent rounded, whole-foot elevations at selected locations along flooding sources that have been studied in detail. Flood Profiles in this FIS Report provide a comprehensive and definitive tool to determine specific flood elevations along a stream studied by detailed methods. In order to reduce the risk of damage from floods up to the base (1% annual chance) flood, communities are advised to consider these elevations when issuing building permits for structures.

2.4 Watershed Characteristics

Because a FIS is a probability analysis that may not account for some of the factors listed below, communities are strongly encouraged to consider adopting more restrictive or higher floodplain management criteria or ordinances than the minimum Federal requirements. Communities may also increase the validity of their flood hazard data by investing in continuous maintenance of river gages (see the **Data Validity and Reliability** paragraph below). If the U.S. Geological Survey (USGS) or other agencies do not maintain gages on the flooding sources of interest, partnerships with the USGS may be pursued, or local gages may be installed. For more information, see Section 9.0 of this report.

This flood hazard study represents an analysis of certain watershed characteristics, some of which are summarized as follows:

Section 3.0 – Insurance Applications

For flood insurance applications, the FIRM designates flood insurance rate zones and, in 1% annual chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies. Table 2, "Flood Zone Designations," includes a description of each type of flood hazard zone.

Table 2—Flood Zone Designations

Zone	Description
A	Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations or depths are shown within this zone.
AE	Zone AE is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the FIS Report by detailed methods. In most instances, whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AH	Zone AH is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.
AO	Zone AO is the flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.
AR	Zone AR is the flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
A99	Zone A99 is the flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No Base Flood Elevations or depths are shown within this zone.
V	Zone V is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no Base Flood Elevations are shown within this zone.
VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot Base Flood Elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Table 2—Flood Zone Designations

Zone	Description
X	Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2% annual chance floodplain, areas within the 0.2% annual chance floodplain, and to areas of 1% annual chance flooding where average depths are less than 1 foot, areas of 1% annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1% annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone.
D	Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

Section 5.0 – Engineering Methods

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic methods were used to determine the flood hazard data required for this FIS.

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationship for each flooding source studied in detail affecting the county.

Previous Countywide Analyses

Johnston County had a previously printed countywide FIS Report describing each community's hydrologic analyses. Those analyses have been compiled from the FIS Report and are summarized below. These analyses remain valid for those flooding sources listed in Table 6, "Flooding Sources Studied by Detailed Methods: Redelineated."

The United States Geological Survey (USGS) has operated stream gaging stations on the Neuse River in Johnston County for many years. Peak discharge-frequency relationships for the Neuse River were based on a log-Pearson Type III analysis of five gages on the river with lengths of record ranging from 48-70 years (Water Resources Council, 1976; U.S. Department of the Interior, 1965). However, flows on the Neuse River are now modified by Falls Lake. Discharges from the gage analysis were modified by a routing procedure to account for the storage effects of Falls Lake.

Peak discharge-frequency relationships for Swift Creek, Black Creek, Middle Creek, Buffalo Creek, Buffalo Creek (East and West), Little Creek, Little Creek Tributary, Poplar Creek, Sams Creek, and Swift Creek were based on a log-Pearson Type III analysis of 52 gages with lengths of record ranging from 10 to 50 years (Water Resources Council, 1976; U.S. Department of the Interior, 1965). These gages monitor drainage areas of less than 200 square miles in the Piedmont region of North Carolina.

Discharges for Moccasin Creek (near Princeton), Mill Creek (South), Stone Creek, Hannah Creek, and Stony Fork were based on a similar study of 50 gages in the Coastal Plains region of North Carolina.

Peak discharges were calculated at various locations for the 10-, 50-, 100-, and 500-year frequency floods. On Buffalo Creek and Spring Branch, the discharges were adjusted to account for existing urbanization in the watershed using a method developed by the USGS on streams in North Carolina. Discharges on Buffalo Creek were modified by storage at Buffalo Road.

Discharges for Moccasin Creek (near Princeton) and Mill Creek (South) were reduced at the lower reaches by overflow to the Neuse River. For Moccasin Creek (near Princeton), discharges were also reduced by storage at Holts Lake.

Flood hydrographs and flood storage models were developed in Johnston County to define the stage-storage relationships of Holts Lake and the Black Creek basin. The 100-year flood was routed through Holts Lake, and it was found that storage in Holts Lake was insignificant from a discharge or flood stage reduction standpoint. Therefore, no changes in the hydrology were made.

The following analyses are valid for the subsequent stream reaches: Little Creek, from the confluence with Swift Creek to a point approximately 3,000 feet upstream of J J Ranch Dam; Little Poplar Creek, from the confluence with Poplar Creek to U.S. Highway 70; Poplar Creek, from the confluence with the Neuse River to Swift Creek Road; Swift Creek, from a point approximately 1.5 miles downstream of the confluence of Little Creek to approximately 3,500 feet upstream of Interstate Route 40; Unnamed Tributary (#1) to Swift Creek, from the confluence with Swift Creek to the Wake County line; Unnamed Tributary (#2) to Swift Creek, from the confluence with Swift Creek to NC 1525; and White Oak Creek, from the confluence with Swift Creek to the Wake County line.

The USACE HEC-2 Flood Hydrograph Package was used for the hydrologic method (USACE, 1991). The Soil Conservation Service (SCS) dimensionless unit hydrograph was used as the method to calculate the hydrograph for each sub-basin. The normal depth channel routing was used for the routing methodology. The raw data for drainage areas, curve number, lag and routing times were obtained from USGS Quadrangle maps (U.S. Department of the Interior, 1974, et cetera). The hypothetical storm information was obtained from Technical Paper No. 40 (U.S. Department of Commerce, 1963).

The detailed study is divided into two categories; Poplar Creek watershed and Swift Creek watershed. Within the studied areas, there are two streamflow gages, both located on Swift Creek upstream of the Johnston County line. One gage is located at McCullars Crossroads (0208758850), but the period of record for the gage is from 1992-1994. The other gage is located in Apex (02087580) and the period of record was from 1954-1971. Due to the poor reliability of such a short period of record, the hydrologic models for studied watersheds were calibrated to historical floods using the hydraulic models and historical high water elevations along studied streams.

Revised Analyses for Countywide FIS

The hydrologic analyses for the Neuse River basin, except for flooding sources with stream gages, were performed using the urban and rural regression equations developed by the USGS. The urban equations were published in "Estimation of Flood-Frequency Characteristics of Small Urban Streams in North Carolina Water Resources Investigations Report 99-4114." Regression equations are mathematical formulas that relate the flow in the stream to physical factors such as the area of the basin and the percentage of the surface that is impervious (paved). Regression equations are developed by fitting a line through the center of the points on a graph that compares flood flows to basin area. The results reflect the "statistical average" of the data. If a gage station is located on the stream being studied, data from that station can be used to adjust the regression results to more accurately estimate the flood flow. There are three separate regional regression equations that cover North Carolina. Johnston County is located in the hydrologic region known as the Blue Ridge/Piedmont region. The Blue Ridge/Piedmont equation was used to estimate the 1% annual chance flow for the streams in Johnston County. Analyses of historical high-water marks obtained from interviews of county residents were used to confirm the accuracy of the regression equation estimates.

A summary of the drainage area-peak discharge relationships for the flooding sources studied by detailed methods is shown in Table 8, "Summary of Discharges."

Table 8—Summary of Discharges

Flooding Source	Location	Drainage Area *(square miles)*	Discharges *(cfs)* 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Stony Fork (continued)	Approximately 0.6 mile upstream of Shade Tree Road	1.56	*	*	1,101	*
Stony Fork Tributary	Approximately 0.4 mile upstream of the confluence with Stony Fork	3.78	*	*	1,709	*
	Approximately 0.6 mile downstream of Federal Road	3.39	*	*	1,597	*
	Approximately 0.2 mile downstream of Federal Road	3.12	*	*	1,518	*
	Approximately 0.1 mile upstream of Interstate 40	2.64	*	*	1,368	*
Swift Creek	At the mouth	287.0	8,500	16,100	20,500	34,900
	Above Middle Creek (at North Carolina 210)	157.0	5,970	11,380	14,560	24,900
	Approximately 1.3 miles downstream from confluence of Little Creek	139.1	8,340	12,800	15,200	22,800
	Approximately 2.0 miles downstream of Lee Road	120.8	7,160	10,500	12,500	19,100
	Approximately 1.1 miles downstream of Lee Road	117.9	7,100	10,400	12,400	19,000
	Approximately 1.2 mile downstream of Barber Mill Road	113.9	7,090	10,100	12,200	18,700
	Approximately 0.9 mile upstream of Barber Mill Road	110.1	7,100	9,990	12,100	18,800
	Approximately 2.0 miles upstream of Barber Mill Road	105.3	7,030	9,560	11,700	18,500
	Approximately 0.9 mile downstream of Cornwallis Road	89.4	6,190	8,430	9,540	12,700
	Approximately 0.3 mile upstream of N.C. Route 42	81.2	6,040	8,180	9,290	12,200

Table 8—Summary of Discharges

Flooding Source	Location	Drainage Area (*square miles*)	Discharges (*cfs*) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Unnamed Tributary (#1) to Swift Creek	At the confluence with Swift Creek	4.7	2,080	3,770	4,670	7,660
	Approximately 100 feet downstream of New Bethel Church Road	4.1	2,020	3,560	4,430	7,380
Unnamed Tributary (#2) to Swift Creek	At the confluence with Swift Creek	2.2	960	1,670	2,050	3,290
	Approximately 1.1 mile downstream of Cornwallis Road	1.5	1,040	1,670	2,010	3,080
White Oak Creek	At the confluence with Swift Creek	14.6	2,190	3,730	4,630	7,640
	Approximately 480 feet upstream of N.C. Route 42	13.6	2,230	3,780	4,720	7,910
	Approximately 0.8 mile upstream of Winston Road	12.0	2,530	4,380	5,510	9,420
	Approximately 120 feet downstream of Winston Road	10.3	2,480	4,250	5,270	8,680
	Approximately 1.6 miles upstream of Winston Road	8.0	2,460	4,300	5,330	8,780

*Data not available

[1]Modified by storage at State Route 1003

[2]Discharges reduced by storage at U.S. Highway 70

[3]Part of flow for Mill Creek goes into the Neuse River

[4]Part of flow from Moccasin Creek basin goes into Raccoon Swamp

[5]Discharge reduced by storage

[6]Modified by Falls Lake

Table 10—Roughness Coefficients

Stream	Channel "n"	Overbank "n"
Swift Creek	0.043 - 0.05	0.105 - 0.168
Unnamed Tributary (#1) to Swift Creek	0.04 - 0.043	0.105 - 0.133
Unnamed Tributary (#2) to Swift Creek	0.039 - 0.04	0.11 - 0.154
White Oak Creek	0.033 - 0.047	0.1 - 0.16

For flooding sources studied by limited detailed methods in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this report and the FIRM panels. This method entails developing a HEC-RAS hydraulic model, resulting in the calculation of BFEs and the delineation of the 1% annual chance floodplain (designated as Zone AE). Cross sections for the flooding sources studied by limited detailed methods were obtained using digital elevation data obtained with LIDAR technology developed as part of the North Carolina Statewide Floodplain Mapping Program. The hydraulic model is prepared using this digital elevation data, without surveying bathymetric or structural data. Where bridge or culvert data are readily available, such as from the North Carolina Department of Transportation, these data have been reflected in the hydraulic model. If these structural data are not readily available, field measurements of these structures were made to approximate their geometry in the hydraulic models. In addition, this method does not include field surveys that determine specifics on channel and floodplain characteristics. A limited detailed study is a "buildable" product that can be upgraded to a fully detailed study at a later date by verifying stream channel characteristics, bridge and culvert opening geometry, and by analyzing multiple recurrence intervals.

The results of the HEC-RAS computations are tabulated for all cross sections (Table 11, "Limited Detailed Flood Hazard Data"). Flood Profiles have not been developed for streams studied by limited detailed methods. In addition, floodways for streams studied by limited detailed methods are not delineated on the FIRM. However, the 1% annual chance water-surface elevations, flood discharges, and non-encroachment widths from the limited detailed studies for every modeled cross section are given in Table 11. The non-encroachment widths given at modeled cross sections can be used by communities to enforce floodplain management ordinances that meet the requirement defined in 44 CFR 60.3(c)(10).

Between cross sections for streams studied by limited detailed methods, 1% annual chance water-surface elevations should be calculated by mathematical interpolation using the distance along the stream centerline. Non-encroachment widths and, therefore, the location of a non-encroachment area boundary between cross sections should be determined based on either 1) mathematical interpolation, or 2) the non-encroachment width at the upstream or downstream cross section, whichever is larger. If the width determined by this second method is wider than the Special Flood Hazard Area (SFHA) or the 1% annual chance floodplain delineated on the FIRM for this location along the stream, the non-encroachment area shall be considered to be coincident with the SFHA. A full detailed study incorporating field survey data in the HEC-RAS hydraulic model may be submitted for a Letter of Map Revision (LOMR) request to map a regulatory floodway along a section of a stream in lieu of applying the non-encroachment widths listed in Table 11. FEMA's current (as of August 2001) map revision structure exempts submittal fees for map revision requests based solely on the submission of more detailed data.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Swift Creek								
040	3,950	1,370	12,932	1.6	123.4	116.5[2]	116.9	0.4
052	5,210	1,520	12,845	1.1	123.5	116.9[2]	117.5	0.6
062	6,225	1,580	12,478	1.2	123.5	117.1[2]	117.8	0.7
077	7,660	1,390	8,893	1.6	123.6	117.6[2]	118.5	0.9
105	10,480	1,145	10,881	1.3	123.7	118.7[2]	119.7	1.0
122	12,200	1,550	15,995	0.9	123.7	120.0[2]	120.8	0.8
139	13,890	1,700	13,968	1.0	123.8	120.5[2]	121.3	0.8
170	16,980	1,620	15,584	0.9	123.8	120.8[2]	121.7	0.9
190	19,000	1,240	9,083	1.6	123.8	121.4[2]	122.4	1.0
204	20,400	1,100	9,005	1.6	123.8	122.0[2]	122.9	0.9
215	21,460	700	5,912	2.5	123.8	123.1[2]	123.8	0.7
223	22,300	480	3,832	3.8	124.8	124.8	125.2	0.4
233	23,290	400	3,226	4.5	127.5	127.5	127.7	0.2
243	24,300	520	4,528	3.2	130.1	130.1	130.2	0.1
251	25,120	880	8,137	1.8	131.1	131.1	131.3	0.2
282	28,230	850	8,038	1.8	132.3	132.3	132.8	0.5
293	29,330	800	6,979	2.1	132.9	132.9	133.6	0.7
310	31,000	1,000	8,303	1.8	133.9	133.9	134.7	0.8
315	31,530	1,065	10,034	1.5	134.4	134.4	135.3	0.9
332	33,200	850	7,041	2.0	135.0	135.0	136.0	1.0
346	34,640	360	3,589	4.0	136.9	136.9	137.6	0.7
355	35,500	350	2,830	5.1	138.9	138.9	139.4	0.5
373	37,320	340	5,168	2.8	141.7	141.7	142.3	0.6

[1]Feet above mouth

[2]Elevation computed without consideration of backwater effects from the Neuse River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

SWIFT CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Swift Creek (continued)								
400	40,020	250	3,250	4.3	144.4	144.4	145.1	0.7
441	44,100	300	5,576	2.5	148.7	148.7	149.5	0.8
461	46,083	229	4,094	3.7	149.8	149.8	150.6	0.8
472	47,177	241	3,952	3.8	150.3	150.3	151.1	0.8
492	49,212	158	2,384	6.4	152.0	151.5	152.2	0.7
505	50,535	190	3,356	4.5	153.6	153.2	153.8	0.6
524	52,434	419	5,685	2.7	155.1	154.7	155.3	0.6
539	53,911	206	3,615	3.5	155.8	155.5	155.8	0.3
562	56,186	323	4,964	2.5	156.5	156.1	156.8	0.7
581	58,137	216	3,040	4.1	157.0	156.4	157.4	1.0
607	60,743	426	3,787	3.3	158.8	158.3	159.2	0.9
630	63,012	305	3,512	3.6	160.2	159.7	160.7	1.0
652	65,203	740	10,356	1.2	164.2	164.2	165.1	0.9
676	67,560	800	9,419	1.3	164.9	164.7	165.5	0.8
689	68,941	450	6,125	2.0	165.4	165.4	166.2	0.8
710	71,012	452	6,007	2.1	167.2	167.2	167.9	0.7
733	73,275	887	12,777	1.0	167.8	167.8	168.7	0.9
755	75,495	360	4,846	2.6	168.4	168.4	169.3	0.9
781	78,067	1,169	12,328	1.0	169.6	169.6	170.5	0.9
801	80,062	650	7,487	1.7	169.9	169.9	170.8	0.9
818	81,766	569	7,205	1.7	170.8	170.8	171.7	0.9
838	83,823	477	6,354	2.0	172.5	172.5	173.2	0.7
859	85,870	605	7,969	1.5	173.2	173.2	174.0	0.8
882	88,227	961	11,629	1.0	173.8	173.8	174.7	0.9

[1]Feet above mouth

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

SWIFT CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Swift Creek (continued)								
910	91,008	799	10,271	1.2	174.6	174.6	175.5	0.9
940	93,951	775	10,321	1.2	176.1	176.1	176.9	0.8
966	96,628	663	8,597	1.4	177.2	177.2	178.0	0.8
995	99,542	930	14,535	0.8	177.7	177.7	178.7	1.0
1031	103,116	1,483	15,728	0.7	178.3	178.3	179.3	1.0
1059	105,871	2,250	20,001	0.6	178.8	178.8	179.8	1.0
1097	109,730	1,081	7,499	1.6	179.6	179.6	180.6	1.0
1131	113,089	567	3,666	3.2	182.7	182.7	183.4	0.7
1160	116,011	327	3,053	3.8	185.5	185.5	186.3	0.8
1189	118,897	559	6,004	1.6	187.9	187.9	188.7	0.8
1236	123,628	332	3,935	2.4	189.2	189.2	189.9	0.7
42 1272	127,159	951	11,011	0.9	189.8	189.8	190.7	0.9
1326	132,630	900	7,829	1.2	192.1	192.1	192.9	0.8
1359	135,894	901	6,222	1.5	193.6	193.6	194.4	0.8
1384	138,418	618	5,547	1.7	195.0	195.0	195.8	0.8
1407	140,722	821	5,813	2.0	197.1	197.1	197.7	0.6
1421	142,050	416	4,451	2.7	201.0	201.0	201.5	0.5
1445	144,485	1,090	9,478	1.3	202.1	202.1	202.7	0.6

[1]Feet above mouth

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

SWIFT CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Unnamed Tributary (#1) to Swift Creek								
016	1,561	170	1,381	3.4	192.3	190.6[2]	191.6	1.0
020	2,018	160	1,106	4.2	192.3	191.6[2]	192.6	1.0
028	2,847	255	1,933	2.4	194.3	194.3	195.2	0.9
036	3,601	97	599	7.8	195.1	195.1	196.1	1.0
045	4,516	225	1,658	2.8	200.5	200.5	201.5	1.0
058	5,783	310	1,931	2.3	203.5	203.5	204.5	1.0
067	6,716	335	2,217	2.0	204.5	204.5	205.5	1.0
076	7,602	240	1,349	3.3	205.7	205.7	206.7	1.0
083	8,256	100	739	6.0	207.9	207.9	208.9	1.0
092	9,175	235	1,735	2.6	211.7	211.7	212.7	1.0
101	10,051	258	1,407	2.4	213.4	213.4	214.4	1.0
112	11,235	400	958	3.6	216.6	216.6	217.6	1.0

[1] Feet above confluence with Swift Creek

[2] Elevation computed without consideration of backwater effects from Swift Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

UNNAMED TRIBUTARY (#1) TO SWIFT CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Unnamed Tributary (#2) to Swift Creek								
010	1,001	100	522	3.9	177.1	174.2[2]	175.0	0.8
016	1,598	160	698	2.9	177.1	175.8[2]	176.8	1.0
022	2,200	100	457	4.5	178.2	178.2	178.5	0.3
036	3,558	51	296	6.9	185.0	185.0	185.9	0.9
042	4,164	37	253	8.1	187.9	187.9	188.9	1.0
050	5,025	37	180	11.4	194.8	194.8	195.1	0.3
059	5,945	46	279	7.3	202.0	202.0	203.0	1.0
068	6,801	85	336	6.1	208.4	208.4	209.0	0.6
076	7,579	120	651	3.1	214.1	214.1	215.1	1.0
085	8,506	85	430	4.7	218.5	218.5	218.8	0.3
092	9,237	65	346	5.8	223.0	223.0	223.9	0.9
102	10,191	40	232	5.7	229.6	229.6	230.6	1.0
112	11,179	55	181	7.3	236.8	236.8	236.9	0.1
121	12,065	80	365	3.6	245.9	245.9	246.9	1.0
130	12,960	80	489	2.7	251.6	251.6	252.2	0.6

[1] Feet above confluence with Swift Creek

[2] Elevation computed without consideration of backwater effects from Swift Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

JOHNSTON COUNTY, NC AND INCORPORATED AREAS

FLOODWAY DATA

UNNAMED TRIBUTARY (#2) TO SWIFT CREEK