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PRELIMINARY DRAINAGE REPORT

FOR

ORE TOWN SOLAR PROJECT

PINAL COUNTY, ARIZONA

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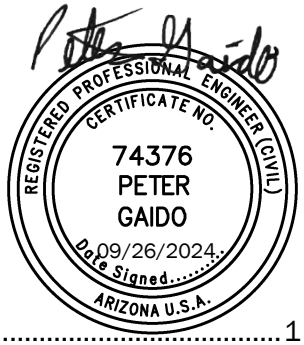
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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 PROJECT NAME, LOCATION AND TOPOGRAPHY 1
1.2 PURPOSE OF STUDY 2
1.3 EFFECTIVE FLOODPLAIN 2
1.4 PREVIOUS STUDIES 2
1.4.1 PINAL COUNTY AREA DRAINAGE MASTER PLAN 2
2.0 MAPPING AND SURVEY INFORMATION 3
3.0 EXISTING CONDITIONS HYDROLOGIC ANALYSIS 3
3.1 EXISTING DRAINAGE PATTERNS 3
3.2 METHOD DESCRIPTION 3
3.3 PARAMETER ESTIMATION 4
3.3.1 MODEL DOMAIN 5
3.3.2 GRID SIZE 5
3.3.3 RAINFALL DATA 5
3.3.4 SOILS DATA 6
3.3.5 LAND USE CLASSIFICATION 7
3.3.6 ROUGHNESS COEFFICIENT 8
3.4 RAINFALL LOSSES 8
3.4.1 SURFACE RETENTION LOSS (IA) 8
3.4.2 HYDRAULIC CONDUCTIVITY (XKSAT) 8
3.4.3 CAPILLARY SUCTION (PSIF) 9
3.4.4 VOLUMETRIC SOIL MOISTURE DEFICIT (DTHETA) 9
3.5 FLO-2D HYDRAULIC STRUCTURES 9
3.6 FLO-2D INPUT AND MODEL CONTROLS 9
3.7 FLO-2D MODELING RESULTS EVALUATION 9
3.7.1 CHECKING OUTPUT FILES 9
3.7.2 FLO-2D POST PROCESSOR 10
3.8 CALIBRATION 10
3.9 RESULTS 11
4.0 POST PROJECT HYDROLOGIC ANALYSIS 11
4.1 METHOD DESCRIPTION 12
4.2 PARAMETER ESTIMATION 12
4.2.1 MODEL DOMAIN 12
4.2.2 LAND USE CLASSIFICATION 13
4.3 FLO-2D INPUT AND MODEL CONTROLS 13
5.0 PROPOSED DRAINAGE INFRASTRUCTURE 13
5.1 MAINTENANCE ROADS 14
5.2 PRELIMINARY CHANNELS 14
5.3 RETENTION REQUIREMENTS 14
5.3.1 REQUIRED RETENTION VOLUME ESTIMATE 14
5.3.2 PRELIMINARY RETENTION BASIN CAPACITY DESIGN PARAMETERS 16
5.3.3 PRELIMINARY RETENTION BASIN DEWATERING DESIGN PARAMETERS 16

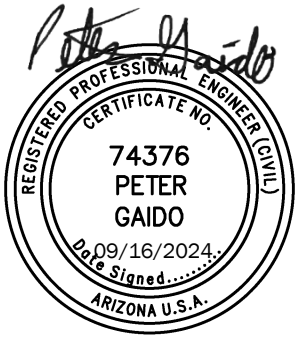
5.4 RESULTS AND HYDROLOGIC COMPARISON 16
5.4.1 FLO-2D POST PROCESSOR 17
6.0 SCOUR ANALYSIS 17
7.0 SUMMARY AND CONCLUSIONS 18
8.0 REFERENCES 19

APPENDICES

A. Exhibits
B. Hydrologic Analysis Supporting Documentation
C. FLO-2D Analysis Results
D. Hydraulic Analysis Supporting Documentation
E. Preliminary Retention & Dewatering Calculations
F. Scour Analysis

EXHIBITS

1. Vicinity Map
2. FEMA Flood Map
3. Soils Map
4. Land Use Map
5. Manning's N-Value Map
6. Overall Pre-Project Flow Depths Map
7. Pre-Project Flow Depths Map
8. Post-Project Flow Depths Map
9. Overall Pre-Project Velocity Map
10. Pre-Project Velocity Map
11. Post-Project Velocity Map
12. Preliminary Drainage Plan
13. Onsite Scour Depth Map



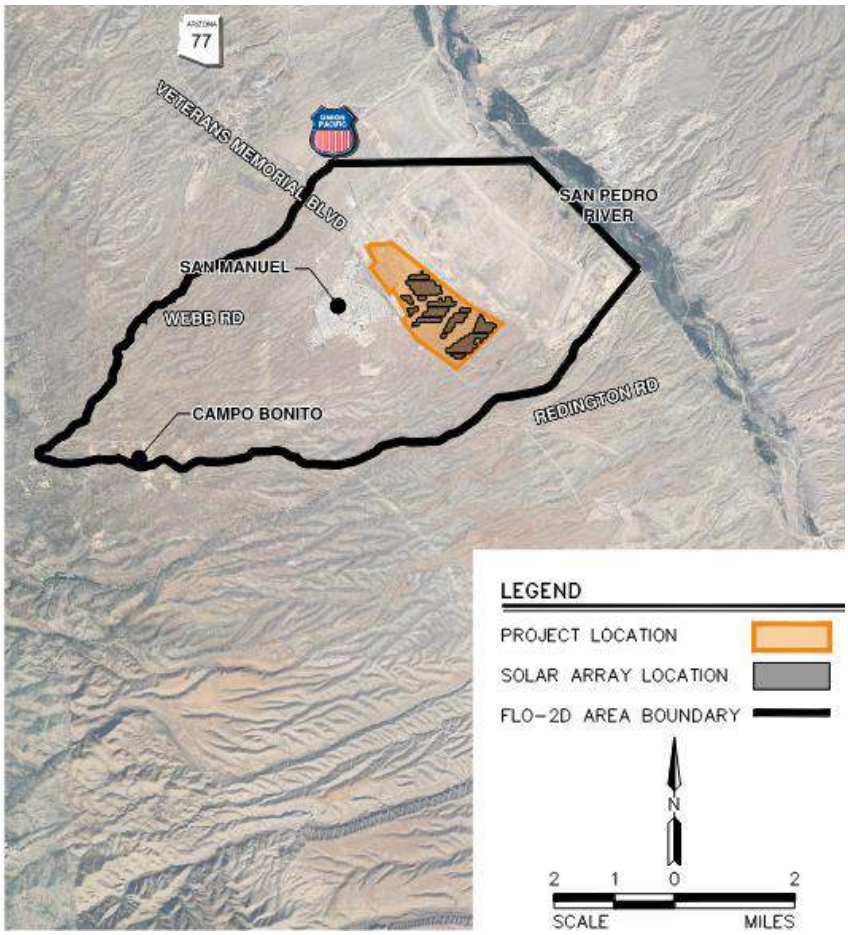
TABLES

1. FLO-2D Model Parameters 4
2. Soil Green and Ampt Parameters 7
3. Land Use Parameters 8
4. 100-YR 6-Hour Flowrates at Floodplain Cross sections 11
5. Post-Project FLO-2D Model Parameters 12
6. 100-Year 6-Hour Flowrates at Floodplain Cross Sections Pre- vs. Post 17

1.0 INTRODUCTION

1.1 PROJECT NAME, LOCATION AND TOPOGRAPHY

The Ore Town Solar Project (the Project) is a proposed solar photovoltaic center and battery storage site located in Pinal County (County) adjacent to the town of San Manuel, and west of the San Pedro River. The Project area encompasses approximately 1,206 acres, and will consist of solar panels, battery storage facilities and a substation over the decommissioned and reclaimed San Manuel Copper Mine. The Project is generally bound by State Route 76 (SR-76, Veterans Memorial Boulevard or Redington Road) to the west, and the reclaimed mine area to the north, east, and south. Specifically, the Project is located on Assessor Parcel Numbers (APN) 30705019R, 30705019W, 30708389E, 30720002B and 307200010. Refer to the figure below and Figure 1 (Vicinity Map) of Appendix A for the Project location.



Vicinity Map

The study area for the hydrologic and hydraulic analyses prepared for this report encompass an approximately 31 square mile area which is ultimately tributary to the San Pedro Wash just downstream of the Project. The Project is located within a reclaimed mine area, which is traversed by a number of braided wash corridors, an existing channel, and other graded areas, but is primarily vacant and drains as unconcentrated surface flow to tailing ponds to the northeast. The study area is included in Figure 1.

1.2 PURPOSE OF STUDY

The purpose of this Preliminary Drainage Report is to provide hydrologic and hydraulic analysis for the Project to define the development constraints, identify preliminary stormwater conveyance and retention facilities, and to establish drainage guidelines according to which future design of the site will adhere. This report and related design has been prepared in accordance with Pinal County's *Drainage Manual Volume I – Design Criteria* (Pinal County, 2004a) and *Volume II –Design Methodology and Procedures* (Pinal County, 2004b) as well as the *Drainage Design Requirements; Utility-Scale Photovoltaic (PV) Solar and Wind Power Generating Facilities Memorandum* (PV DDR; Pinal County, 2021).

1.3 EFFECTIVE FLOODPLAIN

The property is located within the Federal Emergency Management Agency's (FEMA) Zone X (Shaded) as delineated on the FEMA Flood Insurance Rate Map (FIRM) panel numbered 04021C2550E, dated December 4, 2007, which is presented on Figure 2 (FEMA Flood Map) of Appendix A. The flood hazard zone associated with the Project is defined below:

Zone X (Shaded):

> The flood insurance rate zone which corresponds to areas of 0.2% annual chance flood hazard, or areas of 1% annual chance flood with average depths less than 1 foot or with drainage areas of less than one square mile. No base flood elevations or depths are shown within this zone.

It should be noted that there is a community "administrative floodplain" which is delineated through a portion of the Project. "Administrative floodplains" or "Local Floodplains" are delineated as part of an Area Drainage Master Plan (ADMP) but are not delineated as a Special Flood Hazard Area (SFHA) on FEMA's FIRMs. The Project does not propose to encroach into the administrative floodplain limits and will generally maintain primary offsite flow corridors through the site.

1.4 PREVIOUS STUDIES

1.4.1 Pinal County Area Drainage Master Plan

The Pinal County Area Drainage Master Plan (the ADMP; Entellus, 2010) is a regional hydrologic study that incorporates the Project area. The ADMP provides a framework for regional hydrologic modeling and assessment of regional drainage conditions in order to identify areas that may be susceptible to flood related hazards. Additionally, the ADMP established an inventory of culverts and roadway crossings for the watershed impacting the study, which was referenced for the hydrologic studies prepared as part of this Project. However, due to the regional nature of the ADMP, the peak flow offsite flow rates draining through the Project were not detailed to reference for design. As described previously, a potential "Administrative Floodplain" was delineated as part of this study, which drains through the site. The ADMP was not otherwise referenced for the analyses prepared as part of this report.

2.0 MAPPING AND SURVEY INFORMATION

The topographic information used in this study was obtained from the United States Geological Survey (USGS) website which provides publicly available topographic information. The best data available for the site consisted of Original Product Resolution GeoTIFF(s) with a resolution of 0.5 meters, resampled to 24-foot cells. The GeoTIFF(s) were downloaded from the USGS TNM Download (V2.0) website, combined in ArcGIS, and converted from meters to feet for use in FLO-2D. All elevation information is based on the North American Vertical Datum of 1988 (NAVD 88) and the horizontal North American Datum 1983 (NAD83) State Plane, Arizona Central Zone, International (feet).

3.0 EXISTING CONDITIONS HYDROLOGIC ANALYSIS

3.1 EXISTING DRAINAGE PATTERNS

The Project is located just upstream of the tailings ponds which remain from past mining activities and approximately 2 miles upstream of the San Pedro River. The watershed upstream of the Project is primarily undeveloped with the exception of the town of San Manuel. Flows generally drain as sheet flow or within braided washes towards Redington Road, where a number of culverts convey flows underneath the roadway, although as shown on Figure 6 (Overall Pre-Project Flow Depths Map) and Figure 7 (Pre-Project Flow Depths Map), the runoff overtops the roadway in several locations. Regardless of how the offsite flows are conveyed past the roadway, a series of existing channels and berms located near the upstream boundary of the Project intercept the runoff and drain to the tailings ponds or the San Pedro River. As shown in Figure 7, these existing facilities contain a large portion of the total runoff crossing the roadway, but several breakout locations occur. These breakouts continue to drain northeast through the site, forming three primary drainage corridors. Refer to Figure 6, Figure 7, Figure 9 (Overall Pre-Project Velocity Map), and Figure 10 (Pre-Project Velocity Map) of Appendix A for existing flow patterns and drainage facilities.

Runoff generated onsite drains generally northeast as unconcentrated flow, which forms rills and much of the site ultimately drains to one of the three large wash corridors. Onsite flows which do not drain to one of these washes continue northeast of the site to existing facilities downstream of the site. With the exception of the aforementioned channels and embankments, no drainage specific facilities exist onsite. Refer to Figures 6, 7, 9 and 10 for existing drainage conditions.

3.2 METHOD DESCRIPTION

Hydrologic and hydraulic analysis of the pre-project condition 100-year, 6-hour storm event was performed in accordance with Pinal County standards for solar development using the FLO-2D Pro program (Build No. 23.10.25) and QGIS (Version 3.28.11) to generate input files. The existing (pre-project) condition was analyzed to determine the existing drainage conditions, quantify the peak 100-year 6-hour flowrates and existing flow patterns that affect the Project.

The pre-project condition analysis included the entire upstream tributary area to approximately two miles downstream of the property. The study has been prepared using the guidance and methods outlined in the Arizona Department of Transportation

(ADOT) Highway Drainage Design Manual – Volume 2, Hydrology (ADOT HDDM, 2014) and the FLO-2D QGIS Plugin User's Manual (June 2020).

The surface runoff that affects the Project is unconfined sheet flow that is best characterized by a two-dimensional hydraulic analysis. FLO-2D was used because of the ability to model two-dimensional flow and analyze rainfall and infiltration losses for the study area.

3.3 PARAMETER ESTIMATION

Table 1: FLO-2D Model Parameters	
Parameter/Data	**Description**
Topographic Data	Topographic data was obtained from USGS in the form of GeoTIFF files that were then geo-referenced, converted to feet, and imported to QGIS for use in the FLO-2D Pro program to develop the grid elevations. Section 2.0 for further details.
FLO-2D Grid	A grid size of 20 foot by 20 foot was developed in QGIS. This resulted in a model with 2,167,482 grids for the 31 square mile area. See Section 3.3.1 and 3.3.2 for further details.
Rainfall Data	The 100-year, 6-hour and 24-hour storm event were modeled, and the 6-hour storm produced more conservative results, and therefore is the governing storm event for this analysis. A single precipitation value was modeled based on the watershed centroid and resulted in a depth of 3.08 inches for the 6-hour storm event. The SCS Type II rainfall distribution pattern was used. See Section 3.3.3 for further details.
Soils Data	Soil Data was obtained from the Natural Resource Conservation Service (NRCS) soil map, which is available for online download at the NRCS Web Soil Survey website. The entire Project area falls within the boundary of the AZ 661 Soil Survey which covers Eastern Pinal and Southern Gila Counties. The ADOT HDDM Appendix B Soil Green and Ampt (G&A) bare-soil parameters were used for the individual soil groups. However, certain soils were not included in the ADOT HDDM Appendix B and G&A soil parameters were not available. For these areas the Soil Survey data was supplemented with information from the General Soils State Soil Geographic Database (STATSGO) available directly from the ADOT website. This information was obtained in both spatial and tabular form and included G&A soil parameters in the tabular form. See Section 3.3.4 for further details.
Green and Ampt Parameters (G&A)	The FLO-2D model uses the Green & Ampt infiltration method to compute rainfall losses. These G&A bare-soil parameters were obtained from the ADOT HDDM Appendix B and from the existing General Soils STATSGO data made available by ADOT.
Land Use	Land Use categories were obtained from the USGS National Land Cover Database (NLCD) for 2021. The NLCD 2021 data was obtained as a GeoTIFF and was converted to a shapefile for use in FLO-2D and QGIS. The Land Use Categories were assigned antecedent moisture conditions, initial abstractions, and vegetation covers based on guidelines from the ADOT HDDM and aerial imagery. The impervious percentage was obtained directly from the NLCD 2021 data impervious percentages.
Roughness Coefficient	Manning's n-values were determined based on the delineated land use category. See Section 3.3.6 for further details.

3.3.1 MODEL DOMAIN

The pre-project model domain consists of 2,167,482 grids covering approximately 31 square miles and includes the entire upstream tributary drainage area to the Project to and approximately 2 miles downstream of the site.

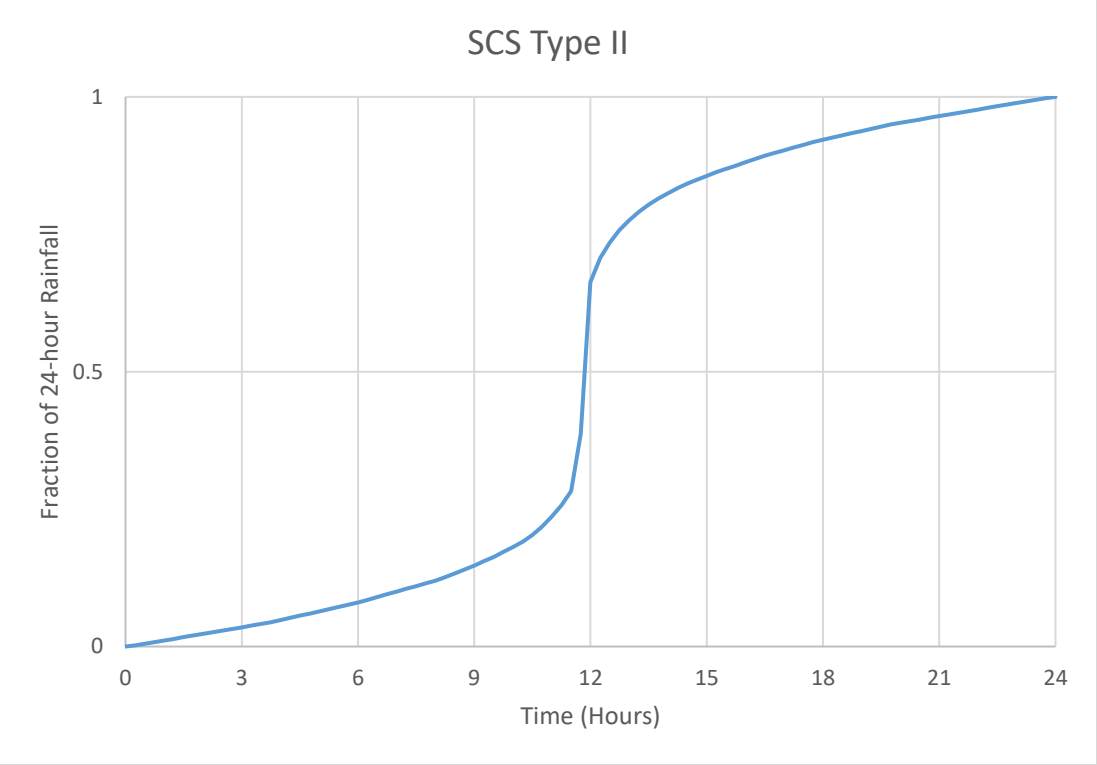
3.3.2 GRID SIZE

A grid size of 20-feet was used for the pre-project condition. This grid size was appropriate, considering the study area is 31 square miles. Utilizing this grid size, the FLO-2D computational domain included more than 2 million cells. A smaller grid size would not have been practical, since the FLO-2D model computational time would be greatly increased, and there would be diminished returns due to topographic detail obtained from USGS. The 20-foot grid size was found to be reasonable to provide general information about the existing overland flow patterns while also maintaining a reasonable model run time. The model area captures all of the tributary drainage area to the Project and includes an additional area west and south of the site to ensure sufficient area was included to accurately calculate downstream boundary conditions.

3.3.3 RAINFALL DATA

Pinal County requires an analysis of the 100-year storm event to ensure that post-project peak flow rates are at or below the existing 100-year peak flow rates. For this Project, the 100-year, 6-hour and 100-year, 24-hour storm events were modeled, however the 6-hour event was determined to govern as it produced more conservative flow rates. Rainfall data was obtained from point precipitation frequency estimates of NOAA Atlas 14, Volume I, Version 5, available on the National Oceanic Atmospheric Administration's website. A rainfall depth of 3.08 inches was used, which corresponds to the 6-hour 100-year storm event. The NOAA 14 data is included in Appendix B.

The rainfall distribution pattern used was obtained from the Soil Conservation Service (SCS) type II storm pattern. The SCS, now known as the Natural Resources Conservation Service (NRCS), developed storm rainfall patterns for the different areas of the United States. The Type II storm is used for areas outside of pacific climates or areas that are not affected by the Gulf of Mexico and Atlantic Ocean tropical storms and hurricanes. This storm rainfall pattern is appropriate for the rainfall patterns present in western Arizona, which are not affected by either pacific storm climates or the Gulf of Mexico and Atlantic tropical storms and hurricanes. The SCS Type II rainfall storm pattern was added to the FLO-2D program and is included in the figure below.



SCS TYPE II RAINFALL PATTERN

3.3.4 SOILS DATA

The ADOT HDDM was referenced for guidance on FLO-2D modeling and recommended G&A parameters. The ADOT HDDM Appendix B includes G&A values for various soil types and these are listed in Table B-4. The NRCS Soil Survey AZ661 is a detailed soil survey area for the Eastern Pinal and Southern Gila Counties, Arizona. This soil group encompasses most of the tributary drainage area, however Table B-4 did not list G&A parameters for a small area at the upstream end of the watershed. In areas where the AZ661 soil groups did not have representative G&A values, the General Soil Map (GSM) from the State Soil Geographic Database (STATSGO) was used. The GSM soil values were downloaded from the AZDOT.gov website and included spatial and tabular data that provided G&A parameters. These parameters were included in the soil table below and are included in Appendix B.

According to the NRCS Web Soil Survey, the majority of the soils in the study area are considered well drained, which indicates that the soil could be anticipated to infiltrate a larger percentage of the rainfall within the study area, resulting in a lesser surface flow rate observed in the FLO-2D modeling. Near the Project area the soil is primarily sand and gravel with more than 80 inches to the nearest restrictive feature. Limiting soil depths were used as a method of calibration and of the FLO-2D modeling are discussed further in Section 3.8. The soils map is included in Figure 3 (Soils Map) of Appendix A.

Table 2: Soil Green and Ampt Parameters							
Soil Map Name	Soil Symbol	XKSAT (ADOT) (inch/hr)	ROCKOUT [0-100%]	PSIF (ADOT) (in)	Saturated Content	Calculated DTHETA DRY (ADOT)	Calculated DTHETA NORMAL (ADOT)
AZ661	1	0.5	0	3.24	0.4	0.25	0.32
AZ661	6	0.87	0	3.54	0.41	0.28	0.37
AZ661	14	0.83	33.3	4.72	0.4	0.25	0.35
AZ661	43	1.34	0	1.79	0.41	0.29	0.37
AZ661	47	0.05	0	20.58	0.49	0.09	0.25
AZ661	51	0.39	0	7.66	0.39	0.2	0.3
AZ661	64	0.01	0	11.42	0.48	0.06	0.18
AZ661	69	0.03	0	10.49	0.46	0.12	0.24
AZ661	71	0.49	0	4	0.42	0.24	0.33
AZ661	78	0.87	0	3.89	0.39	0.27	0.36
AZ661	87	0.31	25	5.13	0.42	0.22	0.31
AZ661	93	0.3	0	8.38	0.39	0.2	0.31
AZ661	98	0.05	0	9.11	0.46	0.13	0.25
GSMSTATSGO	s429	0.28	30	6.14	0.42	0.2	0.31
	Average	**0.09**	-	**7.55**	**0.44**	-	-

3.3.5 LAND USE CLASSIFICATION

Land use for the drainage area was classified based on the National Land Cover Database (NLCD) 2021. The NLCD 2021 data was obtained as a GeoTIFF and was converted to a shapefile for use in FLO-2D and QGIS. The NLCD also provides a map of impervious percentage for the study area. The majority of the study area, 89%, is classified as barren which has an impervious percentage of 0%. The Land Use categories were assigned antecedent moisture conditions, initial abstractions, and vegetation covers based on guidelines from the ADOT HDDM and aerial imagery. Initial abstraction values were assigned based on Table 3-1 of the ADOT HDDM. For example, the shrub/scrub initial abstraction value was based on the desert rangeland and hillslopes land use which uses a max storage (IA) value of 0.15, and barren land use was assigned an IA of 0.10. The land use classifications and assigned parameters are shown in the table below and included in Appendix B. Land use areas are illustrated in Figure 4 (Land Use Map) of Appendix A.

Table 3. Land Use Parameters					
LU CODE	**Description**	**Antecedent Moisture Condition**	**IA**	**Impervious %**	**Vegetation Cover %**
11	Open Water	wet	0	100	0
21	Developed, Open Space	dry	0.05	80	0
22	Developed, Low Intensity	dry	0.05	80	0
23	Developed, Medium Intensity	dry	0.05	95	0
24	Developed, High Intensity	dry	0.05	95	0
31	Barren Land (Rock/Sand/Clay)	dry	0.35	0	0
42	Evergreen Forest	normal	0.1	0	50
52	Shrub/Scrub	dry	0.15	0	20
71	Grasslands/Herbaceous	dry	0.5	0	85
90	Woody Wetlands	wet	0.5	0	85

3.3.6 ROUGHNESS COEFFICIENT

A variable roughness coefficient was assigned for the entire study area based on the delineated land use. Manning's n-values are based off recommended values suggested for like land use types in the DDM. Areas associated with the Manning's n-values referenced for this study are illustrated in Figure 5 (Manning's N-Value Map) of Appendix A. A table listing the Manning's n-value corresponding to each land use is provided in Appendix B.

3.4 RAINFALL LOSSES

Rainfall losses were computed using the G&A infiltration parameters within the FLO-2D model. The G&A parameters were assigned and/or calculated in accordance with the ADOT HDDM. The G&A parameters were defined based on the XKSAT, PSIF, and DTHETA values based on the soil data obtained from the NRCS Web Soil Survey and GSM STATSGO. These parameters are discussed in the following sections.

3.4.1 SURFACE RETENTION LOSS (IA)

The initial abstraction values (FLO-2D 'abstrinf' value) were assigned based on the land use designations and similar values of initial abstraction as outlined in the ADOT HDDM. Table 3-1 of the ADOT HDDM assigns max storage values which corresponds to the ABSTRINF parameter in FLO-2D. The initial abstraction assigned to each land use is included in Table 3 above.

3.4.2 HYDRAULIC CONDUCTIVITY (XKSAT)

Hydraulic conductivity (FLO-2D 'hydc') is defined as the soils ability to conduct water through the soil column and affects the infiltration ability of the soil. This parameter is represented in FLO-2D by XKSAT and within the study area ranged from 0.01 to 1.34 inches/hour. These values were referenced from the ADOT HDDM Appendix B and GSM soil tables. This value is the bare soil conductivity, which was adjusted based on vegetative cover in FLO-2D. Vegetative cover was assigned based on aerial imagery.

The values for XKSAT are included in Table 2 and the vegetative cover is included in Table 3.

3.4.3 CAPILLARY SUCTION (PSIF)

PSIF (FLO-2D 'soils') is a function of the soil properties and this G&A parameter was assigned based on the soil values outlined in the ADOT HDDM Appendix B soil tables.

3.4.4 VOLUMETRIC SOIL MOISTURE DEFICIT (DTHETA)

The volumetric soil moisture deficits were calculated in FLO-2D (FLO-2D 'dtheta') for both normal and dry conditions. The calculation is the difference between the saturated soil content and the normal and dry condition, respectively. The dry condition was used for the majority of the watershed, with the exception of delineated Evergreen Forest which used the normal condition, and open water and Woody Wetlands which used the wet condition. These values are a function of the soil properties and this G&A parameter was assigned based on the soil values outlined in the ADOT HDDM Appendix B soil tables.

3.5 FLO-2D HYDRAULIC STRUCTURES

There are several large culvert crossings within the upstream watershed that were included in the model. The culverts alignments were drawn in Civil3D and exported as shape files for inclusion in QGIS. Culvert data was obtained from the Pinal ADMP, and rating tables were developed using HY-8. The locations of culvert crossings are illustrated on Figures 6, 7, 9 and 10.

3.6 FLO-2D INPUT AND MODEL CONTROLS

A TOL setting of 0.004 feet was used to minimize the overcounting of depression storage. This is the TOL setting typically used by the Flood Control District of Maricopa County (FCDMC) per the FCDMC Supplemental Technical Document. The model was run for 12 hours to ensure the peak of the storm event was modeled. An output interval of 0.1 hours, was used along with a floodplain limiting Froude Number of 0.9. These parameters are used by FLO-2D to provide detailed information while also preserving the stability of the model.

3.7 FLO-2D MODELING RESULTS EVALUATION

3.7.1 CHECKING OUTPUT FILES

A review of the model output files was performed to assess the accuracy of the model and to ensure that there were no error messages that might impact the results. The 'SUMMARY.OUT' file shows that the model maintained an accurate volume conservation and that the 5.105 acre-feet of rainfall volume was accounted for in water lost to infiltration & interception, floodplain storage and in the floodplain outflow hydrograph. Approximately 36% of the rainfall volume was lost to infiltration and interception, with the remaining volume either accounted for in floodplain storage or in outflow exiting the model. The 'VELTIMFP.OUT' file was reviewed, and almost almost 1,000 cells were identified with velocities exceeding 10 ft/s. These cells are located

along the boundary of the study area or in washes which do not directly impact the Project area.

The 'ERROR.CHK' file was also reviewed. No fatal data input errors were encountered. The only message displayed was regarding the initial abstraction and use of a lower TOL value to ensure that depression storage was not overcounted. The TOL parameter was set to 0.004 as described in Section 3.5.

3.7.2 FLO-2D POST PROCESSOR

The FLO-2D results were processed utilizing the FLO-2D MapCrafter program which reads the 'FPLAIN.DAT' data and generates TIFF files for the flow depths, elevation at cell, and volume at cell.

The FLO-2D HYDROG program was also used to generate hydrograph information for the floodplain cross sections that were imported into the FLO-2D model. These cross sections provided peak flow rate information for areas of interest and at the Project's upstream and downstream boundaries. The results of the HYDROG program are included in Appendix C and peak flow rates are included in Figure 6, Figure 7, Figure 9 and Figure 10.

3.8 CALIBRATION

Calibration was performed by adjusting limiting soil infiltration depth based on a HEC-HMS analysis of the tributary drainage area. A HEC-HMS model was developed using the average soil parameters over the entire area. Area-weighted averages of the soil saturated content, wilting point, and field capacity were calculated. For the conductivity and soil suction parameters, the area-weighted logarithms were calculated per the ADOT HDDM Section 3. Additionally, land use values for impervious percentage and initial abstraction were calculated based on area-weighted averages for the entire study area. The average G&A parameters were included in the HEC-HMS model for the study area. The HEC-HMS model results yielded a loss volume of 1.13 inches from the 3.08 inches of rainfall and a discharge volume of 1.95 inches. This results in a loss volume to rainfall ratio of approximately 37%.

The limiting soil depth was related to the loss volume calculated in HEC-HMS through a ratio of the loss volume (inches) divided by the DTHETA for dry conditions, which is the predominant condition for the watershed. This ratio yields a comparison that calculates the total depth of the soil column that would result in a loss volume comparable to that produced in HEC-HMS. The equation can be summarized as follows,

$$limiting\ soil\ depth = \frac{loss\ volume}{DTHETA}$$

$$limiting\ soil\ depth = \frac{1.13\ in.}{0.26} = 4.3\ inches = 0.36\ ft$$

In order for a more conservative analysis, an additional factor of safety was applied, and a limiting soil depth of 0.25 ft was assigned uniformly to every soil category in the study area since this soil depth was based on the area weighted average of the G&A

parameters of all of the soil groups present within the study area. The results of this calibration was a volume of 1,855 acre-feet lost to infiltration and interception from the total 5,105 acre-feet rainfall volume which is roughly a 36% loss volume to rainfall ratio. This ratio closely matches the 37% calculated by HEC-HMS, which ensures that the proposed onsite facilities are adequately sized to manage runoff during the design storm event and account for variations in the underlying soil conditions within the study area.

3.9 RESULTS

Peak flow rates entering and leaving the Project boundary were obtained through the use of floodplain cross sections in FLO-2D. The resulting flow rates are included in Figure 7 and Figure 10 of Appendix A.

Table 4: 100-Year 6-Hour Flowrates at Floodplain Cross Sections	
Floodplain Cross Section	**100-Year 6-Hour Flowrate (cfs)**
XS-7	305
XS-11	99
XS-23	13
XS-27	169
XS-29	114
XS-31	256
XS-33	69
XS-34	234
XS-35	823
XS-36	1,120
XS-37	5
XS-38	536
XS-39	69
XS-40	39
XS-41	67
XS-42	256

4.0 POST PROJECT HYDROLOGIC ANALYSIS

The post-project hydrologic analysis was prepared to demonstrate the effect of the Project on the resulting flowrates exiting the Project. To maintain post-project flowrates below the existing 6-hour 100-year peak flow rates, multiple retention basins are proposed throughout the Project. These retention basins are generally located within natural low points where flow exits the Project under existing conditions. The Project slopes primarily northeast, within a series of washes or as shallow sheet flow. This drainage pattern will continue under proposed conditions.

Per Pinal County standards, a management approach for the post-project condition was defined wherein the offsite runoff will be channelized as necessary to protect the site, and will generally continue to flow through the Project in the primary wash corridors as in existing conditions. The proposed retention basins will include overflow weirs designed to discharge the peak flow rate at a depth not to exceed 1 foot. Additional runoff generated by the addition of the solar panels and the resulting increase in impervious area will be retained within the

retention basins and are anticipated to be dewatered via bleed-off pipes and/or drywells and natural infiltration. Retention basins were preliminarily located along the downstream boundary of the Project or in areas of existing ponding. The preliminary retention basin locations are illustrated in Figures 8 (Post-Project Flow Depths Map) and Figure 11 (Post-Project Velocity Map), and Figure 12 (Preliminary Drainage Plan) which includes the proposed retention volumes that will be used to attenuate the increased onsite runoff.

4.1 METHOD DESCRIPTION

Hydrologic and hydraulic analysis of the post-project condition 100-year 6-hour storm event was performed using the FLO-2D Pro program (Build No. 23.10.25) and QGIS (Version 3.28.11). Similar to the pre-project condition, the post-project study area was analyzed using parameters prepared using the guidance and methods outlined in the ADOT HDDM. Infiltration parameters were modified for the post-project condition to account for the changes in land use and impervious percentage within the Project. The topography was also revised to include the addition of the retention basins.

4.2 PARAMETER ESTIMATION

Table 5: Post-Project FLO-2D Model Parameters	
Parameter/Data	**Description**
Topographic Data	Topographic data was modified to include the proposed retention basins, channels and berms.
FLO-2D Grid	No change from pre-project condition.
Rainfall Data	No change from pre-project condition.
Soils Data	No change from pre-project condition.
Green and Ampt Parameters (G&A)	No change from pre-project condition.
Land Use	Land Use categories were modified to include the post-project condition. Within the Project boundary, two new land use classifications (solar arrays and battery storage/substation) were included with an imperviousness percentage of 5% and 90%, respectively. An initial abstraction of 0.15 was used for the solar arrays, consistent with the existing initial abstraction, and 0.10 for the batter storage/substation areas. The initial saturation used was normal. Refer to Section 4.2.2 for additional detail.
Roughness Coefficient	The roughness coefficient for the solar array areas were modified to 0.045, reflective of the underlying existing roughness value, and the battery storage and substation areas were modified to 0.028. Roughness values were otherwise unmodified from the pre-project model.

4.2.1 MODEL DOMAIN

The post-project model domain was not modified from the pre-project model. The post-project model utilizes 20-foot by 20-foot grids to accurately reflect the proposed onsite grading of retention basins and embankments. The resulting model domain for the post-project condition consisted of 2,167,482 grids covering the approximately 31 square mile area.

4.2.2 LAND USE CLASSIFICATION

The land use for post-project condition was modified to include the expected change in impervious percentage that will result with the addition of solar panels and battery storage for the Project. The solar panels will be located on posts and will be elevated above the expected 100-year flood depth, and the battery storage facilities are similarly anticipated to be constructed on elevated pads. The increase in runoff expected because of the Project is primarily due to the increase in impervious area that the solar arrays and battery storage facilities will provide. Under existing conditions, the rainfall that falls on the Project site is able to fall directly on bare soil where it can infiltrate the soil, reducing the overall surface runoff. Under proposed conditions the rain will first fall on the solar panels, concentrating along a drip line before falling on the soil. This will create discontinuous flow paths and reduce the expected soil infiltration. This reduction in infiltration was represented through an increased impervious coverage over the Project.

The Project does not propose overall grading of the site. Where possible vegetation will remain in place and would only be removed where it directly impacts the placement of the solar panels or battery units. Additionally, the maintenance roads will be dirt roads treated with dust palliatives and will not cover the majority of the site. Therefore, it is not expected that the dirt roads will greatly increase the impervious cover or reduce the infiltration ability of the site.

Based on assessments of aerial imagery and comparisons with other solar array sites, an impervious percentage of 5% was used over the portions of the Project planned for solar arrays, and 90% for the battery storage and substation areas. This percentage will account for open areas within the site between rows of panels and along maintenance roads. Although the solar panels are impervious, they are discontinuous and any rainfall that falls on them will drain to the bare soil and will allow for infiltration on a majority of the site.

4.3 FLO-2D INPUT AND MODEL CONTROLS

The pre-project topography was modified using the assign grid elevation tool in FLO-2D PRO QGIS Plugin to reflect the proposed retention basin grading. The retention basins have been preliminarily designed to retain the tributary onsite runoff generated from the post-project condition. A TOL setting of 0.004 feet was used to minimize the overcounting of depression storage. The model was run for 12 hours, consistent with the pre-project model. An output interval of 0.1 hours, was used along with a floodplain limiting Froude Number of 0.9.

5.0 PROPOSED DRAINAGE INFRASTRUCTURE

The primary constraint of the developed drainage design is to maintain or reduce flow rates at the outfall points to equal to or less than the flow rates for historic conditions. The proposed drainage infrastructure to manage stormwater for the Project consists of a channel and retention basin. This drainage report assumes, in accordance with County Drainage Rules and Regulations that development of a site will not increase flow rates or discharge a higher flow volume from its property boundary, nor alter the historic discharge location. The following sections describe the proposed concepts and preliminary design of the drainage facilities required for the Project.

5.1 MAINTENANCE ROADS

Maintenance roads in the interior of the Project and connecting the adjacent roadways will primarily be surfaced with gravel or will be constructed of compacted native soils that may be treated with a dust palliative. The roadway surface will be set near the adjacent grades and will be graded to allow cross drainage patterns to be maintained. Portions of the site, such as driveway connections to existing paved roads, or portions of the substation or battery storage area may be paved with asphalt.

5.2 PRELIMINARY CHANNELS

As illustrated in Figure 7, there are several locations where offsite runoff breaks out of the existing channels and berms at the upstream end of the site, and drains through the property. As shown on Figure 8 and Figure 12, several collector channels have been preliminarily designed to intercept this runoff prior to draining through the site, and direct the offsite flow to the historic drainage corridor. Hydraflow was utilized to preliminarily size these channels, referencing peak flow rates obtained from the results of upstream cross sections in the Pre-Development FLO-2D model. The channels were designed to convey the 100-year peak flow rate, while providing at least 12-inches of freeboard. As shown in Figure 8, the Post-Project FLO-2D model reflects these channels, and the runoff is directed to the historic outfall location. The channel lining will be designed to withstand the flow velocities and to mitigate erosion potential. Results of the Hydraflow analyses are included in Appendix D.

5.3 RETENTION REQUIREMENTS

Developed areas within Pinal County are required to regulate stormwater discharge such that net flow rates and flow volume exiting from the site are equal to or less than the pre-development rate. This is often controlled through the construction of retention basins. The following sections describe the sizing of the proposed retention basins designed in accordance with the County's applicable drainage design standards. The preliminary retention basin locations have been set at the natural low points along the downstream edges of the developed area. Solar panel arrays and battery storage unit pads will be graded to route flows to the retention basin.

5.3.1 REQUIRED RETENTION VOLUME ESTIMATE

The County typically requires new developments to retain the 100-year, 2-hour retention volume generated onsite. However, in light of the nature of the development (utility scale solar power generation) and the proximity to existing well-defined washes, a reduced retention requirement is being pursued. Specifically, the 100-year, 2-hour retention volume will be provided for the BESS and substation areas, while the greater of the first flush volume and volumetric difference between runoff generated in pre-development and post-development conditions (Pre- vs. Post-) volume will be provided for the remaining developed portions of the Project. Additionally, the volume provided will be sufficient to demonstrate that the peak flow rates leaving the site under post-development conditions do not exceed pre-development conditions. The equations used to determine retention volumes is provided below:

100-Year, 2-Hour

$$V_R=C*(P/12)*A$$

where: V_R = 100-Yr, 2-Hr Required Retention Volume (ft^3)
C = Area-Weighted Runoff Coefficient
P = 100-year, 2-hour Precipitation Depth (in) = 2.61 inches
A = Drainage Area (ft^2)

Pre vs. Post

$$V_{Pre\ vs.\ Post} = (C_{post}-C_{pre})*(P/12)*A$$

Where:

$V_{Pre\ vs\ post}$ = the 100-year, pre-vs. post retention volume (ft^3)
C_{pre} = Undeveloped condition "C" value (0.50)
C_{post} = Developed condition "C" value (0.70 or 0.95)
P = the 100-year, 2-hour rainfall depth (2.61 inches)
A = the drainage area (ft^2).

First Flush

$$V_{FF}=C*(P/12)*A$$

where: V_{FF} = First Flush Required Retention Volume (ft^3)
C = First Flush Area-Weighted Runoff Coefficient (1.0)
P = 100-year, 2-hour Precipitation Depth (in) = 2.61 inches
A = Drainage Area (ft^2)

The 100-year, 2-hour precipitation depth at the Project site is 2.61 inches as indicated by the NOAA Atlas 14 Point Precipitation Frequency Estimates. Pinal County recommended runoff coefficients were assigned on the basis of the proposed land uses for the Project. Coefficients for the substation and battery storage units were conservatively determined to be impervious, and the entire tributary area containing solar panels was set to a "C" value of 0.70, regardless of the density of solar panels within the area, and the pre-project undeveloped condition references a "C" value of 0.50. The retention calculations tables included in Appendix E show the preliminary weighted runoff coefficient values chosen for the land use in the individual drainage areas of the site. The weighted coefficients consider both the additional impervious area created by the solar array, substation, battery footprints and the significant amount of area that will effectively remain natural once construction has been completed. These tables also show required retention volumes to contain the 100-year, 2-hour calculated retention requirements for the developed areas within Pinal County in accordance County regulations.

Retention facilities will not be provided for those portions of the site that are to remain undisturbed, which will continue to drain in historic fashion. This includes areas such as those portions of the site located outside of the perimeter fencing, washes, and undisturbed vacant land. Final location and sizing for retention basins and dewatering facilities for the Project will be based on weighted runoff coefficients to account for the solar arrays, batteries, equipment pads, access roads, and open areas. Final design of these retention facilities will be provided with the improvement plans and final drainage report. It should be noted that the locations of retention facilities are

preliminary are subject to change. At final design, the retention facilities may be located downstream, closer to existing retention facilities which are outside of the current development limits. Should offsite retention facilities be utilized, appropriate drainage agreements and easements shall be obtained as required.

In general, the volumes provided by the proposed basins exceed the calculated retention volume required. The design volumes provided were increased as necessary until attenuation of flows was observed in the FLO-2D model results. Floodplain cross sections are shown to demonstrate that the peak flow rates leaving the site are attenuated below the existing condition flow rates.

5.3.2 PRELIMINARY RETENTION BASIN CAPACITY DESIGN PARAMETERS

Final required retention volumes will be prepared during submittal of the improvement plans. Final location and configuration of retention basin will be documented in the final drainage report. The maximum design ponding depth is equal to or less than 3 feet, however, the total depth of the basins may exceed this depth to sides other than the anticipated overflow embankment. As this exceeds the typical maximum depth criteria of Pinal County, safety measures such as fencing shall be implemented around the retention basins. Retention basins have been designed to retain onsite flows, while offsite flows are generally routed through the site via proposed berms and/or channels to the primary wash corridors. The retention basins have not been designed to retain offsite flows.

5.3.3 PRELIMINARY RETENTION BASIN DEWATERING DESIGN PARAMETERS

The preferred method for dewatering retention basins is direct infiltration, bleed-off and drywells where necessary. Where soil infiltration does not adequately dewater the retention basin within a maximum 36 hours, drywells and/or bleed-off pipes will be used to dewater the basins; or, by methods otherwise approved by the County Drainage Engineer. Final location and sizing for retention basins and dewatering facilities will be provided with the improvement plans and final drainage report. Preliminary drywell calculations are included in Appendix E, which assume the most conservative scenario in which bleed-off is not feasible for any retention basins. At locations where bleed-off may be used, bleed-off pipes will be installed at least 1 foot above the basin bottom and ensure that at minimum, the first flush volume generated onsite is retained. Final dewatering design is to be provided with the subsequent final drainage report. Post construction geotechnical tests will be performed in order to determine the actual drywell disposal rate of any installed drywells, as well as the natural infiltration rate of each basin. The actual number of drywells and/or sizing of bleed-off facilities may be revised based on the drywell discharge rates determined by the post construction geotechnical tests.

5.4 RESULTS AND HYDROLOGIC COMPARISON

The results of the post-project condition model were compared with a pre-project condition model to ensure that the 100-year 6-hour peak flow rates leaving the site were at or below existing rates. Table 6 below shows the post-project peak flow rates compared with the pre-project peak flow rates. The retention basins function as intended to attenuate the flow and reduce the additional runoff generated by the post-project conditions.

5.4.1 FLO-2D POST PROCESSOR

The developed condition FLO-2D results were processed utilizing the FLO-2D MapCrafter program which reads the 'FPLAIN.DAT' data and generates TIFF files for the flow depths, elevation at cell, and volume at cell.

The FLO-2D HYDROG program was also used to generate hydrograph information for the floodplain cross sections that were imported into the FLO-2D model. These cross sections provided peak flow rate information for areas of interest and at the Project's upstream and downstream boundaries. The results of the HYDROG program are included in Appendix C and peak flow rates are included in Figure 8, Figure 11, and Figure 12.

Table 6: 100-Year 6-Hour Flowrates at Floodplain Cross Sections Pre-vs. Post

Floodplain Cross Section	Pre-Project (cfs)	Post-Project (cfs)
XS-31	256	211
XS-33	69	5
XS-34	234	163
XS-35	823	756
XS-36	1,120	964
XS-37	5	4
XS-38	536	508
XS-39	69	63
XS-40	39	1
XS-41	67	3
XS-42	256	224

6.0 SCOUR ANALYSIS

An onsite scour analysis for the Project area has been performed referencing the maximum flow depth and velocity results of the post-project conditions FLO-2D model, and the resulting scour depths are mapped on Figure 13 (Onsite Scour Depth Map). Due to the general sheet flow conditions which are anticipated to occur outside of the wash corridors, the site experiences variations in flow depths and velocities. As such, the HEC-18 pier scour equation was referenced in conjunction with the results of each cell within the solar array areas of the property. The long term scour component was assumed to be 0, as regular maintenance will be performed, which will preclude any long term effects of scour. General scour was set to 0, as the site will continue to allow sheet flow through the property to the wash corridors (which will remain natural), and continuity of sediment transport capacity is maintained upstream and within the site. Bedform scour and low flow scour are not applicable in overbank or sheet flow conditions and were accordingly assumed to be equal to 0. A factor of safety of 1.2 was conservatively applied to the onsite scour analysis due to the sandy soil conditions. Scour depth calculations are included in Appendix F, and the onsite scour map is shown on Figure 13. A geotechnical investigation and evaluation should be performed in order to evaluate the underlying soil conditions onsite, and to determine specific scour protection measures.

7.0 SUMMARY AND CONCLUSIONS

The preliminary drainage report analyzed the onsite and offsite runoff affecting the Project under existing and proposed conditions. The post-project analysis demonstrates the retention provided onsite will attenuate the post-project onsite runoff such that the 6-hour 100-year flowrates will remain less than existing conditions. The FLO-2D analysis was prepared in accordance with the ADOT HDDM. The post-project future design of drainage infrastructure will maintain the historical drainage patterns and will conform to the Pinal County Drainage Ordinance, Pinal County Drainage Manual, and Pinal County Floodplain Ordinance standards. Where any deviations from these standards are proposed, County approval and/or waivers will be obtained. Based on the hydrologic and hydraulic analyses prepared in this report, no adverse drainage impacts are expected to either upstream or downstream existing properties or drainage ways from the site. The study has determined that:

- The Project will result in a decrease in soil infiltration, represented by a 5% imperviousness percentage applied over the entire solar array area, and 90% over the battery storage and substation areas.

- 100-Year 6-hour flowrates exiting the site have been reduced to existing or below existing levels through the use of retention basins throughout the Project.

- A preliminary scour analysis was undertaken to determine scour depths for the solar panel posts. These scour depths shall be observed to ensure that the solar panels are protected from the 100-year storm event.

- Solar panels and battery storage units will be elevated above the 100-year 6-hour flow depths as determined by the FLO-2D analyses.

- The Project will provide all-weather access to the Project entrance.

8.0 REFERENCES

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Pinal County, (August, 2004a). *Drainage Design Pinal County Drainage Manual, Volume 1.*

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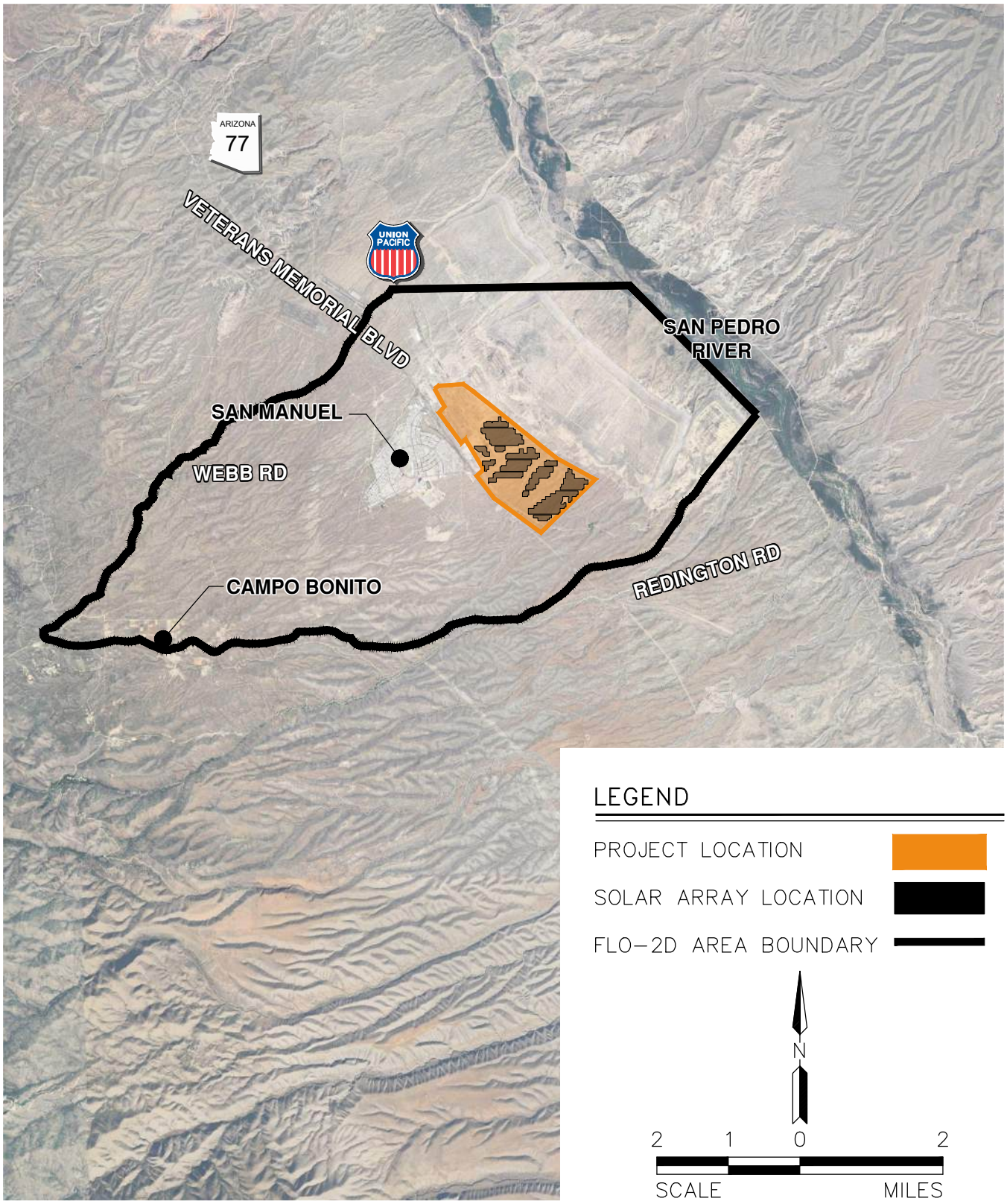
Pinal County, (March, 2021). *Drainage Design Requirements; Utility-Scale Photovoltaic (PV) Solar and Wind Power Generating Facilities.*

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APPENDIX A

EXHIBITS



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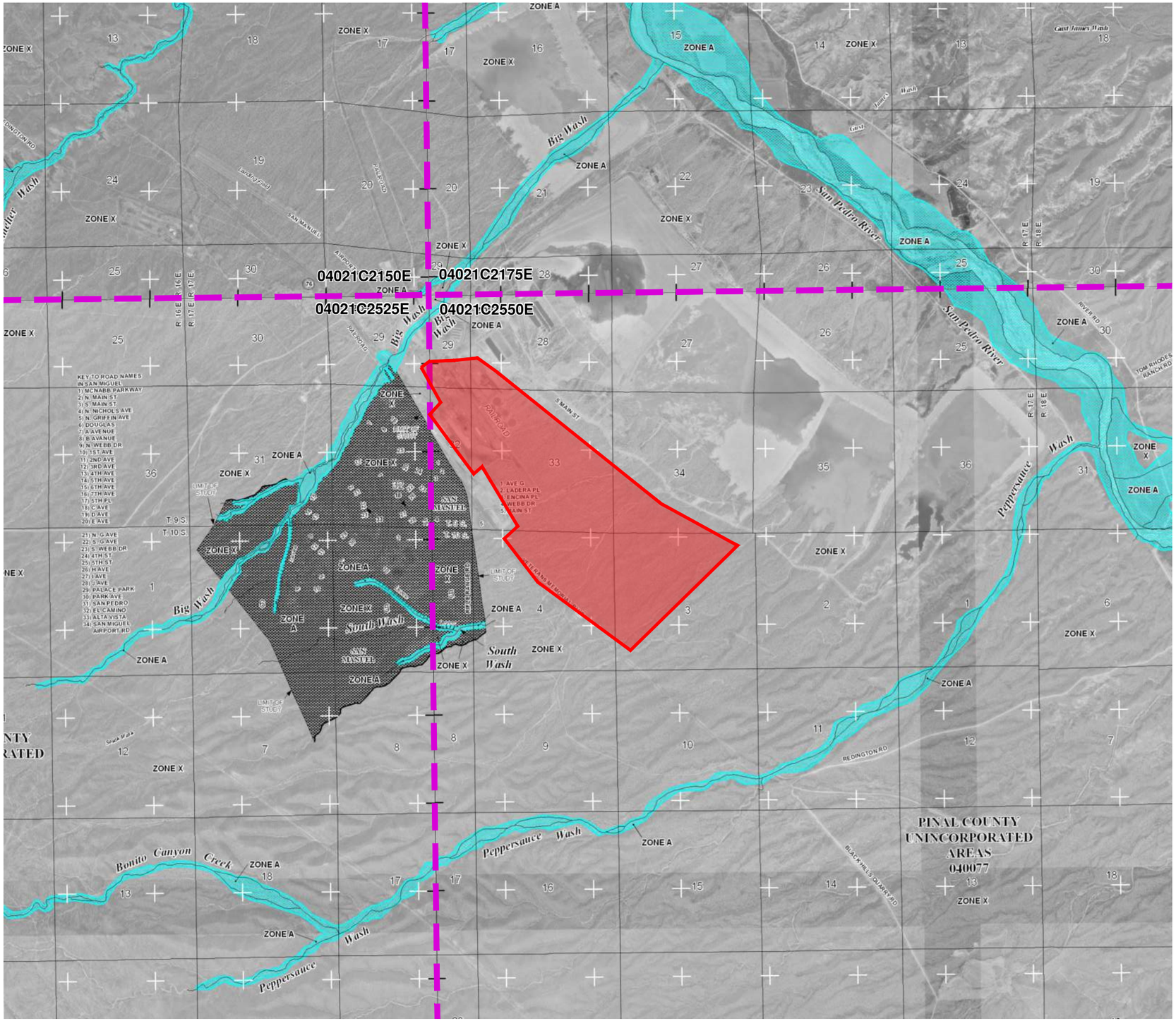
ORE TOWN SOLAR

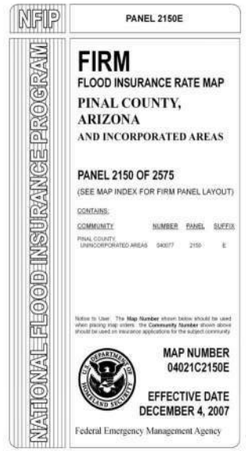
PINAL COUNTY, ARIZONA

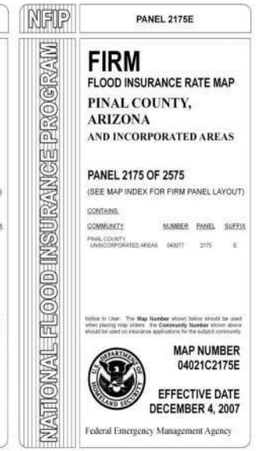
FIG 1: VICINITY MAP

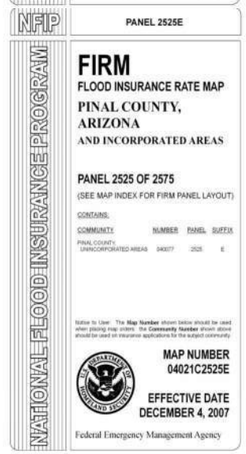
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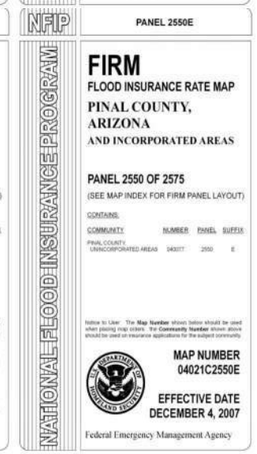
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LEGEND

PROJECT LOCATION

FEMA MAP LIMITS

N

4000 2000 0 4000

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FIG 2: FEMA FLOOD MAP

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LEGEND

PROJECT LOCATION

MODEL BOUNDARY

SOIL GROUPS

- 1
- 6
- 14
- 43
- 47
- 51
- 64
- 69
- 71
- 78
- 93
- 98
- s429

N

2000 1000 0 2000 4000

SCALE FEET

VETERANS MEMORIAL BLVD

UNION PACIFIC

SAN PEDRO RIVER

SAN MANUEL

WEBB RD

REDINGTON RD

CAMPO BONITO

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FIG 3: SOILS MAP

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LEGEND

PROJECT LOCATION

MODEL BOUNDARY

MANNING'S N-VALUE

- 11 OPEN WATER
- 21 DEVELOPED, OPEN SPACE
- 22 DEVELOPED, LOW INTENSITY
- 23 DEVELOPED, MEDIUM INTENSITY
- 24 DEVELOPED, HIGH INTENSITY
- 31 BARREN LAND (ROOK, SAND, CLAY)
- 42 EVERGREEN FOREST
- 52 SHRUB/SCRUB
- 71 GREENLANDS/HERBACEOUS
- 90 WOODY WETLANDS

DEVELOPED LAND USE

- BATTERY STORAGE & SUBSTATION
- SOLAR ARRAYS

N

2000 1000 0 2000 4000

SCALE FEET

VETERANS MEMORIAL BLVD

SAN PEDRO RIVER

SAN MANUEL

WEBB RD

REDINGTON RD

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FIG 4: LAND USE MAP

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LEGEND

PROJECT LOCATION

MODEL BOUNDARY

MANNING'S N-VALUE

- 0.020
- 0.026
- 0.028
- 0.035
- 0.040
- 0.045
- 0.065

N

2000 1000 0 2000 4000

SCALE FEET

VETERANS MEMORIAL BLVD

SAN PEDRO RIVER

SAN MANUEL

WEBB RD

REDINGTON RD

CAMPO BONITO

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FIG 5: MANNING'S N-VALUE MAP

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LEGEND

- MODEL BOUNDARY
- PROJECT LOCATION
- CROSS-SECTION
- COMMUNITY FLOODPLAIN
- FEMA FLOODPLAIN

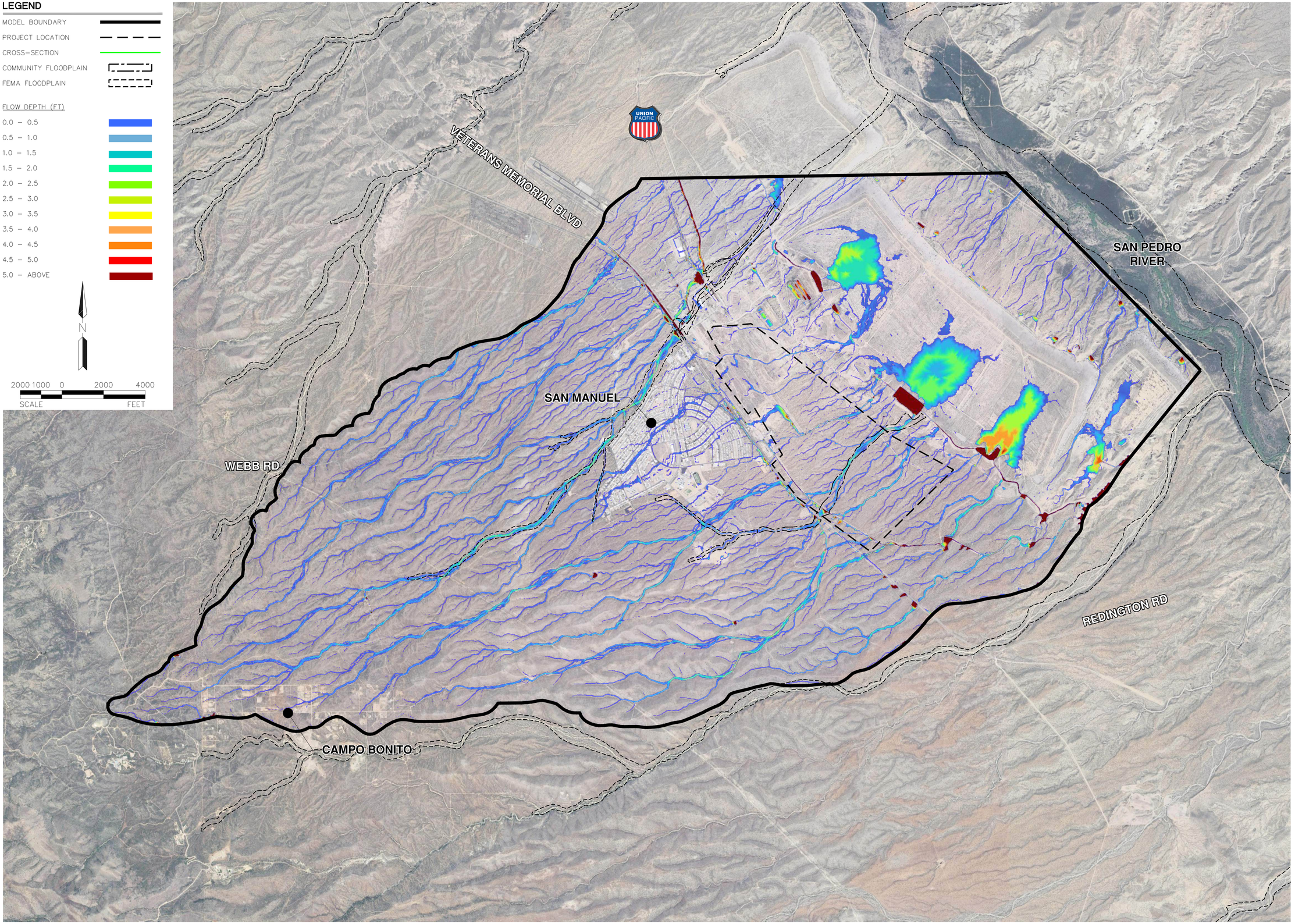
FLOW DEPTH (FT)

- 0.0 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- 2.0 – 2.5
- 2.5 – 3.0
- 3.0 – 3.5
- 3.5 – 4.0
- 4.0 – 4.5
- 4.5 – 5.0
- 5.0 – ABOVE

N

2000 1000 0 2000 4000

SCALE FEET



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FIG 6: OVERALL PRE-PROJECT FLOW DETPH MAP

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U:\2500\2592\2592.01 Avantus\REPORTS\DRAINAGE\PDR\Exhibits\2592 Fig 6 – Overall Pre-Project Flow Map.dwg 8/30/2024 3:40 PM

LEGEND

- PROJECT LOCATION
- CROSS-SECTION
- COMMUNITY FLOODPLAIN
- FEMA FLOODPLAIN
- CULVERT ID — CU-X
- CROSS SECTION ID — XS-X

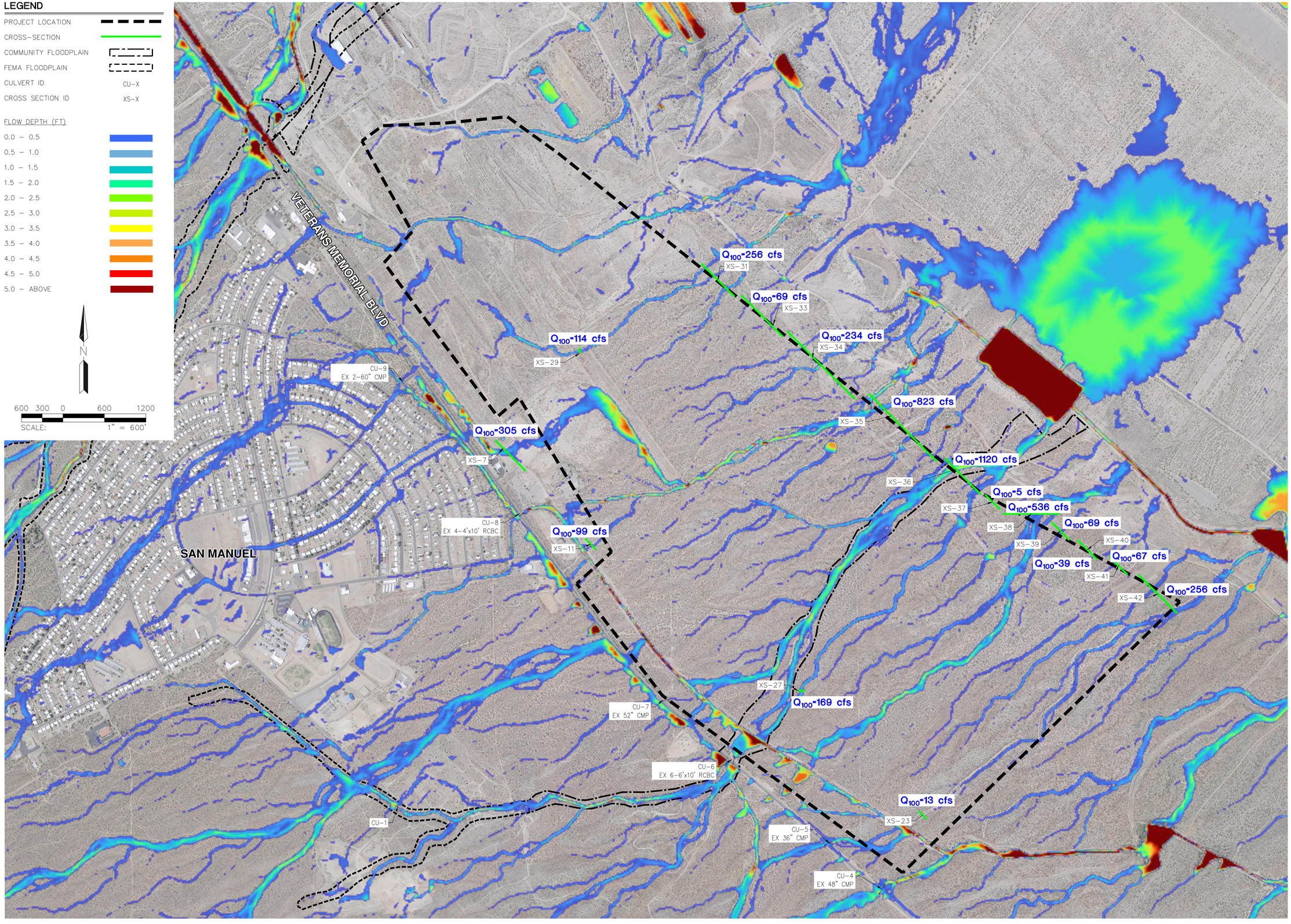
FLOW DEPTH (FT)

- 0.0 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- 2.0 – 2.5
- 2.5 – 3.0
- 3.0 – 3.5
- 3.5 – 4.0
- 4.0 – 4.5
- 4.5 – 5.0
- 5.0 – ABOVE

N

600 300 0 600 1200

SCALE: 1" = 600'



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FIG 7: PRE-PROJECT FLOW DEPTH MAP

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PROJ NO.: 2592
DATE: SEP 2024
SCALE: 1" = 600'
DRAWN: DM
DESIGNED: PG
APPROVED: BB

DWG. NO.
7

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U:\2500\2592\2592.01 Avantus\REPORTS\DRAINAGE\PDR\Exhibits\2592 Fig 7 – Pre-Project Flow Map.dwg 9/5/2024 7:55 AM

LEGEND

- PROJECT LOCATION
- CROSS-SECTION
- COMMUNITY FLOODPLAIN
- FEMA FLOODPLAIN
- CULVERT ID — CU-X
- CROSS SECTION ID — XS-X

FLOW DEPTH (FT)

- 0.0 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- 2.0 – 2.5
- 2.5 – 3.0
- 3.0 – 3.5
- 3.5 – 4.0
- 4.0 – 4.5
- 4.5 – 5.0
- 5.0 – ABOVE

N

600 300 0 600 1200

SCALE: 1" = 600'

VETERANS MEMORIAL BLVD

SAN MANUEL

Q_{100}=211 cfs
XS-31

Q_{100}=5 cfs
XS-33

Q_{100}=114 cfs
XS-29

Q_{100}=163 cfs
XS-34

CU-9
EX 2-60" CMP

Q_{100}=756 cfs
XS-35

Q_{100}=305 cfs
XS-7

Q_{100}=964 cfs
XS-36

Q_{100}=4 cfs
XS-37

Q_{100}=508 cfs
XS-38

CU-8
EX 4-4'x10' RCBC

Q_{100}=63 cfs
XS-40

Q_{100}=99 cfs
XS-11

XS-39

Q_{100}=3 cfs

Q_{100}=1 cfs
XS-41

Q_{100}=224 cfs
XS-42

XS-27

Q_{100}=169 cfs

CU-7
EX 52" CMP

CU-6
EX 6-6'x10' RCBC

Q_{100}=13 cfs
XS-23

CU-1

CU-5
EX 36" CMP

CU-4
EX 48" CMP

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FIG 8: POST-PROJECT FLOW DEPTH MAP

HILGARTWILSON

PROJ NO.: 2592
DATE: SEP 2024
SCALE: 1" = 600'
DRAWN: DM
DESIGNED: PG
APPROVED: BB

DWG. NO.
8

LEGEND

- MODEL BOUNDARY
- PROJECT LOCATION
- CROSS-SECTION
- COMMUNITY FLOODPLAIN
- FEMA FLOODPLAIN

VELOCITY (FPS)

- 0.0 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- 2.0 – 2.5
- 2.5 – 3.0
- 3.0 – 3.5
- 3.5 – 4.0
- 4.0 – 4.5
- 4.5 – 5.0
- 5.0 – ABOVE

N

2000 1000 0 2000 4000

SCALE FEET

VETERANS MEMORIAL BLVD

UNION PACIFIC

SAN PEDRO RIVER

SAN MANUEL

WEBB RD

REDINGTON RD

CAMPO BONITO

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FIG 9: OVERALL PRE-PROJECT VELOCITY

HILGARTWILSON

PROJ NO.:	2592
DATE:	AUG 2024
SCALE:	1" = 2,000'
DRAWN:	DM
DESIGNED:	PG
APPROVED:	BB

DWG. NO.

9

LEGEND

- PROJECT LOCATION
- CROSS-SECTION
- COMMUNITY FLOODPLAIN
- FEMA FLOODPLAIN
- CULVERT ID — CU-X
- CROSS SECTION ID — XS-X

VELOCITY (FPS)

- 0.0 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- 2.0 – 2.5
- 2.5 – 3.0
- 3.0 – 3.5
- 3.5 – 4.0
- 4.0 – 4.5
- 4.5 – 5.0
- 5.0 – ABOVE

N

600 300 0 600 1200

SCALE: 1" = 600'

VETERANS MEMORIAL BLVD

SAN MANUEL

Q_{100}=256 cfs
XS-31

Q_{100}=69 cfs
XS-33

Q_{100}=234 cfs
XS-34

Q_{100}=823 cfs
XS-35

Q_{100}=1120 cfs
XS-36

Q_{100}=5 cfs
XS-37

Q_{100}=536 cfs
XS-38

Q_{100}=69 cfs
XS-39

Q_{100}=39 cfs
XS-40

Q_{100}=67 cfs
XS-41

Q_{100}=256 cfs
XS-42

Q_{100}=114 cfs
XS-29

CU-9
EX 2-60" CMP

Q_{100}=305 cfs
XS-7

CU-8
EX 4-4'x10' RCBC

Q_{100}=99 cfs
XS-11

XS-27

Q_{100}=169 cfs

CU-7
EX 52" CMP

CU-6
EX 6-6'x10' RCBC

CU-1

Q_{100}=13 cfs
XS-23

CU-5
EX 36" CMP

CU-4
EX 48" CMP

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FIG 10: PRE-PROJECT VELOCITY

HILGARTWILSON
PROJ NO.: 2592
DATE: SEP 2024
SCALE: 1" = 600'
DRAWN: DM
DESIGNED: PG
APPROVED: BB
DWG. NO.
10

U:\2500\2592\2592.01 Avantus\REPORTS\DRAINAGE\PDR\Exhibits\2592 Fig 10 – Pre-Project Velocity.dwg 9/5/2024 7:57 AM

LEGEND

- PROJECT LOCATION
- CROSS-SECTION
- COMMUNITY FLOODPLAIN
- FEMA FLOODPLAIN
- CULVERT ID — CU-X
- CROSS SECTION ID — XS-X

VELOCITY (FPS)

- 0.0 – 0.5
- 0.5 – 1.0
- 1.0 – 1.5
- 1.5 – 2.0
- 2.0 – 2.5
- 2.5 – 3.0
- 3.0 – 3.5
- 3.5 – 4.0
- 4.0 – 4.5
- 4.5 – 5.0
- 5.0 – ABOVE

N

600 300 0 600 1200

SCALE: 1" = 600'

VETERANS MEMORIAL BLVD

SAN MANUEL

Q_{100}=211 cfs
XS-31

Q_{100}=5 cfs
XS-33

Q_{100}=114 cfs
XS-29

Q_{100}=163 cfs
XS-34

CU-9
EX 2-60" CMP

Q_{100}=756 cfs
XS-35

Q_{100}=305 cfs
XS-7

Q_{100}=964 cfs
XS-36

Q_{100}=4 cfs
XS-37

Q_{100}=508 cfs
XS-38

Q_{100}=63 cfs
XS-39

XS-40

Q_{100}=3 cfs

Q_{100}=1 cfs
XS-41

Q_{100}=224 cfs
XS-42

CU-8
EX 4-4'x10' RCBC

Q_{100}=99 cfs
XS-11

XS-27

Q_{100}=169 cfs

CU-7
EX 52" CMP

CU-6
EX 6-6'x10' RCBC

Q_{100}=13 cfs
XS-23

CU-1

CU-5
EX 36" CMP

CU-4
EX 48" CMP

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FIG 11: POST-PROJECT VELOCITY

HILGARTWILSON

PROJ NO.:	2592
DATE:	SEP 2024
SCALE:	1" = 600'
DRAWN:	DM
DESIGNED:	PG
APPROVED:	BB

DWG. NO.
11

LEGEND

- PROJECT LOCATION
- DRAINAGE AREA
- COMMUNITY FLOODPLAIN
- FEMA FLOODPLAN
- DRAINAGE CHANNEL
- DRAINAGE AREA ID — ON-XX
- 100-YEAR PEAK FLOW — Q_{100}-XXX cfs
- RETENTION BASIN ID — RB-XX
- RETENTION BASIN
- FLOW ARROW (OFFSITE)
- FLOW ARROW (ONSITE)
- ULTIMATE OUTFALL
- EXISTING CULVERT CROSSING

N

600 300 0 600 1200

SCALE: 1" = 600'

VETERANS MEMORIAL BLVD

SAN MANUEL

PROPOSED SUBSTATION

PROPOSED BESS

BERM

EXISTING CHANNEL

SPREADER BASIN

C-1D

C-1A

C-1B

C-1C

C-2A

C-3A

C-4A

ON-1A

ON-1B1

ON-1B2

ON-1D

ON-2A

ON-3A

ON-4A

RB-1A
HWE=3213
BTM=3210
V_{REQ}=70,343 CF
V_{PVD}=97,959 CF

RB-1B1
HWE=3211.20
BTM=3208.20
V_{REQ}=89,309 CF
V_{PVD}=109,066 CF

RB-1B2
HWE=3211.20
BTM=3208.20
V_{REQ}=48,119 CF
V_{PVD}=177,498 CF

RB-1D
HWE=3103
BTM=3100
TOTAL V_{REQ}=274,528 CF
TOTAL V_{PVD}=651,379 CF

RB-2A
HWE=3071
BTM=3068
V_{REQ}=400,640 CF
V_{PVD}=500,859 CF

RB-3A
HWE=3060
BTM=3063
V_{REQ}=133,111 CF
V_{PVD}=202,116 CF

RB-4A
HWE=3043
BTM=3040
V_{REQ}=336,781 CF
V_{PVD}=591,717 CF

Q_{100}-620 cfs

Q_{100}-931 cfs

Q_{100}-508 cfs

RB-1A RB-1B1 RB-1B2 RB-1D RB-2A RB-3A RB-4A

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FIG 12: PRELIMINARY DRAINAGE PLAN

HILGARTWILSON

PROJ NO.: 2592
DATE: AUG 2024
SCALE: 1" = 600'
DRAWN: DM
DESIGNED: PG
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DWG. NO.
12

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U:\2500\2592\2592.01 Avantus\REPORTS\DRAINAGE\PDR\Exhibits\2592 Fig 12 – Preliminary Drainage plan.dwg 8/30/2024 10:17 AM

LEGEND

PROJECT BOUNDARY

COMMUNITY FLOODPLAIN

FEMA FLOODPLAIN

RETENTION BASIN

SCOUR DEPTH (FT)

0.0 – 0.5

0.5 – 1.0

1.0 – 1.5

1.5 – 2.0

2.0 – 2.5

2.5 – 3.0

3.0 – 3.5

3.5 – 4.0

4.0 – 4.5

4.5 – 5.0

5.0 – ABOVE

N

600 300 0 600 1200

SCALE: 1" = 600'

VETERANS MEMORIAL BLVD

SAN MANUEL

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FIG 13: ONSITE SCOUR DEPTH MAP

HILGARTWILSON

PROJ NO.: 2592

DATE: AUG 2024

SCALE: 1" = 600'

DRAWN: DM

DESIGNED: PG

APPROVED: BB

DWG. NO.

13

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APPENDIX B

HYDROLOGIC ANALYSIS SUPPORTING DOCUMENTATION

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STUDY AREA INPUT TABLES

SOILS, LAND USE, MANNING'S N-VALUE

Soil Table

Project: 2592 - Ore Town Solar Project
Prepared by: PG
Date: Aug, 2024

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Soil Map Name	Soil Symbol	XKSAT (ADOT) (inch/hr)	ROCKOUT [0-100%]	PSIF (ADOT) (in)	Saturated Content	Wilting Point (dry)	Field Capacity (normal)	Calculated DTHETA DRY (ADOT)	Calculated DTHETA NORMAL (ADOT)
AZ661	1	0.5	0	3.24	0.4	0.08	0.15	0.25	0.32
AZ661	6	0.87	0	3.54	0.41	0.04	0.13	0.28	0.37
AZ661	14	0.83	33.3	4.72	0.4	0.05	0.15	0.25	0.35
AZ661	43	1.34	0	1.79	0.41	0.04	0.12	0.29	0.37
AZ661	47	0.05	0	20.58	0.49	0.24	0.4	0.09	0.25
AZ661	51	0.39	0	7.66	0.39	0.09	0.19	0.2	0.3
AZ661	64	0.01	0	11.42	0.48	0.3	0.42	0.06	0.18
AZ661	69	0.03	0	10.49	0.46	0.22	0.34	0.12	0.24
AZ661	71	0.49	0	4	0.42	0.09	0.18	0.24	0.33
AZ661	78	0.87	0	3.89	0.39	0.03	0.12	0.27	0.36
AZ661	87	0.31	25	5.13	0.42	0.11	0.2	0.22	0.31
AZ661	93	0.3	0	8.38	0.39	0.08	0.19	0.2	0.31
AZ661	98	0.05	0	9.11	0.46	0.21	0.33	0.13	0.25
GSMSTATSGO	s429	0.28	30	6.14	0.42	0.11	0.22	0.2	0.31
	Average [(2)]	**0.09**	-	**7.55**	**0.44**	**0.17**	**0.28**	-	-

Notes:
(1) AZ661 soil Green and Ampt Parameters were assigned based on ADOT HDDM Appendix B
(2) Area-weighted and log-weighted averages were calculated per ADOT HDDM

Land Use Table

Project: 2592 - Ore Town Solar Project
Prepared by: PG
Date: Aug, 2024

LU CODE [1]	Description	Antecedent Moisture Condition	IA	Impervious %	Vegetation Cover % [4]
11	Open Water	wet	0	100	0
21	Developed, Open Space	dry	0.05	80	0
22	Developed, Low Intensity	dry	0.05	80	0
23	Developed, Medium Intensity	dry	0.05	95	0
24	Developed, High Intensity	dry	0.05	95	0
31	Barren Land (Rock/Sand/Clay)	dry	0.35	0	0
42	Evergreen Forest	normal	0.1	0	50
52	Shrub/Scrub	dry	0.15	0	20
71	Grasslands/Herbaceous	dry	0.5	0	85
90	Woody Wetlands	wet	0.5	0	85
- [5]	Solar Array	normal	0.15	5	5
- [6]	Battery Storage & Substation	normal	0.1	90	0

Notes:
(1) Land Use was obtained from the NLCD Land Cover 2021 CONUS Land Cover and references description and LU code from that dataset
(2) Land Use 31 and 52 correspond to NDR Land Use Code from the Flood Control District of Maricopa County Hydrology Manual
(3) Land Use 71 uses values from AG Land Use Code from the Flood Control District of Maricopa County Hydrology Manual
(4) Vegetation cover was estimated from aerial imagery for each land use
(5) The post-project solar array land use used a combination of the underlying shrub/scrub land use with an increased impervious percentage reflecting the addition of the solar arrays
(6) The post-project battery storage/substation land use conservatively assumes 90% impervious area.

Manning's N-values

Project: 2592 - Ore Town Solar Project
Prepared by: PG
Date: Aug, 2024

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Description	Manning's N value [1]
Open Water	0.04
Developed, Open Space	0.026
Developed, Low Intensity	0.026
Developed, Medium Intensity	0.02
Developed, High Intensity	0.02
Barren Land (Rock/Sand/Clay)	0.035
Evergreen Forest	0.065
Shrub/Scrub	0.045
Grasslands/Herbaceous	0.065
Woody Wetlands	0.065
Solar Array	0.045
Battery Storage & Substation	0.028

Notes:
(1) Manning's N-values were referenced from Table 7.1 of the FCDMC FLO2D Verification Report (FCDMC, May 2016)

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NOAA 14 RAINFALL DATA

NOAA Atlas 14, Volume 1, Version 5
Location name: San Manuel, Arizona, USA*
Latitude: 32.6074°, Longitude: -110.6138°
Elevation: 3195 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.237** (0.208-0.271)	**0.305** (0.269-0.350)	**0.402** (0.352-0.460)	**0.477** (0.415-0.544)	**0.579** (0.499-0.660)	**0.658** (0.559-0.752)	**0.740** (0.621-0.849)	**0.824** (0.681-0.950)	**0.936** (0.757-1.09)	**1.02** (0.812-1.20)
10-min	**0.360** (0.317-0.412)	**0.465** (0.409-0.533)	**0.613** (0.536-0.701)	**0.726** (0.632-0.828)	**0.882** (0.759-1.00)	**1.00** (0.852-1.14)	**1.13** (0.945-1.29)	**1.25** (1.04-1.45)	**1.42** (1.15-1.66)	**1.56** (1.24-1.82)
15-min	**0.447** (0.393-0.512)	**0.576** (0.507-0.660)	**0.760** (0.665-0.869)	**0.900** (0.784-1.03)	**1.09** (0.941-1.24)	**1.24** (1.06-1.42)	**1.40** (1.17-1.60)	**1.56** (1.28-1.79)	**1.77** (1.43-2.06)	**1.93** (1.53-2.26)
30-min	**0.602** (0.529-0.689)	**0.776** (0.683-0.889)	**1.02** (0.895-1.17)	**1.21** (1.06-1.38)	**1.47** (1.27-1.68)	**1.67** (1.42-1.91)	**1.88** (1.58-2.16)	**2.09** (1.73-2.42)	**2.38** (1.92-2.77)	**2.60** (2.06-3.05)
60-min	**0.745** (0.655-0.853)	**0.960** (0.845-1.10)	**1.27** (1.11-1.45)	**1.50** (1.31-1.71)	**1.82** (1.57-2.08)	**2.07** (1.76-2.36)	**2.33** (1.95-2.67)	**2.59** (2.14-2.99)	**2.94** (2.38-3.42)	**3.22** (2.55-3.77)
2-hr	**0.854** (0.757-0.967)	**1.08** (0.964-1.23)	**1.41** (1.25-1.60)	**1.67** (1.47-1.89)	**2.03** (1.77-2.30)	**2.32** (1.99-2.61)	**2.61** (2.22-2.96)	**2.92** (2.44-3.33)	**3.35** (2.73-3.86)	**3.69** (2.95-4.29)
3-hr	**0.900** (0.803-1.02)	**1.14** (1.01-1.29)	**1.47** (1.30-1.66)	**1.73** (1.52-1.96)	**2.10** (1.84-2.38)	**2.40** (2.07-2.72)	**2.72** (2.31-3.10)	**3.06** (2.55-3.51)	**3.54** (2.86-4.10)	**3.92** (3.10-4.58)
6-hr	**1.04** (0.931-1.18)	**1.31** (1.17-1.48)	**1.67** (1.48-1.88)	**1.96** (1.73-2.21)	**2.38** (2.07-2.67)	**2.71** (2.34-3.05)	**3.08** (2.61-3.47)	**3.46** (2.88-3.92)	**4.00** (3.24-4.59)	**4.45** (3.53-5.15)
12-hr	**1.20** (1.08-1.35)	**1.50** (1.34-1.68)	**1.88** (1.68-2.12)	**2.20** (1.96-2.47)	**2.64** (2.33-2.96)	**2.99** (2.61-3.36)	**3.37** (2.89-3.79)	**3.75** (3.17-4.26)	**4.30** (3.55-4.93)	**4.75** (3.85-5.49)
24-hr	**1.39** (1.28-1.52)	**1.73** (1.60-1.89)	**2.17** (1.99-2.36)	**2.52** (2.30-2.74)	**3.01** (2.73-3.28)	**3.40** (3.06-3.70)	**3.80** (3.39-4.16)	**4.22** (3.73-4.64)	**4.79** (4.15-5.34)	**5.25** (4.48-5.89)
2-day	**1.53** (1.40-1.67)	**1.91** (1.75-2.10)	**2.39** (2.19-2.62)	**2.79** (2.55-3.05)	**3.33** (3.02-3.65)	**3.76** (3.37-4.12)	**4.20** (3.74-4.64)	**4.66** (4.10-5.18)	**5.29** (4.58-5.98)	**5.78** (4.93-6.62)
3-day	**1.65** (1.51-1.82)	**2.06** (1.89-2.28)	**2.60** (2.37-2.86)	**3.04** (2.77-3.35)	**3.67** (3.31-4.06)	**4.18** (3.72-4.64)	**4.72** (4.15-5.26)	**5.28** (4.58-5.96)	**6.09** (5.17-6.97)	**6.73** (5.61-7.81)
4-day	**1.77** (1.62-1.97)	**2.22** (2.02-2.46)	**2.80** (2.56-3.11)	**3.30** (2.99-3.66)	**4.02** (3.60-4.48)	**4.60** (4.08-5.15)	**5.24** (4.57-5.88)	**5.91** (5.08-6.72)	**6.89** (5.76-7.96)	**7.68** (6.29-9.00)
7-day	**2.08** (1.89-2.29)	**2.59** (2.36-2.86)	**3.29** (2.98-3.63)	**3.89** (3.51-4.31)	**4.77** (4.25-5.29)	**5.50** (4.84-6.15)	**6.30** (5.47-7.08)	**7.18** (6.12-8.16)	**8.45** (7.02-9.73)	**9.51** (7.76-11.1)
10-day	**2.33** (2.13-2.58)	**2.92** (2.66-3.21)	**3.68** (3.36-4.06)	**4.33** (3.93-4.78)	**5.29** (4.74-5.84)	**6.07** (5.39-6.74)	**6.93** (6.06-7.76)	**7.86** (6.75-8.91)	**9.19** (7.70-10.6)	**10.3** (8.46-12.0)
20-day	**3.04** (2.78-3.33)	**3.81** (3.48-4.18)	**4.81** (4.39-5.26)	**5.63** (5.12-6.17)	**6.80** (6.13-7.46)	**7.74** (6.90-8.54)	**8.74** (7.72-9.71)	**9.81** (8.51-11.0)	**11.3** (9.60-12.8)	**12.5** (10.4-14.4)
30-day	**3.70** (3.41-4.02)	**4.62** (4.25-5.01)	**5.74** (5.28-6.22)	**6.65** (6.10-7.21)	**7.90** (7.19-8.59)	**8.88** (8.00-9.69)	**9.89** (8.84-10.9)	**10.9** (9.65-12.1)	**12.4** (10.7-13.9)	**13.5** (11.5-15.3)
45-day	**4.47** (4.13-4.84)	**5.58** (5.16-6.05)	**6.86** (6.36-7.42)	**7.85** (7.27-8.48)	**9.16** (8.43-9.90)	**10.1** (9.27-11.0)	**11.1** (10.1-12.1)	**12.0** (10.9-13.2)	**13.3** (11.9-14.7)	**14.2** (12.6-15.8)
60-day	**5.06** (4.68-5.48)	**6.31** (5.83-6.83)	**7.77** (7.18-8.40)	**8.89** (8.20-9.62)	**10.4** (9.52-11.2)	**11.5** (10.5-12.5)	**12.6** (11.4-13.7)	**13.7** (12.3-15.0)	**15.0** (13.4-16.7)	**16.1** (14.2-18.0)

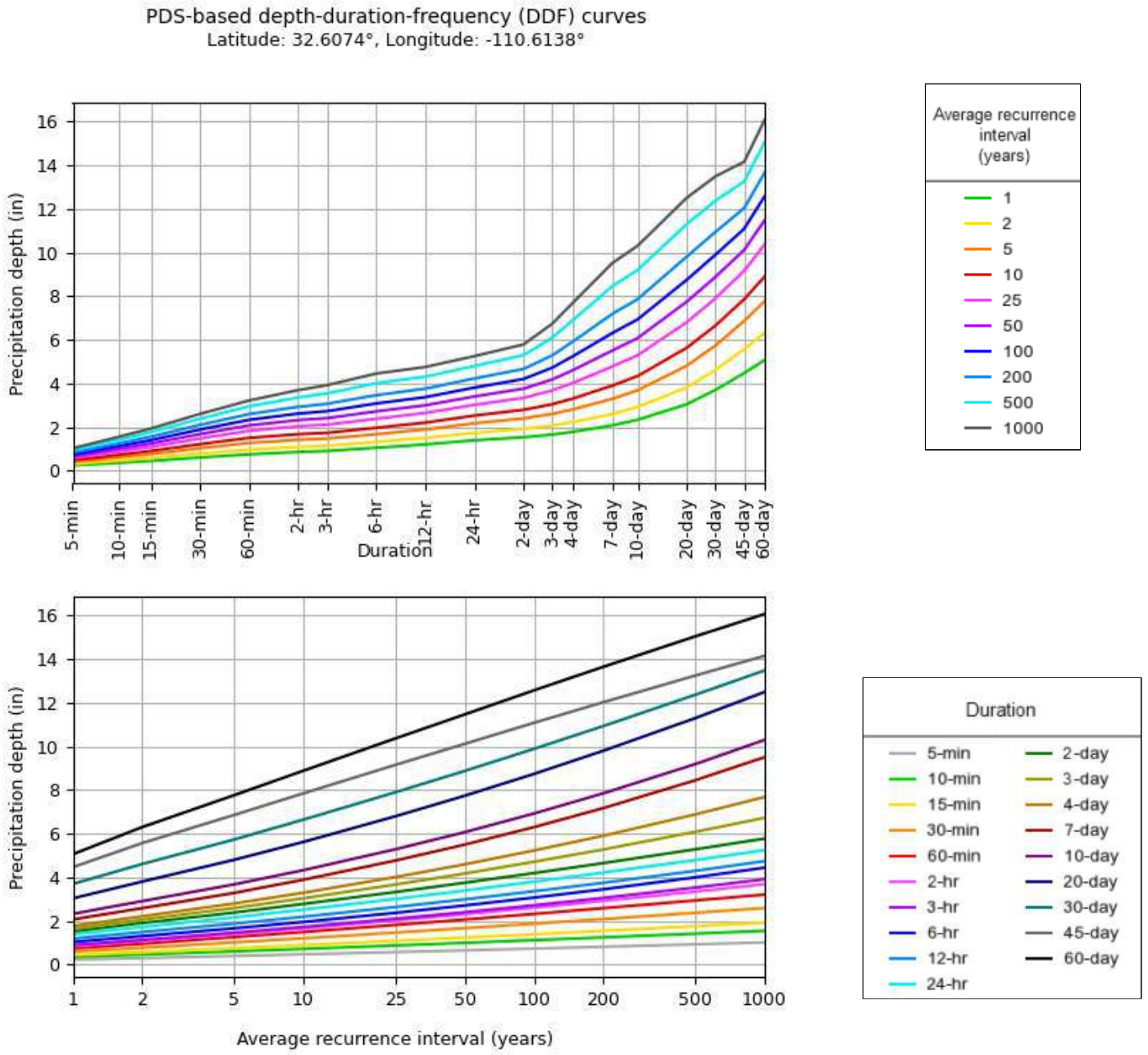
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



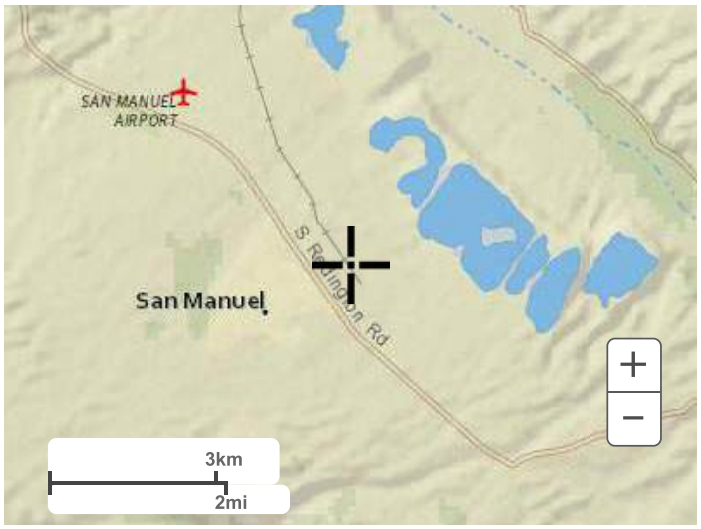
NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Wed Oct 25 20:37:23 2023

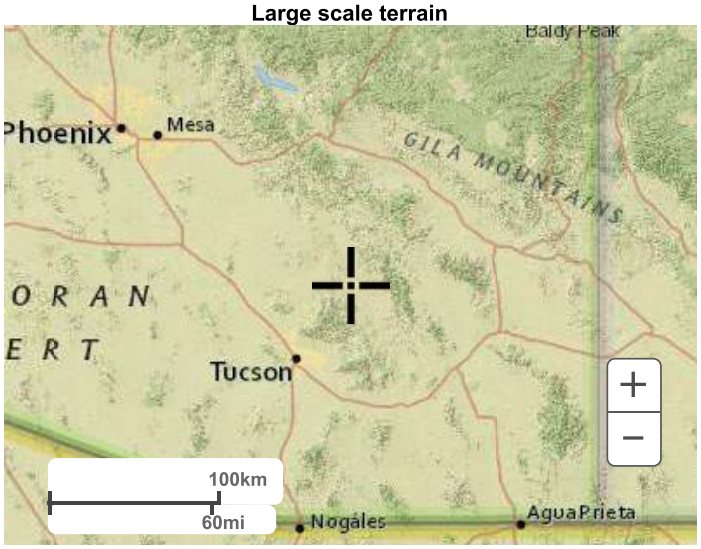
Back to Top

Maps & aerials

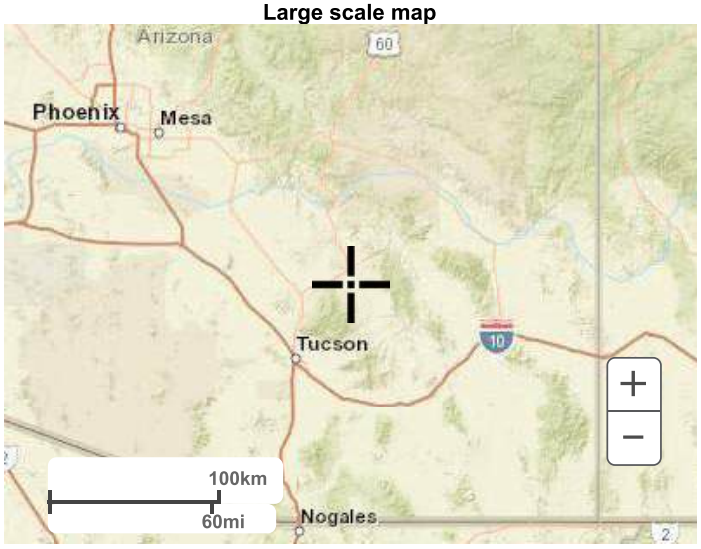
Small scale terrain



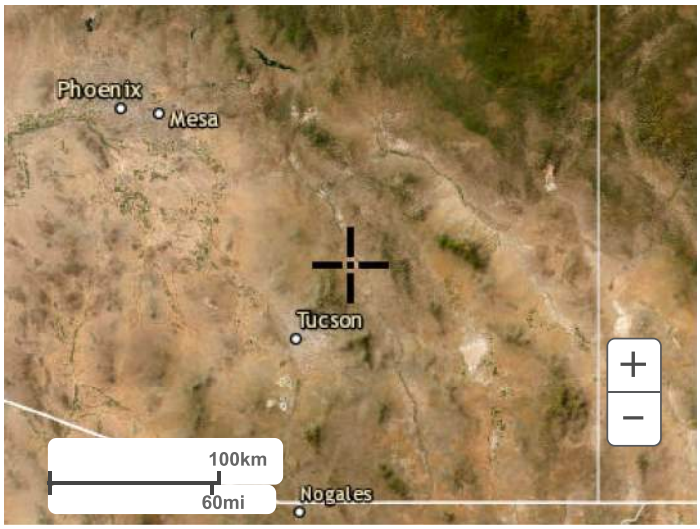
Large scale terrain



Large scale map



Large scale aerial



Back to Top

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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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NRCS SOILS MAP

United States Department of Agriculture

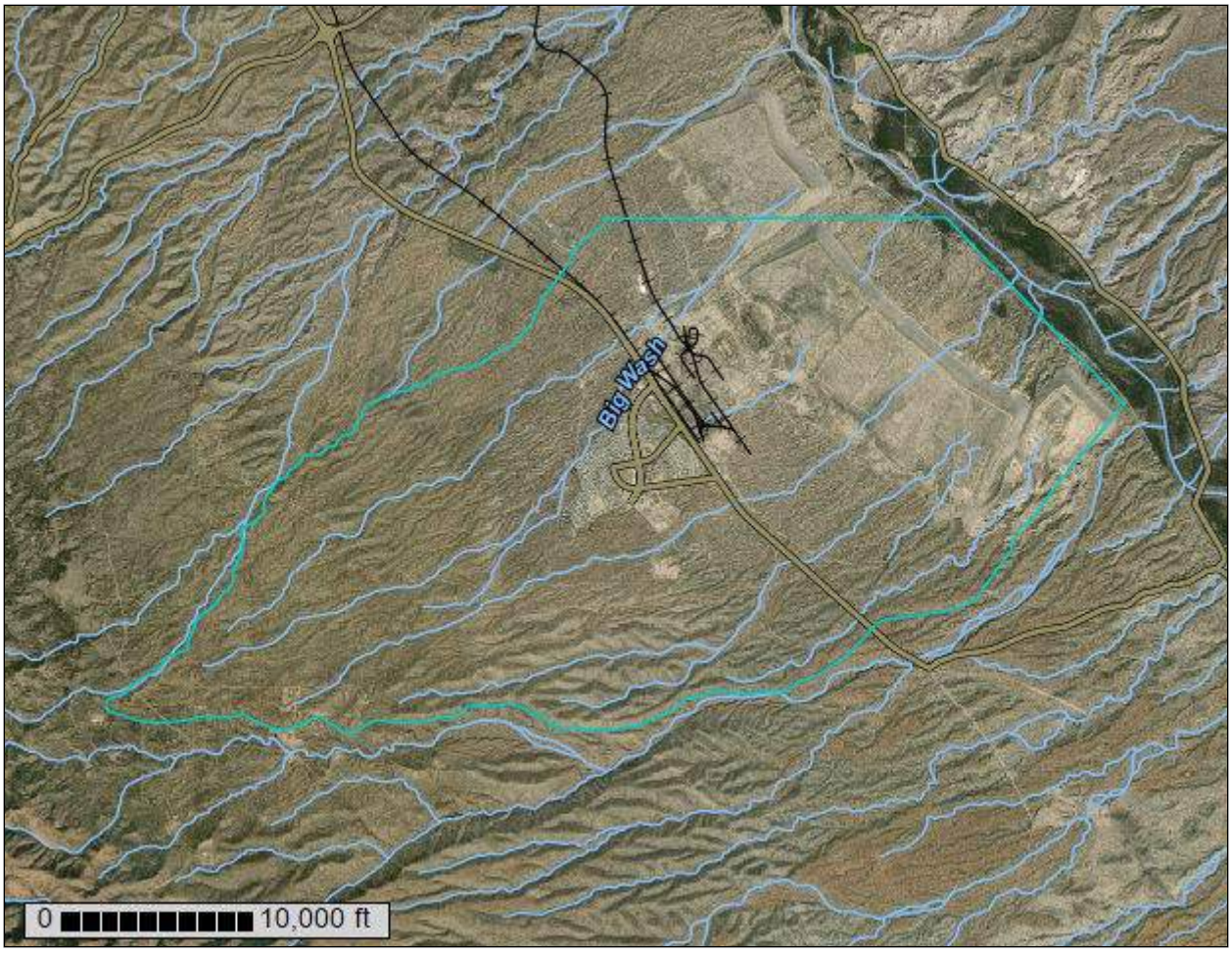
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Coronado National Forest, Arizona, Parts of Cochise, Graham, Pima and Pinal Counties; and Eastern Pinal and Southern Gila Counties, Arizona

Ore Town Solar Project

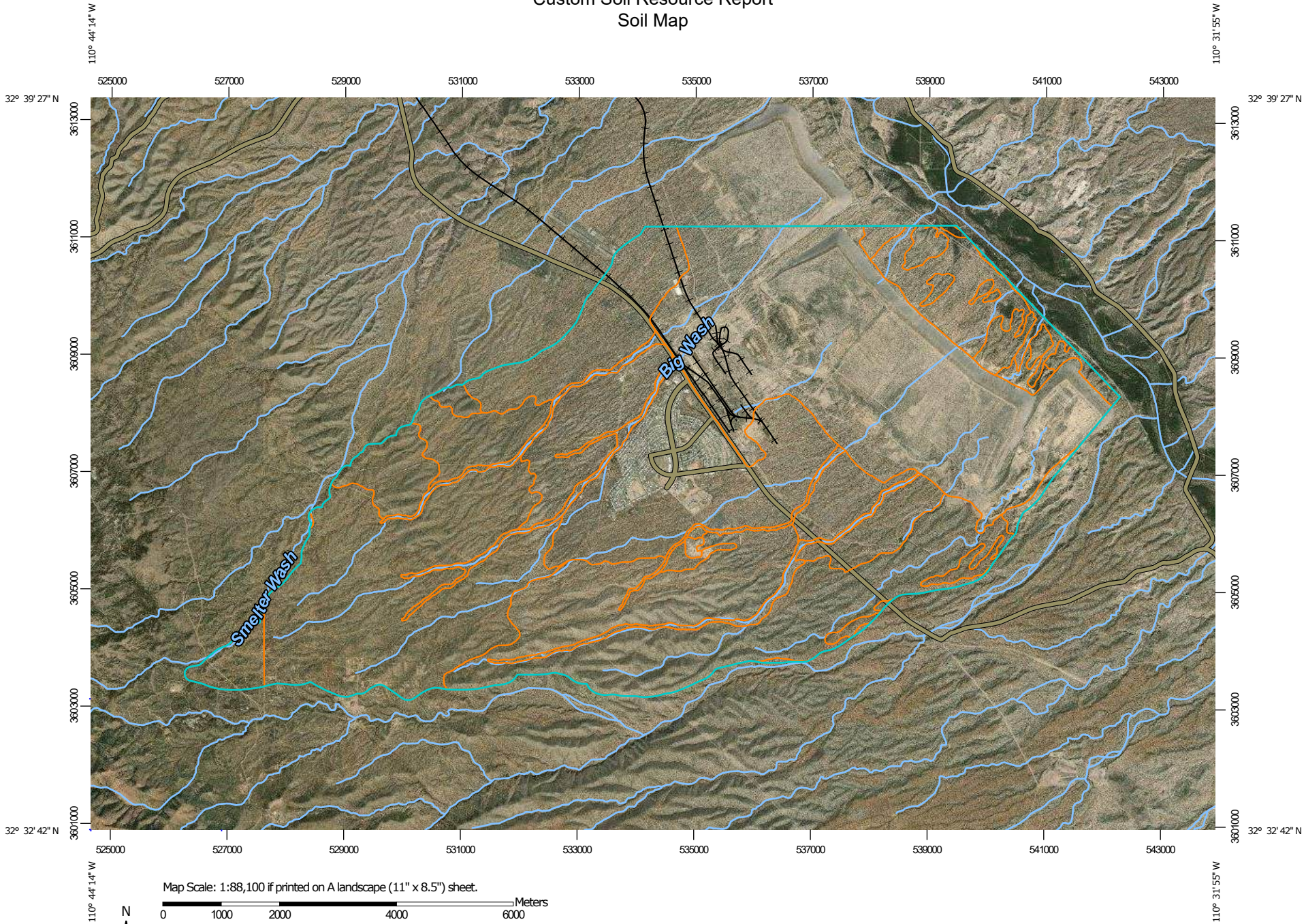


August 29, 2024

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


110° 44' 14" W
110° 31' 55" W
525000
527000
529000
531000
533000
535000
537000
539000
541000
543000
32° 39' 27" N
32° 32' 42" N
3613000
3611000
3609000
3607000
3605000
3603000
3601000
Big Wash
Smelter Wash
Map Scale: 1:88,100 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0
1000
2000
4000
6000
Feet
0
4000
8000
16000
24000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Coronado National Forest, Arizona, Parts of Cochise, Graham, Pima and Pinal Counties
Survey Area Data: Version 10, Sep 8, 2023

Soil Survey Area: Eastern Pinal and Southern Gila Counties, Arizona
Survey Area Data: Version 19, Sep 8, 2023

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Oct 30, 2017

MAP LEGEND

MAP INFORMATION

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

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APPENDIX C

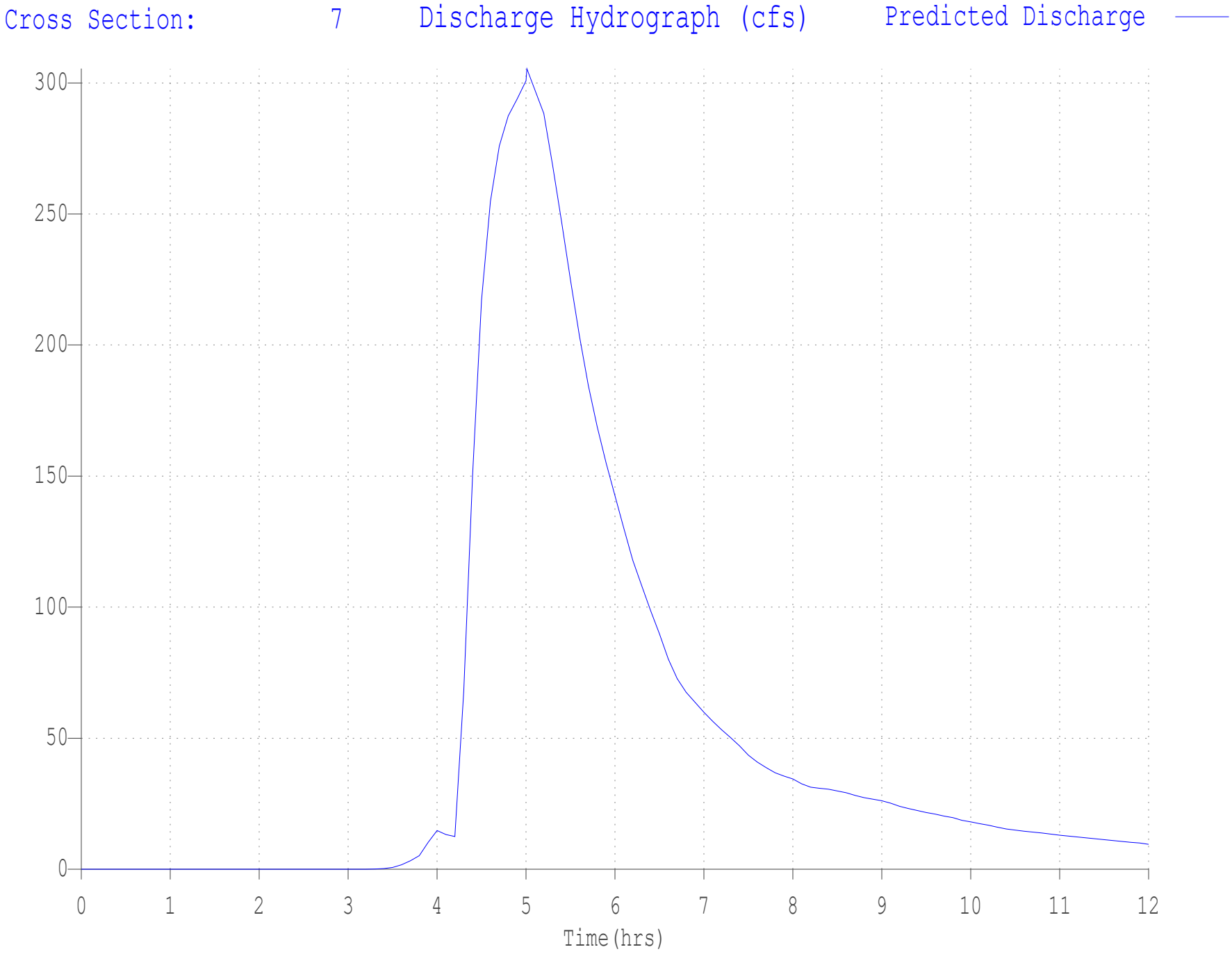
FLO-2D ANALYSIS RESULTS

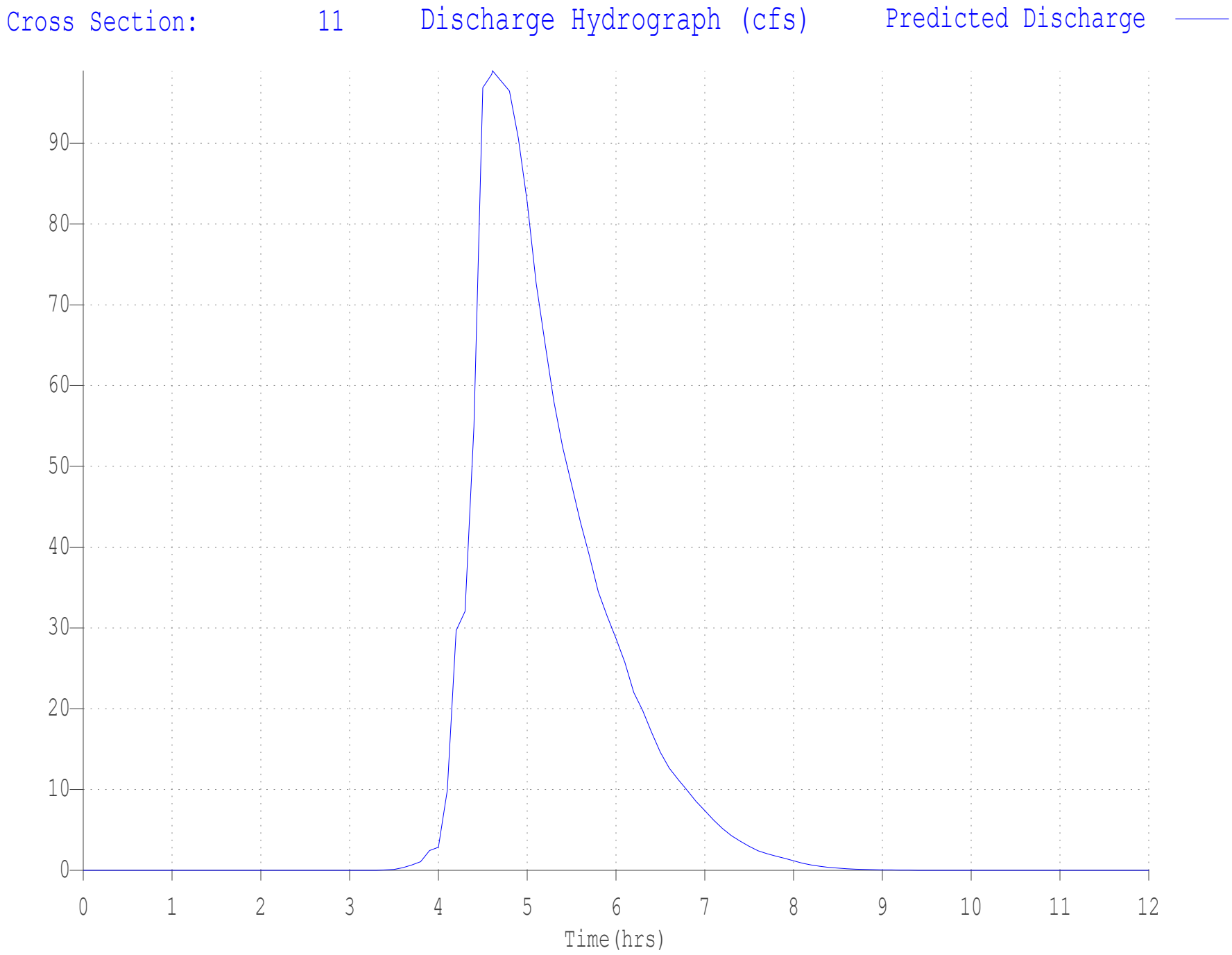
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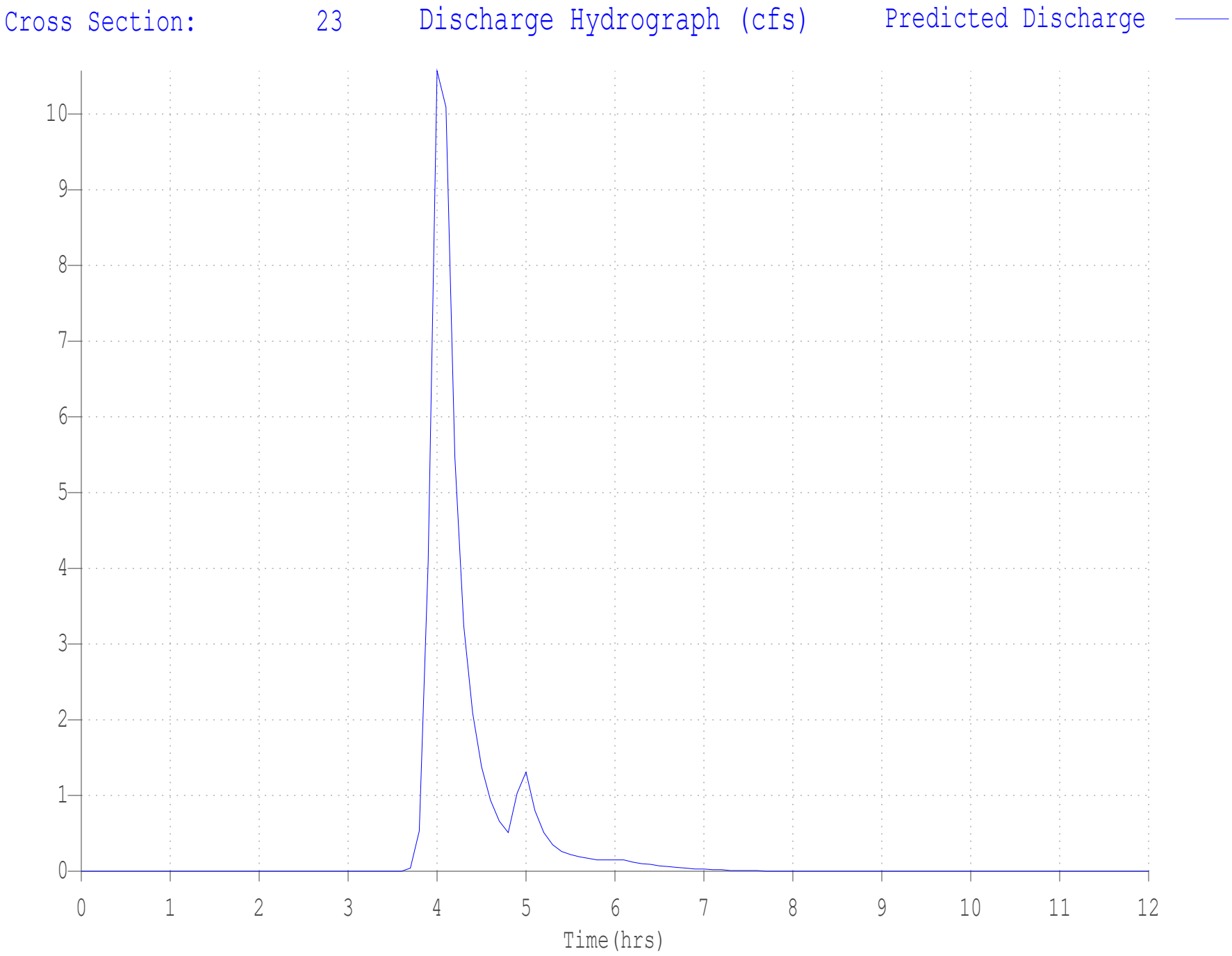
HAS JOINED COLLIERS ENGINEERING & DESIGN

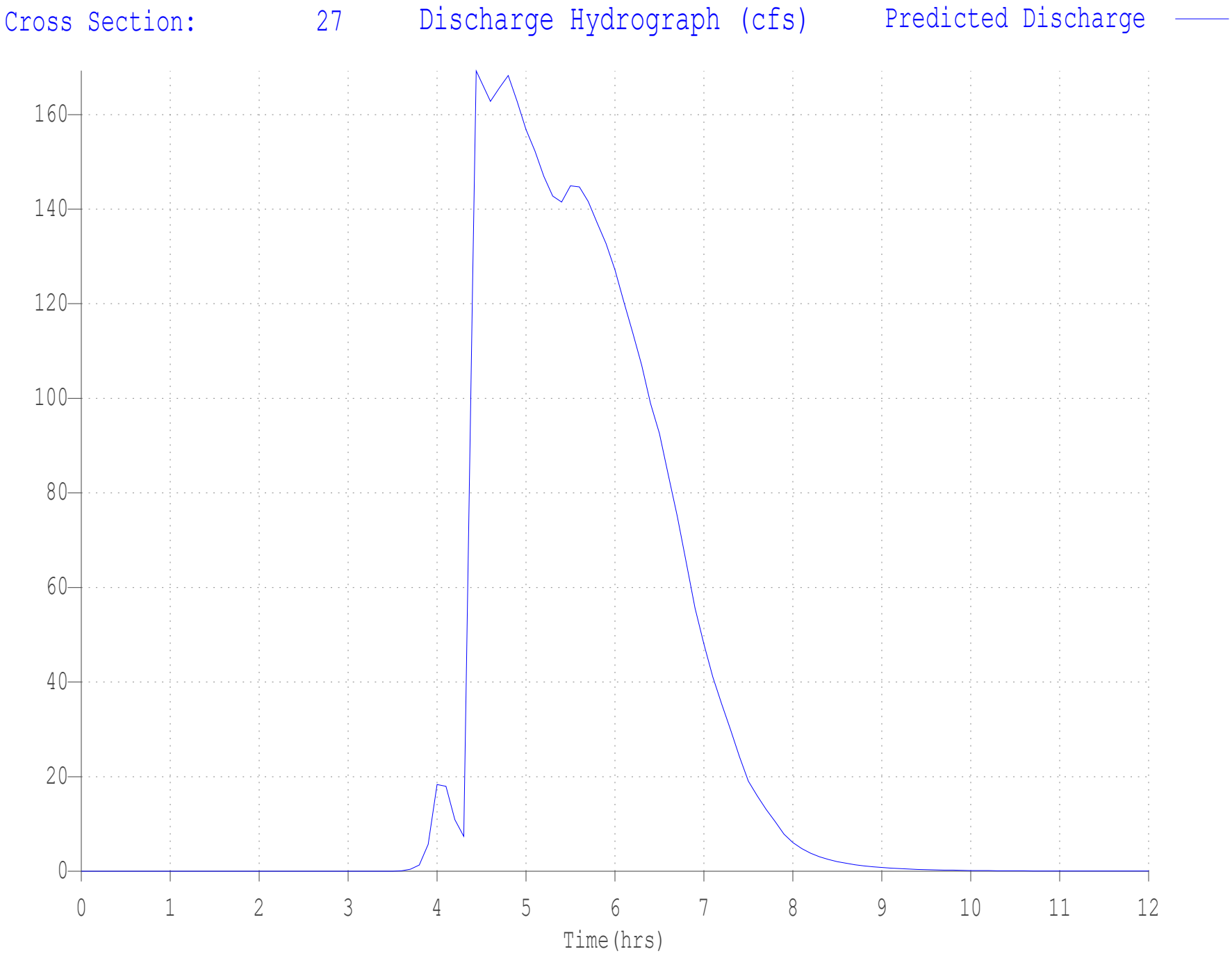
FLO-2D
6—HOUR PRE-PROJECT MODEL

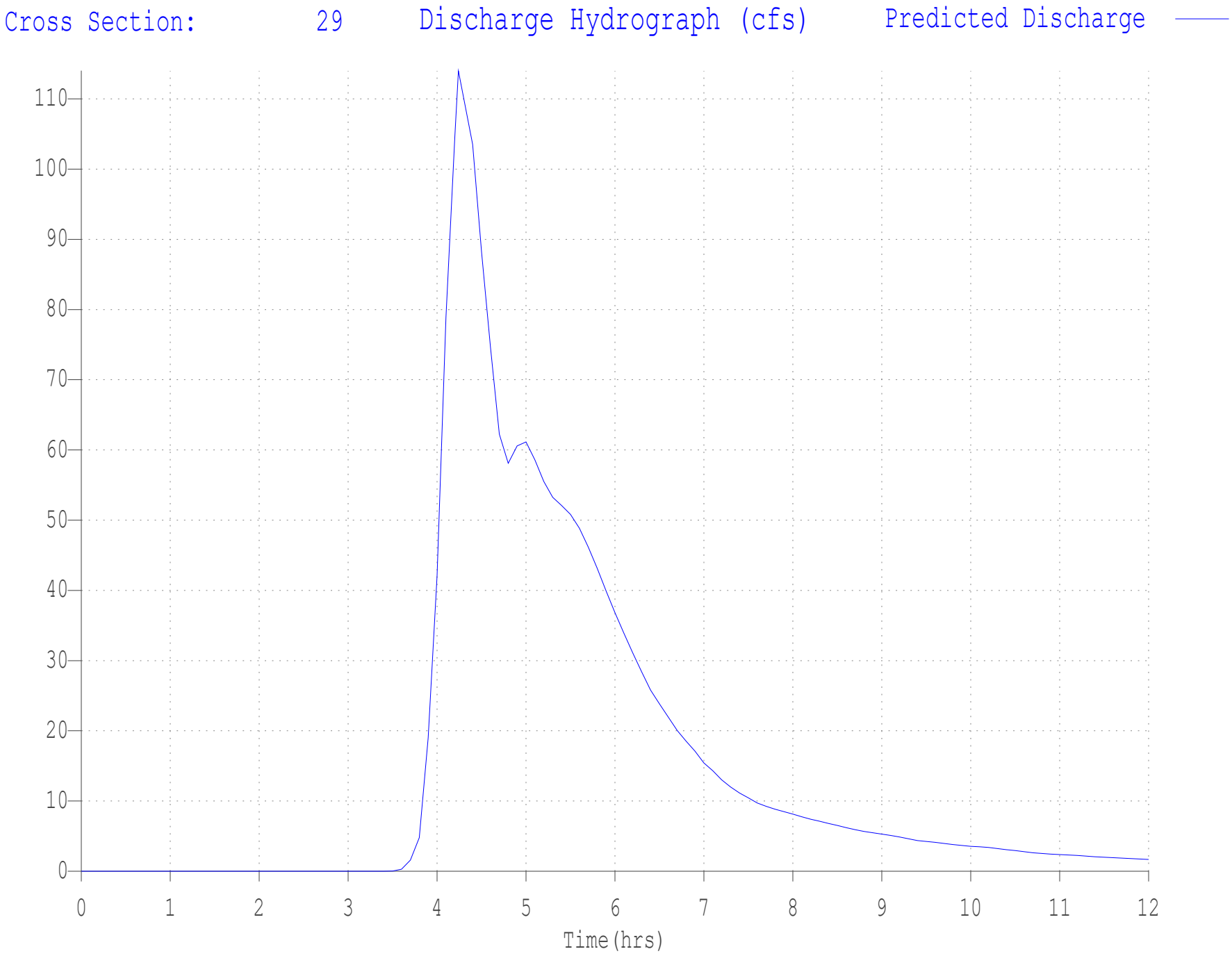
FLOODPLAIN CROSS SECTION HYDROGRAPHS

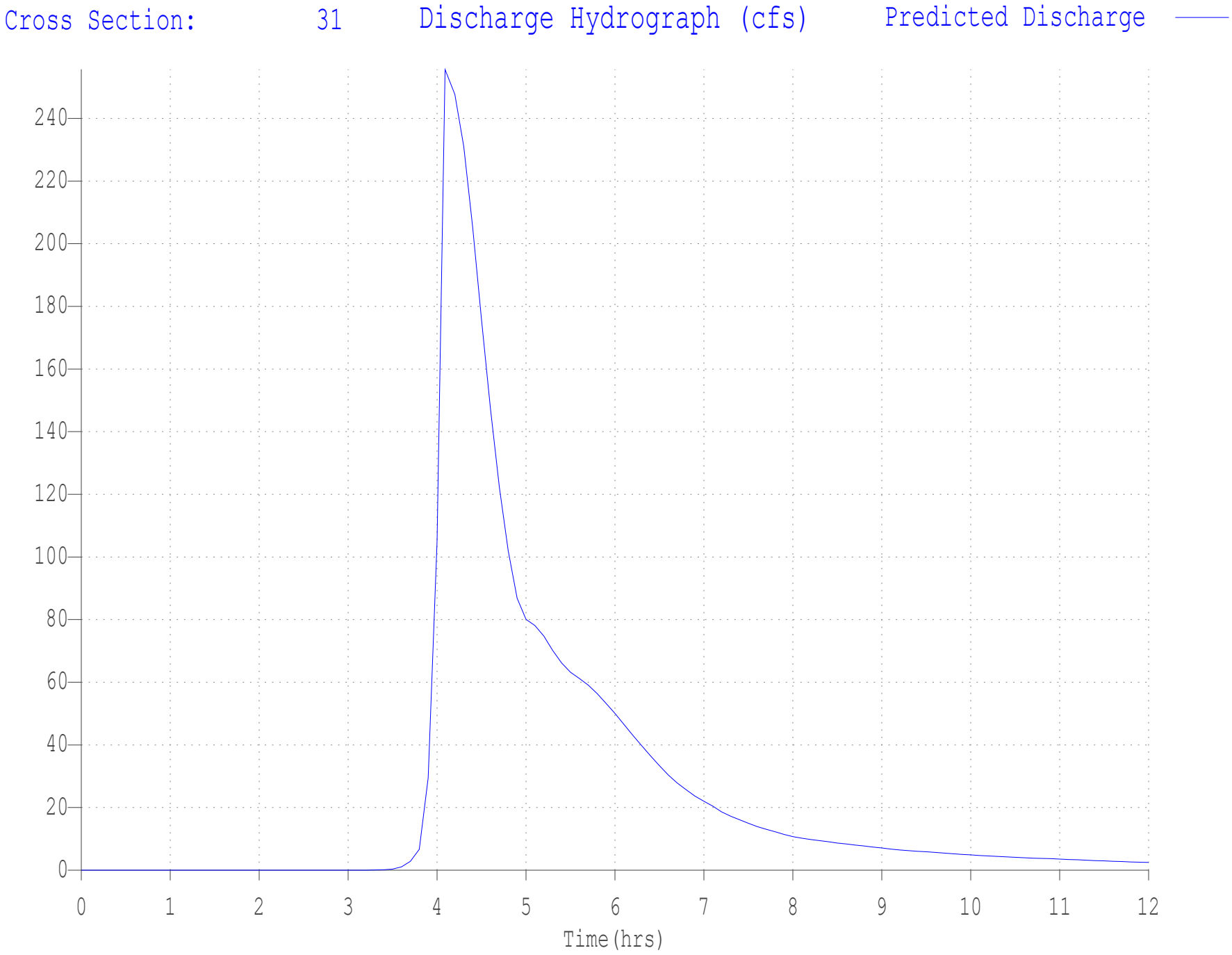

Cross Section: 7
Discharge Hydrograph (cfs)
Predicted Discharge
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

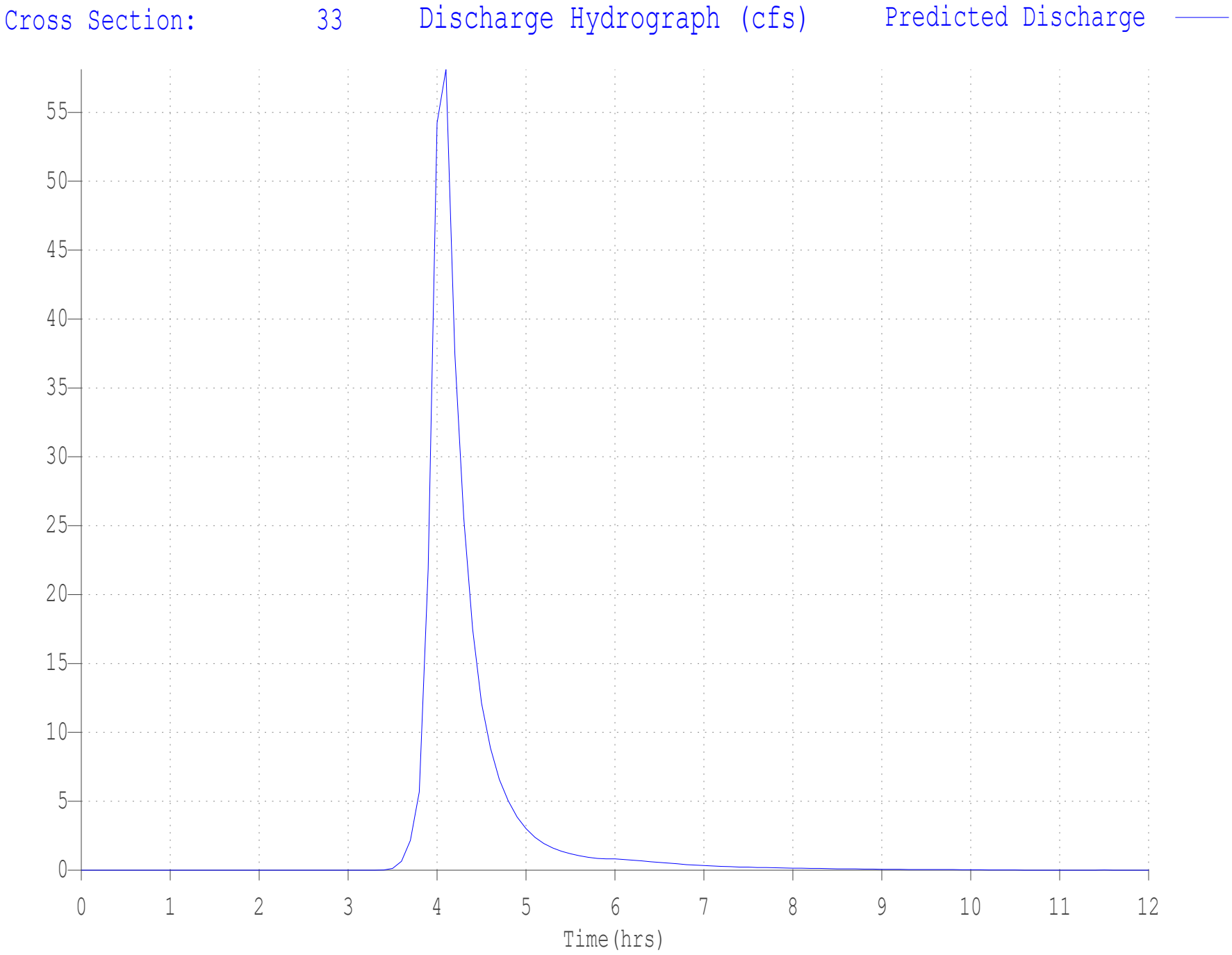

Cross Section: 11
Discharge Hydrograph (cfs)
Predicted Discharge
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

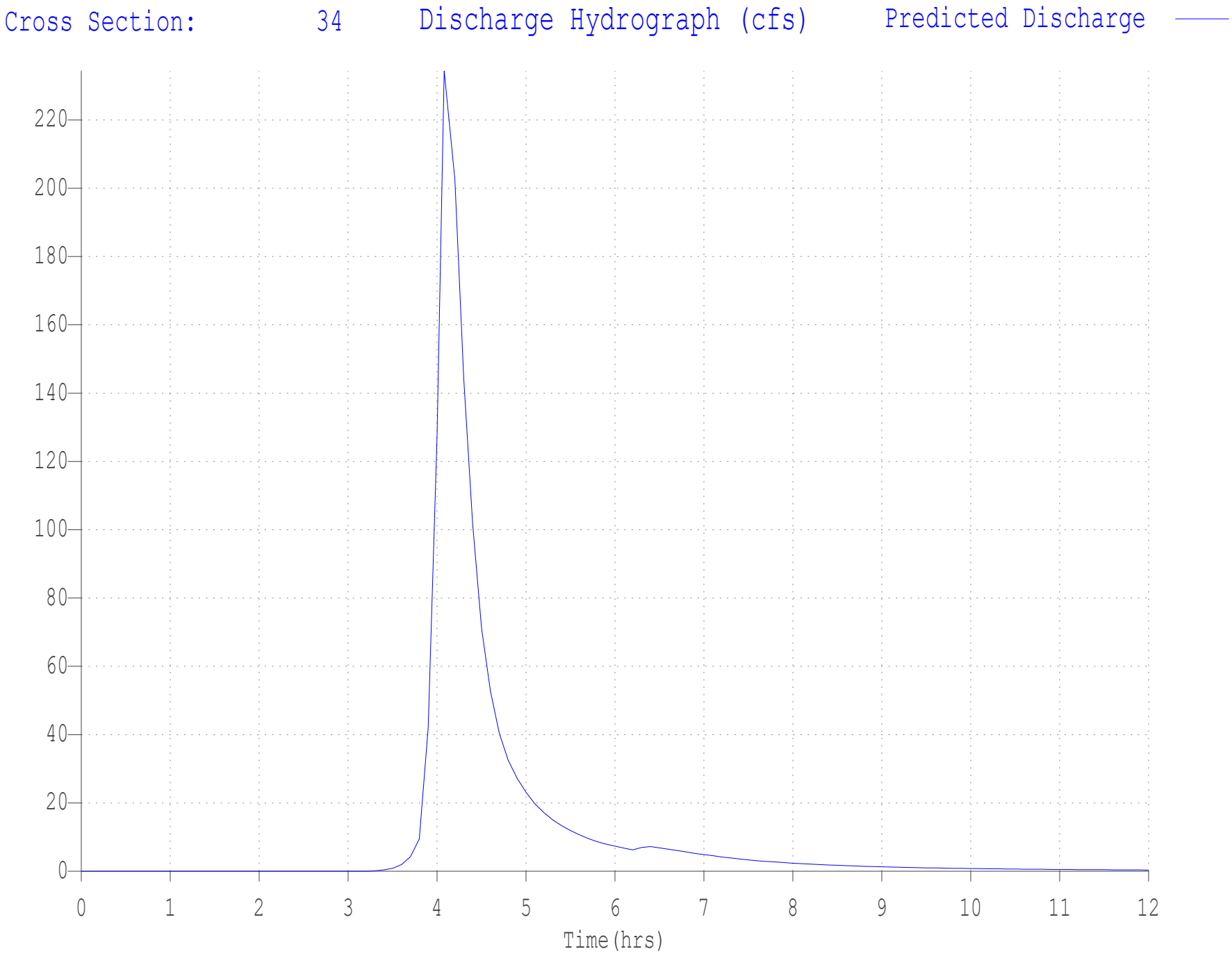

Cross Section: 23 Discharge Hydrograph (cfs) Predicted Discharge
10
9
8
7
6
5
4
3
2
1
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

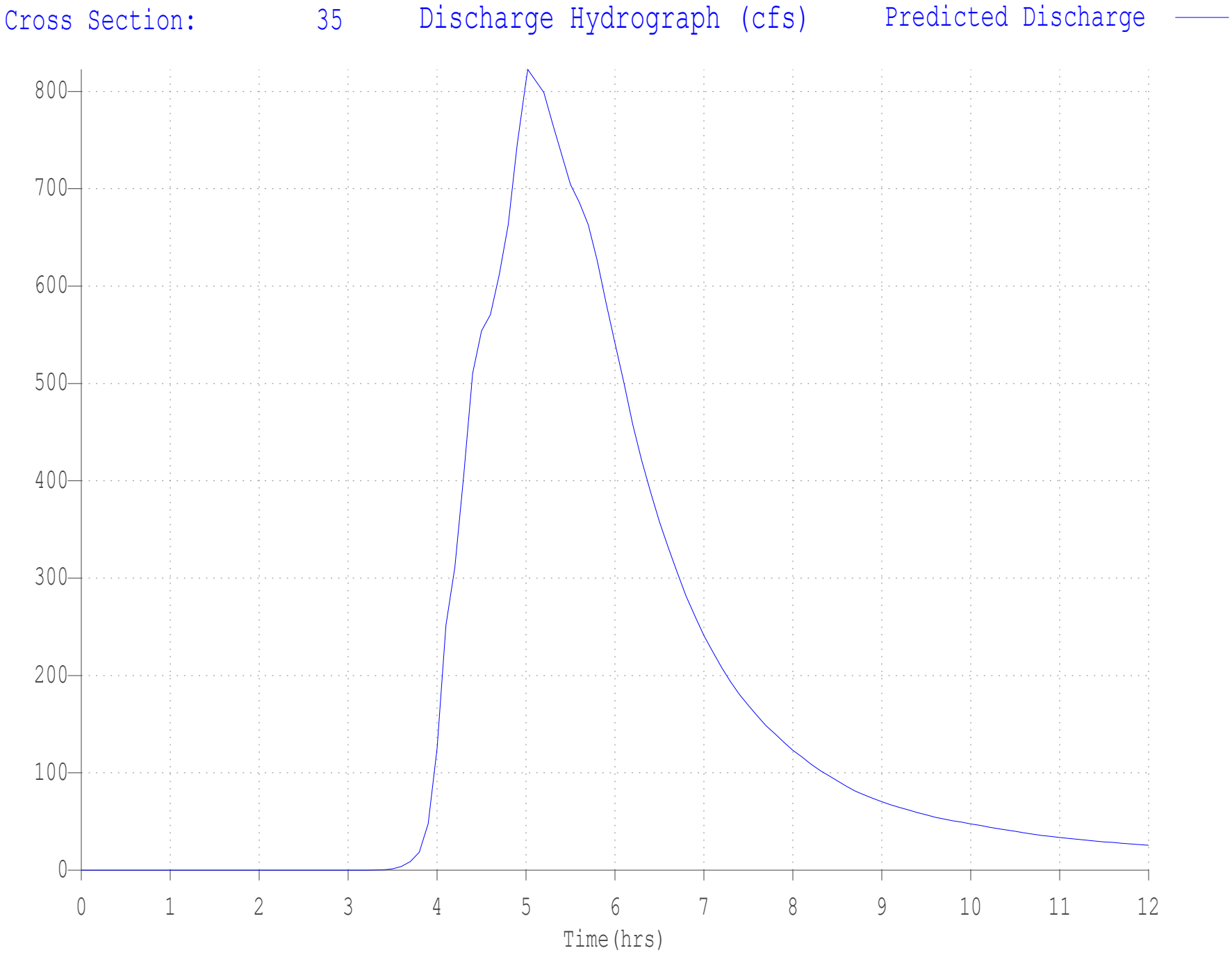

Cross Section: 27 Discharge Hydrograph (cfs) Predicted Discharge
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

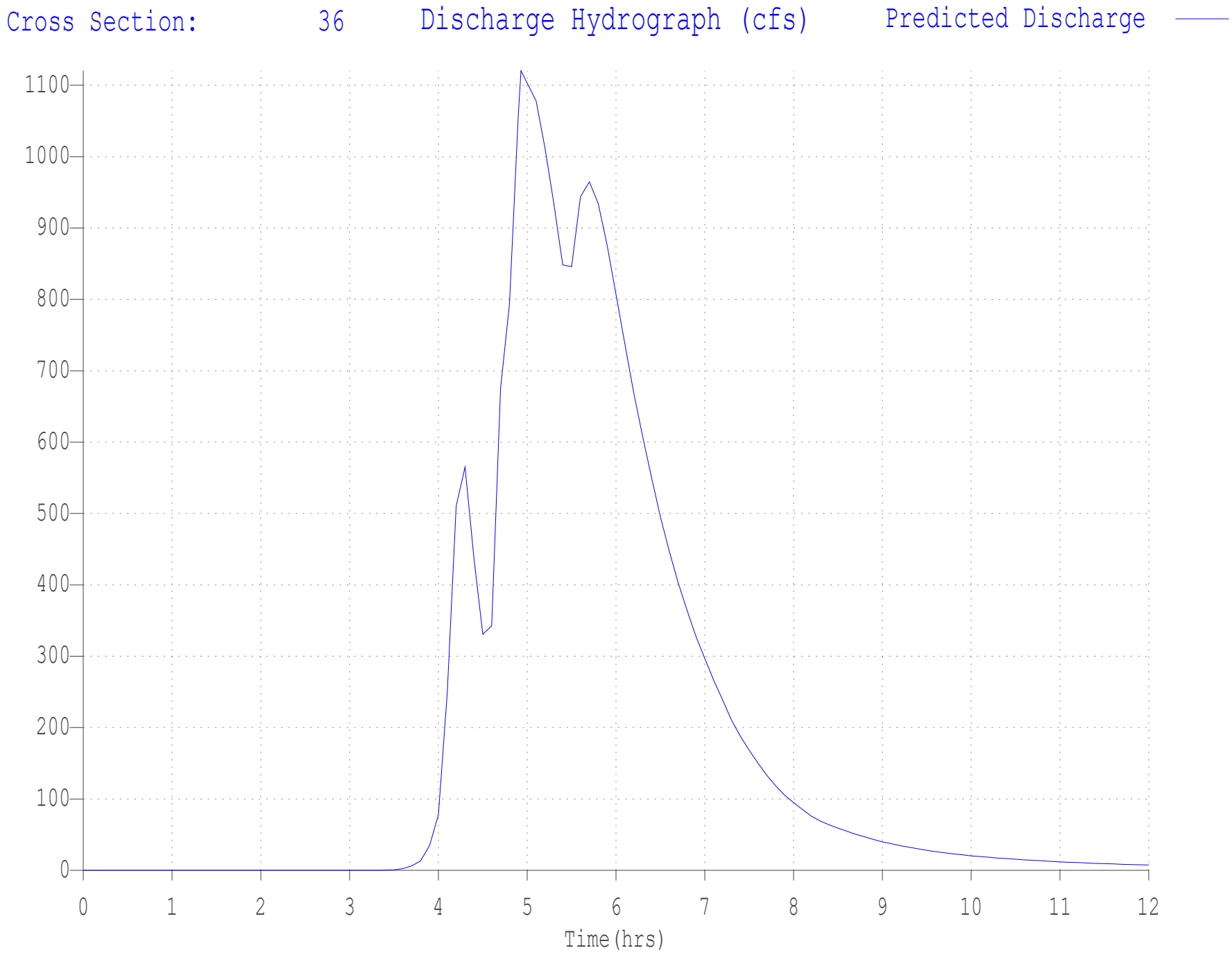

Cross Section: 29 Discharge Hydrograph (cfs) Predicted Discharge
110
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

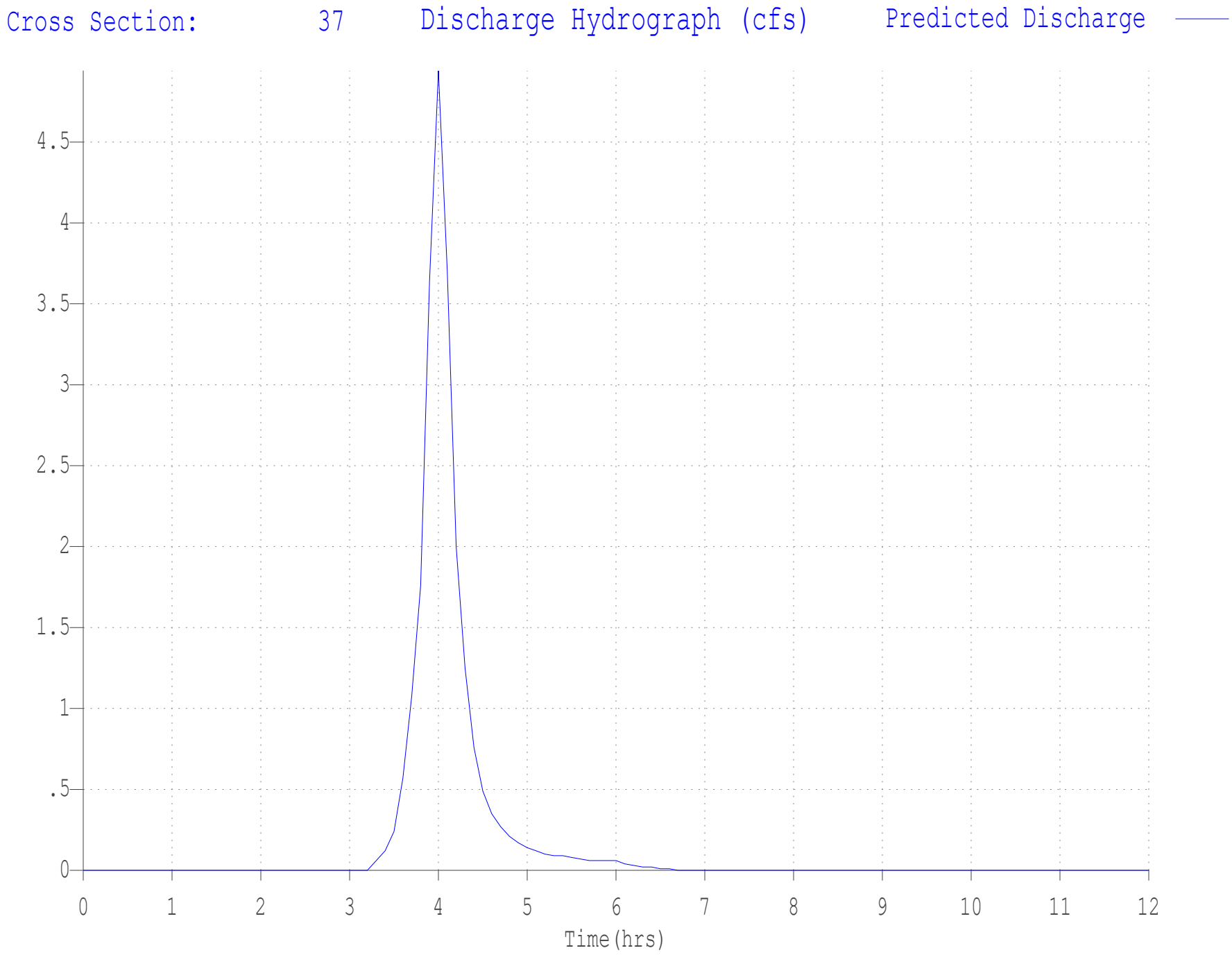

Cross Section: 31 Discharge Hydrograph (cfs) Predicted Discharge
240
220
200
180
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

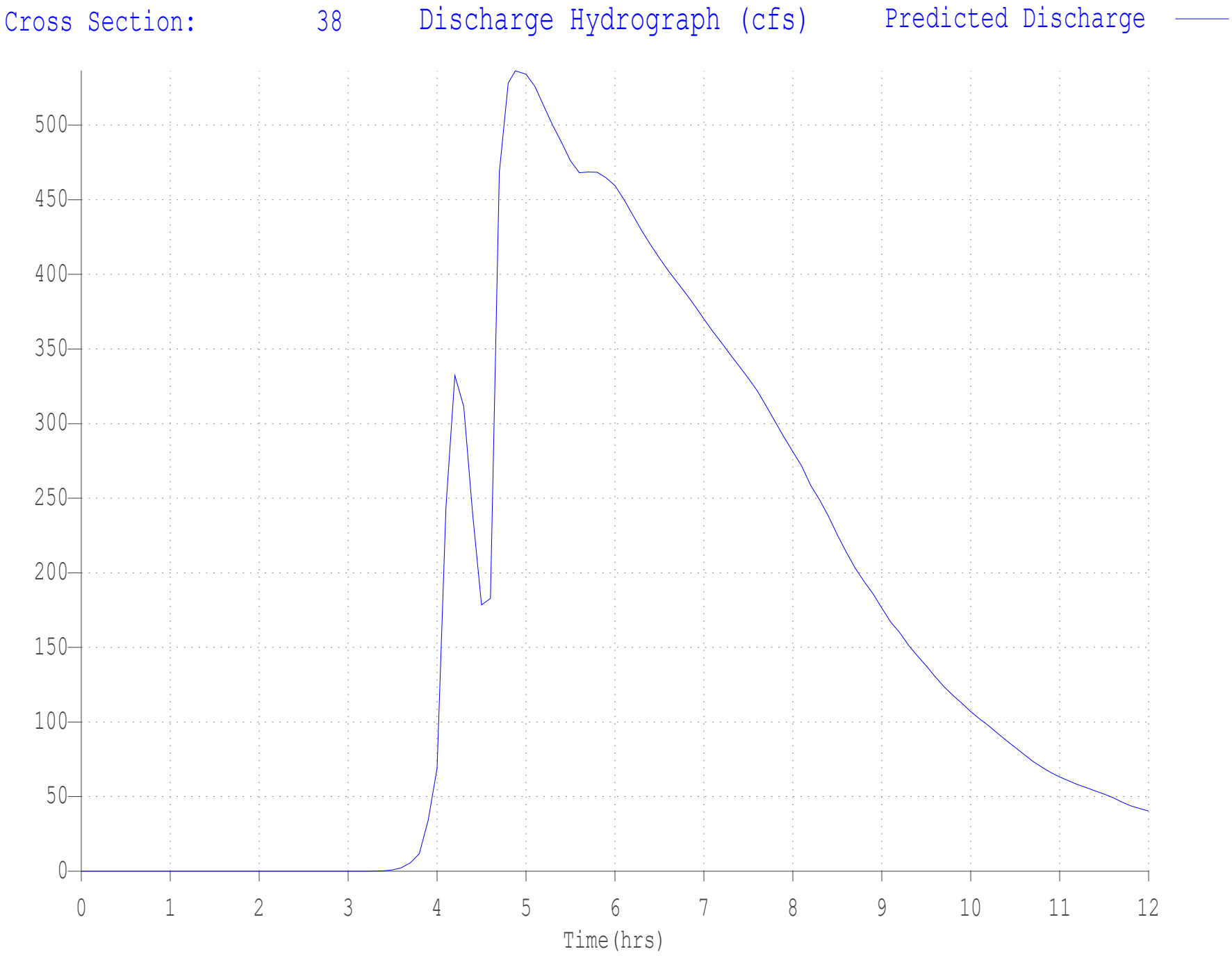

Cross Section: 33 Discharge Hydrograph (cfs) Predicted Discharge
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

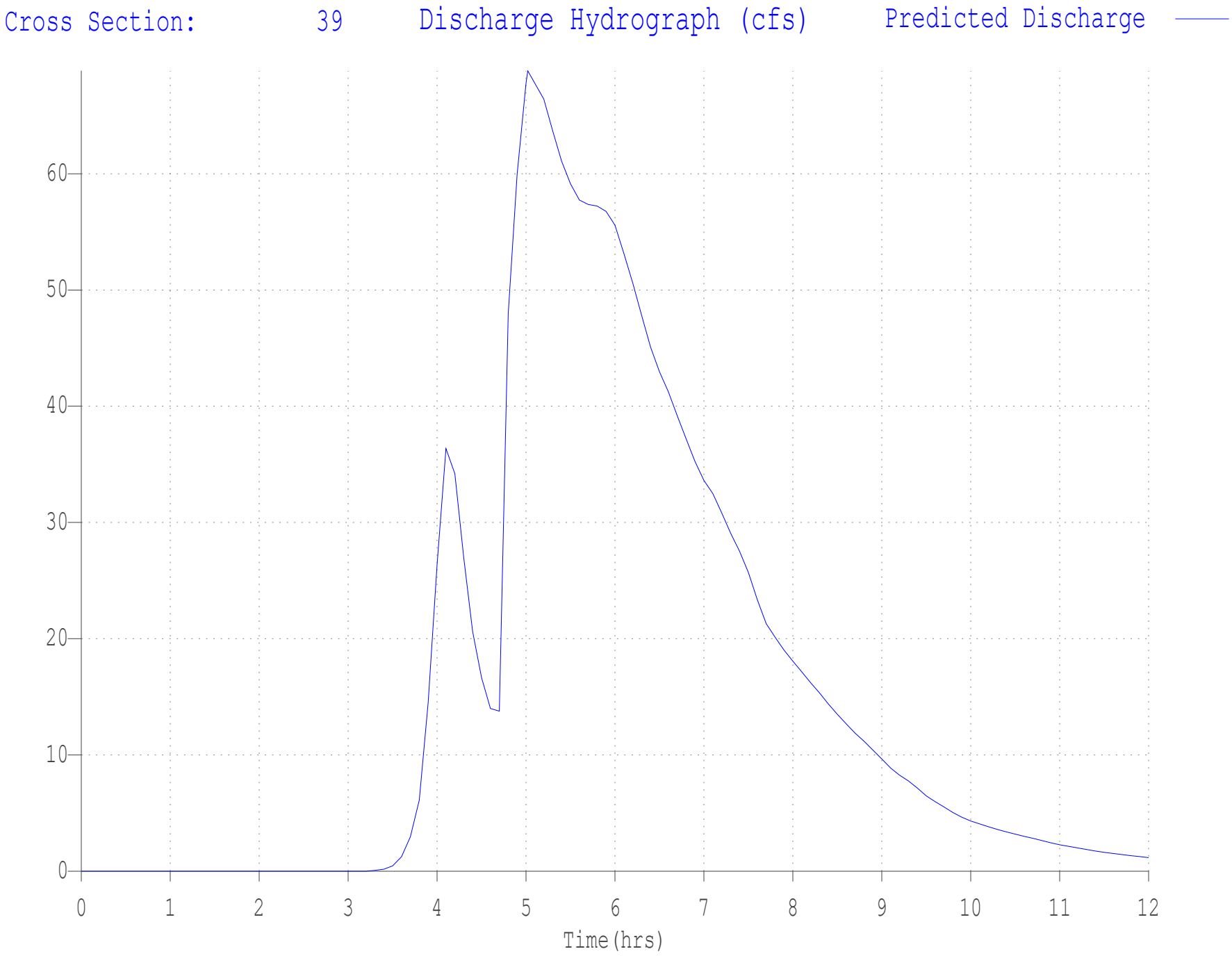

Cross Section: 34
Discharge Hydrograph (cfs)
Predicted Discharge
220
200
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

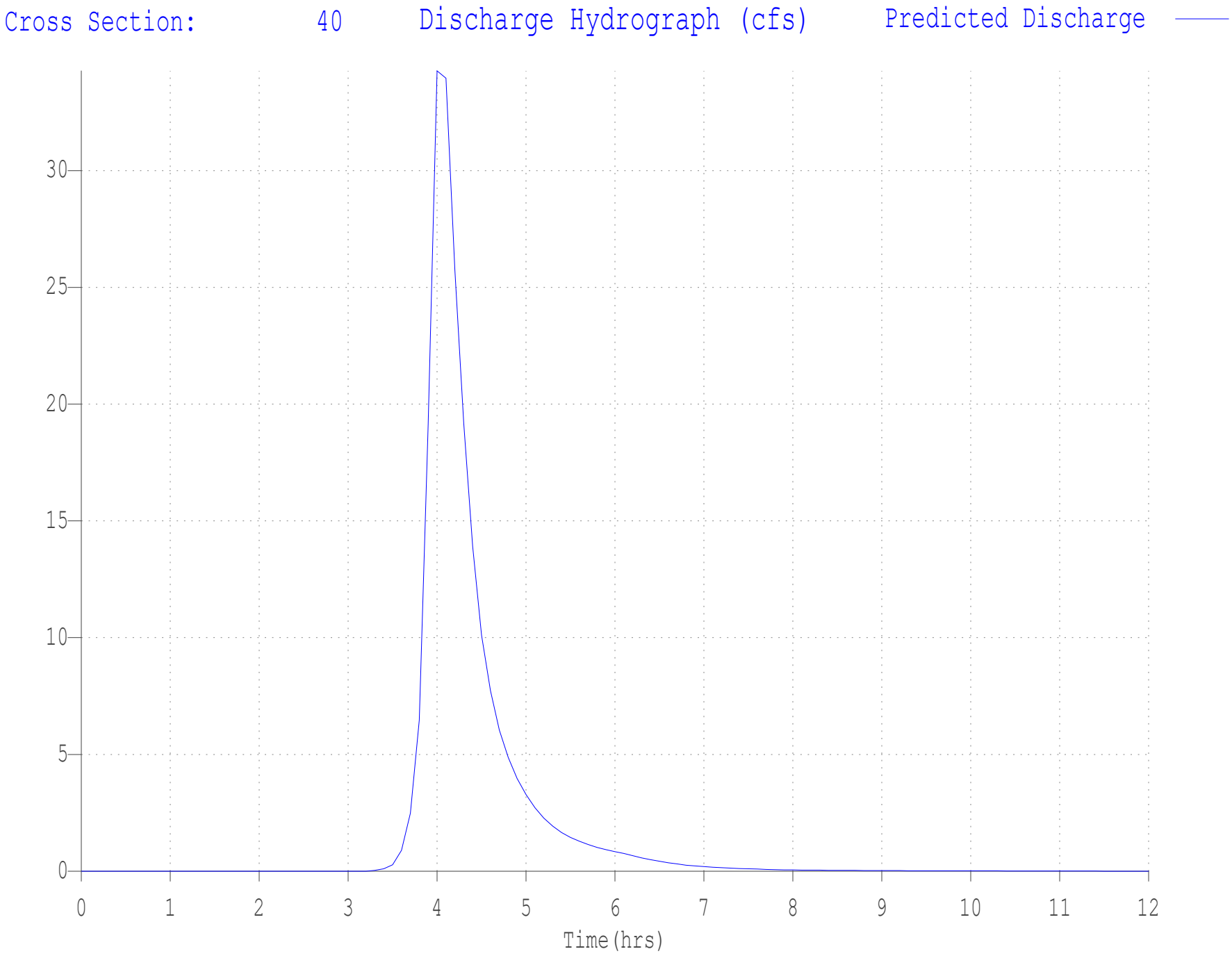

Cross Section: 35
Discharge Hydrograph (cfs)
Predicted Discharge
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

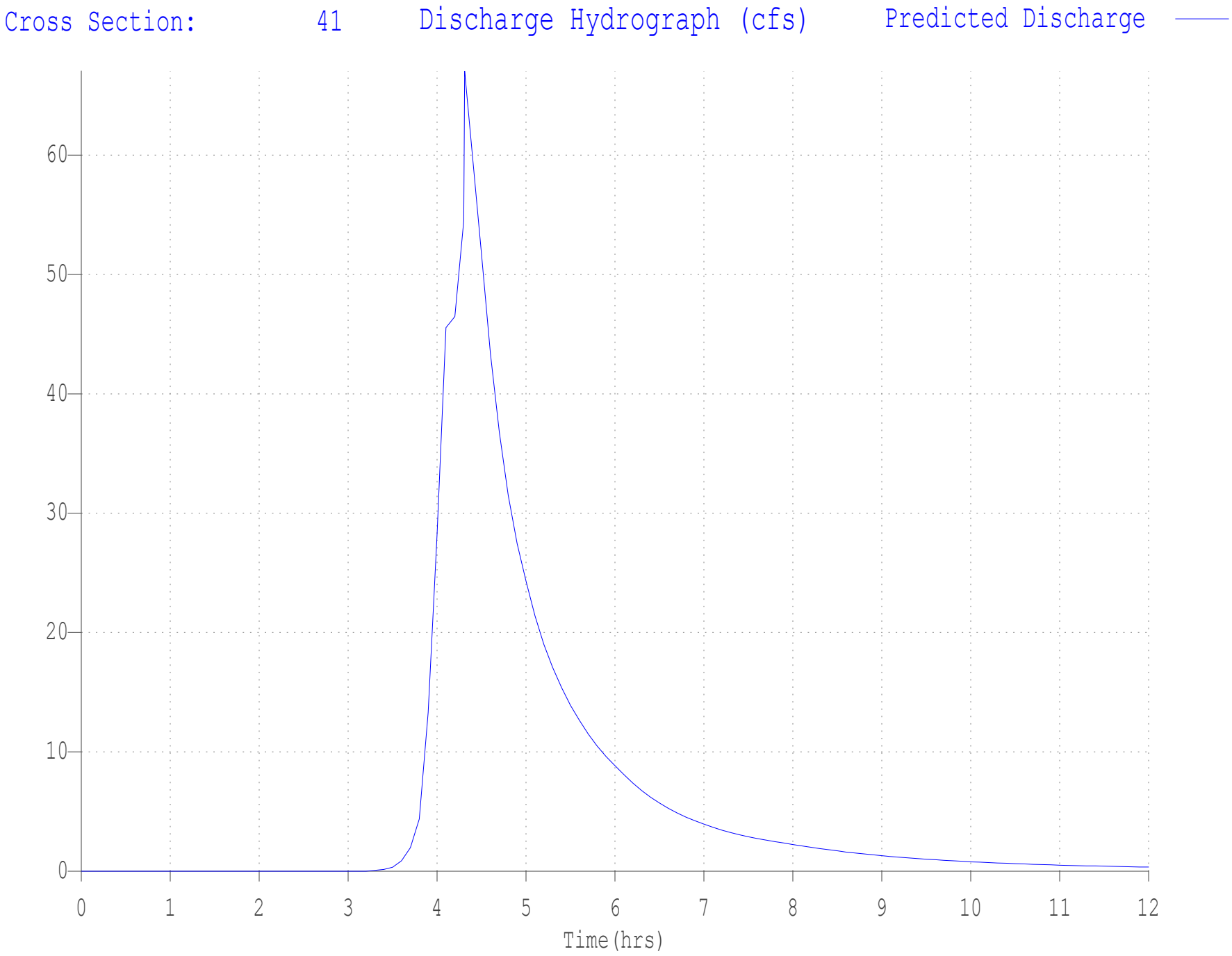

Cross Section: 36 Discharge Hydrograph (cfs)
Predicted Discharge
1100
1000
900
800
700
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

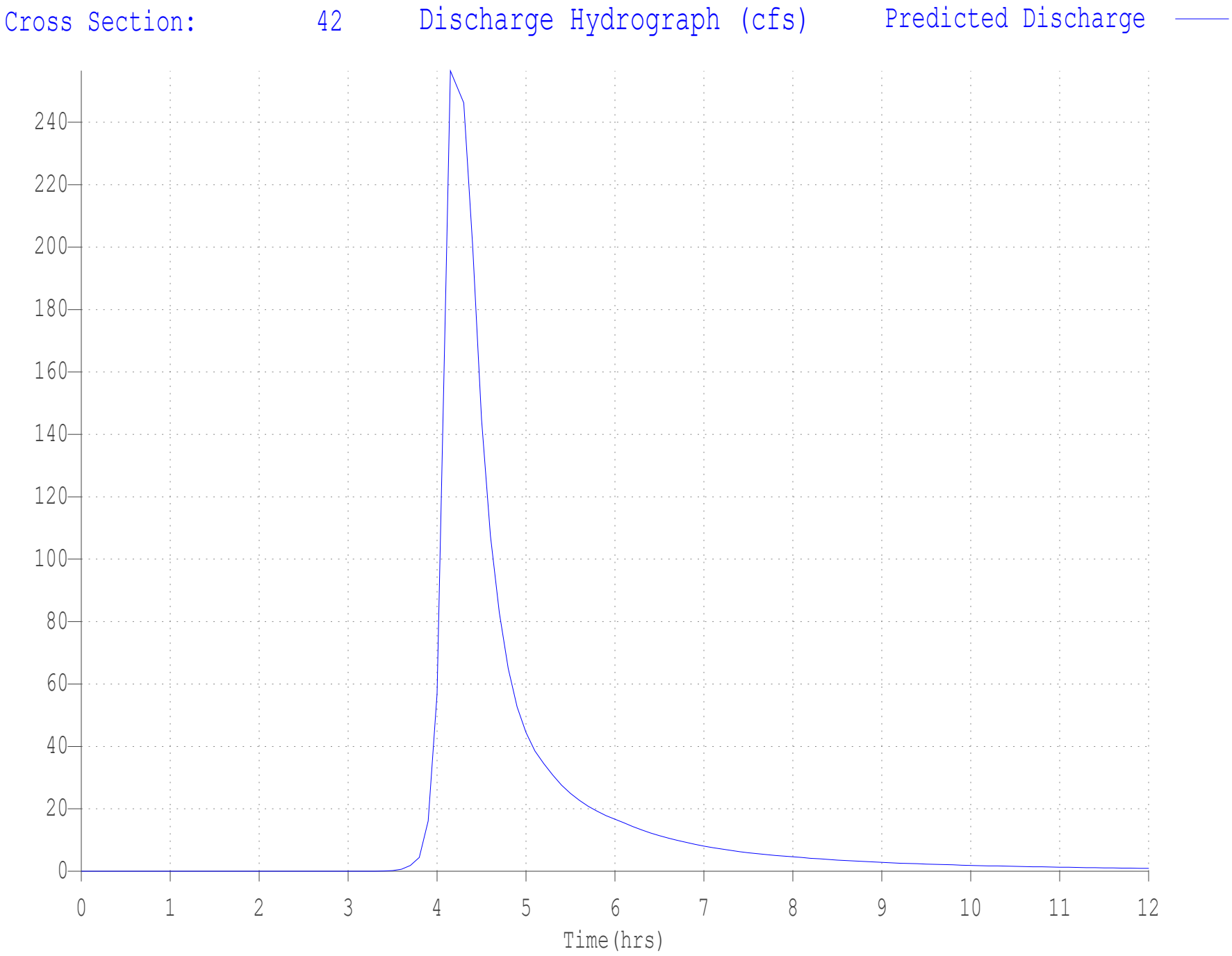

Cross Section: 37 Discharge Hydrograph (cfs) Predicted Discharge
4.5
4
3.5
3
2.5
2
1.5
1
.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)


Cross Section: 38
Discharge Hydrograph (cfs)
Predicted Discharge
500
450
400
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)


Cross Section: 39 Discharge Hydrograph (cfs) Predicted Discharge
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)


Cross Section: 40
Discharge Hydrograph (cfs)
Predicted Discharge
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)


Cross Section: 41
Discharge Hydrograph (cfs)
Predicted Discharge
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

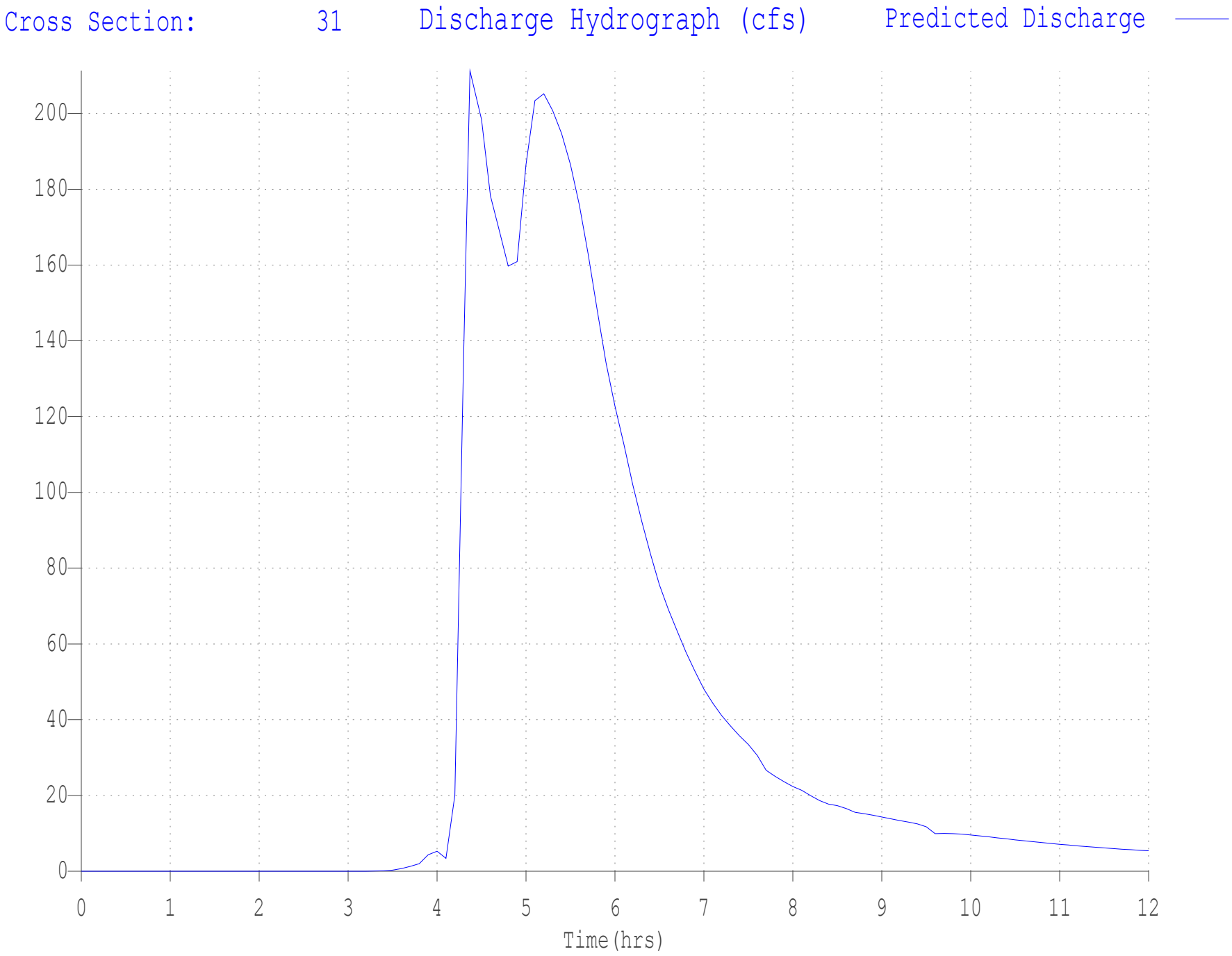

Cross Section: 42 Discharge Hydrograph (cfs) Predicted Discharge
240
220
200
180
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

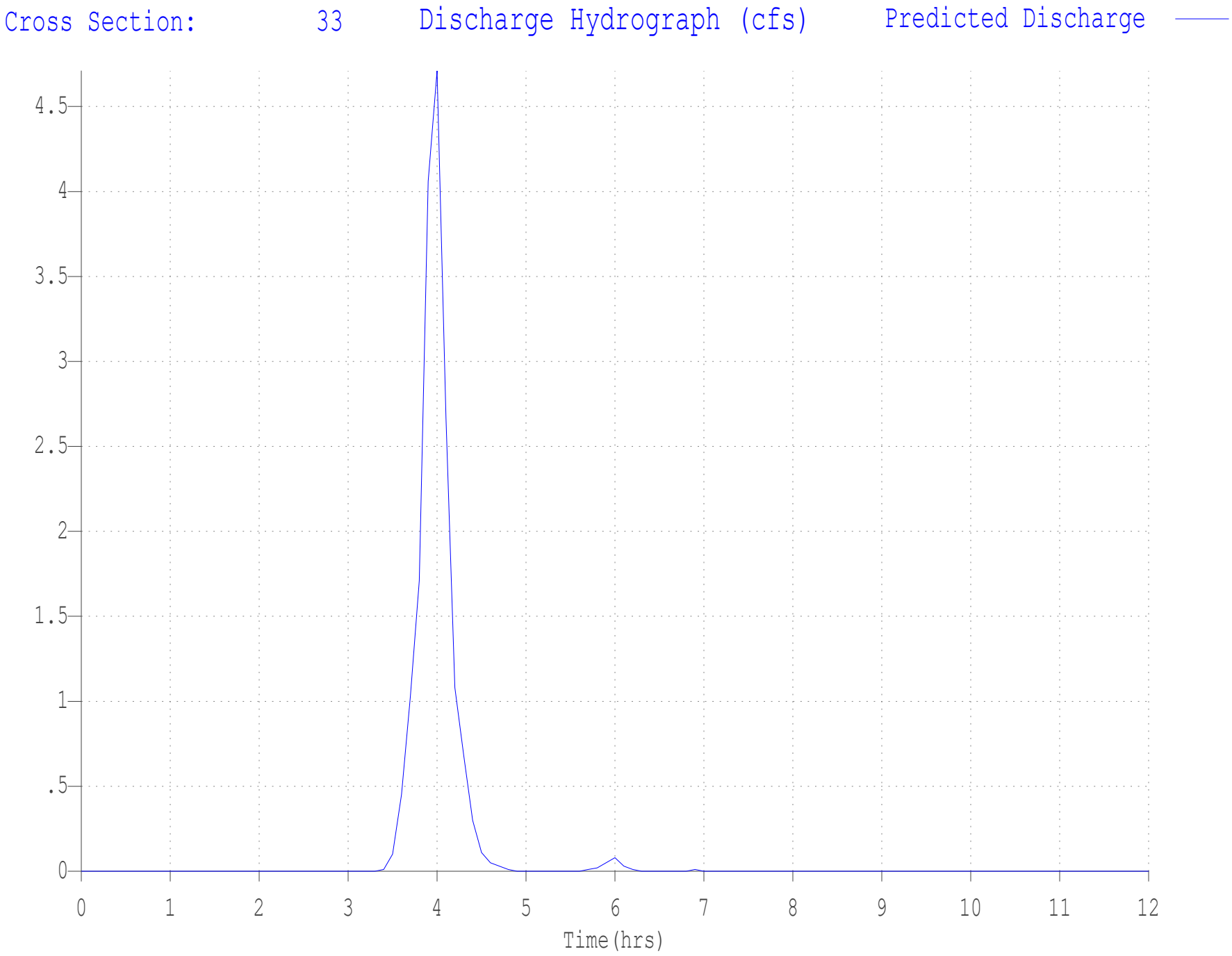
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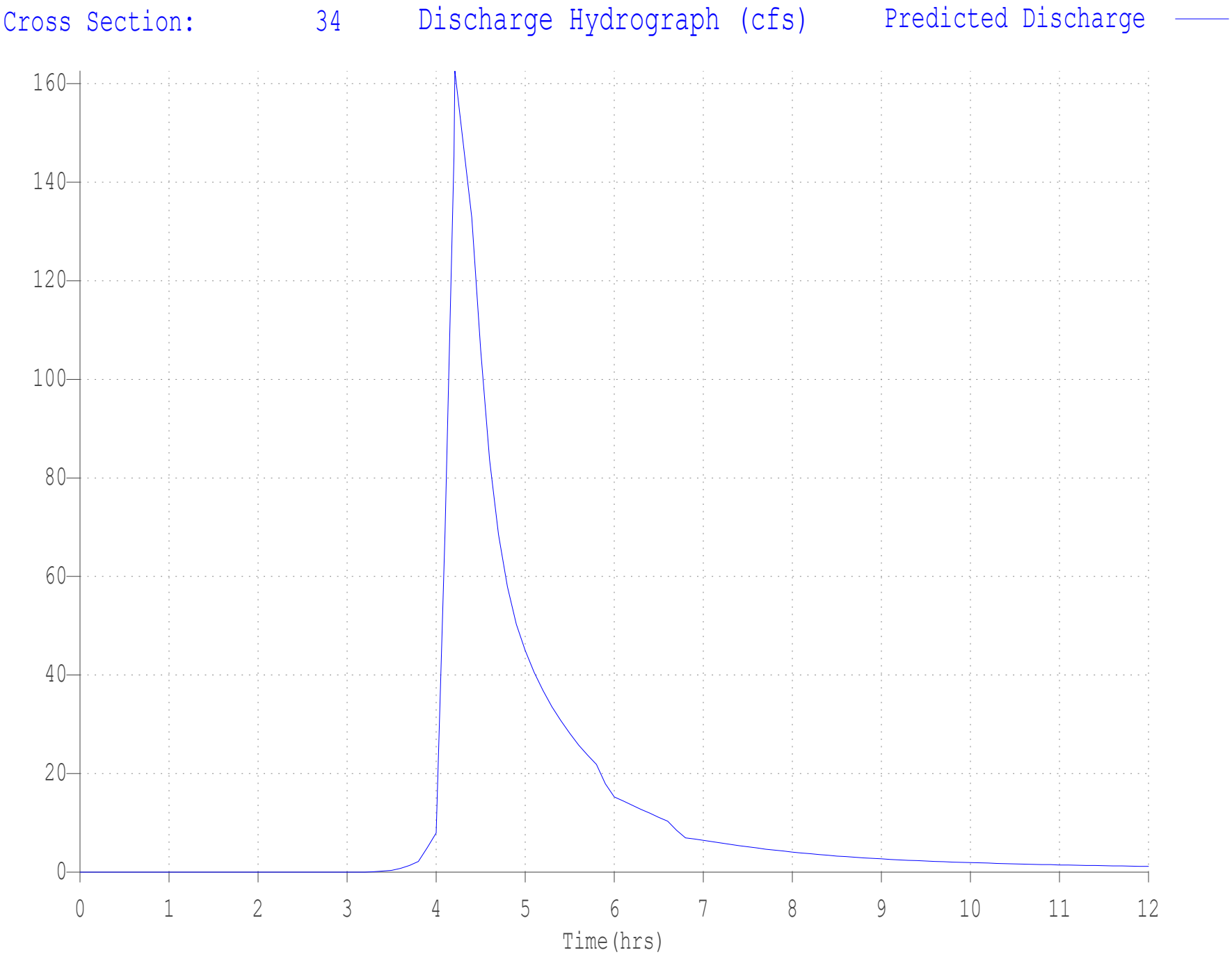
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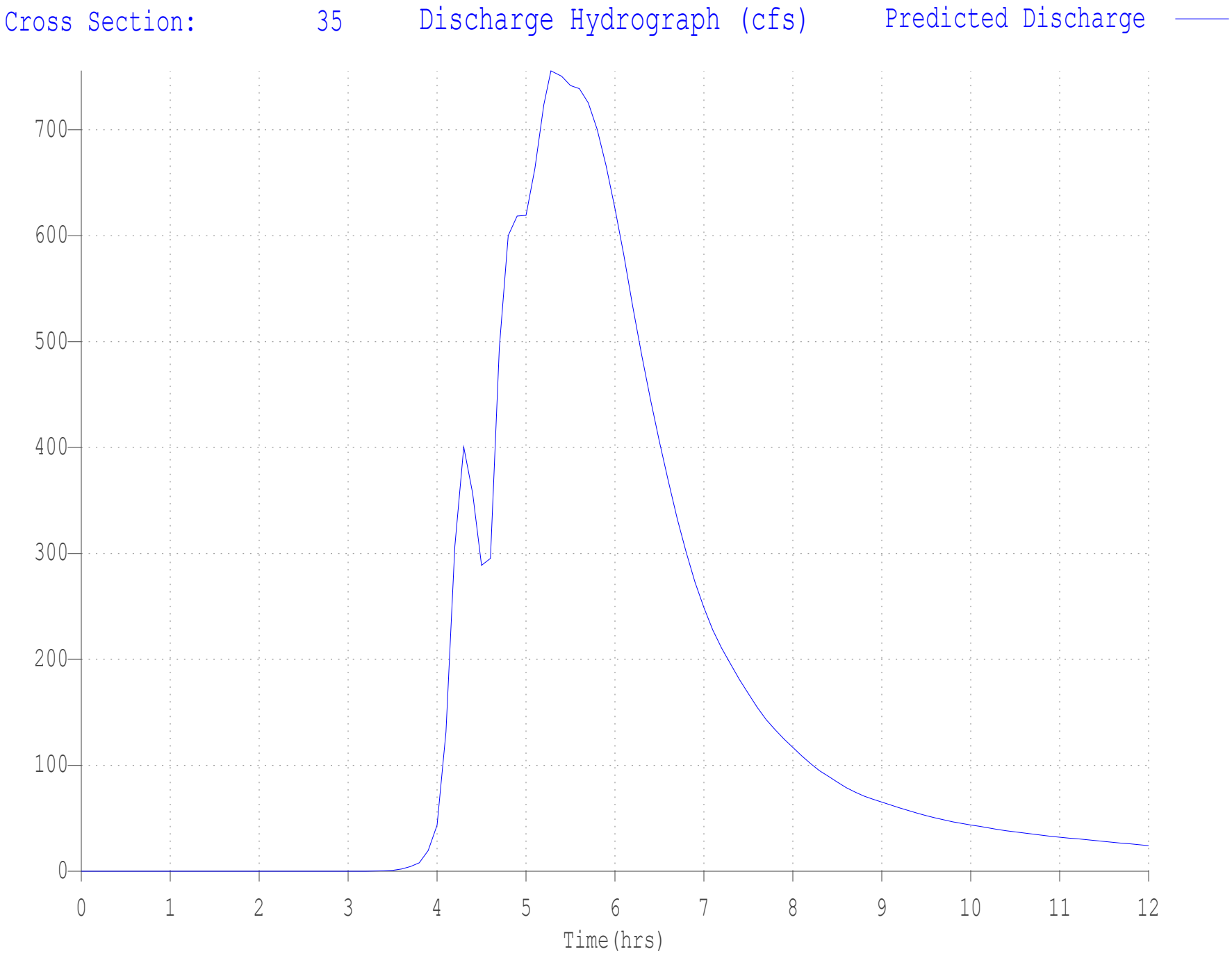
FLO-2D
6–HOUR POST-PROJECT MODEL

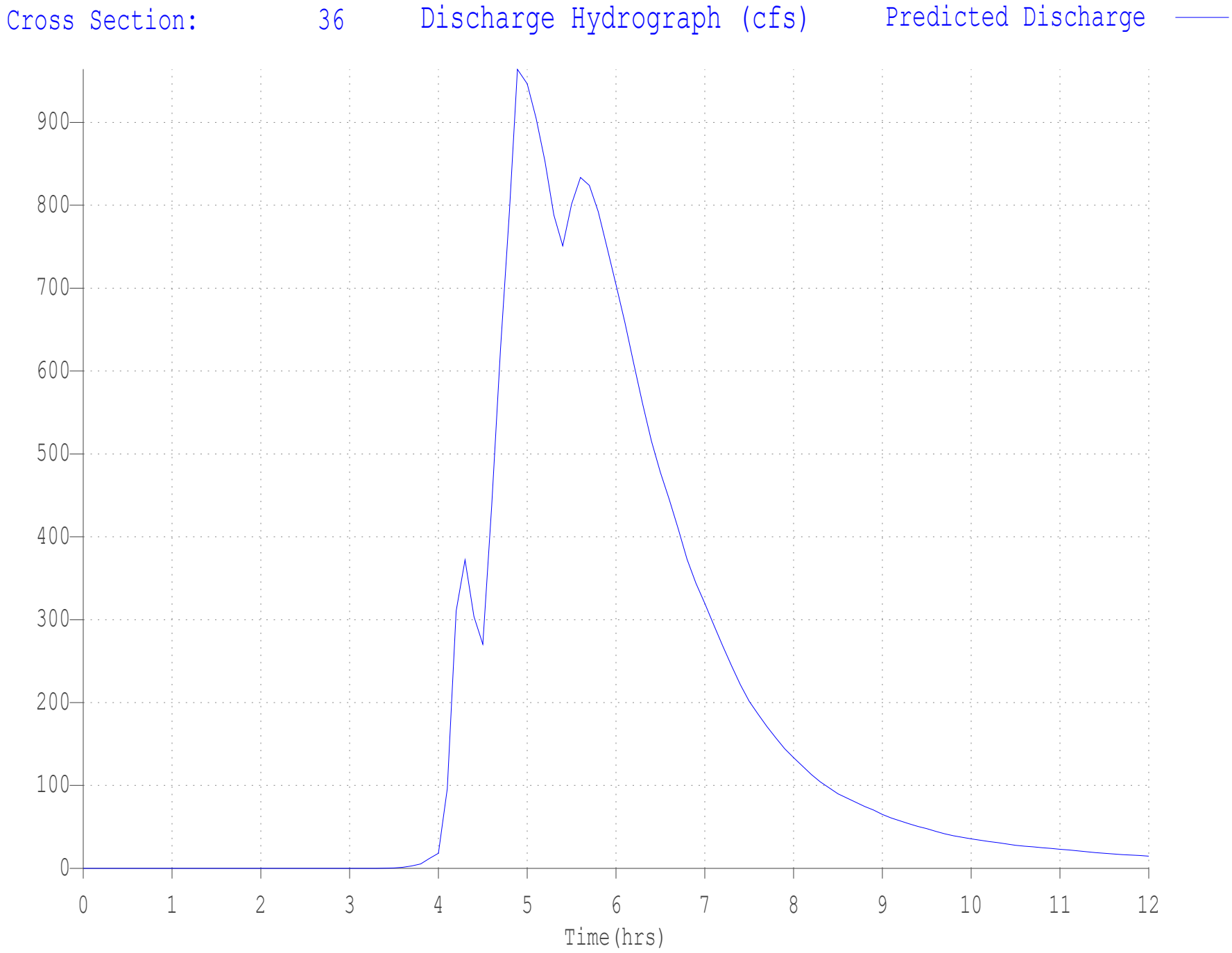
FLOODPLAIN CROSS SECTION HYDROGRAPHS

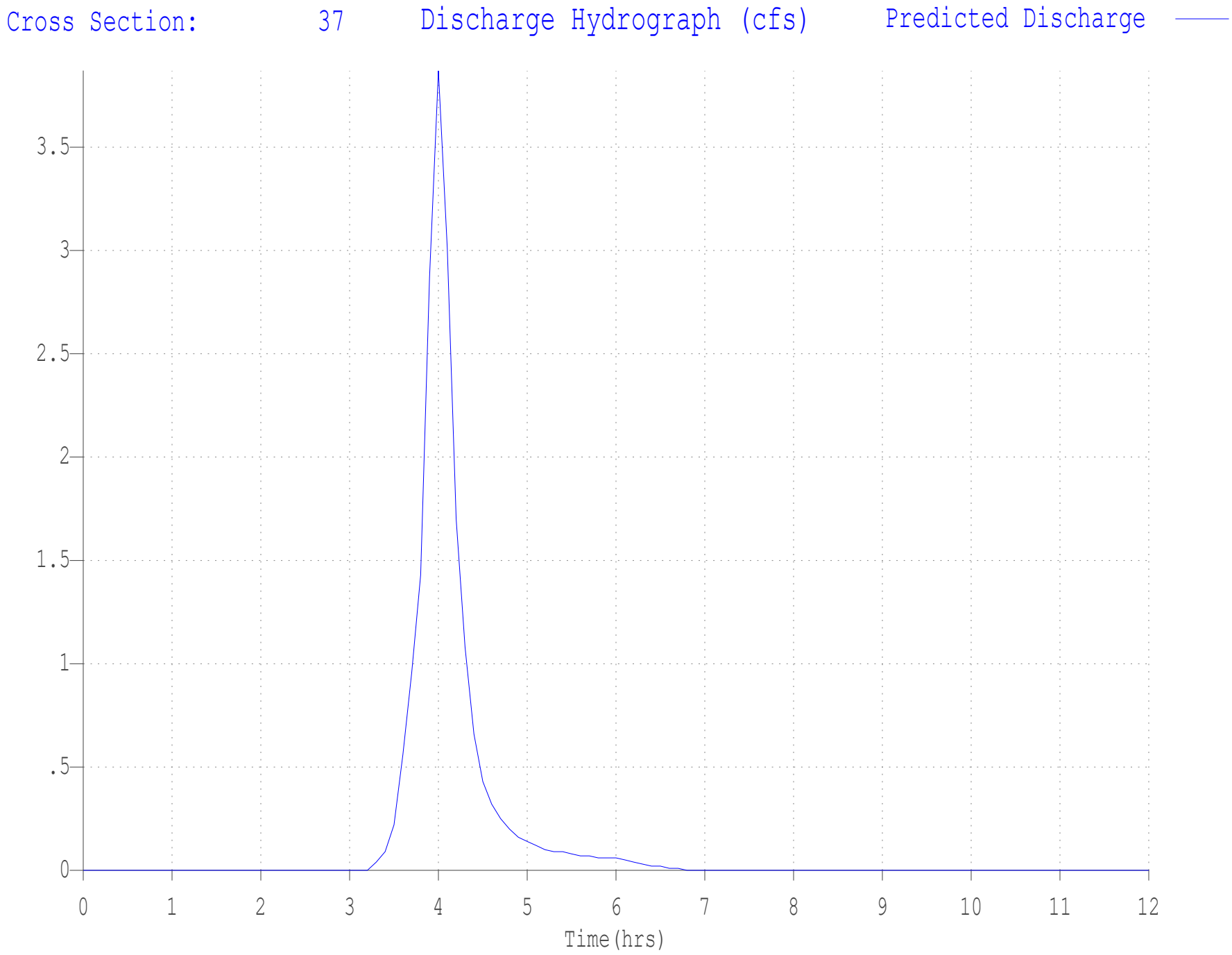

Cross Section: 31
Discharge Hydrograph (cfs)
Predicted Discharge
200
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

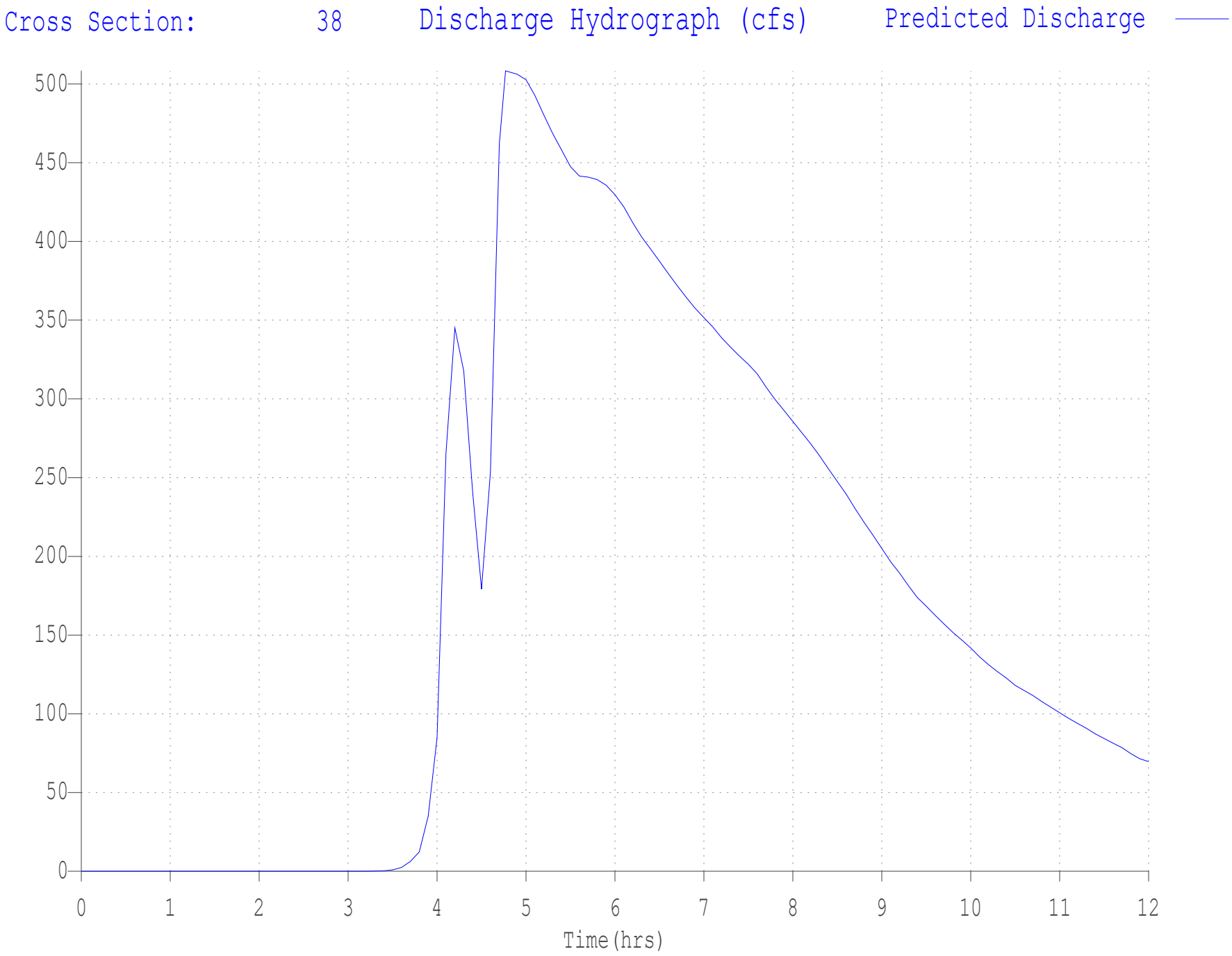

Cross Section: 33 Discharge Hydrograph (cfs) Predicted Discharge
4.5
4
3.5
3
2.5
2
1.5
1
.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)

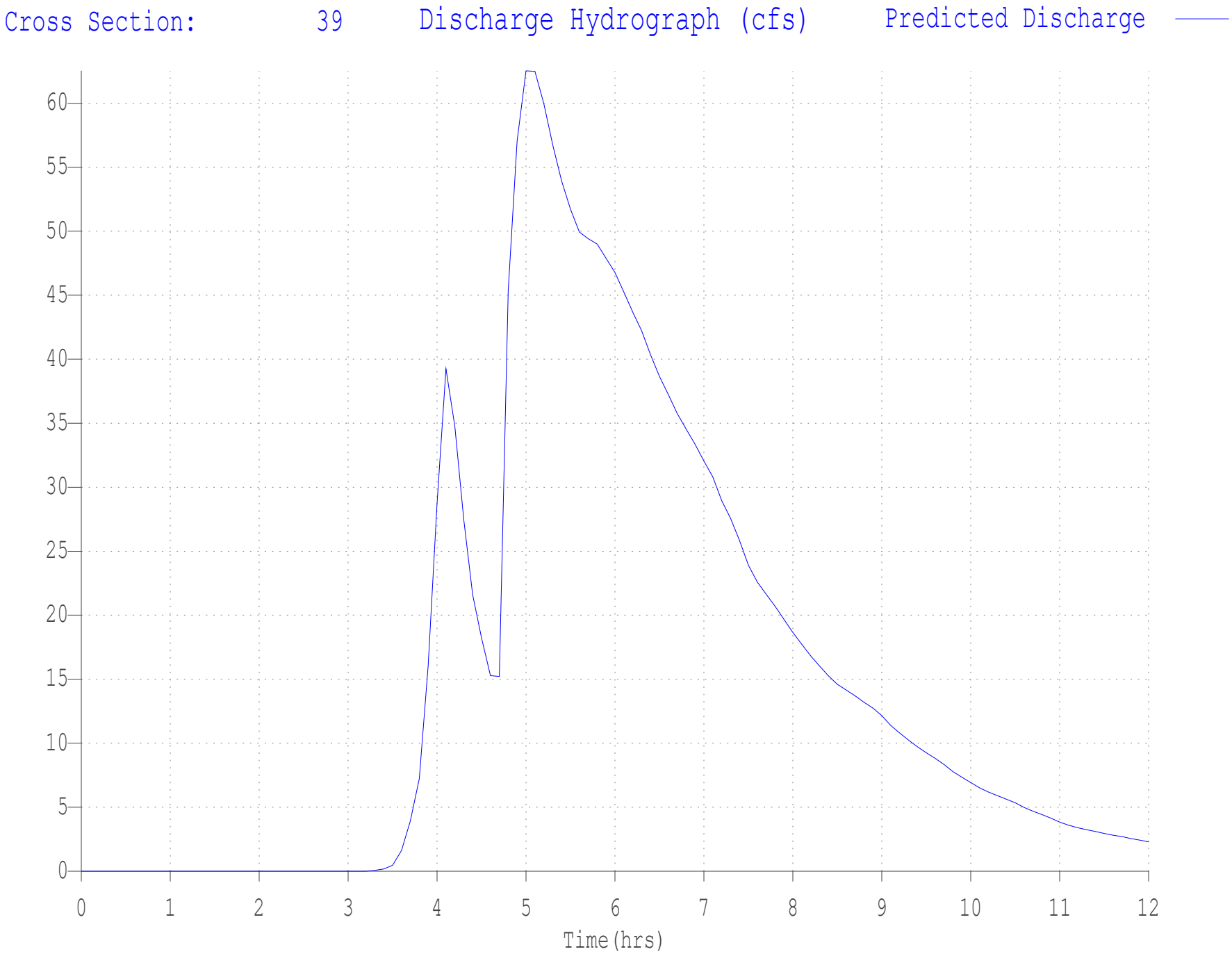

Cross Section: 34
Discharge Hydrograph (cfs)
Predicted Discharge
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

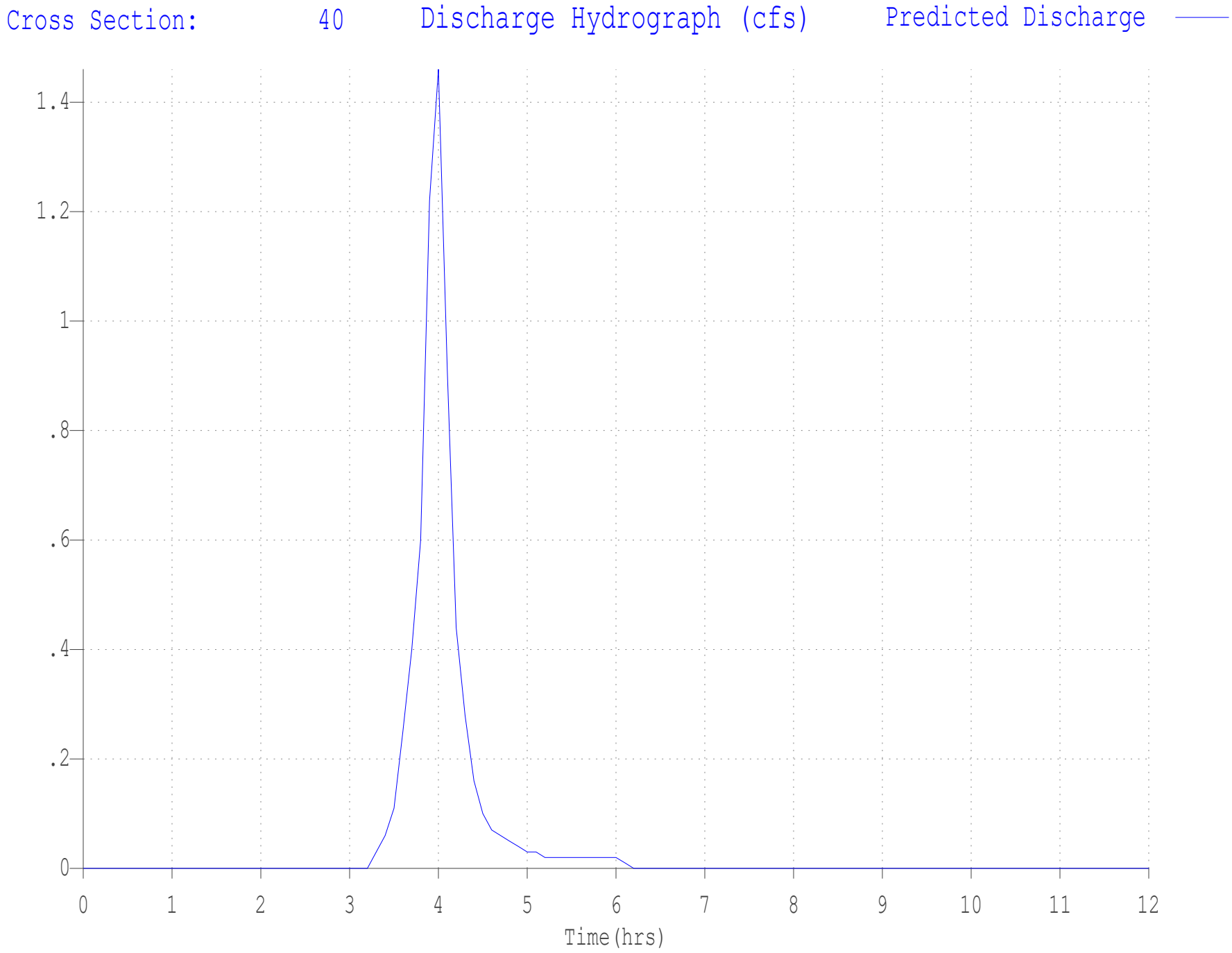

Cross Section: 35
Discharge Hydrograph (cfs)
Predicted Discharge
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

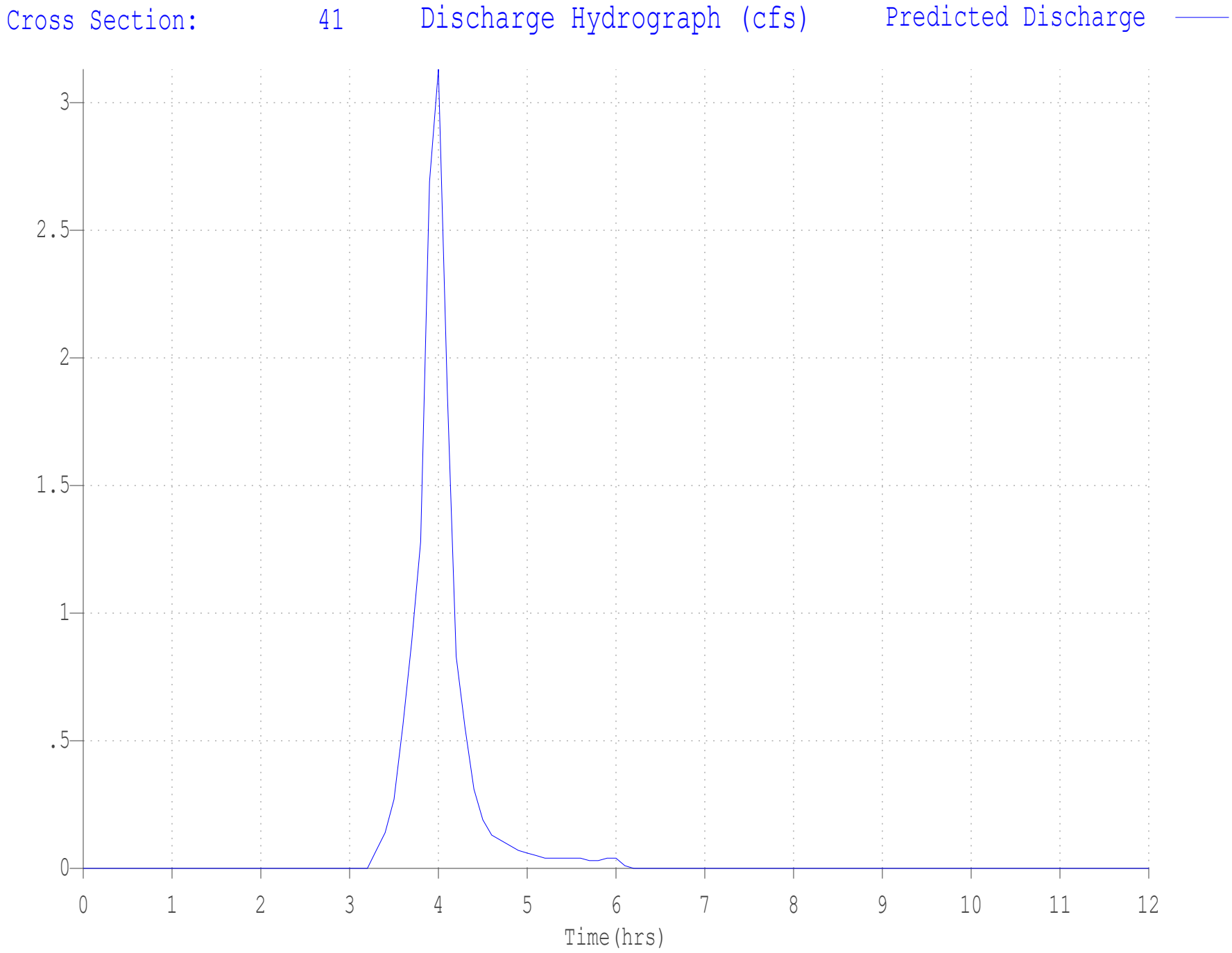

Cross Section: 36
Discharge Hydrograph (cfs)
Predicted Discharge
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

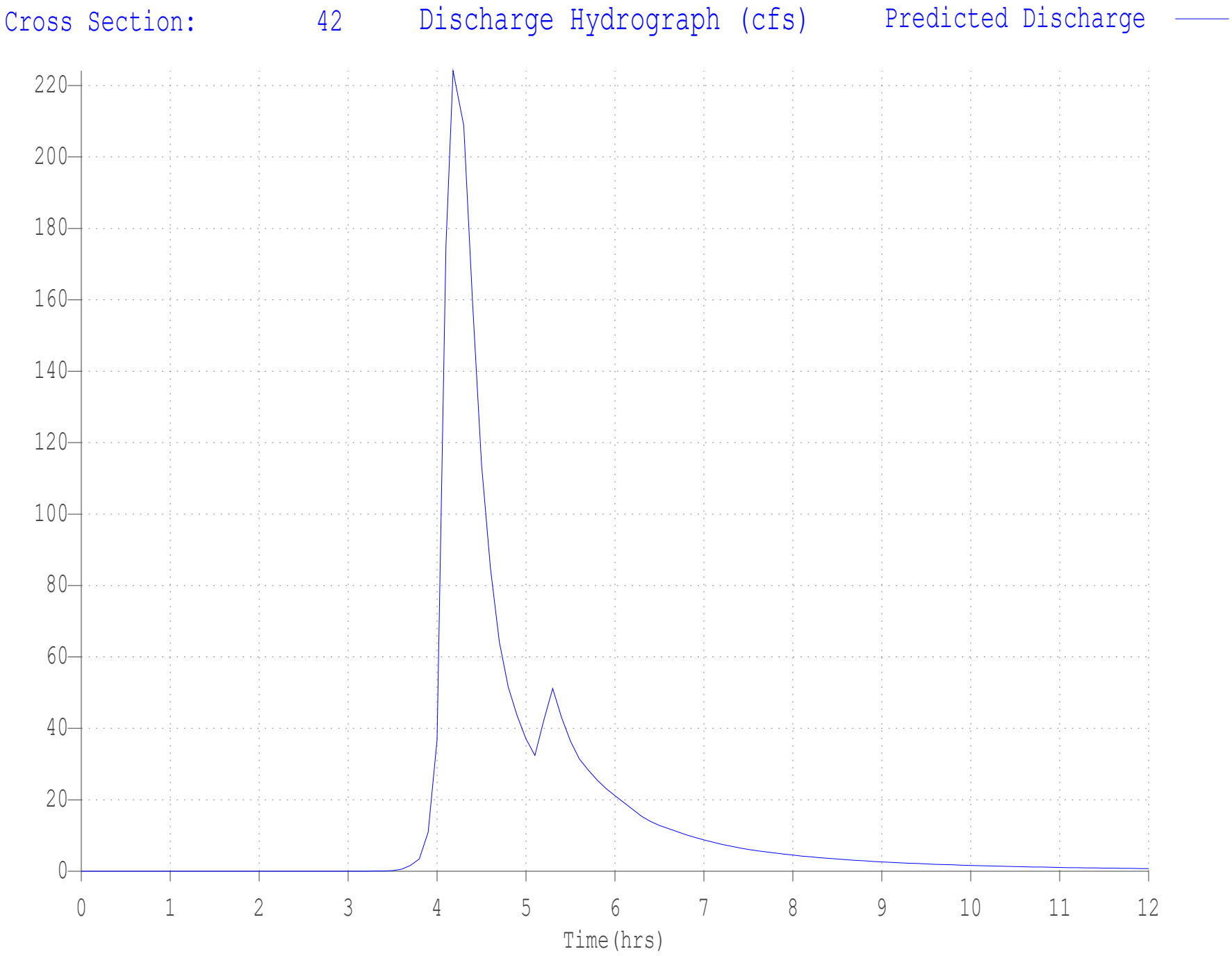

Cross Section: 37 Discharge Hydrograph (cfs) Predicted Discharge
3.5
3
2.5
2
1.5
1
.5
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)


Cross Section: 38
Discharge Hydrograph (cfs)
Predicted Discharge
500
450
400
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)


Cross Section: 39 Discharge Hydrograph (cfs) Predicted Discharge
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Time(hrs)


Cross Section: 40
Discharge Hydrograph (cfs)
Predicted Discharge
1.4
1.2
1
.8
.6
.4
.2
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)


Cross Section: 41
Discharge Hydrograph (cfs)
Predicted Discharge
3
2.5
2
1.5
1
.5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)


Cross Section: 42
Discharge Hydrograph (cfs)
Predicted Discharge
220
200
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Time(hrs)

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APPENDIX D

HYDRAULIC ANALYSIS SUPPORTING DOCUMENTATION

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 29 2024

C-1C (XS-7)

Trapezoidal

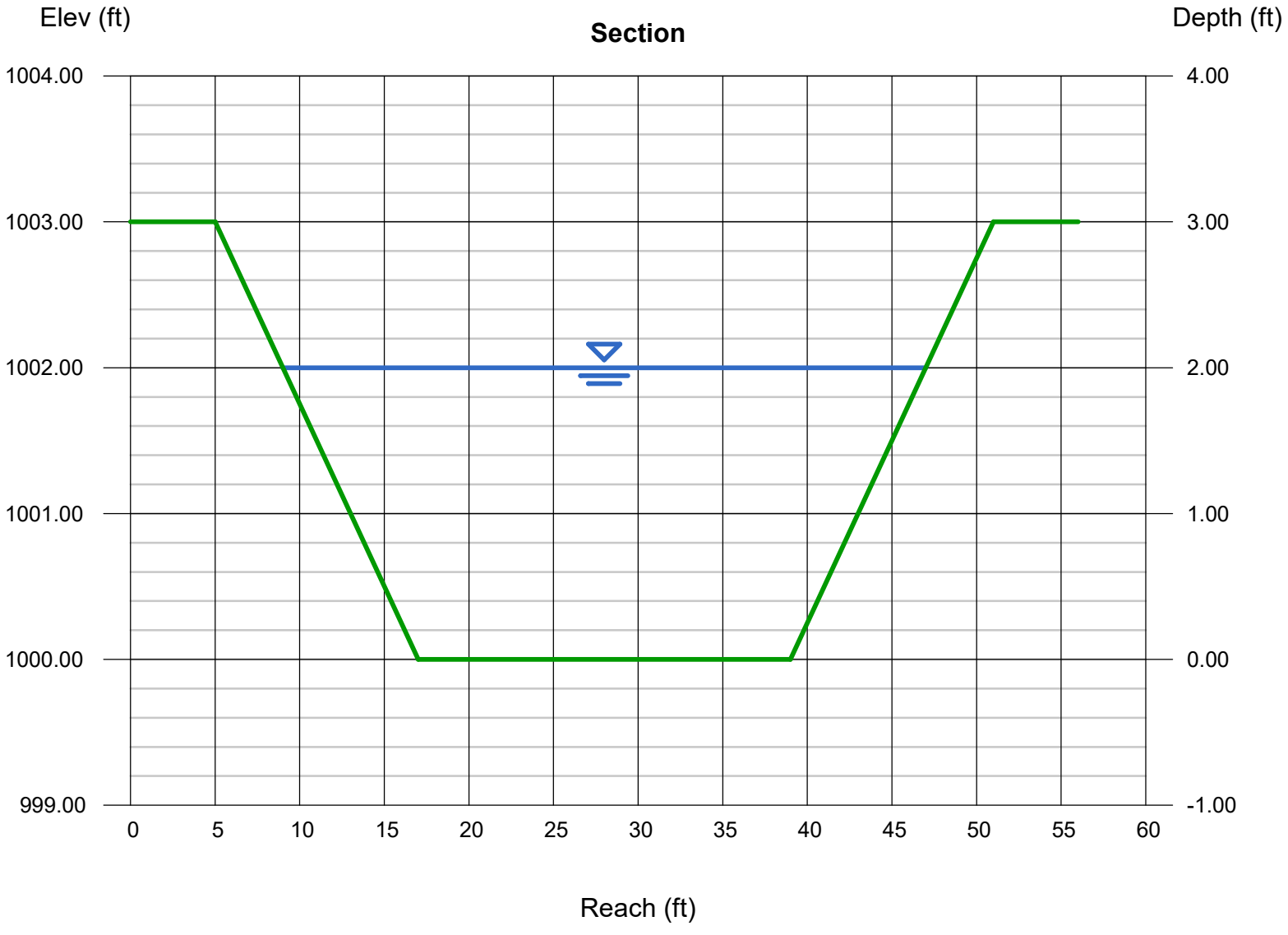
Bottom Width (ft)	= 22.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 1000.00
Slope (%)	= 0.80
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 305.41

Highlighted

Depth (ft)	= 2.00
Q (cfs)	= 305.41
Area (sqft)	= 60.00
Velocity (ft/s)	= 5.09
Wetted Perim (ft)	= 38.49
Crit Depth, Yc (ft)	= 1.64
Top Width (ft)	= 38.00
EGL (ft)	= 2.40



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 29 2024

C-3B (XS-27)

Trapezoidal

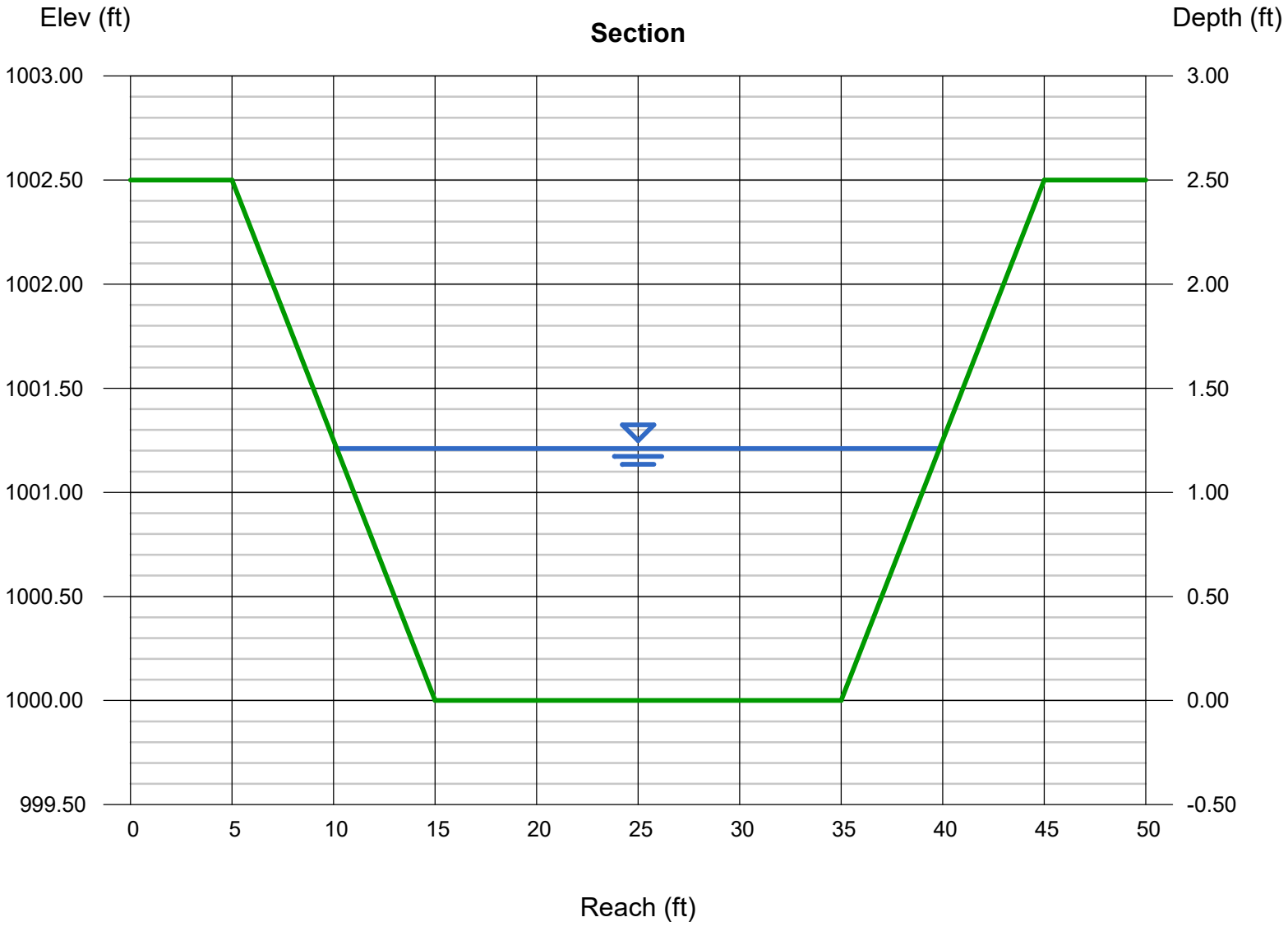
Bottom Width (ft)	= 20.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 1000.00
Slope (%)	= 0.80
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 114.00

Highlighted

Depth (ft)	= 1.21
Q (cfs)	= 114.00
Area (sqft)	= 30.06
Velocity (ft/s)	= 3.79
Wetted Perim (ft)	= 29.98
Crit Depth, Yc (ft)	= 0.94
Top Width (ft)	= 29.68
EGL (ft)	= 1.43



Channel Report

C-2A (XS-11)

Trapezoidal

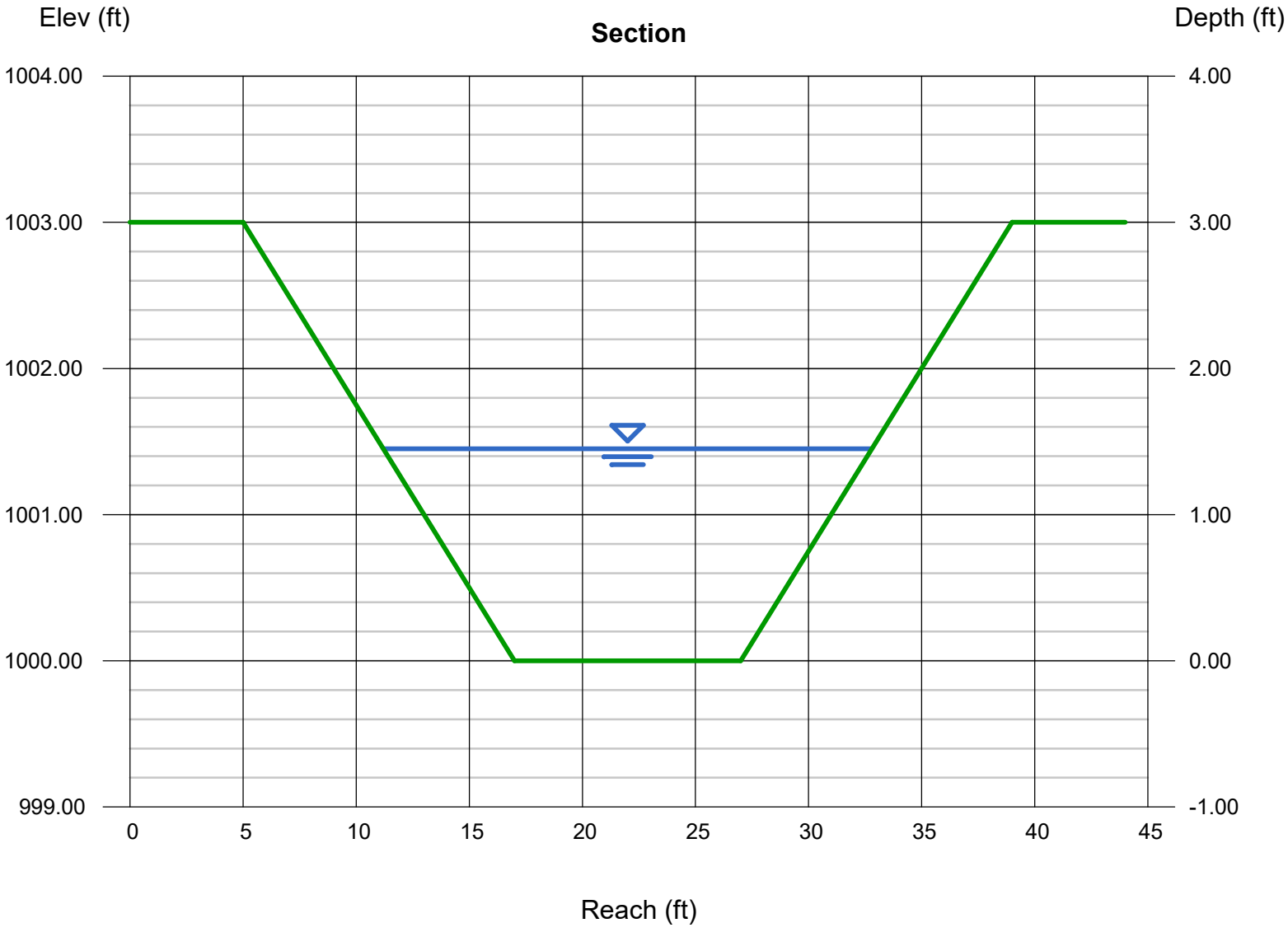
Bottom Width (ft)	= 10.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 1000.00
Slope (%)	= 1.00
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 98.97

Highlighted

Depth (ft)	= 1.45
Q (cfs)	= 98.97
Area (sqft)	= 22.91
Velocity (ft/s)	= 4.32
Wetted Perim (ft)	= 21.96
Crit Depth, Yc (ft)	= 1.23
Top Width (ft)	= 21.60
EGL (ft)	= 1.74



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 29 2024

C-3A (XS-27)

Trapezoidal

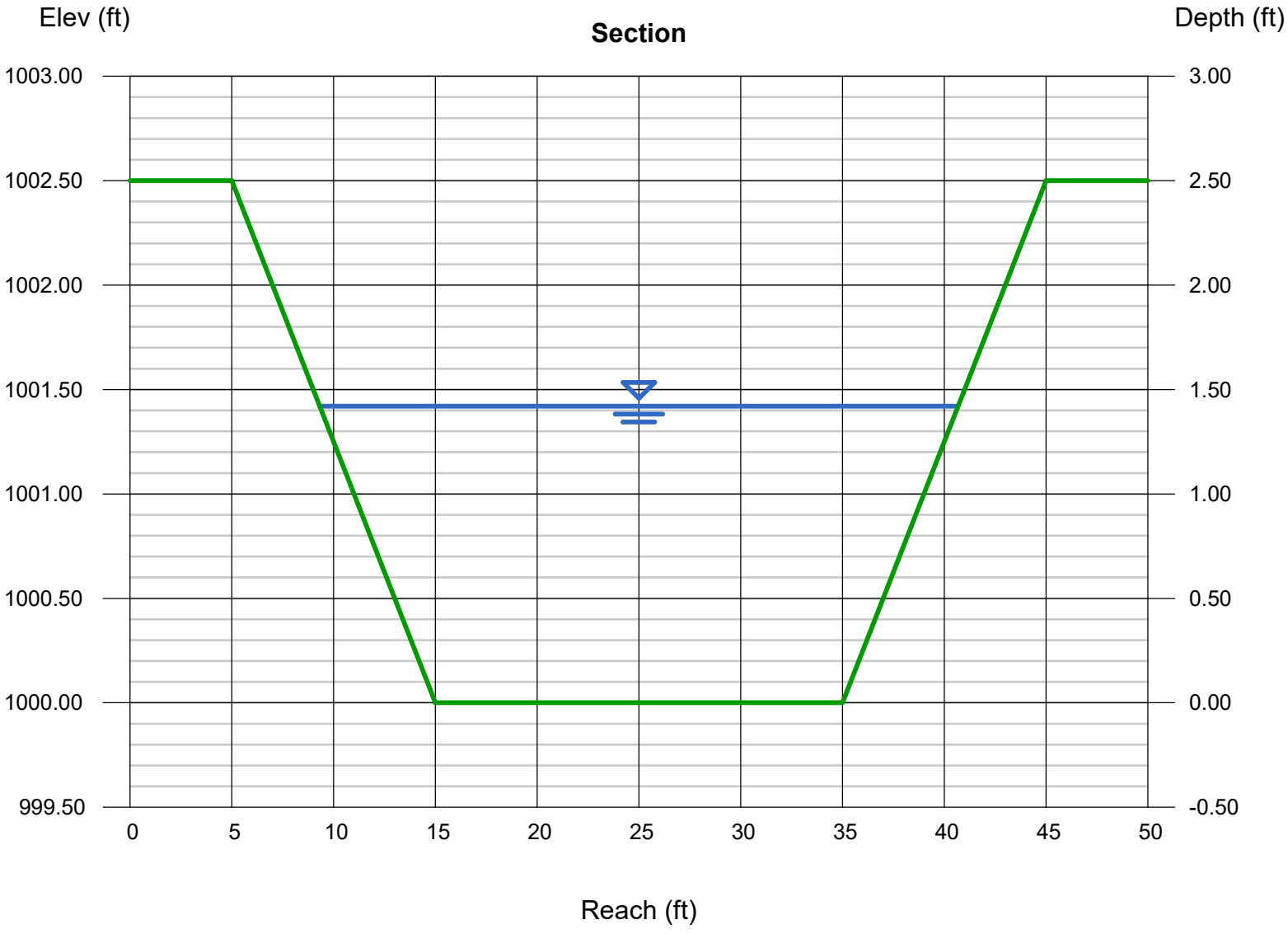
Bottom Width (ft)	= 20.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.50
Invert Elev (ft)	= 1000.00
Slope (%)	= 1.00
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 169.24

Highlighted

Depth (ft)	= 1.42
Q (cfs)	= 169.24
Area (sqft)	= 36.47
Velocity (ft/s)	= 4.64
Wetted Perim (ft)	= 31.71
Crit Depth, Yc (ft)	= 1.21
Top Width (ft)	= 31.36
EGL (ft)	= 1.75



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 29 2024

C-4A (XS-23)

Trapezoidal

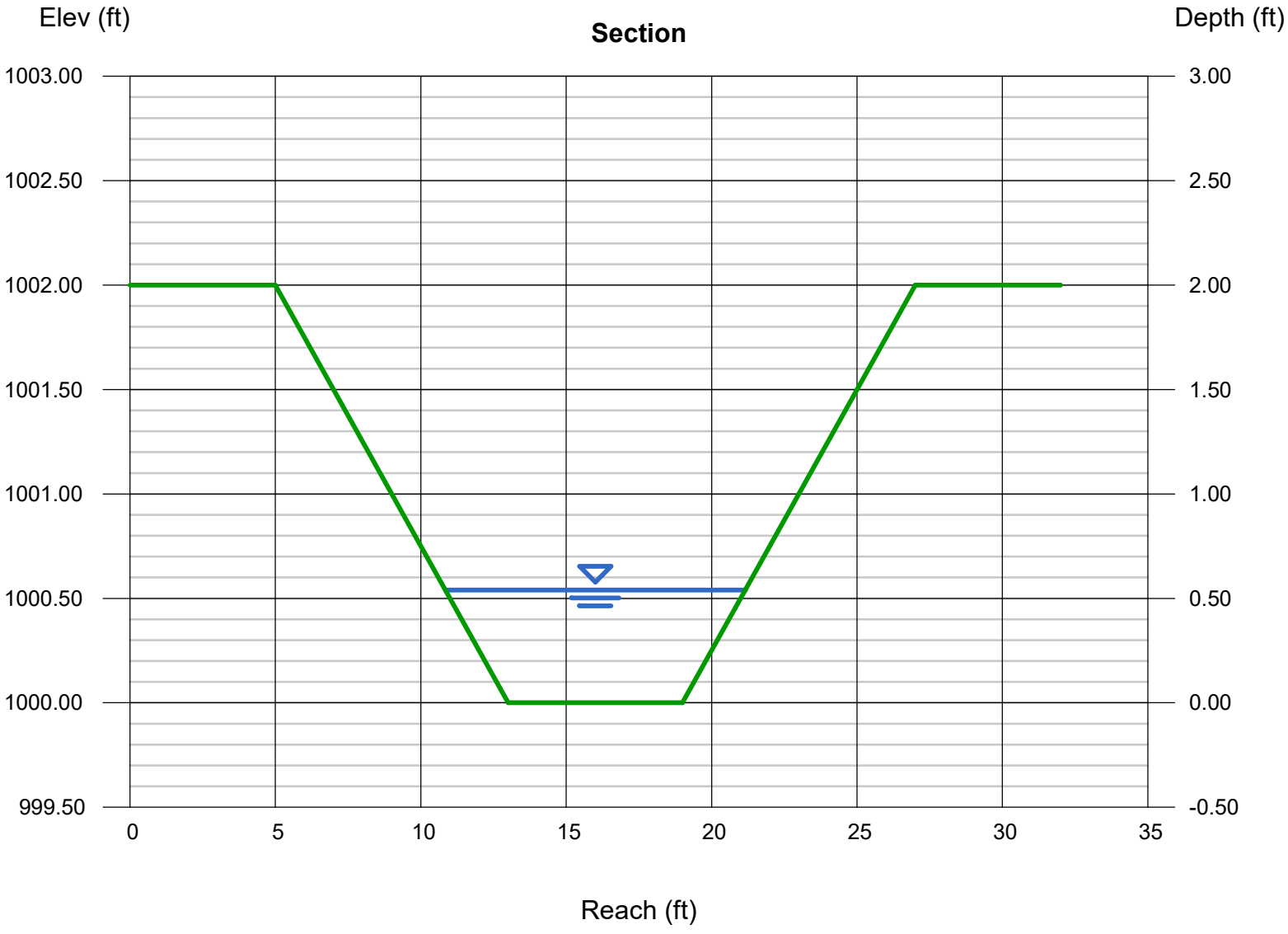
Bottom Width (ft)	= 6.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1000.00
Slope (%)	= 1.50
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 12.55

Highlighted

Depth (ft)	= 0.54
Q (cfs)	= 12.55
Area (sqft)	= 4.41
Velocity (ft/s)	= 2.85
Wetted Perim (ft)	= 10.45
Crit Depth, Yc (ft)	= 0.47
Top Width (ft)	= 10.32
EGL (ft)	= 0.67



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APPENDIX E

PRELIMINARY RETENTION & DEWATERING CALCULATIONS

WEIGHTED RUNOFF COEFFICIENT CALCULATIONS

Project: 2592 - Ore Town Solar Project

Prepared by: PJG

Date: Aug, 2024

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Landuse[1]	100-Year C Coefficient
Solar Panels	0.70
Substation and Battery Storage Units	0.95
Undeveloped Desert Rangeland & Open Space	0.50

Drainage Subarea ID(s)	Subarea Surface Types & Areas				100-YR Weighted Coefficient
	Solar Panels	Substation and Battery Storage Units	Undeveloped Desert Rangeland & Open Space	Total	
	[ft^2]	[ft^2]	[ft^2]	[ft^2]	C_w
ON-1A	0	66,716	520,071	586,787	0.55
ON-1B1	0	298,148	254,750	552,898	0.74
ON-1B2	0	0	0	818,994	0.70
ON-1D	0	0	0	6,310,991	0.70
ON-2A	9,210,108	0	0	9,210,108	0.70
ON-3A	3,060,024	0	0	3,060,024	0.70
ON-4A	7,742,087	0	0	7,742,087	0.70

NOTES:

(1) From Table 2-1 of the Pinal County Drainage Manual, Volume 2: Design Methodology and Procedures, Chapter 2: Hydrology, August 2004.

PRELIMINARY 100-YR, 2-HR RETENTION CALCULATION TABLE

Project: 2592 - Ore Town Solar Project

Prepared by: PJG

Date: Aug, 2024

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100-Yr, 2-Hr Volume Required = C_w * (P/ 12) * A

Where: A= Plan-view area of an individual drainage area
Cw=Weighted Runoff Coefficient (100-Yr)
P=2.61 in (100-Yr, 2-Hr)

Pre- vs. Post- Volume Required = (C_{post} - C_{pre}) * (P/ 12) * A

Where: A= Plan-view area of an individual drainage area
C_{Post}=Post-Development Weighted Runoff Coefficient (100-Yr)
C_{Pre}=Pree-Development Weighted Runoff Coefficient (0.50)
P=2.61 in (100-Yr, 2-Hr)

First Flush Storage Volume = C_{FF} * P/12 * A

Where: A= Plan-view area of an individual drainage area
C_{FF}=Runoff Coefficient (set=1)
P=0.5 in

Retention Basin ID	Drainage Subarea ID	Total Area	Developed Condition Runoff 100-YR "C" Coefficient	First Flush Retention Volume Required(1)	Pre vs. Post	100-Yr, 2-Hr Retention Volume Required	Retention Volume Provided
		[ft^2]		[ft^3]	[ft^3]	[ft^3]	[ft^3]
RB-1A	ON-1A	586,787	0.55	24,449	6,530	70,343	97,959
RB-1B1	ON-1B1	552,898	0.74	23,037	29,181	89,309	109,066
RB-1B2	ON-1B2	818,994	0.70	34,125	35,626	124,692	177,498
RB-1D	ON-1D	6,310,991	0.70	262,958	274,528	960,848	651,379
RB-2A	ON-2A	9,210,108	0.70	383,755	400,640	1,402,239	500,859
RB-3A	ON-3A	3,060,024	0.70	127,501	133,111	465,889	202,116
RB-4A	ON-4A	7,742,087	0.70	322,587	336,781	1,178,733	591,717

DEWATERING CALCULATIONS TABLE

Project: 2592 - Ore Town Solar Project

Prepared by: PJG

Date: Aug, 2024

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Retention Basin System ID	Volume to Dewater Via Drywell	Drywell Disposal Rate[1]	Number of Drywells[2][3]	Drywell Drain Rate (R_T)	Time to Drain[4] $T=V_P/3600\ R_T$
	[ft^3]	(cfs)	[ea.]	[cfs]	[hrs]
RB-1A	70,343	0.10	6	0.6	32.6
RB-1B1	89,309	0.10	7	0.7	35.4
RB-1B2	124,692	0.10	10	1.0	34.6
RB-1D	274,528	0.10	22	2.2	34.7
RB-2A	400,640	0.10	31	3.1	35.9
RB-3A	133,111	0.10	11	1.1	33.6
RB-4A	336,781	0.10	26	2.6	36.0
TOTAL			**113**		

NOTES:

(1) Disposal rate referenced from Pinal County Drainage Manual Volume I: Design Criteria (PCDM Vol 1), Section 3.10.4.2 Drywells.

(2) Number of drywells based on accepted and assumed design disposal rate (0.10 cfs). Final dewatering facilities, including number of drywells will be determined once percolation testing has been performed.

(3) All drywells must be registered with the Arizona Department of Environmental Quality (ADEQ).

(4) Design of all stormwater storage facilities is such that the stored runoff is completely discharged from the facility within 36 hours after the runoff event has ended. The draining of stormwater storage facilities may be accomplished via in-situ percolation, drywells, or a combination thereof.

(5) Prelminary design does not account for any disposal via natural infiltration or bleed-off.

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APPENDIX F

SCOUR ANALYSIS

SCOUR CALCULATION

Project: 2592 - Ore Town Solar Project
Prepared by: PG
Date: Sep, 2024

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Pier Local Scour

HEC-18 basic pier scour equation

$$Z_{local/a} = 2.0K_1K_2K_3(y_1/a)^{0.35}Fr_1^{0.43}*FS$$

where:

z_{local} = local scour depth for piers, ft;
y_1 = flow depth directly upstream of the pier, ft
K_1 = correction factor for pier nose shape
K_2 = correction factor for angle of attack of flow = $(Cos\theta+(L/a)Sin\theta)^{0.65}$
K_3 = correction factor for bed condition; set to 1.0 if bed form trough scour calculated separately
a= pier width,ft;
L= length of pier, ft;
g= gravitational acceleration, 32.2 ft/s^2
Fr_1 = Froude Number directly upstream of the pier = $V_1/(gy_1)^{1/2}$
V_1= mean velocity of flow directly upstream of the pier, ft/s.
FS = Factor of safety = 1.2

Y_1 (1)	F_r	V_1 (1)	K_1	K_2	K_3	a	L	Z_{local}
0.15	0.25	0.54	1.0	1.3	1.1	0.5	0.5	1.5

Notes:
(1) Example values utilized. Figure 13 illustrates the scour depth referencing maximum flow depth and velocity results for each cell as determined in the FLO-2D model.