

Delugah Woods Subdivision - Orland Township Flood Reduction Alternatives Analysis

Supplemental Report - June 2024



Prepared for:

Orland Township Highway Department
16125 South Wolf Road
Orland Park, IL 60467



Prepared by:

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9575 W. Higgins Road
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CHAPTER 1 PROJECT OVERVIEW

1.1 INTRODUCTION

Christopher B. Burke Engineering, LTD. (CBBEL) was tasked by Orland Township to investigate historic and current drainage issues in the Delugah Woods Subdivision and to conduct hydraulic modeling of Spring Creek in Orland Township to address the frequent flooding of 157th Street caused by high water levels of Spring Creek during periods of high precipitation.

The Delugah Woods Subdivision is a residential subdivision in Orland Township located north of 159th Street between Will-Cook Road and Wolf Road. A primary access road to the Subdivision from the east is 157th Street, which crosses Spring Creek approximately 0.25 miles west of Wolf Road. A location map is included as Exhibit 1. 157th Street dips significantly at its crossing with Spring Creek resulting in frequent inundation of the roadway and limiting access to the subdivision to Lynch Drive to the west. Hydraulic modeling conducted by CBBEL concluded that 157th Street has an approximately ten percent (10%) chance of inundation in any given year. According to the FEMA effective Flood Insurance Map (FIRM) Panel 682 of 832 for Cook County, Illinois and Incorporated Areas, Spring Creek is mapped as studied Zone AE floodplain (Exhibit 2). The FIRM indicates that floodway is delineated and a USGS StreamStats report (Appendix 1) estimates a drainage area 1.29 square miles tributary to the culvert at 157th Street.

This study was initiated to investigate what public improvements, if any, were available and feasible to improve drainage in the subdivision. The findings of the study are presented in the following report.

1.2 SUBDIVISION DRAINAGE INVESTIGATION (JUNE 2024 SUPPLEMENT)

Delugah Woods subdivision has a long history of reported drainage problems and property flooding. To investigate the current drainage conditions, a flood questionnaire was distributed to 249 properties in the study area as part of a public outreach program. Of the 249, only 13 completed questionnaires were returned. Other aspects of the public outreach process, such as public information meetings for residents, were completed during the study. Addendum 1 of this report contains additional information on the outreach process.

The 13 returned questionnaires were reviewed. The drainage problems described were primarily related to grading resulting from the topography of the area. All were located on private property, outside of the right of way. Several reported basement seepage as the source of flooding. A desktop review of the study areas was completed to understand the topography and drainage patterns, as well as site visits and field review of conditions.

Our review indicates that two main types of “flooding” exist in Delugah Woods subdivision. One is related to Spring Creek. At flood stages, Spring Creek will overtop 157th Street, causing road closures and impacting the ability to access the subdivision. Depending on the severity of the storm

event, Spring Creek may remain at flood stage for an extended period of time, which can impact drainage of adjacent properties, can exacerbate subsurface drainage problems such as seepage into basements, and may create water quality issues if any septic fields are located within or near the Spring Creek floodplain.

The second type of flooding is distributed throughout the subdivision and can be characterized as single-lot drainage problems. There are no reports of overland flooding (not seepage related) where floodwater entered a residence. Reports typically indicate overland flow routes that have undesirably long draindown times. A review of these locations found that potential grading improvements to resolve the issues would need to occur within private properties and outside of the public right of way.

Much of this area was subdivided, and some of the homes built, before the Federal Emergency Management Agency's National Flood Insurance Program and stormwater management regulations. Portions of some of the yards are below the base flood elevation of Spring Creek. The profile of Spring Creek and corresponding flood profile is relatively flat through this area. Given the low ground elevations on some of the lots relative to the flood elevations along Spring Creek, there is not a feasible solution to address most of the flooding in this area. However, the public improvement that would be the most impactful, beneficial, and feasible was to eliminate the roadway flooding associated with Spring Creek at 157th Street. Several alternatives related to 157th Street were evaluated for consideration and are summarized in the following report.

1.3 HYDRAULIC MODEL DEVELOPMENT

In 2016, CBBEL compiled a Letter of Map Revision (LOMR) request for the remapping of the reach of Spring Creek between 108th Avenue and immediately downstream of Will-Cook Road (Exhibit 3). The report was submitted in August 2016, revised February 2019, and approved by FEMA in 2019. The LOMR report is included as Appendix 2. The LOMR was based on peak flowrates from a HEC-HMS hydrologic model created as part of the Metropolitan Water Reclamation District of Greater Chicago (MWRD) Detailed Watershed Plan for the Calumet-Sag Channel Watershed (DWP). The DWP is included as Appendix 6 in the attached LOMR report.

CBBEL conducted a critical duration analysis of the DWP HEC-HMS model and determined that the 12-hour storm event produced the maximum water surface elevations for the 100-year event throughout the subject reach. As such, the 12-hour storm event was the storm selected to analyze in the HEC-RAS Hydraulic modeling. Hydrographs generated in the HEC-HMS model were input at eleven (11) locations along the reach within the unsteady HEC-RAS hydraulic model. The existing conditions HEC-RAS hydraulic model used in the analysis was developed by CBBEL as part of same LOMR referenced above. CBBEL modified the existing conditions model to develop the four (4) alternatives presented in this report.

1.4 EXISTING CONDITIONS MODEL RESULTS

The level of service of a culvert refers to the storm event which surpasses the conveyance capacity of the culvert and causes the roadway to overtop. Using this criterion, CBBEL determined that the existing 60" CMP culvert at 157th Street has a less-than 10-year level of service, meaning that there is a greater-than 10% chance of 157th Street overtopping in any given year.

The cause of roadway overtopping at 157th Street was found to have three causes: 1) the low elevation of the roadway at the Spring Creek crossing compared to surrounding topography; 2) a restrictive culvert at 157th Street; 3) restrictive culverts downstream of 157th Street which raise water surface elevations further upstream. An annotated HEC-RAS water surface profile is included as the existing conditions profile in **Appendix 3** which shows 157th Street for the 100-year and 10-year storms. A culvert located approximately 0.7 miles downstream of 157th street at a private access drive is shown on the HEC-RAS profile as the most restrictive of the downstream culverts. For the 100-year event, the upstream water surface elevation at the private drive culvert is 2.1-FT higher than the downstream water surface elevation. This restriction propagates upstream to 157th street which is inundated frequently due to its low elevation.

CHAPTER 2 ALTERNATIVES ANALYSIS

This study identifies projects to alleviate flooding on 157th Street. A preliminary analysis by CBBEL determined that there was no feasible alternative to alleviate the inundation of 157th Street without elevating the roadway. Since the low elevation is a primary factor in the frequent inundation of 157th Street, all alternatives presented below involve raising 157th Street approximately 2-FT. Each alternative was modeled as providing a 100-year level of service for 157th Street. The alternatives are summarized in **Table 1** and detailed in the following sections.

Table 1. Alternatives Analysis Summary

Alternative ID	Culverts Improved	Total Stormwater Storage Volume Required	Flood Easements Required	Water Surface Elevation Reduction
1	157 th Street, Private Drive	0.55 AC-FT	0.16 AC	0.3 FT
2	157 th Street, Private Drive	25 AC-FT	N/A	0.5 FT
3	157 th Street	25 AC-FT	N/A	0.2 FT
4 (Preferred)	157th Street	0.55 AC-FT	N/A	N/A

2.1 COMPENSATORY STORAGE

All of the alternatives evaluated include raising the roadway to elevate it above the floodplain. This will necessarily place fill within the floodplain for which compensatory storage must be provided. The quantity of storage required would be determined during project design, however we have preliminarily estimated that approximately 0.75 ac-ft of volume would be required. It may be possible to obtain the required volume within the 157th street right of way. There are other platted rights-of-way without roadways in the floodplain (114th Court, 115th Avenue, 115th Court, 158th Street) that could be excavated to achieve the required volume. There are also many vacant privately-owned parcels within the subdivision that have limited value due to the presence of wetlands and floodplain that could be potential compensatory storage locations. All of these options would be evaluated in a later design stage to determine the most cost-effective compensatory storage scenario. For the purpose of this report, we have included a placeholder budget cost for property acquisition.

2.2 ALTERNATIVE 1

The proposed Alternative 1 improvements are shown on Exhibit 4 and include the following:

- Elevating the minimum elevation of 157th Street from 690.1 to 692.0'
- Compensatory storage to mitigate for floodplain fill associated with raising road
- Replacing the existing 60" CMP culvert at 157th Street with a 7' X 5' reinforced concrete box culvert
- Replacing the CMP Private Drive culvert with a 5' X 5' reinforced concrete box culvert

- Obtaining flood easements downstream of the Private Drive crossing and upstream of Will-Cook Road

Alternative 1 results in approximately 0.3-FT of flood reduction in the Delugah Woods subdivision which is primarily caused by the increased conveyance of the 5' X 5' RCBC at the Private Drive. Downstream of the Private Drive, flows are increased approximately 10-CFS compared to the existing conditions. The increased flows necessitate approximately 0.16 AC of flood easement between Will-Cook Road and the Private Drive, however no additional structures were within the floodplain. The 0.3-FT of flood reduction does not remove any existing structures from the floodplain upstream of 159th Street.

2.3 ALTERNATIVE 2

The proposed Alternative 2 improvements are shown on Exhibit 5 and include the following:

- Elevating the minimum elevation of 157th Street from 690.1 to 692.0'
- Compensatory storage to mitigate for floodplain fill associated with raising road
- Replacing the existing 60" CMP culvert at 157th Street with a 7' X 5' reinforced concrete box culvert
- Replacing the CMP Private Drive culvert with a 5' X 5' reinforced concrete box culvert
- Providing 25 AC-FT of Storage upstream of 157th Street

Alternative 2 results in approximately 0.5-FT of 100-year flood reduction in the Delugah Woods subdivision by increasing conveyance of the 157th Street culvert and the Private Drive culvert. Downstream effects are limited to less than 0.1-FT of water surface increase by the creation of 25 AC-FT of online storage along Spring Creek. This alternative does not remove any existing structures from the floodplain upstream of 159th Street. The alternative provides a 50-year level of protection to a farm access road immediately upstream of 157th Street.

2.4 ALTERNATIVE 3

The proposed Alternative 3 improvements are shown on Exhibit 6 and include the following:

- Elevating the minimum elevation of 157th Street from 690.1 to 692.0'
- Compensatory storage to mitigate for floodplain fill associated with raising road
- Replacing the existing 60" CMP culvert at 157th Street with a 7' X 5' reinforced concrete box culvert
- Providing 25 AC-FT of Storage upstream of 157th Street

Alternative 3 results in an approximately 0.2-FT 100-year flood elevation decrease in the Delugah Woods subdivision resulting from the 25 AC-FT of flood storage provided and the increased conveyance of the 157th Street culvert. The storage provided with Alternative 3 also limits downstream impacts to less than 0.1-FT of water surface elevation increase for the 100-year event. The improvements do not remove any existing structures from the floodplain.

2.5 ALTERNATIVE 4

The proposed Alternative 4 improvements are shown on Exhibit 7 and include the following:

- Elevating the minimum elevation of 157th Street from 690.1 to 692.0'
- Compensatory storage to mitigate for floodplain fill associated with raising road
- Replacing the existing 60" CMP culvert at 157th Street with a 10' X 5' reinforced concrete box culvert

Alternative 4 was designed to eliminate flooding on 157th street for the 100-year event while minimizing disturbance to the surrounding area by limiting the scope of work to 157th Street. In the existing condition overtopping is a significant mode of conveyance of Spring Creek at the 157th Street Crossing. The proposed culvert for Alternative 4 is designed to contain both the existing culvert flows and the existing overtopping flows entirely within the 5' X 10' culvert. Since the cumulative conveyance is matched for the existing and proposed conditions, the extent and elevation of the floodplain is closely matched throughout the studied reach. An annotated HEC-RAS profile of Alternative 4 for the 100-year event is included as the proposed profile in Appendix 3.

A comparison between the existing and proposed water surface elevations for Alternative 4 is presented in Table 2 below.

Table 2. 100-Year Water Surface Elevation Summary

Cross Section	Existing WSE	Proposed WSE	Change in WSE (FT)
Wolf Road	694.75	694.75	0
151st Street. (US)	694.63	694.63	0
151st Street (DS)	692.84	692.84	0
Farm Access Road	691.85	691.91	0.06
157th Street	691.8	691.86	0.06
159th Street	691.75	691.69	-0.06
Juanita Drive	691.58	691.53	-0.05
Private Drive	691.22	691.17	-0.05
Field Access Road	688.95	688.95	0
Will Cook Road	688.34	688.34	0
Downstream Extent	684.7	684.7	0

2.6 PREFERRED ALTERNATIVE

Alternative 4 was chosen as the preferred alternative due to its constructability and benefits to the inundation experienced on 157th Street. It was determined that stormwater storage as proposed in Alternative 2 and Alternative 3 did not provide significant flood elevation benefits. No structures were identified that would benefit from storage that could feasibly be provided near the project area. Alternative 4 was chosen due to it being a lower cost option which provided similar flooding benefits to the other alternatives analyzed. A concept level cost estimate is included in Appendix 4.

CHAPTER 3 CONCLUSION

CBBEL determined Alternative 4 to be the preferred alternative due to the cost effectiveness and practical benefits of the alternative. Alternatives 1, 2, and 3 provide flood elevation benefits in the Delugah Woods subdivision; however, those reductions do not result in structures being removed from the floodplain. As such, the additional cost of storage, flood easements and additional culvert replacements would not provide a functional benefit to the Township.

CHAPTER 4 ADDENDUM 1

Public Outreach and Participation Summary

Christopher B. Burke Engineering, Ltd. (CBBEL) has prepared this addendum to the May 2023 “157th Street Flood Reduction Alternatives Analysis” report to summarize the public outreach and participation aspects of the study. In June of 2022, a total of 249 flood questionnaires were mailed out by CBBEL on behalf of the Orland Township Highway Department (OTHD) to residents in the general study area (northwest of 159th Street and Wolf Road). Of these 249 questionnaires, 14 were returned undeliverable and 13 completed questionnaires were received. The 13 completed questionnaires were reviewed, and in all cases, the flooding described indicated problems that were specific to a single lot and were located on private property. Based on the responses received, Orland Township determined that working on alternatives and solutions that address the historical and chronic flooding of 157th Street would provide the most direct and long-lasting benefits for all residents, whether impacted directly or indirectly by the flooding associated with Spring Creek and the 157th Street culvert.

A public Information Forum for residents was also held on 7/6/23 at the Orland Park Public Library to discuss critical OTHD projects including the flood study and results. Based on the sign in sheet, there were 21 residents, or otherwise interested parties, in attendance at the informational forum. The flyer created and distributed to inform residents about the forum is attached to this addendum.

Additionally, flood study information including the Final Report are posted and publicly available on the OTHD’s website at [Road District of Orland Township | Road District of Orland Township \(orlandroaddistrict.org\)](https://www.roaddistrictoforlandtownship.org).

Orland Road District

*Come hear what your
Highway Department is doing
to support your community*

Open to the Public

Informational Forum Invite

DISCUSSION TOPICS:

Unincorporated Orland Township
Road Pavement Program

ATTENDING SPEAKERS:



Antonio Rubino
Highway Commissioner



Christopher Burke
Engineering

FOR ANY QUESTIONS:

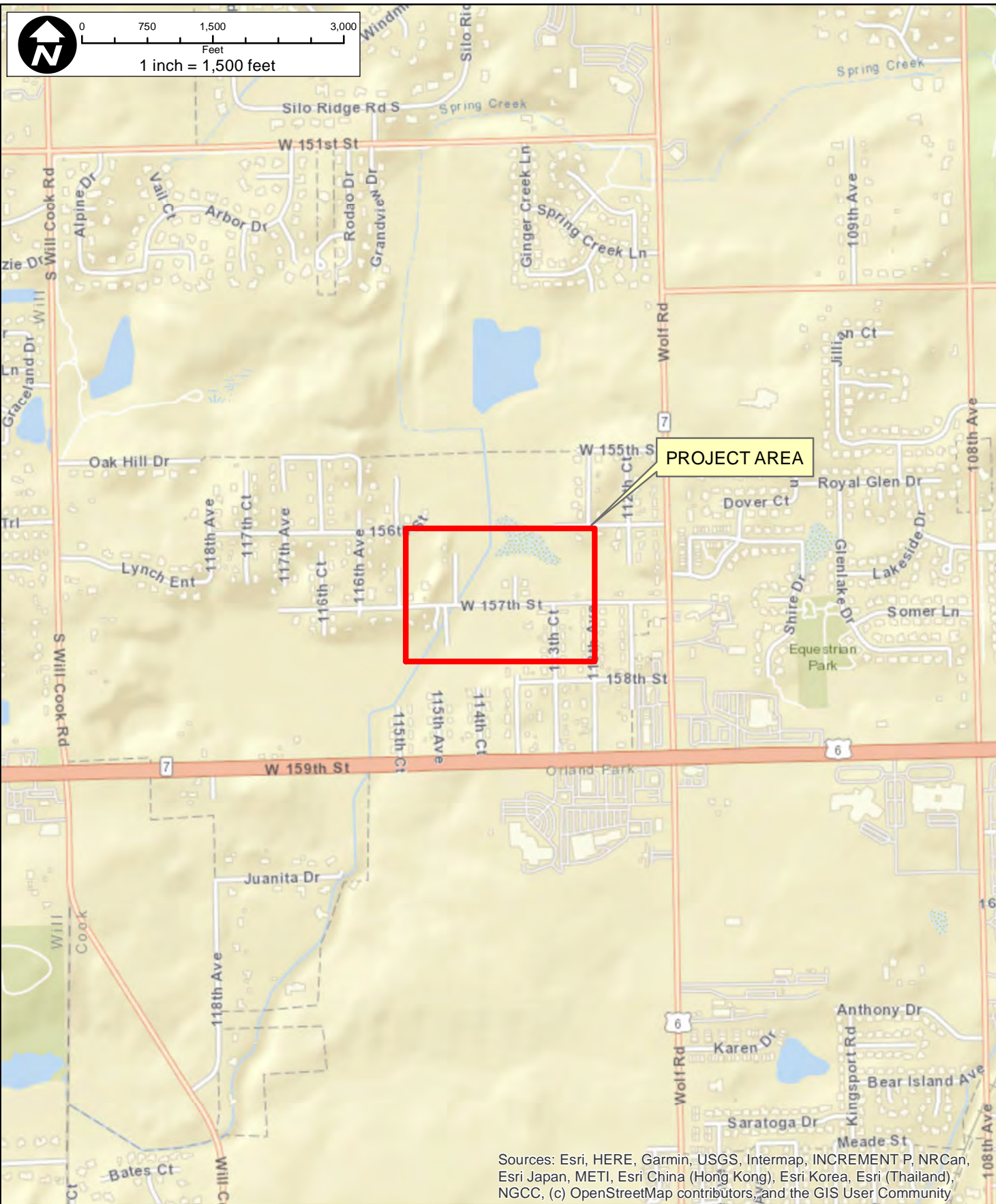
708.403.5148

MEETING DATE:

Thursday,
July 6th 2023
at 6:00PM


MEETING LOCATION:

Orland Park Library
14921 Ravinia Avenue
Orland Park, IL 60462



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Path: N:\ORLANDTOWNSHIP\220268\GIS\Exhibits\EXH_1_LOCMAP.mxd

CLIENT: ORLAND TOWNSHIP	TITLE: LOCATION MAP	PROJ. 220268
		DATE: 06/07/2023
		SHEET 1 OF 1
		DRAWING NO.
 Christopher B. Burke Engineering, Ltd. 9575 West Higgins Road, Suite 600, Rosemont, IL 60018 (847) 823-0500 FAX (847) 823-0520	DSGN.	
	DWN. JKV	
	CHKD. -	
	FILE: EXH_1_LOCMAP	
	SCALE: 1:0	
	AUTHOR:	
	PLOT DATE:	6/7/2023
		EXH 1

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or flood plain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or flood plain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

In the State of Illinois, any portion of a stream or watercourse that lies within the **floodway fringe** of a studied (AE) stream may have a state regulated floodway. The FIRM may not depict these state regulated floodways.

Floodways restricted by anthropogenic features such as bridges and culverts are drawn to reflect natural conditions and may not agree with the model computed widths listed in the Floodway Data table in the Flood Insurance Study report.

Multiple **topographic sources** may have been used in the delineation of Special Flood Hazard Areas. See Flood Insurance Study report for details on source resolution and geographic extent.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 16. The horizontal datum was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services, NOAA, NNGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey. Digital orthorectification with a spatial resolution of 0.3 meter ground sample distance were photogrammetrically compiled from aerial photography acquired during the leaf-off period of spring 2005.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The Special Flood Hazard Areas and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

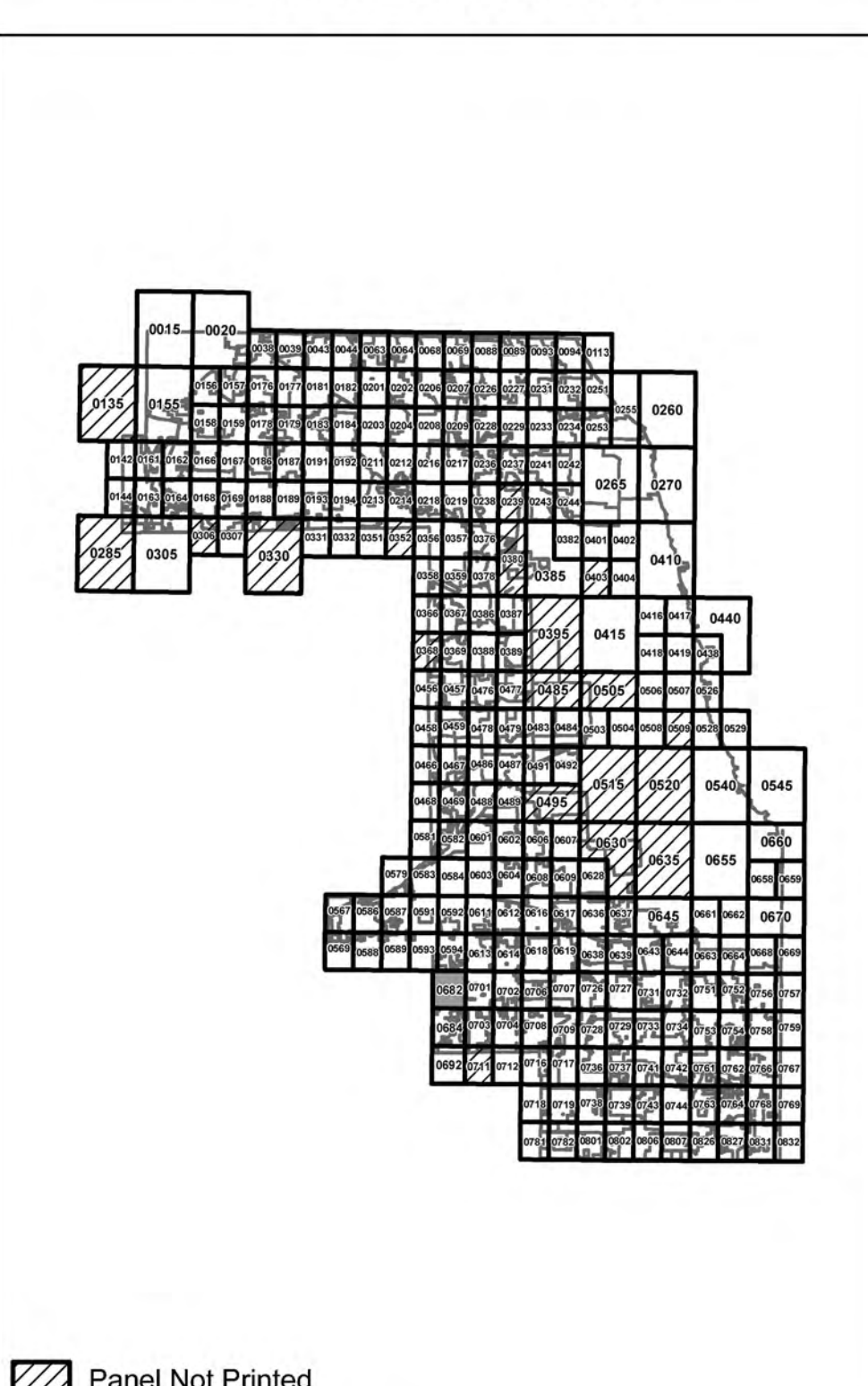
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital version of this map. The FEMA Map Service Center may also be reached by fax at 1-800-358-9620 and its website at www.msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at www.fema.gov/business/infr/.

PANEL INDEX



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equalled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE AE
No Base Flood Elevations determined. Base Flood Elevations determined. Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined. Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR
Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently identified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99
Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined. Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE V
Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE
Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X
Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE D
Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
Base Flood Elevation line and value; elevation in feet*
Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A - Cross section line
23 - Transact line
45° 02' 08" 93° 02' 12" - Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4989000 N - 5000-foot grid tick; Illinois State Plane East Coordinate System, 3776 zone (FIPSZONE 1201) Transverse Mercator
1565000 FT - 5000-foot grid tick; Illinois State Plane East Coordinate System, 3776 zone (FIPSZONE 1201) Transverse Mercator
DX5510x - Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 - River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
NOVEMBER 6, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
December 20, 2002; February 4, 2004; June 2, 2005; December 16, 2005; November 16, 2006; and April 16, 2007

August 19, 2008 - to reflect updated topographic information, to update corporate limits, to add road names, to incorporate previously issued Letters of Map Revision, to change Base Flood Elevations, to add Special Flood Hazard Areas and Base Flood Elevations, and to change zone designations.

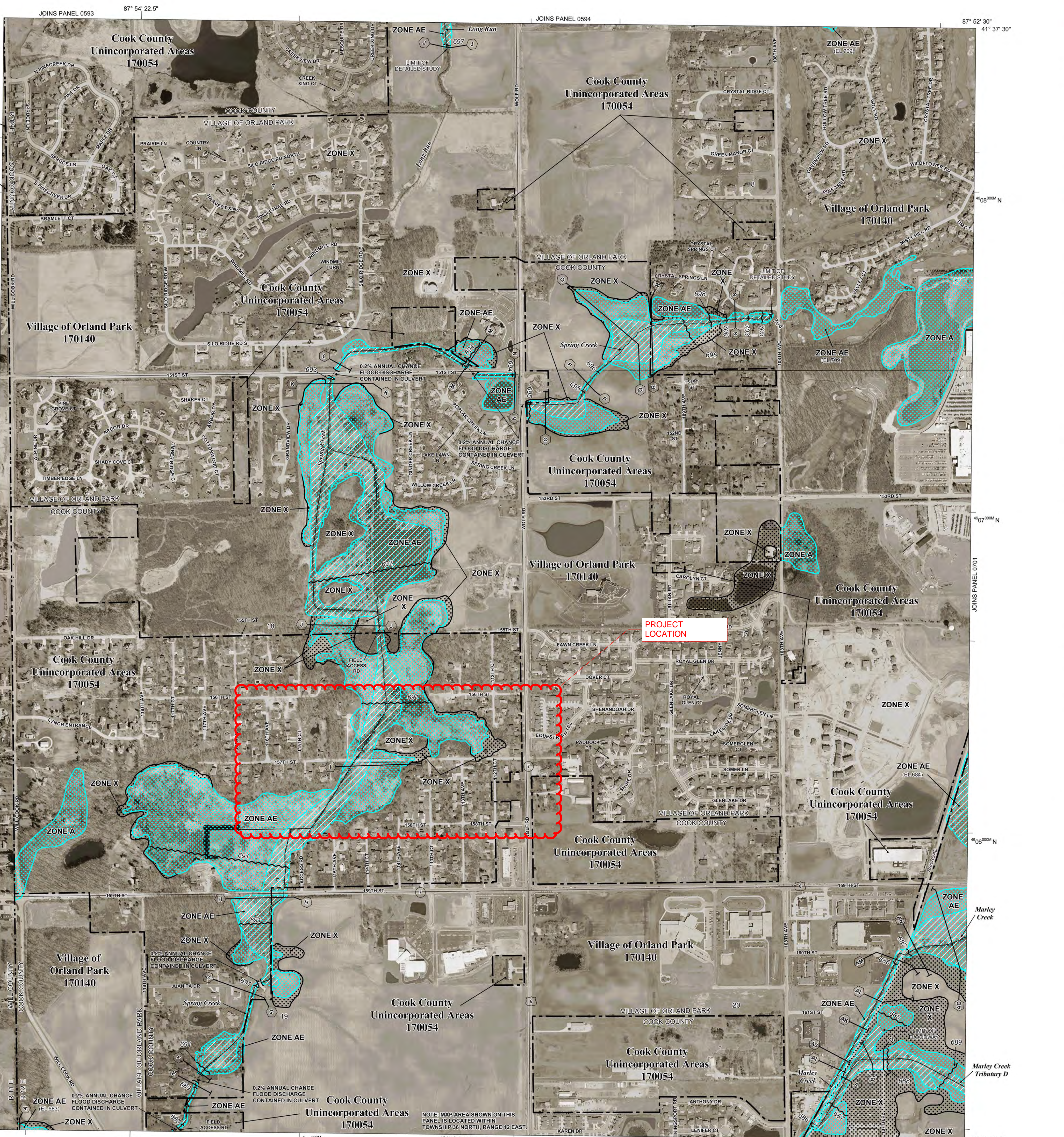
For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

FLOOD HAZARD INFORMATION IS NOT SHOWN ON THIS MAP IN AREAS OUTSIDE OF COOK COUNTY



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0682J

FIRM
FLOOD INSURANCE RATE MAP
COOK COUNTY,
ILLINOIS
AND INCORPORATED AREAS

PANEL 682 OF 832
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

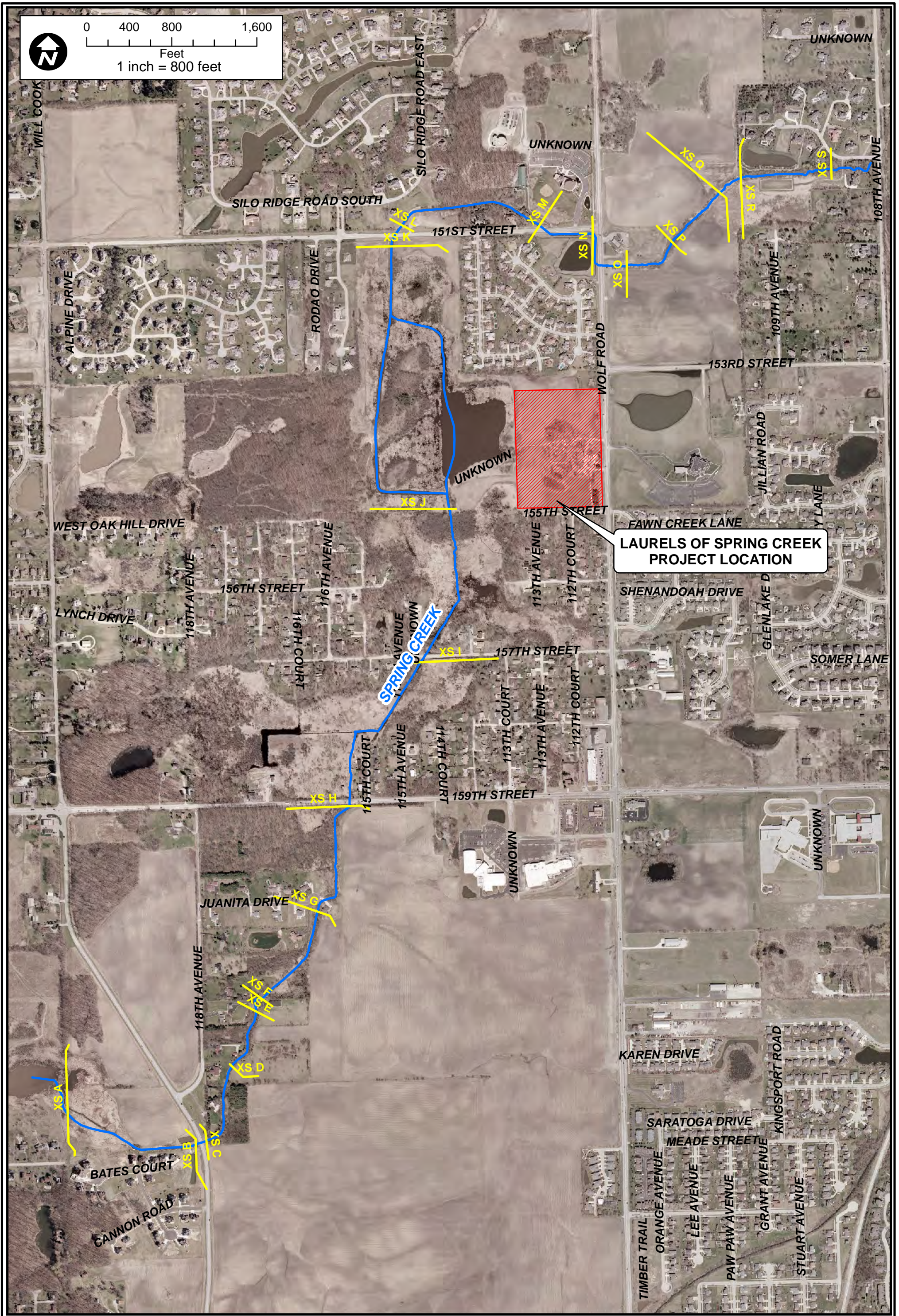
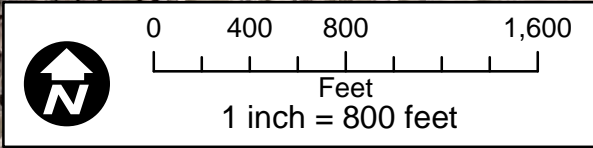
COMMUNITY	NUMBER	PANEL	SUFFIX
COOK COUNTY	170054	0682	J
ORLAND PARK, VILLAGE OF	170140	0682	J

NOTE TO USER: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
17031C0682J

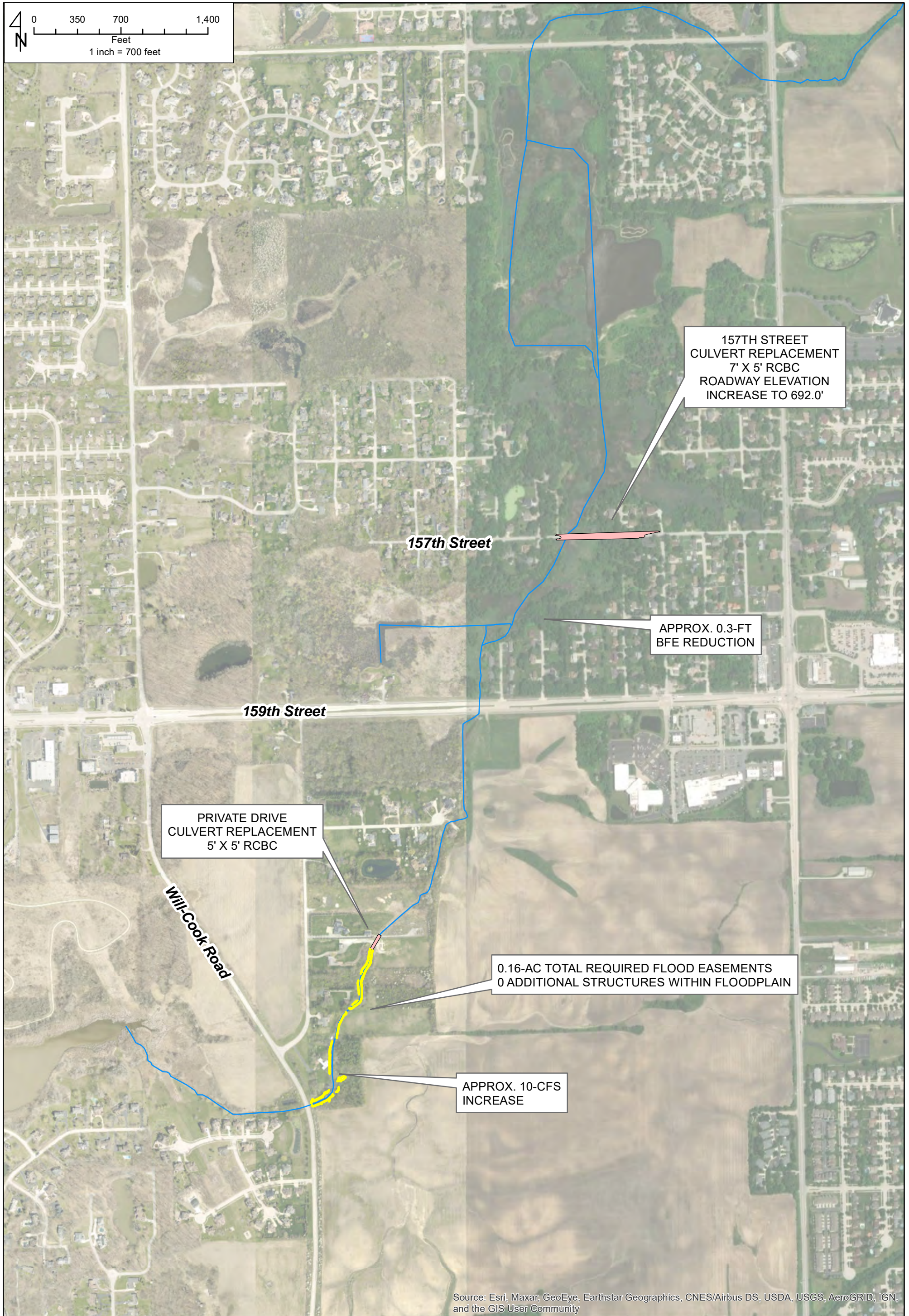
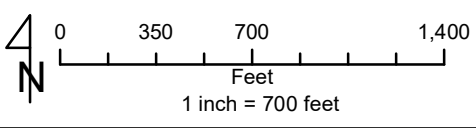
MAP REVISED
AUGUST 19, 2008

Federal Emergency Management Agency



**LAURELS OF SPRING CREEK
PROJECT LOCATION**

<p>CHRISTOPHER B. BURKE ENGINEERING LTD. 9575 West Higgins Road, Suite 600 Rosemont, Illinois 60018 (847) 823-0500</p>	CLIENT	ORLAND TOWNSHIP	PROJECT NO.	220268	DSGN.	MJB	CHKD.	JJJ		
	TITLE	SPRING CREEK LOMR CROSS SECTION LOCATION MAP							DATE	2/15/16
									EX3	



157TH STREET
CULVERT REPLACEMENT
7' X 5' RCBC
ROADWAY ELEVATION
INCREASE TO 692.0'

157th Street

APPROX. 0.3-FT
BFE REDUCTION

159th Street


PRIVATE DRIVE
CULVERT REPLACEMENT
5' X 5' RCBC

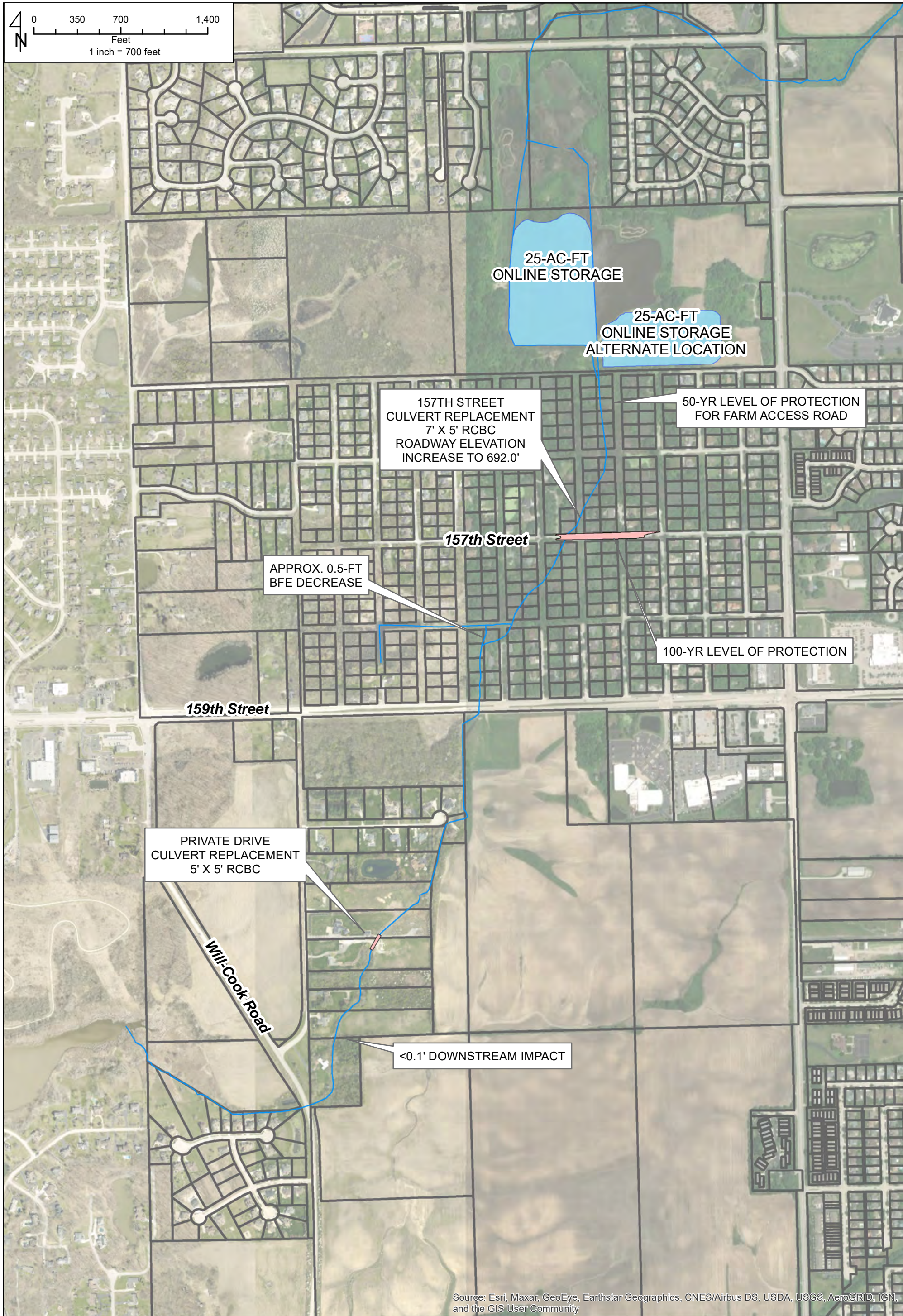
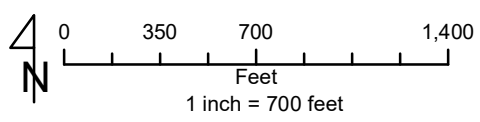
Will-Cook Road

0.16-AC TOTAL REQUIRED FLOOD EASEMENTS
0 ADDITIONAL STRUCTURES WITHIN FLOODPLAIN


APPROX. 10-CFS
INCREASE

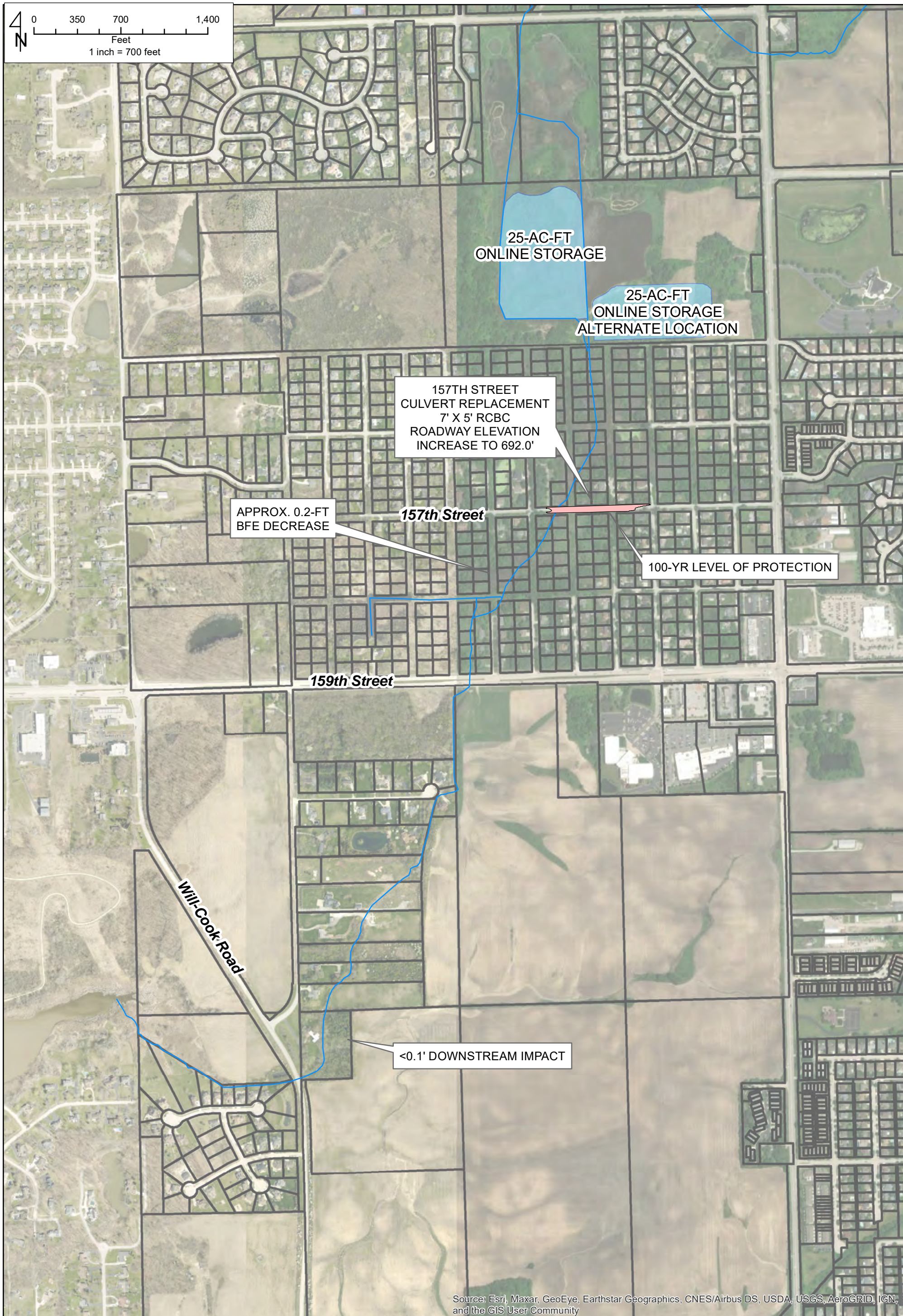
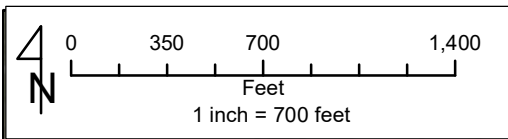
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

CLIENT: ORLAND TOWNSHIP		TITLE: ALTERNATIVE 1		PROJ. NO. 220268
				DATE: 5/16/2023
 Christopher B. Burke Engineering, Ltd 9575 W. Higgins Rd, Suite 600 • Rosemont, IL 60018 • (847) 823-0500	DSGN.		SCALE:	1:0
	DWN.	JKV	AUTHOR:	
	CHKD.		PLOT DATE:	5/16/2023
	FILE:	N:\ORLANDTOWNSHIP\220268\GIS\Exhibits\ALT1_1.mxd		
				SHEET 1 OF 1
				DRAWING NO.
				EXH 1




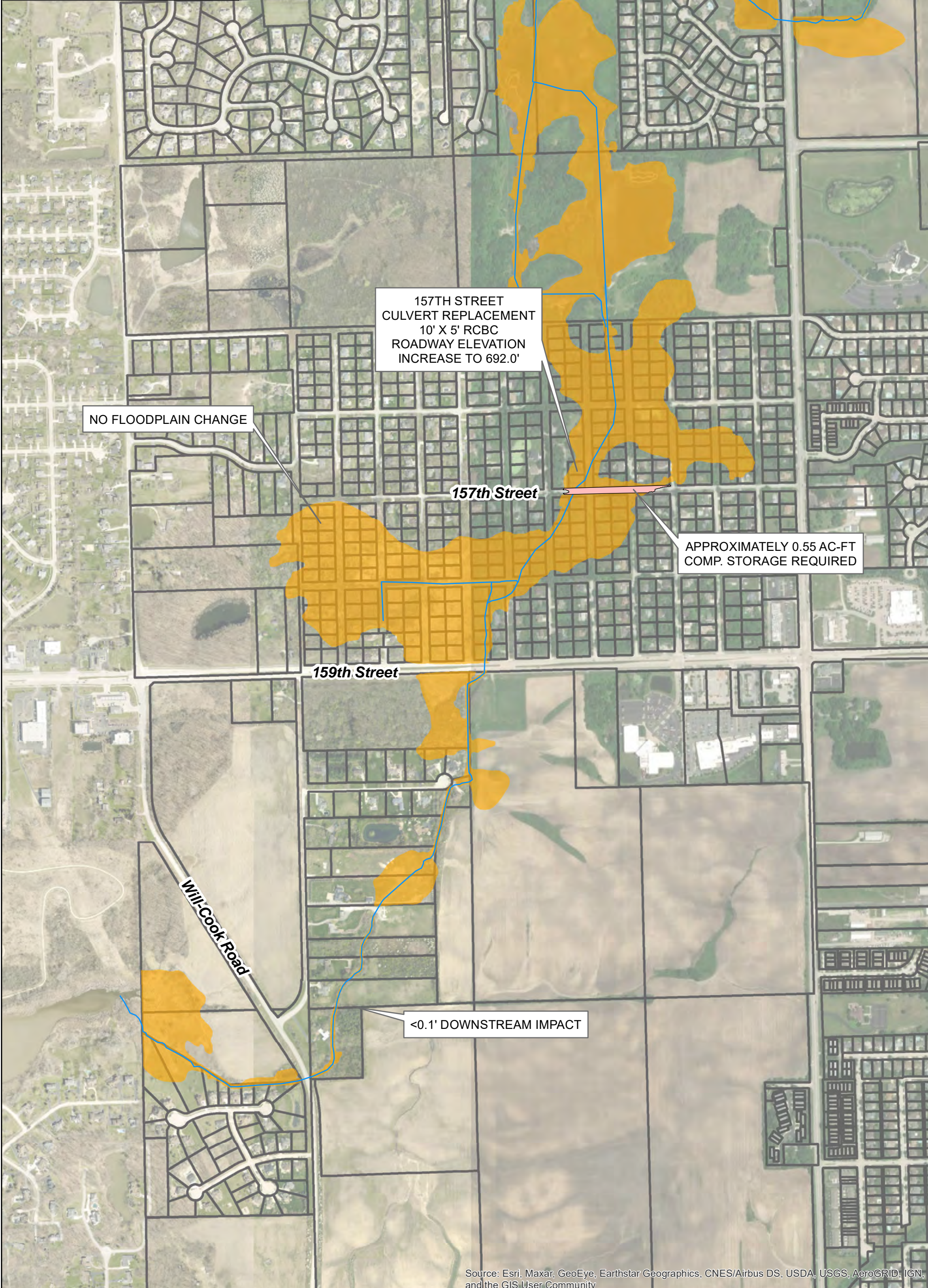
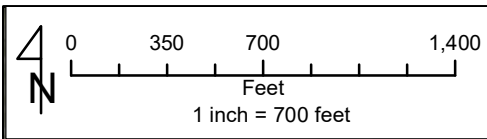
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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				DATE: 5/16/2023
 Christopher B. Burke Engineering, Ltd 9575 W. Higgins Rd, Suite 600 • Rosemont, IL 60018 • (847) 823-0500	DSGN.		SCALE:	1:0
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	CHKD.		PLOT DATE:	5/16/2023
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				SHEET 1 OF 1
				DRAWING NO. EXH 2




Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

CLIENT: ORLAND TOWNSHIP		TITLE: ALTERNATIVE 3		PROJ. NO. 220268
				DATE: 5/16/2023
 Christopher B. Burke Engineering, Ltd 9575 W. Higgins Rd, Suite 600 • Rosemont, IL 60018 • (847) 823-0500	DSGN.		SCALE:	1:0
	DWN.	JKV	AUTHOR:	
	CHKD.		PLOT DATE:	5/16/2023
	FILE:	N:\ORLANDTOWNSHIP\220268\GIS\Exhibits\ALT3.mxd		
				SHEET 1 OF 1
				DRAWING NO.
				EXH 3



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

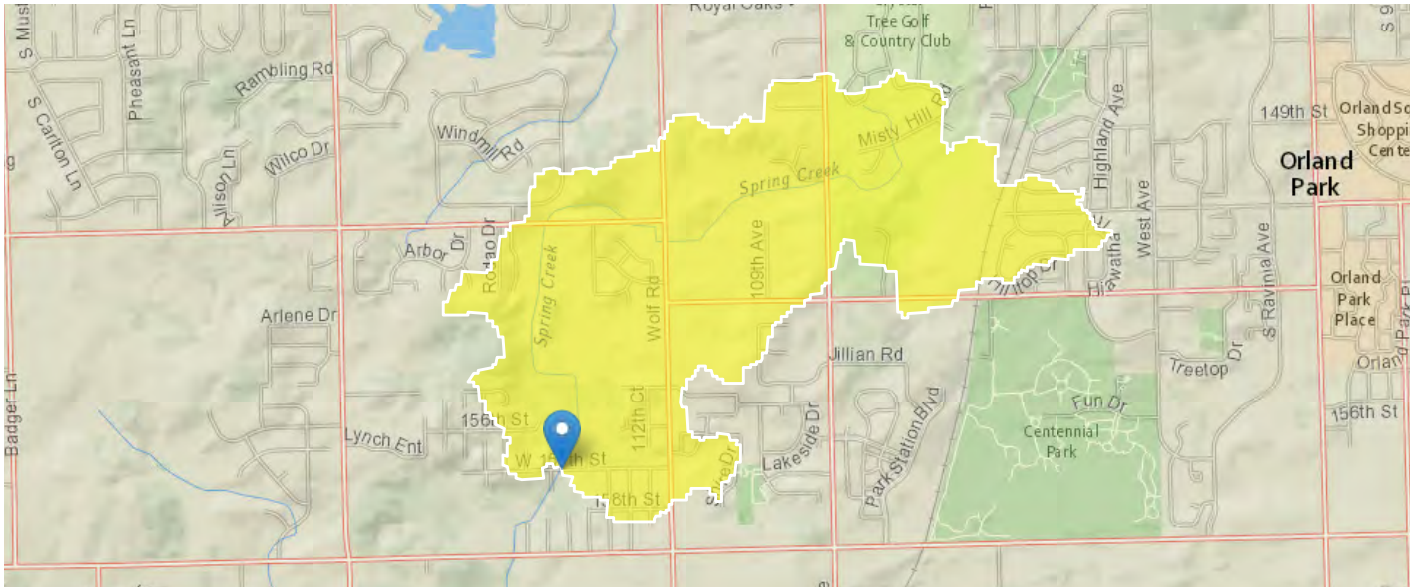
CLIENT: ORLAND TOWNSHIP	TITLE: ALTERNATIVE 4	PROJ. NO. 220268	
		DATE: 5/16/2023	
 Christopher B. Burke Engineering, Ltd 9575 W. Higgins Rd, Suite 600 • Rosemont, IL 60018 • (847) 823-0500	DSGN.	SCALE: 1:0	SHEET 1 OF 1
	DWN. JKV	AUTHOR:	DRAWING NO.
	CHKD.	PLOT DATE: 5/16/2023	
	FILE:	N:\ORLANDTOWNSHIP\220268\GIS\Exhibits\ALT4.mxd	

APPENDIX 1

USGS STREAMSTATS REPORT

StreamStats - Spring Creek at 157th Street

Region ID: IL
Workspace ID: IL20230607142244689000
Clicked Point (Latitude, Longitude): 41.60426, -87.89781
Time: 2023-06-07 09:23:07 -0500



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.29	square miles
FLC11DVLHM	Fraction of drainage area that is in low to high developed land-use classes 22-24 from NLCD 2011	0.627	decimal fraction
FSSURGDC78	Fraction of land area that is in very poorly drained and unknown likely water drainage classes 7 and 8 from SSURGO	0.233	decimal fraction
RELRELF	Basin relief divided by basin perimeter	8.03	feet per mi

Bankfull Statistics

Bankfull Statistics Parameters [Interior Plains D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.29	square miles	0.19305	59927.7393

Bankfull Statistics Parameters [Central Lowland P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.29	square miles	0.200772	59927.66594

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.29	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Interior Plains D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	12.8	ft
Bieger_D_channel_depth	1.57	ft
Bieger_D_channel_cross_sectional_area	24.3	ft^2

Bankfull Statistics Flow Report [Central Lowland P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	14.7	ft
Bieger_P_channel_depth	1.93	ft
Bieger_P_channel_cross_sectional_area	23.4	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	13.5	ft
Bieger_USA_channel_depth	1.27	ft
Bieger_USA_channel_cross_sectional_area	19.6	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	12.8	ft
Bieger_D_channel_depth	1.57	ft
Bieger_D_channel_cross_sectional_area	24.3	ft^2
Bieger_P_channel_width	14.7	ft
Bieger_P_channel_depth	1.93	ft
Bieger_P_channel_cross_sectional_area	23.4	ft^2
Bieger_USA_channel_width	13.5	ft
Bieger_USA_channel_depth	1.27	ft
Bieger_USA_channel_cross_sectional_area	19.6	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G., 2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages)

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

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USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.15.0

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

APPENDIX 2

CBBEL LOMR REPORT FOR SUBJECT REACH



**Federal Emergency Management Agency
Letter of Map Revision Request
Spring Creek**

Orland Park, Cook County, Illinois

Prepared for

Village of Orland Park
14700 Ravinia Avenue
Orland Park, IL 60462

August 2016

Revised: February 2019

Prepared by

Christopher B. Burke Engineering, Ltd.
9575 West Higgins Road, Suite 600
Rosemont, IL 60007



CBBEL Project No. 15-0582

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- Table 3 – Hydraulic Model Summary Table

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- Exhibit 2A Cook County FIRM Panel 682
- Exhibit 2B Cook County FIRM Panel 684
- Exhibit 3 Subbasin Map
- Exhibit 4 Hydraulic Exhibit
- Exhibit 5 Annotated FIRM

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- Appendix 2 Hydrologic Calculations
- Appendix 3 FEMA FIS Information
- Appendix 4 FEMA MT-2 Forms
- Appendix 5 Digital Deliverables
- Appendix 6 MWRDGC Detailed Watershed Plan for the Calumet-Sag Channel Watershed

PROJECT OVERVIEW

INTRODUCTION

On behalf of the Village of Orland Park (Village), Christopher B. Burke Engineering Ltd. (CBBEL) has prepared this report to summarize the results of updated hydrologic and hydraulic modeling for Spring Creek through the Village (Exhibit 1) in support of a Federal Emergency Management Agency (FEMA) Letter of Map Revision (LOMR). The Village has requested the latest hydraulic model be used to update the regulatory flood mapping so any future development along Spring Creek can accurately account for flood risk. According to the FEMA effective Flood Insurance Map (FIRM) Panels 682 and 684 of 832 for Cook County, Illinois and Incorporated Areas, Spring Creek is mapped as studied Zone AE floodplain (Exhibit 2). The FIRM indicates that floodway is delineated and the FEMA Flood Insurance Study (FIS) shows that Spring Creek has a tributary area of 2.3 square miles at 118th Avenue which is just upstream of the county boundary.

The effective regulatory models obtained from the Illinois State Water Survey (ISWS) consist of a HEC-1 hydrologic model and WSP-2 hydraulic model both developed by CWR Consultants Inc. (CWR) as part of LOMR completed in 2000. The hydraulic model begins just downstream of 108th avenue and ends at the Will-Cook County boundary. The next section describes the updated analysis using current modeling in support of a LOMR for Spring Creek through the Village.

PROJECT APPROACH

The Village would like to update the Spring Creek regulatory flood mapping with the latest, most accurate modeling available for Spring Creek. In 2009, the Metropolitan Water Reclamation District of Greater Chicago (MWRD) completed its Detailed Watershed Plan for the Calumet-Sag Channel Watershed (DWP). As part of this study, a new HEC-HMS hydrologic model and a HEC-RAS unsteady-state hydraulic model were developed for Spring Creek. CBBEL is proposing to use these models in the LOMR request.

Spring Creek has many inline storage areas behind culvert crossings that attenuate flows along the reach. In traditional hydrologic and steady-state hydraulic modeling, these storage areas would be input into the hydrologic model to represent the flow attenuation and then generate the resultant maximum flowrate. Conversely, when performing unsteady-state hydraulic modeling, the hydrologic model is setup without inline storage areas. Hydrographs generated from the hydrologic model are input into the unsteady-state hydraulic model at specified locations and the attenuation from the inline storage areas are represented directly in the unsteady-state hydraulic model. Due to the difficulty with trying to define a floodway using unsteady-state hydraulic modeling, CBBEL is proposing to use the maximum resultant flows from the unsteady-state hydraulic model and input them into a steady-state hydraulic model at representative locations. The steady-state hydraulic model would then be the new effective model from which to define the floodway.

HYDROLOGIC MODELING

Model parameters for the HEC-HMS hydrologic model were generated using HEC-GeoHMS. 14 subbasins with an average drainage area of 118 acres drain to Spring Creek. SCS Curve Numbers (CN) and Time of Concentrations (Tc) were uniquely generated for each subbasin and are described in Table 1 below. A more detailed discussion of the hydrologic modeling is included in the MWRD DWP (Appendix 6).

Table 1 – Hydrologic Parameters Summary

Subbasin ID	Area (ac)	CN	Tc (min)
W610	103.2	84.4	22.7
W560	107.7	78.2	15.5
W510	110.4	79.9	20.8
W460	121.4	83.6	20.8
W450	118.0	80.5	18.8
W360	131.7	80.7	37.7
W280	79.6	82.7	16.8
W270	68.4	82.6	14.4
W260	107.1	83.1	38.6
W250	174.4	79.2	22.3
W240	114.0	72.0	19.3
W800	174.5	76.5	29.8
W700	132.9	75.4	34.8
W760	115.1	77.8	17.5

Hydrographs generated in the HEC-HMS model were input at eleven (11) locations along the reach within the unsteady HEC-RAS hydraulic model. A 100-year critical duration analysis was performed which determined that the 12-hour storm produced the maximum flows on average throughout the reach. The 12-hour critical duration is the same as the current HEC-1 effective hydrologic model. The critical duration analysis is summarized in Table 2.

Table 2 – Critical Duration Analysis Summary

Location	XS ID	Storm Event			
		6-hour	12-hour	18-hour	24-hour
Downstream Limit	482.8005	352.3	361.2	356.0	388.1
Will Cook Rd	1799.666	260.1	271.7	264.6	248.9
159th St	5556.618	102.3	113.3	116.3	117.7
151st St	12001.15	169.9	176.9	177.9	171.2
Wolf Rd	14406.13	138.1	145.5	145.4	141.3

HYDRAULIC MODELING

FLOODPLAIN

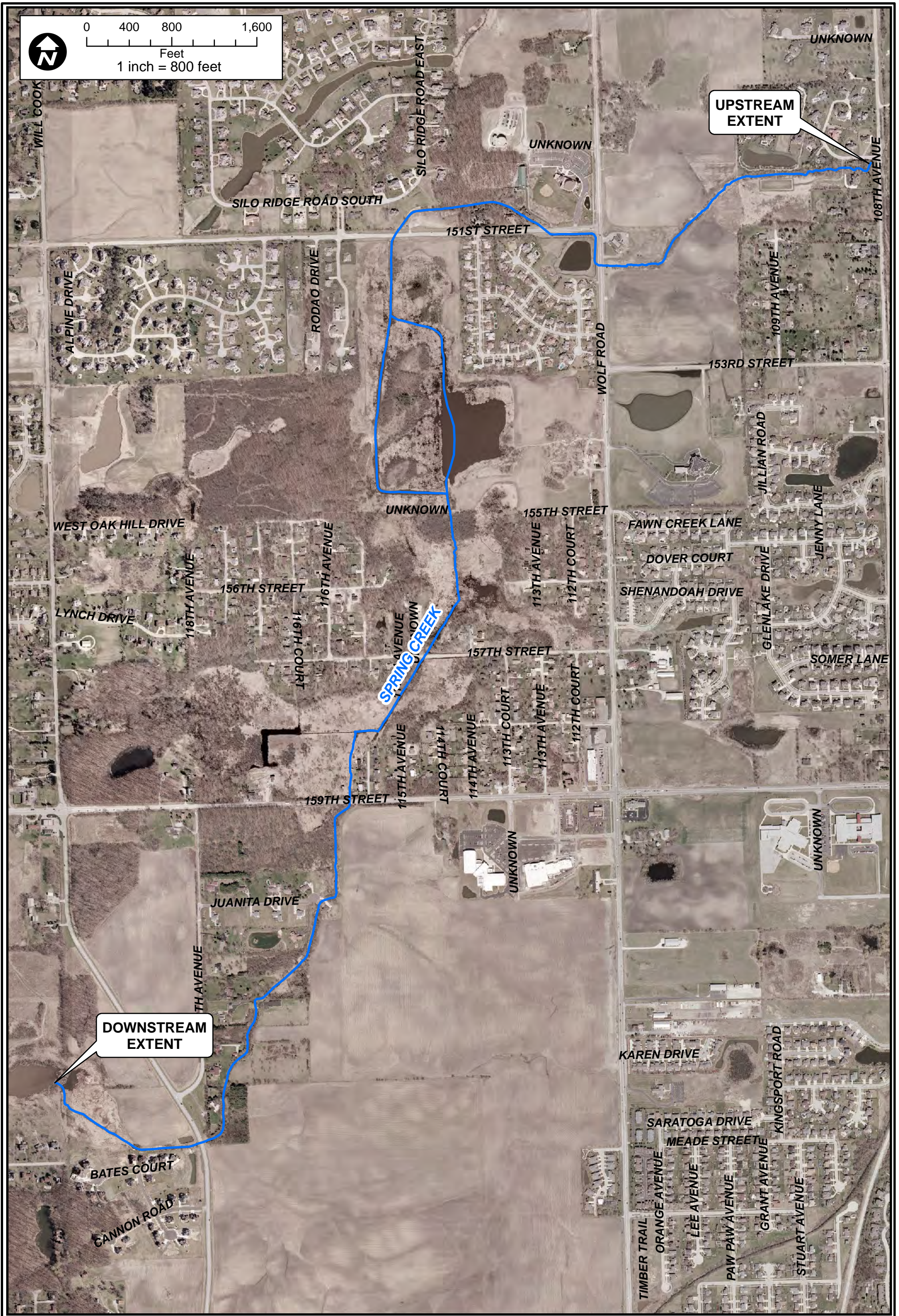
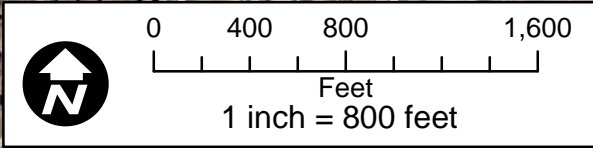
A steady-state hydraulic model was developed based on the same model geometry used in the unsteady HEC-RAS model. Eleven (11) flow change locations were determined at appropriate locations based on significant changes in flow along the reach shown for the 100-year storm (Appendix 2). 100-year flows were input into the HEC-RAS model and the resulting flood profile was compared to the current regulatory flood profile and summarized in Table 2 below. Cross-section locations are shown on the attached Exhibit 4. Modeling analyses for the 10-, 50-, and 500-year flood events have been performed and are provided in Appendix 1.

Table 3 – Hydraulic Model Summary Table

FIS XS	FIS Q (cfs)	FIS WSEL	CBBEL HEC-RAS Station	CBBEL Q (cfs)	Current CBBEL WSEL	Difference (Current CBBEL - FIS)
S	67	700.7	16983.37	69	698.96	-1.74
R	98	695.8	16024.4	86	695.12	-0.68
Q	98	695.8	15850.19	86	695.11	-0.69
P	139	695.3	15212.53	86	694.94	-0.36
O	139	694.7	14457.09	145	694.85	0.15
Wolf Road						
N	148	693.9	13981.41	153	694.76	0.86
151st Street (Upstream Crossing)						
M	183	693.6	13453.85	179	694.57	0.97
L	183	693.1	12019.91	179	692.81	-0.29
151st Street (Downstream Crossing)						
K	144	692.8	11831.4	179	692.61	-0.19
J	144	691.4	8722.829	131	691.81	0.41
155th Street						
157th Street						
I	97	691.3	7193.714	117	691.78	0.48
159th Street						
H	105	691.1	5490.413	113	691.63	0.53
Jaunita Drive						
G	105	690.9	4346.582	113	691.28	0.38
F	105	690.8	3331.113	113	691.22	0.42
Private Drive						
E	105	689.4	3196.567	100	688.68	-0.72
Field Access Road						
D	107	688.4	2582.291	100	687.79	-0.61
C	259	686.7	1799.666	304	687.55	0.85
Will-Cook Road						
B	259	685.2	1670.018	304	686.97	1.77
A	738	682.9	482.8005	361	684.71	1.81

FLOODWAY

A new floodway was determined using IDNR-OWR floodway construction criteria where the floodway boundaries were encroached to maintain 90% of the floodplain storage, limit velocity increases to 10% and limit water surface elevation increases to 0.1 feet. The revised floodway data tables are included in Appendix 1. The revised floodway was then scaled onto the annotated FIRM as shown on Exhibit 5.



CHRISTOPHER B. BURKE ENGINEERING LTD. 9575 West Higgins Road, Suite 600 Rosemont, Illinois 60018 (847) 823-0500	CLIENT	VILLAGE OF ORLAND PARK	PROJECT NO.	15-0582	DSGN.	MJB	CHKD.	JJJ
	TITLE	SPRING CREEK LOCATION MAP			DATE	2/15/16		

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or flood plain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or flood plain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

In the State of Illinois, any portion of a stream or watercourse that lies within the **floodway fringe** of a studied (AE) stream may have a state regulated floodway. The FIRM may not depict these state regulated floodways.

Floodways restricted by anthropogenic features such as bridges and culverts are drawn to reflect natural conditions and may not agree with the model computed widths listed in the Floodway Data table in the Flood Insurance Study report.

Multiple **topographic sources** may have been used in the delineation of Special Flood Hazard Areas. See Flood Insurance Study report for details on source resolution and geographic extent.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 16. The horizontal datum was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services, NOAA, NNGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey. Digital orthorectified imagery with a spatial resolution of 0.3 meter ground sample distance was photogrammetrically compiled from aerial photography acquired during the leaf-off period of spring 2005.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The Special Flood Hazard Areas and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

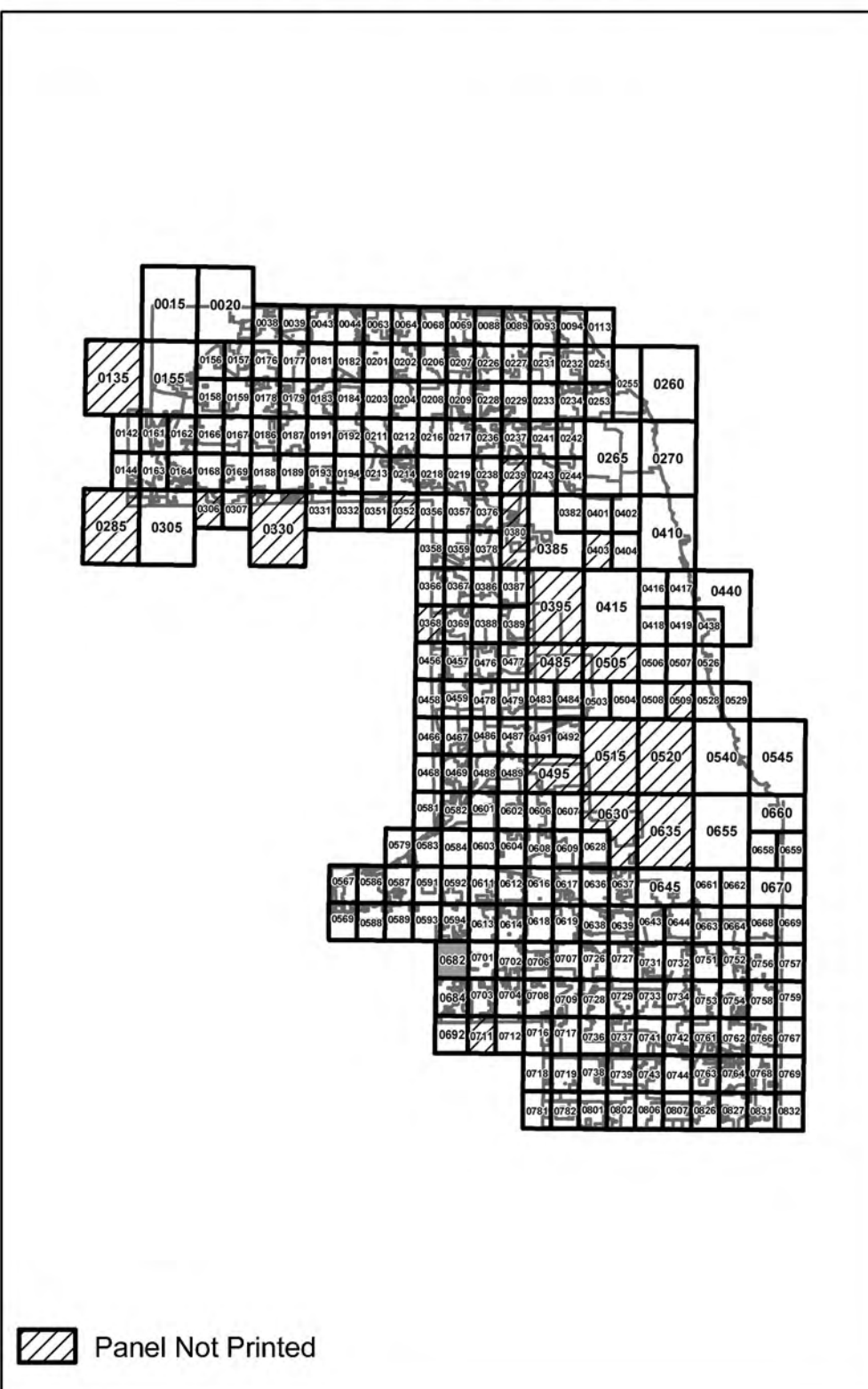
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital version of this map. The FEMA Map Service Center may also be reached by fax at 1-800-358-9620 and its website at www.msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at www.fema.gov/business/nfip/.

PANEL INDEX



Panel Not Printed

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equalled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE AE** No Base Flood Elevations determined. Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently determined. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE D Areas determined to be outside the 0.2% annual chance floodplain.

Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Base Flood Elevation line and value; elevation in feet*

Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A - Cross section line

23 - Transact line

45° 02' 08" 93' 02' 12" - Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4997000 N - 1000-meter Universal Transverse Mercator grid values, zone 16

1565000 FT - 5000-foot grid tick; Illinois State Plane East Coordinate System, 3776 zone (FIPSZONE 1201) Transverse Mercator

DX5510x - Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 - River Mile

MAP REPOSITORIES - Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP - NOVEMBER 6, 2000

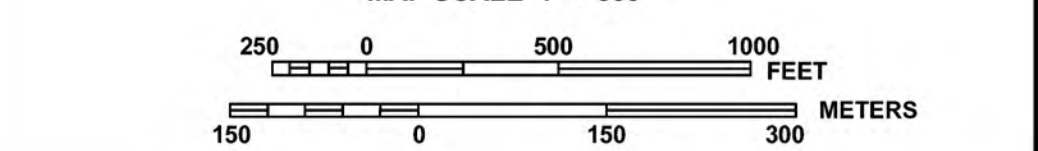
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL - December 20, 2002; February 4, 2004; June 2, 2005; December 16, 2005; November 16, 2006; and April 16, 2007

August 19, 2008 - to reflect updated topographic information, to update corporate limits, to add road names, to incorporate previously issued Letters of Map Revision, to change Base Flood Elevations, to add Special Flood Hazard Areas and Base Flood Elevations, and to change zone designations.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0682J

FIRM FLOOD INSURANCE RATE MAP COOK COUNTY, ILLINOIS AND INCORPORATED AREAS

PANEL 682 OF 832
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COOK COUNTY	170054	0682	J
ORLAND PARK, VILLAGE OF	170140	0682	J

Notes to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER 17031C0682J

MAP REVISED AUGUST 19, 2008

Federal Emergency Management Agency

Panel Not Printed

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or flood plain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or flood plain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

In the State of Illinois, any portion of a stream or watercourse that lies within the **floodway fringe** of a studied (AE) stream may have a state regulated floodway. The FIRM may not depict these state regulated floodways.

Floodways restricted by anthropogenic features such as bridges and culverts are drawn to reflect natural conditions and may not agree with the model computed widths listed in the Floodway Data table in the Flood Insurance Study report.

Multiple **topographic sources** may have been used in the delineation of Special Flood Hazard Areas. See Flood Insurance Study report for details on source resolution and geographic extent.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 16. The horizontal datum was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services, NOAA, NNGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the United States Geological Survey. Digital orthorectified imagery with a spatial resolution of 0.3 meter ground sample distance were photogrammetrically compiled from aerial photography acquired during the leaf-off period of spring 2005.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The Special Flood Hazard Areas and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

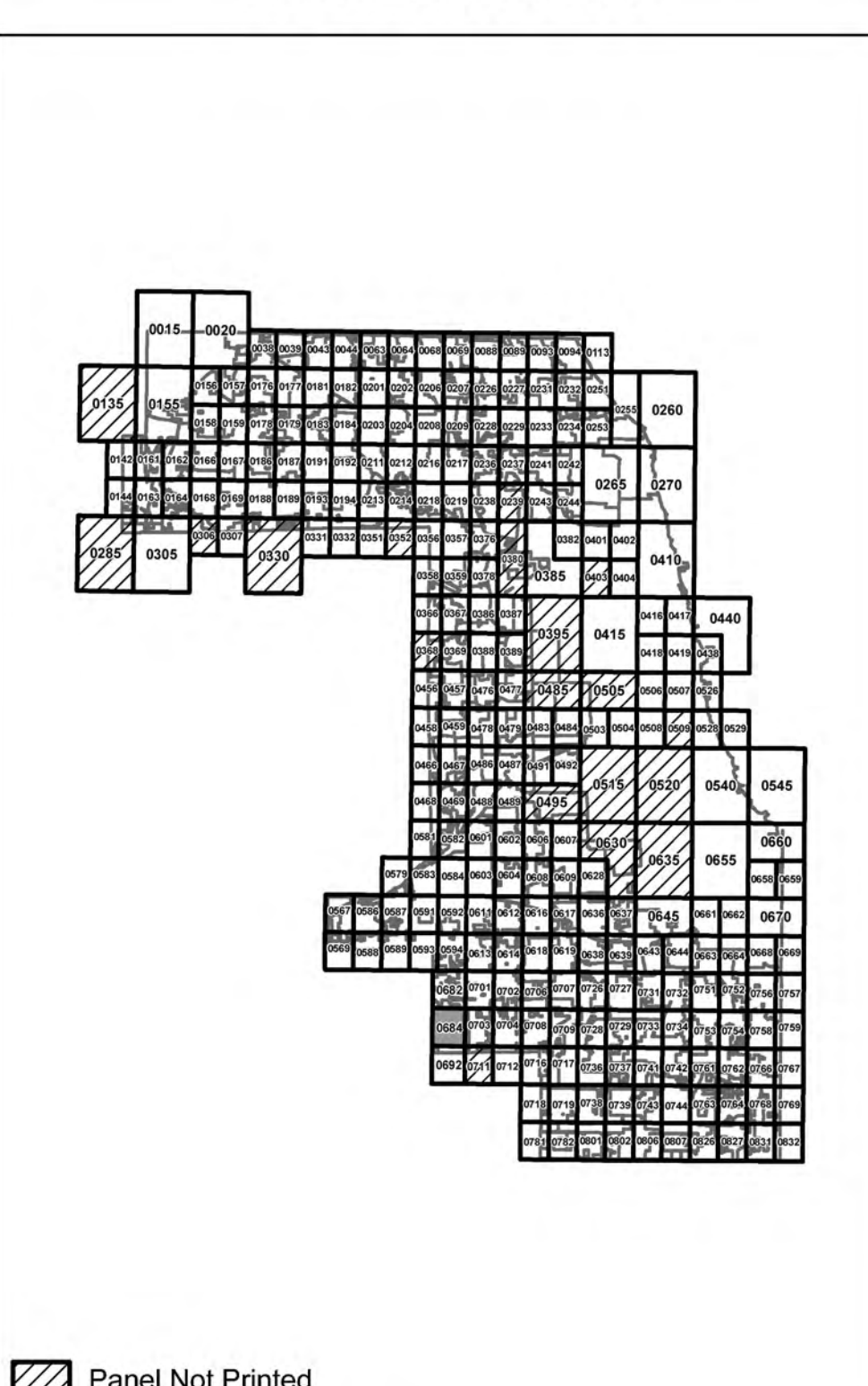
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

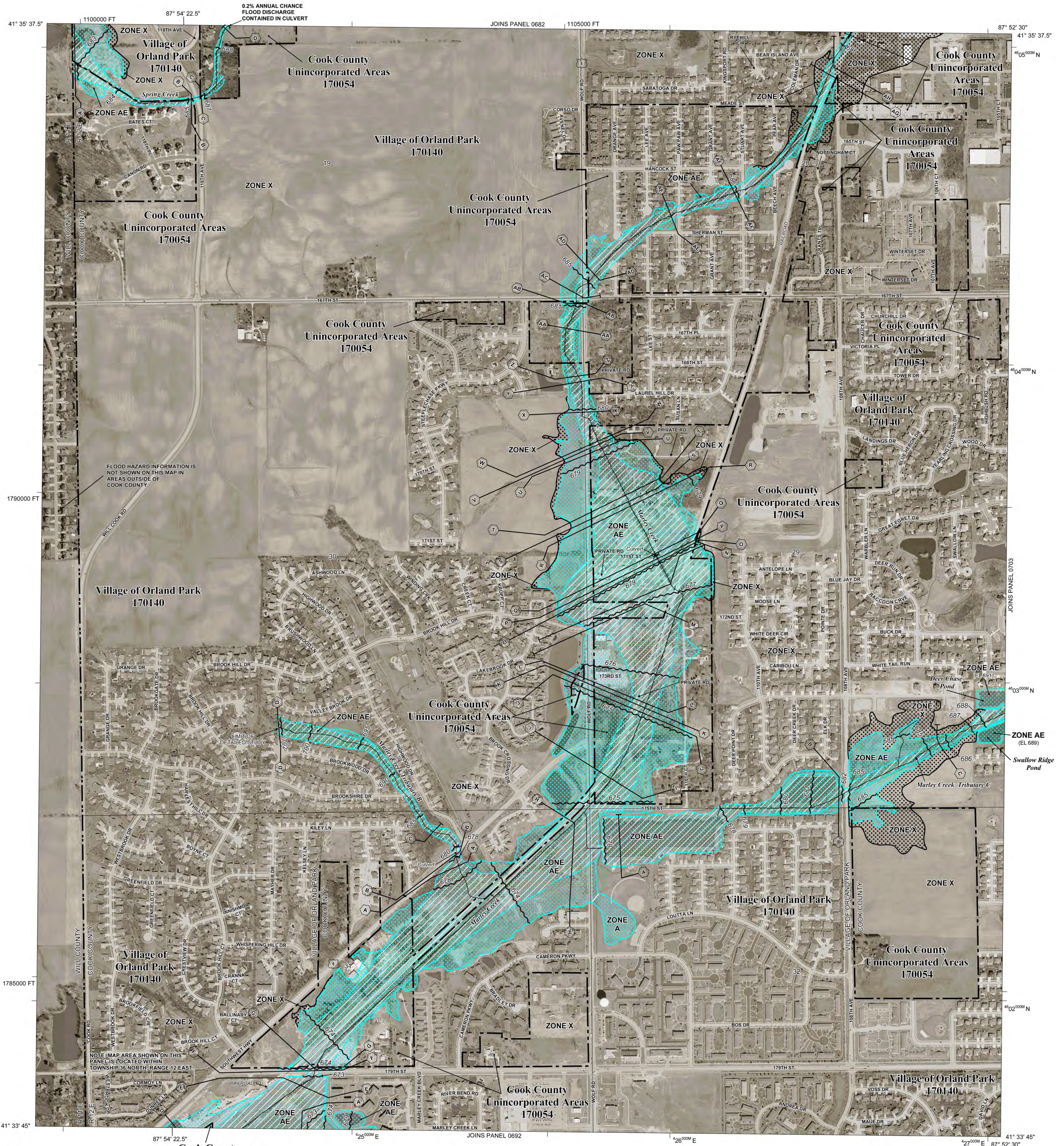
Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital version of this map. The FEMA Map Service Center may also be reached by fax at 1-800-358-9620 and its website at www.msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at www.fema.gov/business/info/.

PANEL INDEX



Panel Not Printed



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined. Base Flood Elevations determined.

ZONE AE Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently derelictified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined. Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Base Flood Elevation line and value; elevation in feet*

Base Flood Elevation value where uniform within zone; elevation in feet*

(EL 987)

*Referenced to the North American Vertical Datum of 1988

A Cross section line

23 Transsect line

45° 02' 08" 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

4990000 N 1000-meter Universal Transverse Mercator grid values, zone 16

1565000 FT 5000-foot grid tick; Illinois State Plane East Coordinate System, 3776 zone (FIPS ZONE 1201) Transverse Mercator

DX5510x Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 River Mile

MAP REPOSITORIES

Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

NOVEMBER 6, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

December 20, 2002; February 4, 2004; June 2, 2005; December 16, 2005; November 16, 2006; and April 16, 2007

August 19, 2008 - to reflect updated topographic information, to update corporate limits, to add road names, to incorporate previously issued Letters of Map Revision, to change Base Flood Elevations, to add Special Flood Hazard Areas and Base Flood Elevations, and to change zone designations.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0684J

FIRM

FLOOD INSURANCE RATE MAP

COOK COUNTY, ILLINOIS

AND INCORPORATED AREAS

PANEL 684 OF 832

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

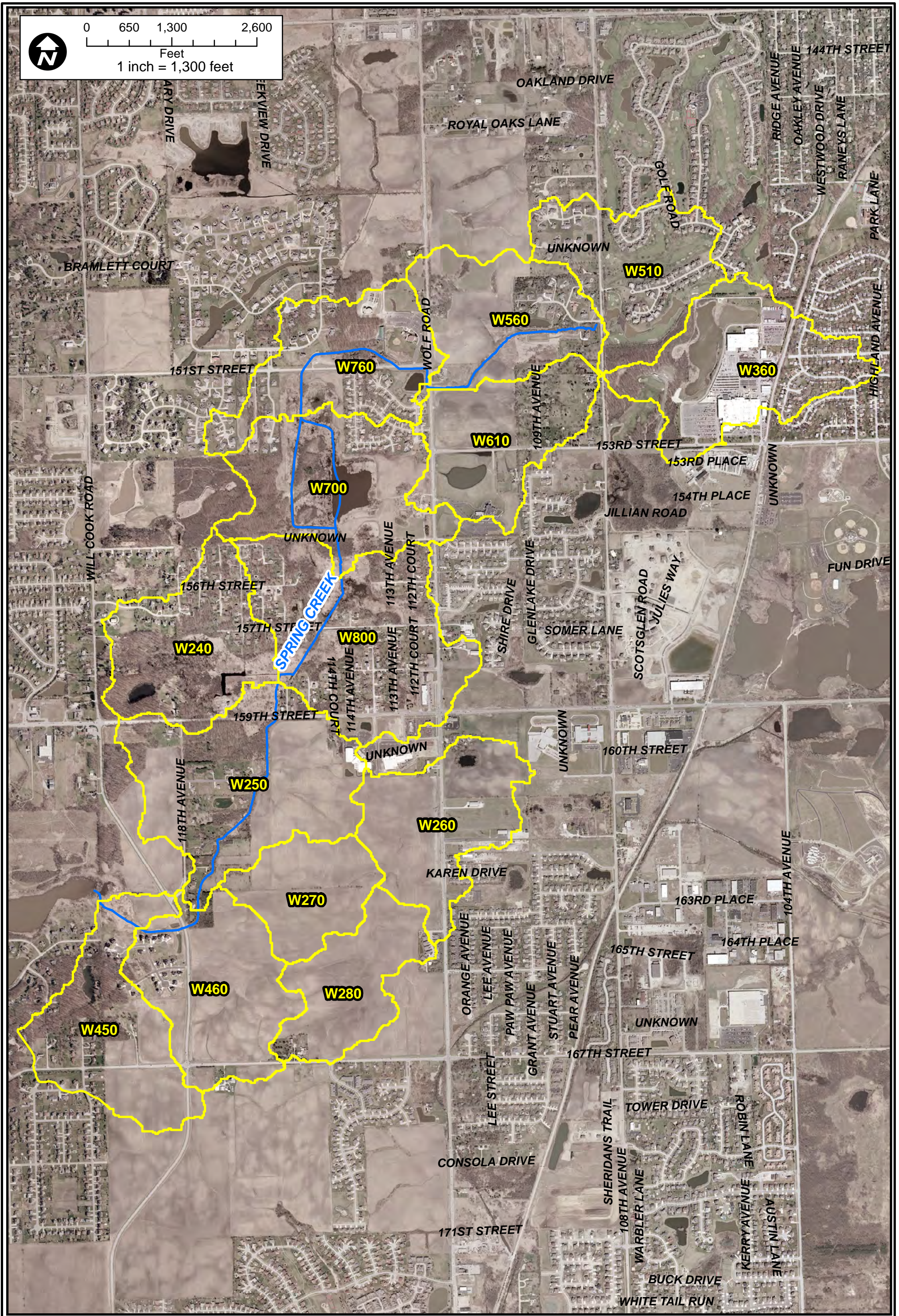
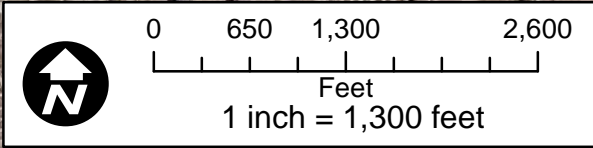
COMMUNITY	NUMBER	PANEL	SUFFIX
COOK COUNTY	170054	0684	J
ORLAND PARK, VILLAGE OF	170140	0684	J

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

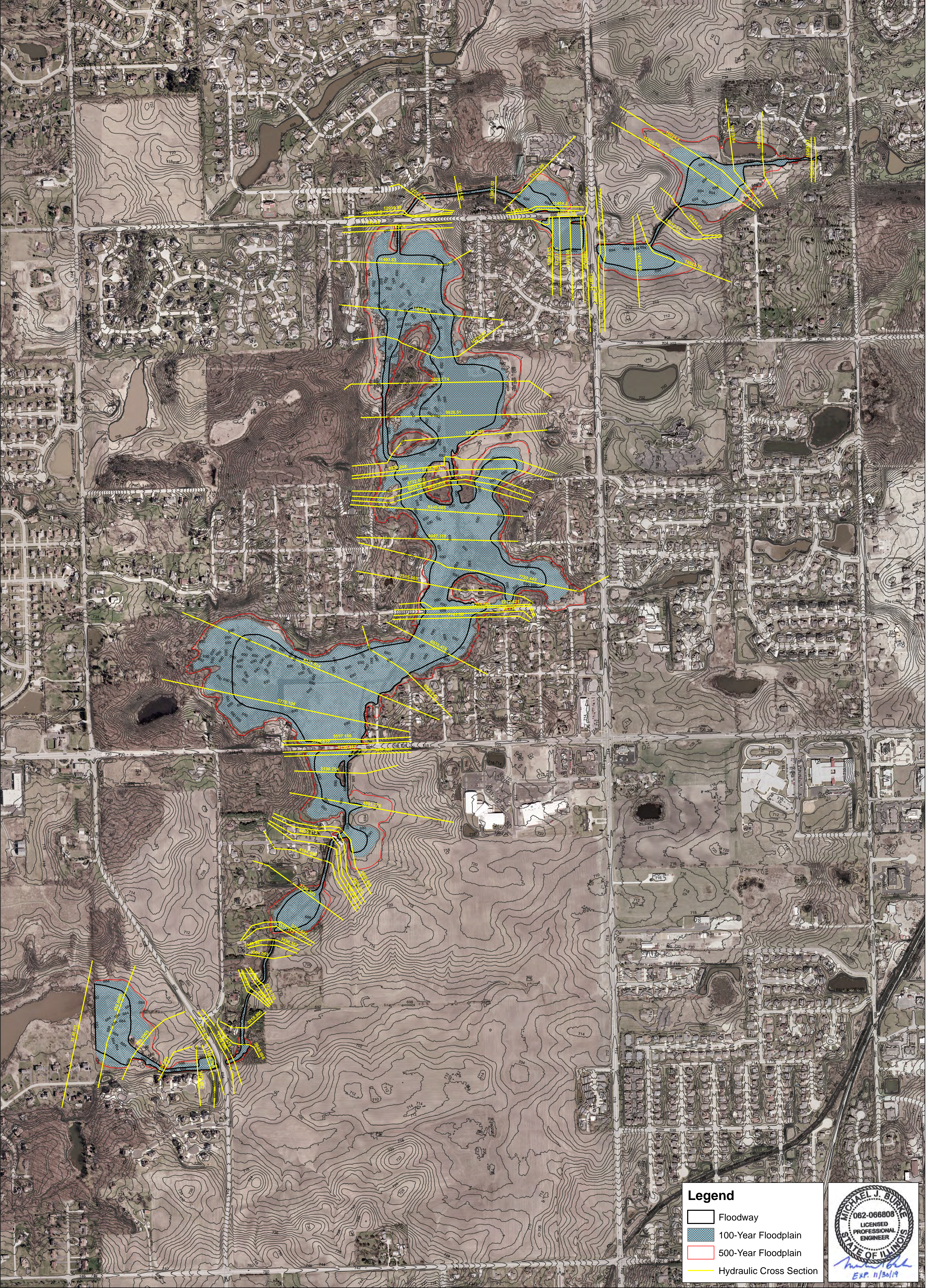
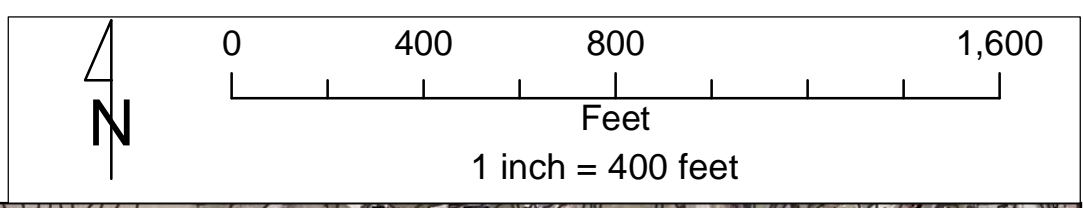
MAP NUMBER
17031C0684J

MAP REVISED
AUGUST 19, 2008

Federal Emergency Management Agency



CHRISTOPHER B. BURKE ENGINEERING LTD. 9575 West Higgins Road, Suite 600 Rosemont, Illinois 60018 (847) 823-0500	CLIENT	VILLAGE OF ORLAND PARK	PROJECT NO.	15-0582	DSGN.	MJB	CHKD.	JJJ
	TITLE	SPRING CREEK SUBBASIN MAP			DATE	8/31/18		



Legend

- Floodway
- 100-Year Floodplain
- 500-Year Floodplain
- Hydraulic Cross Section

MICHAEL J. BURKE
062-066808
LICENSED
PROFESSIONAL
ENGINEER
STATE OF ILLINOIS

Michael J. Burke
EXP. 11/30/19

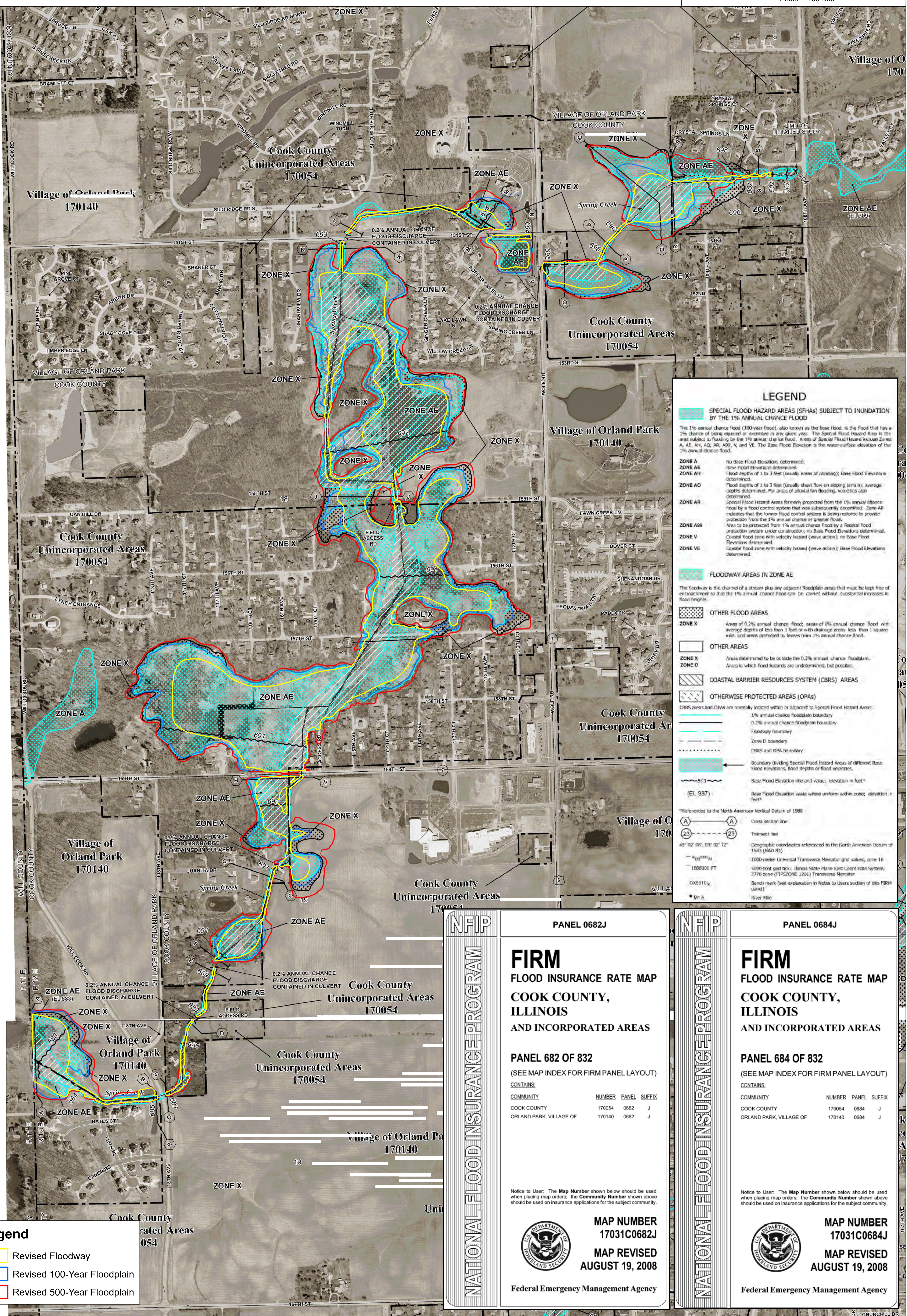
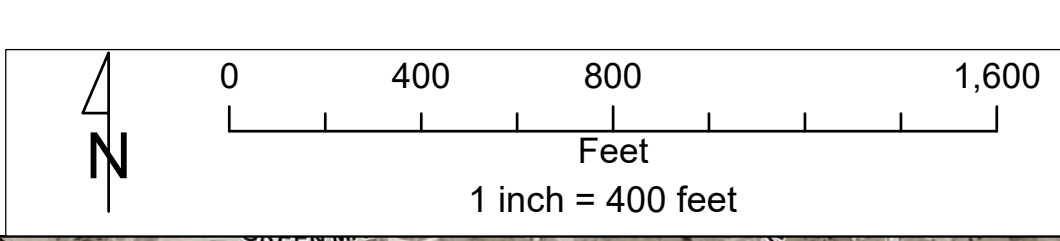
CHRISTOPHER B. BURKE ENGINEERING LTD.
9575 West Higgins Road, Suite 600
Rosemont, Illinois 60018
(847) 823-0500

CLIENT:
VILLAGE OF ORLAND PARK

1	02/13/19	PE STAMP & DOWNSTREAM EDITS	DSN.	MJB
			CHKD.	JJJ
			SCALE	
			GIS USER	
No.	DATE	NATURE OF REVISION	MODEL	ArcGIS 9.2
FILE NAME:				
DATE:		05/06/16		

TITLE:
*SPRING CREEK
HYDRAULIC EXHIBIT*

PROJ. NO. 15-0225
SHEET 1 OF 1
DRAWING NO.
EX 4



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined; Base Flood Elevations determined.

ZONE AE Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AO Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently determined. Zone AO indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE AR Areas to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE A99 Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone A boundary
Zone AE boundary
CBRS and OPA boundary
Boundary linking Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Base Flood Elevation line and value; elevation in feet¹
(EL 987)

Base Flood Elevation value where uniform within zone; elevation in feet¹

¹Referenced to the North American Vertical Datum of 1988

Cross section line
Transect line

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
1665000 FT
1000-meter Universal Transverse Mercator grid values, zone 16
5000-foot grid ticks; Illinois State Plane East Coordinate System, 3776 zone (FIPSZONE 1201) Transverse Mercator
Bench mark (see explanation in Notes to Users section of this FIRMP panel)
M 1.5
River Mile

NFIP

PANEL 0682J

FIRM
FLOOD INSURANCE RATE MAP
COOK COUNTY,
ILLINOIS
AND INCORPORATED AREAS

PANEL 682 OF 832
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COOK COUNTY	170054	0682	J
ORLAND PARK, VILLAGE OF	170140	0682	J

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

MAP NUMBER
17031C0682J
MAP REVISED
AUGUST 19, 2008

Federal Emergency Management Agency

NFIP

PANEL 0684J

FIRM
FLOOD INSURANCE RATE MAP
COOK COUNTY,
ILLINOIS
AND INCORPORATED AREAS

PANEL 684 OF 832
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COOK COUNTY	170054	0684	J
ORLAND PARK, VILLAGE OF	170140	0684	J

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

MAP NUMBER
17031C0684J
MAP REVISED
AUGUST 19, 2008

Federal Emergency Management Agency

Legend

- Revised Floodway
- Revised 100-Year Floodplain
- Revised 500-Year Floodplain

CHRISTOPHER B. BURKE ENGINEERING LTD.
9575 West Higgins Road, Suite 600
Rosemont, Illinois 60018
(847) 823-0500

CLIENT: **VILLAGE OF ORLAND PARK**

No.	DATE	NATURE OF REVISION	DSN.	MJB	TITLE:
	02/13/19	DOWNSTREAM EDITS	CHKD.	JJJ	
			SCALE		
			GIS USER		
			MODEL	ArcGIS 9.2	
FILE NAME:					
DATE:		05/17/16			

SPRING CREEK
ANNOTATED FIRM

PROJ. NO. 15-0582
SHEET 1 OF 1
DRAWING NO. EX 5

Appendix 1
Hydraulic Modeling Summary Tables

FLOODWAY RESULTS TABLE

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main

Reach	River Sta	Profile	Top Width (ft)	W.S. Elev (ft)	Area (sq ft)	Vel Total (ft/s)
Main	17035.08	100-YR	20.44	699.31	28.27	2.44
Main	17035.08	Floodway	20.44	699.31	28.27	2.44
Main	16983.37	100-YR	16.81	698.96	18.26	3.78
Main	16983.37	Floodway	16.81	698.96	18.26	3.78
Main	16899.4*	100-YR	17.45	698.31	18.49	3.73
Main	16899.4*	Floodway	17.45	698.31	18.49	3.73
Main	16815.4*	100-YR	17.95	697.65	18.53	3.72
Main	16815.4*	Floodway	17.95	697.65	18.53	3.72
Main	16731.5*	100-YR	18.49	696.99	18.77	3.68
Main	16731.5*	Floodway	18.49	696.99	18.77	3.68
Main	16647.5*	100-YR	18.90	696.32	18.60	3.71
Main	16647.5*	Floodway	18.90	696.32	18.60	3.71
Main	16563.6*	100-YR	19.20	695.74	20.13	3.43
Main	16563.6*	Floodway	19.21	695.74	20.15	3.42
Main	16479.65	100-YR	20.84	695.48	27.42	2.52
Main	16479.65	Floodway	20.86	695.48	27.45	2.51
Main	16403.7*	100-YR	26.84	695.35	34.31	2.01
Main	16403.7*	Floodway	26.86	695.35	34.37	2.01
Main	16327.7*	100-YR	39.63	695.26	42.54	1.62
Main	16327.7*	Floodway	33.68	695.27	42.51	1.62
Main	16251.7*	100-YR	122.38	695.21	63.41	1.09
Main	16251.7*	Floodway	98.29	695.21	59.46	1.16
Main	16175.84	100-YR	192.14	695.16	102.23	0.84
Main	16175.84	Floodway	166.39	695.16	94.68	0.91
Main	16100.*	100-YR	143.40	695.12	92.52	0.93
Main	16100.*	Floodway	126.81	695.12	87.86	0.98
Main	16024.40	100-YR	595.71	695.12	420.15	0.24
Main	16024.40	Floodway	464.99	695.12	400.85	0.25
Main	15850.19	100-YR	700.51	695.11	622.51	0.16
Main	15850.19	Floodway	540.00	695.11	583.13	0.17
Main	15434.41	100-YR	19.93	695.01	54.88	1.57
Main	15434.41	Floodway	19.93	695.01	54.92	1.57
Main	15212.53	100-YR	21.26	694.94	62.31	1.38
Main	15212.53	Floodway	21.27	694.94	62.35	1.38

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main (Continued)

Reach	River Sta	Profile	Top Width (ft)	W.S. Elev (ft)	Area (sq ft)	Vel Total (ft/s)
Main	14922.76	100-YR	432.27	694.92	502.15	0.40
Main	14922.76	Floodway	337.78	694.93	459.11	0.40
Main	14774.58	100-YR	325.76	694.89	418.90	0.55
Main	14774.58	Floodway	266.56	694.90	382.77	0.55
Main	14457.09	100-YR	219.32	694.85	316.04	0.64
Main	14457.09	Floodway	175.72	694.85	290.76	0.64
Main	14406.13	100-YR	140.46	694.84	301.17	0.64
Main	14406.13	Floodway	100.46	694.84	273.88	0.64
Main	14204.08		Culvert			
Main	13981.41	100-YR	32.88	694.76	154.62	1.03
Main	13981.41	Floodway	32.89	694.76	154.69	1.03
Main	13949.59	100-YR	325.68	694.75	1370.05	1.12
Main	13949.59	Floodway	287.37	694.75	1241.85	1.12
Main	13839.56	100-YR	351.53	694.74	1466.90	1.03
Main	13839.56	Floodway	313.35	694.74	1329.57	1.03
Main	13732.13	100-YR	365.00	694.75	1188.71	0.38
Main	13732.13	Floodway	331.88	694.75	1075.03	0.41
Main	13662.15	100-YR	261.68	694.73	239.07	0.80
Main	13662.15	Floodway	222.09	694.73	217.55	0.80
Main	13628.36	100-YR	205.13	694.73	238.97	0.86
Main	13628.36	Floodway	145.69	694.73	220.38	0.86
Main	13536.36		Culvert			
Main	13453.85	100-YR	333.16	694.57	399.70	1.08
Main	13453.85	Floodway	272.58	694.58	360.29	1.08
Main	13414.20	100-YR	346.75	694.56	377.63	0.93
Main	13414.20	Floodway	274.00	694.57	348.71	0.93
Main	13217.08	100-YR	174.43	694.44	169.00	1.32
Main	13217.08	Floodway	150.54	694.44	155.50	1.32
Main	13001.02	100-YR	23.89	694.13	80.14	2.23
Main	13001.02	Floodway	23.89	694.13	80.21	2.23
Main	12615.85	100-YR	26.44	693.43	84.13	2.13
Main	12615.85	Floodway	26.46	693.44	84.28	2.12
Main	12216.99	100-YR	34.73	693.08	101.96	1.76
Main	12216.99	Floodway	34.76	693.09	102.23	1.75

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main (Continued)

Reach	River Sta	Profile	Top Width (ft)	W.S. Elev (ft)	Area (sq ft)	Vel Total (ft/s)
Main	12019.91	100-YR	23.02	692.81	62.36	2.87
Main	12019.91	Floodway	23.00	692.82	62.60	2.86
Main	12001.15	100-YR	28.52	692.84	102.38	1.75
Main	12001.15	Floodway	28.49	692.85	102.67	1.74
Main	11937.42		Culvert			
Main	11882.28	100-YR	40.35	692.70	143.14	1.48
Main	11882.28	Floodway	33.85	692.71	129.64	1.49
Main	11831.40	100-YR	94.42	692.61	100.95	2.34
Main	11831.40	Floodway	68.60	692.62	91.95	2.33
Main	11746.9*	100-YR	128.19	692.52	107.78	1.66
Main	11746.9*	Floodway	90.08	692.53	102.03	1.75
Main	11662.5*	100-YR	219.12	692.40	132.20	1.35
Main	11662.5*	Floodway	141.02	692.42	120.05	1.49
Main	11578.0*	100-YR	449.36	692.28	221.17	0.81
Main	11578.0*	Floodway	362.20	692.29	200.98	0.89
Main	11493.63	100-YR	808.64	692.24	683.14	0.26
Main	11493.63	Floodway	709.04	692.26	633.46	0.28
Main	11398.6*	100-YR	801.35	692.19	583.66	0.31
Main	11398.6*	Floodway	627.99	692.21	523.81	0.34
Main	11303.5*	100-YR	795.41	692.13	529.62	0.34
Main	11303.5*	Floodway	610.08	692.14	475.69	0.38
Main	11208.5*	100-YR	714.98	692.07	521.27	0.34
Main	11208.5*	Floodway	576.29	692.08	467.59	0.38
Main	11113.5*	100-YR	662.36	692.02	547.72	0.33
Main	11113.5*	Floodway	528.12	692.03	494.29	0.36
Main	11018.49	100-YR	648.72	692.00	605.90	0.22
Main	11018.49	Floodway	533.79	692.01	553.44	0.24
Main	10922.5*	100-YR	566.51	691.97	506.63	0.26
Main	10922.5*	Floodway	424.96	691.98	467.01	0.28
Main	10826.6*	100-YR	525.08	691.96	519.77	0.25
Main	10826.6*	Floodway	410.55	691.96	484.08	0.27
Main	10730.67	100-YR	501.77	691.94	547.90	0.24
Main	10730.67	Floodway	402.18	691.95	513.20	0.26

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main (Continued)

Reach	River Sta	Profile	Top Width	W.S. Elev	Area	Vel Total
			(ft)	(ft)	(sq ft)	(ft/s)
Main	10638.0*	100-YR	553.90	691.94	665.50	0.20
Main	10638.0*	Floodway	382.33	691.95	604.58	0.22
Main	10545.5*	100-YR	617.16	691.94	894.09	0.15
Main	10545.5*	Floodway	459.42	691.94	808.14	0.16
Main	10452.9*	100-YR	710.06	691.93	1222.49	0.11
Main	10452.9*	Floodway	551.22	691.94	1100.28	0.12
Main	10360.3*	100-YR	740.01	691.93	1636.75	0.08
Main	10360.3*	Floodway	634.48	691.94	1492.99	0.09
Main	10267.74	100-YR	815.73	691.93	2125.62	0.40
Main	10267.74	Floodway	708.47	691.94	1983.21	0.41
Main	10182.4*	100-YR	768.42	691.93	2038.32	0.06
Main	10182.4*	Floodway	673.29	691.94	1853.78	0.07
Main	10097.1*	100-YR	765.46	691.93	1965.85	0.07
Main	10097.1*	Floodway	678.75	691.94	1797.19	0.07
Main	10011.8*	100-YR	790.61	691.93	1901.31	0.07
Main	10011.8*	Floodway	707.39	691.94	1733.40	0.08
Main	9926.510	100-YR	881.45	691.93	1918.46	0.39
Main	9926.510	Floodway	793.18	691.93	1720.70	0.39
Main	9491.793	100-YR	436.45	691.89	967.13	0.49
Main	9491.793	Floodway	380.34	691.90	878.70	0.49
Main	9382.780		Inl Struct			
Main	8939.248	100-YR	847.33	691.89	743.79	0.18
Main	8939.248	Floodway	646.47	691.89	678.25	0.20
Main	8784.397	100-YR	885.21	691.86	906.16	0.30
Main	8784.397	Floodway	713.96	691.87	821.41	0.31
Main	8722.829	100-YR	594.57	691.81	749.82	0.30
Main	8722.829	Floodway	513.55	691.82	677.28	0.33
Main	8695.034		Culvert			
Main	8674.268	100-YR	659.81	691.81	830.50	0.25
Main	8674.268	Floodway	567.19	691.82	747.13	0.26
Main	8631.519	100-YR	612.68	691.81	796.76	0.26
Main	8631.519	Floodway	487.74	691.81	713.98	0.26
Main	8345.665	100-YR	1240.99	691.80	1780.23	0.08
Main	8345.665	Floodway	1047.74	691.80	1601.29	0.09

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main (Continued)

Reach	River Sta	Profile	Top Width (ft)	W.S. Elev (ft)	Area (sq ft)	Vel Total (ft/s)
Main	8047.118	100-YR	746.24	691.79	1631.94	0.11
Main	8047.118	Floodway	615.00	691.80	1469.77	0.12
Main	7739.449	100-YR	1501.85	691.79	2501.67	0.10
Main	7739.449	Floodway	1153.00	691.79	2241.54	0.11
Main	7515.565	100-YR	332.20	691.79	747.61	0.23
Main	7515.565	Floodway	288.42	691.79	677.40	0.23
Main	7272.821	100-YR	909.38	691.78	1444.37	0.11
Main	7272.821	Floodway	680.00	691.78	1299.06	0.12
Main	7255.385	100-YR	811.72	691.78	2077.96	0.10
Main	7255.385	Floodway	620.00	691.78	1893.19	0.11
Main	7226.812		Culvert			
Main	7193.714	100-YR	667.23	691.78	1769.09	0.07
Main	7193.714	Floodway	535.00	691.78	1593.66	0.08
Main	7141.580	100-YR	609.82	691.78	1175.11	0.11
Main	7141.580	Floodway	515.00	691.78	1052.10	0.11
Main	7071.87*	100-YR	558.56	691.77	1173.94	0.10
Main	7071.87*	Floodway	463.00	691.78	1053.05	0.11
Main	7002.16*	100-YR	547.70	691.77	1181.38	0.10
Main	7002.16*	Floodway	430.00	691.77	1063.98	0.11
Main	6932.458	100-YR	513.27	691.77	1203.73	0.10
Main	6932.458	Floodway	418.00	691.77	1088.43	0.11
Main	6846.57*	100-YR	444.15	691.77	779.47	0.15
Main	6846.57*	Floodway	332.00	691.77	731.46	0.16
Main	6760.7*	100-YR	313.07	691.76	536.42	0.22
Main	6760.7*	Floodway	215.00	691.76	483.08	0.24
Main	6674.82*	100-YR	349.69	691.76	470.26	0.25
Main	6674.82*	Floodway	221.45	691.76	431.11	0.27
Main	6588.943	100-YR	526.88	691.76	1002.16	0.12
Main	6588.943	Floodway	476.59	691.76	903.15	0.13
Main	6495.53*	100-YR	712.80	691.75	1432.96	0.08
Main	6495.53*	Floodway	631.44	691.76	1287.40	0.09
Main	6402.13*	100-YR	906.49	691.75	1878.17	0.06
Main	6402.13*	Floodway	789.38	691.75	1689.07	0.07

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main (Continued)

Reach	River Sta	Profile	Top Width	W.S. Elev	Area	Vel Total
			(ft)	(ft)	(sq ft)	(ft/s)
Main	6308.73*	100-YR	1141.81	691.75	2345.54	0.06
Main	6308.73*	Floodway	956.08	691.75	2116.43	0.06
Main	6215.32*	100-YR	1485.95	691.75	2900.12	0.06
Main	6215.32*	Floodway	1153.92	691.75	2628.16	0.06
Main	6121.924	100-YR	1805.53	691.75	3649.23	0.07
Main	6121.924	Floodway	1522.04	691.75	3327.81	0.07
Main	6035.96*	100-YR	1748.64	691.75	3579.73	0.08
Main	6035.96*	Floodway	1446.54	691.75	3242.90	0.08
Main	5950.01*	100-YR	1703.48	691.75	3556.17	0.09
Main	5950.01*	Floodway	1417.91	691.75	3246.43	0.09
Main	5864.05*	100-YR	1677.45	691.75	3569.02	0.11
Main	5864.05*	Floodway	1358.99	691.75	3218.99	0.10
Main	5778.104	100-YR	1651.33	691.75	3599.88	0.14
Main	5778.104	Floodway	1364.84	691.75	3293.75	0.14
Main	5687.63*	100-YR	1144.72	691.74	2724.66	0.23
Main	5687.63*	Floodway	1018.52	691.75	2554.39	0.23
Main	5597.166	100-YR	647.62	691.73	1655.24	0.53
Main	5597.166	Floodway	573.61	691.74	1503.24	0.53
Main	5556.618	100-YR	534.54	691.72	1041.92	0.91
Main	5556.618	Floodway	426.28	691.72	950.96	0.91
Main	5525.006		Culvert			
Main	5490.413	100-YR	375.60	691.63	334.72	0.90
Main	5490.413	Floodway	329.52	691.63	304.80	0.90
Main	5437.667	100-YR	474.11	691.64	1131.93	0.44
Main	5437.667	Floodway	400.73	691.64	1025.33	0.44
Main	5357.86*	100-YR	408.08	691.63	926.63	0.54
Main	5357.86*	Floodway	344.74	691.63	832.76	0.54
Main	5278.05*	100-YR	347.05	691.62	752.99	0.68
Main	5278.05*	Floodway	300.41	691.62	683.09	0.68
Main	5198.254	100-YR	283.19	691.61	605.26	0.87
Main	5198.254	Floodway	249.73	691.61	551.24	0.87
Main	5121.63*	100-YR	311.87	691.60	595.50	0.81
Main	5121.63*	Floodway	262.34	691.60	543.37	0.81
Main	5045.01*	100-YR	321.91	691.59	619.70	0.74

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main (Continued)

Reach	River Sta	Profile	Top Width (ft)	W.S. Elev (ft)	Area (sq ft)	Vel Total (ft/s)
Main	5045.01*	Floodway	263.28	691.59	565.89	0.74
Main	4968.39*	100-YR	343.05	691.59	695.60	0.59
Main	4968.39*	Floodway	279.00	691.59	630.29	0.59
Main	4891.776	100-YR	531.24	691.58	864.78	0.36
Main	4891.776	Floodway	410.00	691.59	790.14	0.37
Main	4810.20*	100-YR	452.48	691.58	410.14	0.38
Main	4810.20*	Floodway	322.00	691.58	376.24	0.40
Main	4728.63*	100-YR	296.53	691.57	278.18	0.41
Main	4728.63*	Floodway	278.12	691.57	249.97	0.45
Main	4647.06*	100-YR	278.97	691.56	274.52	0.41
Main	4647.06*	Floodway	263.89	691.56	248.78	0.45
Main	4565.488	100-YR	260.73	691.55	269.96	0.51
Main	4565.488	Floodway	186.61	691.55	242.82	0.51
Main	4504.263	100-YR	69.61	691.54	157.14	0.81
Main	4504.263	Floodway	52.32	691.54	142.47	0.81
Main	4461.252		Culvert			
Main	4430.212	100-YR	28.57	691.29	120.83	1.14
Main	4430.212	Floodway	28.00	691.29	120.74	1.14
Main	4346.582	100-YR	30.16	691.28	117.13	0.96
Main	4346.582	Floodway	30.16	691.28	117.14	0.96
Main	4194.408	100-YR	30.00	691.25	109.41	1.03
Main	4194.408	Floodway	30.00	691.25	109.43	1.03
Main	3788.373	100-YR	283.09	691.24	575.05	0.20
Main	3788.373	Floodway	220.00	691.24	525.61	0.21
Main	3395.646	100-YR	218.85	691.23	533.36	0.23
Main	3395.646	Floodway	160.00	691.23	493.01	0.23
Main	3331.113	100-YR	91.03	691.22	189.34	0.72
Main	3331.113	Floodway	60.00	691.22	179.06	0.72
Main	3265.168		Culvert			
Main	3196.567	100-YR	20.85	688.68	61.40	1.88
Main	3196.567	Floodway	20.67	688.69	61.65	1.87
Main	3141.921	100-YR	17.34	688.65	52.66	1.90
Main	3141.921	Floodway	17.38	688.66	52.88	1.89

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main (Continued)

Reach	River Sta	Profile	Top Width (ft)	W.S. Elev (ft)	Area (sq ft)	Vel Total (ft/s)
Main	3004.055	100-YR	22.57	688.60	75.51	1.32
Main	3004.055	Floodway	22.60	688.62	75.81	1.32
Main	2734.719	100-YR	21.54	688.49	62.22	1.61
Main	2734.719	Floodway	21.59	688.50	62.54	1.60
Main	2688.915	100-YR	21.62	688.45	58.31	1.72
Main	2688.915	Floodway	21.68	688.47	58.64	1.71
Main	2653.174		Culvert			
Main	2626.817	100-YR	11.41	687.84	36.90	2.71
Main	2626.817	Floodway	11.46	687.86	37.17	2.69
Main	2582.291	100-YR	14.48	687.79	43.97	2.27
Main	2582.291	Floodway	14.52	687.82	44.33	2.26
Main	2218.895	100-YR	34.14	687.76	123.53	0.81
Main	2218.895	Floodway	34.22	687.78	124.39	0.80
Main	2049.666	100-YR	81.10	687.74	158.02	0.63
Main	2049.666	Floodway	76.61	687.77	158.54	0.63
Main	1853.478	100-YR	37.65	687.60	135.87	2.24
Main	1853.478	Floodway	37.86	687.63	136.94	2.22
Main	1799.666	100-YR	37.60	687.55	132.27	2.30
Main	1799.666	Floodway	33.00	687.58	131.03	2.32
Main	1727.858		Culvert			
Main	1670.018	100-YR	37.57	686.97	115.43	2.89
Main	1670.018	Floodway	29.07	687.00	108.04	2.87
Main	1606.765	100-YR	426.71	686.96	395.62	1.75
Main	1606.765	Floodway	126.26	686.99	357.50	1.72
Main	1475.852	100-YR	54.44	686.64	94.39	3.22
Main	1475.852	Floodway	32.00	686.66	88.09	3.45
Main	1134.554	100-YR	37.17	685.92	101.35	3.00
Main	1134.554	Floodway	27.00	685.92	91.99	3.30
Main	792.3003	100-YR	194.29	684.65	115.08	2.64
Main	792.3003	Floodway	129.58	684.65	104.55	2.91
Main	482.8005	100-YR	848.37	684.71	1417.70	0.25
Main	482.8005	Floodway	677.52	684.71	1313.92	0.27
Main	35.46111	100-YR	769.39	684.70	1919.79	0.19
Main	35.46111	Floodway	623.00	684.70	1762.01	0.20

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 10-YR

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17035.08	10-YR	42.00	696.40	698.88	698.00	698.95	0.001999	2.07	20.33	17.16	0.33
Main	16983.37	10-YR	42.00	696.00	698.58		698.76	0.007732	3.36	12.50	13.29	0.61
Main	16899.4*	10-YR	42.00	695.54	697.95		698.11	0.007641	3.30	12.74	14.12	0.61
Main	16815.4*	10-YR	42.00	695.08	697.30		697.47	0.007715	3.26	12.88	14.87	0.62
Main	16731.5*	10-YR	42.00	694.62	696.65		696.81	0.007751	3.23	13.02	15.56	0.62
Main	16647.5*	10-YR	42.00	694.16	696.01		696.17	0.007623	3.18	13.22	16.15	0.62
Main	16563.6*	10-YR	42.00	693.70	695.33		695.50	0.008508	3.27	12.83	16.38	0.65
Main	16479.65	10-YR	42.00	693.24	694.96		695.05	0.003322	2.40	17.48	17.52	0.42
Main	16403.7*	10-YR	42.00	693.01	694.75		694.82	0.002787	2.12	19.79	21.14	0.39
Main	16327.7*	10-YR	42.00	692.78	694.56		694.62	0.002295	1.90	22.15	24.30	0.35
Main	16251.7*	10-YR	42.00	692.54	694.43		694.47	0.001619	1.65	25.51	26.66	0.30
Main	16175.84	10-YR	49.00	692.31	694.30		694.35	0.001600	1.68	29.19	29.37	0.30
Main	16100.*	10-YR	49.00	692.07	694.21		694.24	0.001110	1.44	34.09	32.96	0.25
Main	16024.40	10-YR	49.00	691.83	694.16		694.18	0.000577	1.09	69.43	199.59	0.18
Main	15850.19	10-YR	49.00	691.30	694.04		694.07	0.000691	1.55	88.99	281.55	0.21
Main	15434.41	10-YR	49.00	690.01	693.78		693.81	0.000535	1.49	32.93	15.71	0.18
Main	15212.53	10-YR	49.00	689.73	693.69		693.72	0.000354	1.28	38.33	17.10	0.15
Main	14922.76	10-YR	49.00	689.36	693.63		693.64	0.000181	0.79	74.16	188.79	0.11
Main	14774.58	10-YR	78.00	689.19	693.54		693.58	0.000673	1.68	56.23	155.72	0.21
Main	14457.09	10-YR	78.00	688.79	693.42		693.44	0.000292	1.13	77.91	64.02	0.14
Main	14406.13	10-YR	78.00	688.73	693.42	689.63	693.43	0.000069	0.80	133.03	88.47	0.07
Main	14204.08		Culvert									
Main	13981.41	10-YR	81.00	688.38	693.39	689.31	693.40	0.000042	0.73	110.49	29.42	0.06
Main	13949.59	10-YR	81.00	688.37	693.38	690.00	693.40	0.000069	0.86	93.95	307.92	0.08
Main	13839.56	10-YR	81.00	688.25	693.38	689.91	693.39	0.000058	0.85	98.25	328.23	0.08
Main	13732.13	10-YR	81.00	688.19	693.37	689.92	693.38	0.000069	0.92	95.62	313.87	0.08
Main	13662.15	10-YR	81.00	688.17	693.36	689.95	693.38	0.000078	0.96	95.59	55.44	0.09
Main	13628.36	10-YR	81.00	688.12	693.36	689.59	693.37	0.000048	0.80	113.40	45.57	0.07
Main	13536.36		Culvert									
Main	13453.85	10-YR	93.00	688.72	693.32	689.71	693.33	0.000237	0.82	114.64	98.98	0.08
Main	13414.20	10-YR	93.00	689.00	693.31	690.29	693.32	0.000259	0.79	118.45	61.37	0.08
Main	13217.08	10-YR	93.00	688.99	693.21		693.24	0.000733	1.29	71.85	24.63	0.13
Main	13001.02	10-YR	93.00	688.98	692.97		693.02	0.001521	1.72	54.19	20.79	0.19
Main	12615.85	10-YR	93.00	688.85	692.44		692.47	0.001293	1.57	59.23	23.51	0.17
Main	12216.99	10-YR	93.00	688.69	692.18		692.20	0.000405	1.29	72.30	30.85	0.15
Main	12019.91	10-YR	93.00	688.59	692.01		692.08	0.001134	2.05	45.26	19.81	0.24
Main	12001.15	10-YR	93.00	688.06	692.02	689.03	692.04	0.000261	1.16	80.23	25.97	0.12
Main	11937.42		Culvert									
Main	11882.28	10-YR	93.00	687.94	691.97	688.92	691.99	0.000137	0.97	100.31	38.30	0.09
Main	11831.40	10-YR	93.00	688.77	691.93	689.98	691.97	0.000576	1.56	59.79	23.86	0.17
Main	11746.9*	10-YR	93.00	688.77	691.87		691.91	0.000832	1.63	57.27	31.77	0.19
Main	11662.5*	10-YR	93.00	688.77	691.78		691.83	0.001166	1.69	56.24	45.55	0.20
Main	11578.0*	10-YR	93.00	688.76	691.67		691.72	0.001473	1.69	63.08	98.45	0.20
Main	11493.63	10-YR	93.00	688.76	691.60		691.62	0.000811	1.19	216.99	546.55	0.14
Main	11398.6*	10-YR	93.00	688.76	691.51		691.53	0.001002	1.29	149.59	313.40	0.15
Main	11303.5*	10-YR	93.00	688.76	691.41		691.43	0.000980	1.23	143.73	270.70	0.15
Main	11208.5*	10-YR	93.00	688.75	691.32		691.34	0.000869	1.12	153.82	223.94	0.14
Main	11113.5*	10-YR	93.00	688.75	691.25		691.26	0.000726	0.98	179.19	229.04	0.13
Main	11018.49	10-YR	92.00	688.75	691.19		691.20	0.000554	0.83	221.80	280.11	0.11
Main	10922.5*	10-YR	92.00	688.75	691.13		691.14	0.000465	0.75	211.57	161.44	0.10
Main	10826.6*	10-YR	92.00	688.75	691.09		691.09	0.000354	0.64	230.70	168.74	0.09
Main	10730.67	10-YR	92.00	688.75	691.05		691.06	0.000236	0.51	265.46	190.23	0.07
Main	10638.0*	10-YR	92.00	688.74	691.04		691.04	0.000180	0.44	300.48	293.80	0.06
Main	10545.5*	10-YR	92.00	688.73	691.03		691.03	0.000107	0.33	415.17	419.51	0.05
Main	10452.9*	10-YR	92.00	688.72	691.03		691.03	0.000043	0.21	649.97	552.15	0.03
Main	10360.3*	10-YR	92.00	688.71	691.03		691.03	0.000011	0.11	1017.98	645.29	0.02
Main	10267.74	10-YR	92.00	688.70	691.02		691.03	0.000134	0.39	207.89	695.75	0.05
Main	10182.4*	10-YR	92.00	688.69	691.02		691.02	0.000015	0.13	1386.05	689.80	0.02
Main	10097.1*	10-YR	92.00	688.68	691.02		691.02	0.000011	0.12	1327.18	667.51	0.02
Main	10011.8*	10-YR	92.00	688.67	691.02		691.02	0.000007	0.10	1284.42	621.65	0.01
Main	9926.510	10-YR	92.00	688.66	691.01		691.02	0.000196	0.52	162.87	595.58	0.07
Main	9491.793	10-YR	92.00	688.61	690.96	689.24	690.96	0.000211	0.45	171.43	327.42	0.07
Main	9382.780		Int Struct									
Main	8939.248	10-YR	92.00	688.30	690.95		690.95	0.000241	0.50	232.70	270.96	0.07
Main	8784.397	10-YR	92.00	688.22	690.85		690.88	0.001637	1.50	103.09	409.74	0.19
Main	8722.829	10-YR	92.00	688.12	690.67	689.44	690.71	0.002924	1.75	129.18	309.16	0.25
Main	8695.034		Culvert									
Main	8674.268	10-YR	92.00	687.48	690.66	688.72	690.68	0.000651	1.11	145.75	384.90	0.13
Main	8631.519	10-YR	92.00	687.41	690.63	688.67	690.64	0.000828	1.12	192.31	344.44	0.14
Main	8345.665	10-YR	92.00	687.28	690.54		690.54	0.000209	0.57	312.29	684.60	0.07
Main	8047.118	10-YR	80.00	687.10	690.46		690.47	0.000293	0.67	197.91	581.44	0.08
Main	7739.449	10-YR	80.00	686.99	690.44		690.44	0.000044	0.35	347.90	689.55	0.03
Main	7515.565	10-YR	80.00	686.79	690.43		690.43	0.000064	0.37	255.56	240.18	0.04
Main	7272.821	10-YR	80.00	686.67	690.41		690.41	0.000091	0.52	248.12	455.87	0.05
Main	7255.385	10-YR	80.00	686.00	690.39	687.90	690.40	0.000661	1.09	223.59	626.92	0.13
Main	7226.812		Culvert									
Main	7193.714	10-YR	80.00	685.90	690.38	687.83	690.39	0.000044	0.35	816.64	608.23	0.03
Main	7141.580	10-YR	80.00	686.28	690.38	687.19	690.38	0.000101	0.35	375.40	430.28	0.04
Main	7071.87*	10-YR	80.00	686.28	690.37		690.37	0.000081	0.35	428.93	485.01	0.04

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 10-YR (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7002.16*	10-YR	80.00	686.27	690.37		690.37	0.000067	0.38	473.25	467.79	0.04
Main	6932.458	10-YR	80.00	686.27	690.36		690.36	0.000058	0.41	505.38	443.23	0.04
Main	6846.57*	10-YR	80.00	686.27	690.35		690.35	0.000097	0.54	277.86	248.95	0.05
Main	6760.7*	10-YR	80.00	686.27	690.34		690.35	0.000121	0.60	196.77	154.18	0.06
Main	6674.82*	10-YR	80.00	686.26	690.33		690.33	0.000133	0.63	173.90	106.16	0.06
Main	6588.943	10-YR	80.00	686.26	690.32		690.32	0.000094	0.53	373.78	345.34	0.05
Main	6495.53*	10-YR	80.00	686.26	690.32		690.32	0.000048	0.38	514.24	515.16	0.04
Main	6402.13*	10-YR	80.00	686.26	690.31		690.31	0.000034	0.32	659.26	714.47	0.03
Main	6308.73*	10-YR	80.00	686.27	690.31	687.21	690.31	0.000026	0.27	728.18	907.37	0.03
Main	6215.32*	10-YR	80.00	686.27	690.31	687.16	690.31	0.000018	0.23	783.88	1082.10	0.02
Main	6121.924	10-YR	80.00	686.27	690.30	687.12	690.31	0.000017	0.22	732.71	1236.08	0.02
Main	6035.96*	10-YR	80.00	686.27	690.30	687.16	690.30	0.000018	0.23	731.67	1260.63	0.02
Main	5950.01*	10-YR	80.00	686.27	690.30	687.22	690.30	0.000023	0.25	657.79	1281.47	0.03
Main	5864.05*	10-YR	80.00	686.27	690.30	687.29	690.30	0.000031	0.29	565.48	1282.12	0.03
Main	5778.104	10-YR	80.00	686.27	690.29	687.44	690.30	0.000046	0.34	457.86	1280.11	0.03
Main	5687.63*	10-YR	80.00	686.28	690.28	687.69	690.29	0.000112	0.56	250.69	1034.58	0.06
Main	5597.166	10-YR	80.00	686.28	690.26		690.27	0.000277	0.92	107.95	620.52	0.10
Main	5556.618	10-YR	80.00	686.43	690.23	687.42	690.25	0.000319	1.08	76.07	374.12	0.11
Main	5525.006		Culvert									
Main	5490.413	10-YR	70.00	685.19	690.17	686.15	690.18	0.000111	0.75	93.40	28.76	0.06
Main	5437.667	10-YR	70.00	685.35	690.17	686.10	690.17	0.000032	0.39	180.81	428.18	0.04
Main	5357.86*	10-YR	70.00	685.35	690.16	686.25	690.17	0.000051	0.48	145.61	353.76	0.04
Main	5278.05*	10-YR	70.00	685.34	690.16	686.44	690.16	0.000086	0.61	115.40	254.40	0.06
Main	5198.254	10-YR	70.00	685.34	690.14		690.15	0.000164	0.80	87.86	212.77	0.08
Main	5121.63*	10-YR	70.00	685.34	690.13	686.71	690.14	0.000149	0.75	93.17	188.88	0.07
Main	5045.01*	10-YR	70.00	685.34	690.12	686.71	690.13	0.000132	0.70	100.36	221.34	0.07
Main	4968.39*	10-YR	70.00	685.33	690.11	686.71	690.12	0.000114	0.63	111.08	246.88	0.07
Main	4891.776	10-YR	70.00	685.33	690.11		690.11	0.000086	0.53	144.57	276.83	0.06
Main	4810.20*	10-YR	70.00	685.33	690.10	686.78	690.10	0.000118	0.60	120.07	57.13	0.07
Main	4728.63*	10-YR	70.00	685.33	690.08	686.84	690.09	0.000155	0.67	108.12	52.80	0.07
Main	4647.06*	10-YR	70.00	685.32	690.07	686.87	690.08	0.000189	0.75	98.45	48.18	0.08
Main	4565.488	10-YR	70.00	685.32	690.05		690.06	0.000232	0.83	90.85	45.31	0.09
Main	4504.263	10-YR	70.00	685.32	690.03	687.04	690.05	0.000208	0.84	82.96	27.74	0.09
Main	4461.252		Culvert									
Main	4430.212	10-YR	70.00	684.72	689.93	686.52	689.94	0.000170	0.96	74.31	25.03	0.08
Main	4346.582	10-YR	70.00	685.50	689.91	686.66	689.92	0.000225	0.89	78.77	25.67	0.09
Main	4194.408	10-YR	70.00	685.49	689.87		689.88	0.000286	0.97	71.93	24.43	0.10
Main	3788.373	10-YR	70.00	685.36	689.85		689.85	0.000034	0.36	242.49	167.55	0.04
Main	3395.646	10-YR	70.00	685.01	689.84		689.84	0.000022	0.43	273.23	140.45	0.04
Main	3331.113	10-YR	70.00	685.09	689.83	686.37	689.84	0.000065	0.65	109.54	35.53	0.06
Main	3265.168		Culvert									
Main	3196.567	10-YR	70.00	683.69	687.70	685.71	687.76	0.000764	1.98	39.25	18.72	0.20
Main	3141.921	10-YR	70.00	683.98	687.65		687.71	0.000972	1.91	36.63	14.99	0.22
Main	3004.055	10-YR	70.00	683.97	687.60		687.62	0.000381	1.30	53.91	20.25	0.14
Main	2734.719	10-YR	70.00	683.96	687.43		687.48	0.000802	1.70	41.16	18.39	0.20
Main	2688.915	10-YR	70.00	683.95	687.38	685.63	687.43	0.001083	1.89	37.13	17.72	0.23
Main	2653.174		Culvert									
Main	2626.817	10-YR	70.00	683.44	686.53	685.10	686.67	0.002942	3.00	23.35	9.59	0.34
Main	2582.291	10-YR	70.00	683.33	686.42	685.12	686.54	0.002434	2.72	25.76	12.13	0.33
Main	2218.895	10-YR	70.00	682.33	686.34		686.35	0.000172	0.90	78.11	29.71	0.10
Main	2049.666	10-YR	70.00	681.91	686.31		686.32	0.000176	0.92	76.03	28.16	0.10
Main	1853.478	10-YR	157.00	681.42	686.20		686.24	0.000575	1.76	89.16	30.27	0.18
Main	1799.666	10-YR	157.00	681.24	686.15	683.19	686.21	0.000793	1.86	84.62	30.53	0.20
Main	1727.858		Culvert									
Main	1670.018	10-YR	157.00	681.24	685.94	683.20	686.01	0.000991	2.18	76.81	32.89	0.22
Main	1606.765	10-YR	157.00	681.22	685.90	684.19	685.94	0.000800	1.59	105.22	126.64	0.20
Main	1475.852	10-YR	157.00	681.21	685.64		685.76	0.002734	2.76	56.97	32.14	0.36
Main	1134.554	10-YR	157.00	681.17	685.05		685.12	0.001295	2.21	70.97	32.32	0.26
Main	792.3003	10-YR	157.00	681.12	684.19		684.36	0.004439	3.37	53.78	78.00	0.46
Main	482.8005	10-YR	183.00	680.38	684.20		684.21	0.000124	0.78	1018.38	752.16	0.08
Main	35.46111	10-YR	183.00	680.10	684.20	680.43	684.20	0.000005	0.21	1550.93	711.37	0.02

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 50-YR

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17035.08	50-YR	60.00	696.40	699.18	698.25	699.26	0.002185	2.33	25.79	19.47	0.36
Main	16983.37	50-YR	60.00	696.00	698.85		699.06	0.007881	3.65	16.42	15.78	0.63
Main	16899.4*	50-YR	60.00	695.54	698.20		698.40	0.007819	3.61	16.63	16.47	0.63
Main	16815.4*	50-YR	60.00	695.08	697.54		697.74	0.007890	3.59	16.70	16.98	0.64
Main	16731.5*	50-YR	60.00	694.62	696.89		697.08	0.007800	3.56	16.86	17.47	0.64
Main	16647.5*	50-YR	60.00	694.16	696.22		696.42	0.008007	3.56	16.85	17.95	0.65
Main	16563.6*	50-YR	60.00	693.70	695.60		695.78	0.007185	3.44	17.47	18.23	0.62
Main	16479.65	50-YR	60.00	693.24	695.29		695.39	0.002913	2.54	23.60	19.63	0.41
Main	16403.7*	50-YR	60.00	693.01	695.13		695.20	0.002063	2.10	28.58	24.74	0.34
Main	16327.7*	50-YR	60.00	692.78	695.01		695.06	0.001447	1.75	34.37	30.22	0.29
Main	16251.7*	50-YR	60.00	692.54	694.93		694.97	0.000991	1.45	41.71	47.17	0.24
Main	16175.84	50-YR	75.00	692.31	694.85		694.89	0.001117	1.52	57.81	99.89	0.25
Main	16100.*	50-YR	75.00	692.07	694.79		694.82	0.000708	1.33	59.33	64.51	0.21
Main	16024.40	50-YR	75.00	691.83	694.77		694.78	0.000169	0.71	235.00	417.29	0.10
Main	15850.19	50-YR	75.00	691.30	694.75		694.75	0.000118	0.81	362.80	545.40	0.09
Main	15434.41	50-YR	75.00	690.01	694.62		694.66	0.000469	1.58	47.42	18.60	0.17
Main	15212.53	50-YR	75.00	689.73	694.54		694.57	0.000326	1.39	54.15	19.94	0.15
Main	14922.76	50-YR	75.00	689.36	694.52		694.52	0.000084	0.70	165.13	389.22	0.08
Main	14774.58	50-YR	123.00	689.19	694.48		694.50	0.000268	1.37	188.01	297.80	0.14
Main	14457.09	50-YR	123.00	688.79	694.41		694.43	0.000159	1.09	174.29	200.79	0.11
Main	14406.13	50-YR	123.00	688.73	694.41	689.95	694.42	0.000070	0.93	197.60	121.03	0.07
Main	14204.08		Culvert									
Main	13981.41	50-YR	129.00	688.38	694.35	689.65	694.37	0.000054	0.94	137.03	31.83	0.08
Main	13949.59	50-YR	129.00	688.37	694.35	690.32	694.36	0.000085	1.05	122.79	320.22	0.09
Main	13839.56	50-YR	129.00	688.25	694.34	690.23	694.35	0.000070	1.06	132.00	343.78	0.09
Main	13732.13	50-YR	129.00	688.19	694.34	690.26	694.35	0.000045	0.84	247.88	362.93	0.07
Main	13662.15	50-YR	129.00	688.17	694.32	690.29	694.34	0.000081	1.11	161.01	117.04	0.09
Main	13628.36	50-YR	129.00	688.12	694.32	689.92	694.34	0.000055	0.98	158.84	91.01	0.08
Main	13536.36		Culvert									
Main	13453.85	50-YR	150.00	688.72	694.22	690.13	694.23	0.000287	1.04	150.09	274.68	0.09
Main	13414.20	50-YR	150.00	689.00	694.21	690.58	694.22	0.000286	0.95	168.07	282.12	0.09
Main	13217.08	50-YR	150.00	688.99	694.09		694.12	0.000880	1.58	99.10	105.78	0.15
Main	13001.02	50-YR	150.00	688.98	693.79		693.86	0.001767	2.08	72.22	22.98	0.21
Main	12615.85	50-YR	150.00	688.85	693.15		693.21	0.001612	1.95	76.74	25.61	0.20
Main	12216.99	50-YR	150.00	688.69	692.83		692.87	0.000510	1.61	93.34	33.77	0.17
Main	12019.91	50-YR	150.00	688.59	692.60		692.70	0.001538	2.61	57.51	22.02	0.28
Main	12001.15	50-YR	150.00	688.06	692.62	689.40	692.65	0.000407	1.56	96.20	27.85	0.15
Main	11937.42		Culvert									
Main	11882.28	50-YR	150.00	687.94	692.51	689.27	692.54	0.000222	1.36	115.87	39.83	0.12
Main	11831.40	50-YR	150.00	688.77	692.44	690.31	692.51	0.000859	2.08	72.24	78.71	0.22
Main	11746.9*	50-YR	150.00	688.77	692.36		692.42	0.001136	2.07	89.43	98.78	0.22
Main	11662.5*	50-YR	150.00	688.77	692.25		692.31	0.001509	2.10	102.52	162.59	0.23
Main	11578.0*	50-YR	150.00	688.76	692.12		692.17	0.001639	1.95	160.31	355.16	0.22
Main	11493.63	50-YR	150.00	688.76	692.09		692.09	0.000437	0.97	558.88	781.19	0.10
Main	11398.6*	50-YR	150.00	688.76	692.03		692.04	0.000601	1.13	457.53	756.69	0.12
Main	11303.5*	50-YR	150.00	688.76	691.97		691.98	0.000642	1.15	409.51	679.44	0.13
Main	11208.5*	50-YR	150.00	688.75	691.91		691.92	0.000574	1.07	410.81	626.80	0.12
Main	11113.5*	50-YR	150.00	688.75	691.86		691.87	0.000463	0.95	444.76	592.20	0.11
Main	11018.49	50-YR	153.00	688.75	691.82		691.83	0.000369	0.84	497.47	585.00	0.10
Main	10922.5*	50-YR	153.00	688.75	691.78		691.78	0.000365	0.82	406.12	459.84	0.10
Main	10826.6*	50-YR	153.00	688.75	691.74		691.75	0.000275	0.70	414.74	423.50	0.08
Main	10730.67	50-YR	153.00	688.75	691.72		691.72	0.000192	0.58	443.12	409.08	0.07
Main	10638.0*	50-YR	153.00	688.74	691.71		691.71	0.000134	0.47	548.43	459.20	0.06
Main	10545.5*	50-YR	153.00	688.73	691.70		691.70	0.000075	0.34	752.58	573.31	0.04
Main	10452.9*	50-YR	153.00	688.72	691.70		691.70	0.000032	0.22	1058.19	671.57	0.03
Main	10360.3*	50-YR	153.00	688.71	691.70		691.70	0.000010	0.12	1464.66	705.86	0.02
Main	10267.74	50-YR	153.00	688.70	691.69		691.69	0.000149	0.46	287.57	776.07	0.06
Main	10182.4*	50-YR	153.00	688.69	691.69		691.69	0.000016	0.16	1857.83	733.36	0.02
Main	10097.1*	50-YR	153.00	688.68	691.69		691.69	0.000012	0.15	1786.02	722.89	0.02
Main	10011.8*	50-YR	153.00	688.67	691.69		691.69	0.000008	0.12	1716.13	716.91	0.01
Main	9926.510	50-YR	153.00	688.66	691.68		691.69	0.000210	0.62	264.68	803.92	0.07
Main	9491.793	50-YR	153.00	688.61	691.62	689.42	691.63	0.000212	0.55	236.93	374.26	0.07
Main	9382.780		Int Struct									
Main	8939.248	50-YR	153.00	688.30	691.61		691.61	0.000196	0.49	524.41	667.17	0.07
Main	8784.397	50-YR	153.00	688.22	691.55		691.57	0.000993	1.37	303.54	737.44	0.15
Main	8722.829	50-YR	153.00	688.12	691.43	689.90	691.44	0.001251	1.26	317.47	506.42	0.16
Main	8695.034		Culvert									
Main	8674.268	50-YR	153.00	687.48	691.43	689.08	691.44	0.000446	1.01	372.50	562.86	0.11
Main	8631.519	50-YR	153.00	687.41	691.41	689.07	691.42	0.000508	1.01	386.37	485.11	0.11
Main	8345.665	50-YR	153.00	687.28	691.38		691.39	0.000058	0.38	1125.87	1144.01	0.04
Main	8047.118	50-YR	107.00	687.10	691.37		691.37	0.000041	0.31	786.98	722.72	0.03
Main	7739.449	50-YR	107.00	686.99	691.36		691.36	0.000017	0.26	897.04	1370.68	0.02
Main	7515.565	50-YR	107.00	686.79	691.36		691.36	0.000035	0.34	424.65	314.69	0.03
Main	7272.821	50-YR	107.00	686.67	691.35		691.35	0.000041	0.41	776.56	827.11	0.04
Main	7255.385	50-YR	107.00	686.00	691.35	688.08	691.35	0.000096	0.52	864.44	777.03	0.05
Main	7226.812		Culvert									
Main	7193.714	50-YR	107.00	685.90	691.35	688.02	691.35	0.000020	0.28	1357.69	658.22	0.02
Main	7141.580	50-YR	107.00	686.28	691.34	687.33	691.34	0.000039	0.26	864.47	587.34	0.02
Main	7071.87*	50-YR	107.00	686.28	691.34		691.34	0.000030	0.26	934.86	543.77	0.02

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 50-YR (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7002.16*	50-YR	107.00	686.27	691.34		691.34	0.000027	0.28	947.73	514.21	0.02
Main	6932.458	50-YR	107.00	686.27	691.33		691.34	0.000025	0.32	982.03	504.57	0.03
Main	6846.57*	50-YR	107.00	686.27	691.33		691.33	0.000047	0.44	596.00	386.96	0.04
Main	6760.7*	50-YR	107.00	686.27	691.32		691.33	0.000064	0.52	409.09	248.15	0.04
Main	6674.82*	50-YR	107.00	686.26	691.32		691.32	0.000075	0.56	339.17	253.18	0.05
Main	6588.943	50-YR	107.00	686.26	691.31		691.32	0.000039	0.41	781.99	467.60	0.03
Main	6495.53*	50-YR	107.00	686.26	691.31		691.31	0.000016	0.26	1122.05	695.70	0.02
Main	6402.13*	50-YR	107.00	686.26	691.31		691.31	0.000011	0.21	1481.41	888.85	0.02
Main	6308.73*	50-YR	107.00	686.27	691.31	687.34	691.31	0.000009	0.19	1527.31	1088.77	0.02
Main	6215.32*	50-YR	107.00	686.27	691.31	687.29	691.31	0.000008	0.18	1493.34	1382.60	0.02
Main	6121.924	50-YR	107.00	686.27	691.31	687.24	691.31	0.000007	0.17	1354.23	1775.50	0.01
Main	6035.96*	50-YR	107.00	686.27	691.31	687.29	691.31	0.000008	0.18	1278.75	1724.88	0.02
Main	5950.01*	50-YR	107.00	686.27	691.31	687.34	691.31	0.000011	0.21	1126.42	1682.72	0.02
Main	5864.05*	50-YR	107.00	686.27	691.31	687.44	691.31	0.000014	0.23	941.52	1647.18	0.02
Main	5778.104	50-YR	107.00	686.27	691.30	687.61	691.30	0.000020	0.28	735.15	1611.92	0.02
Main	5687.63*	50-YR	107.00	686.28	691.30	687.89	691.30	0.000044	0.43	426.66	1137.36	0.04
Main	5597.166	50-YR	107.00	686.28	691.29		691.29	0.000107	0.69	185.11	642.32	0.06
Main	5556.618	50-YR	107.00	686.43	691.27	687.62	691.28	0.000196	1.02	112.23	500.07	0.09
Main	5525.006		Culvert									
Main	5490.413	50-YR	101.00	685.19	691.19	686.49	691.20	0.000112	0.87	116.10	206.84	0.07
Main	5437.667	50-YR	101.00	685.35	691.19	686.29	691.19	0.000031	0.43	233.25	459.13	0.04
Main	5357.86*	50-YR	101.00	685.35	691.19	686.44	691.19	0.000050	0.53	188.97	393.44	0.05
Main	5278.05*	50-YR	101.00	685.34	691.18	686.64	691.19	0.000084	0.67	150.83	333.21	0.06
Main	5198.254	50-YR	101.00	685.34	691.16		691.18	0.000156	0.87	116.26	269.16	0.08
Main	5121.63*	50-YR	101.00	685.34	691.15	686.94	691.16	0.000138	0.81	124.59	289.76	0.07
Main	5045.01*	50-YR	101.00	685.34	691.15	686.94	691.15	0.000119	0.74	136.01	303.26	0.07
Main	4968.39*	50-YR	101.00	685.33	691.14	686.94	691.15	0.000097	0.65	160.90	315.67	0.06
Main	4891.776	50-YR	101.00	685.33	691.13		691.14	0.000056	0.52	235.45	348.44	0.05
Main	4810.20*	50-YR	101.00	685.33	691.13	687.02	691.13	0.000080	0.59	202.82	229.71	0.06
Main	4728.63*	50-YR	101.00	685.33	691.12	687.09	691.13	0.000108	0.65	178.59	129.05	0.06
Main	4647.06*	50-YR	101.00	685.32	691.11	687.14	691.12	0.000138	0.71	167.52	143.45	0.07
Main	4565.488	50-YR	101.00	685.32	691.09		691.10	0.000176	0.78	158.64	182.17	0.08
Main	4504.263	50-YR	101.00	685.32	691.08	687.29	691.09	0.000207	0.85	118.84	61.86	0.09
Main	4461.252		Culvert									
Main	4430.212	50-YR	101.00	684.72	690.88	686.76	690.90	0.000176	1.12	91.66	27.44	0.09
Main	4346.582	50-YR	101.00	685.50	690.87	686.93	690.88	0.000213	0.96	104.96	28.90	0.09
Main	4194.408	50-YR	101.00	685.49	690.83		690.85	0.000266	1.04	97.31	28.32	0.10
Main	3788.373	50-YR	101.00	685.36	690.82		690.82	0.000024	0.35	460.50	256.16	0.03
Main	3395.646	50-YR	101.00	685.01	690.81		690.81	0.000018	0.45	424.93	210.15	0.04
Main	3331.113	50-YR	101.00	685.09	690.80	686.58	690.81	0.000057	0.72	143.29	69.09	0.06
Main	3265.168		Culvert									
Main	3196.567	50-YR	102.00	683.69	688.51	686.06	688.59	0.000709	2.24	50.86	20.49	0.20
Main	3141.921	50-YR	102.00	683.98	688.47		688.54	0.000896	2.05	49.69	16.91	0.21
Main	3004.055	50-YR	102.00	683.97	688.42		688.45	0.000365	1.43	71.41	22.15	0.14
Main	2734.719	50-YR	102.00	683.96	688.27		688.32	0.000667	1.77	57.70	20.91	0.19
Main	2688.915	50-YR	102.00	683.95	688.23	685.99	688.28	0.000848	1.90	53.57	20.81	0.21
Main	2653.174		Culvert									
Main	2626.817	50-YR	102.00	683.44	687.36	685.49	687.52	0.002714	3.22	31.68	10.47	0.33
Main	2582.291	50-YR	102.00	683.33	687.28	685.47	687.40	0.001920	2.77	36.77	13.60	0.30
Main	2218.895	50-YR	102.00	682.33	687.22		687.23	0.000154	0.97	105.46	32.50	0.09
Main	2049.666	50-YR	102.00	681.91	687.19		687.20	0.000159	0.98	117.55	65.11	0.10
Main	1853.478	50-YR	244.00	681.42	687.05		687.12	0.000663	2.10	116.41	33.63	0.20
Main	1799.666	50-YR	244.00	681.24	687.01	684.20	687.08	0.000871	2.17	112.53	34.85	0.21
Main	1727.858		Culvert									
Main	1670.018	50-YR	244.00	681.24	686.59	684.01	686.70	0.001225	2.76	94.59	35.82	0.25
Main	1606.765	50-YR	244.00	681.22	686.56	684.65	686.61	0.000686	1.77	147.63	130.93	0.20
Main	1475.852	50-YR	244.00	681.21	686.28		686.43	0.002656	3.08	79.28	37.13	0.37
Main	1134.554	50-YR	244.00	681.17	685.62		685.73	0.001594	2.70	90.26	35.48	0.30
Main	792.3003	50-YR	244.00	681.12	684.46		684.75	0.006135	4.38	82.91	144.50	0.55
Main	482.8005	50-YR	288.00	680.38	684.51		684.51	0.000178	1.01	1252.57	792.53	0.10
Main	35.46111	50-YR	288.00	680.10	684.50	680.54	684.50	0.000009	0.29	1767.93	743.10	0.02

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 100-YR

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17035.08	100-YR	69.00	696.40	699.31	698.36	699.40	0.002268	2.44	28.27	20.44	0.37
Main	16983.37	100-YR	69.00	696.00	698.96		699.19	0.007931	3.78	18.26	16.81	0.64
Main	16899.4*	100-YR	69.00	695.54	698.31		698.53	0.007827	3.73	18.49	17.45	0.64
Main	16815.4*	100-YR	69.00	695.08	697.65		697.86	0.007922	3.72	18.53	17.95	0.65
Main	16731.5*	100-YR	69.00	694.62	696.99		697.20	0.007773	3.68	18.77	18.49	0.64
Main	16647.5*	100-YR	69.00	694.16	696.32		696.53	0.008157	3.71	18.60	18.90	0.66
Main	16563.6*	100-YR	69.00	693.70	695.74		695.92	0.006350	3.43	20.13	19.20	0.59
Main	16479.65	100-YR	69.00	693.24	695.48		695.58	0.002535	2.52	27.42	20.84	0.39
Main	16403.7*	100-YR	69.00	693.01	695.35		695.41	0.001655	2.01	34.31	26.84	0.31
Main	16327.7*	100-YR	69.00	692.78	695.26		695.31	0.001096	1.63	42.54	39.63	0.26
Main	16251.7*	100-YR	69.00	692.54	695.21		695.24	0.000694	1.30	63.41	122.38	0.20
Main	16175.84	100-YR	86.00	692.31	695.16		695.18	0.000673	1.29	102.23	192.14	0.20
Main	16100.*	100-YR	86.00	692.07	695.12		695.14	0.000448	1.18	92.52	143.40	0.17
Main	16024.40	100-YR	86.00	691.83	695.12		695.12	0.000083	0.56	365.86	595.71	0.07
Main	15850.19	100-YR	86.00	691.30	695.11		695.11	0.000061	0.64	545.03	700.51	0.07
Main	15434.41	100-YR	86.00	690.01	695.01		695.05	0.000417	1.57	54.88	19.93	0.17
Main	15212.53	100-YR	86.00	689.73	694.94		694.97	0.000293	1.38	62.31	21.26	0.14
Main	14922.76	100-YR	86.00	689.36	694.92		694.93	0.000061	0.66	212.96	432.27	0.07
Main	14774.58	100-YR	145.00	689.19	694.89		694.91	0.000184	1.23	262.80	325.76	0.12
Main	14457.09	100-YR	145.00	688.79	694.85		694.86	0.000126	1.06	227.27	219.32	0.10
Main	14406.13	100-YR	145.00	688.73	694.84	690.09	694.86	0.000070	0.99	225.97	140.46	0.07
Main	14204.08		Culvert									
Main	13981.41	100-YR	153.00	688.38	694.76	689.80	694.77	0.000060	1.03	148.43	32.88	0.08
Main	13949.59	100-YR	153.00	688.37	694.75	690.47	694.77	0.000089	1.12	136.14	325.68	0.10
Main	13839.56	100-YR	153.00	688.25	694.74	690.37	694.76	0.000074	1.14	148.01	351.53	0.09
Main	13732.13	100-YR	153.00	688.19	694.75	690.40	694.75	0.000019	0.57	397.65	365.00	0.05
Main	13662.15	100-YR	153.00	688.17	694.73	690.44	694.75	0.000079	1.15	192.23	261.68	0.09
Main	13628.36	100-YR	153.00	688.12	694.73	690.06	694.74	0.000057	1.06	178.52	205.13	0.08
Main	13536.36		Culvert									
Main	13453.85	100-YR	179.00	688.72	694.57	690.27	694.59	0.000311	1.15	165.04	333.16	0.09
Main	13414.20	100-YR	179.00	689.00	694.56	690.73	694.58	0.000290	1.01	193.17	346.75	0.09
Main	13217.08	100-YR	179.00	688.99	694.44		694.48	0.000881	1.66	135.34	174.43	0.15
Main	13001.02	100-YR	179.00	688.98	694.13		694.21	0.001883	2.23	80.14	23.89	0.21
Main	12615.85	100-YR	179.00	688.85	693.43		693.50	0.001772	2.13	84.13	26.44	0.21
Main	12216.99	100-YR	179.00	688.69	693.08		693.13	0.000564	1.76	101.96	34.73	0.18
Main	12019.91	100-YR	179.00	688.59	692.81		692.94	0.001774	2.87	62.36	23.02	0.31
Main	12001.15	100-YR	179.00	688.06	692.84	689.58	692.88	0.000487	1.75	102.38	28.52	0.16
Main	11937.42		Culvert									
Main	11882.28	100-YR	179.00	687.94	692.70	689.56	692.73	0.000272	1.55	121.21	40.35	0.13
Main	11831.40	100-YR	179.00	688.77	692.61	690.48	692.69	0.001038	2.34	76.44	94.42	0.24
Main	11746.9*	100-YR	179.00	688.77	692.52		692.59	0.001259	2.24	107.78	128.19	0.23
Main	11662.5*	100-YR	179.00	688.77	692.40		692.47	0.001626	2.24	132.20	219.12	0.24
Main	11578.0*	100-YR	179.00	688.76	692.28		692.33	0.001600	1.99	221.17	449.36	0.22
Main	11493.63	100-YR	179.00	688.76	692.24		692.25	0.000401	0.96	683.14	808.64	0.10
Main	11398.6*	100-YR	179.00	688.76	692.19		692.20	0.000545	1.11	583.66	801.35	0.12
Main	11303.5*	100-YR	179.00	688.76	692.13		692.15	0.000620	1.18	529.62	795.41	0.13
Main	11208.5*	100-YR	179.00	688.75	692.07		692.09	0.000569	1.11	521.27	714.98	0.12
Main	11113.5*	100-YR	179.00	688.75	692.02		692.03	0.000475	1.00	547.72	662.36	0.11
Main	11018.49	100-YR	131.00	688.75	692.00		692.00	0.000194	0.64	605.90	648.72	0.07
Main	10922.5*	100-YR	131.00	688.75	691.97		691.98	0.000182	0.61	506.63	566.51	0.07
Main	10826.6*	100-YR	131.00	688.75	691.96		691.96	0.000137	0.53	519.77	525.08	0.06
Main	10730.67	100-YR	131.00	688.75	691.94		691.95	0.000094	0.44	547.90	501.77	0.05
Main	10638.0*	100-YR	131.00	688.74	691.94		691.94	0.000065	0.35	665.50	553.90	0.04
Main	10545.5*	100-YR	131.00	688.73	691.94		691.94	0.000036	0.26	894.09	617.16	0.03
Main	10452.9*	100-YR	131.00	688.72	691.93		691.93	0.000016	0.17	1222.49	710.06	0.02
Main	10360.3*	100-YR	131.00	688.71	691.93		691.93	0.000005	0.10	1636.75	740.01	0.01
Main	10267.74	100-YR	131.00	688.70	691.93		691.93	0.000079	0.36	325.23	815.73	0.04
Main	10182.4*	100-YR	131.00	688.69	691.93		691.93	0.000009	0.13	2038.32	768.42	0.01
Main	10097.1*	100-YR	131.00	688.68	691.93		691.93	0.000006	0.11	1965.85	765.46	0.01
Main	10011.8*	100-YR	131.00	688.67	691.93		691.93	0.000004	0.09	1901.31	790.61	0.01
Main	9926.510	100-YR	131.00	688.66	691.93		691.93	0.000108	0.47	337.01	881.45	0.05
Main	9491.793	100-YR	131.00	688.61	691.89	689.36	691.90	0.000110	0.42	268.05	436.45	0.05
Main	9382.780		Inl Struct									
Main	8939.248	100-YR	131.00	688.30	691.89		691.89	0.000086	0.34	732.20	847.33	0.04
Main	8784.397	100-YR	131.00	688.22	691.86		691.87	0.000400	0.92	435.45	885.21	0.10
Main	8722.829	100-YR	131.00	688.12	691.81	689.74	691.82	0.000420	0.81	439.62	594.57	0.10
Main	8695.034		Culvert									
Main	8674.268	100-YR	131.00	687.48	691.81	688.96	691.82	0.000167	0.67	521.52	659.81	0.07
Main	8631.519	100-YR	131.00	687.41	691.81	688.93	691.81	0.000194	0.68	511.30	612.68	0.07
Main	8345.665	100-YR	131.00	687.28	691.80		691.80	0.000017	0.23	1622.88	1240.99	0.02
Main	8047.118	100-YR	117.00	687.10	691.79		691.79	0.000020	0.23	1098.06	746.24	0.02
Main	7739.449	100-YR	117.00	686.99	691.79		691.79	0.000010	0.21	1181.74	1501.85	0.02
Main	7515.565	100-YR	117.00	686.79	691.79		691.79	0.000027	0.32	512.50	332.20	0.03
Main	7272.821	100-YR	117.00	686.67	691.78		691.78	0.000027	0.36	1107.21	909.38	0.03
Main	7255.385	100-YR	117.00	686.00	691.78	688.14	691.78	0.000051	0.41	1171.85	811.72	0.04
Main	7226.812		Culvert									
Main	7193.714	100-YR	117.00	685.90	691.78	688.09	691.78	0.000014	0.26	1609.04	667.23	0.02
Main	7141.580	100-YR	117.00	686.28	691.78	687.38	691.78	0.000025	0.23	1107.45	609.82	0.02
Main	7071.87*	100-YR	117.00	686.28	691.77		691.77	0.000021	0.23	1173.94	558.56	0.02

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 100-YR (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7002.16*	100-YR	117.00	686.27	691.77		691.77	0.000019	0.25	1181.38	547.70	0.02
Main	6932.458	100-YR	117.00	686.27	691.77		691.77	0.000018	0.29	1203.73	513.27	0.02
Main	6846.57*	100-YR	117.00	686.27	691.77		691.77	0.000034	0.40	779.47	444.15	0.03
Main	6760.7*	100-YR	117.00	686.27	691.76		691.76	0.000048	0.48	536.42	313.07	0.04
Main	6674.82*	100-YR	117.00	686.26	691.76		691.76	0.000055	0.51	470.26	349.69	0.04
Main	6588.943	100-YR	117.00	686.26	691.76		691.76	0.000027	0.36	1002.16	526.88	0.03
Main	6495.53*	100-YR	117.00	686.26	691.75		691.75	0.000010	0.22	1432.96	712.80	0.02
Main	6402.13*	100-YR	117.00	686.26	691.75		691.75	0.000007	0.18	1878.17	906.49	0.01
Main	6308.73*	100-YR	117.00	686.27	691.75	687.39	691.75	0.000006	0.17	1897.59	1141.81	0.01
Main	6215.32*	100-YR	117.00	686.27	691.75	687.33	691.75	0.000005	0.16	1816.34	1485.95	0.01
Main	6121.924	100-YR	117.00	686.27	691.75	687.29	691.75	0.000005	0.16	1635.49	1805.53	0.01
Main	6035.96*	100-YR	117.00	686.27	691.75	687.33	691.75	0.000006	0.17	1526.06	1748.64	0.01
Main	5950.01*	100-YR	117.00	686.27	691.75	687.39	691.75	0.000008	0.19	1337.92	1703.48	0.02
Main	5864.05*	100-YR	117.00	686.27	691.75	687.50	691.75	0.000010	0.22	1114.09	1677.45	0.02
Main	5778.104	100-YR	117.00	686.27	691.75	687.67	691.75	0.000015	0.26	862.49	1651.33	0.02
Main	5687.63*	100-YR	117.00	686.28	691.74	687.95	691.75	0.000032	0.39	504.24	1144.72	0.03
Main	5597.166	100-YR	117.00	686.28	691.73		691.74	0.000075	0.63	220.46	647.62	0.06
Main	5556.618	100-YR	117.00	686.43	691.72	687.69	691.73	0.000158	0.98	127.99	534.54	0.08
Main	5525.006		Culvert									
Main	5490.413	100-YR	113.00	685.19	691.63	686.57	691.65	0.000107	0.90	125.95	375.60	0.07
Main	5437.667	100-YR	113.00	685.35	691.64	686.34	691.64	0.000029	0.44	257.09	474.11	0.04
Main	5357.86*	100-YR	113.00	685.35	691.63	686.50	691.64	0.000047	0.54	208.94	408.08	0.04
Main	5278.05*	100-YR	113.00	685.34	691.62	686.72	691.63	0.000079	0.68	167.23	347.05	0.06
Main	5198.254	100-YR	113.00	685.34	691.61		691.62	0.000145	0.87	129.51	283.19	0.07
Main	5121.63*	100-YR	113.00	685.34	691.60	687.02	691.61	0.000127	0.81	139.39	311.87	0.07
Main	5045.01*	100-YR	113.00	685.34	691.59	687.02	691.60	0.000108	0.74	152.96	321.91	0.07
Main	4968.39*	100-YR	113.00	685.33	691.59	687.02	691.59	0.000087	0.64	190.36	343.05	0.06
Main	4891.776	100-YR	113.00	685.33	691.58		691.59	0.000045	0.51	315.21	531.24	0.04
Main	4810.20*	100-YR	113.00	685.33	691.58	687.10	691.58	0.000060	0.55	295.62	452.48	0.05
Main	4728.63*	100-YR	113.00	685.33	691.57	687.19	691.58	0.000079	0.60	278.18	296.53	0.06
Main	4647.06*	100-YR	113.00	685.32	691.56	687.24	691.57	0.000098	0.64	274.52	278.97	0.06
Main	4565.488	100-YR	113.00	685.32	691.55		691.56	0.000127	0.71	219.87	260.73	0.07
Main	4504.263	100-YR	113.00	685.32	691.54	687.37	691.55	0.000165	0.82	139.90	69.61	0.08
Main	4461.252		Culvert									
Main	4430.212	100-YR	113.00	684.72	691.29	686.85	691.32	0.000170	1.16	99.08	28.57	0.09
Main	4346.582	100-YR	113.00	685.50	691.28	687.01	691.30	0.000197	0.96	117.13	30.16	0.09
Main	4194.408	100-YR	113.00	685.49	691.25		691.26	0.000244	1.03	109.41	30.00	0.10
Main	3788.373	100-YR	113.00	685.36	691.24		691.24	0.000019	0.34	575.05	283.09	0.03
Main	3395.646	100-YR	113.00	685.01	691.23		691.23	0.000016	0.44	493.65	218.85	0.03
Main	3331.113	100-YR	113.00	685.09	691.22	686.65	691.23	0.000053	0.74	157.85	91.03	0.06
Main	3265.168		Culvert									
Main	3196.567	100-YR	100.00	683.69	688.68	686.04	688.74	0.000589	2.10	53.22	20.85	0.19
Main	3141.921	100-YR	100.00	683.98	688.65		688.70	0.000736	1.90	52.66	17.34	0.19
Main	3004.055	100-YR	100.00	683.97	688.60		688.63	0.000300	1.32	75.51	22.57	0.13
Main	2734.719	100-YR	100.00	683.96	688.49		688.53	0.000521	1.61	62.22	21.54	0.17
Main	2688.915	100-YR	100.00	683.95	688.45	685.97	688.50	0.000648	1.72	58.31	21.62	0.18
Main	2653.174		Culvert									
Main	2626.817	100-YR	100.00	683.44	687.84	685.47	687.95	0.001769	2.71	36.90	11.41	0.27
Main	2582.291	100-YR	100.00	683.33	687.79	685.45	687.87	0.001129	2.27	43.97	14.48	0.23
Main	2218.895	100-YR	100.00	682.33	687.76		687.77	0.000094	0.81	123.53	34.14	0.08
Main	2049.666	100-YR	100.00	681.91	687.74		687.75	0.000092	0.80	158.02	81.10	0.07
Main	1853.478	100-YR	304.00	681.42	687.60		687.68	0.000713	2.24	135.87	37.65	0.21
Main	1799.666	100-YR	304.00	681.24	687.55	684.48	687.63	0.000867	2.30	132.27	37.60	0.22
Main	1727.858		Culvert									
Main	1670.018	100-YR	304.00	681.24	686.97	684.40	687.11	0.001352	3.09	105.08	37.57	0.27
Main	1606.765	100-YR	304.00	681.22	686.96	684.90	687.01	0.000636	1.88	173.68	426.71	0.19
Main	1475.852	100-YR	304.00	681.21	686.64		686.80	0.002630	3.27	94.39	54.44	0.38
Main	1134.554	100-YR	304.00	681.17	685.92		686.06	0.001793	3.00	101.35	37.17	0.32
Main	792.3003	100-YR	304.00	681.12	684.65		684.99	0.006496	4.80	115.08	194.29	0.58
Main	482.8005	100-YR	361.00	680.38	684.71		684.72	0.000202	1.13	1417.70	848.37	0.11
Main	35.46111	100-YR	361.00	680.10	684.70	680.61	684.70	0.000011	0.35	1919.79	769.39	0.03

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 500-YR

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17035.08	500-YR	162.00	696.40	700.15	699.15	700.34	0.002575	3.52	46.37	26.99	0.42
Main	16983.37	500-YR	162.00	696.00	699.77		700.11	0.008133	4.66	34.79	24.21	0.68
Main	16899.4*	500-YR	162.00	695.54	699.09		699.43	0.008079	4.62	35.06	24.86	0.69
Main	16815.4*	500-YR	162.00	695.08	698.41		698.74	0.008141	4.62	35.04	25.22	0.69
Main	16731.5*	500-YR	162.00	694.62	697.73		698.07	0.007958	4.62	35.10	25.09	0.69
Main	16647.5*	500-YR	162.00	694.16	697.08		697.41	0.007605	4.59	35.27	24.68	0.68
Main	16563.6*	500-YR	162.00	693.70	696.54		696.83	0.006038	4.29	38.02	31.52	0.61
Main	16479.65	500-YR	162.00	693.24	696.47		696.55	0.001441	2.60	138.44	221.31	0.32
Main	16403.7*	500-YR	162.00	693.01	696.41		696.46	0.000824	2.02	197.63	257.50	0.24
Main	16327.7*	500-YR	162.00	692.78	696.38		696.41	0.000446	1.53	271.75	282.17	0.18
Main	16251.7*	500-YR	162.00	692.54	696.37		696.38	0.000251	1.18	357.35	308.93	0.14
Main	16175.84	500-YR	161.00	692.31	696.36		696.37	0.000146	0.93	454.20	337.80	0.10
Main	16100.*	500-YR	161.00	692.07	696.35		696.36	0.000087	0.71	675.32	652.37	0.08
Main	16024.40	500-YR	161.00	691.83	696.35		696.35	0.000024	0.42	1108.29	1154.01	0.04
Main	15850.19	500-YR	161.00	691.30	696.35		696.35	0.000023	0.50	1315.24	1142.18	0.04
Main	15434.41	500-YR	161.00	690.01	696.25		696.31	0.000482	1.96	82.64	30.77	0.19
Main	15212.53	500-YR	161.00	689.73	696.17		696.22	0.000372	1.77	90.94	25.36	0.16
Main	14922.76	500-YR	161.00	689.36	696.17		696.17	0.000051	0.76	388.64	645.23	0.07
Main	14774.58	500-YR	227.00	689.19	696.15		696.16	0.000088	1.05	502.92	393.69	0.09
Main	14457.09	500-YR	227.00	688.79	696.12		696.13	0.000084	1.07	391.02	270.14	0.09
Main	14406.13	500-YR	227.00	688.73	696.11	690.57	696.13	0.000074	1.17	309.44	254.00	0.08
Main	14204.08		Culvert									
Main	13981.41	500-YR	235.00	688.38	695.88	690.32	695.91	0.000077	1.30	180.98	209.47	0.09
Main	13949.59	500-YR	235.00	688.37	695.88	690.89	695.90	0.000097	1.35	177.35	341.88	0.11
Main	13839.56	500-YR	235.00	688.25	695.88	690.80	695.89	0.000049	1.03	324.39	378.01	0.08
Main	13732.13	500-YR	235.00	688.19	695.89	690.86	695.89	0.000005	0.32	817.69	377.29	0.02
Main	13662.15	500-YR	235.00	688.17	695.87	690.91	695.89	0.000077	1.26	280.07	340.91	0.09
Main	13628.36	500-YR	235.00	688.12	695.86	690.58	695.88	0.000065	1.28	234.61	215.17	0.09
Main	13536.36		Culvert									
Main	13453.85	500-YR	255.00	688.72	695.48	690.62	695.51	0.000342	1.35	203.23	387.42	0.10
Main	13414.20	500-YR	255.00	689.00	695.47	691.05	695.49	0.000271	1.12	261.04	472.25	0.09
Main	13217.08	500-YR	255.00	688.99	695.38		695.41	0.000602	1.54	279.94	372.83	0.13
Main	13001.02	500-YR	255.00	688.98	695.08		695.18	0.001855	2.45	104.12	26.42	0.22
Main	12615.85	500-YR	255.00	688.85	694.42		694.50	0.001641	2.28	111.79	29.63	0.21
Main	12216.99	500-YR	255.00	688.69	694.13		694.18	0.000453	1.81	140.91	41.25	0.17
Main	12019.91	500-YR	255.00	688.59	693.91		694.03	0.001298	2.82	91.57	32.20	0.27
Main	12001.15	500-YR	255.00	688.06	693.93	689.99	693.99	0.000441	1.89	136.56	37.63	0.16
Main	11937.42		Culvert									
Main	11882.28	500-YR	255.00	687.94	693.73	689.88	693.78	0.000267	1.76	151.21	43.29	0.13
Main	11831.40	500-YR	255.00	688.77	693.85	690.85	693.74	0.000867	2.45	104.02	232.03	0.22
Main	11746.9*	500-YR	255.00	688.77	693.65		693.67	0.000423	1.51	386.03	384.21	0.14
Main	11662.5*	500-YR	255.00	688.77	693.62		693.63	0.000345	1.22	643.40	645.39	0.11
Main	11578.0*	500-YR	255.00	688.76	693.61		693.61	0.000154	0.78	1172.61	819.77	0.07
Main	11493.63	500-YR	255.00	688.76	693.60		693.60	0.000052	0.44	1873.38	910.91	0.04
Main	11398.6*	500-YR	255.00	688.76	693.60		693.60	0.000061	0.49	1809.52	922.99	0.04
Main	11303.5*	500-YR	255.00	688.76	693.59		693.59	0.000061	0.49	1805.36	939.80	0.04
Main	11208.5*	500-YR	255.00	688.75	693.59		693.59	0.000057	0.48	1839.29	946.08	0.04
Main	11113.5*	500-YR	255.00	688.75	693.58		693.58	0.000051	0.45	1910.39	976.40	0.04
Main	11018.49	500-YR	159.00	688.75	693.58		693.58	0.000017	0.26	2008.13	1017.75	0.02
Main	10922.5*	500-YR	159.00	688.75	693.57		693.58	0.000018	0.27	1682.67	871.74	0.02
Main	10826.6*	500-YR	159.00	688.75	693.57		693.57	0.000016	0.26	1634.17	790.39	0.02
Main	10730.67	500-YR	159.00	688.75	693.57		693.57	0.000014	0.23	1614.29	759.28	0.02
Main	10638.0*	500-YR	159.00	688.74	693.57		693.57	0.000010	0.19	1794.52	796.05	0.02
Main	10545.5*	500-YR	159.00	688.73	693.57		693.57	0.000006	0.15	2115.93	846.68	0.01
Main	10452.9*	500-YR	159.00	688.72	693.57		693.57	0.000003	0.10	2539.06	899.72	0.01
Main	10360.3*	500-YR	159.00	688.71	693.57		693.57	0.000001	0.07	3058.69	965.15	0.01
Main	10267.74	500-YR	159.00	688.70	693.57		693.57	0.000006	0.14	1894.19	1110.58	0.01
Main	10182.4*	500-YR	159.00	688.69	693.57		693.57	0.000002	0.09	3501.41	1001.83	0.01
Main	10097.1*	500-YR	159.00	688.68	693.57		693.57	0.000002	0.08	3419.85	1012.16	0.01
Main	10011.8*	500-YR	159.00	688.67	693.57		693.57	0.000001	0.06	3410.35	1018.53	0.01
Main	9926.510	500-YR	159.00	688.66	693.57		693.57	0.000007	0.15	2052.03	1212.48	0.01
Main	9491.793	500-YR	159.00	688.61	693.57	689.43	693.57	0.000014	0.21	1219.05	725.97	0.02
Main	9382.780		Int Struct									
Main	8939.248	500-YR	159.00	688.30	693.56		693.56	0.000008	0.16	2616.31	1293.89	0.02
Main	8784.397	500-YR	159.00	688.22	693.56		693.56	0.000040	0.37	1347.42	1178.11	0.03
Main	8722.829	500-YR	159.00	688.12	693.55	690.31	693.55	0.000051	0.39	1266.45	975.93	0.04
Main	8695.034		Culvert									
Main	8674.268	500-YR	159.00	687.48	693.55	689.12	693.55	0.000024	0.34	1452.32	986.33	0.03
Main	8631.519	500-YR	159.00	687.41	693.55	689.10	693.55	0.000029	0.36	1410.69	985.88	0.03
Main	8345.665	500-YR	159.00	687.28	693.55		693.55	0.000002	0.11	3942.61	1382.51	0.01
Main	8047.118	500-YR	145.00	687.10	693.55		693.55	0.000003	0.11	2477.88	837.64	0.01
Main	7739.449	500-YR	145.00	686.99	693.55		693.55	0.000002	0.12	2365.71	1594.50	0.01
Main	7515.565	500-YR	145.00	686.79	693.54		693.55	0.000009	0.24	916.53	411.57	0.02
Main	7272.821	500-YR	145.00	686.67	693.54		693.54	0.000006	0.20	2793.83	1012.44	0.01
Main	7255.385	500-YR	145.00	686.00	693.54	688.32	693.54	0.000009	0.22	2711.15	966.95	0.02
Main	7226.812		Culvert									
Main	7193.714	500-YR	145.00	685.90	693.54	688.28	693.54	0.000004	0.17	3039.51	834.45	0.01
Main	7141.580	500-YR	145.00	686.28	693.54	687.49	693.54	0.000006	0.13	2304.20	675.12	0.01
Main	7071.87*	500-YR	145.00	686.28	693.54		693.54	0.000006	0.15	2236.60	641.81	0.01

HEC-RAS Plan: LOMR Steady River: Spring Creek Reach: Main Profile: 500-YR (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7002.16*	500-YR	145.00	686.27	693.54		693.54	0.000006	0.17	2186.52	587.56	0.01
Main	6932.458	500-YR	145.00	686.27	693.54		693.54	0.000006	0.20	2143.25	562.50	0.01
Main	6846.57*	500-YR	145.00	686.27	693.54		693.54	0.000009	0.26	1660.30	516.41	0.02
Main	6760.7*	500-YR	145.00	686.27	693.54		693.54	0.000014	0.32	1276.80	576.10	0.02
Main	6674.82*	500-YR	145.00	686.26	693.54		693.54	0.000014	0.32	1374.95	608.64	0.02
Main	6588.943	500-YR	145.00	686.26	693.54		693.54	0.000007	0.23	2010.35	629.09	0.02
Main	6495.53*	500-YR	145.00	686.26	693.53		693.54	0.000003	0.14	2780.55	831.45	0.01
Main	6402.13*	500-YR	145.00	686.26	693.53		693.53	0.000002	0.12	3611.66	1049.78	0.01
Main	6308.73*	500-YR	145.00	686.27	693.53	687.48	693.53	0.000002	0.11	3421.87	1336.60	0.01
Main	6215.32*	500-YR	145.00	686.27	693.53	687.44	693.53	0.000002	0.11	3144.21	1612.74	0.01
Main	6121.924	500-YR	145.00	686.27	693.53	687.39	693.53	0.000002	0.11	2790.65	1883.41	0.01
Main	6035.96*	500-YR	145.00	686.27	693.53	687.45	693.53	0.000002	0.13	2548.96	1836.51	0.01
Main	5950.01*	500-YR	145.00	686.27	693.53	687.51	693.53	0.000003	0.14	2229.77	1785.38	0.01
Main	5864.05*	500-YR	145.00	686.27	693.53	687.62	693.53	0.000004	0.16	1831.71	1745.16	0.01
Main	5778.104	500-YR	145.00	686.27	693.53	687.84	693.53	0.000005	0.19	1394.90	1702.18	0.01
Main	5687.63*	500-YR	145.00	686.28	693.53	688.12	693.53	0.000011	0.29	838.01	1202.20	0.02
Main	5597.166	500-YR	145.00	686.28	693.53		693.53	0.000024	0.45	363.14	669.70	0.03
Main	5556.618	500-YR	145.00	686.43	693.52	687.87	693.53	0.000069	0.81	190.95	637.29	0.06
Main	5525.006		Culvert									
Main	5490.413	500-YR	142.00	685.19	693.40	686.75	693.41	0.000069	0.86	165.22	548.24	0.06
Main	5437.667	500-YR	142.00	685.35	693.41	686.49	693.41	0.000016	0.40	358.57	539.52	0.03
Main	5357.86*	500-YR	142.00	685.35	693.40	686.65	693.41	0.000027	0.48	295.58	471.20	0.04
Main	5278.05*	500-YR	142.00	685.34	693.40	686.87	693.40	0.000046	0.59	238.71	404.59	0.04
Main	5198.254	500-YR	142.00	685.34	693.39		693.40	0.000082	0.76	187.92	341.64	0.06
Main	5121.63*	500-YR	142.00	685.34	693.38	687.21	693.39	0.000069	0.69	205.55	361.35	0.05
Main	5045.01*	500-YR	142.00	685.34	693.38	687.20	693.39	0.000054	0.60	289.62	532.72	0.05
Main	4968.39*	500-YR	142.00	685.33	693.38	687.19	693.38	0.000027	0.47	590.31	688.23	0.04
Main	4891.776	500-YR	142.00	685.33	693.38		693.38	0.000013	0.34	1045.92	784.24	0.02
Main	4810.20*	500-YR	142.00	685.33	693.38	687.29	693.38	0.000013	0.34	1027.13	783.77	0.02
Main	4728.63*	500-YR	142.00	685.33	693.38	687.38	693.38	0.000015	0.35	989.15	683.57	0.03
Main	4647.06*	500-YR	142.00	685.32	693.38	687.45	693.38	0.000016	0.34	940.79	445.21	0.03
Main	4565.488	500-YR	142.00	685.32	693.37		693.37	0.000032	0.47	480.09	411.98	0.04
Main	4504.263	500-YR	142.00	685.32	693.36	687.54	693.37	0.000062	0.65	227.86	79.10	0.05
Main	4461.252		Culvert									
Main	4430.212	500-YR	142.00	684.72	692.97	687.02	692.99	0.000110	1.11	129.34	35.01	0.07
Main	4346.582	500-YR	142.00	685.50	692.96	687.22	692.97	0.000108	0.83	171.78	34.94	0.07
Main	4194.408	500-YR	142.00	685.49	692.94		692.95	0.000127	0.85	166.11	36.87	0.07
Main	3788.373	500-YR	142.00	685.36	692.94		692.94	0.000007	0.25	1105.69	336.92	0.02
Main	3395.646	500-YR	142.00	685.01	692.94		692.94	0.000008	0.37	773.15	260.38	0.02
Main	3331.113	500-YR	142.00	685.09	692.93	686.82	692.94	0.000029	0.68	217.19	148.47	0.05
Main	3265.168		Culvert									
Main	3196.567	500-YR	113.00	683.69	689.83	686.16	689.88	0.000315	1.83	69.67	23.36	0.14
Main	3141.921	500-YR	113.00	683.98	689.82		689.85	0.000368	1.51	74.68	20.31	0.14
Main	3004.055	500-YR	113.00	683.97	689.80		689.81	0.000157	1.09	104.03	25.31	0.09
Main	2734.719	500-YR	113.00	683.96	689.74		689.76	0.000231	1.23	91.57	25.29	0.11
Main	2688.915	500-YR	113.00	683.95	689.73	686.08	689.75	0.000264	1.27	88.77	26.00	0.12
Main	2653.174		Culvert									
Main	2626.817	500-YR	113.00	683.44	689.24	685.62	689.31	0.000814	2.06	54.94	14.22	0.18
Main	2582.291	500-YR	113.00	683.33	689.23	685.58	689.27	0.000468	1.70	66.54	16.94	0.15
Main	2218.895	500-YR	113.00	682.33	689.22		689.23	0.000040	0.64	176.81	39.83	0.05
Main	2049.666	500-YR	113.00	681.91	689.22		689.22	0.000033	0.57	293.90	106.89	0.05
Main	1853.478	500-YR	484.00	681.42	689.07		689.16	0.000697	2.43	199.15	48.16	0.21
Main	1799.666	500-YR	484.00	681.24	689.02	685.14	689.12	0.000747	2.51	193.68	46.94	0.21
Main	1727.858		Culvert									
Main	1670.018	500-YR	484.00	681.24	687.85	685.30	688.09	0.001731	3.99	129.56	60.63	0.32
Main	1606.765	500-YR	484.00	681.22	687.88	685.50	687.95	0.000580	2.16	237.77	443.18	0.19
Main	1475.852	500-YR	484.00	681.21	687.41		687.61	0.002340	3.67	157.83	96.96	0.37
Main	1134.554	500-YR	484.00	681.17	686.55		686.78	0.002512	3.85	125.63	40.66	0.39
Main	792.3003	500-YR	484.00	681.12	685.20		685.53	0.005573	5.17	260.15	355.38	0.56
Main	482.8005	500-YR	585.00	680.38	685.22		685.22	0.000259	1.41	1860.57	894.69	0.13
Main	35.46111	500-YR	585.00	680.10	685.20	680.80	685.20	0.000020	0.49	2312.92	803.77	0.04

Floodway Calculation Table

Reach	River Sta	Profile	Top Width	W.S. Elev	Area	Vel Total	Floodway Top Width	Floodway WSEL	Floodway Area	Floodway Velocity	Storage Percentage	Change in Velocity	WSEL
			(ft)	(ft)	(sq ft)	(ft/s)	(ft)	(ft)	(sq ft)	(ft/s)			
Main	17035.08	100-YR	20.44	699.31	28.27	2.44	20.44	699.31	28.27	2.44	1.00	0.00	0
Main	16983.37	100-YR	16.81	698.96	18.26	3.78	16.81	698.96	18.26	3.78	1.00	0.00	0
Main	16899.4*	100-YR	17.45	698.31	18.49	3.73	17.45	698.31	18.49	3.73	1.00	0.00	0
Main	16815.4*	100-YR	17.95	697.65	18.53	3.72	17.95	697.65	18.53	3.72	1.00	0.00	0
Main	16731.5*	100-YR	18.49	696.99	18.77	3.68	18.49	696.99	18.77	3.68	1.00	0.00	0
Main	16647.5*	100-YR	18.9	696.32	18.6	3.71	18.9	696.32	18.6	3.71	1.00	0.00	0
Main	16563.6*	100-YR	19.2	695.74	20.13	3.43	19.21	695.74	20.15	3.42	1.00	0.00	0
Main	16479.65	100-YR	20.84	695.48	27.42	2.52	20.86	695.48	27.45	2.51	1.00	0.00	0
Main	16403.7*	100-YR	26.84	695.35	34.31	2.01	26.86	695.35	34.37	2.01	1.00	0.00	0
Main	16327.7*	100-YR	39.63	695.26	42.54	1.62	33.68	695.27	42.51	1.62	1.00	0.00	0.01
Main	16251.7*	100-YR	122.38	695.21	63.41	1.09	98.29	695.21	59.46	1.16	0.94	0.06	0
Main	16175.84	100-YR	192.14	695.16	102.23	0.84	166.39	695.16	94.68	0.91	0.93	0.08	0
Main	16100.*	100-YR	143.4	695.12	92.52	0.93	126.81	695.12	87.86	0.98	0.95	0.05	0
Main	16024.4	100-YR	595.71	695.12	420.15	0.24	464.99	695.12	400.85	0.25	0.95	0.04	0
Main	15850.19	100-YR	700.51	695.11	622.51	0.16	540	695.11	583.13	0.17	0.94	0.06	0
Main	15434.41	100-YR	19.93	695.01	54.88	1.57	19.93	695.01	54.92	1.57	1.00	0.00	0
Main	15212.53	100-YR	21.26	694.94	62.31	1.38	21.27	694.94	62.35	1.38	1.00	0.00	0
Main	14922.76	100-YR	432.27	694.92	502.15	0.4	337.78	694.93	459.11	0.4	0.91	0.00	0.01
Main	14774.58	100-YR	325.76	694.89	418.9	0.55	266.56	694.9	382.77	0.55	0.91	0.00	0.01
Main	14457.09	100-YR	219.32	694.85	316.04	0.64	175.72	694.85	290.76	0.64	0.92	0.00	0
Main	14406.13	100-YR	140.46	694.84	301.17	0.64	100.46	694.84	273.88	0.64	0.91	0.00	0
Main	14204.08		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	13981.41	100-YR	32.88	694.76	154.62	1.03	32.89	694.76	154.69	1.03	1.00	0.00	0
Main	13949.59	100-YR	325.68	694.75	1370.05	1.12	287.37	694.75	1241.85	1.12	0.91	0.00	0
Main	13839.56	100-YR	351.53	694.74	1466.9	1.03	313.35	694.74	1329.57	1.03	0.91	0.00	0
Main	13732.13	100-YR	365	694.75	1188.71	0.38	331.88	694.75	1075.03	0.41	0.90	0.08	0
Main	13662.15	100-YR	261.68	694.73	239.07	0.8	222.09	694.73	217.55	0.8	0.91	0.00	0
Main	13628.36	100-YR	205.13	694.73	238.97	0.86	145.69	694.73	220.38	0.86	0.92	0.00	0
Main	13536.36		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	13453.85	100-YR	333.16	694.57	399.7	1.08	272.58	694.58	360.29	1.08	0.90	0.00	0.01
Main	13414.2	100-YR	346.75	694.56	377.63	0.93	274	694.57	348.71	0.93	0.92	0.00	0.01
Main	13217.08	100-YR	174.43	694.44	169	1.32	150.54	694.44	155.5	1.32	0.92	0.00	0
Main	13001.02	100-YR	23.89	694.13	80.14	2.23	23.89	694.13	80.21	2.23	1.00	0.00	0
Main	12615.85	100-YR	26.44	693.43	84.13	2.13	26.46	693.44	84.28	2.12	1.00	0.00	0.01
Main	12216.99	100-YR	34.73	693.08	101.96	1.76	34.76	693.09	102.23	1.75	1.00	-0.01	0.01
Main	12019.91	100-YR	23.02	692.81	62.36	2.87	23	692.82	62.6	2.86	1.00	0.00	0.01
Main	12001.15	100-YR	28.52	692.84	102.38	1.75	28.49	692.85	102.67	1.74	1.00	-0.01	0.01
Main	11937.42		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	11882.28	100-YR	40.35	692.7	143.14	1.48	33.85	692.71	129.64	1.49	0.91	0.01	0.01
Main	11831.4	100-YR	94.42	692.61	100.95	2.34	68.6	692.62	91.95	2.33	0.91	0.00	0.01
Main	11746.9*	100-YR	128.19	692.52	107.78	1.66	90.08	692.53	102.03	1.75	0.95	0.05	0.01
Main	11662.5*	100-YR	219.12	692.4	132.2	1.35	141.02	692.42	120.05	1.49	0.91	0.10	0.02
Main	11578.0*	100-YR	449.36	692.28	221.17	0.81	362.2	692.29	200.98	0.89	0.91	0.10	0.01

Floodway Calculation Table

Reach	River Sta	Profile	Top Width	W.S. Elev	Area	Vel Total	Floodway Top Width	Floodway WSEL	Floodway Area	Floodway Velocity	Storage Percentage	Change in Velocity	WSEL
Main	11493.63	100-YR	808.64	692.24	683.14	0.26	709.04	692.26	633.46	0.28	0.93	0.08	0.02
Main	11398.6*	100-YR	801.35	692.19	583.66	0.31	627.99	692.21	523.81	0.34	0.90	0.10	0.02
Main	11303.5*	100-YR	795.41	692.13	529.62	0.34	610.08	692.14	475.69	0.38	0.90	0.12	0.01
Main	11208.5*	100-YR	714.98	692.07	521.27	0.34	576.29	692.08	467.59	0.38	0.90	0.12	0.01
Main	11113.5*	100-YR	662.36	692.02	547.72	0.33	528.12	692.03	494.29	0.36	0.90	0.09	0.01
Main	11018.49	100-YR	648.72	692	605.9	0.22	533.79	692.01	553.44	0.24	0.91	0.09	0.01
Main	10922.5*	100-YR	566.51	691.97	506.63	0.26	424.96	691.98	467.01	0.28	0.92	0.08	0.01
Main	10826.6*	100-YR	525.08	691.96	519.77	0.25	410.55	691.96	484.08	0.27	0.93	0.08	0
Main	10730.67	100-YR	501.77	691.94	547.9	0.24	402.18	691.95	513.2	0.26	0.94	0.08	0.01
Main	10638.0*	100-YR	553.9	691.94	665.5	0.2	382.33	691.95	604.58	0.22	0.91	0.10	0.01
Main	10545.5*	100-YR	617.16	691.94	894.09	0.15	459.42	691.94	808.14	0.16	0.90	0.07	0
Main	10452.9*	100-YR	710.06	691.93	1222.49	0.11	551.22	691.94	1100.28	0.12	0.90	0.09	0.01
Main	10360.3*	100-YR	740.01	691.93	1636.75	0.08	634.48	691.94	1492.99	0.09	0.91	0.13	0.01
Main	10267.74	100-YR	815.73	691.93	2125.62	0.4	708.47	691.94	1983.21	0.41	0.93	0.02	0.01
Main	10182.4*	100-YR	768.42	691.93	2038.32	0.06	673.29	691.94	1853.78	0.07	0.91	0.17	0.01
Main	10097.1*	100-YR	765.46	691.93	1965.85	0.07	678.75	691.94	1797.19	0.07	0.91	0.00	0.01
Main	10011.8*	100-YR	790.61	691.93	1901.31	0.07	707.39	691.94	1733.4	0.08	0.91	0.14	0.01
Main	9926.51	100-YR	881.45	691.93	1918.46	0.39	793.18	691.93	1720.7	0.39	0.90	0.00	0
Main	9491.793	100-YR	436.45	691.89	967.13	0.49	380.34	691.9	878.70	0.49	0.91	0.00	0.01
Main	9382.78		Inl Struct				Inl Struct				#DIV/0!	#DIV/0!	0
Main	8939.248	100-YR	847.33	691.89	743.79	0.18	646.47	691.89	678.25	0.2	0.91	0.11	0
Main	8784.397	100-YR	885.21	691.86	906.16	0.3	713.96	691.87	821.41	0.31	0.91	0.03	0.01
Main	8722.829	100-YR	594.57	691.81	749.82	0.3	513.55	691.82	677.28	0.33	0.90	0.10	0.01
Main	8695.034		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	8674.268	100-YR	659.81	691.81	830.5	0.25	567.19	691.82	747.13	0.26	0.90	0.04	0.01
Main	8631.519	100-YR	612.68	691.81	796.76	0.26	487.74	691.81	713.98	0.26	0.90	0.00	0
Main	8345.665	100-YR	1240.99	691.8	1780.23	0.08	1047.74	691.8	1601.29	0.09	0.90	0.13	0
Main	8047.118	100-YR	746.24	691.79	1631.94	0.11	615	691.8	1469.77	0.12	0.90	0.09	0.01
Main	7739.449	100-YR	1501.85	691.79	2501.67	0.1	1153	691.79	2241.54	0.11	0.90	0.10	0
Main	7515.565	100-YR	332.2	691.79	747.61	0.23	288.42	691.79	677.4	0.23	0.91	0.00	0
Main	7272.821	100-YR	909.38	691.78	1444.37	0.11	680	691.78	1299.06	0.12	0.90	0.09	0
Main	7255.385	100-YR	811.72	691.78	2077.96	0.1	620	691.78	1893.19	0.11	0.91	0.10	0
Main	7226.812		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	7193.714	100-YR	667.23	691.78	1769.09	0.07	535	691.78	1593.66	0.08	0.90	0.14	0
Main	7141.58	100-YR	609.82	691.78	1175.11	0.11	515	691.78	1052.1	0.11	0.90	0.00	0
Main	7071.87*	100-YR	558.56	691.77	1173.94	0.1	463	691.78	1053.05	0.11	0.90	0.10	0.01
Main	7002.16*	100-YR	547.7	691.77	1181.38	0.1	430	691.77	1063.98	0.11	0.90	0.10	0
Main	6932.458	100-YR	513.27	691.77	1203.73	0.1	418	691.77	1088.43	0.11	0.90	0.10	0
Main	6846.57*	100-YR	444.15	691.77	779.47	0.15	332	691.77	731.46	0.16	0.94	0.07	0
Main	6760.7*	100-YR	313.07	691.76	536.42	0.22	215	691.76	483.08	0.24	0.90	0.09	0
Main	6674.82*	100-YR	349.69	691.76	470.26	0.25	221.45	691.76	431.11	0.27	0.92	0.08	0
Main	6588.943	100-YR	526.88	691.76	1002.16	0.12	476.59	691.76	903.15	0.13	0.90	0.08	0
Main	6495.53*	100-YR	712.8	691.75	1432.96	0.08	631.44	691.76	1287.4	0.09	0.90	0.13	0.01
Main	6402.13*	100-YR	906.49	691.75	1878.17	0.06	789.38	691.75	1689.07	0.07	0.90	0.17	0

Floodway Calculation Table

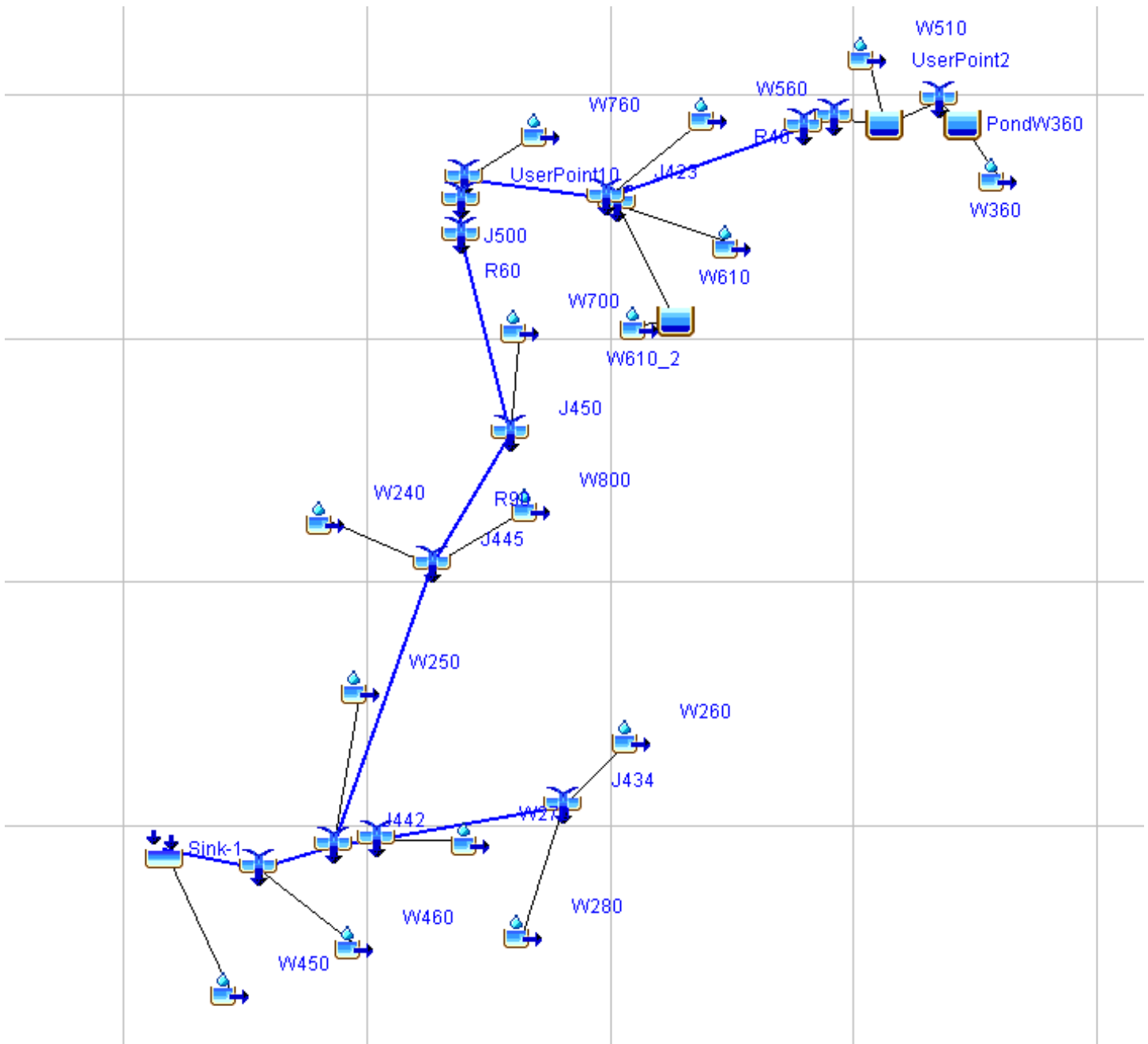
Reach	River Sta	Profile	Top Width	W.S. Elev	Area	Vel Total	Floodway Top Width	Floodway WSEL	Floodway Area	Floodway Velocity	Storage Percentage	Change in Velocity	WSEL
Main	6308.73*	100-YR	1141.81	691.75	2345.54	0.06	956.08	691.75	2116.43	0.06	0.90	0.00	0
Main	6215.32*	100-YR	1485.95	691.75	2900.12	0.06	1153.92	691.75	2628.16	0.06	0.91	0.00	0
Main	6121.924	100-YR	1805.53	691.75	3649.23	0.07	1522.04	691.75	3327.81	0.07	0.91	0.00	0
Main	6035.96*	100-YR	1748.64	691.75	3579.73	0.08	1446.54	691.75	3242.9	0.08	0.91	0.00	0
Main	5950.01*	100-YR	1703.48	691.75	3556.17	0.09	1417.91	691.75	3246.43	0.09	0.91	0.00	0
Main	5864.05*	100-YR	1677.45	691.75	3569.02	0.11	1358.99	691.75	3218.99	0.1	0.90	-0.09	0
Main	5778.104	100-YR	1651.33	691.75	3599.88	0.14	1364.84	691.75	3293.75	0.14	0.91	0.00	0
Main	5687.63*	100-YR	1144.72	691.74	2724.66	0.23	1018.52	691.75	2554.39	0.23	0.94	0.00	0.01
Main	5597.166	100-YR	647.62	691.73	1655.24	0.53	573.61	691.74	1503.24	0.53	0.91	0.00	0.01
Main	5556.618	100-YR	534.54	691.72	1041.92	0.91	426.28	691.72	950.96	0.91	0.91	0.00	0
Main	5525.006		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	5490.413	100-YR	375.6	691.63	334.72	0.9	329.52	691.63	304.8	0.9	0.91	0.00	0
Main	5437.667	100-YR	474.11	691.64	1131.93	0.44	400.73	691.64	1025.33	0.44	0.91	0.00	0
Main	5357.86*	100-YR	408.08	691.63	926.63	0.54	344.74	691.63	832.76	0.54	0.90	0.00	0
Main	5278.05*	100-YR	347.05	691.62	752.99	0.68	300.41	691.62	683.09	0.68	0.91	0.00	0
Main	5198.254	100-YR	283.19	691.61	605.26	0.87	249.73	691.61	551.24	0.87	0.91	0.00	0
Main	5121.63*	100-YR	311.87	691.6	595.5	0.81	262.34	691.6	543.37	0.81	0.91	0.00	0
Main	5045.01*	100-YR	321.91	691.59	619.7	0.74	263.28	691.59	565.89	0.74	0.91	0.00	0
Main	4968.39*	100-YR	343.05	691.59	695.6	0.59	279	691.59	630.29	0.59	0.91	0.00	0
Main	4891.776	100-YR	531.24	691.58	864.78	0.36	410	691.59	790.14	0.37	0.91	0.03	0.01
Main	4810.20*	100-YR	452.48	691.58	410.14	0.38	322	691.58	376.24	0.4	0.92	0.05	0
Main	4728.63*	100-YR	296.53	691.57	278.18	0.41	278.12	691.57	249.97	0.45	0.90	0.10	0
Main	4647.06*	100-YR	278.97	691.56	274.52	0.41	263.89	691.56	248.78	0.45	0.91	0.10	0
Main	4565.488	100-YR	260.73	691.55	269.96	0.51	186.61	691.55	242.82	0.51	0.90	0.00	0
Main	4504.263	100-YR	69.61	691.54	157.14	0.81	52.32	691.54	142.47	0.81	0.91	0.00	0
Main	4461.252		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	4430.212	100-YR	28.57	691.29	120.83	1.14	28	691.29	120.74	1.14	1.00	0.00	0
Main	4346.582	100-YR	30.16	691.28	117.13	0.96	30.16	691.28	117.14	0.96	1.00	0.00	0
Main	4194.408	100-YR	30	691.25	109.41	1.03	30	691.25	109.43	1.03	1.00	0.00	0
Main	3788.373	100-YR	283.09	691.24	575.05	0.2	220	691.24	525.61	0.21	0.91	0.05	0
Main	3395.646	100-YR	218.85	691.23	533.36	0.23	160	691.23	493.01	0.23	0.92	0.00	0
Main	3331.113	100-YR	91.03	691.22	189.34	0.72	60	691.22	179.06	0.72	0.95	0.00	0
Main	3265.168		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	3196.567	100-YR	20.85	688.68	61.4	1.88	20.67	688.69	61.65	1.87	1.00	-0.01	0.01
Main	3141.921	100-YR	17.34	688.65	52.66	1.9	17.38	688.66	52.88	1.89	1.00	-0.01	0.01
Main	3004.055	100-YR	22.57	688.6	75.51	1.32	22.6	688.62	75.81	1.32	1.00	0.00	0.02
Main	2734.719	100-YR	21.54	688.49	62.22	1.61	21.59	688.5	62.54	1.6	1.01	-0.01	0.01
Main	2688.915	100-YR	21.62	688.45	58.31	1.72	21.68	688.47	58.64	1.71	1.01	-0.01	0.02
Main	2653.174		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	2626.817	100-YR	11.41	687.84	36.9	2.71	11.46	687.86	37.17	2.69	1.01	-0.01	0.02
Main	2582.291	100-YR	14.48	687.79	43.97	2.27	14.52	687.82	44.33	2.26	1.01	0.00	0.03
Main	2218.895	100-YR	34.14	687.76	123.53	0.81	34.22	687.78	124.39	0.8	1.01	-0.01	0.02
Main	2049.666	100-YR	81.1	687.74	158.02	0.63	76.61	687.77	158.54	0.63	1.00	0.00	0.03
Main	1853.478	100-YR	37.65	687.6	135.87	2.24	37.86	687.63	136.94	2.22	1.01	-0.01	0.03

Floodway Calculation Table

Reach	River Sta	Profile	Top Width	W.S. Elev	Area	Vel Total	Floodway Top Width	Floodway WSEL	Floodway Area	Floodway Velocity	Storage Percentage	Change in Velocity	WSEL
Main	1799.666	100-YR	37.6	687.55	132.27	2.3	33	687.58	131.03	2.32	0.99	0.01	0.03
Main	1727.858		Culvert				Culvert				#DIV/0!	#DIV/0!	0
Main	1670.018	100-YR	37.57	686.97	115.43	2.89	29.07	687	108.04	2.87	0.94	-0.01	0.03
Main	1606.765	100-YR	426.71	686.96	395.62	1.75	126.26	686.99	357.5	1.72	0.90	-0.02	0.03
Main	1475.852	100-YR	54.44	686.64	94.39	3.22	32	686.66	88.09	3.45	0.93	0.07	0.02
Main	1134.554	100-YR	37.17	685.92	101.35	3	27	685.92	91.99	3.3	0.91	0.10	0
Main	792.3003	100-YR	194.29	684.65	115.08	2.64	129.58	684.65	104.55	2.91	0.91	0.10	0
Main	482.8005	100-YR	848.37	684.71	1417.7	0.25	677.52	684.71	1313.92	0.27	0.93	0.08	0
Main	35.46111	100-YR	769.39	684.7	1919.79	0.19	623	684.7	1762.01	0.2	0.92	0.05	0

Appendix 2
Hydrologic Calculations

HEC-HMS MODEL SCHEMATIC





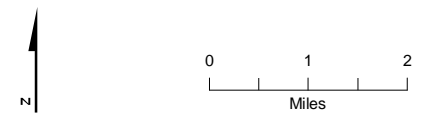
LEGEND

Calumet-Sag Curve Numbers

Value

High : 100

Low : 30



DRAFT

Appendix D.1
Calumet-Sag Watershed Curve Number Grid



Data Comparison Table

Location	Area (sq. mi.)		
	FIS	LOMR	StreamStats
At 118th Avenue (XS 1799.666)	2.3	2.3	2.3
At 159th Street (XS 5556.618)	1.6	1.6	1.5
At 151st Street and Wold Road (XS 13628.36)	0.8	0.8	0.8

Location	10-Year Flows (cfs)		
	FIS	LOMR	StreamStats
At 118th Avenue (XS 1799.666)	108	157	139
At 159th Street (XS 5556.618)	61	80	96
At 151st Street and Wold Road (XS 13628.36)	64	81	72

Location	50-Year Flows (cfs)		
	FIS	LOMR	StreamStats
At 118th Avenue (XS 1799.666)	205	244	210
At 159th Street (XS 5556.618)	90	107	146
At 151st Street and Wold Road (XS 13628.36)	112	129	113

Location	100-Year Flows (cfs)		
	FIS	LOMR	StreamStats
At 118th Avenue (XS 1799.666)	259	304	247
At 159th Street (XS 5556.618)	97	117	172
At 151st Street and Wold Road (XS 13628.36)	139	153	135

Location	500-Year Flows (cfs)		
	FIS	LOMR	StreamStats
At 118th Avenue (XS 1799.666)	396	484	342
At 159th Street (XS 5556.618)	117	145	241
At 151st Street and Wold Road (XS 13628.36)	195	235	193

FIS XS	CBBEL HEC-RAS Station	Flowrate (cfs)			WSEL (ft, NAVD)		
		FIS	Unsteady Model	Steady Model	FIS	Unsteady Model	Steady Model
S	16983.37	67	63	69	700.7	698.9	698.96
R	16024.4	98	73	86	695.8	695.06	695.12
Q	15850.19	98	75	86	695.8	695.05	695.11
P	15212.53	139	82	86	695.3	694.87	694.94
O	14457.09	139	145	145	694.7	694.75	694.85
Wolf Road							
N	13981.41	148	145	153	693.9	694.66	694.76
151st Street (Upstream Crossing)							
M	13453.85	183	153	179	693.6	694.48	694.57
L	12019.91	183	176	179	693.1	692.78	692.81
151st Street (Downstream Crossing)							
K	11831.4	144	177	179	692.8	692.63	692.61
J	8722.829	144	124	131	691.4	691.83	691.81
155th Street							
157th Street							
I	7193.714	97	116	117	691.3	691.78	691.78
159th Street							
H	5490.413	105	113	113	691.1	691.65	691.63
Jaunita Drive							
G	4346.582	105	113	113	690.9	691.3	691.28
F	3331.113	105	113	113	690.8	691.21	691.22
Private Drive							
E	3196.567	105	83	100	689.4	689.07	688.68
Field Access Road							
D	2582.291	107	90	100	688.4	688.55	687.79
C	1799.666	259	272	304	686.7	688.34	687.55
Will-Cook Road							
B	1670.018	259	245	304	685.2	688.01	686.97
A	482.8005	738	361	361	682.9	684.74	684.71

HEC-RAS Plan: 10yrHuff River: Spring Creek Reach: Main Profile: Max WS (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7193.714	Max WS	76.38	685.90	690.36		690.36	0.000042	0.35	800.28	604.47	0.03
Main	7141.580	Max WS	76.39	686.28	690.35		690.35	0.000096	0.34	363.67	421.85	0.03
Main	7071.87*	Max WS	75.63	686.28	690.34		690.35	0.000076	0.34	414.99	478.56	0.03
Main	7002.16*	Max WS	75.20	686.27	690.34		690.34	0.000062	0.36	459.96	466.66	0.04
Main	6932.458	Max WS	74.93	686.27	690.33		690.33	0.000053	0.39	493.28	433.95	0.04
Main	6846.57*	Max WS	74.49	686.27	690.33		690.33	0.000089	0.51	271.49	240.33	0.05
Main	6760.7*	Max WS	73.19	686.27	690.32		690.32	0.000105	0.55	193.10	146.92	0.05
Main	6674.82*	Max WS	72.46	686.26	690.31		690.31	0.000112	0.58	171.50	104.47	0.06
Main	6588.943	Max WS	71.65	686.26	690.30		690.30	0.000078	0.48	366.24	342.47	0.05
Main	6495.53*	Max WS	71.08	686.26	690.29		690.29	0.000040	0.34	503.17	512.33	0.03
Main	6402.13*	Max WS	71.07	686.26	690.29		690.29	0.000028	0.29	644.48	705.85	0.03
Main	6308.73*	Max WS	70.82	686.27	690.29		690.29	0.000021	0.24	713.69	903.29	0.02
Main	6215.32*	Max WS	71.05	686.27	690.29		690.29	0.000015	0.21	770.65	1088.96	0.02
Main	6121.924	Max WS	70.82	686.27	690.29		690.29	0.000014	0.20	721.28	1209.10	0.02
Main	6035.98*	Max WS	70.36	686.27	690.28		690.28	0.000015	0.20	721.43	1251.83	0.02
Main	5950.01*	Max WS	70.60	686.27	690.28		690.28	0.000019	0.23	649.40	1259.34	0.02
Main	5864.05*	Max WS	70.62	686.27	690.28		690.28	0.000025	0.26	558.98	1272.02	0.03
Main	5778.104	Max WS	70.34	686.27	690.28		690.28	0.000036	0.30	453.31	1272.65	0.03
Main	5687.63*	Max WS	70.30	686.28	690.27		690.27	0.000089	0.49	248.22	1028.11	0.05
Main	5597.166	Max WS	70.21	686.28	690.25		690.26	0.000216	0.81	107.42	620.42	0.09
Main	5556.618	Max WS	70.16	686.43	690.23		690.25	0.000246	0.95	76.04	374.02	0.09
Main	5525.006		Culvert									
Main	5490.413	Max WS	70.08	685.19	690.19		690.20	0.000110	0.75	93.85	32.44	0.06
Main	5437.687	Max WS	70.07	685.35	690.19		690.19	0.000031	0.39	181.90	428.82	0.04
Main	5357.86*	Max WS	70.05	685.35	690.18		690.19	0.000050	0.48	146.51	355.21	0.04
Main	5278.05*	Max WS	70.05	685.34	690.18		690.18	0.000085	0.60	118.13	255.34	0.06
Main	5198.254	Max WS	70.02	685.34	690.16		690.17	0.000161	0.79	88.44	213.87	0.08
Main	5121.63*	Max WS	69.99	685.34	690.15		690.16	0.000146	0.75	93.83	193.22	0.07
Main	5045.01*	Max WS	70.03	685.34	690.14		690.15	0.000130	0.69	101.12	222.98	0.07
Main	4968.39*	Max WS	70.00	685.33	690.14		690.14	0.000111	0.63	112.00	248.83	0.06
Main	4891.778	Max WS	69.98	685.33	690.13		690.13	0.000084	0.52	146.41	280.52	0.06
Main	4810.20*	Max WS	69.97	685.33	690.12		690.13	0.000115	0.60	121.48	57.72	0.06
Main	4728.63*	Max WS	69.95	685.33	690.11		690.12	0.000151	0.67	109.44	53.31	0.07
Main	4647.06*	Max WS	69.96	685.32	690.09		690.10	0.000184	0.74	99.68	48.60	0.08
Main	4565.488	Max WS	69.96	685.32	690.07		690.08	0.000225	0.82	92.02	45.68	0.09
Main	4504.263	Max WS	69.94	685.32	690.06		690.07	0.000203	0.84	83.69	27.83	0.08
Main	4481.252		Culvert									
Main	4430.212	Max WS	69.89	684.72	689.95		689.96	0.000166	0.95	74.74	25.09	0.08
Main	4346.582	Max WS	69.90	685.50	689.94		689.95	0.000219	0.88	79.41	25.75	0.09
Main	4194.408	Max WS	69.84	685.49	689.90		689.91	0.000278	0.98	72.56	24.53	0.10
Main	3788.373	Max WS	69.83	685.36	689.84		689.84	0.000034	0.36	241.20	166.34	0.04
Main	3395.646	Max WS	69.82	685.01	689.83		689.83	0.000022	0.43	272.13	140.00	0.04
Main	3331.113	Max WS	69.82	685.09	689.82		689.83	0.000065	0.65	109.34	35.50	0.06
Main	3265.168		Culvert									
Main	3196.567	Max WS	68.66	683.69	687.81		687.87	0.000645	1.87	40.88	18.97	0.19
Main	3141.921	Max WS	68.83	683.98	687.77		687.82	0.000821	1.79	38.46	15.27	0.20
Main	3004.055	Max WS	69.23	683.97	687.72		687.74	0.000327	1.23	56.47	20.54	0.13
Main	2734.719	Max WS	69.99	683.96	687.57		687.61	0.000678	1.60	43.72	18.80	0.19
Main	2688.915	Max WS	70.15	683.95	687.52		687.57	0.000898	1.76	39.82	18.26	0.21
Main	2653.174		Culvert									
Main	2626.817	Max WS	52.37	683.44	687.10		687.15	0.000911	1.81	28.98	10.20	0.19
Main	2592.291	Max WS	52.85	683.33	687.08		687.11	0.000638	1.55	34.05	13.25	0.17
Main	2218.895	Max WS	56.47	682.33	686.97		686.98	0.000059	0.58	97.64	31.76	0.06
Main	2049.666	Max WS	56.46	681.91	686.96		686.97	0.000060	0.59	103.55	57.69	0.06
Main	1853.478	Max WS	126.93	681.42	686.90		686.92	0.000200	1.14	111.44	32.71	0.11
Main	1799.666	Max WS	127.02	681.24	686.89		686.91	0.000261	1.17	108.50	34.26	0.12
Main	1727.858		Culvert									
Main	1670.018	Max WS	125.77	681.24	686.78		686.81	0.000272	1.35	99.96	36.72	0.12
Main	1606.765	Max WS	126.18	681.22	686.78		686.79	0.000136	0.84	162.23	132.64	0.09
Main	1475.852	Max WS	151.94	681.21	685.68		685.79	0.002383	2.60	58.46	32.48	0.34
Main	1134.554	Max WS	154.06	681.17	685.12		685.19	0.001141	2.10	73.25	32.71	0.25
Main	792.3003	Max WS	154.01	681.12	684.56		684.66	0.001996	2.58	68.20	162.25	0.32
Main	482.8005	Max WS	179.52	680.36	684.22		684.23	0.000115	0.76	1032.40	754.69	0.08
Main	35.46111	Max WS	5.02	680.10	684.20	677.02	684.20	0.000000	0.01	1550.93	711.37	0.00

80

70

70

157

183

50-yr

HEC-RAS Plan: 50yrHuff River: Spring Creek Reach: Main Profile: Max WS

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit.W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/s)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17035.08	Max WS	55.61	696.40	699.16		699.23	0.001958	2.19	25.38	19.31	0.34
Main	16983.37	Max WS	55.61	696.00	698.80		698.99	0.007750	3.57	15.58	15.27	0.62
Main	16899.4*	Max WS	56.07	695.54	699.15		698.35	0.007715	3.53	15.88	16.06	0.63
Main	16815.4*	Max WS	56.44	695.08	697.50		697.69	0.007821	3.53	16.00	16.63	0.63
Main	16731.5*	Max WS	57.06	694.62	696.86		697.05	0.007853	3.49	16.37	17.23	0.63
Main	16647.5*	Max WS	57.67	694.16	696.20		696.39	0.007983	3.52	16.38	92.81	0.64
Main	16583.6*	Max WS	57.62	693.70	695.60		695.77	0.006674	3.31	17.42	130.04	0.60
Main	16479.85	Max WS	58.40	693.24	695.26		695.36	0.003002	2.55	22.90	149.46	0.41
Main	16403.7*	Max WS	59.12	693.01	695.08		695.16	0.002228	2.15	27.49	164.07	0.36
Main	16327.7*	Max WS	59.75	692.78	694.96		695.01	0.001841	1.83	32.68	185.59	0.31
Main	16251.7*	Max WS	60.44	692.54	694.86		694.90	0.001177	1.55	38.99	203.84	0.26
Main	16175.84	Max WS	61.20	692.31	694.80		694.82	0.000836	1.31	52.96	265.07	0.22
Main	16100.*	Max WS	62.83	692.07	694.75		694.77	0.000540	1.15	56.63	61.40	0.18
Main	16024.40	Max WS	64.06	691.83	694.72		694.72	0.000146	0.65	217.81	403.56	0.10
Main	15950.19	Max WS	65.64	691.30	694.70		694.70	0.000105	0.75	340.11	519.17	0.09
Main	15434.41	Max WS	69.76	690.01	694.57		694.60	0.000431	1.50	46.37	18.41	0.17
Main	15212.53	Max WS	71.90	689.73	694.49		694.52	0.000316	1.36	53.04	19.76	0.15
Main	14922.76	Max WS	74.71	689.36	694.45		694.45	0.000094	0.72	157.08	380.08	0.08
Main	14774.58	Max WS	118.89	689.19	694.40		694.42	0.000285	1.38	175.48	288.80	0.14
Main	14457.09	Max WS	122.58	688.79	694.33		694.35	0.000178	1.13	163.87	197.11	0.12
Main	14406.13	Max WS	123.24	688.73	694.32		694.34	0.000076	0.96	191.91	118.24	0.08
Main	14204.08											
Main	13981.41	Max WS	123.15	688.38	694.26		694.28	0.000052	0.92	134.54	31.80	0.07
Main	13949.59	Max WS	123.68	688.37	694.26		694.27	0.000083	1.03	119.99	319.04	0.09
Main	13839.56	Max WS	125.12	688.25	694.25		694.27	0.000070	1.05	128.64	342.08	0.09
Main	13732.13	Max WS	126.51	688.19	694.25		694.26	0.000057	0.94	215.21	362.47	0.08
Main	13662.15	Max WS	127.40	688.17	694.24		694.25	0.000085	1.13	154.40	107.21	0.09
Main	13628.36	Max WS	128.94	688.12	694.23		694.25	0.000058	1.00	154.65	73.13	0.08
Main	13536.36											
Main	13453.85	Max WS	128.98	688.72	694.13		694.14	0.000228	0.92	146.52	253.42	0.08
Main	13414.20	Max WS	129.37	689.00	694.12		694.13	0.000230	0.84	162.25	265.39	0.08
Main	13217.08	Max WS	132.36	688.99	694.01		694.04	0.000734	1.43	94.80	76.32	0.14
Main	13001.02	Max WS	135.44	688.98	693.74		693.79	0.001517	1.91	70.89	22.83	0.19
Main	12615.85	Max WS	140.34	688.85	693.18		693.23	0.001367	1.81	77.81	25.71	0.18
Main	12216.99	Max WS	145.23	688.69	692.82		692.86	0.000481	1.56	93.17	33.74	0.17
Main	12019.91	Max WS	147.75	688.59	692.56		692.66	0.001550	2.61	56.70	21.87	0.29
Main	12001.15	Max WS	148.08	688.06	692.60		692.64	0.000401	1.54	95.86	27.81	0.15
Main	11937.42											
Main	11862.28	Max WS	148.03	687.94	692.51		692.54	0.000216	1.34	115.90	39.83	0.11
Main	11831.40	Max WS	147.98	688.77	692.45		692.51	0.000828	2.04	72.49	79.41	0.21
Main	11746.9*	Max WS	149.29	688.77	692.37		692.43	0.001106	2.05	90.56	99.27	0.22
Main	11662.5*	Max WS	149.75	688.77	692.26		692.32	0.001479	2.08	104.11	164.24	0.23
Main	11578.0*	Max WS	149.61	688.76	692.13		692.18	0.001592	1.93	164.00	360.07	0.21
Main	11493.63	Max WS	149.78	688.76	692.06		692.06	0.000480	1.02	534.36	775.72	0.11
Main	11398.6*	Max WS	150.21	688.76	692.00		692.01	0.000671	1.19	431.07	739.58	0.13
Main	11303.5*	Max WS	149.92	688.76	691.93		691.94	0.000719	1.20	381.19	662.25	0.13
Main	11208.5*	Max WS	149.41	688.75	691.86		691.87	0.000643	1.12	380.57	599.57	0.13
Main	11113.5*	Max WS	147.55	688.75	691.81		691.82	0.000510	0.98	413.30	566.03	0.11
Main	11018.49	Max WS	147.06	688.75	691.76		691.77	0.000385	0.84	464.66	557.73	0.10
Main	10922.5*	Max WS	147.34	688.75	691.72		691.73	0.000379	0.82	380.29	424.84	0.10
Main	10826.6*	Max WS	147.88	688.75	691.68		691.69	0.000288	0.71	390.45	388.74	0.08
Main	10730.67	Max WS	147.96	688.75	691.65		691.66	0.000199	0.58	419.25	374.61	0.07
Main	10638.0*	Max WS	148.67	688.74	691.64		691.64	0.000142	0.48	520.14	441.33	0.06
Main	10545.5*	Max WS	148.84	688.73	691.63		691.64	0.000079	0.35	716.19	552.73	0.04
Main	10452.9*	Max WS	149.70	688.72	691.63		691.63	0.000035	0.22	1014.33	657.62	0.03
Main	10360.3*	Max WS	150.26	688.71	691.63		691.63	0.000011	0.12	1417.97	696.42	0.02
Main	10267.74	Max WS	150.74	688.70	691.62		691.63	0.000158	0.46	277.79	763.34	0.06
Main	10182.4*	Max WS	151.02	688.69	691.62		691.62	0.000017	0.17	1803.67	723.85	0.02
Main	10097.1*	Max WS	151.80	688.68	691.61		691.61	0.000013	0.15	1732.41	717.15	0.02
Main	10011.8*	Max WS	152.44	688.67	691.61		691.61	0.000008	0.12	1664.51	679.95	0.01
Main	9926.510	Max WS	152.91	688.66	691.60		691.61	0.000234	0.65	244.58	751.09	0.07
Main	9491.793	Max WS	120.62	688.61	691.53	689.33	691.53	0.000149	0.45	227.75	363.73	0.06
Main	9392.780											
Main	8939.246	Max WS	120.62	688.30	691.52		691.52	0.000145	0.42	467.35	811.99	0.06
Main	8784.397	Max WS	119.06	688.22	691.48		691.49	0.000694	1.13	279.58	716.15	0.13
Main	8722.829	Max WS	115.36	688.12	691.41		691.42	0.000744	0.97	311.35	500.79	0.12
Main	8695.034											
Main	8674.268	Max WS	114.57	687.48	691.40		691.41	0.000261	0.77	363.78	556.83	0.08
Main	8631.519	Max WS	113.82	687.41	691.39		691.40	0.000289	0.76	381.91	483.96	0.08
Main	8345.665	Max WS	109.22	687.28	691.36		691.36	0.000032	0.28	1094.68	1137.46	0.03
Main	8047.118	Max WS	106.80	687.10	691.35		691.35	0.000043	0.32	770.49	721.39	0.03
Main	7739.449	Max WS	106.09	686.99	691.34		691.34	0.000017	0.26	881.62	1363.38	0.02
Main	7515.565	Max WS	105.06	686.79	691.33		691.33	0.000035	0.33	420.15	313.76	0.03
Main	7272.821	Max WS	104.52	686.67	691.32		691.33	0.000040	0.41	761.04	822.35	0.04
Main	7255.385	Max WS	104.50	686.00	691.32		691.32	0.000096	0.52	848.18	776.29	0.05
Main	7226.812											

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HEC-RAS Plan: 50yrHuff River: Spring Creek Reach: Main Profile: Max WS (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7193.714	Max WS	104.14	685.90	691.32		691.32	0.000019	0.28	1343.99	657.73	0.02
Main	7141.580	Max WS	104.15	686.28	691.32		691.32	0.000038	0.26	851.51	586.10	0.02
Main	7071.87*	Max WS	104.02	686.28	691.32		691.32	0.000030	0.25	922.29	542.96	0.02
Main	7002.16*	Max WS	104.00	686.27	691.31		691.32	0.000026	0.28	936.04	509.88	0.02
Main	6932.458	Max WS	103.28	686.27	691.31		691.31	0.000024	0.32	970.89	504.07	0.03
Main	6846.57*	Max WS	102.78	686.27	691.31		691.31	0.000044	0.43	587.74	384.08	0.04
Main	6760.7*	Max WS	102.08	686.27	691.30		691.31	0.000059	0.50	403.98	247.24	0.04
Main	6674.82*	Max WS	102.26	686.26	691.30		691.30	0.000070	0.54	334.15	249.64	0.05
Main	6588.943	Max WS	101.93	686.26	691.29		691.29	0.000036	0.39	772.34	465.14	0.03
Main	6495.53*	Max WS	100.89	686.26	691.29		691.29	0.000015	0.25	1107.49	694.82	0.02
Main	6402.13*	Max WS	101.52	686.26	691.29		691.29	0.000010	0.20	1462.87	887.99	0.02
Main	6308.73*	Max WS	101.41	686.27	691.29		691.29	0.000008	0.19	1510.06	1087.65	0.02
Main	6215.32*	Max WS	101.11	686.27	691.29		691.29	0.000007	0.17	1478.39	1378.06	0.01
Main	6121.924	Max WS	101.07	686.27	691.29		691.29	0.000007	0.17	1341.30	1773.98	0.01
Main	6035.96*	Max WS	101.01	686.27	691.29		691.29	0.000008	0.18	1267.50	1720.88	0.02
Main	5950.01*	Max WS	100.98	686.27	691.29		691.29	0.000010	0.20	1116.84	1681.84	0.02
Main	5864.05*	Max WS	100.81	686.27	691.29		691.29	0.000013	0.22	933.80	1645.45	0.02
Main	5778.104	Max WS	100.79	686.27	691.28		691.28	0.000019	0.26	729.60	1607.51	0.02
Main	5687.63*	Max WS	100.80	686.28	691.28		691.28	0.000040	0.41	423.39	1137.05	0.04
Main	5597.166	Max WS	100.80	686.28	691.27		691.27	0.000097	0.66	183.79	642.12	0.06
Main	5556.618	Max WS	100.68	686.43	691.26		691.27	0.000175	0.97	111.83	499.20	0.08
Main	5525.006		Culvert									
Main	5490.413	Max WS	100.49	685.19	691.19		691.20	0.000111	0.87	116.09	206.71	0.07
Main	5437.667	Max WS	100.52	685.35	691.19		691.20	0.000031	0.43	233.36	459.20	0.04
Main	5357.86*	Max WS	100.49	685.35	691.19		691.19	0.000050	0.53	189.06	393.49	0.05
Main	5278.05*	Max WS	100.37	685.34	691.18		691.19	0.000083	0.67	150.92	333.28	0.06
Main	5198.254	Max WS	100.47	685.34	691.17		691.18	0.000154	0.86	116.33	269.24	0.08
Main	5121.63*	Max WS	100.35	685.34	691.16		691.17	0.000136	0.80	124.69	289.94	0.07
Main	5045.01*	Max WS	100.41	685.34	691.15		691.16	0.000117	0.74	136.14	303.47	0.07
Main	4968.39*	Max WS	100.34	685.33	691.14		691.15	0.000096	0.65	161.16	315.88	0.06
Main	4891.776	Max WS	100.37	685.33	691.14		691.14	0.000055	0.52	235.93	349.13	0.05
Main	4810.20*	Max WS	100.35	685.33	691.13		691.14	0.000079	0.59	203.35	231.10	0.06
Main	4728.63*	Max WS	100.32	685.33	691.12		691.13	0.000106	0.65	178.20	133.99	0.06
Main	4647.06*	Max WS	100.34	685.32	691.11		691.12	0.000135	0.71	168.21	147.48	0.07
Main	4565.488	Max WS	100.32	685.32	691.10		691.11	0.000172	0.77	158.26	183.73	0.08
Main	4504.263	Max WS	100.33	685.32	691.08		691.10	0.000203	0.85	119.10	62.10	0.09
Main	4481.252		Culvert									
Main	4430.212	Max WS	100.22	684.72	690.88		690.90	0.000173	1.11	91.67	27.44	0.09
Main	4346.582	Max WS	100.18	685.50	690.87		690.89	0.000209	0.95	105.05	28.91	0.09
Main	4194.408	Max WS	100.17	685.49	690.84		690.85	0.000261	1.03	97.42	28.34	0.10
Main	3788.373	Max WS	100.12	685.36	690.79		690.79	0.000024	0.35	451.76	255.16	0.03
Main	3395.646	Max WS	100.12	685.01	690.78		690.78	0.000018	0.45	419.37	208.53	0.04
Main	3331.113	Max WS	100.11	685.09	690.77		690.78	0.000058	0.72	142.21	67.52	0.06
Main	3265.168		Culvert									
Main	3196.567	Max WS	99.10	683.69	688.65		688.71	0.000593	2.10	52.82	20.79	0.19
Main	3141.921	Max WS	99.44	683.98	688.62		688.68	0.000746	1.91	52.19	17.28	0.19
Main	3004.055	Max WS	100.24	683.97	688.57		688.60	0.000310	1.34	74.80	22.50	0.13
Main	2734.719	Max WS	101.77	683.96	688.44		688.48	0.000564	1.66	61.22	21.41	0.17
Main	2698.915	Max WS	81.91	683.95	688.41		688.45	0.000451	1.42	57.51	21.49	0.15
Main	2653.174		Culvert									
Main	2626.817	Max WS	78.19	683.44	688.03		688.09	0.000929	2.00	39.17	11.80	0.19
Main	2582.291	Max WS	79.11	683.33	688.02		688.06	0.000580	1.67	47.26	14.86	0.17
Main	2218.895	Max WS	85.83	682.33	687.93		687.93	0.000061	0.66	129.30	34.65	0.06
Main	2049.666	Max WS	85.86	681.91	687.92		687.92	0.000058	0.64	172.54	86.12	0.06
Main	1853.478	Max WS	212.07	681.42	687.83		687.86	0.000298	1.47	144.66	39.33	0.13
Main	1799.666	Max WS	212.16	681.24	687.81		687.84	0.000347	1.49	142.12	38.90	0.14
Main	1727.858		Culvert									
Main	1670.018	Max WS	198.70	681.24	687.58		687.62	0.000355	1.74	121.98	49.68	0.14
Main	1606.765	Max WS	199.85	681.22	687.59		687.61	0.000132	0.98	217.60	438.20	0.09
Main	1475.852	Max WS	240.68	681.21	686.30		686.44	0.002539	3.02	79.81	37.26	0.36
Main	1134.554	Max WS	244.12	681.17	685.62		685.73	0.001592	2.70	109.34	35.49	0.30
Main	792.3003	Max WS	244.10	681.12	684.94		685.07	0.002352	3.14	179.08	270.39	0.36
Main	482.8005	Max WS	288.48	680.38	684.53		684.54	0.000171	1.00	1273.57	796.00	0.10
Main	35.46111	Max WS	4.92	680.10	684.50	677.01	684.50	0.000000	0.01	1767.93	743.10	0.00

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100-yr

HEC-RAS Plan: 100yr12hrHuf River: Spring Creek Reach: Main Profile: Max WS

Reach	River Sta	Profile	Q Total (cfs)	Min Ch EJ (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17035.08	Max WS	63.43	696.40	699.27		699.36	0.002032	2.29	27.65	20.20	0.35
Main	16983.37	Max WS	63.41	696.00	698.90		699.11	0.007787	3.68	17.23	16.24	0.63
Main	16899.4*	Max WS	63.95	695.54	698.25		698.46	0.007777	3.66	17.49	16.92	0.63
Main	16815.4*	Max WS	64.48	695.08	697.60		697.81	0.007839	3.65	17.67	17.48	0.64
Main	16731.5*	Max WS	65.02	694.62	696.95		697.15	0.007675	3.61	18.03	18.10	0.64
Main	16647.5*	Max WS	65.49	694.16	696.29		696.49	0.008019	3.64	17.99	99.52	0.65
Main	16563.6*	Max WS	65.30	693.70	695.73		695.90	0.005879	3.28	19.90	131.76	0.57
Main	16479.65	Max WS	66.31	693.24	695.44		695.54	0.002545	2.49	26.61	152.27	0.39
Main	16403.7*	Max WS	67.19	693.01	695.31		695.37	0.001716	2.02	33.20	168.72	0.32
Main	16327.7*	Max WS	68.10	692.78	695.22		695.26	0.001178	1.67	40.86	191.62	0.26
Main	16251.7*	Max WS	68.95	692.54	695.16		695.19	0.000791	1.36	57.44	274.07	0.22
Main	16175.84	Max WS	69.84	692.31	695.12		695.14	0.000495	1.09	94.53	358.85	0.17
Main	16100.*	Max WS	71.58	692.07	695.08		695.10	0.000340	1.01	86.86	128.49	0.15
Main	16024.40	Max WS	73.32	691.83	695.06		695.07	0.000069	0.50	343.19	557.79	0.07
Main	15850.19	Max WS	75.28	691.30	695.05		695.06	0.000053	0.59	517.68	680.16	0.06
Main	15434.41	Max WS	79.76	690.01	694.94		694.98	0.000383	1.49	53.56	19.70	0.16
Main	15212.53	Max WS	82.42	689.73	694.87		694.90	0.000288	1.35	60.89	21.04	0.14
Main	14922.76	Max WS	85.93	689.36	694.84		694.84	0.000069	0.68	202.59	423.08	0.07
Main	14774.58	Max WS	139.92	689.19	694.81		694.82	0.000197	1.26	247.11	319.14	0.12
Main	14457.09	Max WS	144.62	688.79	694.75		694.77	0.000141	1.10	215.57	214.96	0.11
Main	14406.13	Max WS	145.45	688.73	694.75		694.76	0.000076	1.01	219.71	135.52	0.08
Main	14204.08											
Main	13981.41	Max WS	145.40	688.38	694.66		694.67	0.000057	1.00	145.66	32.62	0.08
Main	13949.59	Max WS	146.02	688.37	694.65		694.67	0.000087	1.10	132.86	324.37	0.10
Main	13839.58	Max WS	147.80	688.25	694.64		694.66	0.000074	1.13	144.04	349.65	0.09
Main	13732.13	Max WS	149.55	688.19	694.65		694.65	0.000024	0.63	361.30	364.50	0.05
Main	13662.15	Max WS	150.69	688.17	694.64		694.65	0.000083	1.17	184.96	199.38	0.09
Main	13628.36	Max WS	152.66	688.12	694.63		694.65	0.000061	1.08	173.84	202.09	0.08
Main	13536.36											
Main	13453.85	Max WS	152.66	688.72	694.48		694.50	0.000243	1.00	161.09	321.02	0.08
Main	13414.20	Max WS	153.13	689.00	694.47		694.49	0.000232	0.89	166.75	328.85	0.08
Main	13217.08	Max WS	157.03	688.99	694.36		694.39	0.000743	1.51	125.17	163.37	0.14
Main	13001.02	Max WS	160.80	688.98	694.07		694.13	0.001601	2.04	78.65	23.72	0.20
Main	12815.85	Max WS	166.98	688.85	693.48		693.54	0.001485	1.96	85.26	26.57	0.19
Main	12216.99	Max WS	173.19	688.69	693.09		693.13	0.000525	1.70	102.12	34.75	0.17
Main	12019.91	Max WS	176.39	688.59	692.78		692.91	0.001776	2.86	61.62	22.86	0.31
Main	12001.15	Max WS	176.88	688.06	692.83		692.88	0.000477	1.73	102.32	28.52	0.16
Main	11937.42											
Main	11882.28	Max WS	176.80	687.94	692.71		692.74	0.000263	1.52	121.59	40.39	0.13
Main	11831.40	Max WS	176.64	688.77	692.63		692.71	0.000988	2.29	77.09	95.93	0.23
Main	11746.9*	Max WS	178.45	688.77	692.55		692.62	0.001197	2.20	112.00	137.02	0.23
Main	11662.5*	Max WS	178.69	688.77	692.44		692.50	0.001528	2.18	140.01	226.32	0.23
Main	11578.0*	Max WS	178.62	688.78	692.31		692.36	0.001452	1.91	236.60	487.48	0.21
Main	11493.83	Max WS	179.21	688.76	692.24		692.25	0.000403	0.97	681.95	808.38	0.10
Main	11398.6*	Max WS	179.36	688.76	692.19		692.20	0.000546	1.11	584.20	801.49	0.12
Main	11303.5*	Max WS	178.53	688.70	692.14		692.15	0.000609	1.17	533.12	797.56	0.12
Main	11208.5*	Max WS	171.53	688.75	692.09		692.10	0.000508	1.06	529.50	719.82	0.11
Main	11113.5*	Max WS	131.78	688.75	692.04		692.05	0.000245	0.73	560.78	671.03	0.08
Main	11018.49	Max WS	131.21	688.75	692.02		692.03	0.000184	0.62	623.54	658.71	0.07
Main	10922.5*	Max WS	130.55	688.75	692.00		692.01	0.000170	0.60	523.13	576.02	0.07
Main	10826.6*	Max WS	130.06	688.75	691.99		691.99	0.000127	0.51	535.73	531.20	0.06
Main	10730.67	Max WS	129.86	688.75	691.97		691.98	0.000088	0.42	563.68	509.85	0.05
Main	10638.0*	Max WS	129.75	688.74	691.97		691.97	0.000061	0.34	682.87	568.33	0.04
Main	10545.5*	Max WS	129.29	688.73	691.97		691.97	0.000034	0.25	912.97	622.76	0.03
Main	10452.9*	Max WS	129.87	688.72	691.96		691.96	0.000015	0.16	1243.98	714.95	0.02
Main	10360.3*	Max WS	130.08	688.71	691.96		691.96	0.000005	0.09	1658.98	747.43	0.01
Main	10267.74	Max WS	129.99	688.70	691.96		691.96	0.000075	0.35	330.29	822.22	0.04
Main	10182.4*	Max WS	130.21	688.69	691.96		691.96	0.000009	0.12	2058.13	773.65	0.01
Main	10097.1*	Max WS	130.16	688.68	691.96		691.96	0.000006	0.11	1985.60	767.61	0.01
Main	10011.8*	Max WS	130.65	688.67	691.96		691.96	0.000004	0.09	1921.72	794.40	0.01
Main	9926.510	Max WS	130.63	688.66	691.95		691.95	0.000104	0.46	344.37	887.83	0.05
Main	9491.793	Max WS	129.11	688.61	691.89	689.31	691.90	0.000107	0.41	267.76	435.61	0.05
Main	9382.760											
Main	8939.248	Max WS	129.11	688.30	691.89		691.89	0.000093	0.33	732.62	847.64	0.04
Main	8784.397	Max WS	127.85	688.22	691.86		691.87	0.000378	0.89	437.32	886.15	0.10
Main	8722.829	Max WS	123.75	688.12	691.83		691.83	0.000379	0.77	443.88	596.76	0.09
Main	8695.034											
Main	8674.268	Max WS	122.46	687.48	691.83		691.83	0.000143	0.62	526.47	661.75	0.06
Main	8631.519	Max WS	122.23	687.41	691.82		691.82	0.000166	0.63	516.20	615.57	0.06
Main	8345.665	Max WS	118.08	687.28	691.80		691.80	0.000014	0.20	1622.88	1240.99	0.02
Main	8047.118	Max WS	117.43	687.10	691.79		691.79	0.000020	0.23	1098.52	746.26	0.02
Main	7739.449	Max WS	117.19	686.99	691.79		691.79	0.000010	0.21	1162.11	1501.96	0.02
Main	7515.565	Max WS	116.42	686.79	691.79		691.79	0.000026	0.31	512.72	332.24	0.03
Main	7272.821	Max WS	115.74	686.67	691.78		691.78	0.000027	0.36	1108.76	909.56	0.03
Main	7255.385	Max WS	115.73	686.00	691.78		691.78	0.000048	0.41	1172.59	811.80	0.04
Main	7226.812											

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HEC-RAS Plan: 100yr12hrHuf River: Spring Creek Reach: Main Profile: Max WS (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7193.714	Max WS	115.73	685.90	691.78		691.78	0.000014	0.25	1609.69	667.25	0.02
Main	7141.580	Max WS	115.92	686.28	691.78		691.78	0.000025	0.23	1108.11	609.87	0.02
Main	7071.87*	Max WS	115.61	686.28	691.78		691.78	0.000020	0.22	1174.79	558.61	0.02
Main	7002.16*	Max WS	115.59	686.27	691.77		691.77	0.000018	0.25	1182.42	547.75	0.02
Main	6932.458	Max WS	115.28	686.27	691.77		691.77	0.000017	0.29	1204.96	513.31	0.02
Main	6846.57*	Max WS	114.94	686.27	691.77		691.77	0.000033	0.40	780.72	444.26	0.03
Main	6760.7*	Max WS	114.76	686.27	691.77		691.77	0.000046	0.47	537.49	313.14	0.04
Main	6674.82*	Max WS	114.32	686.26	691.76		691.76	0.000052	0.50	471.65	350.83	0.04
Main	6588.943	Max WS	114.14	686.26	691.76		691.76	0.000025	0.35	1003.87	526.99	0.03
Main	6495.53*	Max WS	113.85	686.26	691.76		691.76	0.000010	0.22	1435.09	712.92	0.02
Main	6402.13*	Max WS	113.82	686.26	691.76		691.76	0.000007	0.18	1880.99	806.63	0.01
Main	6308.73*	Max WS	113.99	686.27	691.76		691.76	0.000006	0.17	1900.25	1141.92	0.01
Main	6215.32*	Max WS	113.76	686.27	691.76		691.76	0.000005	0.16	1818.75	1486.22	0.01
Main	6121.924	Max WS	113.69	686.27	691.75		691.75	0.000005	0.15	1637.59	1806.30	0.01
Main	6035.96*	Max WS	113.52	686.27	691.75		691.75	0.000006	0.16	1527.98	1748.82	0.01
Main	5950.01*	Max WS	113.53	686.27	691.75		691.75	0.000007	0.18	1339.59	1703.71	0.02
Main	5864.05*	Max WS	113.33	686.27	691.75		691.75	0.000010	0.21	1115.55	1677.57	0.02
Main	5778.104	Max WS	113.32	686.27	691.75		691.75	0.000014	0.25	863.61	1651.64	0.02
Main	5687.63*	Max WS	113.45	686.28	691.75		691.75	0.000030	0.38	505.01	1144.78	0.03
Main	5597.166	Max WS	113.39	686.28	691.74		691.74	0.000070	0.61	220.93	647.69	0.05
Main	5556.618	Max WS	113.31	686.43	691.73		691.74	0.000147	0.95	128.34	535.36	0.08
Main	5525.008		Culvert									
Main	5490.413	Max WS	112.92	685.19	691.65		691.66	0.000106	0.89	126.32	381.95	0.07
Main	5437.687	Max WS	113.02	685.35	691.65		691.66	0.000029	0.44	258.13	475.20	0.04
Main	5357.89*	Max WS	113.07	685.35	691.65		691.65	0.000047	0.54	209.83	408.87	0.04
Main	5278.05*	Max WS	112.81	685.34	691.64		691.65	0.000077	0.67	167.97	347.56	0.06
Main	5198.254	Max WS	112.85	685.34	691.63		691.64	0.000142	0.87	130.12	283.87	0.07
Main	5121.63*	Max WS	112.93	685.34	691.62		691.63	0.000125	0.81	140.08	312.51	0.07
Main	5045.01*	Max WS	112.87	685.34	691.61		691.62	0.000106	0.73	153.78	322.95	0.07
Main	4968.39*	Max WS	112.86	685.33	691.61		691.61	0.000085	0.64	192.02	343.59	0.06
Main	4891.776	Max WS	112.95	685.33	691.61		691.61	0.000044	0.50	321.29	534.95	0.04
Main	4810.20*	Max WS	112.81	685.33	691.60		691.61	0.000058	0.55	301.66	460.56	0.05
Main	4728.63*	Max WS	112.77	685.33	691.59		691.60	0.000077	0.60	284.72	297.29	0.06
Main	4647.06*	Max WS	112.79	685.32	691.59		691.59	0.000095	0.64	280.74	284.06	0.06
Main	4565.488	Max WS	112.80	685.32	691.58		691.58	0.000123	0.70	222.87	263.71	0.07
Main	4504.283	Max WS	112.78	685.32	691.56		691.57	0.000161	0.82	140.99	69.72	0.08
Main	4461.252		Culvert									
Main	4430.212	Max WS	112.69	684.72	691.31		691.33	0.000167	1.15	99.35	28.61	0.09
Main	4346.582	Max WS	112.67	685.50	691.30		691.31	0.000193	0.98	117.67	30.21	0.09
Main	4194.408	Max WS	112.64	685.49	691.27		691.28	0.000239	1.02	109.98	30.08	0.09
Main	3788.373	Max WS	112.59	685.36	691.22		691.22	0.000019	0.34	569.94	282.45	0.03
Main	3395.646	Max WS	112.59	685.01	691.21		691.22	0.000016	0.44	490.75	218.52	0.03
Main	3331.113	Max WS	112.59	685.09	691.21		691.21	0.000053	0.73	157.35	90.44	0.06
Main	3265.168		Culvert									
Main	3196.567	Max WS	83.39	683.69	689.07		689.11	0.000296	1.59	58.88	21.71	0.13
Main	3141.921	Max WS	84.62	683.98	689.06		689.09	0.000371	1.41	60.03	18.39	0.14
Main	3004.055	Max WS	84.27	683.97	689.03		689.05	0.000151	0.99	85.44	23.56	0.09
Main	2734.719	Max WS	89.97	683.96	688.97		688.99	0.000273	1.23	72.91	22.98	0.12
Main	2688.915	Max WS	91.05	683.95	688.95		688.98	0.000334	1.31	69.50	23.43	0.13
Main	2653.174		Culvert									
Main	2626.817	Max WS	88.53	683.44	688.56		688.62	0.000804	1.94	45.68	12.85	0.18
Main	2582.291	Max WS	89.80	683.33	688.55		688.59	0.000465	1.62	55.41	15.78	0.15
Main	2218.895	Max WS	99.88	682.33	688.47		688.48	0.000054	0.67	148.72	36.31	0.06
Main	2049.666	Max WS	99.84	681.91	688.47		688.47	0.000047	0.63	221.52	91.62	0.05
Main	1853.478	Max WS	272.92	681.42	688.36		688.40	0.000349	1.64	166.78	43.36	0.15
Main	1799.666	Max WS	271.73	681.24	688.34		688.38	0.000388	1.66	163.51	41.59	0.15
Main	1727.858		Culvert									
Main	1670.018	Max WS	244.81	681.24	688.01		688.07	0.000398	1.95	133.88	64.11	0.15
Main	1606.765	Max WS	246.35	681.22	688.03		688.05	0.000129	1.04	248.85	445.87	0.09
Main	1475.852	Max WS	299.44	681.21	686.62		686.79	0.002598	3.24	93.63	53.30	0.37
Main	1134.554	Max WS	303.85	681.17	685.87		686.02	0.001861	3.05	99.58	36.91	0.33
Main	792.3003	Max WS	303.77	681.12	685.15		685.29	0.002397	3.35	244.04	334.40	0.36
Main	482.8005	Max WS	361.19	680.38	684.74		684.74	0.000198	1.12	1442.74	852.75	0.11
Main	35.46111	Max WS	4.93	680.10	684.70	677.01	684.70	0.000000	0.00	1919.79	769.39	0.00

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500-yr

HEC-RAS Plan: 500yrHuff River: Spring Creek Reach: Main Profile: Max WS

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	17035.08	Max WS	154.25	696.40	700.14		700.31	0.002371	3.37	46.15	26.91	0.40
Main	16993.37	Max WS	154.23	696.00	699.73		700.00	0.007850	4.54	33.96	23.90	0.67
Main	16899.4*	Max WS	156.42	695.54	699.07		699.39	0.007841	4.53	34.52	24.65	0.67
Main	16815.4*	Max WS	158.62	695.08	698.41		698.73	0.007874	4.54	34.93	25.18	0.68
Main	16731.5*	Max WS	160.79	694.62	697.74		698.06	0.007727	4.56	35.29	25.70	0.68
Main	16647.5*	Max WS	162.33	694.16	697.11		697.42	0.007255	4.52	35.93	125.44	0.66
Main	16583.6*	Max WS	159.13	693.70	696.80		696.86	0.005232	4.06	39.91	153.68	0.57
Main	16479.65	Max WS	143.42	693.24	696.44		696.51	0.001207	2.36	132.33	363.30	0.29
Main	16403.7*	Max WS	139.98	693.01	696.38		696.42	0.000656	1.78	190.28	417.72	0.21
Main	16327.7*	Max WS	139.10	692.78	696.35		696.37	0.000350	1.34	283.17	451.62	0.16
Main	16251.7*	Max WS	139.91	692.54	696.34		696.35	0.000199	1.04	347.74	487.78	0.12
Main	16175.84	Max WS	140.68	692.31	696.33		696.33	0.000118	0.83	443.59	526.64	0.09
Main	16100.*	Max WS	142.13	692.07	696.32		696.32	0.000073	0.64	652.10	646.04	0.07
Main	16024.40	Max WS	144.13	691.83	696.31		696.31	0.000021	0.38	1081.63	1151.29	0.04
Main	15850.19	Max WS	146.33	691.30	696.31		696.31	0.000020	0.46	1290.75	1138.26	0.04
Main	15434.41	Max WS	153.22	690.01	696.19		696.24	0.000466	1.90	80.76	26.08	0.18
Main	15212.53	Max WS	156.69	689.73	696.10		696.15	0.000370	1.76	89.26	25.13	0.16
Main	14922.76	Max WS	160.62	689.36	696.07		696.07	0.000056	0.79	373.05	640.92	0.07
Main	14774.58	Max WS	221.44	689.19	696.05		696.06	0.000093	1.07	482.99	389.15	0.09
Main	14457.09	Max WS	226.45	688.79	696.02		696.03	0.000091	1.10	377.61	286.97	0.09
Main	14406.13	Max WS	227.33	688.73	696.01		696.03	0.000079	1.20	302.92	243.88	0.08
Main	14204.08											
Main	13981.41	Max WS	227.29	688.38	695.77		695.80	0.000078	1.28	177.82	158.51	0.09
Main	13949.59	Max WS	227.99	688.37	695.77		695.80	0.000098	1.34	173.16	339.96	0.11
Main	13839.58	Max WS	229.88	688.25	695.77		695.79	0.000063	1.16	283.18	377.29	0.09
Main	13732.13	Max WS	231.72	688.19	695.78		695.78	0.000005	0.34	776.20	375.03	0.02
Main	13662.15	Max WS	232.93	688.17	695.76		695.78	0.000081	1.29	272.01	336.97	0.10
Main	13628.38	Max WS	235.00	688.12	695.75		695.78	0.000069	1.31	229.39	214.25	0.09
Main	13536.38											
Main	13453.85	Max WS	234.98	688.72	695.38		695.40	0.000310	1.27	198.79	385.11	0.09
Main	13414.20	Max WS	235.51	689.00	695.37		695.39	0.000250	1.06	253.12	457.88	0.09
Main	13217.08	Max WS	239.59	688.99	695.27		695.30	0.000601	1.52	262.87	363.86	0.13
Main	13001.02	Max WS	243.46	688.98	694.94		695.03	0.001868	2.42	100.41	26.05	0.22
Main	12815.85	Max WS	249.28	688.85	694.24		694.33	0.001790	2.34	106.50	29.01	0.22
Main	12216.99	Max WS	254.99	688.69	693.78		693.85	0.000609	2.00	127.26	37.42	0.19
Main	12019.91	Max WS	215.97	688.59	693.47		693.59	0.001411	2.74	78.71	26.57	0.28
Main	12001.15	Max WS	217.42	688.06	693.52		693.57	0.000430	1.77	122.49	30.06	0.15
Main	11937.42											
Main	11882.28	Max WS	209.34	687.94	693.38		693.41	0.000227	1.55	140.85	42.27	0.12
Main	11831.40	Max WS	198.12	688.77	693.31		693.38	0.000680	2.09	94.91	188.70	0.20
Main	11746.9*	Max WS	193.51	688.77	693.30		693.32	0.000417	1.44	269.78	276.94	0.14
Main	11682.5*	Max WS	183.59	688.77	693.27		693.28	0.000340	1.16	434.03	514.54	0.11
Main	11578.0*	Max WS	170.72	688.76	693.25		693.25	0.000137	0.70	884.45	791.30	0.07
Main	11493.83	Max WS	166.09	688.76	693.24		693.24	0.000039	0.37	1548.68	896.38	0.03
Main	11398.6*	Max WS	166.37	688.76	693.24		693.24	0.000045	0.39	1484.40	893.74	0.04
Main	11303.5*	Max WS	164.19	688.76	693.24		693.24	0.000044	0.39	1478.83	802.23	0.04
Main	11208.5*	Max WS	161.94	688.75	693.23		693.23	0.000039	0.37	1507.33	917.33	0.03
Main	11113.5*	Max WS	159.48	688.75	693.23		693.23	0.000034	0.35	1588.65	964.88	0.03
Main	11018.49	Max WS	158.65	688.75	693.22		693.23	0.000029	0.32	1651.57	998.12	0.03
Main	10922.5*	Max WS	157.03	688.75	693.22		693.22	0.000029	0.32	1384.21	813.43	0.03
Main	10826.6*	Max WS	156.24	688.75	693.22		693.22	0.000025	0.30	1361.11	748.57	0.03
Main	10730.67	Max WS	155.10	688.75	693.22		693.22	0.000020	0.28	1349.38	730.59	0.02
Main	10638.0*	Max WS	154.73	688.74	693.21		693.21	0.000014	0.22	1517.45	759.24	0.02
Main	10545.5*	Max WS	154.32	688.73	693.21		693.21	0.000008	0.17	1820.00	815.66	0.02
Main	10452.9*	Max WS	153.51	688.72	693.21		693.21	0.000004	0.11	2227.35	844.68	0.01
Main	10360.3*	Max WS	153.87	688.71	693.21		693.21	0.000002	0.07	2720.58	934.38	0.01
Main	10267.74	Max WS	153.19	688.70	693.21		693.21	0.000010	0.17	1503.87	1077.86	0.02
Main	10182.4*	Max WS	153.80	688.69	693.21		693.21	0.000003	0.09	3150.51	967.44	0.01
Main	10097.1*	Max WS	153.74	688.68	693.21		693.21	0.000002	0.08	3065.47	955.25	0.01
Main	10011.8*	Max WS	152.79	688.67	693.21		693.21	0.000002	0.07	3051.04	995.34	0.01
Main	9926.510	Max WS	152.75	688.66	693.21		693.21	0.000012	0.19	1624.64	1175.15	0.02
Main	9491.793	Max WS	151.17	688.61	693.20	689.40	693.21	0.000023	0.28	965.83	671.55	0.03
Main	9382.780											
Main	8939.248	Max WS	150.23	688.30	693.20		693.20	0.000012	0.17	2170.57	1221.82	0.02
Main	8784.397	Max WS	149.61	688.22	693.20		693.20	0.000054	0.41	1121.84	1122.96	0.04
Main	8722.829	Max WS	147.79	688.12	693.19		693.19	0.000067	0.42	1058.86	905.73	0.04
Main	8695.034											
Main	8674.268	Max WS	146.67	687.48	693.19		693.19	0.000031	0.36	1225.82	913.29	0.03
Main	8631.519	Max WS	146.65	687.41	693.19		693.19	0.000038	0.39	1178.05	892.80	0.03
Main	8345.665	Max WS	146.05	687.28	693.19		693.19	0.000003	0.11	3445.67	1380.48	0.01
Main	8047.118	Max WS	145.26	687.10	693.18		693.18	0.000004	0.13	2179.16	804.60	0.01
Main	7739.449	Max WS	145.13	686.99	693.18		693.18	0.000003	0.14	2118.96	1571.94	0.01
Main	7515.565	Max WS	144.46	686.79	693.18		693.18	0.000012	0.26	827.59	393.42	0.02
Main	7272.821	Max WS	144.57	686.67	693.18		693.18	0.000008	0.23	2427.32	1000.42	0.02
Main	7255.385	Max WS	144.28	686.00	693.18		693.18	0.000013	0.26	2361.20	954.49	0.02
Main	7226.812											

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HEC-RAS Plan: 500yrHuff River: Spring Creek Reach: Main Profile: Max WS (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main	7193.714	Max WS	143.95	685.90	693.18		693.18	0.000005	0.19	2752.24	751.89	0.01
Main	7141.580	Max WS	143.74	686.28	693.18		693.18	0.000007	0.14	2062.80	654.34	0.01
Main	7071.87*	Max WS	143.59	686.28	693.18		693.18	0.000007	0.16	2005.61	628.95	0.01
Main	7002.16*	Max WS	143.57	686.27	693.18		693.18	0.000007	0.19	1974.31	579.78	0.01
Main	6932.458	Max WS	143.85	686.27	693.18		693.18	0.000007	0.22	1943.87	540.30	0.02
Main	6846.57*	Max WS	143.42	686.27	693.17		693.18	0.000012	0.29	1473.65	509.99	0.02
Main	6760.7*	Max WS	143.83	686.27	693.17		693.17	0.000019	0.36	1082.81	487.35	0.03
Main	6674.82*	Max WS	143.40	686.26	693.17		693.17	0.000019	0.38	1158.24	591.06	0.03
Main	6588.943	Max WS	143.38	686.26	693.17		693.17	0.000009	0.25	1788.87	586.25	0.02
Main	6495.53*	Max WS	143.35	686.26	693.17		693.17	0.000003	0.15	2489.00	783.12	0.01
Main	6402.13*	Max WS	143.21	686.26	693.17		693.17	0.000002	0.13	3235.78	1016.16	0.01
Main	6308.73*	Max WS	143.29	686.27	693.17		693.17	0.000002	0.12	3103.93	1306.15	0.01
Main	6215.32*	Max WS	143.01	686.27	693.17		693.17	0.000002	0.12	2867.12	1585.12	0.01
Main	6121.924	Max WS	143.14	686.27	693.17		693.17	0.000002	0.12	2550.29	1865.59	0.01
Main	6035.96*	Max WS	143.05	686.27	693.17		693.17	0.000003	0.14	2336.29	1822.73	0.01
Main	5950.01*	Max WS	142.99	686.27	693.17		693.17	0.000004	0.15	2042.51	1770.92	0.01
Main	5864.05*	Max WS	142.67	686.27	693.17		693.17	0.000005	0.17	1679.28	1728.72	0.01
Main	5778.104	Max WS	142.85	686.27	693.17		693.17	0.000007	0.21	1284.16	1693.12	0.02
Main	5697.63*	Max WS	142.96	686.28	693.17		693.17	0.000014	0.31	784.14	1186.19	0.02
Main	5597.166	Max WS	142.79	686.28	693.16		693.16	0.000030	0.49	333.86	664.88	0.04
Main	5556.818	Max WS	142.78	686.43	693.15		693.16	0.000084	0.86	178.20	616.59	0.06
Main	5525.008		Culvert									
Main	5490.413	Max WS	142.02	685.19	693.04		693.05	0.000081	0.90	157.19	530.09	0.06
Main	5437.687	Max WS	142.06	685.35	693.05		693.05	0.000019	0.43	337.14	527.79	0.03
Main	5357.86*	Max WS	141.97	685.35	693.04		693.05	0.000034	0.51	276.95	459.45	0.04
Main	5278.05*	Max WS	142.01	685.34	693.04		693.04	0.000056	0.64	223.41	394.25	0.05
Main	5198.254	Max WS	141.96	685.34	693.03		693.04	0.000099	0.81	175.35	333.47	0.06
Main	5121.63*	Max WS	141.99	685.34	693.02		693.03	0.000084	0.74	190.97	351.09	0.06
Main	5045.01*	Max WS	141.89	685.34	693.02		693.02	0.000069	0.66	229.33	431.38	0.05
Main	4968.39*	Max WS	141.91	685.33	693.02		693.02	0.000038	0.53	455.87	656.91	0.04
Main	4891.776	Max WS	141.88	685.33	693.02		693.02	0.000017	0.38	870.48	744.51	0.03
Main	4810.20*	Max WS	141.86	685.33	693.01		693.01	0.000019	0.38	854.20	743.34	0.03
Main	4728.63*	Max WS	141.83	685.33	693.01		693.01	0.000022	0.40	818.76	573.10	0.03
Main	4647.06*	Max WS	141.80	685.32	693.01		693.01	0.000024	0.40	782.42	416.91	0.03
Main	4565.488	Max WS	141.86	685.32	693.00		693.01	0.000045	0.52	426.38	394.86	0.04
Main	4504.263	Max WS	141.83	685.32	693.00		693.01	0.000060	0.71	209.61	76.46	0.06
Main	4461.252		Culvert									
Main	4430.212	Max WS	141.58	684.72	692.59		692.61	0.000132	1.17	122.46	33.39	0.08
Main	4348.582	Max WS	141.59	685.50	692.58		692.60	0.000133	0.89	158.79	33.87	0.07
Main	4194.408	Max WS	141.60	685.49	692.56		692.57	0.000159	0.93	152.32	35.32	0.08
Main	3798.373	Max WS	141.53	685.38	692.53		692.53	0.000009	0.28	959.62	325.15	0.02
Main	3395.646	Max WS	141.55	685.01	692.53		692.53	0.000010	0.40	705.80	245.61	0.03
Main	3331.113	Max WS	141.54	685.09	692.52		692.53	0.000036	0.72	203.00	138.50	0.05
Main	3285.168		Culvert									
Main	3198.507	Max WS	69.32	683.69	690.42		690.43	0.000082	1.00	78.09	24.64	0.07
Main	3141.921	Max WS	72.12	683.98	690.41		690.42	0.000098	0.83	87.27	21.82	0.07
Main	3004.055	Max WS	78.67	683.97	690.41		690.41	0.000052	0.66	119.89	26.71	0.05
Main	2734.719	Max WS	91.09	683.98	690.38		690.39	0.000095	0.84	108.31	27.12	0.07
Main	2688.915	Max WS	93.51	683.95	690.37		690.38	0.000110	0.88	106.14	27.79	0.08
Main	2653.174		Culvert									
Main	2628.817	Max WS	91.66	683.44	690.03		690.06	0.000324	1.37	66.68	15.78	0.12
Main	2582.291	Max WS	94.04	683.33	690.02		690.04	0.000194	1.17	80.55	18.31	0.10
Main	2218.895	Max WS	112.85	682.33	689.99		690.00	0.000024	0.55	210.21	46.48	0.04
Main	2049.666	Max WS	112.82	681.91	689.99		689.99	0.000019	0.46	392.57	159.83	0.04
Main	1853.478	Max WS	426.62	681.42	689.89		689.94	0.000321	1.77	242.50	84.15	0.15
Main	1799.666	Max WS	426.91	681.24	689.87		689.92	0.000327	1.85	236.30	54.48	0.14
Main	1727.858		Culvert									
Main	1670.018	Max WS	378.43	681.24	688.99		689.08	0.000521	2.51	160.82	93.35	0.18
Main	1608.785	Max WS	382.66	681.22	689.03		689.05	0.000129	1.21	323.05	463.00	0.10
Main	1475.852	Max WS	476.44	681.21	687.39		687.58	0.002336	3.65	155.66	96.23	0.37
Main	1134.554	Max WS	484.22	681.17	686.48		686.72	0.002672	3.94	122.88	40.28	0.40
Main	792.3003	Max WS	484.05	681.12	685.67		685.82	0.002383	3.77	453.50	448.64	0.37
Main	482.8005	Max WS	585.41	680.38	685.25		685.26	0.000248	1.39	1890.53	896.97	0.13
Main	35.46111	Max WS	4.95	680.10	685.20	677.01	685.20	0.000000	0.00	2312.92	803.77	0.00

145

142

113

484

585

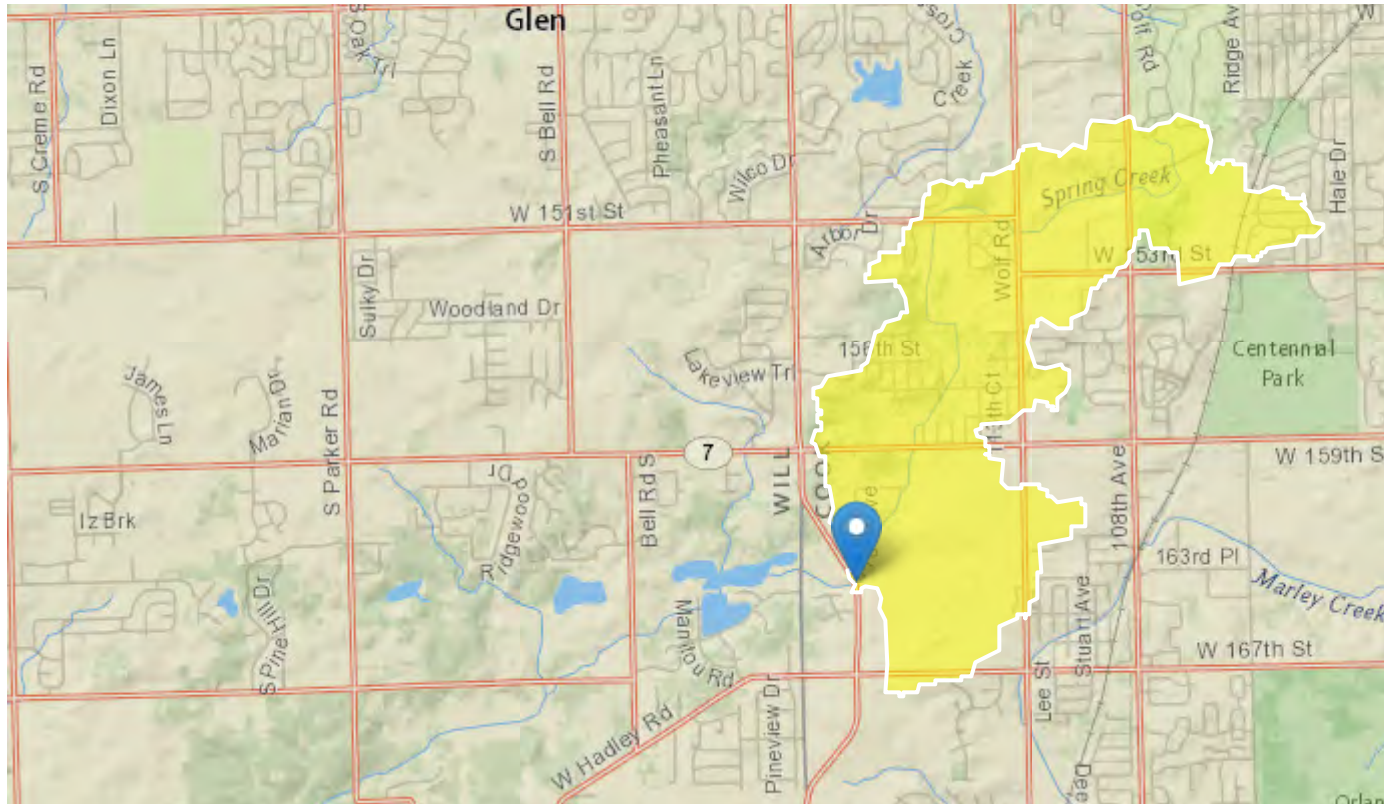
StreamStats Report

Region ID: IL

Workspace ID: IL20180620215737951000

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Time: 2018-06-20 16:57:52 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	2.31	square miles
FLC11DVLMH	Fraction of drainage area that is in low to high developed land-use classes 22-24 from NLCD 2011	0.509	decimal fraction
FSSURGDC78	Fraction of land area that is in very poorly drained and unknown likely water drainage classes 7 and 8 from SSURGO	0.173	decimal fraction
RELRELF	Basin relief divided by basin perimeter	5.84	feet per mi

Peak-Flow Statistics Parameters [Region 2 Peak Rural and Urban 2016 5050]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.31	square miles	0.078	1351
FLC11DVLMH	Frac_Lo_Med_Hi_Developed_from_NLCD2011	0.509	decimal fraction	0.0022	0.979
FSSURGDC78	Fraction_SSURGO_Drainage_Classes_7_and_8	0.173	decimal fraction	0	0.256
RELRELF	Relative Relief	5.84	feet per mi	0.821	37.3

Peak-Flow Statistics Flow Report [Region 2 Peak Rural and Urban 2016 5050]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
Urban 2 Year Peak Flood	75.3	ft ³ /s	35.8	158	46
Urban 5 Year Peak Flood	111	ft ³ /s	52.1	238	47.1
Urban 10 Year Peak Flood	139	ft ³ /s	63	305	49.6
Urban 25 Year Peak Flood	178	ft ³ /s	76.7	413	52.9
Urban 50 Year Peak Flood	210	ft ³ /s	86.9	510	55.9
Urban 100 Year Peak Flood	247	ft ³ /s	97.1	626	59.4
Urban 500 Year Peak Flood	342	ft ³ /s	122	961	66.9

Peak-Flow Statistics Citations

Over, T.M. , Saito, R.J., Veilleux, A.G., Sharpe, J.B., Soong, D.T., and Ishii, A.L.,2016, Estimation of peak discharge quantiles for selected annual exceedance probabilities in northeastern Illinois: U.S. Geological Survey Scientific Investigations Report 2016-5050, 50 p. (<http://dx.doi.org/10.3133/sir20165050>)

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Application Version: 4.2.1

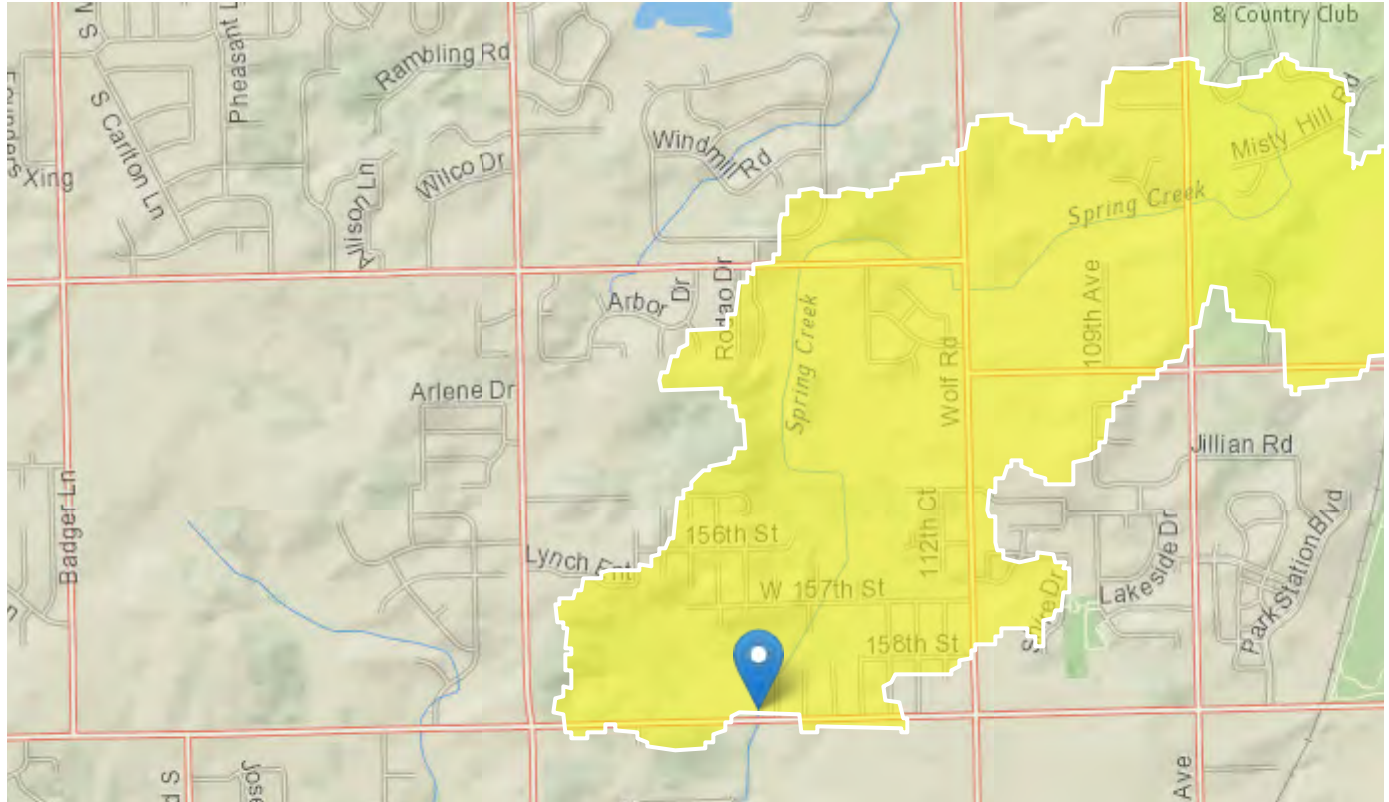
StreamStats Report

Region ID: IL

Workspace ID: IL20180620233548735000

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Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.54	square miles
FLC11DVLMH	Fraction of drainage area that is in low to high developed land-use classes 22-24 from NLCD 2011	0.625	decimal fraction
FSSURGDC78	Fraction of land area that is in very poorly drained and unknown likely water drainage classes 7 and 8 from SSURGO	0.249	decimal fraction
RELRELF	Basin relief divided by basin perimeter	7.15	feet per mi

Peak-Flow Statistics Parameters [Region 2 Peak Rural and Urban 2016 5050]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.078	1351
FLC11DVLMH	Frac_Lo_Med_Hi_Developed_from_NLCD2011	0.625	decimal fraction	0.0022	0.979
FSSURGDC78	Fraction_SSURGO_Drainage_Classes_7_and_8	0.249	decimal fraction	0	0.256
RELRELF	Relative Relief	7.15	feet per mi	0.821	37.3

Peak-Flow Statistics Flow Report [Region 2 Peak Rural and Urban 2016 5050]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
Urban 2 Year Peak Flood	52.5	ft ³ /s	24.7	112	46
Urban 5 Year Peak Flood	76.8	ft ³ /s	35.4	166	47.1
Urban 10 Year Peak Flood	95.6	ft ³ /s	42.8	214	49.6
Urban 25 Year Peak Flood	123	ft ³ /s	52.1	290	52.9
Urban 50 Year Peak Flood	146	ft ³ /s	59.1	360	55.9
Urban 100 Year Peak Flood	172	ft ³ /s	66.2	445	59.4
Urban 500 Year Peak Flood	241	ft ³ /s	83.9	692	66.9

Peak-Flow Statistics Citations

Over, T.M. , Saito, R.J., Veilleux, A.G., Sharpe, J.B., Soong, D.T., and Ishii, A.L.,2016, Estimation of peak discharge quantiles for selected annual exceedance probabilities in northeastern Illinois: U.S. Geological Survey Scientific Investigations Report 2016-5050, 50 p. (<http://dx.doi.org/10.3133/sir20165050>)

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Application Version: 4.2.1

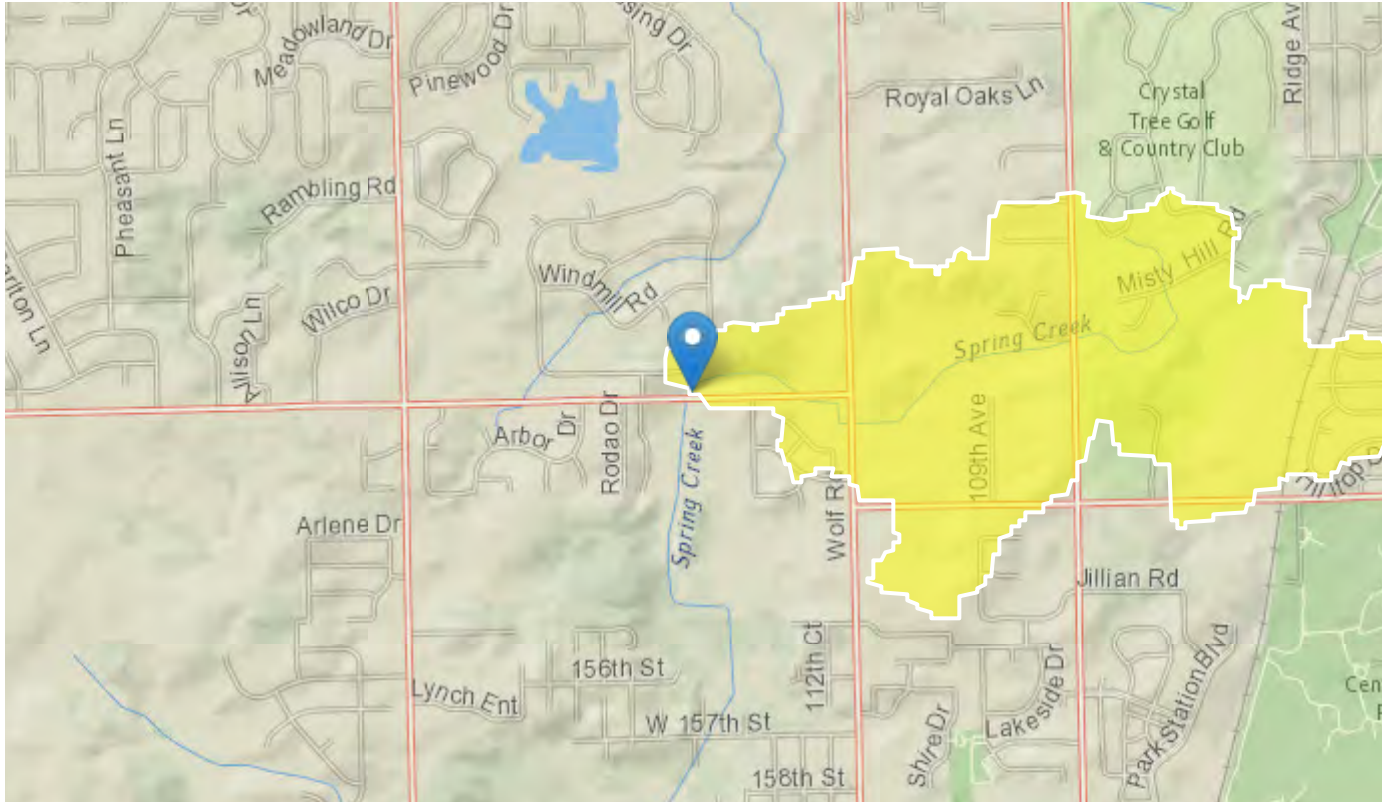
StreamStats Report

Region ID: IL

Workspace ID: IL20180620231051877000

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Time: 2018-06-20 18:11:08 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.81	square miles
FLC11DVLMH	Fraction of drainage area that is in low to high developed land-use classes 22-24 from NLCD 2011	0.605	decimal fraction
FSSURGDC78	Fraction of land area that is in very poorly drained and unknown likely water drainage classes 7 and 8 from SSURGO	0.214	decimal fraction
RELRELF	Basin relief divided by basin perimeter	10.06	feet per mi

Peak-Flow Statistics Parameters [Region 2 Peak Rural and Urban 2016 5050]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.81	square miles	0.078	1351
FLC11DVLMH	Frac_Lo_Med_Hi_Developed_from_NLCD2011	0.605	decimal fraction	0.0022	0.979
FSSURGDC78	Fraction_SSURGO_Drainage_Classes_7_and_8	0.214	decimal fraction	0	0.256
RELRELF	Relative Relief	10.06	feet per mi	0.821	37.3

Peak-Flow Statistics Flow Report [Region 2 Peak Rural and Urban 2016 5050]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
Urban 2 Year Peak Flood	37.2	ft ³ /s	17.5	79.3	46
Urban 5 Year Peak Flood	56.6	ft ³ /s	26.1	123	47.1
Urban 10 Year Peak Flood	72	ft ³ /s	32.2	161	49.6
Urban 25 Year Peak Flood	94.3	ft ³ /s	39.9	223	52.9
Urban 50 Year Peak Flood	113	ft ³ /s	45.9	280	55.9
Urban 100 Year Peak Flood	135	ft ³ /s	51.9	349	59.4
Urban 500 Year Peak Flood	193	ft ³ /s	67.2	556	66.9

Peak-Flow Statistics Citations

Over, T.M. , Saito, R.J., Veilleux, A.G., Sharpe, J.B., Soong, D.T., and Ishii, A.L.,2016, Estimation of peak discharge quantiles for selected annual exceedance probabilities in northeastern Illinois: U.S. Geological Survey Scientific Investigations Report 2016-5050, 50 p. (<http://dx.doi.org/10.3133/sir20165050>)

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Application Version: 4.2.1

Appendix 3
FEMA FIS Information

Table 14 – Summary of Discharges (Continued) ANNOTATED

<i>Flooding Source and Location</i>	<i>Drainage Area (square miles)</i>	<i>Peak Discharges (cubic feet per second)</i>								
		<i>10-Percent- Annual-Chance</i>	<i>2-Percent- Annual-Chance</i>	<i>1-Percent- Annual-Chance</i>	<i>0.2-Percent- Annual-Chance</i>					
Silver Creek										
At mouth at Des Plaines River	11.6	465	712	842	1,125					
At North Avenue	10.3	443	680	802	1,075					
At Armitage Avenue	9.1	351	620	768	1,145					
Approximately 800 feet upstream of Fullerton Avenue	9.1	425	645	770	1,010					
Just upstream of Scott Street	8.7	420	640	760	1,000					
At Grand Avenue	7.4	303	545	669	1,015					
Approximately 1,800 feet upstream of Grand Avenue	6.8	370	570	670	890					
Approximately 800 feet upstream of Belmont Avenue	6.6	360	560	660	880					
At Franklin Avenue	6.4	355	550	655	875					
At Railroad yard	6.1	350	535	640	850					
Skokie River (See entry following Chicago River, North Branch)										
Skokie River, Botanical Garden Diversion										
At confluence with Skokie River	* ³	54	388	543	690					
Skokie River, West Ditch										
At confluence with Skokie River	1.2	72	333	638	1,141					
At Tower Road	0.8	54	67	73	74					
South Navy Ditch										
Just downstream from Soo Line Railroad	1.9	217	351	410	527					
South Tributary to Tinley Creek										
At 88 th Avenue	0.4	*	*	51	*					
Spring Creek										
At 118 th Avenue	2.3	2.3	108	157	205	244	259	304	396	484
At 159 th Street	1.6	1.6	61	80	90	107	97	117	117	145
At 151 st Street and Wolf Road	0.8	0.8	64	81	112	129	139	153	195	235
Stony Creek (East)										
At confluence with Calumet-Sag Channel	4.5	260	395	459	620					
At Sacramento Avenue	4.3	255	390	454	615					
At Central Park Avenue	3.6	205	315	365	495					
At Crawford Avenue	2.4	158	239	277	372					
At Cicero Avenue	0.2	50	75	100	150					

* Data not available

³ Includes split flow from Skokie River downstream of Lake Cook Road plus local drainage

Table 17 - Manning's "n" Values (Continued)

<u>Stream</u>	<u>Channel "n"</u>	<u>Overbank "n"</u>
Poplar Creek South Branch	0.06-0.080	0.04
Poplar Creek Tributary A	0.04-0.08	0.014-0.08
Prairie Creek	0.020-0.150	0.035-1.0
Salt Creek	0.03-0.100	0.023-0.080
Salt Creek, Arlington Heights Branch	0.040-0.070	0.060-0.090
Salt Creek, Arlington Heights Branch, Anderson Drive Tributary	0.05	0.060-0.080
Salt Creek Middle Fork	0.09	0.09
Salt Creek South Fork	0.080-0.095	0.065-0.095
Salt Creek Tributary	0.050-0.080	0.03
Salt Creek Tributary A	0.050-0.060	0.060-0.080
Salt Creek Tributary B	0.050-0.060	0.060-0.080
Salt Creek Tributary C	0.050-0.060	0.060-0.080
Salt Creek Tributary D	0.050-0.060	0.060-0.080
Salt Creek (Upper Reach)	0.050-0.060	0.060-0.080
Salt Creek West Branch	0.040-0.070	0.060-0.080
Salt Creek West Branch Tributary A	0.040-0.070	0.060-0.080
Salt Creek West Branch Tributary #3	0.040-0.070	0.060-0.080
Salt Creek West Branch Tributary #4	0.040-0.070	0.060-0.080
Salt Creek West Branch Tributary #5	0.040-0.070	0.060-0.080
Salt Creek West Branch Tributary #6	0.040-0.070	0.060-0.080
Salt Creek West Branch Tributary #7	0.040-0.070	0.060-0.080
Sexton Ditch	0.04-0.05	0.04-0.05
Silver Creek	0.030-0.1	0.030-0.085
Skokie River	0.022-0.035	0.06-0.08
Skokie River West Ditch	0.035	0.06
Skokie River Botanical Garden Diversion	0.022-0.035	0.06-0.08
South Navy Ditch	0.045	0.08
Spring Creek	0.035-0.080	0.030-0.040
Stony Creek (East)	0.048-0.098	0.014-0.050
Stony Creek (West)	0.035 - 0.09	0.025 - 0.2
Techny Drain	0.040-0.080	0.040-0.065
Techny Drain South Fork	0.040-0.080	0.040-0.065
Third Creek	0.045-0.060	0.047-0.070
Thorn Creek	0.055-0.085	0.046-0.18

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE (FEET)
Spring Creek								
A	0 ⁹⁵ 482	490 678	951 1314	0.8 0.3	682.9 684.7	682.9 684.7	683.0 684.7	0.1 0.0
B	1,280 ⁹⁵ 1,187	35 29	70 108	3.7 2.9	685.2 687.0	685.2 687.0	685.2 687.0	0.0 0.0
C	1,400 ⁹⁵ 1,800	29 33	108 131	2.4 2.3	686.7 687.6	686.7 687.6	686.8 687.6	0.1 0.0
D	2,200 ⁹⁵ 2,582	13 15	45 44	2.4 2.3	688.4 687.8	688.4 687.8	688.5 687.8	0.1 0.0
E	2,720 ⁹⁵ 3,197	15 21	55 62	1.9 1.9	689.4 688.7	689.4 688.7	689.5 688.7	0.1 0.0
F	2,820 ⁹⁵ 3,331	32 60	116 179	0.9 0.7	690.8 691.2	690.8 691.2	690.8 691.2	0.0 0.0
G	3,770 ⁹⁵ 4,347	44 30	112 117	0.9 1.0	690.9 691.3	690.9 691.3	690.9 691.3	0.0 0.0
H	4,820 ⁹⁵ 5,490	440 330	866 305	0.1 0.9	691.1 691.6	691.1 691.6	691.2 691.6	0.1 0.0
I	6,400 ⁹⁵ 7,194	236 535	637 1594	0.2 0.1	691.3 691.8	691.3 691.8	691.3 691.8	0.0 0.0
J	8,001 ⁹⁵ 8,723	50 514	115 677	1.3 0.3	691.4 691.8	691.4 691.8	691.4 691.8	0.0 0.0
K	10,651 ⁹⁵ 11,831	38 69	141 92	1.4 2.3	692.8 692.6	692.8 692.6	692.8 692.6	0.0 0.0
L	10,871 ⁹⁵ 12,020	21 23	79 63	2.3 2.9	693.1 692.8	693.1 692.8	693.2 692.8	0.1 0.0
M	12,171 ⁹⁵ 13,454	37 273	107 361	1.4 1.1	693.6 694.6	693.6 694.6	693.6 694.6	0.0 0.0
N	12,791 ⁹⁵ 13,981	34 33	142 155	1.1 1.0	693.9 694.8	693.9 694.8	694.0 694.8	0.1 0.0
O	13,392 ⁹⁵ 14,457	117 176	127 291	1.1 0.6	694.7 694.9	694.7 694.9	694.7 694.9	0.0 0.0
P	14,022 ⁹⁵ 15,213	30 21	34 62	2.8 1.4	695.3 694.9	695.3 694.9	695.3 694.9	0.0 0.0
Q	14,642 ⁹⁵ 15,850	565 540	433 583	0.2 0.2	695.8 695.1	695.8 695.1	695.8 695.1	0.0 0.0
R	14,877 ⁹⁵ 16,024	397 465	339 401	0.3 0.2	695.8 695.1	695.8 695.1	695.9 695.1	0.1 0.0
S	15,732 ⁹⁵ 16,983	35 17	23 18	3.0 3.8	700.7 699.0	700.7 699.0	700.7 699.0	0.0 0.0

⁹⁵ Feet above Will-Cook county boundary

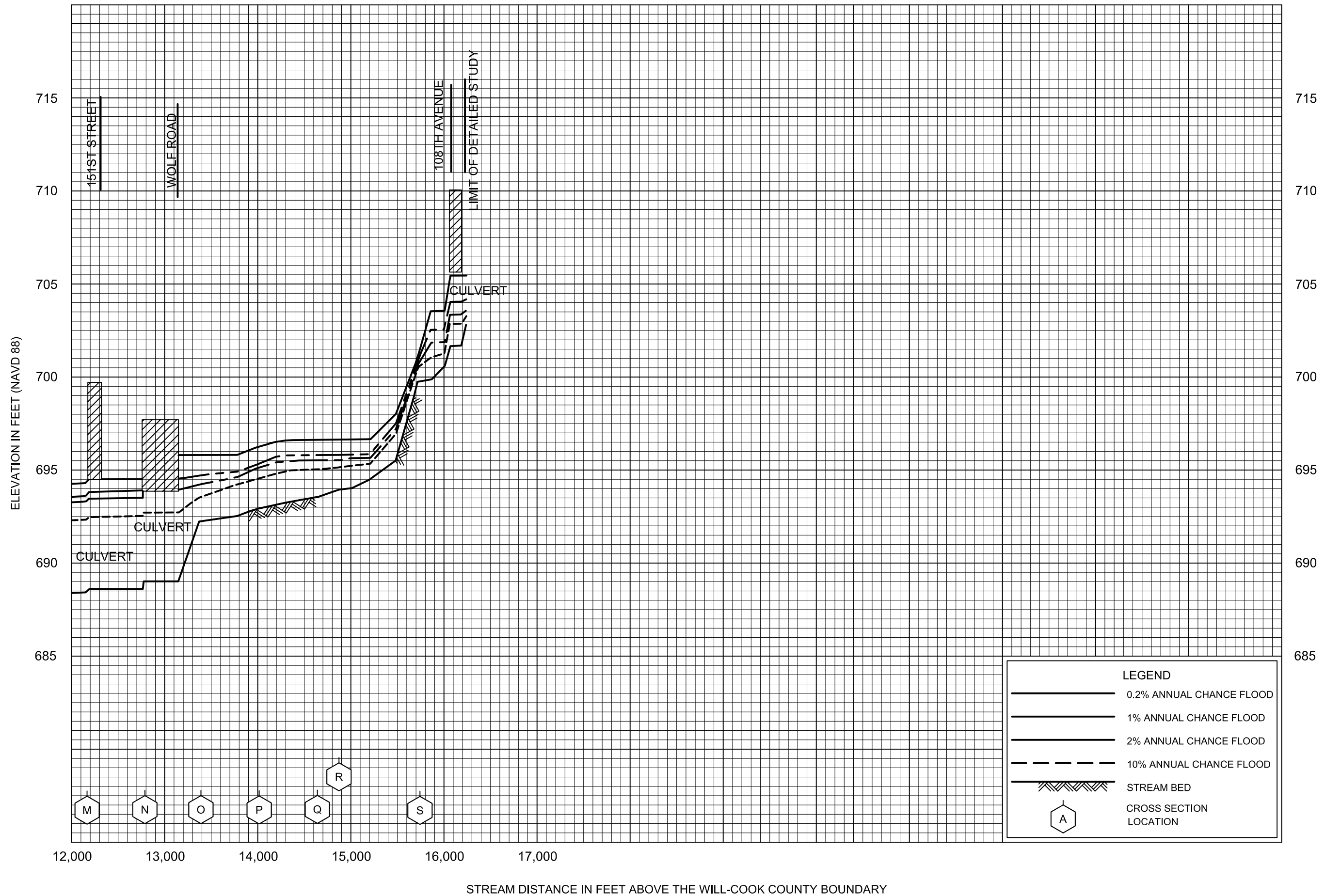
TABLE 19

FEDERAL EMERGENCY MANAGEMENT AGENCY

**COOK COUNTY, IL
AND INCORPORATED AREAS**

FLOODWAY DATA

SPRING CREEK



FLOOD PROFILES

SPRING CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

COOK COUNTY, IL
AND INCORPORATED AREAS

Appendix 4
FEMA MT-2 Forms

U.S. DEPARTMENT OF HOMELAND SECURITY
 FEDERAL EMERGENCY MANAGEMENT AGENCY
OVERVIEW & CONCURRENCE FORM

*O.M.B No. 1660-0016
 Expires February 28, 2014*

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless it displays a valid OMB control number. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a (NFIP) Flood Insurance Rate Maps (FIRM).

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

- CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).
- LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
170140 170054	Village of Orland Park Cook County	IL IL	17031C 17031C	682J 684J	08/19/08 08/19/08

2. a. Flooding Source: Spring Creek

- b. Types of Flooding: Riverine Coastal Shallow Flooding (e.g., Zones AO and AH)
 Alluvial fan Lakes Other (Attach Description)

3. Project Name/Identifier: Spring Creek Restudy

4. FEMA zone designations affected: AE (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

a. The basis for this revision request is (check all that apply)

- Physical Change Improved Methodology/Data Regulatory Floodway Revision Base Map Changes
 Coastal Analysis Hydraulic Analysis Hydrologic Analysis Corrections
 Weir-Dam Changes Levee Certification Alluvial Fan Analysis Natural Changes
 New Topographic Data Other (Attach Description)

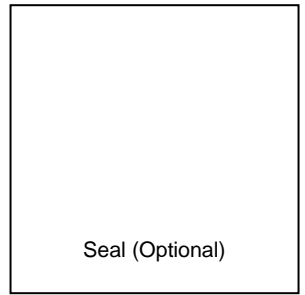
Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)

Required if ...

- | | |
|---|---|
| <input checked="" type="checkbox"/> Riverine Hydrology and Hydraulics Form (Form 2) | New or revised discharges or water-surface elevations |
| <input type="checkbox"/> Riverine Structures Form (Form 3) | Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam |
| <input type="checkbox"/> Coastal Analysis Form (Form 4) | New or revised coastal elevations |
| <input type="checkbox"/> Coastal Structures Form (Form 5) | Addition/revision of coastal structure |
| <input type="checkbox"/> Alluvial Fan Flooding Form (Form 6) | Flood control measures on alluvial fans |



U.S. DEPARTMENT OF HOMELAND SECURITY
 FEDERAL EMERGENCY MANAGEMENT AGENCY
RIVERINE HYDROLOGY & HYDRAULICS FORM

*O.M.B No. 1660-0016
 Expires February 28, 2014*

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 3.5 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Spring Creek

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

- Not revised (skip to section B)
 No existing analysis
 Improved data
 Alternative methodology
 Proposed Conditions (CLOMR)
 Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)
At 118 th Avenue	2.3	259	304
At 159 th Street	1.6	97	118
At 151 st Street and Wolf	0.8	139	153

3. Methodology for New Hydrologic Analysis (check all that apply)

- Statistical Analysis of Gage Records
 Precipitation/Runoff Model → Specify Model: HEC-HMS
 Regional Regression Equations
 Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters), and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Is the hydrology for the revised flooding source(s) affected by sediment transport? Yes No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation..

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit*	<u>Aprox 320 Feet D/S of 108th Ave</u>	<u>FIS S (17035.08)</u>	<u>700.7 (NAVD 88)</u>	<u>699.3 (NAVD 88)</u>
Upstream Limit*	<u>Aprox 1650 Feet D/S of Will Cook Rd</u>	<u>FIS A (35.4611)</u>	<u>682.9 (NAVD 88)</u>	<u>682.3 (NAVD 88)</u>

*Proposed/Revised elevations must tie-into the Effective elevations within 0.5 foot at the downstream and upstream limits of revision.

2. Hydraulic Method/Model Used: HEC-RAS

3. Pre-Submittal Review of Hydraulic Models*
 DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS.

4. **Models Submitted**

	<u>Natural Run</u>		<u>Floodway Run</u>		<u>Datum</u>
	File Name:	Plan Name:	File Name:	Plan Name:	
Duplicate Effective Model*					
Corrected Effective Model*					
Existing or Pre-Project Conditions Model	File Name: SPCR_Design	Plan Name: Existing - 100yr12h	File Name: SPCR_Design	Plan Name: Existing - 100yr12h	NAVD 88
Revised or Post-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	
Other - (attach description)	File Name:	Plan Name:	File Name:	Plan Name:	

* For details, refer to the corresponding section of the instructions.

Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic work map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

Digital Mapping (GIS/CADD) Data Submitted (preferred)

Topographic Information: Cook County 2-foot aerial topography (NAVD88)

Source: Cook County Date: 2008

Accuracy: _____

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach a **copy of the effective FIRM and/or FBFM**, at the same scale as the original, annotated to show the boundaries of the revised 1%-and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%-and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area on revision.

Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? Yes No
- a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:
- The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.
 - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.
- b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? Yes No
If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.
2. Does the request involve the placement or proposed placement of fill? Yes No
If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.
3. For LOMR requests, is the regulatory floodway being revised? Yes No
If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)
4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA. Please see the MT-2 instructions for more detail.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

Appendix 5
Digital Deliverables

Appendix 6

MWRD Detailed Watershed Plan for the Calumet-Sag Watershed

Final Report

**Detailed Watershed Plan for the
Calumet-Sag Channel
Watershed: Volume 1**

Prepared for
**Metropolitan Water Reclamation
District of Greater Chicago**

August 2009

CH2MHILL

1.3.2 Model Setup and Unit Numbering

1.3.2.1 Hydrologic Model Setup

Hydrologic model data was primarily developed within the GeoHMS extension to Arc GIS Version 9.2. The extension provides an interface to geoprocessing functions used to characterize subbasin parameters within the hydrologic model. GeoHMS was used to calculate the CN for each basin; to define the longest flow path, basin slope, and longest flow path slope; and to establish a network connecting hydrologic elements (e.g., subbasins, reservoirs, reaches, and inflow locations) to the outlet of the system. HEC-HMS was used to create and sometimes route stormwater runoff hydrographs to the upstream extent of hydraulic models developed within HEC-RAS. Hydrologic model data was transferred between HEC-HMS and HEC-RAS through HEC-DSS files.

Subbasin Delineation. Each major tributary model (Tinley Creek, Melvina Ditch, etc.) was subdivided into subbasins roughly 100 acres in size to form the basis of the hydrologic model and modeled assuming a unified response to rainfall based on land use characteristics and soil type. Elevation data provided by Cook County, described in Section 2.3.4, was the principal data source used for subbasin delineation. Drainage divides were established based upon consideration of the direction of steepest descent from local elevation maxima, and refined in some instances to reflect modifications to topographic drainage patterns caused by stormwater management infrastructure (storm sewer systems, culverts, etc.). Subbasin boundaries were modified to encompass areas with similar development patterns. Finally, boundaries were defined to most accurately represent the area tributary to specific modeled elements, such as constrictions caused by crossings, and reservoirs. GIS data was developed for all subbasins delineated and used for hydrologic model data development.

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

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

Where:

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

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

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

where:

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

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

TABLE 1.3.2
Description of Curve Number Input Data

Variable Used to Determine CN	Approach for Definition of Variable for Calumet-Sag Channel Watershed Hydrologic Modeling
Ground cover	Chicago Metropolitan Agency for Planning (CMAP) 2001 land use inventory (v.1.2 2006) is used to define land use. A lookup table was developed to link CMAP categories to categories for which CN values have been estimated.
Soil type	The Natural Resources Conservation Service (NRCS) publishes county soil surveys that include a hydrologic classification of A, B, C, or D. If a soil group's infiltration capacity is affected by a high water table, it is classified as, for instance, "A/D," meaning the drained soil has "A" infiltration characteristics, undrained "D." It was assumed that half of these soil groups (by area) are drained.
Antecedent moisture condition	Antecedent Moisture Conditions (AMC) reflect the initial soil storage capacity available for rainfall. For areas within Northeastern Illinois, it is typical to assume an AMC of II.

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

The GeoHMS tool was used to develop an area-weighted average CN for each subbasin.

Runoff Hydrograph Production. The runoff volume produced for a subbasin is converted into a basin-specific hydrograph by using a standard unit hydrograph and an estimate of basin lag time. The lag time is defined as the time elapsed between the centroid, by mass, of the precipitation event and the peak of the runoff hydrograph at the outlet of the subbasin. The lag time was estimated according to Equation 1.3, provided in the HEC-HMS Technical Reference Manual (USACE, 2006):

$$T_{lag} = 0.6T_c \quad (1.3)$$

where:

T_{lag} = Lag time
 T_c = Time of Concentration

TABLE 1.3.3
Runoff Curve Numbers for Urban Areas

Cover Type and Hydrologic Condition	Avg. % Imper- vious Area	A	B	C	D
Fully developed urban areas (vegetation established)					
Open Space (lawns, parks, golf courses, cemeteries, etc.)					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50 to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious Areas					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western Desert Urban Areas					
Natural desert landscaping (pervious areas only)		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin barriers)		96	96	96	96
Urban Districts					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential Districts by Average Lot Size					
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing Urban Areas					
Newly Graded Areas (pervious areas only, no vegetation)		77	86	91	94

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

Note: Table Source is *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture, 1986)

The time of concentration is the time it takes for a drop of water to travel from the hydraulically furthest point in a watershed to the outlet. The time of concentration is estimated as the

sum of the travel time for three different segments of flow, split-up by flow type in each subbasin.

Thus Equation 1.4:

$$T_c = T_{sheet} + T_{shallow} + T_{channel} \quad (1.4)$$

Where:

- T_{sheet} = sheet flow; flow occurring across the land area headwater areas prior to flow accumulation
- $T_{shallow}$ = shallow flow; occurs where sheet flow begins to accumulate into more concentrated patterns, but prior to transitioning into open channel flow
- $T_{channel}$ = flow within natural or manmade drainage facilities within each subwatershed prior to the point of discharge

GeoHMS-derived T_c estimates were not considered accurate; however, GeoHMS also produced a definition of the longest flow path, its length, and slope. The basin parameter estimates were exported to a spreadsheet to support calculation of T_c .

An alternative method of lag time calculations is the CN-based method, characterized in Equation 1.5 (SCS, 1978):

$$T_{lag} = L^8 \frac{(S+1)^7}{(1900Y^{.5})} \quad (1.5)$$

Where:

- L = hydraulic length of the subbasin
- Y = subbasin slope
- S = storage coefficient (in.)

These two approaches to calculation of lag time were performed for each subbasin and reviewed. The quasi-physical estimate of lag time described in Equation 1.4 was generally used for most subbasins. For some subbasins with very low relief, the CN-based method was used as it was considered most representative of the runoff response of the watershed.

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

1.3.3 Storm Duration

A critical-duration analysis was performed to determine the storm duration that generally results in higher water surface estimates for a range of tributary sizes within the Calumet-Sag Channel Watershed. The 12-hour duration storm was identified as the critical duration for streams within the Calumet-Sag Channel Watershed. A second quartile storm is recommended for storms of this duration (Huff, 1992). Table 1.3.4 summarizes rainfall depths for the 12-hour duration storm.

1.3.4 Areal Reduction Factor

The rainfall depths presented in Table 1.3.4 summarize expected point rainfall accumulation for modeled recurrence intervals. The probability of uniform rainfall across a subwatershed decreases with increasing watershed size. Table 21 in Bulletin 71 relates areal mean rainfall depth to rainfall depth at a point (Huff, 1992). Subwatersheds in the Calumet-Sag Channel watershed that were large enough to warrant use of an areal reduction factor are Tinley, Long Run, and Stony Creeks. Modeled rainfall depths were multiplied by approximately 0.98 to account for the expected decrease in probability of uniform rainfall. In addition, the rainfall distribution was modified to the Quartile II distribution for basins 10 to 50 square miles in area, as recommended in Bulletin 71 (Huff, 1992).

TABLE 1.3.4
Rainfall Depths

Recurrence Interval	12-hr Duration Rainfall Depth
2-year	2.64
5-year	3.31
10-year	3.89
25-year	4.79
50-year	5.62
100-year	6.59
500-year	8.96 ^a

^a500-year rainfall depth was determined based on a logarithmic relationship between rainfall depth and recurrence interval.

1.3.5 Hydrologic Routing

Stormwater runoff hydrographs were sometimes routed within HEC-HMS in upstream areas where the resolution of subbasins defined was greater than the hydraulic model extent. In areas where a channel cross section could be identified from topographic data, Muskingum-Cunge routing was performed using the approximate channel geometry from a representative cross section of the modeled hydrologic reach. In most of the watershed, it was impossible to identify channel cross sections in upstream areas. In those cases, a kinematic wave routing approximation was performed.

1.3.6 Hydraulic Model Setup

Hydraulic model data typically was developed through field surveys with some additional definition of channel overbank areas and roadway crests defined using Cook County topographic data. Cross section locations were developed in HEC GeoRAS, and surveyed channel geometry were inserted into topographically generated cross-sectional data. Cross sections were generally surveyed at intervals of 500 to 1,000 feet. Interpolated cross sections were added at many locations to the models to increase stability and reduce errors. Bridges, culverts, and other major hydraulic structures were surveyed within the hydraulic model extent. The locations of all surveyed and modeled cross sections, bridges, culverts, and other structures are shown in a figure within Appendix D.

The Stony Creek hydraulic model was developed using data from a model developed by the USACE in 2001. USACE calibrated the model, which is considered representative of existing conditions along Stony Creek. As part of the DWP, several cross sections were surveyed at locations where the USACE model had cross sections to compare and confirm that the model data reflected current conditions. This comparison concluded that the survey data in the USACE model of Stony Creek was generally consistent, and that the USACE model was valid for defining inundation areas and evaluation of alternative improvement projects.

1.3.6.1 Bridges, Culverts, and Hydraulic Structures

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

1.3.6.2 Cross-Sectional Data

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

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

1.3.6.3 Boundary Conditions

Estimated water surface elevations along the major receiving systems were compared to normal depth of tributaries at the confluence. In most instances, normal depth estimates exceeded the elevation of the receiving system (i.e., Calumet-Sag Channel or Chicago Sanitary Ship Canal). This indicates that the downstream water surface elevation for the waterways is not controlled by the receiving system, as often occurs at stream confluences, but by the ability of the tributary to convey the flows produced in the upstream tributary area. The fact that both the Chicago Sanitary Ship Canal (CSSC) and the Calumet-Sag Channel are manmade, controlled waterways likely contributes to their relatively lower stage compared to their tributaries. Levels of the CSSC and the Calumet-Sag Channel are controlled by the District as required to support navigation and control flooding through operation of the Lockport Lock and Dam.

In cases where the estimated water surface elevation of a channel was required, this data was taken from the Chicago Waterway System (CWS) UNET model, which was obtained from the USACE and converted to HEC-RAS to support DWP development. The I&M Canal was assumed to be represented by water surface elevations along the CSSC as the two water bodies are parallel and directly connected. The specific boundary conditions used for each model

are summarized in the tributary sections. Appendix E contains a detailed summary of the Calumet-Sag Channel hydraulic conditions and methods used to estimate water surface elevation along the CSSC and Calumet-Sag Channel.

1.3.7 Model Run Settings

All hydraulic model simulations were carried out using the fully dynamic, unsteady flow simulation settings within HEC-RAS. The Saint-Venant equations, or the continuity and momentum balance equations for open channel flow, were solved using implicit finite difference scheme. HEC-RAS has the ability to model storage areas and hydraulic connections between storage areas and between stream reaches. The computational time step for model runs varied between 10 and 60 seconds, as necessary for model stability.

1.3.8 Model Calibration and Verification

Model calibration and verifications were performed for tributaries where monitoring data was available to ensure that the hydrologic and hydraulic models accurately predict stormwater runoff response for a range of storm magnitudes. Available monitoring data used for calibration is described in Section 2.3.1. Initial model runs were performed for Tinley Creek, Stony Creek, Mill Creek, Calumet-Sag Tributary B, and Navajo Creek subwatersheds using hydrologic and hydraulic parameters estimated from available GIS data (land-use, soils, topography) and field reconnaissance. Stages (or peak water surface elevation) and runoff volumes were compared to modeled values for a variety of storms. Then, hydrologic and hydraulic parameters with uncertainty were modified within a reasonable range to better represent monitored parameters. Stage was used as the primary calibration variable, since stage directly impacts stormwater damages due to flooding. Stage is also the measured value, both for high-water marks and the USGS gage, which uses a field-measured stage-flow relationship to calculate flow. Runoff volume was also considered, where monitoring data was available.

Initial calibration model results generally over-predicted stage, volume and peak flow rates for Stony Creek and Tinley Creek. Modification to lag time and curve number estimates, in the hydrologic model, and the roughness coefficient in the hydraulic model, were considered to address observed differences. Modification of the lag time was observed to have a minor impact on model results. While discrepancies in stage could be addressed by lowering the roughness coefficient on Tinley Creek, this would increase the over-prediction of peak flow, and would not address the over-prediction of runoff volume. Furthermore, stage was also over-predicted on Stony Creek for its initial calibration runs, and the Stony Creek roughness coefficients were already at the lower end of the acceptable range of values. Although no flow data was available, initial roughness coefficients were considered relatively low. For these reasons, the reduction of curve number values was considered the best method of achieving better correspondence between observed and modeled parameters. A 10 percent curve number reduction from the originally calculated values resulted in the best fit with monitored values for the storms considered.

Detailed calibration results are presented in subwatershed subsections, including hydrographs and comparisons of stage and, where available, runoff volume. Subwatersheds with available calibration data represent a subset of the Calumet-Sag Channel Watershed. Calibration data was available for both the northern part of the watershed, with its flatter topog-

raphy and higher-density development, and the southern part of the watershed with more varied topography and less dense suburban development. The 10 percent reduction of curve number was applied to un-gaged subwatersheds since it was found to be necessary for similar gaged areas of the watershed.

1.3.9 Flood Inundation Mapping

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

1.3.10 Discrepancies Between Inundation Mapping and Regulatory Flood Maps

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

1.3.11 Model Review

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

1.4 Development and Evaluation of Alternatives

1.4.1 Problem Area Identification

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

3.27 Spring Creek

Spring Creek is a regional waterway located in southwestern Cook County, in the southern part of the Calumet-Sag Channel Watershed. The total drainage area of the Spring Creek subwatershed is 2.6 square miles, which includes some drainage area from Will County. Table 3.27.1 summarizes the communities within Cook County that drain to Spring Creek. Figure 3.27.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

The Spring Creek subwatershed contains a mix of suburban development with some open space. Table 3.27.2 summarizes the land use distribution within the Spring Creek subwatershed.

TABLE 3.27.1
Communities Draining to Spring Creek

Community	Tributary Area (mi ²)
Orland Park	1.75
Unincorporated/Forest Preserve	0.85

TABLE 3.27.2
Land Use Distribution for Spring Creek

Land Use Category	Area (acres)	%
Agricultural	651	32.6
Commercial/Industrial	90	4.5
Forest/Open Land	453	22.7
Institutional	44	2.2
Residential	612	30.6
Water/Wetland	147	7.4

3.27.1 Sources of Data

3.27.1.1 Previous Studies

Will County recently created H&H models of existing conditions in Spring Creek to examine floodplain areas and channel improvements for part of Spring Creek in Will County. The model extent does not contain the part of Spring Creek in Cook County and does not begin at the county line, and therefore, did not contribute directly to the development of the Calumet-Sag Channel DWP.

3.27.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Spring Creek. Spring Creek is identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the 303(d) and 305(b) lists. Spring Creek is on the IEPA's 303(d) list due to total manganese, total phosphorous, sedimentation and siltation. No TMDLs have been established for Spring Creek. According to a USEPA water permit discharge query, there is one NPDES permit issued by IEPA to the Andrew Corporation in Orland Park for discharges to Spring Creek. Municipalities discharging to Spring Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.27.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI)

mapping. NWI data for 2001 identify 181.6 acres of wetland areas in the Spring Creek Tributary area. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.27.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA’s Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models used to estimate flood levels generally were not updated. LOMRs were incorporated into revised floodplain areas.

Spring Creek is mapped in detail in the DFIRM mapping update, with Zone AE floodplain shown across the length of Spring Creek. The original hydrologic and hydraulic analyses were performed in 1976. The hydrologic modeling used Regression Equations 73 and 75. The hydraulic routing was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA’s effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.27.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.27.3 summarizes the Form B data for Spring Creek.

TABLE 3.27.3
Community Response Data for Spring Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/Regional	Resolution in DWP
OT1	Orland Township	Overbank flooding, ponding	114th Court and 157th Street	Heavy rains cause overflow of Spring Creek into adjacent subdivision	Regional	Project SPCR-1 will raise 157th Street to reduce frequency of transportation damage
OP10	Orland Park	Maintenance, overbank flooding	Deluga Woods subdivision between 155th and 159th Streets	Lack of maintenance in unincorporated area results in overbank flooding	Regional	Model results did not show property damage due to flooding from a regional waterway in this area. Stream maintenance is recommended.
OP4	Orland Park	Pavement flooding	Southwest Highway at 151st Street	IDOT reported pavement flooding	Local	Problem not located along a regional waterway. This is a local problem

3.27.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Spring Creek subwatershed.

3.27.2 Watershed Analysis

3.27.2.1 Hydrologic Model Development

Subbasin Delineation. The Spring Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. The subwatershed drainage area includes 0.07 square mile of area in Will County that drain into Cook County. This area had available LiDAR topographic data and was delineated in the same manner as the drainage area within Cook County.

Fifteen subbasins were delineated for the Spring Creek Tributary area, with an average area of 111 acres and a total drainage area of 2.6 square miles.

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

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewerded subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.27.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Spring Creek and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's n roughness coefficient to the stream. Appendix D contains field survey information in digital form.

Boundary Conditions. The downstream extent of the Spring Creek model is the point at which Spring Creek drains into Will County. The slope of the main channel there is 0.00083. Normal depth based on this slope was set as the boundary condition for Spring Creek at the point of discharge into Will County.

3.27.2.3 Calibration and Verification

No measured or observed stages were available for Spring Creek to compare model results. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.27.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Flood inundation areas were developed based on HEC-RAS water surface elevations and Cook County topographic data. Figure 3.27.1 shows inundation areas for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Spring Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.27.3 Development and Evaluation of Alternatives

3.27.3.1 Model Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. No property damage due to flooding was identified in the Spring Creek subwatershed. Overtopping of 157th Street, which provides the only means of access to a subdivision west of Spring Creek, was identified as a modeled problem area, as shown in Table 3.27.4. The overtopping of this local road was considered a regional problem because as the only means of access to a subdivision, overtopping of this road by flooding would cut off emergency access to the entire subdivision.

TABLE 3.27.4
Modeled Problem Definition for Spring Creek

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA33	157th Street crossing of Spring Creek	10, 25, 50, 100	OT1	Project SPCR-1 will raise 157th Street to reduce frequency of transportation damage

3.27.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No property damage due to flooding is predicted based upon existing conditions H&H modeling analysis. No erosion or recreation damages were identified for Spring Creek. Transportation damages were explicitly calculated for Spring Creek as the crossing of 157th Street was identified by modeling and WPC members as a frequent flooding issue preventing the only means of access to a subdivision west of Spring Creek. Transportation damages were calculated using the method outlined in “What is a Benefit?” was used (FEMA 2001), using the same period of analysis and discount rate used for property damage due to flooding calculations. Table 3.27.5 lists the existing conditions damages for Spring Creek.

3.27.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in the Spring Creek sub-watershed. Conveyance improvements, increased storage, and levees were considered to address the MPA33 problem at the 157th Street crossing.

TABLE 3.27.5
Estimated Damages for Spring Creek

Damage Category	Estimated Damage (\$)	Note
Property	0	
Erosion	0	
Transportation	24,100	Specific transportation damages calculated for emergency access restrictions at 157th Street.
Recreation	0	

3.27.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding were developed and evaluated to address the damages estimated in Table 3.27.5 consistent with the methodology described in Section 1.4 of this report. Table 3.27.6 summarizes the flood control alternatives developed for Spring Creek.

TABLE 3.27.6
Flood Control Alternatives for Spring Creek

Alternative	Location	Description
SPCR-1	Spring Creek at 157th Street	Raise 157th Street to prevent overtopping, replace culvert with larger culvert, and construct upstream restrictor and weir with same hydraulics as existing conditions.
SPCR-2	Spring Creek from 157th Street to 159th Street	Dredge Spring Creek to increase conveyance. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
SPCR-3	Spring Creek at 157th Street	Raise Road and provide in-line storage to lower downstream WSEL and prevent 157th Street from flooding. This alternative caused an increase in upstream water surface elevations, thus benefits and costs were not developed.

Erosion Control Alternatives. No erosion control alternatives were developed for Spring Creek.

3.27.3.5 Alternative Evaluation and Selection

Alternative SPCR-1 addresses transportation damages associated with the overtopping of 157th Street by raising the road. The hydraulic structure at the crossing would be designed to maintain existing hydraulic conditions upstream and downstream of 157th Street. The culvert would be replaced with two large box culverts with capacity to convey the 100-year design storm. Upstream of the road, a weir is proposed to be built to the existing elevation of the road, with a low flow pipe equal in size to the existing culvert. Noneconomic criteria is a significant factor in development and consideration of this alternative for recommendation as community feedback from Orland Township indicated that frequent flooding of 157th Street cuts off emergency access to an Orland Township neighborhood.

SPCR-2 involves dredging parts of Spring Creek, as suggested by WPC members. This alternative had little impact on modeled WSELs because downstream restrictions limited conveyance capacity. Damages and a cost estimate were not defined for this alternative.

Model results determined that SPCR-3 increased upstream stage, and therefore cannot be recommended in the DWP.

Alternatives included in Table 3.27.6 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Table 3.27.8 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and so costs were not calculated for these alternatives.

Table 3.27.7 below provides a summary of the depth of road flooding for the 157th Street crossing for existing conditions and with recommended alternatives.

TABLE 3.27.7
Spring Creek Road Overtopping Summary

Road Crossing	Road Elevation	25-yr Depth of Flooding	50-yr Depth of Flooding	100-yr Depth of Flooding
157th Street	690.1	0.6	1.2	1.6
157th Street (with alternative SPCR-1)	693.1			

Note: Blank entry indicates that road crossing does not overtop for that particular storm event.

3.27.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.27.8 lists alternatives analyzed in detail. Alternative SPCR-1 is recommended to address transportation damages. Figure 3.27.2 shows the location of recommended alternative SPCR-1 and a comparison of the inundation mapping for existing conditions and with the recommended alternative.

TABLE 3.27.8
Spring Creek Project Alternative Matrix to Support District CIP Prioritization

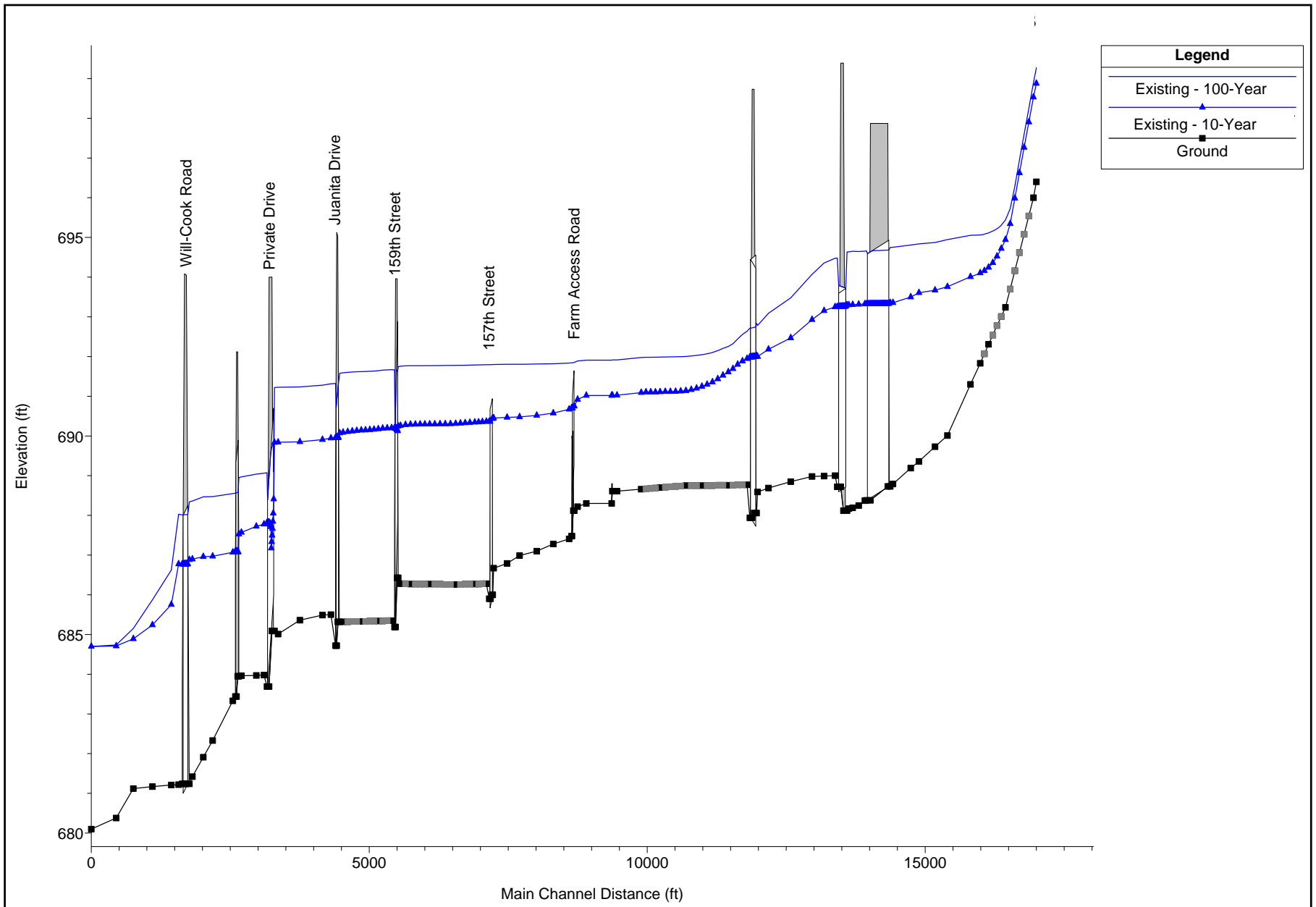
Project	Description	B/C Ratio	Net Benefits (\$)	Total Project Cost (\$)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
SPCR-1	Raise 157th street	0.02	24,100	1,053,800	0	Orland Township	No Impact	Yes	Orland Township

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

APPENDIX 3

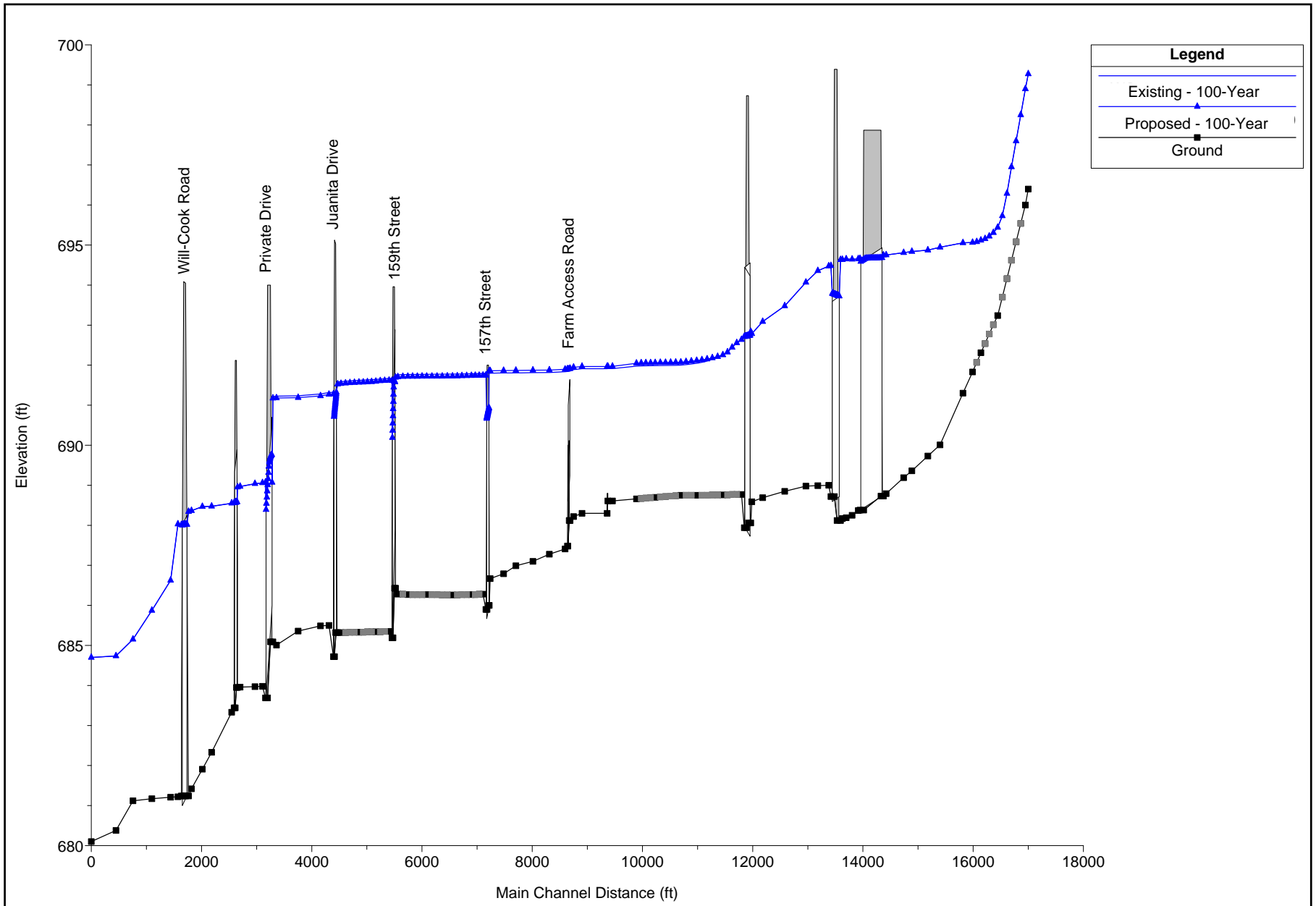
HEC-RAS PROFILES

EXISTING CONDITIONS PROFILE



1 in Horiz. = 2500 ft 1 in Vert. = 3.5 ft

PROPOSED CONDITIONS PROFILE



River Station	100-Year			10-Year		
	Existing Conditions	Proposed Conditions	Change (FT)	Existing Conditions	Proposed Conditions	Change (FT)
17035.08	699.27	699.27	0	698.88	698.88	0
16983.37	698.9	698.9	0	698.53	698.53	0
16479.65	695.44	695.44	0	694.94	694.94	0
16175.84	695.12	695.12	0	694.24	694.24	0
16024.4	695.06	695.06	0	694.1	694.1	0
15850.19	695.05	695.05	0	694.01	694.01	0
15434.41	694.95	694.95	0	693.76	693.76	0
15212.53	694.87	694.87	0	693.67	693.67	0
14922.76	694.84	694.84	0	693.61	693.61	0
14774.58	694.81	694.81	0	693.5	693.5	0
14457.09	694.75	694.75	0	693.36	693.36	0
14406.13	694.75	694.75	0	693.36	693.36	0
Wolf Road						
13981.41	694.66	694.66	0	693.33	693.33	0
13949.59	694.65	694.65	0	693.32	693.32	0
13839.56	694.64	694.64	0	693.32	693.32	0
13732.13	694.65	694.65	0	693.31	693.31	0
13662.15	694.64	694.64	0	693.3	693.3	0
13628.36	694.63	694.63	0	693.3	693.3	0
151st Street. (US)						
13453.85	694.48	694.48	0	693.26	693.26	0
13414.2	694.48	694.48	0	693.25	693.25	0
13217.08	694.36	694.36	0	693.16	693.16	0
13001.02	694.07	694.07	0	692.93	692.93	0
12615.85	693.48	693.48	0	692.47	692.47	0
12216.99	693.09	693.09	0	692.18	692.18	0
12019.91	692.78	692.78	0	692	692	0
12001.15	692.84	692.84	0	692.03	692.03	0
151st Street (DS)						
11882.28	692.71	692.71	0	691.98	691.98	0
11831.4	692.64	692.64	0	691.95	691.95	0
11493.63	692.25	692.26	-0.01	691.61	691.61	0
11018.49	692.05	692.12	-0.07	691.25	691.24	0.01
10730.67	692	692.07	-0.07	691.14	691.13	0.01
10267.74	691.99	692.06	-0.07	691.11	691.1	0.01
9926.51	691.98	692.05	-0.07	691.09	691.08	0.01
9491.793	691.91	691.97	-0.06	691.03	691.01	0.02
8939.248	691.91	691.97	-0.06	691.02	691	0.02
8784.397	691.89	691.95	-0.06	690.92	690.9	0.02
8722.829	691.85	691.91	-0.06	690.75	690.72	0.03
Farm Access Road						
8674.268	691.84	691.9	-0.06	690.7	690.67	0.03
8631.519	691.84	691.9	-0.06	690.67	690.65	0.02
8345.665	691.82	691.88	-0.06	690.58	690.55	0.03
8047.118	691.81	691.87	-0.06	690.52	690.5	0.02
7739.449	691.81	691.87	-0.06	690.48	690.46	0.02
7515.565	691.8	691.86	-0.06	690.47	690.45	0.02
7272.821	691.8	691.86	-0.06	690.45	690.43	0.02
7255.385	691.8	691.86	-0.06	690.44	690.42	0.02
157th Street						
7193.714	691.8	691.75	0.05	690.37	690.37	0
7141.58	691.79	691.74	0.05	690.36	690.36	0
6932.458	691.79	691.74	0.05	690.34	690.34	0
6588.943	691.78	691.72	0.06	690.31	690.31	0
6121.924	691.77	691.72	0.05	690.3	690.3	0
5778.104	691.77	691.72	0.05	690.29	690.29	0
5597.166	691.76	691.71	0.05	690.26	690.26	0
5556.618	691.75	691.69	0.06	690.25	690.25	0
159th Street						
5490.413	691.67	691.61	0.06	690.2	690.2	0
5437.667	691.67	691.62	0.05	690.2	690.2	0
5198.254	691.64	691.59	0.05	690.18	690.18	0
4891.776	691.62	691.57	0.05	690.14	690.14	0
4565.488	691.59	691.54	0.05	690.09	690.09	0
4504.263	691.58	691.53	0.05	690.07	690.07	0
Juanita Drive						
4430.212	691.32	691.28	0.04	689.96	689.96	0
4346.582	691.31	691.27	0.04	689.95	689.95	0
4194.408	691.28	691.23	0.05	689.91	689.91	0
3788.373	691.23	691.19	0.04	689.85	689.85	0
3395.646	691.23	691.18	0.05	689.84	689.84	0
3331.113	691.22	691.17	0.05	689.84	689.83	0.01
Private Drive						
3196.567	689.08	689.07	0.01	687.82	687.83	-0.01
3141.921	689.06	689.06	0	687.78	687.79	-0.01
3004.055	689.04	689.04	0	687.72	687.73	-0.01
2734.719	688.97	688.97	0	687.57	687.58	-0.01
2688.915	688.95	688.95	0	687.53	687.53	0
Field Access Road						

2626.817	688.56	688.56	0	687.09	687.09	0
2582.291	688.55	688.55	0	687.07	687.07	0
2218.895	688.47	688.48	-0.01	686.97	686.97	0
2049.666	688.47	688.47	0	686.96	686.96	0
1853.478	688.36	688.36	0	686.9	686.9	0
1799.666	688.34	688.34	0	686.89	686.89	0
Will Cook Road						
1670.018	688.01	688.01	0	686.77	686.77	0
1606.765	688.03	688.03	0	686.78	686.78	0
1475.852	686.62	686.62	0	685.76	685.76	0
1134.554	685.87	685.87	0	685.24	685.24	0
792.3003	685.15	685.15	0	684.89	684.89	0
482.8005	684.74	684.74	0	684.71	684.71	0
35.46111	684.7	684.7	0	684.7	684.7	0

APPENDIX 4

COST ESTIMATE

Christopher B. Burke Engineering, Ltd.
 9575 West Higgins Road, Suite 600
 Rosemont, Illinois 60018

Orland Township
 157th Street Culvert Replacement Estimate
 Based on Exhibit Alternative #4 (Prepared by CBBEL 5-9-23)
 (CBBEL Project No.: 220268)

LENGTH 800
 WIDTH 22
 RC AREA (SY) 1960

Date: May 15, 2023 (rev 061024 for Comp Storage)

Calculated By: PST

Checked By: JMD

				157TH ST CULVERT REPLACEMENT	
	ITEM	UNIT	UNIT COST	QUANTITY	TOTAL COST
SITE PREP.	TOPSOIL FURNISH AND PLACE, 6"	SQ YD	\$ 5.00	1,430	\$ 7,150.00
	SEEDING, CLASS 1A	SQ YD	\$ 3.00	1,430	\$ 4,290.00
	EROSION CONTROL BLANKET	SQ YD	\$ 3.00	1,430	\$ 4,290.00
	PERIMETER EROSION BARRIER	FOOT	\$ 5.00	1,600	\$ 8,000.00
	COMPENSATORY STORAGE BUDGET (ASSUME 20,000 SF EXCAVATION/RESTORATION)	L. SUM	\$ 75,000.00	1	\$ 75,000.00
CULVERT	REINFORCED CONCRETE BOX CULVERT, 10' x 5'	FOOT	\$ 1,250.00	40	\$ 50,000.00
	PIPE CULVERT REMOVAL	FOOT	\$ 50.00	40	\$ 2,000.00
	BOX CULVERT END SECTIONS (10' x 5') W / GRATE	EACH	\$ 40,000.00	2	\$ 80,000.00
	STONE RIPRAP AND FILTER FABRIC	SQ YD	\$ 150.00	20	\$ 3,000.00
	STEEL PLATE BEAM GUARDRAIL, TYPE A, REMOVAL AND REPLACEMENT	FOOT	\$ 75.00	1,000	\$ 75,000.00
	TRENCH BACKFILL, SPECIAL	CU YD	\$ 45.00	60	\$ 2,700.00
PAVEMENT	PAVEMENT REMOVAL, 18"	SQ YD	\$ 25.00	1,960	\$ 49,000.00
	REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL	CU YD	\$ 75.00	190	\$ 14,250.00
	AGGREGATE SUBGRADE IMPROVEMENT	CU YD	\$ 75.00	70	\$ 5,250.00
	FURNISHED EXCAVATION	CU YD	\$ 50.00	2,170	\$ 108,500.00
	GEOTECHNICAL FABRIC FOR GROUND STABILIZATION	SQ YD	\$ 3.00	420	\$ 1,260.00
	HOT-MIX ASPHALT SURFACE COURSE, MIX "D", N50, 2"	TON	\$ 110.00	220	\$ 24,200.00
	HOT-MIX ASPHALT BINDER COURSE, IL-19.0 N50, 4"	TON	\$ 110.00	440	\$ 48,400.00
	AGGREGATE BASE COURSE, TYPE B, 12"	SQ YD	\$ 20.00	1,960	\$ 39,200.00
	BITUMINOUS MATERIALS (TACK COAT)	POUND	\$ 1.00	1,330	\$ 1,330.00
	AGGREGATE SHOULDERS, TYPE B, 6"	SQ YD	\$ 25.00	360	\$ 9,000.00
	DRIVEWAY REMOVAL AND REPLACEMENT	SQ YD	\$ 65.00	50	\$ 3,250.00
	PAVEMENT STRIPING	L. SUM	\$ 2,500.00	1	\$ 2,500.00
MISC.	COFFERDAM AND DEWATERING	L. SUM	\$ 10,000.00	1	\$ 10,000.00
	MOBILIZATION	L. SUM	+/- 5.0%	1	\$ 30,000.00
	TRAFFIC CONTROL AND PROTECTION	L. SUM	+/- 5.0%	1	\$ 30,000.00
	CONSTRUCTION LAYOUT	L. SUM	+/- 2.5%	1	\$ 15,000.00

NOTES:

- THIS ESTIMATE DOES NOT INCLUDE ROW ACQUISITION, TEMPORARY OR CONSTRUCTION EASEMENTS, OR RELOCATING ANY EXISTING UTILITIES.
- THIS ESTIMATE ASSUMES MAY 2023 CONSTRUCTION COSTS.
- AT THE TIME THIS ESTIMATE WAS PREPARED, CBBEL DID NOT HAVE ACCESS TO THE TOWNSHIP ATLASES.
- THIS ESTIMATE ASSUMES ALL DRIVEWAYS (15' x 15') WILL BE REMOVED AND REPLACED.
- THIS ESTIMATE ASSUMES 10% UNDERCUTTING.

SUBTOTAL =	\$ 702,570.00
CONTINGENCY (20%) =	\$ 140,600.00
CONSTRUCTION TOTAL =	\$ 843,170.00
PROPERTY ACQUISITION FOR COMP STORAGE (BUDGET) =	\$ 50,000.00
DESIGN ENGINEERING (7.5%) =	\$ 63,300.00
CONSTRUCTION ENGINEERING (7.5%) =	\$ 63,300.00
PERMITTING (2.5%) =	\$ 21,100.00

TOTAL COST OF IMPROVEMENTS = \$ 1,040,870.00