In cooperation with the Kane County Department of Environmental Management

Flood-Hazard Study of South Branch

Kishwaukee Watershed, Kane County, Illinois

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U.S. Department of the Interior
U.S. Geological Survey

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	0.4047	hectare (ha)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
	Flow rate	
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
inch per hour (in/h)	0 .0254	meter per hour (m/h)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Flood Hazard Study of South Branch Kishwaukee Watershed, Kane County, Illinois

Purpose

Kane County Department of Environmental Management (KCDEM) seeks to avoid unplanned development in western Kane County that could increase flooding and water quality problems in the Kishwaukee River headwater streams. The headwater streams consist of four presently agriculture-dominated watersheds: Eakin, South Branch Kishwaukee, Coon, and Union watersheds. KCDEM is interested in obtaining accurately mapped floodplain boundaries for these four watersheds using current data and modeling techniques, and disseminating the data to local planning authorities.

The currently effective floodplain mapping is of uncertain accuracy for the following reasons: existing floodplain maps are based on historical inundation or base discharges estimated in the early 1970's, and therefore, are likely to have been superseded; and floodplain boundaries were delineated using rudimentary procedures with few or no cross sections, on maps of inadequate topographic resolution. Watershed models with up-to-date data sets can be used to generate floodplain and floodway maps for current conditions and as tools for managing future watershed development.

Approach

HEC-HMS version 3.1.0 (Hydrologic Engineering Center-Hydrologic Modeling System) was used for the hydrologic simulation of the South Branch Kishwaukee watershed. HEC-RAS version 4.0 (Hydrologic Engineering Center-River Analysis System) was used for the hydraulic simulation of South Branch Kishwaukee Creek and its tributaries.

Description of Study Area

South Branch Kishwaukee watershed, a headwater of the Kishwaukee River, is located in northern Kane County (fig. 1) with a small part of the watershed crossing the county line into McHenry County. Parts of the municipalities of Huntley, Gilberts, Carpentersville, and Algonquin are in the watershed. The area of South Branch Kishwaukee watershed is 9.99 square miles. The elevations in the South Branch Kishwaukee watershed range from 866 to 962.086 ft above mean sea level.

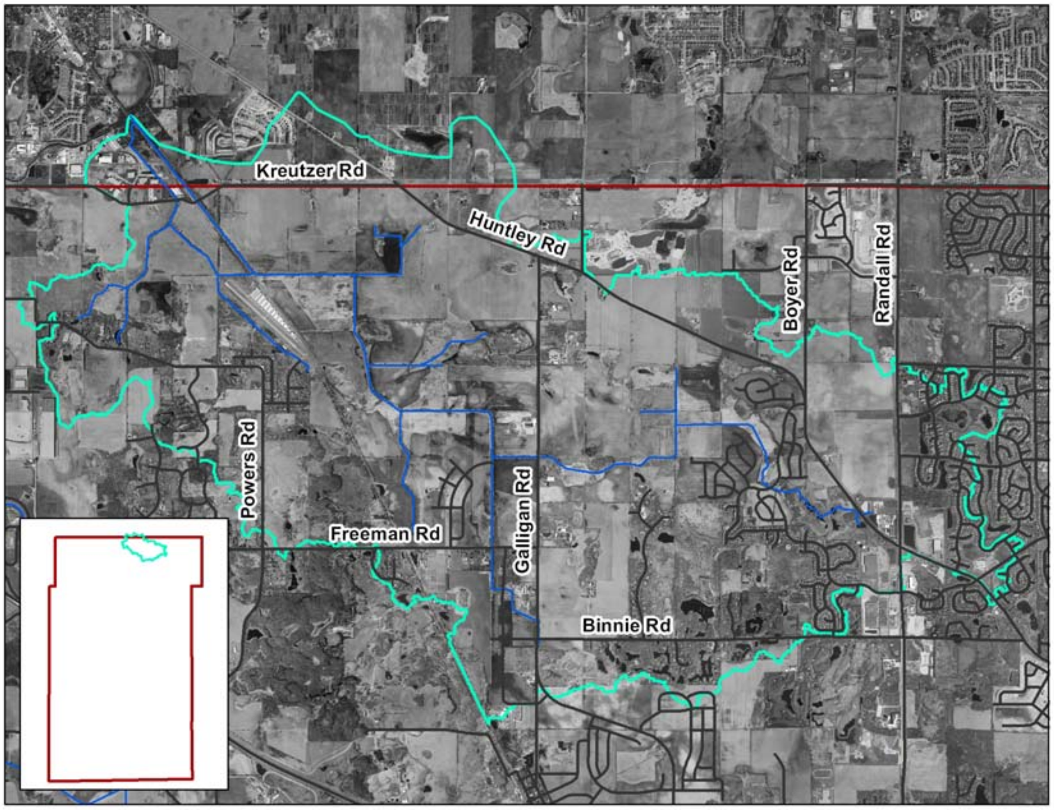


Figure 1. Location of South Branch Kishwaukee watershed in Kane County, Ill. The background aerial photography is from Kane County and the Illinois Natural Resources Geospatial Data Clearinghouse (2009).

Data

Data needed for input and use in model development and verification and flood-hazard mapping included stream and flood-plain cross sections, soil, land use, precipitation, and topography. The coordinate system used in this report is the Illinois State Plane Coordinate System - East Zone HARN (High Accuracy Reference Network), NAD83, and NAVD88 altitude.

DEM/TIN

The digital terrain model (DTM) data were obtained from the Kane County GIS department. The DTM data was derived from the 2001 aerial orthophotography of Kane County and is suitable for two-foot contours. A new set of DTM data were delivered to Kane County in 2008 derived from 2006 photography. The USGS compared both sets of DTM data to 505 surveyed ground points in the South Branch Kishwaukee watershed. The mean error for the 2001 DTM data was found to be 0.84 ft with a standard deviation of 1.07 ft and the mean error for the 2006 DTM data was found to be -0.48 ft with a standard deviation of 1.67 ft. Because the new DTM data were available with only a few months left in the study, the study proceeded with the 2001 DTM data.

Soils

The Soil Survey Geographic (SSURGO) database for Illinois (U.S. Department of Agriculture, Natural Resources Conservation Service, 1995) was used for assessing soil information for the watershed. The hydrologic soil groups A, B, C, and D (Donigian and Davis, 1978, p. 61) were used to classify soils in the watershed. Soil group A has the highest infiltration capacity (0.4-1.0 in/h). Soil group B has the second highest infiltration capacity (0.1-0.4 in/h), and soil groups C and D have smaller infiltration capacities of 0.05-0.1 and 0.01-0.05 in/h, respectively (U.S. Environmental Protection Agency, 2000). Soil group A has the lowest runoff potential because of high infiltration capacity and good drainage, with the amount of runoff increasing for B, C, and D. Soil group B is the dominant soil type for the South Branch Kishwaukee watershed (fig. 2).

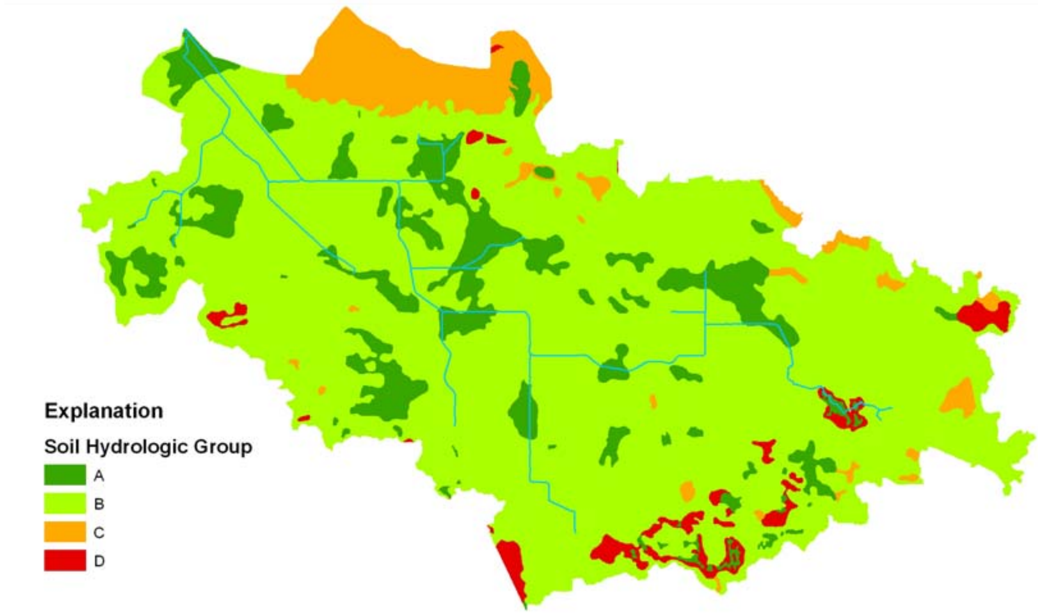


Figure 2. Hydrologic soil groups in the South Branch Kishwaukee watershed

Land-use

The land-use categories used in the hydrologic model were interpreted from the 2001 National Land Cover Data (NLCD) (Multi-Resolution Land Characteristics Consortium, 2008). The USGS digitized the new residential development areas in the watershed using the 2004 Kane aerial map (Thomas Nicoski, Kane County GIS-Technologies, written commun., 2005). The NLCD data did not include a category for roads which were also digitized from the aerial photograph and added to the land cover shapefile. The land-use map developed for the study is figure 3.

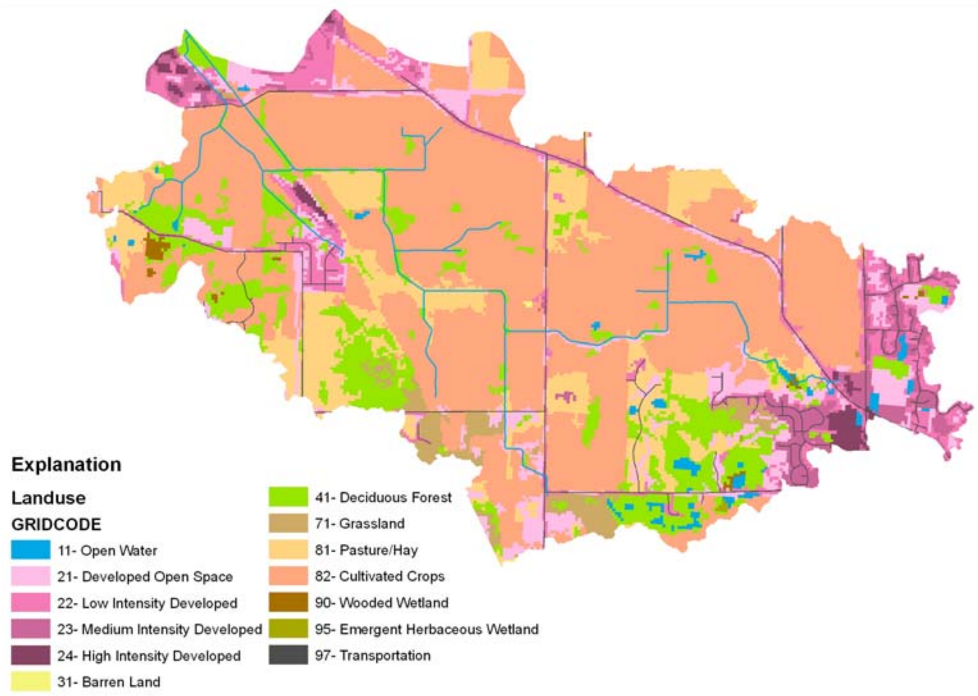


Figure 3. Land use in South Branch Kishwaukee watershed

Hydrologic Modeling

HEC-HMS version 3.1.0 (Hydrologic Engineering Center-Hydrologic Modeling System) was used for the hydrologic simulation of the South Branch Kishwaukee watershed.

Next Generation Radar

Next Generation Radar (NEXRAD) hourly precipitation data for the study area was downloaded from the National Weather Service. A database containing the NEXRAD data from Dec 1994-September 2008 was compiled. The NEXRAD data came from three sources. The data from December 1994-September 2005 were downloaded from the National Weather Service (2007a) archive of River Forecast Center Operational NEXRAD data, the data from January 2006-September 2008 were downloaded from the National Weather Service (2007b) Central Region

Headquarters webpage, and the data from October, November, and December 2005 were requested from the National Weather Service North Central River Forecasting Center.

The precipitation totals from the mid September 2008 storm were input to the HEC-HMS model. Parts of the South Branch Kishwaukee watershed are in six NEXRAD grid cells (fig. 4), however, the totals from two cells were used because each subbasin was assigned the precipitation total from the NEXRAD cell containing the highest proportion of that subbasin's area.

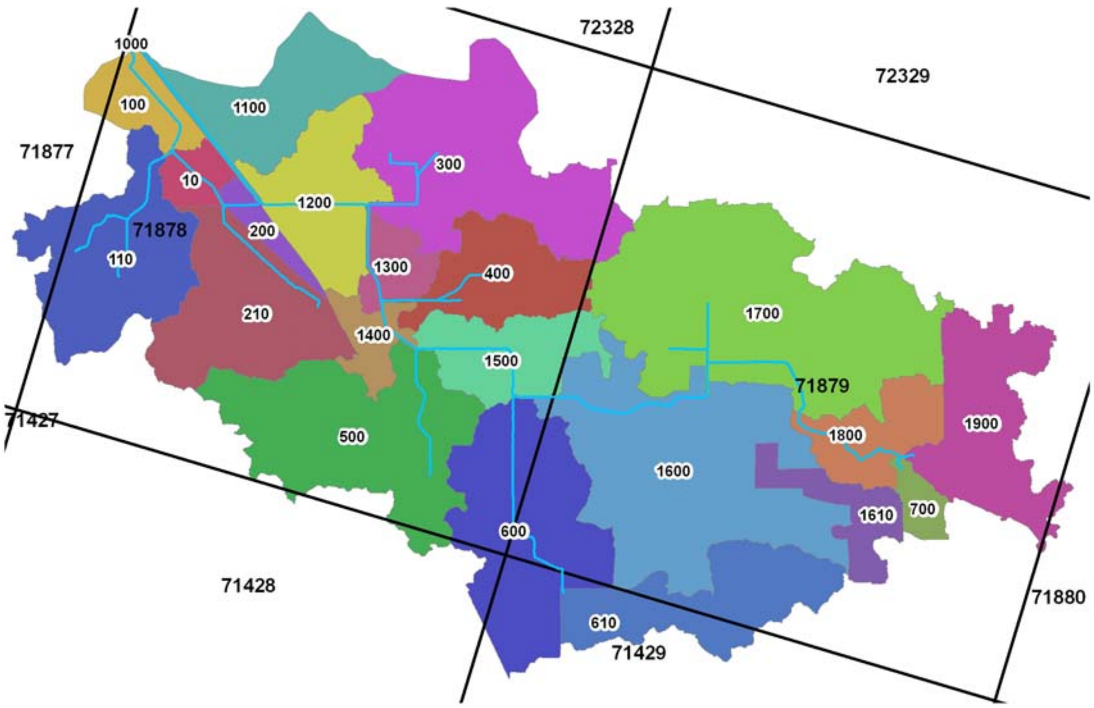


Figure 4. NEXRAD grid over the South Branch Kishwaukee watershed subbasins

Design Storms

Precipitation depths were determined from Huff and Angel (1989) which includes a special study of urban influences on precipitation distribution in Chicago and six surrounding counties, including Kane County. The point precipitation depth was determined from an isohyetal map of the 24-hour storm at different return periods. Then a table in the document was used to determine the depths for different duration storms ranging from 1 hour to 72 hours (table 1). These precipitation depths were then distributed over time (into quartiles) using the table in Huff (1990) for distributing precipitation for watershed areas ranging from 10 to 50 square miles.

Table 1. Areal mean rainfall for South Branch Kishwaukee watershed for a range of return periods and durations

		Cumulative Areal mean rainfall for South Branch Kishwaukee watershed (inches)							
Duration	Huff Quartile	1	2	5	10	25	50	100	500
30 min	1st	0.80	0.96	1.18	1.34	1.64	1.92	2.28	3.29
1 hr	1st	1.06	1.28	1.56	1.78	2.18	2.55	3.03	4.37
2 hr	1st	1.36	1.63	1.99	2.27	2.78	3.25	3.86	5.56
3 hr	1st	1.51	1.81	2.22	2.53	3.10	3.62	4.30	6.21
6 hr	1st	1.79	2.15	2.63	3.00	3.67	4.29	5.09	7.35
12 hr	2nd	2.10	2.52	3.08	3.51	4.31	5.03	5.97	8.64
18 hr	3rd	2.28	2.73	3.34	3.81	4.68	5.46	6.48	9.36
24 hr	3rd	2.44	2.92	3.57	4.08	5.00	5.84	6.93	10.05
48 hr	4th	2.63	3.15	3.86	4.41	5.40	6.31	7.48	11.27
72 hr	4th	2.83	3.39	4.15	4.73	5.80	6.78	8.04	11.92

Model Development

Subbasin Delineation

The subbasin delineation done by Kane County was based on the two-foot contour elevation data. Refinements were made to the delineation because of the need for a subbasin on each stream segment planned for detailed modeling and floodplain mapping. These refinements were also completed using the two-foot contour elevation data. The watershed boundaries were also extended outside of the county boundaries for completeness and calculation of the full watershed area. The extensions of the subbasin boundaries to outside the county were done using USGS 7.5 minute quadrangle topographic data.

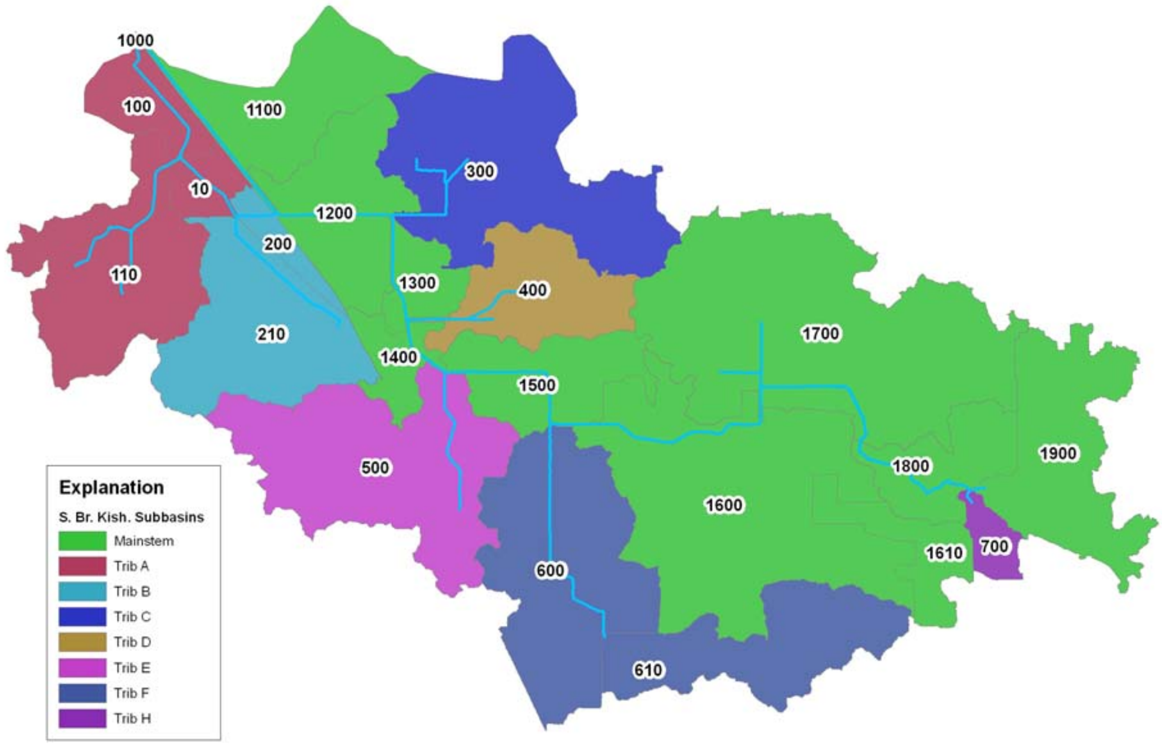


Figure 5. South Branch Kishwaukee watershed subbasins

Baseflow

No stream-gage discharge data were available for the watersheds. Baseflow was defined by the initial discharge, recession constant, and ratio to peak relation. These parameters were developed by looking at the storm hydrographs of other discharge gages in the region, including Coon Creek at Riley, Middle Branch of the South Branch of the Kishwaukee River near Malta, Unnamed Tributary to the South Branch Kishwaukee Creek near Huntley, and Tyler Creek at Elgin. The drainage areas of these gages ranged from 1.67 square miles to 85.1 square miles.

Loss method

The SCS curve number method was used to compute the loss before the start of runoff. The curve number for each watershed was computed using ArcCN (Zhan and Huang, 2004), a GIS utility program. This program computes a curve number for each intersection of soil and land-use type in a subwatershed (table 2). The weighted average of the curve numbers were then computed to assign one curve number to each subbasin. For the design storm runs, an antecedent moisture condition of II was assumed.

Table 2. Curve number table developed for use with ArcCN

LANDUSE	A	B	C	D
11- Open Water	98	98	98	98
21- Developed Open Space	49	69	79	84
22- Low Intensity Developed	57	72	81	86
23- Medium Intensity Developed	77	85	90	92
24- High Intensity Developed	89	92	94	95
31- Barren Land	77	86	91	94
41- Deciduous Forest	36	60	73	79
42- Evergreen Forest	40	66	77	85
71- Grassland	39	61	74	80
81- Pasture/Hay	49	69	79	84
82- Cultivated Crops	67	78	85	89
90- Wooded Wetland	30	55	70	77
95- Emergent Herbaceous Wetland	30	58	71	78
97- Transportation	83	89	92	93

No initial abstraction was specified and no impervious areas outside of that accounted for by the curve number was included in the model.

Hydrologic routing methods

The majority of the reaches in the South Branch Kishwaukee HMS model were routed with the Modified Puls method. This hydrologic routing method was selected because of the small slopes and large amounts of overbank storage in the watershed. The Modified Puls method is built around a storage-discharge relation developed using the hydraulic model, in this case HEC-RAS. To develop the storage-discharge relation, twenty flow profiles were run in the hydraulic model. The largest flow was approximately equal to twice the estimated Regional Flood Frequency discharge, and this was divided by twenty to get the rest of the flows. For stream reaches that were not included in the detailed study and, therefore, not modeled in the HEC-RAS hydraulic model, Kinematic Wave routing was used.

Transform method

The HEC-HMS model includes a transform method which expresses the hydrologic process going on in the subbasin in terms of the surface runoff. The SCS unit hydrograph transform method was used for this study. The SCS unit hydrograph transform method is a function of the calculated curve number and the subbasin length and slope. The input parameter to HMS for this method is a lag time (table 3). The lag time is the time that elapses between the precipitation center of mass and the peak flow of the hydrograph. The lag time was calculated using HEC-GeoHMS Version 4.1 Beta (U.S. Army Corps of Engineers, 2007).

Table 3. Lag time and time of concentration for the South Branch Kishwaukee subbasins

Subbasin	T_{lag} (min)	T_c (hr)
10	32.88	0.91
100	31.33	0.87
110	58.45	1.62
200	40.04	1.11
210	56.13	1.56
300	71.35	1.98
400	81.66	2.27
500	79.98	2.22
600	91.53	2.54
610	72.21	2.01
700	21.09	0.59
1100	74.35	2.07
1200	67.23	1.87
1300	61.71	1.71
1400	48.93	1.36
1500	92.36	2.57
1600	109.39	3.04
1610	14.32	0.40
1700	92.84	2.58
1800	59.39	1.65
1900	64.25	1.78

A summary of the subbasin hydrologic parameters is given in Appendix 1.

Calibration and Verification

The Regional Flood Frequency Equations (Soong and others, 2004) were used to estimate the flows in the subbasins and at the HEC-RAS flow locations. These equations are functions of slope, area, and open water. It is important to note that the regional flood frequency equations do not account for the diversion of flow from Tributary B to Tributary AA. A comparison of the regional flood frequency flows (RFF) and the simulated flows from HEC-HMS are shown in Table 4.

Table 4. A comparison of the flows simulated by the HEC-HMS model and the Regional Flood Frequency equations at selected HEC-RAS flow locations

			10-Year Flows		100-Year Flows	
River	**Reach**	**RS**	**HMS**	**RFF**	**HMS**	**RFF**
Main	**M2**	15934	378.8	247.2	833.6	401.4
Main	**M3**	12400	426.2	303.0	898.1	488.5
Main	**M4**	9681	477.7	349.3	1011.8	563.6
Main	**M5**	6960	347.2	343.1	729.4	548.7
Main	**M6**	4267	325.8	397.3	704.8	635.8
Main	**M7**	1618	353.9	428.8	763.0	684.5
Trib A	**A1**	3200	103.9	96.1	251.0	162.4
Trib A	**A2**	1096	140.8	111.6	373.8	188.6
Trib AA	**AA**	1090	41.7	26.8	136.0	45.9
Trib B	**B1**	2800	113.8	109.4	256.0	188.9
Trib B	**B2**	400	36.1	115.6	53.0	198.7
Trib C	**C**	1341	168.4	153.8	379.4	265.3
Trib D	**D**	1322	57.8	68.8	139.1	116.9
Trib E	**E**	1999	95.6	149.3	264.9	258.5
Trib F	**F**	6400	75.0	27.6	184.1	42.0
Trib F	**F**	2878	166.0	92.8	358.5	148.1

The hydrologic model was run for one event on September 12-15, 2008. The NEXRAD rain data was used as the input rain. The conditions preceding the September 12-15, 2008 storm were drier than normal, so a new set of SCS curve numbers was necessary. Antecedent moisture condition (AMC) I curve numbers for dry conditions (Mays, 2005) were computed. The resulting curve number table is shown below in table 5. The comparison of the simulated and observed water-surface elevations for this storm is presented in the hydraulic modeling section.

Table 5. Curve numbers developed for the design and September 2008 storms

Subbasin	AMC II CN for Design Storms	AMC I CN for September 2008
10	77.5	59.1
100	72.0	51.9
110	72.2	52.1
1100	77.5	59.1
1200	74.8	55.4
1300	70.6	50.2
1400	67.5	46.5
1500	73.6	54.0
1600	71.1	50.8
1610	78.5	60.5
1700	75.7	56.6
1800	74.6	55.2
1900	78.8	60.9
200	68.3	47.5
210	76.1	57.2
300	76.3	57.4
400	72.4	52.4
500	65.6	44.4
600	74.1	54.5
610	71.3	51.1
700	86.4	72.7

Hydraulic Modeling

HEC-RAS version 4.0 Beta and HEC-RAS version 4.0 (Hydrologic Engineering Center-Hydrologic Modeling System) were used for the hydraulic modeling of the South Branch Kishwaukee watershed.

Data

Survey

The IDNR-OWR conducted field survey for selected hydraulic structures and 2 natural cross-sections upstream and downstream of each structure and at stream junctions in the South Branch Kishwaukee watershed to define critical channel geometries. The USGS surveyed some additional cross-sections and high-water marks. Other topographic data needed for describing floodplains were extracted from Kane County's digital terrain model (DTM) using ArcGIS tools. The IDNR-OWR survey data was used to represent the channel portion of the extracted cross section at those locations. For extracted cross sections that did not have surveyed channel data, the channel portion of the extracted data was modified to conform to interpolated thalweg elevations and nearby channel geometry. The approach was used because the high resolution DTM was sufficient for determining most near channel topographic features except for channel depth. Surveyed channel data were also used to supplement the estimate of thalweg elevations in natural reaches, so proper modifications could be made to extracted cross sectional data. Profile plots of the minimum channel elevation of the extracted cross sections and the surveyed cross sections were used to interpolate the thalweg elevations at non-surveyed cross sections.

The IDNR-OWR and USGS surveys and DTM both use the Illinois State Plane Coordinate System - East Zone, NAD83 (1997) coordinates system. According to the DTM metadata, the vertical accuracy of the DTM is sufficient for generating a two-foot contour for the South Branch Kishwaukee watershed (with a vertical accuracy of 1 foot). The IDNR-OWR and USGS cross section and topographic surveys were done using GPS RTK methodology. The vertical accuracy is between 2 to 4 centimeters (0.0656 to 0.1312 ft).

Manning’s roughness coefficients

Manning’s roughness coefficients (*n*-values) were determined based on observations made during field reconnaissance in summer months when vegetation was fully grown and high flows typically occur. These Manning’s roughness coefficients were assigned to other reaches with similar reach conditions as determined from the 2004 aerial DOQ. The resulting Manning’s roughness coefficients vary approximately from 0.03 to 0.05 (average 0.036) in the channel, and from 0.03 to 0.08 (average 0.045) in the flood plains. There were many small reaches where the channels were vegetated and had *n*-values as large as the floodplains. The *n*-values for the channel and overbank areas were chosen from “Table 3-1 Manning’s ‘n’ Values” in the HEC-RAS User’s Manual Version 3.1 (U.S. Army Corps of Engineers, 2002) as well as “Table 5.1.1 Values of the Roughness Coefficient *n*” from Mays (2005).

Model Development

Input flows

A critical duration analysis was performed on the flows generated with the HEC-HMS hydrologic model. Design storms of various durations were run for each return period storm. The storm duration giving the majority of the peak flows in the basin was selected from among the different duration storms and used as input to the HEC-RAS hydraulic model. For the South Branch Kishwaukee watershed, the 18-hour storm produced the majority of the peak flows and was selected as the critical duration (table 6). A flow distribution was performed along each reach so that the flow in the reach changed proportionally to the distance down the reach. In other words, for headwater reaches, the flow at the cross-section representing the mid-point of the subbasin would be approximately half the flow calculated at the outlet of the subbasin. For other reaches, the flow at the mid-point of the subbasin was equal to the average of the flows calculated at the subbasin outlets immediately upstream and downstream.

Table 6. Discharges for 10- and 100-year design storms at an 18-hour duration

River	Reach	RS	Q_{10} (cfs)	Q_{100} (cfs)
Main	M2	15934	378.8	833.6
Main	M3	14376	479.2	1024.0
Main	M3	12400	426.2	898.1
Main	M4	10503	477.9	1021.3
Main	M4	9681	477.7	1011.8
Main	M5	8686	428.2	900.2
Main	M5	6960	347.2	729.4
Main	M6	6054	348.9	744.5
Main	M6	4267	325.8	704.8
Main	M7	3083	348.4	752.7
Main	M7	1618	353.9	763.0
Trib A	A1	5200	43.6	105.4
Trib A	A1	3200	103.9	251.0
Trib A	A2	1096	140.8	373.8
Trib AA	AA	2057	79.6	237.5
Trib AA	AA	1090	41.7	136.0
Trib B	B1	4800	75.9	170.7
Trib B	B1	2800	113.8	256.0
Trib B	B2	1005	40.4	49.1
Trib B	B2	400	36.1	53.0
Trib C	C	2997	92.6	208.7
Trib C	C	1341	168.4	379.4
Trib D	D	2908	56.6	136.3
Trib D	D	1322	57.8	139.1
Trib E	E	3600	76.5	211.9
Trib E	E	1999	95.6	264.9
Trib F	F	6400	75.0	184.1
Trib F	F	6316	120.5	271.3
Trib F	F	2878	166.0	358.5

Ineffective areas

The ineffective flow areas option of HEC-RAS was used to define areas of cross sections that contained water not actively being conveyed (ineffective flow). Ineffective flow areas are specified at natural cross sections where the floodplain is very wide and where contraction/expansion exists, and at hydraulic structures such as bridges and culverts. At very wide natural cross sections, the locations of ineffective flow area are first identified by inspection of an aerial photograph. Later, the locations are adjusted after inspecting the energy gradient line of HEC-RAS output, and inundation drawn on contour maps. For hydraulic structure sites, an initial estimate for locating ineffective areas at expansion and contraction cross sections was obtained using 1:1.5 and 1:1 ratios (streamwise distance to lateral cross-section distance), respectively. Similarly, the locations of ineffective flow areas at approaching and departure cross sections are adjusted by inspecting energy gradient lines, channel velocity, and hydraulic output at structures.

Diversion at Northeastern Corner of Landings Condominium Airport

Analysis of the stream centerline indicated that Tributary B was connected to the upstream end of Tributary AA over a berm (figure 6) at the northeastern corner of Landings Condominium Airport, but the mechanism of connection could not be determined. Field surveys verified that there was no pipe or other man-made connection between Tributary B and AA and that the elevation of the berm was insufficient to prevent high flows from leaving Tributary B and entering Tributary AA. Therefore, this location was simulated as a flow diversion from Tributary B to Tributary AA in the HEC-RAS model.

Estimating flows over a road generally is done by treating the road embankment as a broad-crest weir and estimating the overtopping flows with a weir equation. Survey data collected by the USGS measured the lowest elevation of the field road berm at 877.25 ft NAVD with a 90 foot width (see table in figure 6). However, standard weir equations do not apply to this diversion situation because the weir is oriented at an angle to flows from upstream reach B1, and the flow direction in reach B2 turns about 90° from reach B1.

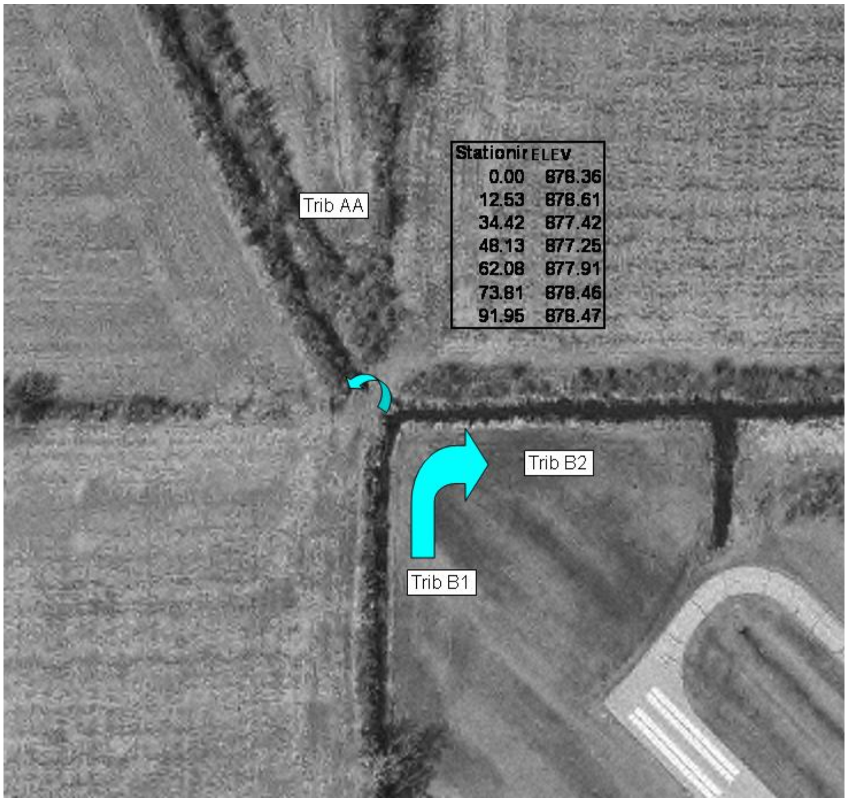


Figure 6. Flow diversion from Tributary B into Tributary AA of South Branch Kishwaukee River

An iterative, trial-and-error approach was used to estimate diverted flows from Tributary B over the berm. A range of discharges in the B1 reach (in-bank flows to greater than 500-year flood peak) were simulated in the HEC-RAS hydraulic model to develop a routing table for the HEC-HMS model. When the estimated water-surface elevation is below 877.25 ft NGVD, no flow is diverted. When estimated water-surface elevation is above the elevation of the berm (877.25 ft NGVD), a trial flow quantity is diverted to Tributary AA with the remaining flow continuing to reach B2. Besides flow quantities, momentum and water-surface elevation at each cross section bordering the diversion were computed and evaluated. There was no strict restriction on the balance of water-surface elevation in Tributary AA, but the discharge and momentum were required to be balanced in the trial-and-error method.

Standard weir equations did not apply to this diversion situation, but they were used to check the diverted flow estimated with the iterative method. Diverted flow was calculated with the weir equations for a weir perpendicular to flow and a weir parallel to the flow with an opening. The perpendicular weir equation would give the maximum flow diversion estimate and the parallel weir equation would give the minimum flow diversion estimate. The diverted flow calculated with the iterative trial-and –error approach was between these two extreme cases.

Profiles

Profiles of the 10- and 100-year flows for each of the detailed study tributaries and the main stem are located in Appendix 2. The 100-year design storm flow simulated by HEC-HMS was used to establish the flow data for the HEC-RAS hydraulic model for estimating 100-year flood stage and for flood plain and floodway analysis.

Calibration and Verification

High Water Mark Collection

High water marks were collected by USGS following the September 12-15, 2008 storm. The locations of these high water marks are shown in Figure 7. The September 2008 storm was estimated to be approximately equivalent to a 25-year, 18-hour storm in the South Branch Kishwaukee watershed.

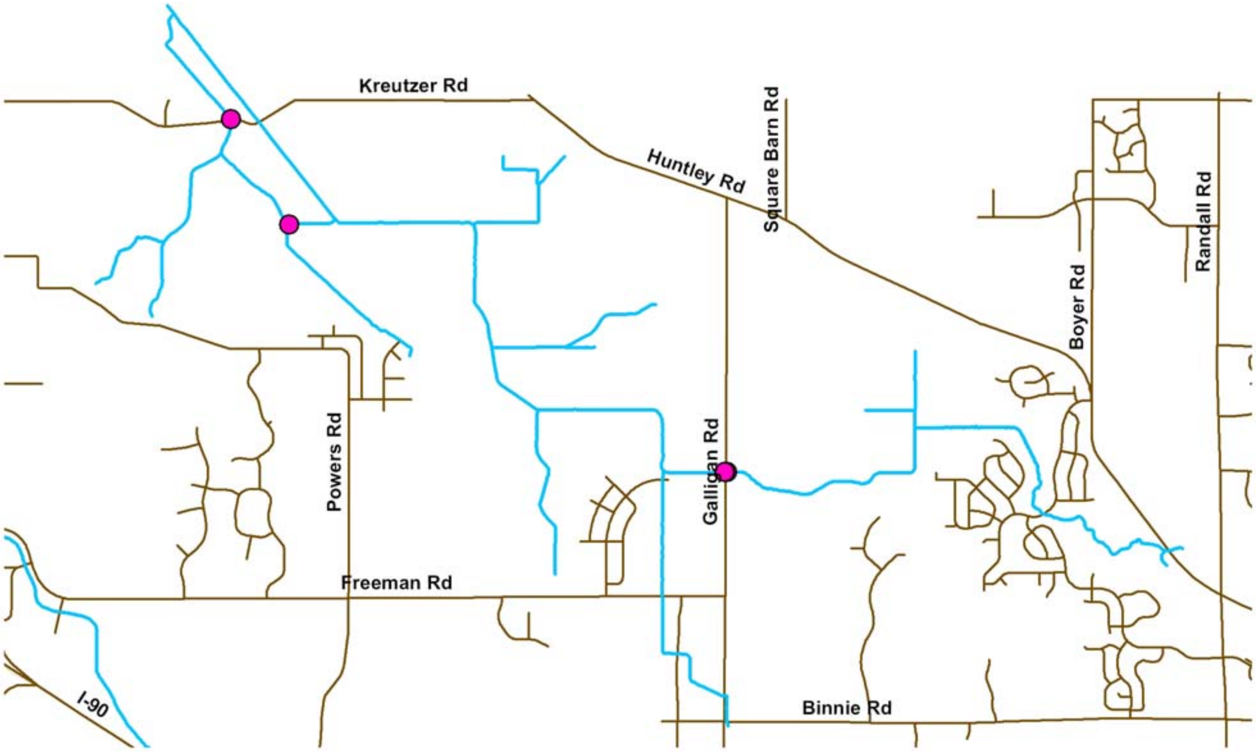


Figure 7. High Water Mark Locations for September 2008 Storm on South Branch Kishwaukee River

Table 7. High Water Mark Verification for September 2008 Storm

High Water Mark Location	Surveyed Elevation	Modeled Elevation	Difference ([Mod]-[Surv])
Galligan Road (US), Mainstem	884.7	884.6	-0.05
Galligan Road (DS), Mainstem	884.9	884.5	-0.4
Kreutzer Road, Trib A	874.7	874.3	-0.4
Diversion at Airport, Trib B	877.4	877.1	-0.3

Adjacent Model Results

The area upstream of Galligan Road is previously studied by CEMCON, Ltd. The USGS model gives a water surface elevation of 888.97 ft at the cross-section just upstream of Galligan

Road, and 887.51 ft at the cross-section just downstream of Galligan Road. The 100-year flow at Galligan Road is 833.6 ft^3/s. The CEMCON Winchester Glen study modeled a water- surface elevation of 889.30 ft just upstream of Galligan Road, and 887.39 just downstream of Galligan Road. This water-surface elevation corresponds to a flow of 737 ft^3/s.

Flood plain and floodway

The water-surface elevations from the hydraulic model were mapped for the 100-year flood plain and floodway. An encroachment analysis was conducted to determine the floodway width using guidelines established by the State of Illinois (Illinois Department of Natural Resources, 2002), which stated that "The regulatory floodway boundaries are determined by hydraulic and hydrologic analyses, which calculate that portion of the flood plain that must be preserved to store and discharge floodwaters without causing damaging or potentially damaging increases in flood stage and flood velocities or loss of flood storage which would result singularly or cumulatively in more than a 0.1 ft increase in flood stage or a 10 percent increase in velocity." For floodway analysis, "In general, the final encroachments should have a consistent and smooth transition from one cross section to the next" (U.S. Army Corps of Engineers, 2002). A plan view of the floodway encroachments was used to determine if the encroachments transitioned smoothly or if they were erratic. Ineffective flow areas can be a cause of erratic encroachment transitions. The erratic encroachments were further refined and the model was re-run to make sure encroachment guidelines were met. At bridge locations, natural cross sections upstream and downstream were used to make sure to make sure that the floodway at the contraction and expansion of the bridge was reasonable.

Maps of the proposed flood-plain and floodway boundaries and the corresponding existing FIRMs are presented in Appendix 3. These proposed maps are not FEMA-approved Flood Insurance Rate Maps, and are subject to revision. The floodway table is presented in Appendix 4.

References Cited

Donigian, A.S. and Davis, H.H., 1978, User’s manual for agricultural runoff management (ARM) model, U.S. Environmental Protection Agency, EPA-600/3-78-080.

Federal Emergency Management Agency, 1996, Flood insurance study, Kane County, Illinois (unincorporated areas): community number 170896, variously paginated.

Graf, J.B., Garklavs, G., and Oberg, K.A., 1982, A technique for estimating time of concentration and storage coefficient values for Illinois streams: U.S. Geological Survey Water-Resources Investigations Report 82-22, 10 p.

Huff, F. A., 1990, Time Distributions of Heavy Rainstorms in Illinois. Illinois State Water Survey, Champaign, Circular 173.

Huff, F.A.and Angel, J.R., 1989, Frequency Distributions of Heavy Rainstorms in Illinois. Illinois State Water Survey, Champaign, Circular 172.

Illinois Department of Natural Resources, 2002, Floodplain Management Resource Guide for Illinois Communities, Section 3708.60 Delineation of the Regulatory Floodway: accessed June 2007, at URL *http://dnr.state.il.us/owr/resman/Downloads/resource_guide_for_IL.pdf*

Illinois Natural Resources Geospatial Data Clearinghouse, 2009, 1998-2001 Illinois Digital Orthophoto Quadrangle (DOQ) data: accessed February 9, 2009 at URL *http://www.isgs.uiuc.edu/nsdihome/webdocs/doqs/*

Mays, L.W., 2005, Water Resources Engineering: John Wiley & Sons, Inc., New Jersey, p.89-92.

Multi-Resolution Land Characteristics Consortium, 2008, National Land Cover Database (NLCD 2001) Multi-zone Download Site: accessed in April 2008 at URL *http://www.mrlc.gov/nlcd_multizone_map.php*

National Weather Service, 2007a, Archive of River Forecast Center Operational NEXRAD Data: accessed in October 2007 at URL *http://dipper.nws.noaa.gov/hdsb/data/nexrad/nexrad.html*.

National Weather Service, 2007b, Central Region Headquarters Home Page: accessed in November 2007 at URL *http://www.crh.noaa.gov/images/ncrfc/data/mpe/grib/*

Straub, T.D., Melching, C.S., and Kocher, K.E., 2000, Equations for estimating Clark unit-hydrograph parameters for small rural watersheds in Illinois: U.S. Geological Survey Water-Resources Investigations Report 00-4184, 24 p.

U.S. Army Corps of Engineers, 2002, HEC-RAS River Analysis System, Hydraulic Reference Manual – Version 3.1.: Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California, various chapters plus appendixes.

U.S. Army Corps of Engineers, 2007, Geo-HMS-Version 4.1 Beta: accessed in October 2007 at *ftp://ftp.esri.com*.

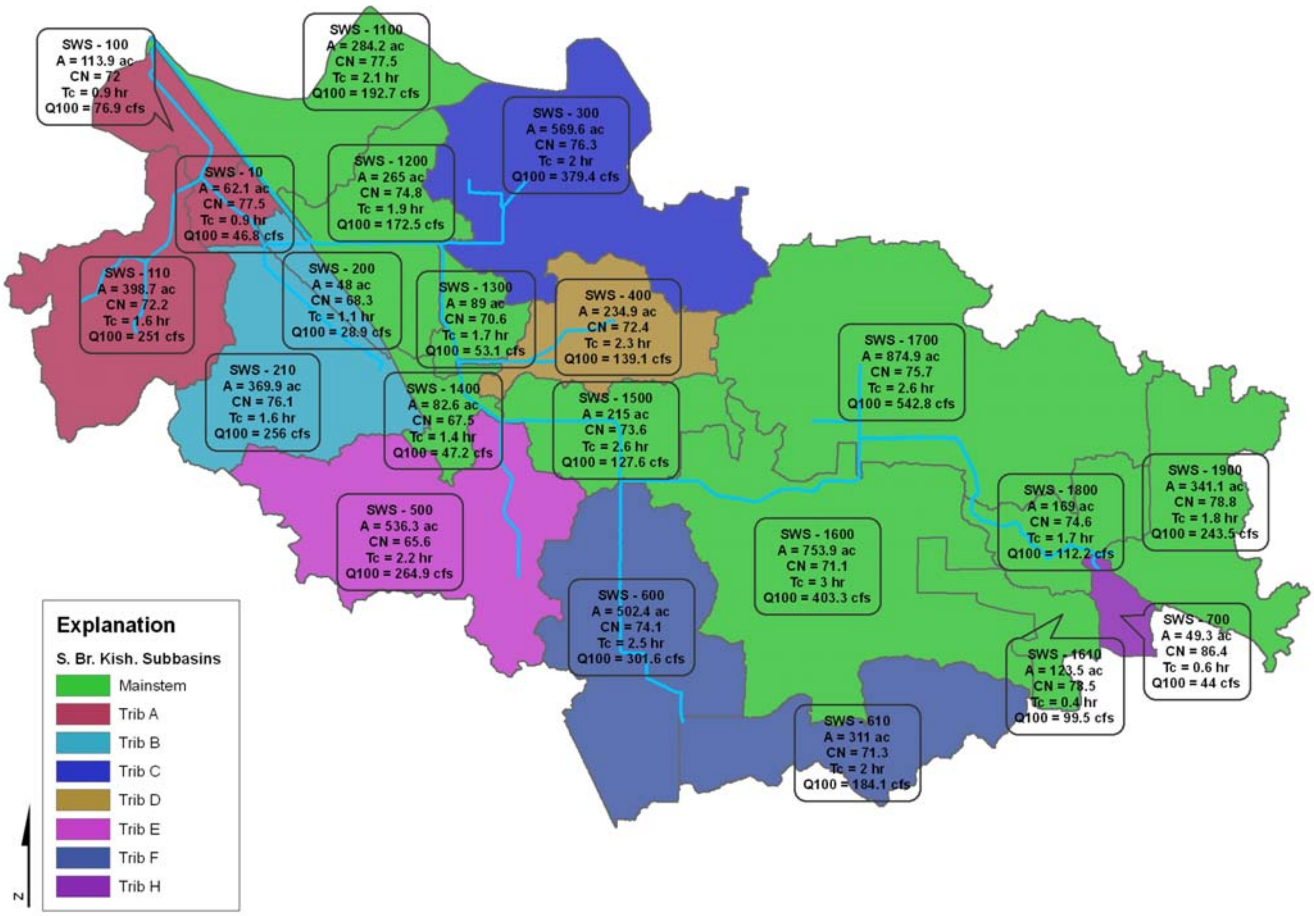
U.S. Department of Agriculture, Natural Resources Conservation Service, 1995, Soil Survey Geographic database: accessed in June 2007 at URL *http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/*.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 2001, Climatological data annual summary, Illinois: Asheville, N.C., Environmental Data Information Service, published annually.

U.S. Environmental Protection Agency, 2000, BASINS Technical Note 6: Estimating Hydrology and Hydraulic parameters for HSPF: Office of Water 4305, EPA-823-R-00-012, 32 p.

Zhan, Xiaoyong and Huang, Min-Lang., 2004, ArcCN-Runoff: an ArcGIS tool for generating curve number and runoff maps: Environmental Modelling & Software, v. 19, p. 875-879.

Appendix 1- Subbasin Summary


SWS - 100
A = 113.9 ac
CN = 72
Tc = 0.9 hr
Q100 = 76.9 cfs
SWS - 1100
A = 284.2 ac
CN = 77.5
Tc = 2.1 hr
Q100 = 192.7 cfs
SWS - 300
A = 569.6 ac
CN = 76.3
Tc = 2 hr
Q100 = 379.4 cfs
SWS - 10
A = 62.1 ac
CN = 77.5
Tc = 0.9 hr
Q100 = 46.8 cfs
SWS - 1200
A = 265 ac
CN = 74.8
Tc = 1.9 hr
Q100 = 172.5 cfs
SWS - 110
A = 398.7 ac
CN = 72.2
Tc = 1.6 hr
Q100 = 251 cfs
SWS - 200
A = 48 ac
CN = 68.3
Tc = 1.1 hr
Q100 = 28.9 cfs
SWS - 1300
A = 89 ac
CN = 70.6
Tc = 1.7 hr
Q100 = 53.1 cfs
SWS - 400
A = 234.9 ac
CN = 72.4
Tc = 2.3 hr
Q100 = 139.1 cfs
SWS - 1700
A = 874.9 ac
CN = 75.7
Tc = 2.6 hr
Q100 = 542.8 cfs
SWS - 210
A = 369.9 ac
CN = 76.1
Tc = 1.6 hr
Q100 = 256 cfs
SWS - 1400
A = 82.6 ac
CN = 67.5
Tc = 1.4 hr
Q100 = 47.2 cfs
SWS - 1500
A = 215 ac
CN = 73.6
Tc = 2.6 hr
Q100 = 127.6 cfs
SWS - 1900
A = 341.1 ac
CN = 78.8
Tc = 1.8 hr
Q100 = 243.5 cfs
SWS - 1800
A = 169 ac
CN = 74.6
Tc = 1.7 hr
Q100 = 112.2 cfs
SWS - 500
A = 536.3 ac
CN = 65.6
Tc = 2.2 hr
Q100 = 264.9 cfs
SWS - 1600
A = 753.9 ac
CN = 71.1
Tc = 3 hr
Q100 = 403.3 cfs
SWS - 600
A = 502.4 ac
CN = 74.1
Tc = 2.5 hr
Q100 = 301.6 cfs
SWS - 700
A = 49.3 ac
CN = 86.4
Tc = 0.6 hr
Q100 = 44 cfs
SWS - 1610
A = 123.5 ac
CN = 78.5
Tc = 0.4 hr
Q100 = 99.5 cfs
SWS - 610
A = 311 ac
CN = 71.3
Tc = 2 hr
Q100 = 184.1 cfs
Explanation
S. Br. Kish. Subbasins
Mainstem
Trib A
Trib B
Trib C
Trib D
Trib E
Trib F
Trib H
N

Appendix 2 - Flood Profiles

Appendix 3 – Flood Plain Maps

Appendix 4 – Floodway Table

			TOP WIDTH (FT)		CROSS SECTION AREA (FT^2)			MEAN VELOCITY (FT/S)			BASE FLOOD WATER SURFACE ELEVATION (FT)		
REACH	CROSS SECTION	STATION	WITHOUT FLOODWAY	WITH FLOODWAY	WITHOUT FLOODWAY	WITH FLOODWAY	PERCENT CHANGE	WITHOUT FLOODWAY	WITH FLOODWAY	PERCENT CHANGE	WITHOUT FLOODWAY	WITH FLOODWAY	CHANGE
MAINSTEM	A	1162	93.1	74.3	4486.3	2963.1	-34.0	1.5	1.6	8.8	880.3	880.3	0.00
	B	3255	125.3	125.4	2868.7	2615.3	-8.8	1.1	1.1	0.0	881.4	881.4	0.01
	C	6054	641.9	431.4	10713.6	7574.9	-29.3	0.6	0.7	9.8	882.0	882.1	0.01
	D	8686	292.1	292.1	952.5	872.9	-8.4	1.4	1.4	0.0	882.5	882.5	0.01
	E	9441	49.1	49.1	1142.3	1036.5	-9.3	4.2	4.2	-0.2	883.3	883.3	0.00
	F	11600	289.5	289.5	3247.1	2426.2	-25.3	1.0	1.0	0.0	884.3	884.3	0.03
	G	13566	316.7	316.7	2328.4	800.2	-65.6	1.6	1.6	0.0	886.7	886.7	0.00
	H	15200	454.4	399.8	2166.5	1516.9	-30.0	0.8	0.9	4.9	887.1	887.1	0.00
TRIBUTARY A	I	405	380.4	229.0	254.6	247.5	-2.8	1.5	1.5	2.7	878.3	878.4	0.10
	J	1362	275.7	201.4	1067.3	965.6	-9.5	0.6	0.6	7.0	879.4	879.5	0.09
	K	3643	816.7	816.7	3542.3	2749.8	-22.4	0.0	0.0	0.0	880.2	880.2	0.03
TRIBUTARY AA	L	1090	32.6	33.1	1237.1	806.2	-34.8	1.2	1.2	-2.5	879.4	879.5	0.08
TRIBUTARY B	M	47	38.5	38.5	527.3	479.6	-9.1	0.2	0.2	0.0	881.4	881.4	0.02
	N	802	470.0	430.0	5138.6	1571.2	-69.4	0.0	0.0	0.0	881.7	881.8	0.02
	O	1159	560.0	480.0	5384.0	1402.8	-73.9	0.2	0.2	5.9	881.8	881.8	0.01
	P	3975	479.3	424.0	1022.8	913.2	-10.7	0.2	0.2	5.6	881.8	881.8	0.02
TRIBUTARY C	Q	400	268.1	268.2	1084.0	626.7	-42.2	0.6	0.6	0.0	882.1	882.1	0.01
	R	2587	219.0	219.0	766.2	702.6	-8.3	0.4	0.4	-2.4	883.0	883.0	0.02
TRIBUTARY D	S	463	40.3	40.3	154.3	154.9	0.3	0.9	0.9	0.0	882.6	882.6	0.01
	T	2418	580.0	453.4	1231.4	1083.6	-12.0	0.2	0.2	10.5	882.8	882.8	-0.02
TRIBUTARY E	U	800	155.0	155.0	1472.3	1401.1	-4.8	0.6	0.6	0.0	884.2	884.3	0.03
	V	2412	337.1	220.0	231.5	209.7	-9.4	0.9	1.0	9.8	888.4	888.4	0.02
	W	3019	301.2	204.0	171.9	158.9	-7.6	1.2	1.3	8.1	888.9	888.9	0.03
TRIBUTARY F	X	400	104.2	104.2	1468.2	1323.9	-9.8	1.0	1.0	0.0	887.2	887.2	0.00
	Y	2210	486.6	398.0	2230.0	2055.0	-7.8	0.3	0.3	7.1	887.4	887.4	0.00
	Z	3602	218.0	218.0	1341.8	827.1	-38.4	0.6	0.6	-1.7	888.7	888.8	0.02
	AA	4190	134.2	134.6	877.4	300.5	-65.8	2.2	2.2	-1.3	889.2	889.2	0.01
	AB	4969	200.0	200.0	1849.3	1058.7	-42.8	0.5	0.5	0.0	891.9	891.9	0.04
	AC	6243	190.1	190.6	3452.3	741.6	-78.5	0.6	0.5	-3.6	895.0	895.1	0.10