3. Tributary Characteristics and Analysis

3.1 West Fork of the NBCR

The West Fork, the northwestern most tributary in the NBCR watershed, has a total stream length of 20.7 miles and a total drainage area of approximately 28 square miles. Table 3.1.1 summarizes the land area of communities within the West Fork subwatershed. The West Fork subwatershed consists primarily of residential and commercial areas and includes a large portion of forest preserve area located in the northern part of the subwatershed. Table 3.1.2 summarizes the land use distribution within the West Fork.

Figures 3.1.1a and 3.1.1b are an overview of the tributary area of the West Fork subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.1.1
Communities Draining to the West Fork[1]

Community/Tributary	Tributary Area (mi^2)
Glenview	9.39
Northbrook	7.77
Deerfield	2.88
Unincorporated	2.01
Riverwoods	1.55
Lincolnshire	1.22
Lake Forest	1.08
Bannockburn	0.82
Deerfield	0.51
Golf	0.34
Mettawa	0.23
Northfield	0.19

[1] Includes communities/area in Lake County

TABLE 3.1.2
Land Use Distribution for the West Fork[1]

Land Use Category	Area (acres)	%
Residential	10,061	55.9
Forest/Open Land	3,076	17.1
Commercial/Industrial	3,053	17.0
Institutional	851	4.7
Transportation/Utility	376	2.1
Water/Wetland	294	1.6
Agricultural	280	1.6

[1] Includes land uses in Lake County

3.1.1 Sources of Data

3.1.1.1 Previous Studies

Data from the 1998 and 2000 FIS regulatory models (HEC-2) were utilized to supplement the newly developed DWP HEC-RAS model for the West Fork. For the Techny Drain tributary, the Village of Northbrook's "Techny Drain Hydrology and Hydraulics" (2007) study was used to assist with subbasin delineation and flow diversion modeling. Additionally, for the Underwriter's Tributary, the 2000 FIS regulatory model was used to assist with subbasin delineation and storage modeling.

3.1.1.2 Water Quality Data

The Illinois Environmental Protection Agency (IEPA) has three Ambient Water Quality Monitoring Network sites on the West Fork. The West Fork, IL-HCCB-05, is identified as impaired in the IEPA's 2008 Integrated Water Quality Report, which includes the Clean Water Act (CWA) 303(d) and 305(b) lists, for Chloride, DDT, Dissolved Oxygen, Phosphorous (Total), Total Suspended Solids (TSS), and

Fecal Coliform. No total maximum daily loads (TMDLs) have been established for the West Fork. TMDLs are currently being developed for chloride and fecal coliform. According to a water permit discharge query from the U.S. Environmental Protection Agency (USEPA), there are three National Pollutant Discharge Elimination System (NPDES) permits issued by IEPA to Prairie Material Sales, Inc. in Northbrook, Underwriters Lab, Inc. in Northbrook, and Village of Golf CSOs for discharges to the West Fork. Municipalities discharging to the West Fork are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was instituted to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.1.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the NBCR Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes approximately 150 acres of wetland areas in the West Fork tributary area. Restoration and enhancement of wetlands are included as part of the recommended alternatives described in the sub-sections below. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.1.1.4 Floodplain Mapping

Flood inundation areas supporting the National Flood Insurance Program (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. Localized Letters of Map Revisions (LOMRs) were incorporated in the revised floodplains. The effective FIS H&H analysis was performed in 1994. The hydrologic modeling was performed by using HEC-1 and Regression Equation 79; Hydraulic routing was performed using HEC-2.

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

3.1.1.5 Stormwater Problem Data

Table 3.1.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.1.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.1.1.6 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. Several studies are currently underway in the West Fork subwatershed; however, no near-term planned flood control projects by others have been identified for this area.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GV-FL-08	Village of Glenview	Intracommunity (local) flooding	Village of Glenview - Villagewide	Ponding and storm sewer flow restriction village-wide. Numerous areas in the Village developed prior to the 1980s have inadequate storm water conveyance and detention	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-11	Village of Glenview	Intracommunity (local) flooding	Illinois Tool Works Detention Pond, Glencoe	Local overbank flooding of existing detention pond due to debris collection at restrictor. Problem causing overbank flooding of local residents' backyards and local power outages.	Local	Problem not located on a regional waterway. This is a local maintenance problem.
GV-ER-03	Village of Glenview	Streambank erosion on intracommunity waterways	John's Dr at Willow Road	Stream bank destabilization, erosion and sedimentation, and wetland/riparian areas at risk. Trees along channels continually contribute to log jams. Invasive species degrade habitat.	Regional	Erosion problem does not threaten structures or conveyance of West Fork. Not addressed by DWP.
GV-SM-04	Village of Glenview	Stream maintenance	North Navy Ditch beginning at John's Dr. Navy Ditch confluence with West Fork	Following removal of buckthorn/brush from North Navy Ditch, remaining large cottonwood/box elder trees exposed to greater wind force, causing limb breakage/tree failure and minor re-blockage of channel	Regional	Maintenance and debris removal recommended in Section 4.
GV-ER-05	Village of Glenview	Streambank erosion on intercommunity waterways	Lehigh Avenue and Chestnut Avenue	Stream bank destabilization, erosion and sedimentation, and wetland/riparian areas at risk. Trees along channels continually contribute to log jams. Invasive species degrade habitat.	Regional	Erosion problem does not threaten structures or conveyance of West Fork. Not addressed by DWP.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GV-FR-06	Village of Glenview	Intercommunity (regional) flooding	Tall Trees Subdivision	Overbank Flooding in Tall Trees Subdivision.	Regional	The recommend alternative for this problem is WF-06.
GV-SM-07	Village of Glenview	Stream maintenance	South Navy Ditch beginning at Lehigh Avenue South Navy Ditch confluence with West Fork	South Navy Ditch beginning at Lehigh Rd, Ongoing aging and breakage of trees along the South Navy Ditch eventually contributes to small log jams.	Regional	Maintenance and debris removal recommended in Section 4.
NB-FR-12	Village of Northbrook	Intercommunity (regional) flooding	Techny Basin 32A (Meadowhill Park)	Overbank flooding, storm sewer flow restriction. Diversion culverts (triple elliptical pipes) prone to clogging during high flow events and do not allow a sufficient amount of water to pass through.	Regional	The recommend alternative for this problem is WF-06.
NB-FR-13	Village of Northbrook, Unincorp Cook County	Intercommunity (regional) flooding	Techny Basin 32A (Meadowhill Park)	Techny Basin 32A Overbank flooding. The Village of Northbrook's major storm sewer outfalls are submerged and conveyance problems result.	Regional	The recommend alternative for this problem is WF-06.
NB-FR-14	Village of Glenview	Intercommunity (regional) flooding	Techny Basin 32B	Overbank flooding	Regional	The recommend alternative for this problem is WF-06.
GV-FR-09	Village of Glenview	Intercommunity (regional) flooding	Techny Basin 32C	Overbank flooding - Techny Basin 32C provides bulk of the Village's upstream storm water protection storage within the West Fork NBCR watershed. Recent storms brought extreme flooding.	Regional	The recommend alternative for this problem is WF-06.
GV-SM-10	Village of Glenview	Stream maintenance	Willow Road & Ravine Avenue Techny Basin 32C	Techny Basin 32C maintenance necessary at the MWRD maintained spillway that has been identified for years at the biannual inspections.	Regional	Maintenance activities recommended in Section 4.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NB-FR-06	Village of Northbrook	Intercommunity (regional) flooding	From Fieldwood Drive and Techny Road to Techny Drain near its confluence with West Fork	Flooding within backwater influence of West Fork NBCR extending approx 2000ft upstream along Techny Drain. Property/structure flooding within the backwater influence for short localized storms	Regional	The recommend alternative for this problem is WF-06.
GV-ER-12	Village of Glenview	Streambank erosion on intercommunity waterways	River between Glenview Road and Waukegan Road	Stream bank destabilization, erosion and sedimentation, wetland/riparian areas at risk. Significant erosion and undermined turf on East bank of West Fork (400 linear ft).	Regional	Confirmed with Village of Glenview that local project to mitigate erosion already implemented.
GV-ER-13	Village of Glenview	Streambank erosion on intercommunity waterways	Lot 16 Bank Stabilization	Streambank destabilization, erosion and sedimentation, wetland/riparian areas at risk. Channel clogged primarily by woody debris. Banks unstable/choked with invasive species, particularly buckthorn.	Regional	Erosion problem does not threaten structures or conveyance of West Fork. Not addressed by DWP.
GV-ER-14	Village of Glenview	Streambank erosion on intercommunity waterways	1201 Long Valley Road	Regional erosion occurring within 30 ft of residence on the west streambank.	Regional	Erosion problem not immediately threatening structure. Not addressed by DWP.
GV-FL-15	Village of Glenview	Intracommunity (local) flooding	Village-wide	Ponding/storm sewer flow restriction in 30% of Village that is partially non-storm-sewered. Village Storm Water Study: inadequate storm water detention/conveyance, inlet capacity.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GV-FL-16	Village of Glenview	Intracommunity (local) flooding	Illinois Route 43 at C, M, & St Paul RR	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-17	Village of Glenview	Intracommunity (local) flooding	Greenwood Avenue at S/O West Lake Avenue	IDOT Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-18	Village of Glenview	Intracommunity (local) flooding	Pfingston Road North of Glenview Road, South of Knollwood Lane	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-19	Village of Glenview	Intracommunity (local) flooding	Shermer Road North of Central Road, South of Robincrest Lane	Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-20	Village of Glenview	Intracommunity (local) flooding	Harlem Avenue North of Lake Street, West of Robincrest Lane	Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GV-FL-21	Village of Glenview	Intracommunity (local) flooding	Spruce Drive South of Lake Street, West of Lehigh Avenue	Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-22	Village of Glenview	Intracommunity (local) flooding	Locust Lane & Rolwind Road	Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-23	Village of Glenview	Intracommunity (local) flooding	Country Lane and North Branch Road	Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FR-24	Village of Glenview	Intercommunity (regional) flooding	Tall Trees Subdivision	Overbank flooding along West fork	Regional	The recommend alternative for this problem is WF-06.
GV-SM-25	Village of Glenview	Stream maintenance	West Fork at Willow Road & Ravine Way and at Chestnut Avenue	Log jam flow obstruction, continuing onwards to river south of Loyola Academy athletic campus. Trash/woody debris in dry former river channel to north of Lot 16.	Regional	Maintenance and debris removal recommended in Section 4.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GV-ER-26	Village of Glenview	Stream maintenance on intercommunity waterways	East side of West Fork NBCR, South of Glenview Road; East side of West Fork NBCR, North of Waukegan Road	Streambank Erosion	Regional	Confirmed with Village of Glenview that local project to mitigate erosion already implemented.
GV-WQ-27	Village of Glenview	Streambank erosion on intercommunity waterways	River between Glenview Road and Waukegan Road	Stream bank destabilization, erosion and sedimentation, water quality affected by pollution, wetland/riparian areas at risk. East bank (400 linear ft) shows significant erosion and undermined turf.	Regional	Confirmed with Village of Glenview that local project to mitigate erosion already implemented.
GV-FL-28	Village of Morton Grove, Village of Glenview, Village of Golf	Intracommunity (local) flooding	Golf Road E/O IL Route 43 (Metra Viaduct)	IDOT Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
GV-FL-29	Village of Golf, Village of Glenview, Village of Morton Grove	Intracommunity (local) flooding	Golf Road/Simpson Street at C, M, & St Paul RR (viaduct)	IDOT Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GV-ER-30	Village of Glenview	Streambank erosion on intercommunity waterways	Raleigh Road from York Road to Baffin Road	Streambank Erosion	Regional	Erosion problem does not threaten structures or conveyance of West Fork. Not addressed by DWP.
GV-FL-31	Village of Glenview	Intracommunity (local) flooding	Illinois Route 43 at S/O Lake Avenue (Block 1200)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NB-FR-15	Unincorp Cook County, Village of Northbrook	Intercommunity (regional) flooding	Village of Northbrook, Unincorporated Cook County	Overbank flooding, and storm sewer flow restriction. Overbank flooding and reduced conveyance capacity of sewers that get submerged.	Regional	The recommend alternative for this problem is WF-06.
NB-SM-16	Unincorp Cook County, Village of Northbrook	Stream Maintenance	Techny Road – Western Avenue to Waukegan Road	CCHD reported that structure number 016-3234 located over West Fork has some debris accumulation at the center pier.	Regional	Maintenance and debris removal recommended in Section 4.
NB-FR-17	Northbrook, Unincorporated Cook County	Intercommunity (regional) flooding	Northbrook, Unincorporated Cook County	Overbank Flooding	Regional	The recommend alternative for this problem is WF-06.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NB-FL-19	Village of Northbrook	Intracommunity (local) flooding	Illinois Route 43 at Techny Road to Sherman Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NB-FL-20	Village of Northbrook	Intracommunity (local) flooding	Willow Road, East of Sherman Road (railroad Viaduct)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NB-ER-07	Village of Northbrook	Streambank erosion on intercommunity waterways	Between Dundee Road & Cherry Lane	Bank erosion and sedimentation. Severe bank erosion along both sides of West Fork NBCR	Regional	The recommend alternative for this problem is WF-03.
NB-ER-08	Village of Northbrook	Streambank erosion on intercommunity waterways	Fair Lane near Dundee Road\Western Avenue Intersection	Banks along the West Fork of the North Branch are severely eroded behind Fair Lane.	Regional	The recommend alternative for this problem is WF-03.
NB-FR-09	Village of Northbrook	Intercommunity (regional) flooding	Somme Prairie Grove Forest Preserve - Dundee & Waukegan Road	FPDCC reported that the West Fork often overtops its banks and spills warm urban runoff into preserve degrading wetland and native habitats adjacent to the river.	Regional	The focus of this DWP is to recommend regional flood control projects to mitigate damage to structures.

TABLE 3.1.3
Community Response Data for the West Fork

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NB-WQ-10	Village of Northbrook	Intercommunity (regional) flooding	Somme Prairie Grove Forest Preserve - Dundee & Waukegan Road	FPDCC reported that the West Fork often overtops its banks and spills warm urban runoff into preserve degrading wetland and native habitats adjacent to the river.	Regional	Water quality problem not addressed by DWP. The focus of this DWP is to recommend regional flood control projects to mitigate damage to structures.
NF-FL-18	Village of Northfield	Intracommunity (local) flooding	Illinois Route 43 at Willow Road to Winnetka Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

[1] All Problem IDs begin with either NB-WFNB- , NB-NVDN-, or NB-NVDS- as all problems are within the North Branch - West Fork, North Navy Ditch, or South Navy Ditch subwatersheds.

3.1.2 Watershed Analysis

3.1.2.1 Hydrologic Model Development

Subbasin Delineation. The West Fork tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The watershed boundaries of the West Fork (western edge) and Des Plaines River (eastern edge) were compared, and discrepancies were identified. Discrepancies generally were minor and resolved by manual review of topographic data and consultation with the Des Plaines River DWP consultant, Christopher B. Burke Engineering.

Hydrologic Parameter Calculations. Table 3.1.4 summarizes the total drainage area, number of modeled subbasins, and average subbasin size for West Fork and its major tributaries.

TABLE 3.1.4
West Fork System Subbasin Summary

Subbasin	Drainage Area (mi^2)	Number of Modeled Subbasins	Average Modeled Subbasin Size (acres)
West Fork	19.3	42	300
Major Tributaries to West Fork			
Underwriters Tributary	0.5	4	85
Techny Drain	2.0	12	105
North Navy Ditch	4.4	5	562
South Navy Ditch	0.3	2	82

Curve Numbers (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 Clark unit hydrograph method was used to convert SCS CN runoff volumes into subbasin-specific hydrographs. Time of concentration (Tc) and storage coefficient (R) parameters for the Clark unit hydrograph method were estimated as described in Section 1.3.2. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.1.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Field surveys of the West Fork and bridge crossings were performed 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 field surveyed channel cross sections. 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 coefficients along the modeled stream length.

Boundary Conditions. The downstream boundary condition for the West Fork is the stage of the Mainstem of the NBCR at the confluence of the two reaches. The unsteady model produces water surface elevations at each time step, therefore providing a downstream

boundary condition at each time step of the simulation. The maximum existing conditions 100 year water surface elevation (WSEL) at this junction is 621.33 feet in vertical elevation datum NAVD 88.

3.1.2.3 Calibration and Verification

Observed Data. As in shown in Figure 2.3.1, three thiessen polygons, based on three different precipitation gages, allow for complete coverage of the West Fork subwatershed. The northernmost thiessen polygon is based on the LCSMC "Riverwoods" gage; the middle and lower portions of the West Fork are covered by CCPN gages 1 and 4, respectively. Data for the September 2008 and October 2001 storms were gathered for calibration and verification of the hydrologic and hydraulic models.

The only USGS stream gage on the West Fork, gage number 05535500, is located at the Dundee Road crossing. Supplemental information on this stream gage can be found in Table 2.3.1. Peak flow information for the calibration and verification events can be found in Table 3.1.5. The Deerfield Reservoir is located immediately south of the Cook County line and upstream of the Dundee Road gage. The location of this reservoir, which significantly attenuates flows, reduced the sensitivity of adjustments made in the hydrologic model upstream of the Cook County line. The HEC-HMS hydrographs (without any adjustments to modeling parameters) were initially used as a boundary condition to the HEC-RAS model. The HEC-RAS model indicated, however, that the Deerfield Reservoir was completely filling with water in the 100-year event, and that a significant amount of flow was leaving the reservoir through the auxiliary spillway. This was not considered representative of reservoir performance, so the HEC-1 hydrograph from the Lake County regulatory model was incorporated as the boundary condition for the HEC-RAS model for modeling design storms.

TABLE 3.1.5
Flow Events at USGS gage 05535500

Date	Peak Monitored Flow (cfs)
9/13/2008	703
10/13/2001	848

Figure 3.1A shows superimposed comparisons of the HEC-RAS and USGS gage hydrographs (river gage 05535500) at the gage location for the 2008 event. Figure 3.1B shows these same hydrographs for the 2001 event. Figures 3.1C and 3.1D show the stage curve comparisons for the September and October events, respectively. Although the HEC-RAS hydrographs show peaks that are lower than the USGS gage peaks, the difference between the observed and calibrated model flows and water surface elevations were generally considered to be within an acceptable margin of error.

FIGURE 3.1A
West Fork flow comparison for September 13, 2008 storm

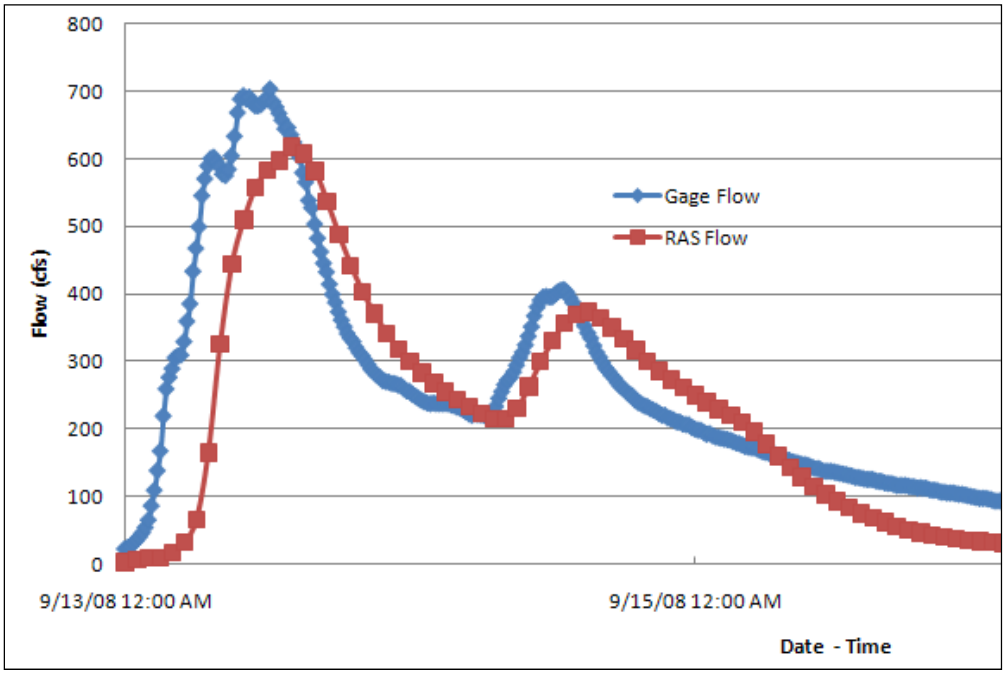


FIGURE 3.1B
West Fork flow comparison for October 13, 2001 storm

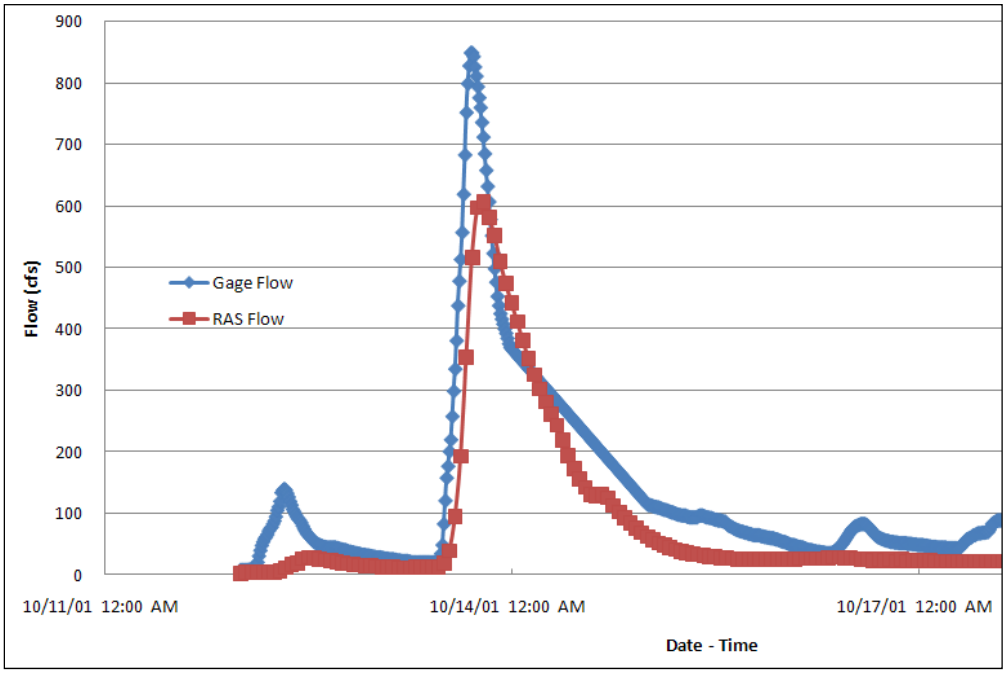


FIGURE 3.1C
West Fork stage comparison for September 13, 2008 storm

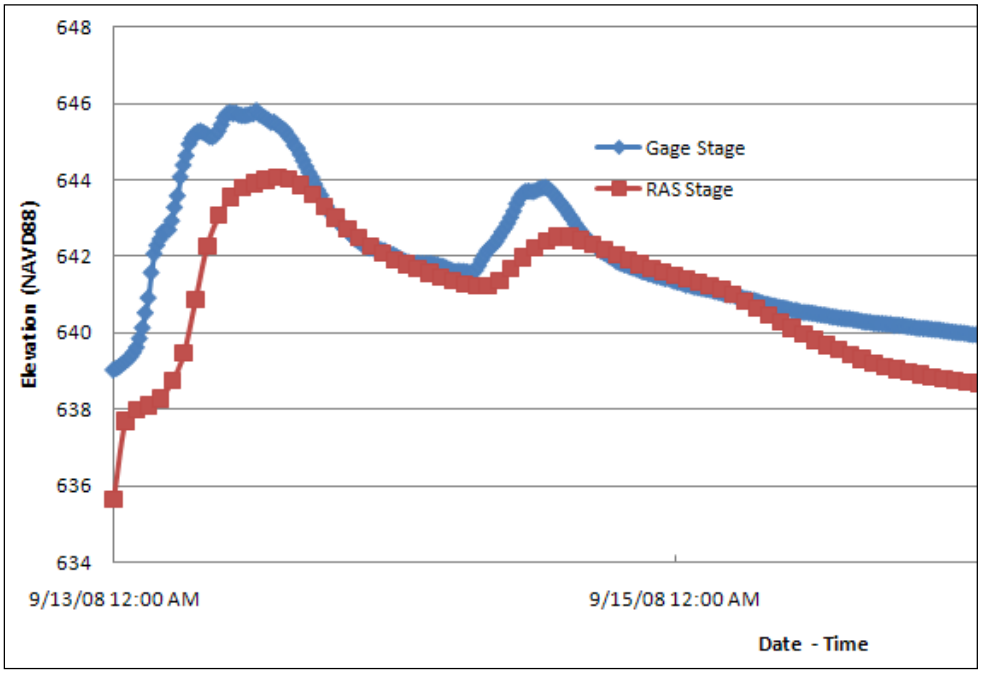
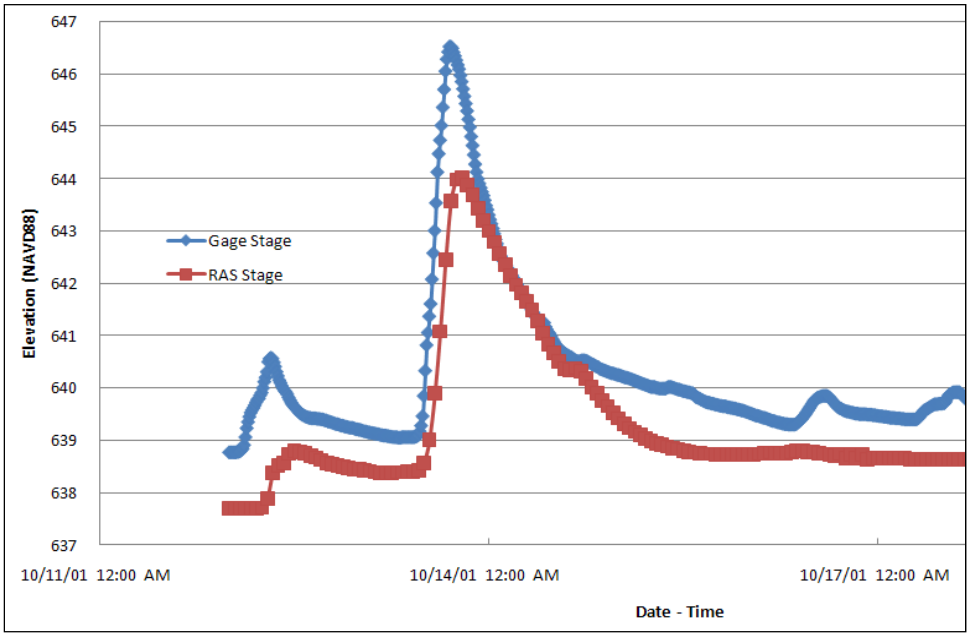


FIGURE 3.1D
West Fork stage comparison for October 13, 2001 storm



Calibration Results. The aforementioned location and operation of the Deerfield Reservoir and associated attenuation of flows upstream of the Dundee Road gage significantly impacts the effects of hydrologic adjustments made upstream. With the results of the HEC-RAS and gage hydrograph comparisons being similar with regard to flow, stage, and hydrograph shape, no modifications were made to the upstream hydrology. Flow, volume, and stage were checked at the Mainstem gages at Touhy Avenue and Albany Avenue, in

order to verify the model met CCSMP criteria. The Mainstem gage comparisons can be found in section 3.4.2.5.

3.1.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figures 3.1.1a and 3.1.1b show inundation areas produced by the hydraulic model for the 100-year, 24-hour duration design storm.

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

3.1.3 Development and Evaluation of Alternatives

3.1.3.1 Modeled Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.1.6 summarizes major problem areas identified through hydraulic modeling of the West Fork.

TABLE 3.1.6
Modeled Problem Definition for the West Fork

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Problem from Table 3.1.3
MPWF1	Between Walters Avenue and Illinois Road	100	NB-FR-12
MPWF2	The Techny Drain just south of Techny Road between the two crossing sets of railroad tracks near the confluence with the West Fork	100	NB-FR-06
MPWF3	The South Navy Ditch and the west overbank of the West Fork between Chestnut Avenue and Lake Avenue	25, 50, 100	GV-FR-06
MPWF4	West overbank of the West Fork between Lake Avenue and Glenview Road	5, 10, 25, 50,100	GV-FR-24
MPWF5	Both overbanks of the West Fork between Glenview Road and Long Valley Road	25, 50, 100	GV-FR-24

Damage Assessment. Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No recreation damages due to flooding were identified for the West Fork. Transportation damages were estimated as 15 percent of property damages plus $200,000 of Metra RR damages due to erosion. Erosion damages were determined for active erosion problems that threaten structures along the banks of the West Fork. For streambank erosion to qualify as threatening, the erosion must occur within 30 feet of a structure.

TABLE 3.1.7
Estimated Damages for the West Fork

Damage Category	Estimated Damage ($)	Note
Property	197,501,000	Structures at risk of flooding
Erosion - structures	1,350,000	Structures at risk due to erosion
Transportation	29,825,000	Assumed as 15% of property damage due to flooding plus Metra RR transportation damages

3.1.3.2 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in the West Fork subwatershed. Increased regional storage was identified as the principal solution for addressing stormwater problems in the West Fork.

3.1.3.3 Alternative Development

Stormwater improvement alternatives were developed to address regional stormwater problems identified in Table 3.1.3, with the aim of reducing damages due to stormwater.

Flood Control Alternatives. Alternative solutions to regional flooding and streambank erosion problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.1.8 summarizes flood and erosion control alternatives developed for the West Fork. Based on the feedback from watershed communities, a review of previous studies, and a consideration of available open tracts of land, stormwater detention alternatives developed for the West Fork were focused primarily on expanding and optimizing existing regional flood control reservoirs.

TABLE 3.1.8
Flood Control and Erosion Control Alternatives for the West Fork

Alternative	Location	Description
WF-01	The Deerfield (USACE 29A) Reservoir, just south of Lake-Cook Road	Raise the overflow weir at the reservoir in order to utilize the full storage capacity
WF-02	The Dundee Road bridge crossing	Reduce the bridge opening in order to restrict flow and store water upstream of the bridge
WF-03	Between Dundee Road and Cherry Lane along the Milwaukee District North Railroad line	Hard armoring of the east bank for stabilization

TABLE 3.1.8
Flood Control and Erosion Control Alternatives for the West Fork

Alternative	Location	Description
WF-04	The Techny 32A Reservoir, just north of Techny Road	Steepen existing side slopes of reservoir to 3(H):1(V); adds approximately 80 acre-ft of storage
WF-05	The Techny 32A Reservoir, just north of Techny Road	Expand 32A Reservoir into the adjacent Anetsberger Golf Course, in addition to WF-04; adds approximately 995 acre-ft of storage
WF-06	The Techny 32A Reservoir, just north of Techny Road	WF-05 Alternative with alterations to the inlet weir and restrictor barrels in order to fully utilize the additional storage
WF-07	The Techny 32B Reservoir, just north of Willow Road	Expansion of 32B in-line storage
WF-08	The Techny 32B Reservoir, just north of Willow Road	WF-07 plus raising the elevation of the Willow Road dam
WF-09	The Techny 32B Reservoir, just north of Willow Road	Techny 32B dam alteration
WF-10	West Fork stream banks from Willow Road to Chestnut Avenue	Streambank stabilization
WF-11	The Techny 32C Reservoir, just south of Willow Road	Techny 32C expansion into the mobile home park at South Branch Road; adds approximately 700 acre-ft of storage
WF-12	The Techny 32C Reservoir, just south of Willow Road	Techny 32C expansion into Lot 16, an open parcel just south of the reservoir; adds approximately 110 acre-ft of storage
WF-13	The Techny 32C Reservoir, just south of Willow Road	Overflow weir adjustment in order to fully utilize existing storage
WF-14	Along the North and South Navy ditches	Erosion stabilization along both ditches
WF-15	Lake Glenview; east of the North Navy Ditch at Lehigh Ave.	Expand the lake in order to reduce discharge into the North Navy Ditch
WF-16	West Fork banks from Glenview Road to Waukegan Road	Erosion Stabilization along both banks
WF-17	West Fork banks from Glenview Road to Old Orchard Road	Erosion Stabilization along both banks
WF-18	West bank of the West Fork at Long Valley Road	Erosion Stabilization of west bank

TABLE 3.1.8
Flood Control and Erosion Control Alternatives for the West Fork

Alternative	Location	Description
WF-19	The Techny 32C Reservoir, just south of Willow Road	Combination of WF-11 and WF-12 storage alternatives
WF-20	32A location and 32C location	Combination of WF-06 and WF-19 storage alternatives
WF-21	The Techny 32B Reservoir, just north of Willow Road	WF-07 plus expansion into the current 'wetland pods'

Erosion Control Alternatives. Six erosion control alternatives, WF-03, -10, -14, -16, -17, and -18, were investigated for the West Fork in order to address the erosion problems that were reported. Alternative WF-03 was recommended based on infrastructure within 30 feet of active streambank erosion. Alternative WF-03 will provide hard armoring of the east streambank where erosion is occurring. See section 3.1.3.5 below for more detail on WF-03. The armoring is conceptually developed to include costs consistent with traditional approaches to armoring, such as concrete walls. As an alternative to using concrete, there are other hard-armoring erosion protection techniques available to stabilize the West Fork that will give a more natural appearance than concrete. For example, the use of riprap in conjunction with geotextile fabric is a hard-armoring protection alternative that can be designed to provide protection to the streambank while providing a more aesthetically pleasing improvement. The protection treatment will be provided along the existing West Fork alignment along the existing east bank slopes and keyed-in at toe of bank slope.

3.1.3.4 Alternative Evaluation and Selection

WF-01 considered raising the elevation of the overflow spillway on the Deerfield (29A) Reservoir. The elevation was raised from 652 to 654 in order to fully utilize existing storage within the basin. While this alternative did reduce WSELs by 0.35 feet over a few hundred feet of stream length, the amount of storage gained was not significant enough to make an impact on any of the regional flooding problems. This alternative is not recommended.

WF-02 considered reducing the Dundee Road bridge opening from 380 square feet to 75 square feet in order to store water in the adjacent upstream forest preserve. A WSEL decrease of 0.6 feet did occur, but this decrease did not extend downstream far enough to positively impact any of the regional flooding problems. Increases in WSELs occurred upstream of the bridge ended, adversely impacting the Underwriter's Tributary. This alternative is not recommended.

WF-03 considered hard armoring the east bank of the West Fork between Dundee Road and Cherry Lane. There are two segments of erosion protection being proposed, the first is a 450 ft by 70 ft area that protects infrastructure, including utility poles and residences, southwest of Fair Lane. The second area is 30 ft by 970 ft; this segment protects Metra's Milwaukee District North railroad embankment and rail infrastructure and includes utility pole relocations. See Figure 3.1.2 for a conceptual plan of this project. This alternative is recommended.

WF-04 considered steepening the side slopes of the Techny 32A reservoir. The current side slopes are approximately 6H:1V and this alternative would steepen side slopes to 3H:1V in order to gain a minimal amount of additional storage. The alternative adds approximately 80 acre-ft of storage, which doesn't reduce WSELs dramatically. The WF-04 alternative is not recommended by itself, but it has been added on to WF-06.

WF-05 considered expanding the Techny 32A reservoir to the west into Northbrook Park District's Anetsberger Golf Course. A buyout of the golf course, combined with the storage gained from WF-04, would allow for approximately an additional 995 acre-ft of storage to be added to the reservoir. This alternative, as is, did not allow for complete utilization of the additional storage because too much in-stream flow was bypassing the reservoir. This alternative, independently, is not recommended.

WF-06 considered reducing the bypass flow around the Techny 32A reservoir and allowing more flow to enter the reservoir described in alternative WF-05. The restrictor barrels on the east side of the reservoir were reduced from 3-66 inch pipes to 1-66 inch pipe, which allows the flow in the channel to back up and increase flow into the inlet weir. As a part of this alternative, the inlet weir length was increased from 90 feet to 200 feet. This increase in weir length allows for flow to enter the reservoir at a higher rate, while reducing the increase in WSEL upstream of the restrictor barrels. In total, this alternative steepens the existing side slopes to 3:1, expands the 32A reservoir into the Anetsberger Golf Course, removes two restrictor barrels, and extends the inlet weir by 110 feet. These proposed changes reduced WSELs in the MPWF1 through MPWF5 modeled problem areas. While the WSEL reductions do not completely eliminate flood damages in these areas, this alternative does improve the regional flooding situation. See Figure 3.1.3a for a conceptual plan of this project. This alternative is recommended as the most beneficial flood control project to mitigate overbank flooding of the West Fork.

WF-07 considered excavation of open space in the northeast corner of the Techny 32B inline reservoir. The alterative involves excavation of approximately 245 acre-ft of open space. The additional storage yields a range of WSEL reductions with a maximum reduction of just over 0.3 feet. The 0.3 ft WSEL reduction does not extend very far downstream and there are minor reductions in inundation, therefore this alternative is not recommended.

WF-08 considered raising the elevation of the Willow Road Dam, which is the inline weir that restricts flow exiting from the Techny 32B reservoir. Raising this weir by 1.7 feet should allow for increased storage in the reservoir, but flows are high enough to overtop the weir at this revised elevation. Raising the weir increases WSEL upstream of the dam while having no positive downstream impact. This alternative is not recommended.

WF-09 considered raising the elevation of the Willow Road Dam to the maximum elevation allowed by the surrounding topography, with the thought that eliminating weir overtop would reduce flow delivered to the downstream channel. Raising the weir height by approximately 6 feet still does not eliminate weir overtop, and the small decrease in downstream WSELs does not justify the large increase in upstream WSELs with negative impacts to the Techny Drain. This alternative is not recommended.

WF-10 considered erosion stabilization along the West Fork banks from Willow Road to Chestnut Avenue. Field review determined that there were no structures within 30 feet of this active streambank erosion, and therefore, this alternative is not recommended.

WF-11 considered expanding the Techny 32C reservoir east into the mobile home park located at the southeast corner of the reservoir. The proposed expansion would create approximately 700 acre-ft of additional storage. This alternative yields a maximum WSEL decrease of 1.3 feet and it addresses modeled problem areas MPWF3 through MPWF5. Because this alternative does not utilize an open parcel in the vicinity of this reservoir, the mobile home buyout by itself is not ideal. This alternative is not recommended.

WF-12 considered using the "Lot 16" parcel for flood storage by tying it into the Techny 32C reservoir system. Lot 16 is an open parcel located in between the 32C reservoir and the Valley Lo Golf Club; the parcel is owned by the Village of Glenview and is available for use. Excavation of this lot and hydraulically connecting it to the 32C reservoir adds approximately 100 acre-ft of storage to the system. Utilization of Lot 16 only yields a maximum of one-third of a foot in WSEL reduction, and considering the cost of construction, this alternative alone would not be worth the cost. This alternative is not recommended.

WF-13 considered raising the 32C overflow weir. Much like the WF-01 alternative, the WF-13 alternative does reduce downstream WSELs, but does not extend far enough to have any realized impact on problem areas with potential structure damages. This alternative is not recommended.

WF-14 considered erosion stabilization along both banks of the North and South Navy Ditches. A field review of the reported erosion problems found no structures within 30 feet of active bank erosion. This alternative is not recommended.

WF-15 considered a possible expansion of Lake Glenview, which is located just upstream of the North Navy Ditch. The outflow from Lake Glenview is the main source of West Fork inflow downstream of the Techny 32C reservoir. Increasing the storage capacity of this lake and restricting the outflow to the West Fork would reduce WSELs in the lower portion of the reach, but in discussing this alternative with the Village of Glenview, the project was deemed to be infeasible at this time. The area surrounding Lake Glenview is fully developed with commercial and recreational infrastructure surrounding the lake, which would make increasing storage capacity of the lake infeasible from design and construction perspectives. This alternative is not recommended.

WF-16 considered erosion stabilization along both banks of the West Fork from Glenview Road to Waukegan Road. A field review of the reported erosion problems found a recently implemented erosion stabilization project, including but not limited to riprap, geostabilization, seeding, and plantings. Upon coordination with the Village of Glenview, the erosion problem was confirmed as mitigated through a local erosion stabilization project implemented by the Village.

WF-17 considered erosion stabilization along both banks of the West Fork from Glenview Road to approximately Long Valley Road. A field review of the reported erosion problem area found that there were no structures within 30 feet of this active streambank erosion, and therefore, this alternative is not recommended.

WF-18 considered erosion stabilization along the west bank of the West Fork near Long Valley Road. A field review of the reported erosion problem area found one residential structure within 30 feet of bank erosion that appeared to be protected by dumped riprap and not at imminent risk of erosion damage. This erosion problem should continue to be monitored for imminent risk to the residential structure at 1201 Long Valley Drive. Due to lack of imminent risk of erosion damage, this alternative is not recommended at this time.

WF-19 considered combining the 32C Reservoir alternatives, WF-11 and WF-12. This alternative included the buyout and excavation of the Sunset Village mobile home park, as well as the utilization of the "Lot 16" parcel for storage. The approximate 814 acre-ft of storage added yields a maximum WSEL decrease of approximately 1.4 feet. This alternative addresses problem areas MPWF3 through MPWF5, but does not completely resolve flooding in these areas. After DWP cost analysis and generation of B/C ratios, this alternative is not recommended as the most cost effective solution to overbank flooding of the West Fork.

WF-20 considered combining the recommended 32C storage alternative with the recommended 32A storage alternative (WF-06 + WF-19.) Based on inquiries from several communities and subsequent direction from the District, this combined alternative was investigated to determine what additional benefits, if any, would occur with the implementation of both projects. Because neither alternative completely eliminates the modeled problem areas on its own, an attempt was made to combine the relative impacts of each reservoir expansion. The result of the combination of these two alternatives is very similar to the result of the 32A reservoir expansion (WF-06) on its own. The 32A expansion attenuates a large portion of the flow within the West Fork reach until the point in the reach where the North Navy Diversion Ditch combines with the West Fork and increases flow values. The 32C reservoir is located north (upstream) of this confluence, and therefore, does not attenuate the peak flows from the North Navy Diversion Ditch that floods areas downstream. This alternative is listed in the DWP as an alternative due to the requested investigation of this combined solution. However, given the very similar benefits as WF-06 and the subsequent B/C ratio that is much lower than WF-06, the recommendation, from a flood mitigation perspective, is to implement WF-06 in lieu of this combined alternative.

WF-21 considered combining the excavation of open space to the northeast of the Techny 32B inline reservoir (WF-07) with excavation of the three existing wetland pods within the reservoir. The alterative involves excavation of approximately 425 total acre-ft. The additional storage yields a range of WSEL reductions with a maximum reduction of just over 0.6 feet. The WSEL reductions address modeled problem areas MPWF3 through MPWF5; while this alternative does not completely resolve flooding issues at these problem areas, it does have a significant positive impact. However, after DWP cost analysis and generation of B/C ratios, this alternative is not recommended as the most cost effective solution to overbank flooding of the West Fork.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.1.9.A provides a comparison of the modeled maximum WSEL and modeled flow at the time of peak at representative locations along the waterway for the recommended alternative WF-06. Tables 3.1.9.B through 3.1.9.D provide a comparison of the modeled maximum WSEL and modeled flow at the time of peak at representative locations

along the waterway for the alternatives that are not recommended and are provided for informational purposes only.

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

Table 3.1.9A provides a comparison of peak flow and stage for existing and proposed conditions for the WF-06 alternative, 32A Reservoir expansion into the Anetsberger Golf Course.

TABLE 3.1.9.A
Recommended Alternative WF-06 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		WF-06	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
West Fork crossing at Techny Road	31035	636.05	1322	634.51	257
West Fork crossing at Willow Road	26572	630.97	1782	629.56	862
West Fork crossing at Chestnut Avenue	18626	628.77	1382	627.05	782
West Fork crossing at East Lake Avenue	15392	627.56	1461	626.22	1002
West Fork crossing at Glenview Road	11870	626.06	1466	624.99	1085
West Fork crossing at Long Valley Road	6664	623.06	1588	622.56	1383
West Fork crossing at Golf Road	1976	622.23	1587	621.74	1329

Table 3.1.9.B provides a comparison of peak flow and stage for existing and proposed conditions for the WF-19 alternative, 32C Reservoir expansion into "Lot 16" parcel and the Sunset Village mobile home park.

TABLE 3.1.9.B
Non-Recommended Alternative WF-19 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		WF-19	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
West Fork crossing at Chestnut Avenue	18626	628.77	1382	627.03	778
West Fork crossing at East Lake Avenue	15392	627.56	1461	626.20	997
West Fork crossing at Glenview Road	11870	626.06	1466	624.98	1080
West Fork crossing at Long Valley Road	6664	623.06	1588	622.55	1377
West Fork crossing at Golf Road	1976	622.23	1587	621.72	1324

Table 3.1.9.C provides a comparison of peak flow and stage for existing and proposed conditions for the WF-20 alternative (WF-06 + WF-19 combined, including reservoir expansions at both Techny 32A + Techny 32C).

TABLE 3.1.9.C
Non-Recommended Alternative WF-20 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		WF-20	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
West Fork crossing at Chestnut Avenue	18626	628.77	1382	627.03	778
West Fork crossing at East Lake Avenue	15392	627.56	1461	626.20	997
West Fork crossing at Glenview Road	11870	626.06	1466	624.98	1080
West Fork crossing at Long Valley Road	6664	623.06	1588	622.55	1377
West Fork crossing at Golf Road	1976	622.23	1587	621.72	1324

Table 3.1.9.D provides a comparison of peak flow and stage for existing and proposed conditions for the WF-21 alternative (32B Reservoir expansion into open space and the current wetland pod areas).

TABLE 3.1.9.D
Non-Recommended Alternative WF-21 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		WF-21	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
West Fork crossing at Willow Road	26572	630.97	1782	630.80	1613
West Fork crossing at Chestnut Avenue	18626	628.77	1382	628.12	1202
West Fork crossing at East Lake Avenue	15392	627.56	1461	626.83	1272
West Fork crossing at Glenview Road	11870	626.06	1466	625.33	1273
West Fork crossing at Long Valley Road	6664	623.06	1588	622.73	1433
West Fork crossing at Golf Road	1976	622.23	1587	621.93	1411

3.1.3.5 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the alternatives studied in detail. Table 3.1.10 lists the alternatives analyzed in detail; however, only alternatives WF-03 and WF-06 are recommended and the other alternatives are provided for informational purposes only. Figures 3.1.3a, 3.1.3b, 3.1.3c and 3.1.3d show a comparison of existing conditions to alternative conditions 100 year inundation mapping with the implementation of alternatives WF-06, WF-19, WF-20, and WF-21, respectively. Figure 3.1.2 displays the location and approximate extents of the WF-03 erosion control alternative.

TABLE 3.1.10
West Fork Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Communities Involved
WF-03	Hard armoring of east bank along Metra Milwaukee North District RR & Fair Lane between Dundee Road and Cherry Lane	0.77	1,550,000	2,022,000	3	Slightly Positive	Yes	Northbrook
WF-06	Expand Techny 32A reservoir into Anetsberger Golf Course and steepen existing reservoir side slopes to 3H:1V	1.26	146,484,000	116,088,000	216	Slightly Positive	Yes	Northbrook, Glenview, Golf, Unincorporated Cook County
WF-19	Expand Techny 32C into Sunset Village Mobile Home Park and Lot 16	0.32	29,692,000	94,210,000	48	Slightly Positive	No	Glenview, Unincorporated Cook County
WF-20	Combine Techny 32A and 32C reservoir expansions into one project	0.70	146,484,000	210,297,000	216	Slightly Positive	No	Northbrook, Glenview, Golf, Unincorporated Cook County
WF-21	Techny 32B expansion of in-line storage	0.60	30,235,000	50,416,000	101	No Impact	No	Northbrook, Glenview

3.2 Middle Fork of the NBCR

The Middle Fork, the second tributary (from west to east) in the NBCR watershed, has a total stream length of 20.9 miles and a total drainage area of 24.6 square miles. Table 3.2.1 summarizes the land area of communities within the Middle Fork subwatershed. The Middle Fork subwatershed consists primarily of residential areas and includes two large portions of forest preserve area in Cook County. The forest preserve areas in Cook County occur from the I-94 crossing to the Sunset Ridge Road crossing and from Winnetka Road to the confluence with the Skokie River. Table 3.2.2 summarizes the land use distribution within the Middle Fork.

Figure 3.2.1 is an overview of the tributary area of the Middle Fork subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.2.1
Communities Draining to the Middle Fork[1]

Community/Tributary	Tributary Area (mi^2)
Lake Forest	6.60
Unincorporated	4.54
Green Oaks	2.62
Northbrook	2.16
Deerfield	2.09
Northfield	1.95
Waukegan	1.39
Bannockburn	1.23
Highland Park	0.81
Mettawa	0.79
Glenview	0.34
North Chicago	Less than 0.1

[1] Includes communities/area in Lake County

TABLE 3.2.2
Land Use Distribution for the Middle Fork[1]

Land Use Category	Area (acres)	%
Residential	7,422	47.2
Forest/Open Land	4,631	29.4
Commercial/Industrial	1,673	10.6
Institutional	573	3.6
Agricultural	561	3.6
Water/Wetland	526	3.3
Transportation/Utility	341	2.2

[1] Includes land use areas in Lake County

3.2.1 Sources of Data

3.2.1.1 Previous Studies

Data from the 1998 and 2000 FIS regulatory models (HEC-2) were utilized for supplementing the newly developed DWP HEC-RAS model for the Middle Fork.

3.2.1.2 Water Quality Data

The IEPA has two Ambient Water Quality Monitoring Network sites on the Middle Fork. Two reaches of the Middle Fork are identified as impaired in the IEPA's 2008 Integrated Water Quality Report, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for the Middle Fork. TMDLs are currently being developed for dissolved oxygen, chloride, and fecal coliform. According to a water permit discharge query from the USEPA, there are no NPDES permits issued by IEPA for discharges to the Middle Fork. Municipalities discharging to the Middle Fork are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was instituted to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.2.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the NBCR watershed. Wetland areas were identified using NWI mapping. NWI data includes 120 acres of wetland areas in the Middle Fork 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.

3.2.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models used to estimate flood levels generally were not updated. LOMRs were incorporated in the revised floodplains. The effective FIS H&H analysis was performed in 1994. The hydrologic modeling was performed by using HEC-1 and Regression Equation 79; Hydraulic routing was performed using HEC-2.

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

3.2.1.5 Stormwater Problem Data

Table 3.2.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.2.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.2.1.6 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 flood control projects by others have been identified in the Middle Fork Subwatershed.

TABLE 3.2.3
Community Response Data for the Middle Fork

Problem ID[2]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NF-FL-14	Village of Northbrook, Village of Northfield, Village of Glenview, Unincorp Cook County	Intracommunity (local) flooding	Sunset Ridge Road - East Lake Ave to Skokie Road	36" corrugated metal pipe West Side, 36" C.P. East Side, 1/4 mile North of Rolling Ridge Rd - some debris accumulation at the East end.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NB-FR-11	Village of Highland Park, Village of Northbrook, Village of Deerfield	Intercommunity (regional) flooding	Northbrook Court, Deerfield, Highland Park	Overbank flooding, storm sewer flow restriction, insufficient river capacity. Regional detention at Northbrook Court fills/backs up river to overflowing. Stream rises into street inlets, street floods	Regional	Regional stormwater solution MF- 03 was investigated but deemed infeasible. Impacted structures would require flood proofing and/or acquisition
NF-FR-15	Village of Northfield, Unincorp Cook County	Intercommunity (regional) flooding	Winnetka Road - Wagner Road to Happ Road	CCHD reported that the creek floods the surrounding property in this area.	Regional	Regional stormwater solution MS-14 addresses overbank flooding of the Middle Fork along Winnetka Road.
NB-ER-01	Village of Northbrook	Streambank erosion on intercommunity waterways	Middle Fork adjacent to properties on Red Coach Lane	Red Coach Lane - Bank erosion and sedimentation. There is severe erosion along the east bank of the Middle Fork NBCR adjacent to the properties on Red Coach Lane.	Regional	The recommended alternative for this problem is MF-06.

TABLE 3.2.3
Community Response Data for the Middle Fork

Problem ID[2]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NB-FR-02	Village of Northbrook	Intercommunity (regional) flooding	Illinois Route 68 at Waukegan Road to Lee Street / Shermer Road	IDOT Pavement Flooding	Regional	IL Route 68 pavement flooding depth due to overbank flooding is less than 0.5 ft. Based on DWP criteria, no alternative recommended for minor roadway flooding.
NB-FR-03	Village of Northbrook	Intercommunity (regional) flooding	Dundee at Timber Lane	IDOT Pavement Flooding	Regional	Modeled and DFIRM inundation areas do not impact this reported location. Problem appears to be a local storm sewer problem.
NB-ER-21	Village of Northbrook	Streambank erosion on intercommunity waterways	Pebblebrook Rd	Regional erosion occurring greater than 30 ft from residences on west and east streambanks	Regional	Erosion problem not immediately threatening structure. Not addressed by DWP
NF-FR-01	Village of Northfield	Intercommunity (regional) flooding	N Bristol & Robin Hood Lane	Willow Hill Condos - Basement and local road flooding due to overbank flooding	Regional	Regional stormwater solution MF-05 was investigated but deemed infeasible due to minimal impact on flooding. Recommend floodproofing and/or acquisition

TABLE 3.2.3
Community Response Data for the Middle Fork

Problem ID[2]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NF-ER-02	Village of Northfield	Intercommunity (regional) flooding	Robin Hood Lane	Complaints about bank erosion/scouring along the North Branch of the Chicago River along Robin Hood Land.	Regional	The recommend alternative for this problem is MF-06.
NF-ER-03	Village of Northfield	Streambank erosion on intercommunity waterways	Meadowbrook Drive to Sunset Lane	Regional erosion occurring within 30 ft of residences and utility poles on west and east streambanks.	Regional	The recommended alternative for this problem is MF-07.
NF-ER-04	Village of Northfield	Streambank erosion on intercommunity waterways	2094 Middle Fork Road	Regional erosion occurring within 30 ft of residence on the west stream bank.	Regional	Erosion problem not immediately threatening structure. Not addressed by DWP
NF-ER-05	Village of Northfield	Streambank erosion on intercommunity waterways	Willow Road to Abbot Court	Regional erosion occurring within 30 ft of residences on the west and east streambanks immediately south of Willow Road.	Regional	The recommended alternative for this problem is MF-07.
NF-ER-17	Village of Northfield	Streambank erosion on intercommunity waterways	North of Winnetka Road along West side of Northfield Road	Streambank Erosion within 30ft of Northfield Road	Regional	The recommended alternative for this problem is MF-07.
NF-FL-18	Village of Northfield	Intracommunity (local) flooding	Illinois Route 43 at Willow Road to Winnetka Road	IDOT Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NF-FR-07	Village of Northfield	Intercommunity (regional) flooding	Interstate Rt 94 at Winnetka Ave to Skokie Road	IDOT Pavement Flooding	Regional	The recommended alternative for this problem is SR-08.

TABLE 3.2.3
Community Response Data for the Middle Fork

Problem ID[2]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NF-FL-06	Village of Northfield	Intracommunity (local) flooding	East Wagner Road, South of Willow	Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NF-FR-08	Village of Northfield	Intercommunity (regional) flooding	South side of Willow Road over Middle Fork	Basement and local flooding due to Overbank flooding	Regional	Regional stormwater solution MF-05 was investigated but deemed infeasible due to minimal impact on flooding. Recommend floodproofing and/or acquisition
NF-FR-09	Village of Northfield	Intercommunity (regional) flooding	North side of Willow Road over Middle Fork	Basement and local flooding due to Overbank flooding	Regional	Regional stormwater solution MF-05 was investigated but deemed infeasible due to minimal impact on flooding. Recommend floodproofing and/or acquisition

[1] All Problem IDs begin with NB-MFNB- as all problems are within the North Branch – Middle Fork subwatershed.

3.2.2 Watershed Analysis

3.2.2.1 Hydrologic Model Development

Subbasin Delineation. The Middle Fork tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The watershed boundaries of the West Fork (western edge) and Skokie River (eastern edge) were compared, and discrepancies were identified. Discrepancies generally were minor and resolved by manual review of topographic data.

Hydrologic Parameter Calculations. Curve Numbers (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 Clark unit hydrograph method was used to convert SCS CN runoff volumes into subbasin-specific hydrographs. Time of concentration (Tc) and storage coefficient (R) parameters for the Clark unit hydrograph method were estimated as described in Section 1.3.2. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.2.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Field surveys of the Middle Fork and bridge crossings were performed 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 field surveyed channel cross sections. 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 coefficients along the modeled stream length.

Boundary Conditions. The downstream boundary condition for the Middle Fork is its confluence with the Skokie River as the two reaches form the Mainstem of the NBCR. The unsteady model produces water surface elevations at each time step, therefore providing a downstream boundary condition at each time step of the simulation. The maximum existing conditions 100 year WSEL at this junction is 624.18 feet in vertical elevation datum NAVD 88.

Subbasin Delineation. The Middle Fork tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The watershed boundaries of the West Fork (western edge) and Skokie River (eastern edge) were compared, and discrepancies were identified. Discrepancies generally were minor and resolved by manual review of topographic data.

3.2.2.3 Calibration and Verification

Observed Data. As in shown in Figure 2.3.1, three thiessen polygons, based on three different precipitation gages, allow for complete coverage of the Middle Fork subwatershed. The northernmost thiessen polygon is based on the LCSMC "Riverwoods" gage; the middle and lower portions of the Middle Fork are covered by CCPN gages 1 and 2, respectively. Data for the September 2008 and October 2001 storms were referenced for calibration and verification of the hydrologic and hydraulic models.

The only USGS stream gage on the Middle Fork, gage number 05534500, is located at the county line on the Lake-Cook Road Bridge. Supplemental information on this stream gage can be found in Table 2.3.1. Peak flow information for the calibration and verification events can be found in Table 3.2.4. Because the USGS gage is outside of the limits of the hydraulic study area, HEC-HMS hydrographs were used for comparison to the gage hydrographs.

TABLE 3.2.4
Flow Events at USGS gage 05534500

Date	Peak Monitored Flow (cfs)
9/13/2008	727
10/13/2001	787

Figure 3.2A shows superimposed comparisons of the HEC-HMS and USGS gage hydrographs (river gage 05534500) at the gage location for the 2008 event. Figure 3.2B shows these same hydrographs for the 2001 event.

FIGURE 3.2A
Middle Fork flow comparison for September 13, 2008 storm

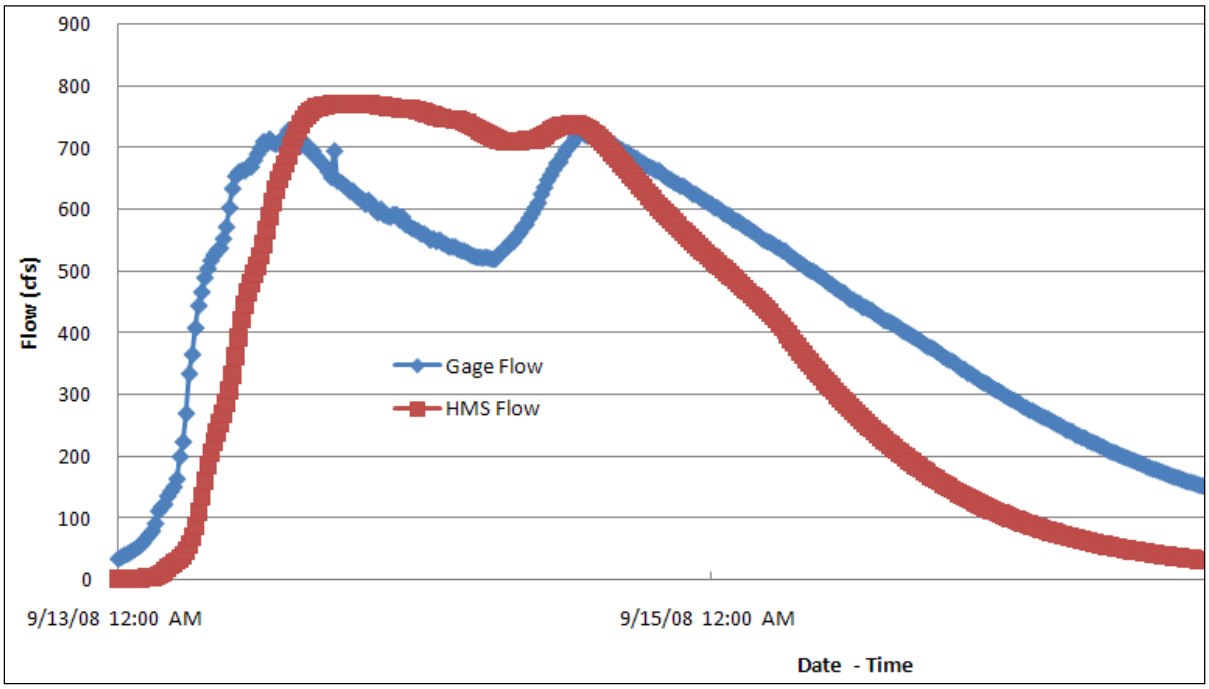
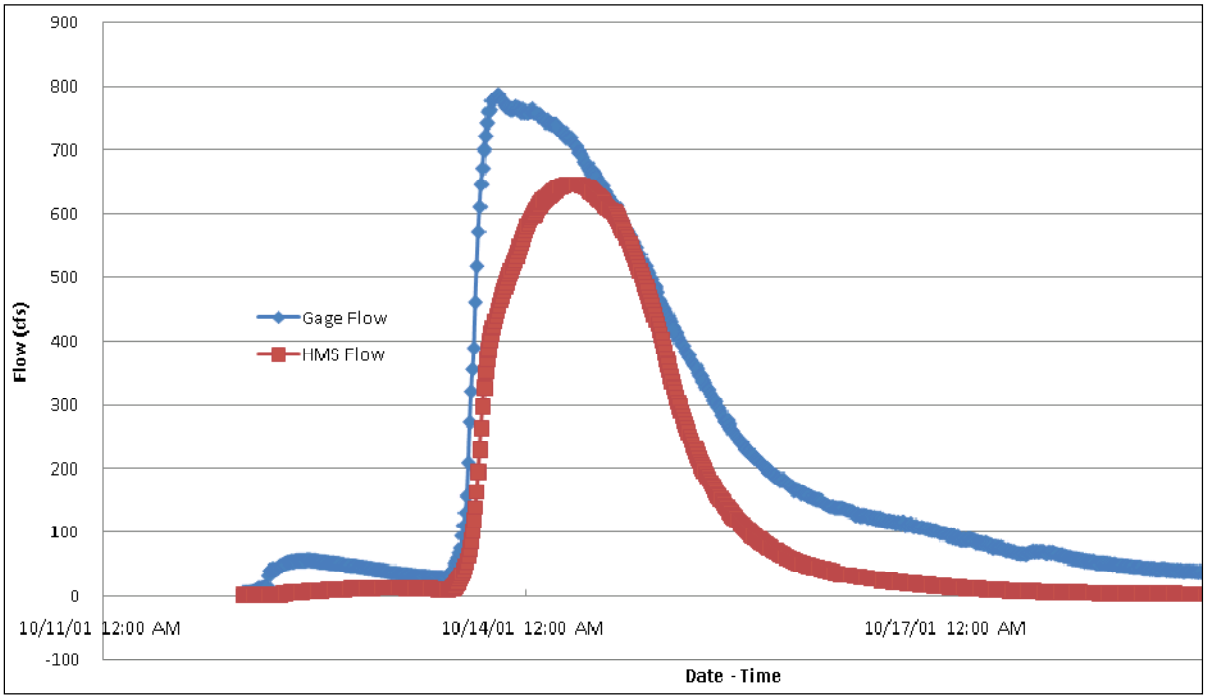


FIGURE 3.2B
Middle Fork flow comparison for October 13, 2001 storm



Calibration Results. With the results of the HEC-HMS and gage hydrograph comparisons being similar with regard to flow, volume, and hydrograph shape, no modifications were made to the upstream hydrology; the difference between the observed and calibrated model flows and water surface elevations were generally considered to be within an acceptable margin of error. Flow, volume, and stage were checked at the Mainstem gages at Touhy Avenue and Albany Avenue, in order to verify the model met CCSMP criteria. The Mainstem gage comparisons can be found in section 3.4.2.5.

3.2.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.2.1 shows inundation areas produced by the hydraulic model for the 100-year, 24-hour duration design storm.

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

3.2.3 Development and Evaluation of Alternatives

3.2.3.1 Modeled Problem Definition

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

TABLE 3.2.5
Modeled Problem Definition for the Middle Fork

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Problem from Table 3.2.3
MPMF1	Northbrook Court Mall parking lot just south of Lake-Cook Road	100	
MPMF2	The Fairview Acres subdivision just southeast of I-94	50, 100	
MPMF3	Roadway inundation at the Dundee Road and Lee Road intersection due to overbank flooding	50, 100	NB-FR-02
MPMF4	Just upstream of the Sunset Ridge Road crossing	50, 100	
MPMF5	Meadowbrook Drive to Old Willow Road	25, 50, 100	
MPMF6	New Willow Road to Winnetka Road	100	

3.2.3.2 Damage Assessment

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No recreation damages due to flooding were identified for the Middle Fork. Transportation damages were estimated as 15 percent of property damages plus $115,000 of Northfield Road damages due to erosion. Erosion damages were determined for active erosion problems that threaten structures along the banks of the Middle Fork. For streambank erosion to qualify as threatening, the erosion must occur within 30 feet of a structure.

TABLE 3.2.6
Estimated Damages for the Middle Fork

Damage Category	Estimated Damage ($)	Note
Property	10,805,000	Structures at risk of flooding
Erosion - structures	8,876,000	Structures at risk due to erosion
Transportation	1,736,000	Assumed as 15% of property damage due to flooding plus Northfield Road damage

3.2.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in the Middle Fork subwatershed. Increased regional storage was identified as the principal solution for addressing stormwater problems in the Middle Fork.

3.2.3.4 Alternative Development

Stormwater improvement alternatives were developed to address regional stormwater problems identified in Table 3.2.3, with the aim of reducing damages due to stormwater.

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

TABLE 3.2.7
Flood Control and Erosion Control Alternatives for the Middle Fork

Alternative	Location	Description
MF-01	200-400 Red Coach Lane	Erosion Stabilization on the east bank of the Middle Fork, along Red Coach Lane
MF-02	The Middle Fork Reservoir , located between the Northbrook Court Mall and I-94	Raise the reservoir overflow weir
MF-03	The Middle Fork Reservoir , located between the Northbrook Court Mall and I-94	Expand the NB Court Reservoir into southern portion of the NB Court mall parking lot; adds approximately 200 acre-ft of storage
MF-04	Rosemary Lane and Waters Edge Lane, just southeast of I-94	Construct a short levee along the east bank of the Middle Fork to prevent overbank flooding into the Fair Acres/Waters Edge subdivision
MF-05	Forest Preserve just upstream of the Dundee Road crossing	Add a new regional flood control reservoir at this location; approximately 600 acre-ft of new storage
MF-06	Robin Hood Lane, just upstream of the New Willow Road crossing	Erosion stabilization along both banks upstream and downstream of New Willow Road
MF-07	Meadowbrook Drive crossing	Erosion stabilization along both banks from upstream of Meadowbrook Drive to Sunset Drive
MF-08	Middlefork Road crossing	Erosion stabilization along the west bank, south of Middlefork Road

Erosion Control Alternatives. Four erosion control alternatives, MF-01, -06, -07, and -08 were investigated for the Middle Fork in order to address the erosion problems that were reported. Alternatives MF-06 and MF-07 are recommended based on infrastructure at imminent risk of erosion damage due to structure being within 30 feet of active streambank erosion. Alternative MF-06 will provide hard armoring of the southern streambank where erosion is occurring. Alternative MF-07 will provide hard armoring of both streambanks where erosion is occurring. The armoring is conceptually developed to include costs consistent with traditional approaches to armoring, such as concrete walls. As an alternative to using concrete, there are other hard-armoring erosion protection techniques available to stabilize the Middle Fork that will give a more natural appearance than concrete. For example, the use of riprap in conjunction with geotextile fabric is a hard-armoring protection alternative that can be designed to provide protection to the streambank while providing a more aesthetically pleasing improvement. The protection treatment will be provided along the existing Middle Fork alignment along the existing east bank slopes and keyed-in in at toe of bank slope.

3.2.3.5 Alternative Evaluation and Selection

MF-01 considered hard armoring the east bank of the Middle Fork along the length of Red Coach Lane. A field review determined that there are no structures within 30 feet of this stream bank erosion, and therefore, this alternative is not recommended.

MF-02 considered raising the elevation of the overflow spillway on the Northbrook Court (Middle Fork) Reservoir. The elevation was raised from 649.3 to 651.5 in order to fully utilize existing storage within the basin. While this alternative did reduce WSELs by 0.18 feet over a few hundred feet of stream length, the amount of storage gained was not significant enough to make an impact on any of the regional flooding problems. This alternative is not recommended.

MF-03 considered expanding the Northbrook Court Reservoir to the north past Northbrook Court Drive and into a portion of the south parking lot. This alternative added 200 acre-ft of additional storage to the reservoir, and reduced WSELs by 0.42 feet, but the reductions spanned very few cross sections downstream and were negligible downstream of the I-94 crossing. This alternative is not recommended.

MF-04 considered constructing a levee on the east bank of the Middle Fork downstream of I-94, just west of Rosemary Lane and Waters Edge Lane. The levee has a maximum height of 2.5 ft. and it protects the Fair Acres/Waters Edge subdivision from overbank flooding during a 100 year design event. See Figure 3.2.2 for a conceptual plan of this project. This alternative is a feasible solution to modeled problem MPMF2, and is recommended.

Because other evaluated alternatives were unable to resolve model problems MPMF3 through MPMF6, alternative MF-05 considered constructing a new regional flood control reservoir on Cook County Forest Preserve. The proposed 600 acre-ft reservoir would be located just northwest of the intersection of Lee Road and Dundee Road, on the west side of the Middle Fork. The reservoir decreases WSELs by 0.27 feet over a short length of stream reach; this decrease does not have much positive impact on the modeled problem areas. This alternative is not recommended. Furthermore, levee projects in these modeled problem areas are not feasible due to the dense development that makes compensatory storage impractical. As such, roadways affected by Middle Fork overbank flooding would need to be raised to eliminate flooding from the Middle Fork and infrastructure affected by Middle Fork overbank flooding would require flood proofing and/or acquisition.

MF-06 considered erosion stabilization on the west bank of the Middle Fork, along Robin Hood Lane, from Bristol Avenue to Abbott Court, and on the east bank from 200 feet upstream of New Willow Road down to Abbott Court. Additionally, this alternative considered erosion stabilization repair along the east bank of the Middle Fork along Northfield Road immediately north of Winnetka Road. This alternative protects structures along each bank that are within 30 feet of the active streambank erosion. See Figure 3.2.3 for a conceptual plan of this project. This alternative is recommended.

MF-07 considered erosion stabilization on the west bank of the Middle Fork from 300 feet upstream of Meadowbrook Drive to approximately 400 feet downstream of Meadowbrook Drive and on the east bank from 200 feet upstream of Meadowbrook Drive downstream to Sunset Drive. This alternative protects structures along each bank that are within 30 feet of

active streambank erosion. See Figure 3.2.4 for a conceptual plan of this project. This alternative is recommended.

MF-08 considered 340 feet of erosion stabilization on the west bank of the Middle Fork starting just downstream of Middlefork Road and running along the 2094 Middle Fork Road property. A field review of the reported erosion problem area found one residential structure within 30 feet of bank erosion, but was not at imminent risk of erosion damage. This erosion problem should continue to be monitored for imminent risk to the residential structure at 2094 Middle Fork Road. Due to lack of imminent risk of erosion damage, this alternative is not recommended at this time.

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

3.2.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the alternatives studied in detail. Table 3.2.8 lists the alternatives analyzed in detail. Figure 3.2.2 shows a comparison of existing conditions to alternative conditions 100 year inundation mapping with the implementation of alternative MF-04. Figures 3.2.3 and 3.2.4 display the locations and approximate extents of the MF-06 and MF-07 alternatives, respectively.

TABLE 3.2.8
Middle Fork Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Communities Involved
MF-04	Construct flood wall and compensatory storage to eliminate overbank flooding in this area	0.12	178,000	1,495,000	4	None	Yes	Northbrook, Unincorporated Cook County
MF-06	Hard armor both stream banks at Willow Road, along Robin Hood Lane, and east bank along Northfield Road	4.59	7,391,000	1,610,000	7	Slightly Positive	Yes	Northfield
MF-07	Hard armor both stream banks at Meadowbrook Drive	1.65	1,600,000	971,000	3	Slightly Positive	Yes	Northfield

3.3 Skokie River

The Skokie River, the eastern most tributary in the NBCR watershed, has a total stream length of 36.8 miles and a total drainage area of 35.3 square miles. Table 3.3.1 summarizes the land area of communities within the Skokie River subwatershed. The Skokie River subwatershed consists primarily of residential areas and includes a large portion of forest preserve area located in the central portion of the subwatershed. Table 3.3.2 summarizes the land use distribution within the Skokie River.

Figure 3.3.1 shows an overview of the tributary area of the Skokie River subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.3.1
Communities Draining to the Skokie River[1]

Community/Tributary	Tributary Area (mi^2)
Highland Park	7.59
Lake Forest	5.17
North Chicago	3.12
Wilmette	3.03
Winnetka	2.49
Unincorporated	3.50
Glencoe	1.91
Waukegan	1.79
Lake Bluff	1.55
Northbrook	1.38
Skokie	1.34
Northfield	1.08
Park City	0.76
Highwood	0.26
Gurnee	0.17
Evanston	0.13
Glenview	Less than 0.1
Kenilworth	Less than 0.1

[1] Includes communities/area in Lake County

TABLE 3.3.2
Land Use Distribution for the Skokie River[1]

Land Use Category	Area (acres)	%
Residential	9,949	44.0
Forest/Open Land	6,588	29.1
Commercial/Industrial	2,879	12.7
Transportation/Utility	1,205	5.3
Institutional	1,116	4.9
Water/Wetland	659	2.9
Agricultural	216	1.0

[1] Includes land uses in Lake County

3.3.1 Sources of Data

3.3.1.1 Previous Studies

Data from the 1998 and 2000 FIS regulatory models (HEC-2) were utilized for supplementing the newly developed DWP HEC-RAS model for the Skokie River.

3.3.1.2 Water Quality Data

The Illinois Environmental Protection Agency (IEPA) has two Ambient Water Quality Monitoring Network sites on the Skokie River. Two reaches of the Skokie River are identified as impaired in the IEPA's 2008 Integrated Water Quality Report, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for the Skokie River. TMDLs are currently being developed for dissolved oxygen and fecal coliform. According to a water permit discharge query from the USEPA, there are no NPDES permits issued by IEPA for discharges to the Skokie River. Municipalities discharging to the Skokie River are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was instituted to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.3.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the NBCR Watershed. Wetland areas were identified using NWI mapping. NWI data includes approximately 747 acres of wetland areas in the Skokie River 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.

3.3.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models used to estimate flood levels generally were not updated. LOMRs were incorporated in the revised floodplains. The effective FIS H&H analysis was performed in 1980. The hydrologic modeling was performed by using HEC-1 and hydraulic modeling was performed using both HEC-2 and FEQ.

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

3.3.1.5 Stormwater Problem Data

Table 3.3.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.3.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.3.1.6 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. Several studies are currently underway in the Skokie River Subwatershed; however, no near-term planned flood control projects by others have been identified in the Skokie River subwatershed.

TABLE 3.3.3
Community Response Data for the Skokie River

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GC-FL-02	Village of Glencoe	Intracommunity (local) flooding	Dundee Road storm sewer (60" dia Sewer)	Dundee Road storm sewer. Most flooding localized to intersections and private properties	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NF-FR-16	Unincorp Cook County, Village of Northfield	Intercommunity (regional) flooding	Village of Northfield, Unincorporated Cook County	Unincorporated Cook County on Skokie River. Downstream overbank flooding due to inefficient use of storage.	Regional	The recommended alternative for this problem is MS-14.
NB-FL-18	Village of Northbrook	Intracommunity (local) flooding	Interstate Route 94 (Edens) at Lake Cook Road	IDOT Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NF-FR-10	Village of Northfield	Intercommunity (regional) flooding	Interstate Route 94 (Edens) at Skokie River	IDOT Pavement Flooding	Regional	The recommended alternative for this problem is MS-14.
NF-FR-19	Village of Northfield	Intercommunity (regional) flooding	From Willow Road heading south to I-94	Overbank Flooding	Regional	The recommended alternative for this problem is MS-14.
WK-FL-02	Winnetka	Intracommunity (local) flooding	Skokie Ditch	Flooding due to poorly defined overflow routes and inadequate capacity of Skokie Ditch storm sewers.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.3.3
Community Response Data for the Skokie River

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NB-FL-04	Village of Northbrook	Intracommunity (local) flooding	Illinois Route 68 at Interstate Route 94 (E/O @ Skokie Boulevard)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NB-FL-05	Village of Northbrook	Intracommunity (local) flooding	Interstate Route 94 (Edens) at Il Route 68 (Dundee Road)	IDOT Pavement Flooding	Local	The recommended alternative for this problem is MS-14.
NF-FR-13	Village of Northfield	Intercommunity (regional) flooding	Interstate Route 94 (Edens) at Willow Road (NB & SB)	Interstate Rt 94 (Edens) at Willow Rd (NB + SB) Pavement flooding	Regional	This DWP includes one recommended regional flood control alternative that addresses this problem: MS-14.
NF-FL-11	Village of Northfield	Intracommunity (local) flooding	Willow Road from Happ Road to Interstate Route 94	IDOT Pavement Flooding Willow Rd from Happ Rd to Interstate Rt 94 Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NF-FL-12	Village of Northfield	Intracommunity (local) flooding	Willow Road at Central Ave Pavement flooding	IDOT Pavement Flooding Willow Rd at Central Ave Pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

[1] All Problem IDs begin with NB-SKRV-, NB-SKWD-, or NB-SKED- as all problems are within the North Branch – Skokie River (Skokie River, Skokie West Ditch, or Skokie East Ditch) subwatershed.

3.3.2 Watershed Analysis

3.3.2.1 Hydrologic Model Development

Subbasin Delineation. The Skokie River tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The watershed boundaries of LM (eastern edge) and the Middle Fork (western edge) were compared, and any discrepancies were resolved.

Hydrologic Parameter Calculations. Table 3.3.4 summarizes the total drainage area, number of modeled subbasins, and average subbasin size for Skokie River and its major tributaries. 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 Clark unit hydrograph method was used to convert SCS CN runoff volumes into subbasin-specific hydrographs. Time of concentration (Tc) and storage coefficient (R) parameters for the Clark unit hydrograph method were estimated as described in Section 1.3.2. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

TABLE 3.3.4
Skokie River System Subbasin Summary

Subbasin	Drainage Area (mi^2)	Number of Modeled Subbasins	Average Modeled Subbasin Size (acres)
Skokie River	13.41	13	660
Major Tributaries to Skokie River			
East Ditch	2.82	2	904
West Ditch	2.22	3	474

3.3.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Field surveys of the Skokie River and bridge crossings were performed 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 field surveyed channel cross sections. 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 coefficients along the modeled stream length.

Boundary Conditions. The downstream boundary condition for the Skokie River is the stage of the confluence of Middle Fork and the Skokie River. The unsteady model produces water surface elevations at each time step, therefore providing a downstream boundary condition at each time step of the simulation. The maximum existing conditions 100 year WSEL at this junction is 624.18 feet in vertical elevation datum NAVD 88.

3.3.2.3 Calibration and Verification

Observed Data. As in shown in Figure 2.3.1, two thiessen polygons, based on two different precipitation gages, allow for complete coverage of the Skokie River subwatershed. The

bulk of the watershed is covered by CCPN gage number 2, and a few subbasins in the southern portion of the watershed are covered by CCPN gage number 4. Data for the September 2008 and October 2001 storms were gathered for calibration and verification of the hydrologic and hydraulic models.

The only USGS stream gage on the Skokie River, gage number 05535070, is located approximately 2500 feet upstream of the Lake/Cook county line at the Clavey Road crossing. Supplemental information on this stream gage can be found in Table 2.3.1. Peak flow information for the calibration and verification events can be found in Table 3.3.5. Because the USGS gage is outside of the limits of the hydraulic study area, HEC-HMS hydrographs were used for comparison to the gage hydrographs.

TABLE 3.3.5
Flow Events at USGS gage 05535070

Date	Peak Monitored Flow (cfs)
9/13/2008	1150
10/14/2001	1230

Figure 3.3A shows superimposed comparisons of the HEC-HMS and USGS gage hydrographs (river gage 05535070) at the gage location for the 2008 event. Figure 3.3B shows these same hydrographs for the 2001 event.

FIGURE 3.3A
Skokie River flow comparison for September 13, 2008 storm

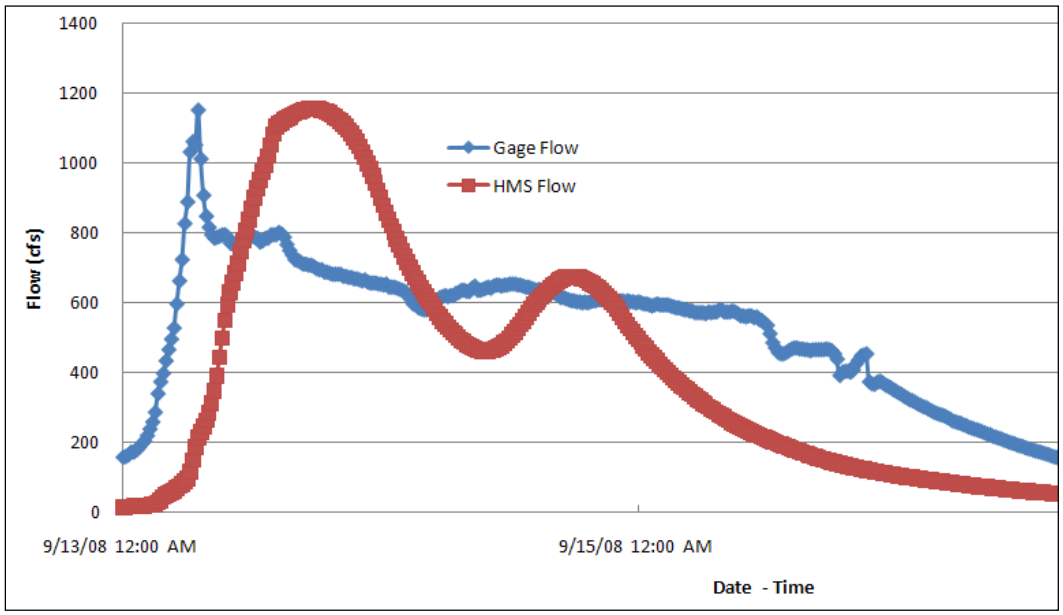
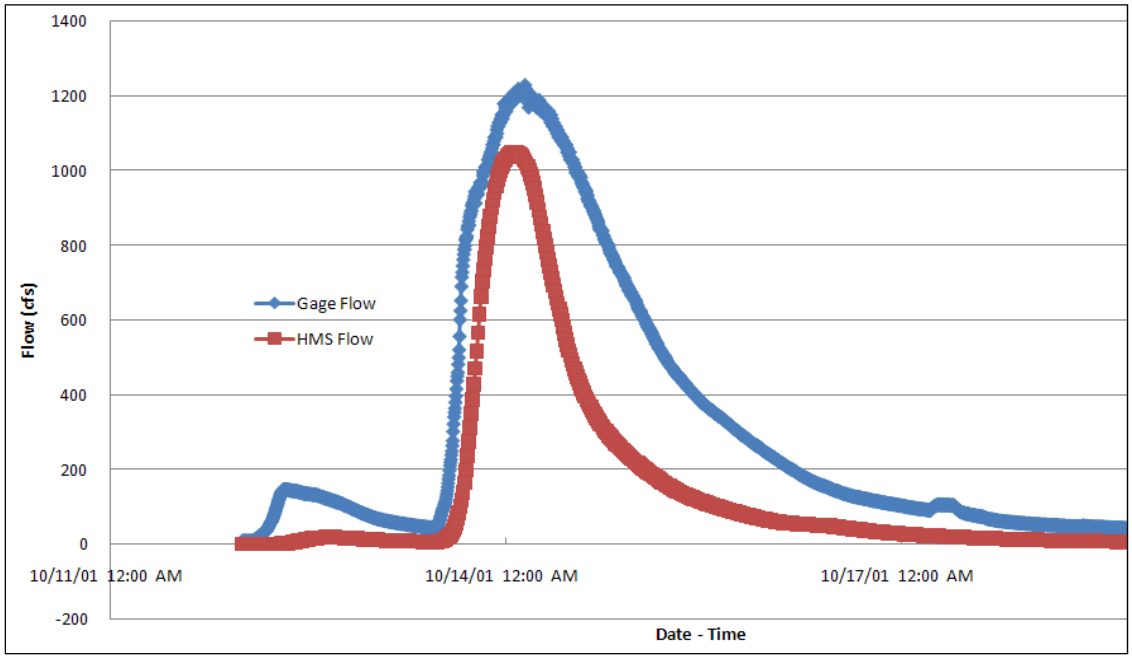


FIGURE 3.3B
Skokie River flow comparison for October 14, 2001 storm



Calibration Results. The September 2008 comparison shown in Figure 3.3A displays a difference in hydrograph shape. The irregular shape of the gage hydrograph is most likely due to either a blockage issue that is causing temporary storage and a reduced flow rate, or an issue with the gage recording itself. Although the September 2008 gage hydrograph could not be duplicated with traditional calibration techniques, the hydrographs compare well for flow and volume. With the results of the HEC-HMS and gage hydrograph comparisons for both events being similar with regard to flow and volume, no modifications were made to the upstream hydrology; the difference between the observed and calibrated model flows and water surface elevations were generally considered to be within an acceptable margin of error. Flow, volume, and stage were checked at the Mainstem gages at Touhy Avenue and Albany Avenue, in order to verify the model met CCSMP criteria. The Mainstem gage comparisons can be found in section 3.4.2.3.

3.3.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.3.1 shows inundation areas produced by the hydraulic model for the 100-year, 24-hour duration design storm.

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

3.3.3 Development and Evaluation of Alternatives

3.3.3.1 Modeled Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.3.6 summarizes major problem areas identified through hydraulic modeling of the Skokie River.

TABLE 3.3.6
Modeled Problem Definition for the Skokie River

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Problem from Table 3.3.3
MPSK1	East Ditch from Tower to Willow Road	10, 25 50, 100	
MPSK2	Both banks of SKRV from Willow Road to Happ Road	10, 25, 50, 100	
MPSK3	I-94 underpass @ Willow Road	100	NF-FR-13
MPSK4	SKRV crossing @ I-94	50, 100	NF-FR-10

3.3.3.2 Damage Assessment

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No recreation damages due to flooding were identified for the Skokie River. Transportation damages were estimated as 15 percent of property damages plus I-94 (Edens Expressway) damages of $7,760,000. No erosion damages were reported for this reach.

TABLE 3.3.7
Estimated Damages for the Skokie River

Damage Category	Estimated Damage ($)	Note
Property	37,041,000	Structures at risk of flooding
Transportation	13,316,000	Assumed as 15% of property damage due to flooding plus I-94 transportation damage

3.3.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in the Skokie River subwatershed. Increased regional storage was identified as the principal solution for addressing stormwater problems in the Skokie River.

3.3.3.4 Alternative Development

Stormwater improvement alternatives were developed to address regional stormwater problems identified in Table 3.3.3, with the aim of reducing damages due to stormwater.

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.3.8 summarizes flood control alternatives developed for the Skokie River. Based on the feedback from watershed communities, a review of previous studies, and a consideration of available open tracts of land, regional flood control alternatives focused on optimizing existing flood control infrastructure and development of a new reservoir.

TABLE 3.3.8
Flood Control and Erosion Control Alternatives for the Skokie River

Alternative	Location	Description
SR-01	I-94 at Voltz Road (due west of the Skokie Country Club)	Construct a new reservoir on a tract of high ground adjacent to the West Ditch of the Skokie River. The 480 acre-ft facility would store water from the West Ditch.
SR-02	I-94 at Voltz Road (due west of the Skokie Country Club)	Construct a new reservoir on a tract of high ground adjacent to the Skokie River/Lagoons. The 480 acre-ft facility would store water from the Skokie River/Lagoons.
SR-03	East Ditch at Tower Road and Forestway Drive	Redirect the East ditch under Forestway Drive and into the Skokie Lagoons
SR-04	Tower Road Dam, Glencoe Road Dam	Relocation of the Tower Road Dam and lowering of the Glencoe Road Dam
SR-05	Willow Road Dam, just north of the Skokie River crossing at Willow Road	Reduce the number of high flow gates from 7 to 3
SR-06	Willow Road Dam, just north of the Skokie River crossing at Willow Road	Remove the low flow gate
SR-07	Willow Road Dam, just north of the Skokie River crossing at Willow Road	Remove all 8 of the current gates and replace them with 1 small gate
SR-08	I-94 (Edens Expressway) at Winnetka Road	Construct 2 levees, one on each side of the I-94 underpass at Winnetka Road

Erosion Control Alternatives. No regional erosion problems were reported for the Skokie River, therefore, no erosion control alternatives are recommended.

3.3.3.5 Alternative Evaluation and Selection

SR-01 considered constructing a regional flood control reservoir on a tract of land located between the Skokie River and I-94. This 480 acre-ft facility would store water from the West Diversion Ditch which runs parallel to the Skokie River from Dundee Road to Willow Road. This alternative does reduce WSELs by 0.74 feet, but this reduction occurs over only a few hundred feet of the West Ditch. Because the reservoir does not address any of the modeled problem areas, this alternative is not recommended.

SR-02 considered constructing the reservoir from SR-01 and using it to store flow from the Skokie River instead of the West Ditch. Through analysis of the hydraulic model, it was determined that the primary source of flooding in the Skokie River Watershed is a backwater effect stemming from the confluence of Skokie River and the Middle Fork. The storage gained from this alternative does not have an impact on the backwater issue and does not resolve any of the modeled problem areas. This alternative is not recommended.

SR-03 considered redirecting the East Diversion Ditch into the Skokie Lagoons with the thought that flow from the East Ditch would be stored in the Lagoons as opposed to in the large eastern floodplain. Currently, the headwater of the East Ditch is located approximately 2,100 feet south of Lake-Cook Road; the reach flows parallel to the Skokie

River until it combines with the Skokie River just north of Willow Road. SR-03 proposes rerouting the east ditch westward into the Skokie Lagoons just upstream of Tower Road in order to reduce inundation downstream of this point. A review of the hydraulic model shows this alternative to be ineffective for 2 reasons: 1) the stage of the Skokie Lagoons is higher than that of the East Ditch causing water to backflow into the East Ditch and 2) The Skokie River backwater impact still causes flooding on the East Ditch south of Tower Road. This alternative has no positive impact and is not recommended.

SR-04 considered relocating the Tower Road Dam from its location upstream of the Skokie Lagoons reach to a new location downstream of the confluence of the Skokie River and the Skokie Lagoons. The relocation would be accompanied by raising the elevation of the dam by two feet. In addition to these alterations, the alternative considered lowering the Glencoe Road dam, located approximately 6,000 feet north of the Tower Road Dam, by approximately two feet. The idea behind performing these changes was that the Tower Road Dam would restrict flow from two reaches instead of just one, and that the Glencoe Road Dam, which was being overtopped, would be dropped to store flow from low flow events while water from high flow events would be restricted and stored by the Tower Road Dam. Due to the backwater effect mentioned in paragraphs for alternatives SR-02 and SR-03, the storage gained from this configuration does not have an impact on the downstream problem areas. This alternative is not recommended.

SR-05 considered reducing the number of high flow gates on the Willow Road Dam from seven to three in order to reduce flow being released to the Skokie River downstream of Willow Road. Currently, the Willow Road Dam has one 8 foot by 7 foot low flow gate, and seven 3.2 foot by 17 foot high flow gates. A reduction in the number of high flow gates from seven to three does decrease the flow released downstream, but this reduction does not yield any decrease in WSELs. This alternative is not recommended.

SR-06 considered removing the low flow gate on the Willow Road Dam. The invert of the low flow gate is approximately 6.5 feet lower than the inverts of the high flow gates. The low flow gate was removed in order to delay and reduce the flow being released downstream. Removal of the low flow gate does decrease the flow released downstream, but this reduction does not yield any decrease in WSELs. This alternative is not recommended.

SR-07 considered reducing the number of gates on the Willow Road Dam to one, resizing that gate to 3.2 foot by 10 foot, and raising the gate invert by six feet. These changes reduce gate discharge by 66%, but this flow reduction has a very minimal impact on downstream WSELs due to the aforementioned Skokie River backwater effect. This alternative is not recommended.

SR-08 considered constructing two small levees around the I-94 underpass at Winnetka Road. The east of I-94 levee is a two foot high, 400 foot long, earthen levee that would be constructed from just east of E. Frontage Road to the I-94 embankment. The west of I-94 levee involves raising 1,400 feet of W. Frontage Road by 2 feet in height; this 1,400 foot segment starts approximately 400 feet south of Winnetka Road. In addition to the levees, an 8 acre area located on the east side of the Skokie River and due east of the two levees will be used for compensatory storage. While storm sewer flooding may still occur in the underpass, this alternative would completely eliminate overbank flooding from the Skokie

River at only at I-94 and Winnetka Road, which partially resolves modeled problem area MPSK4. It should be noted that this project does not address overbank flooding along I-94 at Willow Road and the Skokie River crossing. See Figure 3.3.2 for a conceptual plan of this alternative. This alternative is recommended.

The Skokie River alternative trials yielded no recommended projects that would resolve any of the modeled problem areas. The backwater effect on the Skokie River does not allow for efficient usage of additional upstream flood storage. Section 3.4 addresses this backwater effect and provides recommended alternatives which reduce its impact as well as overbank flooding from the Skokie River. Alternatives that reduce WSELs on the Mainstem reach have a much more significant impact on the Skokie River than the alternatives investigated and described above for the Skokie reach itself.

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

3.3.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the alternatives studied in detail. Table 3.3.9 lists the alternative analyzed in detail. Figure 3.3.2 shows a comparison of existing conditions to alternative conditions 100 year inundation mapping with the implementation of alternative SR-08.

TABLE 3.3.9
Skokie River Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Communities Involved
SR-08[1]	Construct I-94 at Winnetka Road levees and associated compensatory storage to eliminate overbank flooding in this immediate area	1.35	7,760,000	5,761,000	0	None	Yes	Northfield, Unincorporated Cook County, FPDCC, IDOT, Cook County Highway Department

1 - SR-08 project addresses overbank flooding of the Skokie River near I-94 (Edens Expressway) and Winnetka Road. For purposes of benefit calculation for SR-08, no other temporary closure of I-94 due to overbank flooding is assumed.

3.4 Mainstem of the NBCR Upstream of the North Branch Dam

The Mainstem of the North Branch of the Chicago River, which runs from the confluence of the Skokie River and the Middle Fork down to the North Branch Dam at the confluence with the North Shore Channel, has a stream length of 15.6 miles and a drainage area of 21.5 square miles. Table 3.4.1 summarizes the land area of communities within the Mainstem subwatershed. The Mainstem subwatershed consists primarily of residential area and includes with a large portion of forest preserve area being located throughout the bulk of its stream length. Table 3.4.2 summarizes the land use distribution within the Mainstem.

TABLE 3.4.1
Communities Draining to the Mainstem Upstream

Community/Tributary	Tributary Area (mi^2)
Chicago	9.53
Morton Grove	4.99
Niles	4.06
Glenview	1.97
Unincorporated	0.60
Wilmette	0.15
Golf	0.11
Skokie	Less than 0.1
Park Ridge	Less than 0.1

TABLE 3.4.2
Land Use Distribution for the Mainstem Upstream

Land Use Category	Area (acres)	%
Residential	7,602	55.3
Forest/Open Land	3,349	24.4
Commercial/Industrial	1,911	13.9
Institutional	575	4.2
Transportation/Utility	301	2.2
Agricultural	Less than 1	0
Water/Wetland	Less than 1	0

Figures 3.4.1a, 3.4.1b, and 3.4.1c are an overview of the tributary area of the Mainstem subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

3.4.1 Sources of Data

3.4.1.1 Previous Studies

Data from the 1997 FIS regulatory model (HEC-2) were utilized for supplementing the newly developed DWP HEC-RAS model for the Main Stem.

3.4.1.2 Water Quality Data

The IEPA has eight Ambient Water Quality Monitoring Network sites on the Mainstem. Three reaches of the Mainstem are identified as impaired in the IEPA's 2008 Integrated Water Quality Report, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for the Mainstem. TMDLs are currently being developed for dissolved oxygen, chloride, and fecal coliform. According to a water permit discharge query from the USEPA, there are twelve NPDES permits issued by IEPA to the Chicago Tribune, Ozinga Bros., Inc., Metal Management Midwest, Inc., Orange Crush Recycle, Ltd., Apparel Center, Finkl, A. and Sons Company, all in Chicago, and MWRDGC-Perini/Ica/O&G Joint of Morton Grove, Castwell Products, Inc. of Skokie, Unocal Corp. of Northfield, Village of Morton Grove, Village of Skokie, and City of Chicago, for discharges to the Mainstem. Municipalities discharging to the Mainstem are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was instituted to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.4.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the NBCR Watershed. Wetland areas were identified using NWI mapping. NWI data includes approximately 343 acres of wetland areas in the Mainstem tributary area. Restoration and enhancement of wetlands are included as part of the recommended alternatives described in the sub-sections below. 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.

3.4.1.4 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 in the revised floodplains. The effective FIS H&H analysis was performed in both 1978 and 1980 depending on the portion of the river that was modeled. The hydrologic modeling was performed by using HEC-1, TR-20, and I-PTIII with Regression Equation 79; Hydraulic routing was performed using both HEC-2 and WSP2.

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

3.4.1.5 Stormwater Problem Data

Table 3.4.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.4.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.4.1.6 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. Several studies are currently underway in the Mainstem Subwatershed; however, no near-term planned flood control projects by others have been identified in the Mainstem Subwatershed.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-ER-28	City of Chicago	Streambank erosion on intercommunity waterways	LaBagh Woods - Bryn Mawr & Kostner Avenue	FPDCC reported off-site stormwater volumes are causing downcutting in a ditch, thereby lowering the water table in the adjacent natural wetland areas.	Regional	Erosion problem does not threaten structures or conveyance of Mainstem. Not addressed by DWP.
CH-FL-29	City of Chicago	Intracommunity (local) flooding	Citywide	Basement flooding, storm water sewer flow restriction throughout area. City sewer improvements are often focused towards areas of the most complaints.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-30	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Central Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-31	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Milwaukee Avenue (Lane 3)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-32	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Jefferson Park Tunnel (NR Ainslie Street) Lane 3	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FL-33	City of Chicago	Intracommunity (local) flooding	Interstate Route 94 (Edens) at North Elston Avenue (SB)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-34	City of Chicago	Intracommunity (local) flooding	Interstate Route 90 at Austin Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-35	City of Chicago	Intracommunity (local) flooding	Interstate Route 90 at Lawrence Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-36	City of Chicago	Intracommunity (local) flooding	Interstate Route 90 at Bryn Mawr Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-37	City of Chicago	Intracommunity (local) flooding	Interstate Route 90 at Nagle Avenue (NB ramp)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FR-38	City of Chicago	Intercommunity (regional) flooding	LaBagh Woods	FPDCC reported off-site stormwater volumes are causing downcutting in a ditch, thereby lowering the water table in the adjacent natural wetland areas - (ponding checked on form B)	Regional	Problem is not caused by overbank flooding. Not addressed by DWP.
CH-WQ-39	City of Chicago	Intracommunity (local) flooding	Citywide	Basement flooding, storm sewer flow restriction, water quality (pollution) throughout area. The City sewer improvements are often focused towards areas of the most complaints	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-WQ-40	City of Chicago	Intracommunity (local) flooding	Throughout Chicago wetland areas	FPDCC reported off-site stormwater volumes are causing downcutting in a ditch, thereby lowering the water table in the adjacent natural wetland areas - (wetland issue considered WQ)	Local	Problem not located on a regional waterway. Not addressed by DWP.
CH-FL-44	City of Chicago	Intracommunity (local) flooding	Central Avenue at South of Devon Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FR-45	City of Chicago	Intracommunity (regional) flooding	Albany Park	Overbank flooding throughout the community	Regional	The recommended alternative is MS-10.
GV-FL-01	Village of Glenview	Intracommunity (local) flooding	Sunset Ridge Road - East Lake Avenue to Skokie Road	Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
GV-FL-02	Village of Glenview	Intracommunity (local) flooding	East of Harms Road South of Lake Avenue	Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
MG-ER-01	Village of Morton Grove	Streambank erosion on intercommunity waterways	Linne Woods, Village of Morton Grove	Tree impeding flow, failing streambank stabilization	Regional	Upon field visit, erosion problem does not threaten structures or conveyance of Mainstem and existing stabilization appeared to be adequate. Not addressed by DWP.
NL-FL-08	City of Chicago, Village of Niles	Intracommunity (local) flooding	Illinois Route 43 at Howard Street (N/O)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
MG-FL-02	Village of Morton Grove, Village of Glenview	Intracommunity (local) flooding	Illinois Route 43 at Illinois Route 58	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
SK-FL-11	City of Evanston, Village of Skokie	Intracommunity (local) flooding	US Route 41 @ Old Orchard Road to Golf Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
MG-FL-03	Unincorp Cook County, Village of Morton Grove, Village of Golf	Intracommunity (local) flooding	Golf Rd at West of Harms Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NL-FL-09	Village of Skokie, Village of Niles	Intracommunity (local) flooding	Gross Point Road at 7500 Gross Point Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NL-FL-01	Village of Niles	Intracommunity (local) flooding	US Route 14 at Illinois Route 21 (Milwaukee Area)	IDOT Pavement flooding US RT 14 at Illinois Rte 21 (Milwaukee Ave)	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NL-FL-02	Village of Niles	Intracommunity (local) flooding	Illinois Route 21 at Main Street (S/O US Route 14)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NL-FL-03	Village of Niles	Intracommunity (local) flooding	Illinois Route 43 at Oakton Street	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NL-FL-04	Village of Niles	Intracommunity (local) flooding	Dempster Street, East of Harlem Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
NL-FR-05	Village of Niles	Intercommunity (regional) flooding	Tam Golf Course, Niles	Tam Golf Course Flooding- During major storm events, overbank flooding of the adjacent golf course - Tam Golf Course and/or its buildings owned by the Niles Park District.	Regional	This DWP includes one investigated regional flood control alternative that addresses this problem: MS-02
NL-FR-06	Village of Niles	Intercommunity (regional) flooding	Harts Road & Riverside Drive, Niles	Overbank flooding in areas of the intersection of Harts Rd and Riverside Drive during severe storm events.	Regional	This DWP includes one investigated regional flood control alternative that addresses this problem: MS-02. Recommend raising road to eliminate pavement flooding.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
NL-ER-10	Village of Niles	Streambank erosion on intercommunity waterways	Wood River Drive	Erosion problem along the NBCR for the townhouses located at 6620, 6622, 6624, 6626, 6628, 6630, 6632, 6634, 6636, 6638, and 6640 Wood River Drive.	Regional	Erosion problem does not immediately threaten structures or conveyance of Mainstem. Not addressed by DWP.
SK-FL-01	Village of Skokie	Intracommunity (local) flooding	Interstate Route 94 at Illinois Route 58	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-02	Village of Skokie	Intracommunity (local) flooding	US Route 41 at Gross Point Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-03	Village of Skokie	Intracommunity (local) flooding	Gross Point between Emerson & Kenton	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-04	Village of Skokie	Intracommunity (local) flooding	Church Road at Gross Point Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
SK-FL-05	Village of Skokie	Intracommunity (local) flooding	Harms Flatwoods Forest Preserve - Old Orchard Road and Harms Road	FPDCC reported that off-site stormwater volumes from adjacent properties modify the hydrology in this ecologically significant flatwoods community with endangered and threatened plant species.	Local	Problem not located on a regional waterway.
SK-WQ-06	Village of Skokie	Intracommunity (local) flooding	Harms Flatwoods Forest Preserve - Old Orchard Road and Harms Road	FPDCC reported off-site stormwater volumes from adjacent properties modify the hydrology in this ecologically significant flatwoods community with endangered and threatened plant species.	Local	Erosion problem does not threaten structures or conveyance of West Fork. Not addressed by DWP.
UC-ER-01	Uninc. Cook County	Streambank erosion on intercommunity waterways	Harms Flatwoods Forest Preserve - West of Old Orchard Road and Harms Road	FPDCC reported properties on the west side of the forest preserve discharge stormwater directly to forest preserve with impacts of erosion, sedimentation, and habitat degradation.	Local	Erosion problem does not threaten structures or conveyance of Mainstem. Not addressed by DWP.
UC-WQ-02	Uninc. Cook County	Intracommunity (local) flooding	Harms Flatwoods Forest Preserve - West of Old Orchard Road and Harms Road	FPDCC reported properties on the west side of the forest preserve discharge stormwater directly to forest preserve with impacts of erosion, sedimentation, and habitat degradation	Local	Problem not located on a regional waterway.
WM-FL-01	Village of Wilmette	Intracommunity (local) flooding	Wilmette Golf Course at Lake and Harms	Ponding/storm sewer flow restriction after rain events in isolated low areas/storm restrictions. Storm sewer surcharging by high river water levels results in yard ponding/depressed driveways/garages	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.4.3
Community Response Data for the Mainstem Upstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
WM-FL-02	Village of Wilmette	Intracommunity (local) flooding	US Route 41 at N/O Hibbard Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
WM-FL-03	Village of Wilmette	Intracommunity (local) flooding	Interstate Route 94 (Edens) at Glenview Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
WM-FL-04	Village of Wilmette	Intracommunity (local) flooding	Various locations in Wilmette	Map of the local ponding throughout area during the September 2008 storm	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
WM-FL-05	Village of Wilmette	Intracommunity (local) flooding	Various locations Wilmette	Map of the basement Flooding throughout area during September 2008 storm	Local	Problem not located on a regional waterway.
WM-FR-06	Village of Wilmette	Intercommunity (regional) flooding	Wilmette Golf Course	Flooding and ponding at the Wilmette Golf Course after rain events. High water levels in the river causes stormwater to back up within the golf course.	Regional	The recommended alternative is MS-14.

[1] All Problem IDs begin with NB-NBCU- as all problems are within the North Branch – Upstream of the North Branch Dam subwatershed.

3.4.2 Watershed Analysis

3.4.2.1 Hydrologic Model Development

Subbasin Delineation.
The Mainstem tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The watershed boundaries of the Des Plaines River (western edge) and LM (eastern edge) were compared, and discrepancies were identified. Discrepancies generally were minor and resolved by manual review of topographic data and consultation with Des Plaines River DWP consultant, Christopher B. Burke Engineering.

Hydrologic Parameter Calculations.
Table 3.4.4 summarizes the total drainage area, number of modeled subbasins, and average subbasin size for the Mainstem and its major tributaries.

TABLE 3.4.4
Mainstem Upstream System Subbasin Summary

Subbasin	Drainage Area (mi^2)	Number of Modeled Subbasins	Average Modeled Subbasin Size (acres)
Mainstem	21.49	21	655
Major Tributaries to Mainstem			
West Fork	19.70	42	300
Middle Fork	5.01	10	321
Skokie River	13.41	13	660

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 Clark unit hydrograph method was used to convert SCS CN runoff volumes into subbasin-specific hydrographs. Time of concentration (Tc) and storage coefficient (R) parameters for the Clark unit hydrograph method were estimated as described in Section 1.3.2. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.4.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Field surveys of the Mainstem and bridge crossings were performed 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 field 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 coefficients along the modeled stream length.

Boundary Conditions. The downstream boundary condition for the Mainstem is the stage of the NSC; however, this downstream boundary condition can be more appropriately described as the rating curve of the North Branch Dam as it is impacted by the stage of the NSC. The USACE CAWS hydraulic model was utilized to determine the downstream

boundary condition of the Mainstem. The calculation of this boundary condition is further described in Appendix E.

3.4.2.3 Calibration and Verification

Observed Data. As in shown in Figure 2.3.1, two thiessen polygons, based on two different precipitation gages, allow for complete coverage of the Mainstem subwatershed. The upstream-most thiessen polygon is based on CCPN gage number 4; the downstream-most portion of the Mainstem is covered by CCPN gage number 6. Data for the September 2008 and October 2001 storms were gathered for calibration and verification of the hydrologic and hydraulic models.

Chapter 6 of the CCSMP states that calibration and verification comparisons with gage data must come within: 30% for peak flow, 30% for hydrograph volume, and 0.5 feet for peak stage. Both USGS stream gages on the Mainstem were used for calibration and verification of the North Branch of the Chicago River and its tributaries. Mainstem gage 0553600 is located at Touhy Avenue in Niles, and Mainstem gage 05536105 is located at Albany Avenue in Chicago. Tables 3.4.5 and 3.4.6 display monitored peak flow for the September 2008 calibration and October 2001 verification events. An initial check at these gages showed that the existing conditions hydraulic model met 5 of the 6 criterion for CCSMP compliance. The one value that initially did not meet CCSMP criteria was the stage of the Albany Avenue gage. With the hydraulic model displaying accuracy at the Touhy Avenue gage, and showing accuracy for flow and volume at the Albany gage, it was determined that the issue with the Albany stage was most likely hydraulic in nature. The rating curve for the North Branch Dam was adjusted by applying an increase in the weir coefficient of discharge from 3.1 to 3.8, in order to reduce the stage to a compliant level.

TABLE 3.4.5
Flow Events at USGS gage 05536000

Date	Peak Monitored Flow (cfs)
9/13/2008	3,340
10/14/2001	1,710

TABLE 3.4.6
Flow Events at USGS gage 05536105

Date	Peak Monitored Flow (cfs)
9/14/2008	4,310
10/14/2001	1,700

Calibration Results.
Figures 3.4A through 3.4H display stage and flow comparisons between HEC-RAS hydrographs and gage hydrographs at each Mainstem gage, for the calibration and verification events. Tables 3.4.6, 3.4.7, and 3.4.8 depict how the HEC-RAS model matches up with the gage model with regard to peak flow, volume, and peak stage, respectively.

TABLE 3.4.7

Gage and Model Peak Flow Comparison

Gage Number	Gage Peak Flow (cfs)	Model Peak Flow (cfs)	% Difference	Meets CCSMP Req. (30%)
September 2008				
05536000	3,340	3,130	6.3	YES
05536105	4,310	3,573	17.1	YES
October 2001				
05536000	1,710	1,733	1.3	YES
05536105	1,700	1,786	5.1	YES

TABLE 3.4.8

Gage and Model Volume Comparison

Gage Number	Gage Volume (acre-ft)	Model Volume (acre-ft)	% Difference	Meets CCSMP Req. (30%)
September 2008				
05536000	20,548	20,736	0.9	YES
05536105	26,907	22,932	14.8	YES
October 2001				
05536000	12,361	10,853	12.2	YES
05536105	12,909	11,691	9.4	YES

TABLE 3.4.9

Gage and Model Peak Stage Comparison

Gage Number	Gage Elevation (ft)	Model Elevation (ft)	Difference (ft)	Meets CCSMP Req. (<0.5ft)
September 2008				
05536000	613.9	613.6	0.3	YES
05536105	588.3	588.6	0.3	YES
October 2001				
05536000	611.0	611.4	0.4	YES
05536105	586.5	586.8	0.3	YES

*All elevations are given in NAVD88

FIGURE 3.4A
Mainstem flow comparison at the Niles gage (05536000) for September 13, 2008 storm

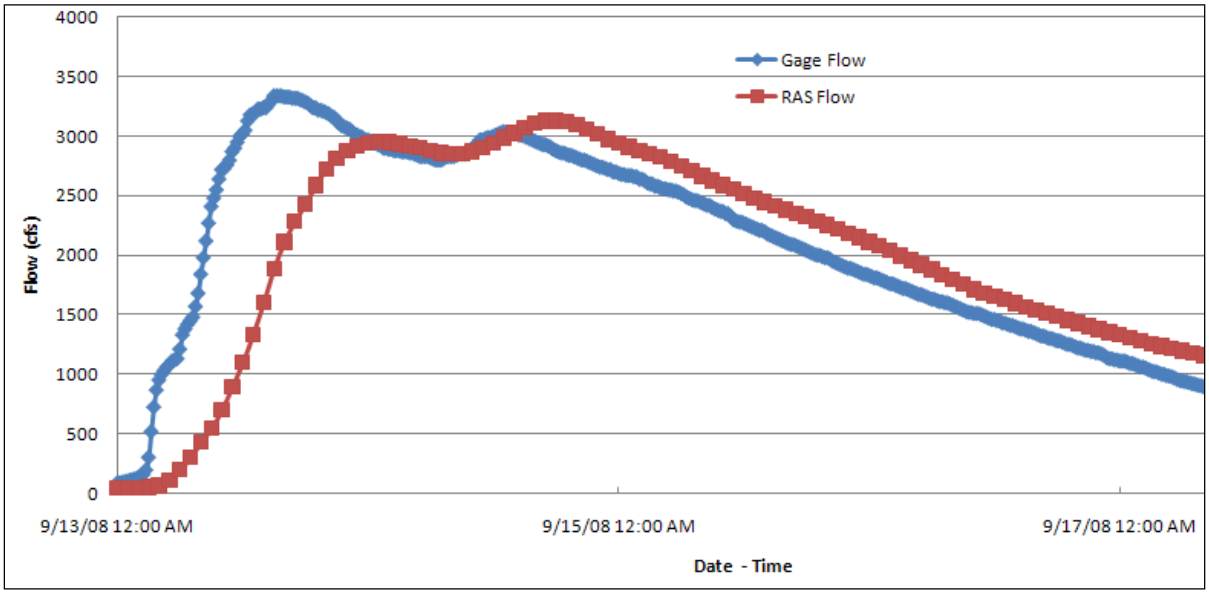


FIGURE 3.4B
Mainstem flow comparison at the Albany gage (05536105) for September 13, 2008 storm

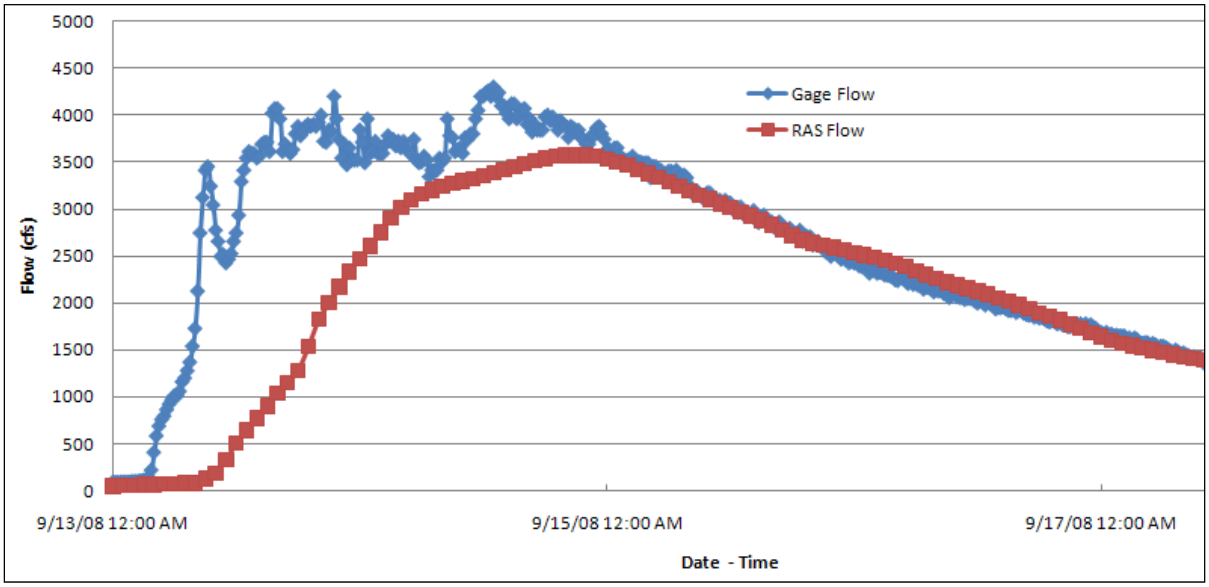


FIGURE 3.4C
Mainstem stage comparison at the Niles gage (05536000) for September 13, 2008 storm

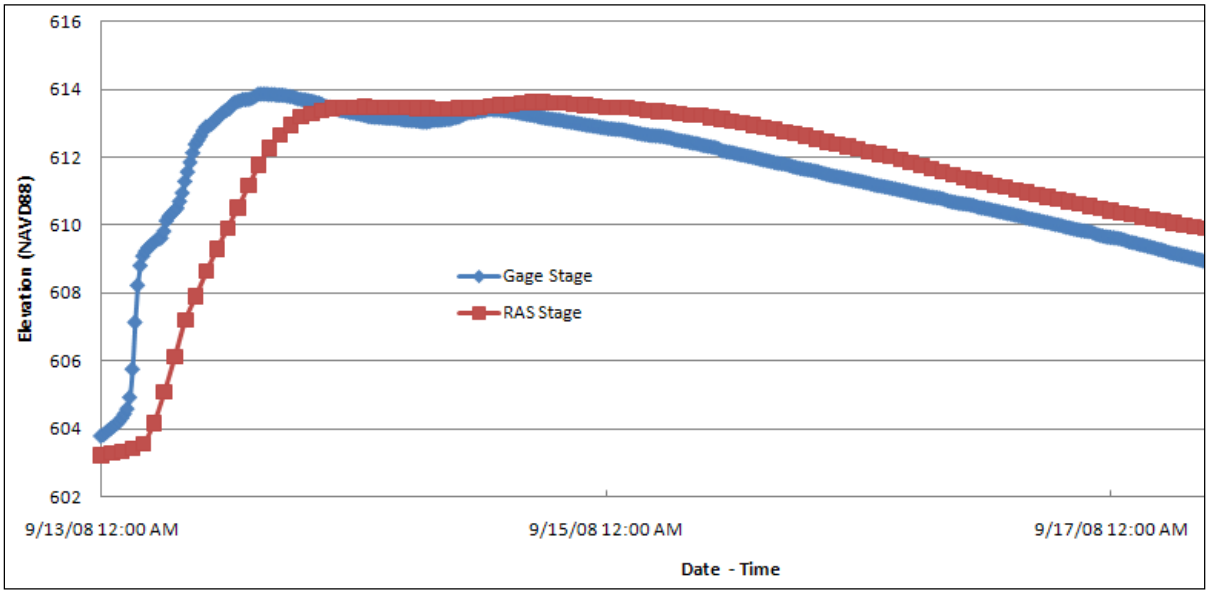


FIGURE 3.4D
Mainstem stage comparison at the Albany gage (05536105) for September 13, 2008 storm

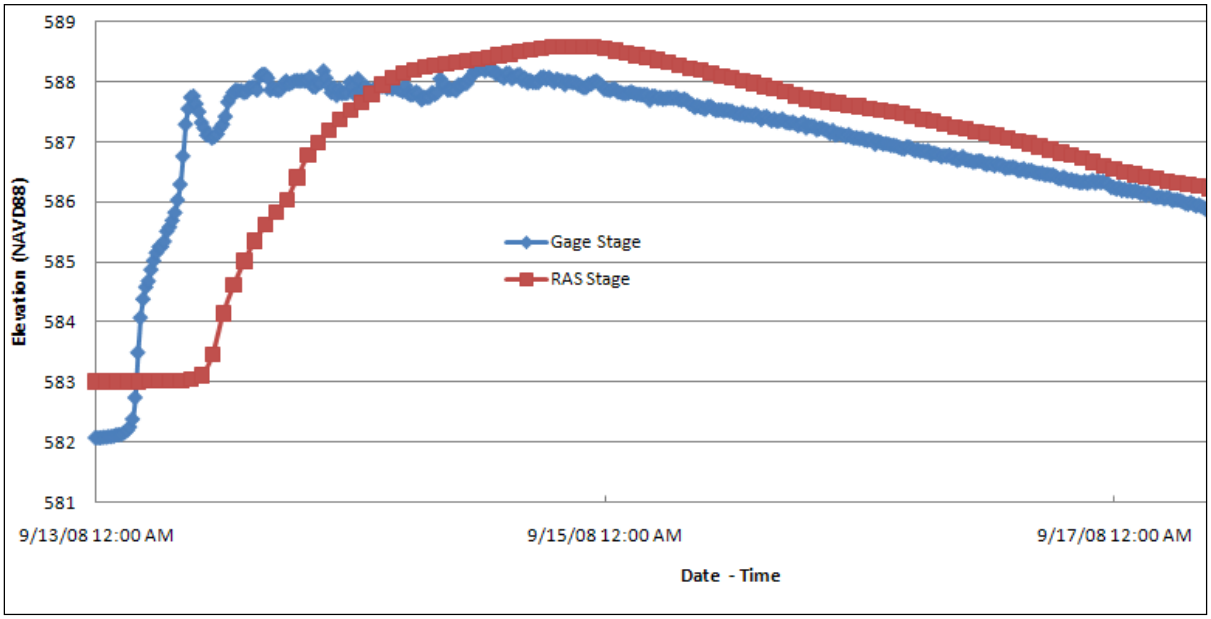


FIGURE 3.4E
Mainstem flow comparison at the Niles gage (05536000) for October 13, 2001 storm

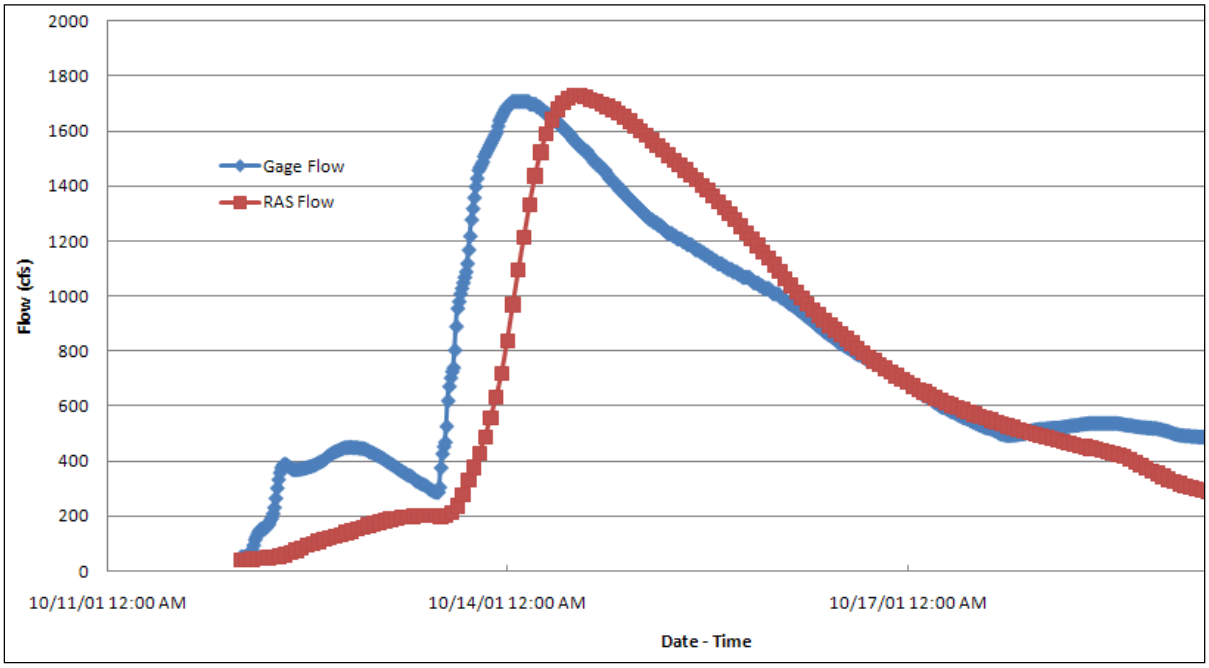


FIGURE 3.4F
Mainstem flow comparison at the Albany gage (05536105) for October 13, 2001 storm

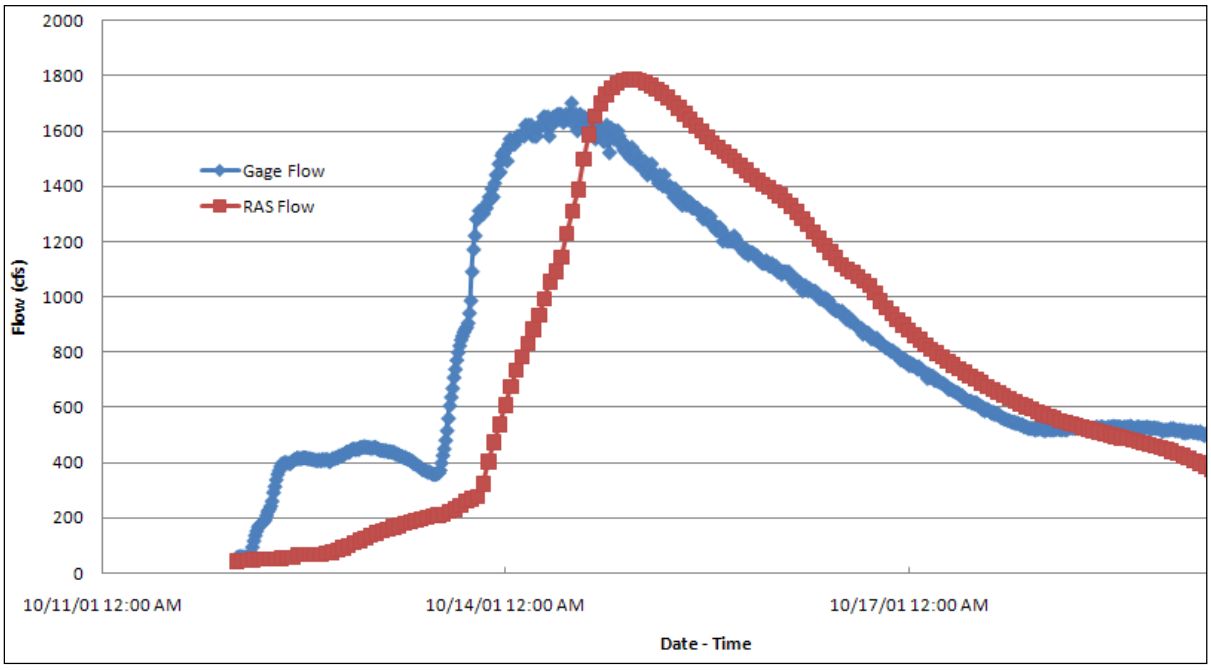


FIGURE 3.4G
Mainstem stage comparison at the Niles gage (05536000) for October 13, 2001 storm

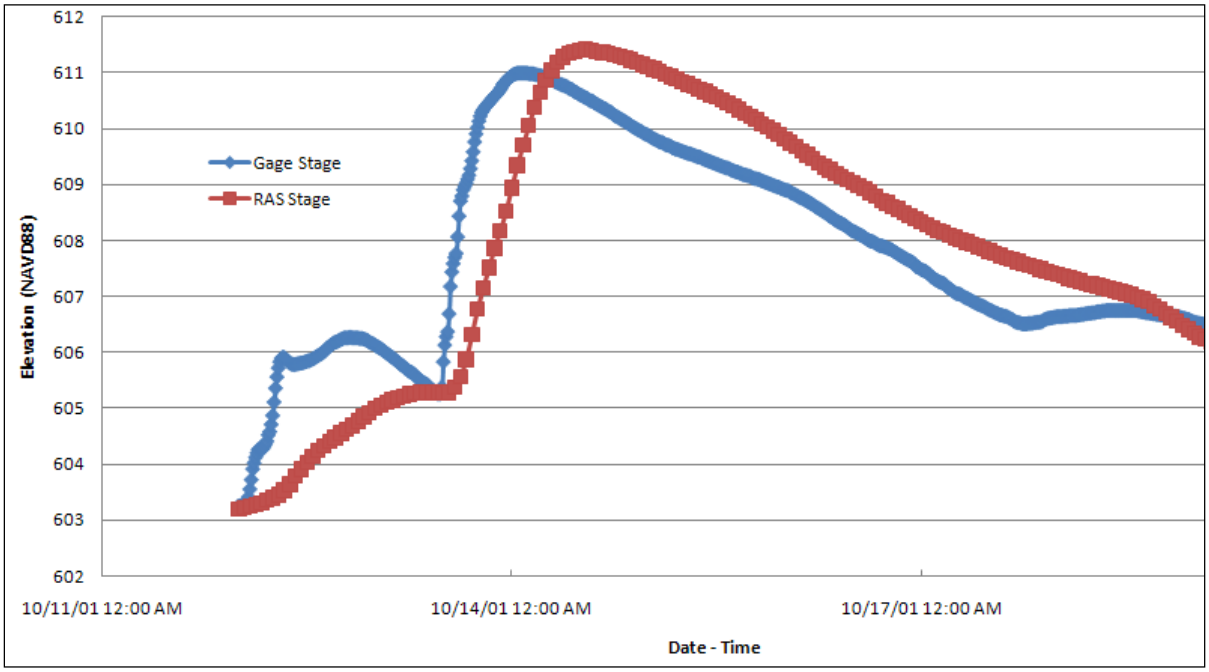
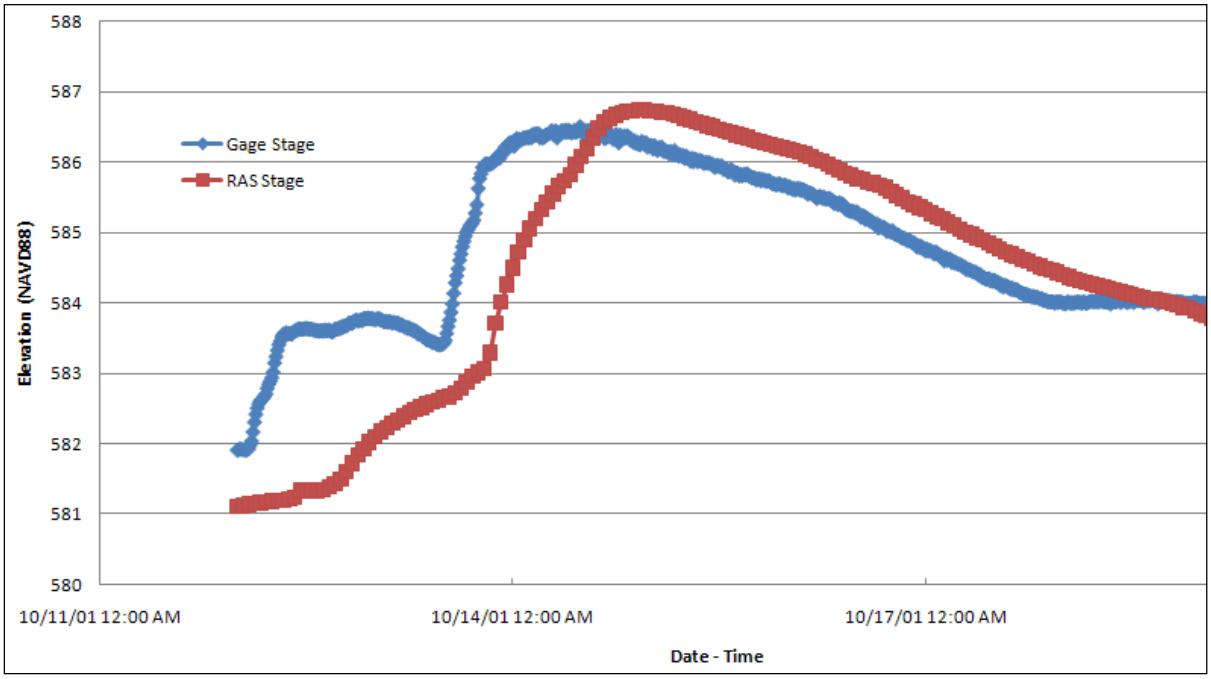


FIGURE 3.4H
Mainstem stage comparison at the Albany gage (05536105) for October 13, 2001 storm



3.4.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figures 3.4.1a-c show inundation areas produced by the hydraulic model for the 100-year, 24-hour duration design storm.

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

3.4.3 Development and Evaluation of Alternatives

3.4.3.1 Modeled Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.4.9 summarizes major problem areas identified through hydraulic modeling of the Mainstem.

TABLE 3.4.10
Modeled Problem Definition for the Mainstem Upstream

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Problem from Table 3.1.3
MPMS1	East overbank flooding hydraulically connected to the subdivision between Glenview Road and Old Orchard Road	10, 25, 50, 100	
MPMS2	East overbank flooding from Howard Street to Harts Road	25, 50, 100	NL-FR-06
MPMS3	Overbank flooding from Foster Avenue to Kedzie Avenue	10, 25,50, 100	CH-FL-29

3.4.3.2 Damage Assessment

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No recreation damages due to flooding were identified for the Mainstem. Transportation damages were estimated as 15 percent of property damages. No erosion damages were calculated because no active streambank erosion was reported within 30 feet of any infrastructure.

TABLE 3.4.11
Estimated Damages for the Mainstem Upstream

Damage Category	Estimated Damage ($)	Note
Property	45,545,000	Structures at risk of flooding
Transportation	6,832,000	Assumed as 15% of property damage due to flooding

3.4.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in the Mainstem subwatershed. A variety of flood control technologies are used in the recommended alternatives including: regional flood control reservoirs, channel modification, levee construction, and flow diversion tunnels.

3.4.3.4 Alternative Development

Stormwater improvement alternatives were developed to address regional stormwater problems identified in Table 3.4.3, with the aim of reducing damages due to stormwater.

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.4.11 summarizes flood control alternatives developed for the Mainstem. Based on the feedback from watershed communities, a review of previous studies, and a consideration of available open tracts of land, stormwater detention alternatives developed for the Mainstem were focused primarily on new reservoir construction on open parcels.

TABLE 3.4.12
Flood Control and Erosion Control Alternatives for the Mainstem Upstream

Alternative	Location	Description
MS-01	Approximately 2,500 feet upstream of the Mainstem crossing at Dempster St	Repair/stabilize a section of streambank in which prior erosion stabilization has failed
MS-02	1,600 feet north of the intersection of Lehigh Ave and Dempster St	Construct a new reservoir on the open parcel at this location
MS-03	Cook County Forest Preserve from Harts Road to I-94	Construct several small in-channel restrictions which would increase floodplain storage on FPDCC land
MS-04	Edgebrook Golf Course, located between Devon Ave and N Central Ave	Construct a new reservoir on the 18 hole golf course
MS-05	Billy Caldwell Golf Course, located northwest of the intersection of N Leader Ave and N Lansing Ave	Construct a new reservoir on the 9 hole golf course
MS-06	LaBagh Woods, approximately 900 ft east of the parking lot	Erosion stabilization along a ditch that runs from a wetland area to the Mainstem
MS-07	Foster Ave. from Avers Ave. to the North Shore Channel	Construct an 18 foot diameter diversion tunnel along Foster Avenue that diverts flow from the Mainstem to the NSC
MS-08	Foster Ave and Pulaski Road	Construct a new reservoir on the open parcels in this area
MS-09	Ridgeway Ave ped bridge	Remove Ridgeway Ave ped bridge to improve channel hydraulics through this area
MS-10	Foster Ave crossing to Kimball Ave crossing	Construct a floodwall to protect the Albany Park neighborhood from overbank flooding
MS-11	Confluence of the Mainstem and the North Shore Channel	Analyze the floodplain impacts of a possible canoe chute addition to the North Branch Dam
MS-12	Wilmette Golf Course, just northeast of the Lake Ave Mainstem crossing	Construct a new regional flood control reservoir on the golf course property
MS-13	Mainstem channel from the Middle Fork confluence to the West Fork confluence	Construct a channel modification that widens the existing channel and increases conveyance for the modified cross sections
MS-14	MS-12 and MS-13 locations	Construct the Wilmette GC reservoir (MS-12) and perform the MS-13 channel modification

Erosion Control Alternatives.

Two erosion control alternatives, MS-01 and MS-06, were investigated for the Mainstem in order to address the erosion problems that were reported. None of these alternatives were selected because no infrastructure is present within 30 feet of active streambank erosion on the Mainstem.

3.4.3.5 Alternative Evaluation and Selection

MS-01 considered erosion stabilization on a section of streambank approximately 2,500 feet upstream of the Mainstem crossing at Dempster Street. Currently, a system of AJAX is in place to stabilize the streambank, but this system is beginning to fail in several locations. Field review of this problem determined that the repair/stabilization area is not within 30 feet of existing infrastructure and the existing stabilization is in fair condition. This alternative is not recommended at this time.

MS-02 considered constructing a new flood control reservoir on an open parcel located just east of Lehigh Ave, between Beckwith Road and Dempster Street. In addition to the construction of the approximate 570 acre-ft reservoir, a restriction culvert would be added to the Mainstem in order to allow for flow to backup into the reservoir. This alternative results in full utilization of the reservoir and utilization of additional storage in the Cook County Forest Preserve floodplain due to the restricted flow backup. While MS-02 does decrease WSELs as much as 1.6 feet in some areas, and as much as 1.2 feet in the Albany Park neighborhood, the alternative causes large WSEL increases on the order of 2 feet through the FPDCC. With the negative impact on FPDCC property and on local neighborhood storm sewer outfalls, this alternative was deemed infeasible. This alternative is not recommended.

MS-03 considered constructing a series of 6 dams on the Mainstem from just upstream of Devon Avenue to just upstream of the LaBagh Woods railroad crossing. The idea behind these storage steps was to restrict flow at each of the dams which would increase WSELs through FPDCC land and allow for additional storage in the Forest Preserve floodplain. The six dams varied in height from 7 to 9 feet and included a small box culvert to bypass low flows. The storage steps do increase WSELs through the forest preserve area, but these upstream increases do not result in any downstream decreases. Because the forest preserve is already storing a significant amount flow in its floodplain, the additional storage is minimal by comparison. This alternative is not recommended.

MS-04 considered constructing a regional flood control reservoir on the Edgebrook Golf Course, located in the Mainstem floodplain from Devon Avenue to North Central Avenue. This proposed 1,730 acre-ft facility would remove 11 holes from the Edgebrook GC and would require a restriction culvert to be built on the Mainstem. This alternative is effective as it reduces WSELs by as much as 1.1 feet the Albany Park neighborhood. Based upon District coordination with the FPDCC, it was determined that storage would be allowed to be built on the golf course to increase its playability; however, a reservoir large enough to mitigate downstream flooding would take up the majority of the land area of the golf course and was not considered feasible by FPDCC. The acreage needed to make an impact on the MPMS3 problem area is not available due to these restrictions. This alternative is not recommended.

MS-05 considered constructing a regional flood control reservoir on the Billy Caldwell Golf Course, located northwest of the intersection of North Leader Avenue and North Lansing Avenue. This proposed 1,700 acre-ft facility would remove all 9 holes from the Billy Caldwell GC and would require a restriction culvert to be built on the Mainstem. This alternative is effective as it reduces WSELs by as much as 1.6 feet in the Albany Park neighborhood. Based upon District coordination with the FPDCC, it was determined that storage would be allowed to be built on the golf course to increase its playability; however, a reservoir large enough to mitigate downstream flooding would take up the majority of the land area of the golf course and was not considered feasible by FPDCC. The acreage needed to make an impact on the MPMS3 problem area is not available due to these restrictions. This alternative is not recommended.

MS-06 considered erosion stabilization on a ditch that conveys water from a wetland area, in the LaBagh Woods Forest Preserve, to the Mainstem. It was reported that down-cutting in this ditch causes the wetland to drain prematurely. Field review of this area determined that streambank erosion does not occur within 30 feet of a structure. This alternative is not recommended.

MS-07 considered constructing a 14 foot diameter diversion tunnel which would run under Foster Avenue from its intersection with Avers Avenue until its discharge into the North Shore Channel. The 14 foot diameter tunnel, which would divert flow from the Mainstem to the North Shore Channel, was originally recommended by MWH Americans, Inc. (MWH) in their January 22, 2010 pre-feasibility evaluation. MWH determined that a 14 foot diameter tunnel would be large enough to divert enough flow to keep the Mainstem within bank for a 100 year event through the Albany Park neighborhood. Based on the DWP hydraulic model, it was determined that, while a 14 foot tunnel would greatly reduce the inundated area, an 18 foot diameter tunnel would come much closer to eliminating overbank flooding through the Albany Park neighborhood. The proposed 18 foot diameter tunnel almost completely resolves the MPMS3 problem area with the exception of a small amount of street flooding in a few locations. However, after the cost analysis performed in this DWP, this alternative is not recommended as the most cost effective solution for the Albany Park neighborhood overbank flooding. The recommended alternative for mitigating Albany Park neighborhood overbank flooding is MS-10. It is noted that the City of Chicago supports the MS-07 alternative in lieu of MS-10. The City of Chicago supports MS-07 because the tunnel would reduce flooding without buyouts, relocations, or construction of a wall through the neighborhood.

MS-08 considered utilizing open parcels near the intersection of Foster Avenue and Pulaski Road for regional flood control. A review of the open parcels showed there was approximately 30 acre-ft of storage to be gained, which is not large enough to have any impact on WSELs. This alternative is not recommended.

MS-09 considered removing the Ridgeway Avenue pedestrian bridge in order to increase conveyance through this area. Because the 2008 FIS profile of the Mainstem shows a positive head differential at the Ridgeway pedestrian bridge, the bridge removal was considered in an attempt to reduce upstream WSELs. The removal of the bridge in the hydraulic model had no impact on WSELs. This alternative is not recommended.

MS-10 considered constructing a floodwall through the heavily inundated overbanks in the Albany Park neighborhood. The proposed south floodwall runs from Foster Avenue, just east of Pulaski Road, to the Kimball Avenue crossing. The north floodwall runs from the southeastern most point of Eugene Field Park down to the Kimball Avenue crossing. This alternative does raise WSELs outside of the limits of the floodwall for a few hundred feet along the stream centerline; the structures impacted by these increases would be candidates for flood proofing and/or acquisition. The floodwall protects approximately 329 structures from overbank flooding. See Figure 3.4.2a for a conceptual plan of this project. This alternative is recommended.

MS-11 considered constructing a canoe chute/fish passage alteration to the North Branch Dam. A study was performed by the University of Illinois with regard to the design of a canoe chute at the dam. The dam geometry from this study was placed into the DWP hydraulic model to see if it had any positive impact on WSELs. The implementation of the canoe chute causes increases in WSELs, and while it may have merits outside of the scope of this DWP, this alternative is not recommended.

MS-12 considered constructing a new reservoir on the existing Wilmette Golf Course which is located on the east overbank of the Mainstem, just downstream of the confluence of the Middle Fork and Skokie River. Full utilization of the golf course land allows for the construction of a 2,800 acre-ft regional flood control reservoir. The proposed reservoir reduces WSELs as much as 1 foot in some areas and provides partial relief for modeled problem areas MPMS2 and MPMS3. MS-12 makes its biggest impact by helping to relieve the aforementioned Skokie River backwater effect. The reduction of backwater on the Skokie River and Middle Fork, due to this alternative, causes partial relief for modeled problem areas MPSK1, MPSK2, MPSK3, and MPMF6. However, this alternative is not recommended as the most cost effective solution to the overbank flooding in these modeled problem areas.

MS-13 considered a channel modification on the Mainstem from its confluence with the West Fork up to the confluence of the Middle Fork and Skokie River. This alternative attempted to relieve the aforementioned backwater issue at the confluence of the Middle Fork and Skokie River. The channel modification includes widening the existing channel by 70 feet on each side in order to increase conveyance in the area of the WSEL backup. This alternative does reduce WSELs by as much as 0.7 feet in portions of the lower Skokie River and Middle Fork, but it increases downstream WSELs by as much as 0.3 feet in the area of MPMS2. Because MS-13 does have a negative impact on another problem area, the alternative is not recommended as an independent project.

MS-14 considered combining alternatives MS-12 and MS-13 in order to increase positive impact on the Skokie River and Middle fork, while eliminating any net negative impact downstream of the channel modification. This alternative results in WSEL decreases by as much as 1.7 feet and does not cause any increases in WSELs. See Figure 3.4.3a for a conceptual plan of this project. This alternative is recommended as the most cost effective solution to overbank flooding to the modeled problem areas MPMS2, MPMS3, MPSK1, MPSK2, MPSK3, and MPMF6. MS-14 provides the approximate 2,800 ac-ft of storage required to mitigate the aforementioned modeled problem areas; however, the FPDCC and Wilmette Park District have indicated their unwillingness to provide land for this alternative.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.4.13.A provides a comparison of the modeled maximum WSEL and modeled flow at the time of peak at representative locations along the waterway for the recommended alternative MS-14. Tables 3.4.13.B through 3.4.13.D provide a comparison of the modeled maximum WSEL and modeled flow at the time of peak at representative locations along the waterway for the alternatives that are not recommended and are provided for informational purposes only.

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

Table 3.4.13.A provides a comparison of peak flow and stage for existing and proposed conditions for the Albany Park Flood Wall alternative.

TABLE 3.4.13.A
Recommended Alternative MS-10 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		MS-10	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Mainstem crossing at Edgebrook cart path	27788	605.41	3639	605.52	3623
Mainstem crossing at Edgebrook cart path	26955	605.24	3637	605.36	3622
Mainstem crossing at Central Avenue	23231	604.47	3803	604.64	3782
Mainstem crossing at the Soo-Line RR	20413	603.79	3796	604.00	3777
Mainstem crossing at Forest Glen Avenue	16129	602.61	3791	602.87	3773
Mainstem crossing at I-94	15202	601.74	3815	602.03	3796
Mainstem crossing at Cicero Avenue	14902	601.35	3846	601.66	3827
Mainstem crossing at LaBagh Woods	11312	600.76	3845	601.14	3826
Mainstem crossing at Foster Avenue	8385	599.78	3844	600.30	3826
Mainstem crossing at Pulaski Road	7647	598.86	3896	599.59	3877
Mainstem crossing at Foster Avenue	7278	598.07	3895	599.04	3877
Mainstem crossing at Foster Avenue	6268	597.18	3895	598.43	3880
Mainstem crossing at Ridgeway Avenue	5542	597.14	3895	598.08	3880
Mainstem crossing at Carmen Avenue	4855	596.83	3895	597.66	3880
Mainstem crossing at Central Park Avenue	4448	596.45	3895	597.31	3880

Mainstem crossing at Bernard Street	3322	595.54	3895	595.77	3880
Mainstem crossing at Kimball Avenue	2961	595.02	3895	594.98	3880
Mainstem crossing at Spaulding Avenue	2066	594.26	3895	594.23	3880
Mainstem crossing at Kedzie Avenue	1254	591.75	3895	591.69	3880
Mainstem crossing at Albany Avenue	541	589.73	3715	589.72	3688

Table 3.4.13.B provides a comparison of peak flow and stage for existing and proposed conditions for the Wilmette Golf Course plus channel modification alternative.

TABLE 3.4.13.B
Recommended Alternative MS-14 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		MS-14	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
West Ditch of the Skokie River @ Tower Road	WD 9339	625.72	82	625.72	82
East Ditch of the Skokie River @ Forest Way (1)	ED 13447	624.61	39	623.48	41
East Ditch of the Skokie River @ Tower Road	ED 7000	624.59	39	623.44	42
East Ditch of Skokie River @ Forest Way (2)	ED 500	624.58	36	623.42	39
Skokie River crossing at Willow Road	SK 9266	624.57	746	623.41	1000
Skokie River crossing at Winnetka Road	SK 6467	624.46	840	623.14	1088
Skokie River crossing at I-94	SK 3768	624.33	961	622.87	1069
Skokie River crossing at Happ Road	SK 1618	624.25	953	622.75	1042
Middle Fork crossing at New Willow Road	MF 5932	626.71	1176	626.67	1178
Middle Fork crossing at Winnetka Road	MF 2887	624.40	1091	624.02	1217
West Fork crossing at Long Valley Road	WF 6664	623.06	1588	622.90	1596
West Fork crossing at Golf Road	WF 1977	622.23	1587	621.95	1592
Mainstem crossing at Lake Avenue	MS 77565	623.69	1976	622.00	1882
Mainstem crossing at Golf Road	MS 65959	621.77	1625	621.07	1312
Mainstem crossing at Dempster Street	MS 57266	620.60	3333	620.21	3107
Mainstem crossing at Howard Street	MS 46884	616.92	3544	616.68	3388
Mainstem crossing at Devon Avenue	MS 31366	606.61	3680	606.41	3593
Mainstem crossing at Central Avenue	MS 23231	604.47	3803	604.11	3658
Mainstem crossing at I-94	MS 15202	601.74	3815	601.46	3672
Mainstem crossing at Pulaski Road	MS 7647	598.86	3896	598.54	3764
Mainstem crossing at Central Park Avenue	MS 4448	596.45	3895	596.15	3766
Mainstem crossing at Kedzie Avenue	MS 1254	591.75	3895	591.28	3765

Table 3.4.13.C provides a comparison of peak flow and stage for existing and proposed conditions for the Foster Avenue Tunnel Diversion.

TABLE 3.4.13.C
Non-Recommended Alternative MS-07 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		MS-07	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Mainstem crossing at Foster Avenue	6268	597.18	3895	593.71	1888
Mainstem crossing at Ridgeway Avenue	5542	597.14	3895	593.62	1888
Mainstem crossing at Carmen Avenue	4855	596.83	3895	593.06	1888
Mainstem crossing at Central Park Avenue	4448	596.45	3895	592.72	1888
Mainstem crossing at Bernard Street	3322	595.54	3895	591.89	1768
Mainstem crossing at Kimball Avenue	2961	595.02	3895	591.63	1766
Mainstem crossing at Spaulding Avenue	2066	594.26	3895	590.76	1760
Mainstem crossing at Kedzie Avenue	1254	591.75	3895	589.72	1760
Mainstem crossing at Albany Avenue	541	589.73	3715	589.29	1762

Table 3.4.13.D provides a comparison of peak flow and stage for existing and proposed conditions for the Wilmette Golf Course Reservoir.

TABLE 3.4.13.D
Non-Recommended Alternative MS-12 Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		MS-12	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
West Ditch of the Skokie River @ Tower Road	WD 9339	625.72	82	625.72	82
East Ditch of the Skokie River @ Forest Way (1)	ED 13447	624.61	39	623.89	39
East Ditch of the Skokie River @ Tower Road	ED 7000	624.59	39	623.86	39
East Ditch of Skokie River @ Forest Way (2)	ED 500	624.58	36	623.85	35
Skokie River crossing at Willow Road	SK 9266	624.57	746	623.84	684
Skokie River crossing at Winnetka Road	SK 6467	624.46	840	623.73	766
Skokie River crossing at I-94	SK 3768	624.33	961	623.60	872
Skokie River crossing at Happ Road	SK 1618	624.25	953	623.54	872
Middle Fork crossing at New Willow Road	MF 5932	626.71	1176	626.68	1179
Middle Fork crossing at Winnetka Road	MF 2887	624.40	1091	624.04	1162

West Fork crossing at Long Valley Road	WF 6664	623.06	1588	622.79	1601
West Fork crossing at Golf Road	WF 1977	622.23	1587	621.76	1594
Mainstem crossing at Lake Avenue	MS 77565	623.69	1976	622.91	1734
Mainstem crossing at Golf Road	MS 65959	621.77	1625	620.92	1138
Mainstem crossing at Dempster Street	MS 57266	620.60	3333	619.98	2980
Mainstem crossing at Howard Street	MS 46884	616.92	3544	616.54	3294
Mainstem crossing at Devon Avenue	MS 31366	606.61	3680	606.32	3541
Mainstem crossing at Central Avenue	MS 23231	604.47	3803	603.91	3577
Mainstem crossing at I-94	MS 15202	601.74	3815	601.31	3590
Mainstem crossing at Pulaski Road	MS 7647	598.86	3896	598.37	3690
Mainstem crossing at Central Park Avenue	MS 4448	596.45	3895	596.01	3693
Mainstem crossing at Kedzie Avenue	MS 1254	591.75	3895	591.03	3692

3.4.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for alternatives studied in detail. Table 3.4.14 lists the alternatives analyzed in detail; however, only alternatives MS-10 and MS-14 are recommended and the other alternatives are provided for informational purposes only. Figures 3.4.2a, 3.4.2b, 3.4.3a, and 3.4.3b show a comparison of existing conditions to alternative conditions 100 year inundation mapping with the implementation of alternatives MS-10, MS-07, MS-14, and MS-12, respectively.

TABLE 3.4.14
Mainstem Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Communities Involved
MS-07	Construct 18 ft diameter tunnel diversion from Foster Rd and Pulaski Rd to Foster Rd and the North Shore Channel	0.47	25,920,000	55,702,000	336	No Impact	No	Chicago
MS-10[1]	Construct floodwall through Albany Park Neighborhood	1.51	24,746,000	16,402,000	329	No Impact	Yes	Chicago
MS-12	Construct new reservoir at Wilmette Public Golf Course	0.24	53,239,000	223,725,000	765	Slightly Positive	No	Chicago, Niles, Morton Grove, Golf, Glenview, Wilmette, Northfield, Unincorporated Cook County, Winnetka
MS-14[2]	Construct new reservoir at Wilmette Public Golf Course along with channel widening from Middle Fork to West Fork	0.25	64,431,000	260,121,000	1,153	Slightly Positive	Yes	Chicago, Niles, Morton Grove, Golf, Glenview, Wilmette, Northfield, Unincorporated Cook County, Winnetka

1 - The City of Chicago has expressed a preference for Alternative MS-07, which is described in Section 3.4.3.5. Alternative MS-10 yields a higher B/C ratio and was therefore selected as the recommended alternative for the DWP. The City of Chicago supports Alternative MS-07 in lieu of Alternative MS-10 because the tunnel would reduce flooding without buyouts, relocations, or construction of a wall through the Albany Park neighborhood.
2 - MS-14 project's total benefits includes benefits to the Middle Fork, Skokie River, and Main Stem NBCR subwatersheds. FPDCC and Wilmette Park District have indicated their unwillingness to provide land for this alternative.

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3.5 North Shore Channel

The NSC, a constructed tributary in the NBCR watershed, enters the Main Stem of the NBCR near Albany Avenue in Chicago, has a stream length of 7.7 miles and a drainage area of 25 square miles. Table 3.5.1 summarizes the land area of communities within the NSC subwatershed. The NSC subwatershed consists primarily of residential areas. Table 3.5.2 summarizes the land use distribution within the NSC.

Figure 3.5.1 shows an overview of the tributary area of the NSC subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.5.1
Communities Draining to the North Shore Channel

Community/Tributary	Tributary Area (mi^2)
Skokie	8.68
Chicago	7.11
Evanston	4.91
Lincolnwood	2.68
Wilmette	1.32
Niles	0.28
Morton Grove	0.03

TABLE 3.5.2
Land Use Distribution for the North Shore Channel

Land Use Category	Area (acres)	%
Residential	10,150	63.0
Commercial/Industrial	2,688	16.7
Forest/Open Land	1,741	10.8
Institutional	870	5.4
Transportation/Utility	563	3.5
Water/Wetland	83	0.5
Agricultural	13	0.1

3.5.1 Sources of Data

3.5.1.1 Previous Studies

The NSC was modeled in HEC-RAS by the USACE as part of their larger CAWS model. This model was utilized as part of the NBCR DWP development.

3.5.1.2 Water Quality Data

The IEPA has seven Ambient Water Quality Monitoring Network sites on the NSC. Two reaches of the NSC are identified as impaired in the IEPA's 2008 Integrated Water Quality Report, which includes the CWA 303(d) and 305(b). The NSC reach IL_HCCA-02 is listed as impaired for Nickel, Dissolved Oxygen, Phosphorous (Total), Zinc, Polychlorinated biphenyls, and Fecal Coliform. NSC reach IL_HCCA-04 is listed as impaired for Mercury and Polychlorinated biphenyls. No TMDLs have been established for the North Shore Channel. According to a water permit discharge query by the),USEPA, there are six NPDES permits issued by IEPA to MWRDGC-North Side WWTP in Skokie, Evanston CSOs, Lincolnwood CSOs, Niles CSOs, Wilmette CSOs, and Chicago CSOs for discharges to the NSC. Municipalities discharging to the NSC are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was instituted to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.5.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the NBCR Watershed. Wetland areas were identified using NWI mapping. NWI data includes approximately 83 acres of wetland areas in the NSC 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.

3.5.1.4 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 in the revised floodplains. The NSC is mapped as a FEMA Zone A floodplain, determined by approximate methods; therefore, no documented effective FIS H&H analysis was performed on the North Shore Channel.

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

3.5.1.5 Stormwater Problem Data

Table 3.5.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.5.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.5.1.6 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. Several studies are currently underway in the NSC Subwatershed; however, no near-term planned flood control projects by others have been identified in the NSC subwatershed.

TABLE 3.5.3
Community Response Data for the North Shore Channel

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FL-41	City of Chicago	Intracommunity (local) flooding	Interstate Route 94 at Peterson/Caldwell Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-42	City of Chicago	Intracommunity (local) flooding	Interstate Route 94 at US Route 14	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-43	City of Chicago	Intracommunity (local) flooding	Devon Avenue at 2750 Devon Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
EV-FL-02	City of Evanston	Intracommunity (local) flooding	Various locations in Evanston	Map of the pavement flooding for the September 2008 storm.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
EV-FL-03	City of Evanston	Intracommunity (local) flooding	Various locations in Evanston	Map of the basement flooding for the September 2008 storm.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
LW-FL-01	Village of Lincolnwood	Intracommunity (local) flooding	Various locations throughout the Village of Lincolnwood	Basement flooding/ponding/water quality pollution. Sewer/floor drain back ups, street flooding, overland flooding entering through window wells, etc. Insufficient capacity of combined sewer system.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.5.3
Community Response Data for the North Shore Channel

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
LW-FL-02	Village of Lincolnwood	Intracommunity (local) flooding	Interstate Route 94 (Edens) at Pratt Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
LW-FL-03	Village of Lincolnwood	Intracommunity (local) flooding	US Route 41 at Crawford Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
LW-FL-04	Village of Lincolnwood	Intracommunity (local) flooding	Touhy Avenue at Crawford Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
LW-WQ-05	Village of Lincolnwood	Intracommunity (local) flooding	Village of Lincolnwood	Basement flooding/ponding/water quality pollution. Sewer/floor drain back ups, street flooding, overland flooding entering through window wells, etc. Insufficient capacity of combined sewer system.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-12	Village of Skokie, Village of Lincolnwood	Intracommunity (local) flooding	Interstate Route 94 (Edens) at Touhy Avenue (NB & SB)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-13	Village of Skokie, Village of Lincolnwood	Intracommunity (local) flooding		IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.5.3
Community Response Data for the North Shore Channel

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
SK-FL-14	Village of Skokie, City of Evanston	Intracommunity (local) flooding	McCormick Boulevard at Emerson Street	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
LW-FL-06	City of Chicago, Village of Lincolnwood	Intracommunity (local) flooding	McCormick Boulevard at Devon Avenue (50 ft north)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
EV-FL-04	Village of Skokie, City of Evanston	Intracommunity (local) flooding	McCormick Boulevard at Golf Road (1/4 mile N/O)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
EV-FL-05	City of Evanston	Intracommunity (local) flooding	McCormick Boulevard at Bridge Street (Northwest Corner)	IDOT Pavement flooding	Local	
SK-FL-15	Village of Skokie, City of Evanston	Intracommunity (local) flooding	McCormick Boulevard at Oakton Street (S/O)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-16	Village of Skokie, City of Evanston	Intracommunity (local) flooding	Crawford Avenue at N/O Golf Road	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.5.3
Community Response Data for the North Shore Channel

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
SK-FL-07	Village of Skokie	Intracommunity (local) flooding	US Route 41 at Skokie Swift (S/O Oakton Street)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-08	Village of Skokie	Intracommunity (local) flooding	Church Road at Central Park (construction zone)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-09	Village of Skokie	Intracommunity (local) flooding	Church Street at E/O US Route 41 (Skokie Boulevard)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
SK-FL-10	Village of Skokie	Intracommunity (local) flooding	Skokie	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

[1] All Problem IDs begin with NB-NSCH- as all problems are within the North Branch – North Shore Channel subwatershed.

3.5.2 Watershed Analysis

3.5.2.1 Hydrologic Model Development

The North Shore Channel tributary area was hydrologically modeled by the USACE CAWS model. No DWP hydrologic model was generated for the North Shore Channel subwatershed.

3.5.2.2 Hydraulic Model Development

The North Shore Channel was hydraulically modeled by the USACE CAWS model. No DWP hydraulic model was generated for the North Shore Channel.

3.5.3 Development and Evaluation of Alternatives

There were no regional problem areas reported or identified through the USACE CAWS model of the North Shore Channel; therefore, no alternatives were developed for this subwatershed.

3.6 Mainstem of the NBCR Downstream of the North Branch Dam

The Mainstem of the NBCR downstream of the North Branch Dam (Mainstem Downstream) has a stream length of 9.0 miles and a drainage area of 38.5 square miles. Table 3.6.1 summarizes the land area of communities within the Mainstem Downstream subwatershed. The Mainstem Downstream subwatershed consists primarily of residential and commercial/industrial areas. Table 3.6.2 summarizes the land use distribution within the Mainstem Downstream.

Figure 3.6.1 shows an overview of the tributary area of the Mainstem Downstream subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.6.1
Communities Draining to the Mainstem Downstream

Community/Tributary	Tributary Area (mi^2)
Chicago	37.33
Norridge	0.56
Harwood Heights	0.38
Unincorporated	0.21

TABLE 3.6.2
Land Use Distribution for the Mainstem Downstream

Land Use Category	Area (acres)	%
Residential	15,360	62.4
Commercial/Industrial	5,818	23.6
Forest/Open Land	1,459	5.9
Institutional	1,178	4.8
Transportation/Utility	640	2.6
Water/Wetland	179	0.7
Agricultural	0	0.0

3.6.1 Sources of Data

3.6.1.1 Previous Studies

The Mainstem Downstream was modeled in HEC-RAS by the USACE as part of their larger CAWS model. This model was utilized as part of the NBCR DWP development.

3.6.1.2 Water Quality Data

See DWP Section 3.4.1.2 for water quality data related to the Mainstem downstream of the North Branch Dam.

3.6.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the NBCR Watershed. Wetland areas were identified using NWI mapping. NWI data includes approximately 83 acres of wetland areas in the Mainstem upstream and downstream of the North Branch Dam 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.

3.6.1.4 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 in the revised floodplains. The Mainstem downstream of the North Branch dam is mapped as a FEMA Zone A floodplain, determined by approximate methods; therefore, no documented effective FIS H&H analysis was performed on the Mainstem downstream of the North Branch dam.

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

3.6.1.5 Stormwater Problem Data

Table 3.6.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.6.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.6.1.6 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. Several studies are currently underway in the Mainstem Downstream Subwatershed; however, no near-term planned flood control projects by others have been identified in the Mainstem Downstream Subwatershed.

TABLE 3.6.3
Community Response Data for the Mainstem Downstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FL-01	City of Chicago	Intracommunity (local) flooding	Citywide	Basement flooding, storm water sewer flow restriction. City sewer improvements are often focused towards areas of the most complaints.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-02	City of Chicago	Intracommunity (local) flooding	Illinois Route 19 at Ravenswood Parkway (both sides)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-03	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at California Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-04	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Edens Junction (Montrose to Wilson)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-05	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Addison Street (NWB & SEB)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-06	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Fullerton Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.6.3
Community Response Data for the Mainstem Downstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FL-07	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Ogden Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-08	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Augusta Blvd (Lane 3) NB	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-09	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Illinois Route 50 (Cicero Ave) Lane 3	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-10	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Damen Avenue (Lane 1) NB	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-11	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Division Street	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-12	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Illinois Route 64 (North Ave) Lane 1 NB	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.6.3
Community Response Data for the Mainstem Downstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FL-13	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Diversey Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-14	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Kimball (Exit 4)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-15	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Ashland Avenue (Lane 1) NB	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-16	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Montrose Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-17	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Kostner Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-18	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Logan Boulevard	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.6.3
Community Response Data for the Mainstem Downstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FL-19	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Armitage Avenue (Lane 1) NB	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-20	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Illinois Route 19 (Irving Park Rd) Lane 1 SB	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-21	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Pulaski Road entrance ramp	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-22	City of Chicago	Intracommunity (local) flooding	Interstate Route 90/94 at Willow Street (W/O)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-23	City of Chicago	Intracommunity (local) flooding	Interstate Route 94 (Edens) at Wilson Road (N/O Kennedy)	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-24	City of Chicago	Intracommunity (local) flooding	Illinois Route 43 at Illinois Route 72 (Higgins Rd) Lane 2	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

TABLE 3.6.3
Community Response Data for the Mainstem Downstream

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CH-FL-25	City of Chicago	Intracommunity (local) flooding	Lawrence Avenue at C, M & St. Paul Road (viaduct) W/O I-94	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-26	City of Chicago	Intracommunity (local) flooding	Lawrence Avenue at Milwaukee Avenue	IDOT Pavement Flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
CH-FL-27	City of Chicago	Intracommunity (local) flooding	Citywide	Basement flooding, storm sewer flow restriction, water quality (pollution). The City sewer improvements are often focused towards areas of the most complaints.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

[1] All Problem IDs begin with NB-NBCU- as all problems are within the North Branch – Downstream of the North Branch Dam subwatershed.

3.6.2 Watershed Analysis

3.6.2.1 Hydrologic Model Development

The Mainstem Downstream tributary area was hydrologically modeled by the USACE CAWS model. No DWP hydrologic model was generated for the Mainstem Downstream subwatershed.

3.6.2.2 Hydraulic Model Development

The Mainstem Downstream was hydraulically modeled by the USACE CAWS model. No DWP hydraulic model was generated for the Mainstem Downstream.

3.6.3 Development and Evaluation of Alternatives

There were no regional problem areas reported or identified through the USACE CAWS model of the Mainstem Downstream, so no alternatives were developed for this subwatershed.

3.7 Lake Michigan Watershed

The LM watershed has a series of eight ravines within Cook County, with a total stream length of 5.3 miles and a drainage area of 15.1 square miles. Table 3.7.1 summarizes the land area of communities within the LM watershed. The LM watershed consists primarily of residential areas. Table 3.7.2 summarizes the land use distribution within the Lake Michigan Watershed.

Figures 3.7.1a and 3.7.1b shows an overview of the tributary area of the Lake Michigan Watershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.7.1
Communities Draining to Lake Michigan Watershed

Community/Tributary	Tributary Area (mi^2)
Chicago	7.85
Evanston	2.60
Glencoe	1.82
Winnetka	1.36
Wilmette	0.86
Kenilworth	0.60

TABLE 3.7.2
Land Use Distribution for Lake Michigan Watershed

Land Use Category	Area (acres)	%
Residential	5,907	60.7
Forest/Open Land	1,536	15.8
Commercial/Industrial	1,312	13.5
Institutional	621	6.4
Transportation/Utility	288	3.0
Water/Wetland	64	0.7
Agricultural	0	0.0

3.7.1 Sources of Data

3.7.1.1 Previous Studies

The Lake Michigan Watershed has no known previous studies for use in DWP H&H modeling.

3.7.1.2 Water Quality Data

The IEPA has two Ambient Water Quality Monitoring Network sites for the LM Watershed. Fourteen locations along the shore of LM, including locations in Cook County, are identified as impaired in the IEPA's 2008 Integrated Water Quality Report, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for LM. According to a water permit discharge query by the USEPA, there are six NPDES permits issued by IEPA to Chicago South WTP, Chicago-Jardine Water Plant, McCormick Place West Hall, Metro Pier & Expo Authority, Northwestern University Central Utility Plant, and Winnetka Electric Plant for discharges to LM. Municipalities discharging to LM are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was instituted to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.7.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the NBCR Watershed. Wetland areas were identified using NWI mapping. NWI data includes approximately 64 acres of wetland areas in the Lake Michigan 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.

3.7.1.4 Floodplain Mapping

FIRMs were obtained from FEMA for the northern Cook County portion of the Lake Michigan Watershed. A review of the maps showed that there are no mapped floodplains except for Lake Michigan.

For Lake Michigan, the USACE developed a storm surge-elevation-frequency relationship based on stillwater elevations due to tide and wind setup to determine the Base Flood Elevation (BFE) for the lake. Wave action was not included in the analysis. The BFE, also known as the 100-year annual chance flood elevation, is 585.0 feet, according to the NAVD 88, along the entire shoreline within Cook County.

3.7.1.5 Stormwater Problem Data

Table 3.7.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.7.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.7.1.6 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. Several studies are currently underway in the LM watershed; however, no near-term planned flood control projects by others have been identified in the LM watershed.

TABLE 3.7.3
Community Response Data for the Lake Michigan Watershed

Problem ID[1]	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
EV-SM-01	Village of Evanston	Streambank erosion on intracommunity waterways	Lake Michigan Beachfront	Erosion at outfall at beach - maintenance	Local	Erosion problem not immediately threatening structure. Not addressed by DWP
GC-EL-01	Village of Glencoe	Streambank erosion on intracommunity waterways	Ravines	Erosion in ravines	Local	Erosion problem not immediately threatening structure. Not addressed by DWP
KW-SM-01	Village of Kenilworth	Stream maintenance	Green Bay Road at Metra North Line	48" culvert silted up and deteriorating - no flooding	Local	Maintenance activities recommended in Section 4.
KW-SM-02	Village of Kenilworth	Stream maintenance	Sheridan Road, North of Kenilworth Ave	Concrete pad surrounding MWRD interceptor is cracked and deteriorating	Local	Maintenance activities recommended in Section 4.
WK-ER-01	Village of Winnetka, Glencoe	Streambank erosion on intercommunity waterways	Lake Michigan Waterfront	Bluff erosion	Regional	Erosion problem not immediately threatening structure. Not addressed by DWP
WK-EL-03	Village of Winnetka	Streambank erosion on intracommunity waterways	Ravines	General streambank erosion	Local	Erosion problem not immediately threatening structure. Not addressed by DWP

[1] All Problem IDs begin with LM- as all problems are within the Lake Michigan watershed.

3.7.2 Watershed Analysis

3.7.2.1 Hydrologic Model Development

Subbasin Delineation. The Lake Michigan ravine subbasins were delineated based upon LiDAR topographic data developed by Cook County in 2003. Table 3.7.4 below displays the results of the subbasin delineations. Based MWRDGC's CCSMP requirement that H&H modeling be performed for all subbasins greater than 0.5 square miles in area and the results from Table 3.7.3, Ravine 1 was the only reach modeled in the Lake Michigan Watershed.

TABLE 3.7.4
Lake Michigan Ravine Subbasin Areas within Cook County

Ravine Number	Area, acres (mi^2)
1	415 (0.648)
2	150 (0.234)
3	28 (0.044)
4	175 (0.273)
5	194 (0.303)
6	31 (0.048)
7	44 (0.069)
8	185 (0.289)[1]

[1] Tributary area of Ravine #8 within Cook County.

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. Using SCS unit hydrograph methodology, 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 sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.7.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Cross-sectional geometry of Ravine #1 was obtained solely from Cook County topographic data. 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 coefficients along the modeled stream length.

Initial attempts to model Ravine 1 were performed using unsteady state analysis. After setting up the HEC-RAS model geometry and several attempts to execute the model, it became apparent that unsteady state analysis would not be feasible for this ravine. Ravine 1 has steep slopes combined with low Manning's n values, which results in high velocity, super critical flow. The HEC-RAS unsteady state analysis does not execute under supercritical conditions. Therefore, modeling analysis was successfully performed using the HEC-RAS steady state analysis with a supercritical flow regime specified.

Boundary Conditions. The downstream boundary condition for Ravine 1 is its outfall at Lake Michigan. The maximum existing conditions 100 year WSEL at this outfall is approximately 585.0 feet in vertical elevation datum NAVD 88.

3.7.2.3 Calibration and Verification

Lake Michigan Ravine 1 does not have stream gages to monitor flow and stage along the ravine and historical high water elevations were not available; therefore, this hydraulic model was unable to be calibrated and verified.

3.7.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.7.1a shows inundation areas produced by the hydraulic model for the 100-year, 24-hour duration design storm for Ravine 1.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in Lake Michigan Ravine 1. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.7.3 Development and Evaluation of Alternatives

The one regional erosion problem reported for the Lake Michigan watershed, bluff erosion along the Lake Michigan waterfront, was investigated. No active bluff erosion was identified within 30 feet of existing infrastructure; therefore, no regional erosion stabilization project was recommended as part of this DWP.

No additional regional flood control problem areas were reported or identified through modeling of Lake Michigan Ravine 1; therefore, no flood control alternatives were developed for this watershed.