Upper Des Plaines River and Tributaries

Integrated Feasibility Report and Environmental Assessment

Appendix E – Economic Analysis

August 2013 (DRAFT)

Study Partnership

Illinois Department of Natural Resources (IDNR)
Southeastern Wisconsin Regional Planning Commission (SEWRPC)
Lake County Stormwater Management Commission (LCSMC)
Lake County Forest Preserve District (LCFPD)
Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)
Cook County Highway Department (CCHD)
Forest Preserve District of Cook County (FPDCC)
U.S. Fish and Wildlife Service (USFWS)
U.S. Army Corps of Engineers (USACE)

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Chicago District

Upper Des Plaines River and Tributaries
Illinois & Wisconsin
Integrated Feasibility Report and Environmental Assessment

Appendix E – Economic Analysis

December 2012

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UPPER DES PLAINES RIVER FEASIBLITY PHASE II STUDY

APPENDIX E – ECONOMICS

CHAPTER 1 – DEMOGRAPHICS

The major portion of the project study area lies within the Chicago metropolitan area and has moderate to high housing values and income levels, a diverse ethnic demographic composition that is predominately Caucasian, and contains good recreational facilities. Current and projected population data for 43 primary communities located within the study area is shown in Table 1.2. The five largest communities affected by overbank flooding as of 2010 are Arlington Heights (75,101), Des Plaines (58,364), Mount Prospect (54,167), Park Ridge (37,480), and Gurnee (31,295).The most densely populated areas are located in Cook County. Municipalities that lie in or intersect the watershed have a total estimated 2010 population of approximately 500,000. Municipalities in Lake County that lie in or intersect the watershed have an estimated 2010 population of approximately 350,000. Municipalities in Kenosha and Racine Counties that lie in or intersect the watershed have an estimated 2010 population of over 100,000. However, recent population growth has been greatest in Kenosha and Racine Counties (11.4%) as compared to Lake County (3.2%) and Cook County (-1.3%) from 2000 to 2010. These trends are projected to continue to at least 2020.

Median housing values and household incomes for the project study area were moderate to high. In Kenosha and Racine Counties, these values ranged from $108,000 (Kenosha) to $159,800 (Pleasant Prairie) for housing and $41,902 (Kenosha) to $62,856 (Pleasant Prairie) for median household income. For Lake County, these values ranged from $118,200 (Waukegan) to $823,300 (Mettawa) for housing and $42,335 (Waukegan) to $158,990 (Riverwoods) for median household income. For Cook County the median housing values ranged from $105,400 (Maywood) to $386,600 (River Forest) and median household income from $40,050 (River Grove) to $89,284 (River Forest).

Much of the land adjacent to the upper Des Plaines River in Illinois is owned by the Lake and Cook County Forest Preserve Districts. These lands are maintained principally as plant and wildlife preserves. As such they provide major aesthetic, picnicking, hiking, and other recreational opportunities to communities within the project area. Adjacent lands along the many tributaries to the Des Plaines River have varied land uses including recreational, residential, commercial and agricultural areas.

State	County	Municipality	2000 Population[1]	2010 Population[2]	% Change 2000-2010	2020 Population[3]	% Change 2010-2020
WI	Racine	Union Grove Village	4,322	4,915	13.72%	5,410	25.17%
	Kenosha	Kenosha City	90,352	99,218	9.81%	106,837	18.25%
		Paddock Lake Village	3,012	2,992	-0.66%	3,708	23.11%
		Pleasant Prairie Village	16,136	19,719	22.21%	20,215	25.28%
IL	Lake	Gurnee Village	28,834	31,295	8.54%	33,472	16.09%
		Hawthorn Woods Village	6,002	7,663	27.67%	12,635	110.51%
		Libertyville Village	20,742	20,315	-2.06%	21,293	2.66%
		Lincolnshire Village	6,108	7,275	19.11%	9,004	47.41%
		Long Grove Village	6,735	8,043	19.42%	9,476	40.70%
		Mettawa Village	367	547	49.05%	1,073	192.37%
		Mundelein Village	30,935	31,064	0.42%	33,062	6.88%
		Old Mill Creek Village	251	178	-29.08%	3,575	1324.30%
		Riverwoods Village	3,843	3,660	-4.76%	3,935	2.39%
		Vernon Hills Village	20,120	25,113	24.82%	23,312	15.86%
		Wadsworth Village	3,083	3,815	23.74%	5,730	85.86%
		Waukegan City	87,901	89,078	1.34%	91,110	3.65%
	Cook/Lake	Arlington Heights Village	76,031	75,101	-1.22%	80,304	5.62%
		Barrington Village	10,168	10,327	1.56%	10,342	1.71%
		Buffalo Grove Village	42,909	41,496	-3.29%	44,475	3.65%
		Deer Park Village	3,102	3,200	3.16%	3,598	15.99%
		Deerfield Village	18,420	18,225	-1.06%	19,734	7.13%
		Wheeling Village	34,496	37,648	9.14%	39,376	14.15%
	Cook	Bellwood Village	20,535	19,071	-7.13%	21,064	2.58%
		Des Plaines City	58,720	58,364	-0.61%	59,802	1.84%
		Elmwood Park Village	25,405	24,883	-2.05%	25,854	1.77%
		Forest Park Village	15,688	14,167	-9.70%	15,720	0.20%
		Franklin Park Village	19,434	18,333	-5.67%	19,860	2.19%
		Lyons Village	10,255	10,729	4.62%	10,777	5.09%
		Maywood Village	26,987	24,090	-10.73%	26,122	-3.21%
		Melrose Park Village	23,171	25,411	9.67%	22,486	-2.96%
		Mount Prospect Village	56,265	54,167	-3.73%	57,454	2.11%
		Niles Village	30,068	29,803	-0.88%	31,943	6.24%
		Norridge Village	14,582	14,572	-0.07%	14,450	-0.91%
		North Riverside Village	6,688	6,672	-0.24%	7,014	4.87%
		Northlake City	11,878	12,323	3.75%	11,260	-5.20%
		Park Ridge City	37,775	37,480	-0.78%	37,005	-2.04%
		Prospect Heights City	17,081	16,256	-4.83%	16,426	-3.83%
		River Forest Village	11,635	11,172	-3.98%	11,632	-0.03%
		River Grove Village	10,668	10,227	-4.13%	10,838	1.59%
		Riverside Village	8,895	8,875	-0.22%	9,190	3.32%
		Rosemont Village	4,224	4,202	-0.52%	4,111	-2.68%
		Schiller Park Village	11,850	11,793	-0.48%	11,669	-1.53%
		Stone Park Village	5,127	4,946	-3.53%	4,611	-10.06%
WI	Racine & Kenosha County Totals		113,822	126,844	11.44%	136,170	19.63%
IL	Lake County Totals		344,029	354,970	3.18%	382,798	11.27%
	Cook County Totals		482,949	476,609	-1.31%	491,996	1.87%

1 - U.S. Census Bureau 2000
2 - https://www.census.gov/popest/data/cities/totals/2011/index.html
3 - Northeastern Illinois Planning Commission endorsed 2030 forecasts interpolated down to 2020 and Southeastern Wisconsin Regional Planning Commission endorsed 2020 forecasts

Table 1.2 – Population Trends in Upper Des Plaines River Watershed Communities

CHAPTER 2 – ECONOMIC METHODOLOGIES

A primary objective in conducting an economic assessment for flood damage reduction studies is to determine equivalent annual damages (EAD) along river reaches in the study area, taking into account all possible flood scenarios. This EAD value can be used compare changes in the damage resulting from various alternative plans over the study period. These estimates take into account all possible storm events that might occur, from very frequent to very infrequent and use interrelated hydrologic, hydraulic, geotechnical and economic information in the analysis. Specifically, EAD is determined by combining baseline and future condition discharge-frequency, stage-discharge (or stage-frequency), and stage-damage functions and integrating the resulting damage-frequency function. This value is then annualized over the study's period of analysis at the current federal discount rate. Uncertainties are present for each of these functions and are factored into the computations.

Although this Phase II Study is related to the Phase I Study, there are major differences between the two. The Phase II study has added ecosystem restoration as a main objective. Additionally, the Phase II Study will look at damages along the tributaries in addition to a reevaluation of the mainstem Des Plaines River. Also, Federal (Corps) planning guidance and computer analysis tools continue to evolve and the current analyses conducted reflect these changes.

The two major flood damage assessment models to be used in this Phase II study evaluations are the Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) and the Visual Interactive System for Transportation Algorithms (VISTA) for transportation impacts. The analysis of transportation impacts was substantially improved from the spreadsheet model used in the Phase I Study by incorporating a state of the art dynamic computer simulation model of traffic flows. Geographic Information Systems (GIS) were also used in the economic analysis for this study. Using GIS, structure inventories within the floodplain and information from public records on parcel improvements were relied upon where physical structure inventories are lacking.

2.1 Summary of Previous Analyses

The Phase I Study was approved in November 1999. This study focused primarily on flooding problems along the mainstem of the Upper Des Plaines River and authorized the implementation of six projects to reduce main stem flooding. A Limited Reevaluation Report (LRR) updating costs and benefits associated with Phase I projects was completed and approved in June 2007. The LRR provided current estimates of project benefits, construction costs, real estate requirement values, and economic justification for the authorized project.

The Phase I Study formulated and evaluated several potential sites for Flood Risk Management (FRM) that were either not implementable due to land availability issues or did not result in positive net benefits. Project benefits were evaluated only on the mainstem of the upper Des Plaines River and showed that the creation of additional flood storage is critical to reducing damages along the mainstem upper Des Plaines

River. This Phase II Study builds on the data collected for the Phase I Study in considering FRM sites located within tributary watersheds and along the mainstem.

The economic analysis of the Phase I Study indicated a need to not only focus on traditional structural damages but also on damages associated with the flood-induced delays in the study area transportation network. Table 2.1 shows a breakdown of equivalent annual benefits associated with the six authorized projects as calculated for the 2007 LRR (2006 price levels, 4.875%). Benefits associated with structures (residential, apartments, commercial, industrial and public categories) account for about half of the total and those associated with transportation (flood induced delays, road repair, and repair induced delays) account for the remainder.

Damage Category	Annual Benefits	Percent of Total
Residential	$ 1,209,000	13%
Apartment and Townhomes	$ 2,019, 000	22%
Commercial, Industrial, Public	$ 1,286,000	14%
Road Repair Cost	$ 548,000	6%
Flood Induced Road Delays	$ 1,330,000	14%
Delays Due to Road Repair	$ 2,515,000	27%
Emergency and Floodfighting Costs	$ 270,000	3%
FIA Cost Reduction	$ 25,000	0.3%
Total Annual Benefits	$ 9,203,000	100%

Table 2.1 – Phase I Study 2007 LRR Annualized Benefits by Damage Category October 2006 Price Levels at a Federal Discount Rate of 4.875%

2.2 HEC-FDA Model Development

Economic flood damages to structures were calculated using the Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) computer program. Over the course of the study, the model has been updated. Results reported here were generated by version 1.2.5.a. HEC-FDA is designed to use risk-based analysis methods for flood risk management studies. Risk and uncertainty input to the model were developed as outlined in Corps Engineering Manual (EM) 1110-2-1419 (Hydrologic Engineering Requirements for Flood Damage Reduction Studies) and EM1110-2-1619 (Risk-Based Analysis for Flood Damage Reduction Studies) and Engineering Regulation (ER) 1105-2-101 (Planning – Risk Analysis for Flood Damage Reduction Studies). Development of Hydrologic and Hydraulic data was developed jointly by the Chicago District and the study partners. Details of this data development are provided in Appendix A (Hydrology & Hydraulics). The following section documents development of structure inventory and economic data used in the HEC-FDA models.

2.2.1 Scope of Study and Data Sets

Prior to the development of any modeling the scope of the project was developed along with an inventory of existing data and needs for new data. The scope of the modeling defines the spatial and temporal limits of the study. The spatial limit was defined by determining the locations of structures within known floodplain limits. The study is

limited to 15 tributary models and the Des Plaines River mainstem. Individual HEC-FDA models were developed for each basin in Illinois. Basins in Wisconsin were modeled separately. The temporal limit was defined according to the baseline and future conditions selected in the hydrologic and hydraulic (H&H) models. At the time the H&H models were being developed, 2002 to 2005, the base year was set to year 2010 to correspond to the probable completion of all Phase I Study authorized projects. Most likely future conditions were set to 2020 based on availability of projected land use data.

The scope of spatial data required was determined through an analysis the 0.01 (1/100) annual exceedance probability (AEP) floodplain as delineated by FEMA's GIS Q3 or DFIRM data. Since the FEMA Q3 and DFIRM data were developed as a tool for the National Flood Insurance Program and not for the intended purpose of this study, a 250 ft buffer was added to acquire outlier structures during the inventory process. In theory this should capture any structures included in the 0.002 (1/500) AEP floodplain.

Economic data for this study are comprised two types of information: 1. identification and cataloging of potentially damaged goods and services; 2. creating and relating engineering data in order to monetize damages to those goods and services.

The first task was to collect/identify those goods and services that could be damaged. Collectively these have been differentiated as structural damages or transportation damages. This differentiation is based on the method of identifying the goods and services and the method used to relate monetary damages to river stages. Table 2.2 presents the damage categories used in this study. Six of the seven categories of damages have been grouped as structural damages. Structural damages relate to some fixed item or property that is damaged by flood waters.

Type	Damage Category	Description
STRUCTURAL	APT	Multi-unit residential structures
	COM	Commercial structures
	IND	Industrial structures
	PUB	Tax-exempt structures in public ownership
	RES	Single-family residential structures
	AUTO	Parked or abandoned vehicles
TRANSPORTATION	TRAFFIC	Flood induced traffic delay and detour damages

Table 2.2 – HEC-FDA Damage Categories

Two categories used in the Phase I Study were eliminated from consideration: Road repairs and transportation delays due to road repairs. As will be discussed in Section 2.2.3, several transportation agencies within the study area revealed that monetary

damages for these categories would be minimal as they are of short duration and occur at low annual exceedance probabilities.

2.2.2 Engineering Data

Structure Elevation Inventory

Developing the structure inventory was a multiple step process. The first step was to identify potentially flooded structures and determine the first floor elevation and low water entry point. Then a depreciated replacement value and a depth-damage function were determined for each structure as discussed in Section 2.2.3.

Structure data from prior studies conducted by USACE and study partners were used wherever possible. Indentified structures not part of existing data sets were surveyed by a land survey crew to obtain the first floor elevation, low water entry elevation, and the lowest adjacent ground elevation. New structure surveys utilized the new survey datum of NAVD while the prior (existing) structure data is on NGVD datum. The datum used for structure datasets in the HEC-FDA models for each tributary and the mainstem was selected to correspond with the datum used by the hydraulic model, with conversions between the datum conducted where appropriate.

If a structure was found subsequent to the elevation survey or would be damaged by only the 0.002 (1/500) AEP event and was not captured within the 250 ft buffer, the required elevation data were obtained from available LiDAR (Light Detection And Ranging) data. LiDAR data collected for this study has a vertical accuracy of approximately 1 ft +/- 1 foot. This degree of accuracy provides a relative estimate of the ground elevation at the structure. LiDAR data is reported with a degree of accuracy for the horizontal and vertical directions for the entire map. This degree of accuracy is not meant to apply specifically to every point on the map but as an overall degree of accuracy of all points sampled. Raw LiDAR data includes structures; a “bare earth” LiDAR model is developed by post-processing the raw data to remove trees and structures. A generalization of the relationship between the LiDAR surface relative to a structure’s first floor, lowest adjacent ground elevation, and the lowest point of entry elevation was developed based on an analysis of the structure survey data, sorted by HEC-FDA occupancy code. The details and results of this analysis are included in Attachment 5.

Stationing and Bank Parameterization

In order to populate the basic structure inventory parameters for stationing and bank designation, the study used GIS to obtain this information from parcel location. GIS was also used to determine assumed vehicle locations with respect to the structures they are associated with and flooded road crossing locations. To create this information a stream alignment was created for each of the models in GIS. Points were created that best represented a parcel, flooded crossing, or vehicle damage area. Using the Linear Referencing method in the ESRI toolbox, a station number was allocated to each of the potentially damaged entities. Stationing was checked and bank designations were assigned by hand in GIS.

2.2.3 Economic Data

Structure Damages

Two methods were utilized to determine the value of structures in Illinois: residential structure valuations were determined through a random sample of tax assessor data, non-residential structure valuations were determined by directly surveying each of those structures. The parcel population for the structure inventory valuation study was created by extracting parcels predominately in the floodplain. Non-residential structures were extracted from this subset to arrive at the residential parcel population for this study. A random sample of 10 percent of all residential structures was created and provided to the contractor, URS Corporation, along with a list of all non-residential structures for individual analysis. Structure valuation was conducted with the USACE GeoFIT program which integrates GIS and Microsoft Access software to compile the data necessary to compute a depreciated replacement value via the Marshall and Swift (M&S) method. Once all the data is loaded into GeoFIT, the depreciated replacement values are generated by the M&S Valuation Service software (Residential computations were based on September 2008 and Non-residential computations were based on October 2008 values).

Assessment values for all residential structures in the study area were determined from each county's tax assessment database. Tax assessments are comprised of land and improvement values for each parcel. Since flooding only affects the structure on a property, the depreciated replacement value of the structure is required. Only the assessed improvement values were utilized. Assessed land values are not included in the depreciated replacement values. Assessments in Cook County (2004 data) are calculated at 16% of the fair market value of the property. Lake County assessments (2005 Data) are at 33.3% of the fair market value.

URS developed depreciated replacement values for 232 structures in Cook County and 151 structures in Lake County. Using these random samples from each county, a relationship between the depreciated replacement value and the respective county's land improvement assessment was created. This index was then used for the remainder of the residential inventory rather than estimating depreciated replacement values for each property separately. The median value of this index (Improvement Assessed Value/Depreciated Replacement Value) for the 232 random residential properties evaluated in Cook County is 6.57 or 15.2%. Therefore the depreciated replacement value for residential units in Cook County is 6.57 times the county's assessed land improvement value. The median value of the index for the depreciated replacement value to the assessed land improvement value in Lake County is 1.92 or 52%. It should be noted that these indices are inclusive of the assessment percentage to fair market value utilized by each county. Attachment 1 of this appendix contains a detailed report of the study conducted by URS. There is a slight deviation in the values reported by URS due to the removal of outlier data points. The averaging of the data is sensitive to the extreme outlier data points and professional judgment was used to make that determination.

HEC-FDA also requires the creation of a monetary damage relationship for goods and services relative to flood stages/frequencies. This relationship is expressed as a depth-damage curve, either as a percent of the structure's value or as a "direct dollar" damage. A depth damage curve is a relationship between the estimated damages of an item and the associated flood depth on or at that item. Each structure is assigned two depth damage functions, one for the structure itself and the other for its contents. Generic depth-damage curves for both non-residential and residential structures were applied to a majority of the structures in the study area. Those not fitting the generic depth-damages curves were assigned direct depth-damage curves. Monetary impacts were calculated as a percentage of the depreciated replacement values of these structures using the appropriate damage function.

The two sets of generic depth-damage functions that were used in the economic analysis of this study were for residential structures as outlined in EGM 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements, and draft non-residential as developed by IWR-USACE and FEMA (Solicitation of Expert Opinion Depth-Damage Function Calculations for the Benefit Cost Analysis Tool, DRAFT, October 2008). Content values associated with residential depth-damage functions were developed as outlined in EGM 04-01. Content values associated with non-residential depth-damage functions were developed by IWR concurrent with the development of the non-residential depth damage curves. The non-residential curves, developed by expert elicitation, account for the potential variability in contents.

Structures classified as requiring their own depth-damage function were individually surveyed by URS. A typical example of a structure not fitting a non-residential generic depth-damage curve is a large manufacturing facility or hospital complex. These structures had the necessary depth-damage relationships developed through an approved Office of Management and Budget (OMB) survey. This survey was conducted as part of the structure value survey conducted by URS, as detailed in Attachment 1.

Depth-damage functions are assigned according to Occupancy Type. All occupancy types and categories used for the purpose of estimating damages in this Study are presented in Table 2.3.

Category	Occupancy Type ID	Occupancy Description
Apartment	APT_P	Apartment/Condo (pre-engineered)
	APT_E	Apartment/Condo (engineered)
Commercial	CLOTH_E	Clothing Store (engineered)
	CLOTH_P	Clothing Store (pre-engineered)
	CONV_E	Convenience Store (engineered)
	CONV_P	Convenience Store (pre-engineered)
	ELEC_E	Electronics Retailer (engineered)
	ELEC_P	Electronics Retailer (pre-engineered)
	FFR_E	Fast Food Restaurant (engineered)
	FFR_P	Fast Food Restaurant (pre-engineered)
	FURN_E	Furniture Store (engineered)

	FURN_P	Furniture Store (pre-engineered)
	GROC_E	Grocery Store (engineered)
	GROC_P	Grocery Store (pre-engineered)
	HOSP_E	Hospital (engineered)
	HOSP_P	Hospital (pre-engineered)
	HTL_E	Hotel (engineered)
	HTL_P	Hotel (pre-engineered)
	MED_E	Medical Office (engineered)
	MED_P	Medical Office (pre-engineered)
	OFF_E	Office Building - One Story (engineered)
	OFF_P	Office Building - One Story (pre-engineered)
	REST_E	Restaurant (engineered)
	REST_P	Restaurant (pre-engineered)
	SERV_E	Service Related Business (engineered)
	SERV_P	Service Related Business (pre-engineered)
Industrial	LT_E	Light Manufacturing (engineered)
	LT_P	Light Manufacturing (pre-engineered)
	WH_E	Warehouse (engineered)
	WH_P	Warehouse (pre-engineered)
	WHR_E	Warehouse Refrigerated (engineered)
	WHR_P	Warehouse Refrigerated (pre-engineered)
Public	CF_E	Correctional Facility (engineered)
	CF_P	Correctional Facility (pre-engineered)
	PS_E	Protective Services (engineered)
	PS_P	Protective Services (pre-engineered)
	REC_E	Recreational (engineered)
	REC_P	Recreational (pre-engineered)
	RF_E	Religious (engineered)
	RF_P	Religious (pre-engineered)
	SCH_E	School (engineered)
	SCH_P	School (pre-engineered)
Residential	1SNB	One Story No Basement
	1SWB	One Story With Basement
	2SNB	Two Story No Basement
	2SWB	Two Story With Basement
	BLNB	Bi-Level No Basement
	BLWB	Bi-Level With Basement
	TLNB	Tri-Level No Basement
	TLWB	Tri-Level With Basement

Table 2.3 – Occupancy types used in study

Modifications to the generic depth damage functions in EGM 04-01 were made to adjust for inconsistencies in certain depth-damage functions as discussed below. Attachment 2 contains graphs, illustrations, and tables for each of the 8 depth-damage relationships.

- The content depth-damage curve for the one story with basement shows damage at eight (8) feet below the first floor while the structure depth-damage reports zero damage. The content depth-damage curve, for a two or more story structure with

basement, has no damage at eight (8) feet below the first floor. However, that same structure reports structural damage, see the structure depth-damage curve, at eight (8) feet below the first floor. Oddly enough, the structure damage at seven and eight feet below the first floor, for a two or more story structure with basement, report the same level of damage 1.7% . The correction in this instance was to zero out the damages on both sets of depth-damages, structure and content, at eight (8) feet below the first floor.

- The Chicago region has a classification for split level in the Cook County Assessors structure codes, however, the generic split level depth-damage functions do not correspond to the construction of typical buildings classified as split level in the region. Two more specific classifications were created, the Bi-Level and Tri-Level. A Bi-Level structure with basement uses the one story with basement depth-damage function with a vertical offset of four (4) feet, therefore damages would not begin until four (4) feet below the first floor. For the Bi-Level function, zero relates to the front door elevation. Bi-Level structure without basement utilize the two or more story with no basement depth-damage function with a vertical offset of four feet, therefore damages would begin at six (6) feet below the first floor. Tri-Level with Basement utilizes the Split Level with Basement depth-damage function with a correction to the seven (7) and eight (8) foot values of the structure damage percentages. The values are zeroed-out for eight (8) feet below first floor and seven (7) feet below first floor were set to the same values as the two or more stories with basement with a mean damage of 1.7% and a 2.7% standard deviation. Tri-Level with no basement used the Split Level with no basement with a vertical offset of four (4) feet; therefore zero percent damage would be at six (6) feet below the first floor.

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) conducted and concluded an assessment of Wisconsin portion of the study area in June of 2003. There are very few potentially damaged structures in Wisconsin, less than 100 in all of Kenosha County. The June 2003 study evaluated structural and non-structural FRM measures, and found that structural measures were not justified in the Wisconsin portion of the watershed.

This independent assessment did not follow the hydrologic and hydraulic methods used in the Illinois portion of the study. Thus the engineering data was not compatible for use with the HEC-FDA program. The economic assessment in Wisconsin used hard copy data provided to USACE from SEWRPC and used a spreadsheet for calculations rather than HEC-FDA. The inventory of structures in Wisconsin was developed from this spreadsheet. For these structures, the 2009 RS Means Cost Estimating Manual was used to determine the depreciated replacement value based on the information provided. Each structure was reassigned to appropriate generic structure classifications in order to use the depth-damage functions discussed above.

Damages attributed to these structures were delineated by SEWRPC and provided to USACE as depths of flooding above first floor for 2, 5, 25, 50, and 100 year events. To determine the depths of flooding for 1, 10, and 500 year flood events the existing data was fitted to a Log Pearson Type III distribution and the additional data was extrapolated from this function.

Vehicle Damages

Vehicle damages were grouped as a structural damage because while they are not inherently fixed to any one location (i.e. transitory) they are a fixed entity, because they are parked or abandoned during a flood event. In accordance with EGM 09-04, Generic Depth-Damage Relationships for Vehicles, vehicles per residential household were determined using U.S. Census data. A distribution of vehicle types was determined using data from the Illinois Secretary of State website combined with data provided in EGM 09-04. The distribution was then applied to the residential structure inventory. Vehicle values were determined for each type of vehicle (Sedans, Sports Car, SUVs, Mini-Vans and Pickups) at three different value levels: Salvage (assumed to be $2,000), Used (Manheim Used Vehicle Value Index $11,899 in 2008), and New (determined from pricing at Edmunds.com). A triangular probability distribution of the three value levels was applied to create a specific value for each vehicle instance. To account for the fact that per zip code, the reported number of vehicles per household reported by the U.S. Census is not in fact a whole number, such as 2, but rather a number such as 1.74, after all the data has been compiled; a random 26%, in this case, of the instances of a second vehicle would be removed from the data set. Vehicle damage accounts for those vehicles abandoned during the evacuation of the subject area. To account for the 88.1% of vehicles that will be moved out of the flood damage area (as specified in EGM 09-04), after all the data had been compiled a random 88.1% of the vehicle instances were removed from the data set. The depth damage curves specified in Table 3 of EGM 09-04 were used, and are shown in Table 2.4 below.

In Wisconsin, there were few residential structures with which to associate vehicles. Given the assumed evacuation of 88.1% of these vehicles during a flood event, the amount of vehicle damages incurred during a flood event would be very small. As a result, vehicle counts, and therefore vehicle damages, were not calculated for watersheds in Wisconsin.

PERCENT DAMAGE TO VEHICLES										
DEPTH ABOVE GROUND (ft)	SEDANS		PICKUPS		SUVs		SPORTS CAR		MINI VANS	
	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION	% DAMAGE	STANDARD DEVIATION
0.5	7.60%	2.42%	5.20%	3.02%	0.00%	11.28%	1.40%	19.22%	0.00%	9.11%
1	28.00%	1.84%	20.30%	2.53%	13.80%	8.76%	29.20%	16.81%	17.80%	6.82%
2	46.20%	1.51%	34.40%	2.33%	30.60%	6.67%	52.80%	13.17%	38.30%	5.33%
3	62.20%	1.45%	47.50%	2.38%	45.80%	5.24%	72.20%	8.47%	56.80%	4.88%
4	76.00%	1.57%	59.60%	2.57%	59.40%	4.78%	87.40%	3.61%	73.30%	5.34%
5	87.60%	1.74%	70.70%	2.81%	71.40%	5.36%	98.40%	6.12%	87.80%	6.23%
6	97.00%	1.92%	80.80%	3.04%	81.80%	6.61%	100.00%	13.80%	100.00%	7.20%
7	100.00%	2.06%	89.90%	3.21%	90.60%	8.17%	100.00%	13.80%	100.00%	7.20%
8	100.00%	2.06%	98.00%	3.32%	97.80%	9.88%	100.00%	13.80%	100.00%	7.20%
9	100.00%	2.06%	100.00%	3.36%	100.00%	11.70%	100.00%	13.80%	100.00%	7.20%
10	100.00%	2.06%	100.00%	3.36%	100.00%	11.70%	100.00%	13.80%	100.00%	7.20%

Table 2.4 – Vehicle Depth-Damage Relationship

Transportation Damages

The concept of transportation damages is not new to USACE studies. Typical methodology is laid out in Section VII of Institute for Water Resources (IWR) Report 88-R-2, National Economic Development Procedure Manual – Urban Flood Damages. VISTA's ascription of dynamic network damages to specific damage location, however, is new.

Vehicles were broken into two categories for the purpose of this analysis, passenger and commercial vehicles. Damages associated with distance and delay were calculated separately for each category of vehicle as discussed below. Monetary output for the distance value associated with transportation damages was computed using a spreadsheet that detailed the operating cost of automobiles and trucks on a per mile basis[1]. This worksheet examines the cost associated with fuel, maintenance, tires, repairs, and depreciation.

Factors associated with these categories are the costs associated with the percentage of vehicles that are operated on highways, in the city, and under severe congestion as well as the additional cost associated with the condition of the pavement. It was assumed that 50% of the drivers were on Highway and 50% were on city roads. Congestion does not factor into the calculation. Road conditions were assumed to be well managed. A value of 26 cents per mile for passenger vehicles and 65.5 cents per-mile for commercial trucks was determined using an average cost of gas of $2.30 and diesel of $2.17. These average costs were developed by averaging the real price of fuel over 80 years, the period for which data was available. The above pricing was updated to current price levels by indexing from the 2008 Price Level to a 2009 Price Level using the Bureau of Labor Statistics Transportation Consumer Price Index data (CUURA207SAT, CUUSA207SAT) for the Chicago-Gary-Kenosha region.

A sensitivity analysis was conducted to evaluate uncertainty associated with volatile fuel prices. The average cost of fuel from 2000 to 2010 is $3.00 per gallon for gasoline and $2.83 per gallon for diesel. The impact of this increase on total expected annual damages is an increase of less than 1%. The sensitivity of the economic analysis to this parameter, therefore, is low. The time value associated with delays and detours has a much larger influence on the results that the cost of fuel, only associated with detours.

Although it is likely that, during a flood event, some trips will be deferred or demurred, a literature review by the VISTA team found that consistent and comprehensive data on this phenomenon is not available. A discussion of the studies reviewed can be found in Section 3.3.6 of Attachment 3. As a result, trips postponed or canceled during a flood event were not included in the analysis.

For passenger vehicles, monetary output for the time value associated with transportation delays was computed using Table D-4: Value of Time Saved by Trip

[1] Barnes, Gary and Langworthy, Peter. The Per-Mile Costs of Operating Automobiles and Trucks. Minnesota Department of Transportation. 2003.

Length and Purpose in ER 1105-2-100, Planning Guidance Notebook. Determination of the value of time saved was taken from the before-tax family income for trips in the study area. The 2006-2008 American Community Survey Profile for Chicago's primary metropolitan statistical area (inclusive of Cook, Dekalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will Counties) shows a median family income of $73,760 in 2008 dollars. Table 2.6 provides the calculations based in Table D-4. The total value of work time saved per vehicle is multiplied by the number of adults per vehicle. The 2004 report by the US Department of Transportation entitled Summary of Travel Trends – 2001 Nation Household Travel Survey reported 1.14 persons per vehicle.

For commercial vehicles, monetary output for the time value associated with delays was calculated as shown in Table 2.7. For this category, since all trips are assumed to be for work purposes, all trips are given the same weight and the rates are not adjusted according to time grouping.

Since this methodology only produces a gross damage value for the entire network it has limited use in plan formulation. A method is needed to ascribe the overall network damages to pertinent damage sites within the network. The System Impacts-Based Aggregation (SIBA) method was selected, as documented in Attachment 3. The ascription allows USACE to create a direct depth-damage relationship for impacted road crossings.

During the development of the road direct depth-damage relationships it was noticed that damages at some road crossings exhibited a decrease in damage estimates with increasing annual exceedance probability. The standard approach in the HEC-FDA modeling environment allocates a spatially fixed good or service to a point along a flooding source, e.g. house or a parked car, whose damages are independent from all other goods or services. As the flood wave passes this point, the stages/ discharges increase for decreasing frequency of a flood event. This produces an increasing damage relationship as the severity of the flooding increases independent of any other house or parked car. The relationship of increased damages to decreased frequency should be monotonic, i.e. the damages consistently do not decrease with decreasing frequency.

The traffic model developed for this study is a dynamic network analysis that allows investigators the ability to see system impacts of decisions at the scale of an individual driver or road segment. For example, the VISTA model can answer the question, "What is the impact to the transportation network if Golf Road is closed for two days?" Once the investigation broadens to multiple impacts to the system network, however, a problem arises as to how to ascribe the model results back to individual crossings. In the prior example, only Golf Road was closed for two days. If First Avenue is also closed for three days, the impacts change. The first scenario, in which only Golf Road is closed, showed that closing this road for two days increased vehicle travel by two miles and delays by 35 minutes. The second scenario, in which both Golf Road and First Avenue are closed, increased vehicle travel by four miles and delays by 45 minutes. Due to the proximity of these roads and the interdependence of travel on them, ascribing damages to Golf Road and First Avenue individually becomes complicated. Unfortunately, superposition does not apply, and the relationship of increasing damages to decreasing frequency is sometimes non-monotonic.

Value of Time Saved 2009PL unless otherwise noted
2003 Mean Household Income[1].....$73,670
Index 2003 Mean Household Income to 2009PL[2].....$76,446
Hourly Rate (2080 Hours per annum).....$36.75

	Value of Time Saved Adjusted to Hourly Basis	Value of Time Saved Adjusted to Hourly Basis	Occupancy Rate[3]	Value of Time Saved Adjusted to Hourly and Occupancy
	$/Hour	% of Hourly Family Income		Value per Vehicle per Hour
Low Time Savings				
0-5 minutes				
Work trips	2.35	6.40%	**1.14**	2.68
Social/Recreation Trips	0.48	1.30%	**1.00**	0.48
Other Trips	0.04	0.10%	**1.00**	0.04
Medium				
6-15 minutes				
Work trips	11.83	32.20%	1.14	13.49
Social/Recreation Trips	8.49	23.10%	1.00	8.49
Other Trips	5.33	14.50%	1.00	5.33
High Time Savings				
Over 15 minutes				
Work trips	19.77	53.80%	1.14	22.54
Social/Recreation Trips	22.05	60.00%	1.00	22.05
Other Trips	23.71	64.50%	1.00	23.71
Vacation				
All Time Savings	27.60	75.10%	1.00	27.60

Weight Categories	**Values**
Work	**0.25**
Social/Rec	**0.22**
Other	**0.53**

Adjusted Rate per Category per Time Grouping

0-5 minutes	0.79
6-15 Minutes	8.07
>15 minutes	23.05

Table 2.6 – Passenger Vehicle Value of Time Saved by Trip Length and Purpose

[1] American Community Survey Profile 2006-2008, Table S1901
[2] Bureau of Labor Statistics CPI for Chicago-Gary-Kenosha region
[3] Per ER 1105-2-100, work trips are evaluated on a per person basis while social, recreation, and other trips are on a per vehicle basis.

Occupation (SOC code)	Employment (1)	Employment percent relative standard error (3)	Hourly mean wage	Annual mean wage	Wage percent relative standard error (3)	Hourly Wage Percentile					Annual Wage Percentile (2)				
						10th	25th	Median	75th	90th	10th	25th	Median	75th	90th
Truck Drivers, Heavy and Tractor-Trailer (533032)	44480	8.3	$21.41	$44,540	2	$14.68	$16.95	$20.72	$25.28	$29.13	$30,540	$35,260	$43,090	$52,580	$60,590
Truck Drivers, Light or Delivery Services (533033)	25160	4.6	$15.56	$32,370	2.1	$8.25	$10.62	$14.33	$19.33	$25.73	$17,150	$22,090	$29,800	$40,210	$53,510

(1) Estimates for detailed occupations do not sum to the totals because the totals include occupations not shown separately. Estimates do not include self-employed workers.

(2) Annual wages have been calculated by multiplying the hourly mean wage by 2,080 hours; where an hourly mean wage is not published, the annual wage has been directly calculated from the reported survey data.

(3) The relative standard error (RSE) is a measure of the reliability of a survey statistic. The smaller the relative standard error, the more precise the estimate.

SOC code: Standard Occupational Classification code -- see http://www.bls.gov/soc/home.htm

Data extracted on March 23, 2009

USACE Weighted Average		
Heavy Trucks (64%)[1]	$	13.23
Light Trucks (36%)[1]	$	5.18
Average Truck Time Value	$	18.41
Index 2007PL to 2008PL	$	19.10

Table 2.7 – Commercial Vehicle Value of Time Saved

[1] Chicago Area Transportation Study (Northern Illinois Planning Council (NIPC), now Chicago Metropolitan Agency for Planning (CMAP)), 2007.

One could view this, in economic terms, by examining firms in a market competing for a fix amount of resources. Let the firms in the market place represent the roads and the fixed resource is the vehicles on those roads. On any particular day there is a fixed amount of resources for use by all firms. If any one firm gains in its resources then another firms must lose in resources so that there are a fixed number of resources. Each day firms can gain and lose share of the limited resources. This is analogous to the VISTA model which has a set number of vehicles in their model, or in our analogy, resources. Each simulation of the VISTA model represents one of the eight hydrological frequencies or in our analogy a comparative day. Comparing individual damaged locations within the VISTA model can be equated to comparing firms in a market acquiring a limited resource. In the context of the analogy above this would be a gain by Buyer A at the expense of Buyer B. Since the market is gaining all the time, then the losses by Buyer B have to be such that the system still gains overall. Let's look at it in terms of market share per day. On day 1, the market has 10 units of which Buyer A has 10%, Buyer B has 50%, and Buyer C has 40%. On day 2, the market increase by 10 units to 20 total units. The percentage each Buyer has in this market is unchanged. On day 3, the market increase by 5 units to a total of 25 units. Buyer A gained in market share by 20% to a total of 30% whereas Buyer B and Buyer C decrease by 10% each. Since the entire market on Day 3 can utilize only 25 units, but the percentage shared by each Buyer changed, the total market is monotonic but the individual buyers are not.

	Day 1	Day 2	Day 3
Buyer A	1	2	7.5
Buyer B	5	10	10
Buyer C	4	8	7.5
Total	10	20	25

Table 2.8 – Non-Monotonic Example

In HEC-FDA damages relative to flood stages must be increasing monotonic functions. Due to the complexity of the VISTA model, specific sites within the transportation network have non-monotonic depth-damage curves. The outcome of this relationship is that some tributary models for the study would realize negative damages at that location during certain frequencies in the HEC-FDA model. Examination of the road network at specific locations shows that congestion during specific hydrologic events can bottle neck traffic in one location, creating improved traffic conditions at nearby intersections.

The proposed resolution to this problem is to force the curves into a monotonically increasing relationship through a conservative reduction in damages. The process simply removes the problem area by trimming the monetary damages in the frequency prior to the trough in the curve, as shown in figure 2.1. The loss in damages due to this method amount to only a 0.05% decrease in expected annual benefits.

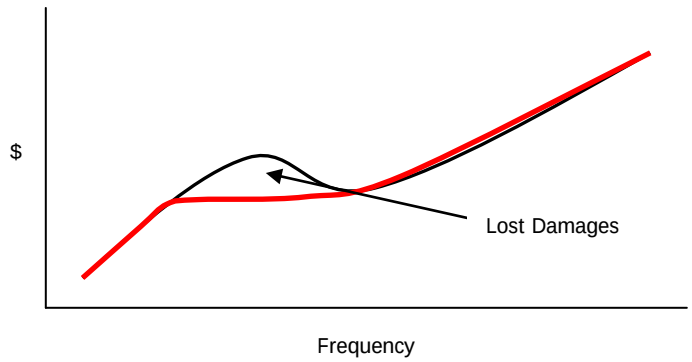

Figure 2.1 – Fitting VISTA results to meet the requirements for HEC-FDA

Physical Damages to Roads

Originally, a process was developed to monetize both physical damages to roads and the delay associated with those damages. Delays and additional mileage incurred during road repairs could be calculated from a modification of the VISTA depth-damage curves, assuming that cleanup and repairs would shut the road down for a single 24 hour period.

An estimate of physical damages to roads was developed by surveying representatives of the local transportation departments impacted by this study. The results of the survey are shown in Table 2.9. As shown in the survey results, the local transportation experts do not feel that costs associated with damages to roads caused by floods are very high and that the majority of damages are associated with debris cleanup. Given that most of the clean up would be scheduled to occur during periods of low traffic volume, including these delays in the planning process would not result in a large increase to the calculated damages. Due to the low value of these physical damages and associated delays, it was decided to not include these categories in the analysis.

Period of analysis and discount rate

Computation of Equivalent Annual Damages, which accounts for changes during the period of analysis, was performed using the current federal discount rate of 3.75% (EGM 13-01 for FY2013) and a period of analysis of 50 years (2010 through 2059). Formulation was conducted using the discount rate current at the time, but final results are reported using the current rate.

Monetary changes between the expected annual damages associated with the “base” year and the “most likely future” conditions were due to the projected changes in population, represented as increased urbanization runoff in the hydrologic model, and projected increase in transportation delays, represented by the increased lost time as a function of monetary loss.

The Upper Des Plaines River and Tributary Study was authorized in WRDA 1999 and at the time the “base” year was set as 2010. The forecasted land use data used to determine the increase urbanization runoff was provided by the Chicago Metropolitan

Agency for Planning, formerly the Northeast Illinois Planning Commission (NIPC). The 2020 regional planning document was a long range forecast in the late 1990's.

Normally the "most likely future" is 25 to 30 years from the base year. In this particular case there was not sufficient forecast information available to create the necessary hydrologic input data. During the development of the transportation delay study the 2020 future was already established. As with any forecast beyond a few years there is a balance that must be struck between the availability of the data and the expertise of the modeler.

Questions	Respondents					
	IDOT	Cook[1]	Lake	Kenosha	AVG	STD
1. Monitor Roadways for flooding/safety impacts and alert public agencies affected by an event						
Estimated Costs (annual)	$75,000	**$6,480**	$5,000	$3,000	$22,370	$35,116
Or Labor (annual man-days)	150	**15**	10	6	45.25	70
2. Installation and removal of detour signs and road barricades						
Estimated Costs (per flooded roadway)	$1,000	**$585**	$250	$1,000	$709	$314
Or Labor (per flooded roadway)	2	**1.5**	0.5	2	1.50	1
3. Flood Protection and other operation provided during a flood event (includes installation, operation, removal, and disposal)						
a. Sandbagging						
Material Estimated Costs (per instance)	$0	**$11,349**	$0	$0	$2,837	$5,675
And Labor (per instance)	0	*12.7*	0	0	3.18	6
b. Pumping						
Material Estimated Costs (per instance)	$0	**$2,393**	0 (NR)	$0	$798	$1,382
And Labor (per instance)	0	*14.2*	2	0	4.05	7
4. Post flood event roadway clean-up						
a. Street and Gutter Sweeping						
Estimated Costs (per flooded roadway)	$2,500	**$1,000**	$0	$100	$900	$1,158
Or Labor (per flooded roadway)	5	2	0	0.2	1.80	2
b. Cleaning of Drainage Structures						
Estimated Costs (per structure)	$1,000	**$398.56**	$0	$100	$375	$450
Or Labor (per structure)	2	0.75	0	0.2	0.74	1
5. Additional Maintenance activities for scour critical bridges and culverts following a flood event						
a. Inspection costs						
Estimated Costs (per structure)	$1,000	**$170**	$500	$0	$418	$440
Or Labor (per structure)	2	0.3	1	0	0.83	1
b. Scour protection measures						
Estimated Costs (material per structure)	$0	**$3,400**	$0	$0	$850	$1,700
And Labor (per structure)	0	NR	0	0	0.00	0
c. Debris removal on piers/abutments						
Estimated Costs (material per structure)	NR	NR	NR	$0	0.00	0
And Labor (per structure)	10	NR	2	0	4.00	5
6. Roadway repairs following a flood event						
a. Shoulder restoration						
Estimated Costs (material per instance)	$1,000	**NR**	NR	$100	$550	$636
And Labor (per structure)	20	NR	5	1	8.67	10
b. Average condition that trigger shoulder erosion						
Depth (ft)	0.5	NR	NR	0.5	0.50	0
And Velocity (ft/s)	NR	NR	NR	NR		
7. Addressing claims for vehicles trapped in flooded underpasses or otherwise damaged by flood waters						
Estimated Costs (per instance)	$5,000	**NR**	$0	$0	$1,667	$2,887
Or Labor (per instance)	10	NR	0	0	3.33	6

Table 2.9 – Survey of Costs Stemming from Flood Damages to Roads (2008 Price Level)

[1] Bolded values provided on survey form, italicized values estimated assuming a labor rate of $500 per man- day.

2.3 – RISK AND UNCERTAINTY

Flood risk management involves defining the probability an area will be flooded resulting in undesirable consequences, and identifying the plan most likely to minimize those consequences. Since risk inherently involves the chance of occurrence, uncertainties associated with the risk analysis are quantified and taken into account. As laid out by Corps regulation ER 1105-2-101, Risk Analysis for Flood Damage Reduction Studies, risk and uncertainty are intrinsic in water resources planning and design. All estimated values in project planning and design are inaccurate to various degrees. With advances in statistical hydrology and the availability of computerized analysis tools, such as the Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) model, it is now possible to improve the evaluation of uncertainties in hydrologic, hydraulic, geotechnical and economic aspects of calculations. Through this risk analysis, and with careful communication of the results, the stakeholders can be better informed about what to expect from flood damage reduction projects and their residual risks.

The determination of equivalent annual damages for a flood risk management study must take into account the complex relationships between and uncertainties in key hydrologic, hydraulic, geotechnical, and economic information:

- Hydrologic - The discharge-frequency function describes the probability a given flood will occur. Variables with uncertainties accounted for in the analysis include gage records that are often short or do not exist, precipitation-runoff computational methods that are not precisely known, and imprecise knowledge of the effectiveness of flow regulating structures. Using graphical probability functions, HEC-FDA calculates error bands based upon the input frequency-discharge curve and the equivalent gage period of record.

- Hydraulic - The stage-discharge function describes the water surface elevation for a given flow rate. Uncertainties arise from the use of simplified models to describe complex hydraulic relationships, including simplified geometric data, effects of hydraulic structures, and errors in estimates of slopes and roughness factors. HEC-FDA calculates error bands to the stage-discharge curve based upon a provided error distribution.

- Geotechnical - The geotechnical levee failure function describes levee failure probabilities in relation to channel and protected area water stages. Uncertainties include geotechnical parameters such as soil and permeability values used in the analysis, mathematical simplifications in analysis models, the frequency and magnitude of physical changes or failure events, and the uncertainty of unseen features such as rodent burrows, cracks within the levee, or other defects. Although geotechnical uncertainties are present, the current version of HEC-FDA does not assign error bands around levee failure functions.

- Economic - The stage-damage function describes the amount of damage that may occur for a given flood elevation. Uncertainties include depth/damage relationships, structure and content values, structure locations, first floor

elevations, flood duration, flood warning time and the response of floodplain inhabitants.

These four inter-related functions make up the conceptual risk approach utilized by the Corps on all flood risk management projects, as illustrated in Figure 2.2. HEC-FDA performs a Monte Carlo simulation of discharge-probability, stage-discharge, and stage-damage relationships, incorporating their associated uncertainties, to compute a damage-probability function. Expected annual damages, an estimate of annual damages for a given condition and year of analysis are calculated by integrating the damage-probability function. HEC-FDA uses a Monte Carlo routine to perform numerous (over 30,000) model realizations by randomly selecting values within the specified uncertainty limits for each function.

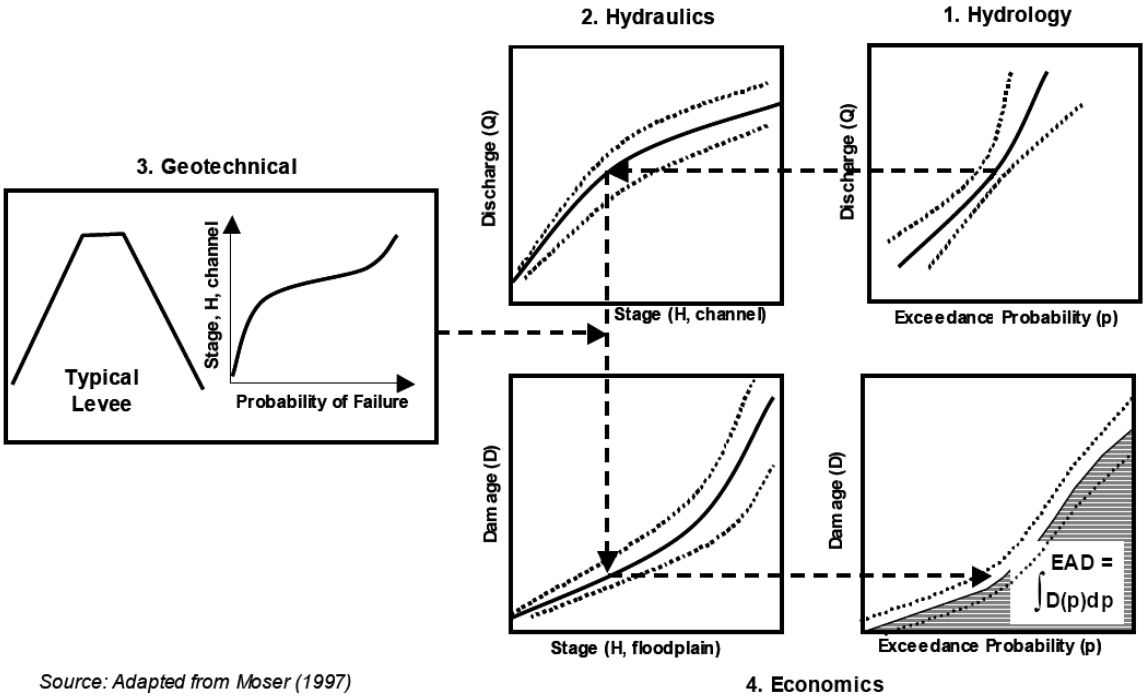

Figure 2.2 – Conceptual Risk Approach for Estimating Flood Damages

Identification and classification of the types of uncertainties in the risk and uncertainty analysis method is the key to both quantifying its impact and understanding its implications to the model results. The majority of the model uncertainty can be classified as *natural variability,* resulting from factors such as chance (e.g. flood-frequency curves). Uncertainty derived from measurement limitations or human error is classified as *knowledge uncertainty*.

Natural variability in a hydrologic system is typically quantified by the discharge-frequency relationship. The HEC-FDA methods provided to quantify this relationship are contained in the Graphical Method and the Analytical Method. Due to the complexity of the study and the need to work in both an effective and efficient way, the Graphical Method was selected over the more rigorous Analytical Method.

Knowledge uncertainty is a major factor in this study. Issues of uncertainty in measurements are commonly experienced. For example, prior to the invention of digital thermometers most oral thermometers got pretty accurate readings using a graduated scale showing tenth of degrees. Currently, many digital thermometers are available that read to the hundredth decimal place, a very accurate measurement. Whether that reading is the same after multiple measurements, however, is a matter of the instrument's precision.

As a more complex example of knowledge uncertainty, engineering hydrology at the watershed scale has limitations based on knowledge and ability to measure at what is sometimes referred to as the "hillslope scale." At this small scale, variations within the system can be included in a detailed model. Most regional hydrology models, however, translate observation and experience of a natural system into an empirical relationship. This relationship creates an output that mimics the system being analyzed. The various input parameters can be measured very accurately and precisely yet, due to gaps in our knowledge of the system, fail to perfectly mimic the modeled system. This study uses a regional model due to the size of the system we are studying. Uncertainty in each of the two types of data sources for the economic analysis, *engineering data* and *economic data*, will be addressed separately. Knowledge uncertainties in this study's engineering data include flood stage variability due to assignment of a Manning's n value and structure elevations.

Manning's n Value Uncertainties

Uncertainty in stage is a function of many parameters including uncertainty in cross-sectional geometry, uncertainty in discharge, and uncertainty in the Manning's n-value. EM 1110-2-1619 provides information on minimal standard deviation of error in stage as function of cross section accuracy and reliability of the Manning's n-value. The geomorphology of the region and the urbanization of the area around the Des Plaines River gave the study team pause as to the whether the EM 1110-2-1619 Table 5-2 method was applicable.

The study assumes that variability in stages is greatly attributed to the ability of the engineer to assign an appropriate Manning's n value. To capture this error, the Manning's n-value of the modeled channel was allowed to vary randomly from the original value by 15% at each cross-section. Stage was then simulated using USACE's HEC-RAS (River Analysis System) model. Three HEC-RAS simulations, the minimum sample required to calculate a standard deviation, were performed and a standard deviation of the stage at each frequency was calculated for each cross-section.

Parameterization of the HEC-FDA model's HygEng data set, discharge and stage uncertainty, utilized a DOS program called WSPRetrieve created by the USACE Hydrologic Engineering Center. This program allows use of HEC-FDA's Graphical Method for the Exceedance Probability Function and sets a global standard deviation value for stage error in water surface profiles. The probability distribution for this global assignment defaults to a normal distribution for stage error, assumed to be constant for

the entire model for all reaches and all water surface profiles. The global assignment feature for the "Set Stage Error" has limitations.

To create a single stage error for the entire model, eight calculated stage standard deviations were aggregated at each cross-section. To capture the maximum error at each particular cross-section the maximum value was selected to represent the stage error for that cross-section. A single stage error value was then generated by taking the averaging stage errors over all cross sections for each particular model. Table 2.10 summarizes the stage errors calculated and applied in each HEC-FDA model. Variation in stage deviation between watersheds is likely due to the complex hydraulics of the system. These calculated stage errors represent as the degree of uncertainty in the calculated profiles for each watershed through perturbation of the Manning's n-value. The low uncertainty shown in Table 2-10 only narrows the potential range of monetary damages relative to the potential values from EM 1110-2-1619.

Watershed	Standard Deviation (ft)
Newport Drainage Ditch	0.07
Mill Creek	0.15
Bull Creek	0.09
Indian Creek	0.15
Buffalo-Wheeling Creek	0.09
McDonald Creek	0.15
Weller Creek	0.14
Farmer-Prairie Creek	0.07
Willow-Higgins Creek	0.09
Silver Creek	0.09
Des Plaines River	0.09

Table 2.10 – Stage Uncertainty tabulation

Structure Elevation Uncertainties

Structure elevation data were taken from field survey and LiDAR data. Survey data were taken from four sources: the Phase I Study, Illinois Department of Natural Resources surveys, a survey conducted by Dynasty Group on behalf of MWRDGC, and surveys conducted by SEWRPC. The majority of the structure elevation information was obtained via field survey thus achieving a higher degree of certainty in the elevation data. Since not all structures need this level of certainty and in some cases there is diminishing return on the time and money invested in such a costly field survey, LiDAR data were used to determine elevations for some structures. LiDAR data was used for structures outside the 1/100 AEP but within the 1/500 AEP floodplain. Since LiDAR only provides an estimate of the ground elevation, the study needed to derive information about a structure's first floor elevation and lowest entry point. Typical relationships between LiDAR ground elevation data and first floor elevations were developed using the field surveyed data. Field survey data was grouped by occupancy code and analyzed for correlations between the ground elevation and the first floor and low entry elevation.

Economic Uncertainties - Structural

The majority of the structural economic uncertainty was predefined by others (EGM 04-01, Residential Generic Depth-Damage Functions, and Non Residential Generic Depth Damage Functions). Non-residential facilities not capable of being classified in generic terms were individually surveyed. For these structures, uncertainty in the damage estimates was reported by the respondent of the survey in terms of Low, Most Likely, and High values.

Economic Uncertainties - Transportation

Uncertainty for the damages due to flood induced delays and detours are based on travel time offset. The concept of travel time offset can be visualized as the effect that road closures have on the daily traffic cycle. A rainfall event could occur during any period of the day. To capture the degree of uncertainty associated with the timing of rainfall events and consequent road closures to diurnal traffic congestion, model runs were prepared that shifted the start of the flooding duration at set increments within a 24 hour period: 0 (No Offset), 3, 8, 13, and 18 hours. Using this method VISTA was able to gage the degree of model sensitivity relative to the starting of road closure and the daily traffic congestion patterns in the network. Attachment 3 provides a detailed explanation of the methods, theory, and results. The conclusion of the VISTA study is that while there is variability in the results due to travel time offset the “no-offset” scenario results should be utilized for economic damage calculation. A triangular distribution was used in HEC-FDA and the maximum and minimum uncertainty damage values were calculated by taking a percentage of the reported damages, as shown in Table 2.11.

Annual Chance of Exceedance (Frequency)	% Uncertainty
99% (1 yr)	0.41%
50% (2 yr)	0.41%
20% (5 yr)	0.41%
10% (10 yr)	0.41%
4% (25 yr)	7.78%
2% (50 yr)	6.60%
1% (100 yr)	18.44%
0.2% (500 yr)	9.59%

Table 2.11 – Uncertainty range for Transportation Depth-Damage Curves

An analysis of the effect of storm start time and duration was conducted for transportation delays in order to determine the critical storm duration. A 24-hour storm was compared with a 10-day storm and showed very little difference in impacts to the transportation network. The analysis was expanded by varying the start time of the storm over a 24 hour period. In comparing the impacts on delays and detours resulting from this variation, the 24-hour storm showed a greater impact on the transportation network than the 10-day storm. The 24-hour storm was therefore selected as the critical duration for the VISTA model. Further discussion of this analysis can be found in Attachment 3.

CHAPTER 3 – WITHOUT PROJECT CONDITIONS

3.1 Existing Flood Damage Reduction Structures

The without-project condition of the upper Des Plaines River watershed is the basis for comparing the alternative plans. In forecasting these conditions, an effort is made to describe foreseeable changes to the most important aspects of the study area over the life of a project. This forecasting is based on an assessment of the existing conditions, previous trends, and predicted trends within the study area. The without-project condition describes the future conditions that will exist if no action is taken. The without-project conditions for the Phase II study include the implementation of the six flood damage reduction projects authorized by the Phase I study. Even though some of these projects have not been implemented, their effects on existing conditions are included as baseline for this analysis.

3.2 Updates to Without Project Condition

During the course of the study, the need for revisions to the mainstem without project condition model inputs was identified. Further discussion of the revisions can be found in Volume 2. The without project condition damages reported here reflect the most current modeling.

The first revision came about as a result of a technical review within the USACE. The work produced by the Project Delivery Team (PDT) underwent Agency Technical Review (ATR) at key points in the study process. During the review immediately prior to finalization of the NED plan, a need for revisions to the estimated value of time delays incurred as a result of flooded road crossings was identified. The revision resulted in a decrease in calculated damages and a parallel decrease in project benefits. Transportation damages were indexed to 0.83 of the originally calculated values. An additional revision was made to the hydraulic model of the mainstem Des Plaines River in Illinois, as discussed in Volume 2.

The data presented here is the most current without project condition data and includes all updates and revisions. However, due to the scale and complexity of the study, both the H&H and economic analyses that had been accomplished at the time these revisions were identified had required a considerable investment of time. Screening data for reservoirs presented in Volume 2 and Appendix B use older data. However, as the updates consistently showed a decrease in damages and benefits, no previously eliminated projects would be reincorporated by repeating the screening analysis. The PDT therefore determined that the existing screening level analysis for reservoirs is appropriate.

3.3 Potentially Damaged Structures

Table 3.1 through Table 3.29 show a breakdown by damage category of the number of structures included in the analysis and the number of structures in that inventory at risk of flood damage. The number of structures presented in these tables includes all

damaged structures, including those damaged below the first floor elevation. Geographically, the Des Plaines River Watershed runs predominately north to south. Urbanization of the Chicagoland area has typically been in a northwestern and southwestern direction. Sub-watersheds in the southern portion of the Des Plaines River watershed are more urbanized and show a greater number of structures at risk of flood damage than watersheds in the northern portion of the study area.

For structures in Wisconsin, presented in Tables 3.1 through 3.7, the data provided by SEWRPC showed no change between baseline and future conditions, therefore, the number of potentially damaged structures does not change between the two scenarios. For these watersheds, a single table showing baseline and future conditions is presented.

Tables 3.8 through 3.29 were created from data provided by HEC-FDA's FDA_StrucDetail.OUT (herein referred to as StrucDetail) and FDA_SdErrors.OUT files (herein referred to as SdErrors). StrucDetail contains estimates for damages to structures at each modeled flood event. Structures that would not be damaged under conditions in which uncertainty would apply can be identified by the fact that they are present in the StrucDetail file, but are not damaged in any of the modeled floods. Tables 3.2 through 3.23 show the number of structures damaged at each of the eight frequencies analyzed, as computed from the StrucDetail file. The SdErrors file reports the number of structures removed by FDA. The difference between the total structure count and the total structures removed is the number of structures damaged with uncertainty applied, as discussed in Section 2.3, presented as "Potentially Damaged Structures." The difference between the number of potentially damaged structures and the number of structures damaged at the 0.2% annual chance of exceedance flood (the most inclusive flood event) is the number of structures identified by uncertainty. By way of example, Table 3.8 shows only one of the inventoried structures damaged at the 500 year event. Four additional structures, however, were identified by varying the uncertain parameters in the model, therefore a total of five structures in the watershed could be potentially damaged due to uncertainty.

Structures not included in the count of structures at risk of flood damage were determined to be "out of the floodplain" by HEC-FDA during its aggregate stage-damage computations. CPD-72, HEC-FDA Flood Damage Reduction Analysis User's Manual provides a detailed breakdown on how the model determines which structures are selected as being "out of the floodplain". As HEC-FDA makes the determination of whether a structure is in or out of the floodplain, the model will check, based on uncertainty, if a structure has the potential for being damaged at the upper and lower uncertainty bounds. If a structure is flagged as "in the floodplain" based on this check, it is analyzed.

Tables 3.30 through 3.32 provide summaries of the inventoried and potentially damaged structures for the entire watershed.

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SNB	One Story No Basement	12		1	1	6	9	10	12	12		12
	1SWB	One Story With Basement	12		2	2	11	12	12	12	12		12
	2SNB	Two Story No Basement	3				1	2	2	3	3		3
	2SWB	Two Story With Basement	1					1	1	1	1		1
	BLNB	Bi-Level No Basement	1				1	1	1	1	1		1
	BLWB	Bi-Level With Basement	5				3	4	5	5	5		5
	TLNB	Tri-Level No Basement											0
	TLWB	Tri-Level With Basement											0
	RES_D	Direct Depth Damage Data											0
	TOTAL RES		34	0	3	3	22	29	31	34	34	0	34
	Total		34	0	3	3	22	29	31	34	34	0	34

Table 3.1 – Brighton Creek Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SNB	One Story No Basement	4				2	4	4	4	4		4
	2SNB	Two Story No Basement	1				1	1	1	1	1		1
	2SWB	Two Story With Basement	2				2	2	2	2	2		2
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1		1
	RES_D	Direct Depth Damage Data	2				1	1	2	2	2		2
	TOTAL RES		10	0	1	1	7	9	10	10	10	0	10
	Total		10	0	1	1	7	9	10	10	10	0	10

Table 3.2 – Dutch Gap Canal Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SWB	One Story With Basement	1					1	1	1	1		1
	TOTAL RES		1	0	0	0	0	1	1	1	1	0	1
	Total		1	0	0	0	0	1	1	1	1	0	1

Table 3.3 – Center Creek Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SWB	One Story With Basement	1		1	1	1	1	1	1	1		1
	RES_D	Direct Depth Damage Data	1					1	1	1	1		1
	TOTAL RES		2	0	1	1	1	2	2	2	2	0	2
	Total		2	0	1	1	1	2	2	2	2	0	2

Table 3.4 – Kilbourn Road Ditch Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SNB	One Story No Basement	6				1	3	4	6	6		6
	1SWB	One Story With Basement	2		1	1	1	2	2	2	2		2
	2SNB	Two Story No Basement	1							1	1		1
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1		1
	TOTAL RES		10	0	2	2	3	6	7	10	10	0	10
	Total		10	0	2	2	3	6	7	10	10	0	10

Table 3.5 – Jerome Creek Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
RES	1SWB	One Story With Basement	4		1	1	1	2	3	4	4		4
	BLWB	Bi-Level With Basement	1							1	1		1
	RES_D	Direct Depth Damage Data	3					2	2	3	3		3
	TOTAL RES		8	0	1	1	1	4	5	8	8	0	8
TRAFFIC		Direct Depth Damage Data[1]	18									18	18
	Total		26	0	1	1	1	4	5	8	8	18	26

[1]This count includes all inventoried crossings in Wisconsin

Table 3.6 – Des Plaines River Mainstem (WI) Potentially Damaged Structures

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
IND	WH_P	Warehouse (pre-engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	4									1	1
	1SWB	One Story With Basement	16										0
	2SNB	Two Story No Basement	1										0
	2SWB	Two Story With Basement	1										0
	BLNB	Bi-Level No Basement	2										0
	BLWB	Bi-Level With Basement	2										0
	TLNB	Tri-Level No Basement	1							1	1		1
	TLWB	Tri-Level With Basement	2										0
	TOTAL RES		29	0	0	0	0	0	0	1	1	1	2
AUTO	SEDAN	Sedan style	4										0
	SPORTS	Sport Cars	1										0
	PICKUPS	Pickup Trucks	2									1	1
	TOTAL AUTO		7	0	0	0	0	0	0	0	0	1	1
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		41	0	0	0	0	0	0	1	1	4	5

Table 3.7 – Newport Drainage Ditch Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
IND	WH_P	Warehouse (pre-engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	4									1	1
	1SWB	One Story With Basement	16										0
	2SNB	Two Story No Basement	1										0
	2SWB	Two Story With Basement	1										0
	BLNB	Bi-Level No Basement	2										0
	BLWB	Bi-Level With Basement	2										0
	TLNB	Tri-Level No Basement	1							1	1		1
	TLWB	Tri-Level With Basement	2										0
	TOTAL RES		29	0	0	0	0	0	0	1	1	1	2
AUTO	SEDAN	Sedan style	4										0
	SPORTS	Sport Cars	1										0
	PICKUPS	Pickup Trucks	2									1	1
	TOTAL AUTO		7	0	0	0	0	0	0	0	0	1	1
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		41	0	0	0	0	0	0	1	1	4	5

Table 3.8 – Newport Drainage Ditch Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	8									1	1
	TOTAL APT		8	0	0	0	0	0	0	0	0	1	1
COM	CLOTH_E	Clothing Store (engineered)	1								1		1
	CONV_E	Convenience Store (engineered)	1								1		1
	ELEC_P	Electronics Retailer (pre-engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	FURN_P	Furniture Store (pre-engineered)	1								1		1
	MED_E	Medical Office (engineered)	2										0
	OFF_E	Office Building - One Story (engineered)	10								4	1	5
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	5								2		2
	COM_D	Direct Depth Damage Data	3									1	1
	TOTAL COM		28	0	0	0	0	0	0	0	9	2	11
IND	LT_E	Light Manufacturing (engineered)	3								2		2
	LT_P	Light Manufacturing (pre-engineered)	2								1		1
	WH_P	Warehouse (pre-engineered)	4					2	3	3	4		4
	IND_D	Direct Depth Damage Data	1									1	1
	TOTAL IND		10	0	0	0	0	2	3	3	7	1	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	1										0
	SCH_E	School (engineered)	2								2		2
	PUB_D	Direct Depth Damage Data	1										0
	TOTAL PUB		5	0	0	0	0	0	0	0	2	0	2
RES	1SNB	One Story No Basement	107					2	2	2	6	1	7
	1SWB	One Story With Basement	70			1	1	2	2	2	4	3	7
	2SNB	Two Story No Basement	56										0
	2SWB	Two Story With Basement	174							1	3	3	6
	BLNB	Bi-Level No Basement	6										0
	BLWB	Bi-Level With Basement	8									1	1
	TLNB	Tri-Level No Basement	41										0
	TLWB	Tri-Level With Basement	34						1	1	1		1
	TOTAL RES		496	0	0	1	1	4	5	6	14	8	22
AUTO	SEDAN	Sedan style	76					1	1	1	3		3
	SPORTS	Sport Cars	5										0
	MINI	Mini Vans	4										0
	SUV	Sports Utility Vehicles	11										0
	PICKUPS	Pickup Trucks	8										0
	TOTAL AUTO		104	0	0	0	0	1	1	1	3	0	3
TRAFFIC		Direct Depth Damage Data	13									6	6
	Total		664	0	0	1	1	7	9	10	35	18	53

Table 3.9 – Mill Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	8									1	1
	TOTAL APT		8	0	0	0	0	0	0	0	0	1	1
COM	CLOTH_E	Clothing Store (engineered)	1								1		1
	CONV_E	Convenience Store (engineered)	1								1		1
	ELEC_P	Electronics Retailer (pre-engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	FURN_P	Furniture Store (pre-engineered)	1								1		1
	MED_E	Medical Office (engineered)	2										0
	OFF_E	Office Building - One Story (engineered)	10								4	1	5
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	5								2		2
	SERV_P	Service Related Business (pre-engineered)											0
	COM_D	Direct Depth Damage Data	3									1	1
	TOTAL COM		28	0	0	0	0	0	0	0	9	2	11
IND	LT_E	Light Manufacturing (engineered)	3							1	2		2
	LT_P	Light Manufacturing (pre-engineered)	2								1		1
	WH_P	Warehouse (pre-engineered)	4				1	3	3	3	4		4
	IND_D	Direct Depth Damage Data	1									1	1
	TOTAL IND		10	0	0	0	1	3	3	4	7	1	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	1										0
	SCH_E	School (engineered)	2							1	2		2
	PUB_D	Direct Depth Damage Data	1										0
	TOTAL PUB		5	0	0	0	0	0	0	1	2	0	2
RES	1SNB	One Story No Basement	107				1	2	2	2	7		7
	1SWB	One Story With Basement	70			1	1	2	2	2	4	3	7
	2SNB	Two Story No Basement	56										0
	2SWB	Two Story With Basement	174							1	4	2	6
	BLNB	Bi-Level No Basement	6										0
	BLWB	Bi-Level With Basement	8									1	1
	TLNB	Tri-Level No Basement	41										0
	TLWB	Tri-Level With Basement	34					1	1	1	1		1
	TOTAL RES		496	0	0	1	2	5	5	6	16	6	22
AUTO	SEDAN	Sedan style	76				1	1	1	1	3		3
	SPORTS	Sport Cars	5										0
	MINI	Mini Vans	4										0
	SUV	Sports Utility Vehicles	11										0
	PICKUPS	Pickup Trucks	8										0
	TOTAL AUTO		104	0	0	0	1	1	1	1	3	0	3
TRAFFIC		Direct Depth Damage Data	13									7	7
	Total		664	0	0	1	4	9	9	12	37	17	54

Table 3.10 – Mill Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	ELEC_E	Electronics Retailer (engineered)	2										0
	FFR_E	Fast Food Restaurant (engineered)	1									1	1
	MED_E	Medical Office (engineered)	1										0
	TOTAL COM		4	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	1							1	1		1
	SCH_E	School (engineered)	1					1	1	1	1		1
	TOTAL PUB		2	0	0	0	0	1	1	2	2	0	2
RES	1SNB	One Story No Basement	2				1	1	2	2	2		2
	1SWB	One Story With Basement	16					1	1	6	9	5	14
	2SNB	Two Story No Basement	1						1	1	1		1
	2SWB	Two Story With Basement	46					1	9	18	20	1	21
	BLNB	Bi-Level No Basement	1								1		1
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	2					2	2	2	2		2
	RES_D	Direct Depth Damage Data	0										0
	TOTAL RES		69	0	0	0	1	5	15	29	35	6	41
AUTO	SEDAN	Sedan style	13							3	4	1	5
	MINI	Mini Vans	1										0
	SUV	Sports Utility Vehicles	1										0
	PICKUPS	Pickup Trucks	1										0
	TOTAL AUTO		16	0	0	0	0	0	0	3	4	1	5
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		95	0	0	0	1	6	16	34	41	9	50

Table 3.11 – Bull Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	ELEC_E	Electronics Retailer (engineered)	2										0
	FFR_E	Fast Food Restaurant (engineered)	1									1	1
	MED_E	Medical Office (engineered)	1										0
	TOTAL COM		4	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	1							1	1		1
	SCH_E	School (engineered)	1					1	1	1	1		1
	TOTAL PUB		2	0	0	0	0	1	1	2	3	5	8
RES	1SNB	One Story No Basement	2				1	2	2	2	2		2
	1SWB	One Story With Basement	16					1	1	6	9	5	14
	2SNB	Two Story No Basement	1							1	1		1
	2SWB	Two Story With Basement	46					1	10	19	20	1	21
	BLNB	Bi-Level No Basement	1									1	1
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	2				1	2	2	2	2		2
	TOTAL RES		69	0	0	0	2	6	15	30	34	7	41
AUTO	SEDAN	Sedan style	13							3	4	1	5
	MINI	Mini Vans	1										0
	SUV	Sports Utility Vehicles	1										0
	PICKUPS	Pickup Trucks	1										0
	TOTAL AUTO		16	0	0	0	0	0	0	3	4	1	5
TRAFFIC		Direct Depth Damage Data	4									2	2
	Total		95	0	0	0	2	7	16	35	41	15	56

Table 3.12 – Bull Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	1										0
	TOTAL APT		1	0	0	0	0	0	0	0	0	0	0
COM	OFF_E	Office Building - One Story (engineered)	2								1	1	2
	SERV_E	Service Related Business (engineered)	2								1		1
	TOTAL COM		4	0	0	0	0	0	0	0	2	1	3
IND	WH_E	Warehouse (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	1										0
	1SWB	One Story With Basement	10						1	1	3		3
	2SNB	Two Story No Basement	12										0
	2SWB	Two Story With Basement	113		1	1	2	3	6	8	32	13	45
	BLWB	Bi-Level With Basement	1										0
	TLWB	Tri-Level With Basement	1								1		1
	TOTAL RES		138	0	1	1	2	3	7	9	36	13	49
AUTO	SEDAN	Sedan style	16								1	2	3
	SPORTS	Sport Cars	1										0
	MINI	Mini Vans	5										0
	SUV	Sports Utility Vehicles	6									1	1
	PICKUPS	Pickup Trucks	3										0
	TOTAL AUTO		31	0	0	0	0	0	0	0	1	3	4
TRAFFIC		Direct Depth Damage Data	6									3	3
	Total		181	0	1	1	2	3	7	9	39	20	59

Table 3.13 – Indian Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	1										0
	TOTAL APT		1	0	0	0	0	0	0	0	0	0	0
COM	OFF_E	Office Building - One Story (engineered)	2								1	1	2
	SERV_E	Service Related Business (engineered)	2								1		1
	TOTAL COM		4	0	0	0	0	0	0	0	2	1	3
IND	WH_E	Warehouse (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	1										0
	1SWB	One Story With Basement	10						1	1	3		3
	2SNB	Two Story No Basement	12										0
	2SWB	Two Story With Basement	113		1	1	2	3	6	8	32	13	45
	BLWB	Bi-Level With Basement	1										0
	TLWB	Tri-Level With Basement	1								1		1
	TOTAL RES		138	0	1	1	2	3	7	9	36	13	49
AUTO	SEDAN	Sedan style	16								1	2	3
	SPORTS	Sport Cars	1										0
	MINI	Mini Vans	5										0
	SUV	Sports Utility Vehicles	6									1	1
	PICKUPS	Pickup Trucks	3										0
	TOTAL AUTO		31	0	0	0	0	0	0	0	1	3	4
TRAFFIC		Direct Depth Damage Data	6									3	3
	Total		181	0	1	1	2	3	7	9	37	19	56

Table 3.14 – Indian Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	37								20	5	25
	APT_D	Direct Depth Damage Data	0										0
	TOTAL APT		37	0	0	0	0	0	0	0	20	5	25
COM	CLOTH_E	Clothing Store (engineered)	8								2		2
	CONV_E	Convenience Store (engineered)	2										0
	ELEC_E	Electronics Retailer (engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	6								1		1
	FURN_E	Furniture Store (engineered)	1									1	1
	FURN_P	Furniture Store (pre-engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	MED_E	Medical Office (engineered)	1								1		1
	OFF_E	Office Building - One Story (engineered)	49					2	3	3	9	1	10
	REST_E	Restaurant (engineered)	4										0
	REST_P	Restaurant (pre-engineered)	1								1		1
	SERV_E	Service Related Business (engineered)	4							1	3		3
	COM_D	Direct Depth Damage Data	1									1	1
	TOTAL COM		80	0	0	0	0	2	3	4	17	3	20
IND	LT_E	Light Manufacturing (engineered)	25								2	1	3
	LT_P	Light Manufacturing (pre-engineered)	1							1	1		1
	WH_E	Warehouse (engineered)	4							1	2	1	3
	WH_P	Warehouse (pre-engineered)	1								1		1
	TOTAL IND		31	0	0	0	0	0	0	2	6	2	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	3										0
	SCH_E	School (engineered)	2										0
	TOTAL PUB		6	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	414				1	10	20	88	342	19	361
	1SWB	One Story With Basement	270						11	22	140	13	153
	2SNB	Two Story No Basement	236					4	14	39	136	31	167
	2SWB	Two Story With Basement	104							2	13	3	16
	BLNB	Bi-Level No Basement	2										0
	TLNB	Tri-Level No Basement	44				1	3	7	11	27	3	30
	TLWB	Tri-Level With Basement	19								4	3	7
	TOTAL RES		1089	0	0	0	2	17	52	162	662	72	734
AUTO	SEDAN	Sedan style	140				1	3	6	12	75	10	85
	SPORTS	Sport Cars	19							3	13	1	14
	MINI	Mini Vans	15							1	3	1	4
	SUV	Sports Utility Vehicles	20							1	4	5	9
	PICKUPS	Pickup Trucks	17							1	6	1	7
	TOTAL AUTO		211	0	0	0	1	3	6	18	101	18	119
TRAFFIC		Direct Depth Damage Data	13									7	7
	Total		1467	0	0	0	3	22	61	186	806	107	913

Table 3.15 – Buffalo-Wheeling Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	37								20	5	25
	TOTAL APT		37	0	0	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	8								2		2
	CONV_E	Convenience Store (engineered)	2										0
	ELEC_E	Electronics Retailer (engineered)	1										0
	FFR_E	Fast Food Restaurant (engineered)	6								1		1
	FURN_E	Furniture Store (engineered)	1									1	1
	FURN_P	Furniture Store (pre-engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	MED_E	Medical Office (engineered)	1								1		1
	OFF_E	Office Building - One Story (engineered)	49					2	3	3	9	1	10
	REST_E	Restaurant (engineered)	4										0
	REST_P	Restaurant (pre-engineered)	1								1		1
	SERV_E	Service Related Business (engineered)	4							1	3		3
	COM_D	Direct Depth Damage Data	1										0
	TOTAL COM		80	0	0	0	0	2	3	4	17	2	19
IND	LT_E	Light Manufacturing (engineered)	25							2	2	1	3
	LT_P	Light Manufacturing (pre-engineered)	1							1	1		1
	WH_E	Warehouse (engineered)	4							1	2	1	3
	WH_P	Warehouse (pre-engineered)	1								1		1
	TOTAL IND		31	0	0	0	0	0	0	4	6	2	8
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	3										0
	SCH_E	School (engineered)	2										0
	TOTAL PUB		6	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	414				1	11	23	119	344	17	361
	1SWB	One Story With Basement	270						11	29	140	13	153
	2SNB	Two Story No Basement	236					4	16	47	139	30	169
	2SWB	Two Story With Basement	104							2	13	3	16
	BLNB	Bi-Level No Basement	2										0
	TLNB	Tri-Level No Basement	44				1	3	7	11	27	3	30
	TLWB	Tri-Level With Basement	19								4	3	7
	TOTAL RES		1089	0	0	0	2	18	57	208	667	69	736
AUTO	SEDAN	Sedan style	140				1	3	6	15	76	9	85
	SPORTS	Sport Cars	19							3	13	1	14
	MINI	Mini Vans	15							1	3	1	4
	SUV	Sports Utility Vehicles	20							2	5	4	9
	PICKUPS	Pickup Trucks	17							1	6	1	7
	TOTAL AUTO		211	0	0	0	1	3	6	22	103	16	119
TRAFFIC		Direct Depth Damage Data	13									7	7
	Total		1467	0	0	0	3	23	65	234	776	102	878

Table 3.16 – Buffalo-Wheeling Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	CONV_E	Convenience Store (engineered)	1										0
	TOTAL COM		1	0	0	0	0	0	0	0	0	0	0
IND	LT_E	Light Manufacturing (engineered)	4										0
	IND_D	Direct Depth Damage Data	0										0
	TOTAL IND		4	0	0	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1										0
	TOTAL PUB		1	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	80									9	9
	2SWB	Two Story With Basement	64								1	4	5
	TLWB	Tri-Level With Basement	35								1	2	3
	TOTAL RES		179	0	0	0	0	0	0	0	2	15	17
AUTO	SEDAN	Sedan style	26										0
	SPORTS	Sport Cars	2										0
	MINI	Mini Vans	2										0
	SUV	Sports Utility Vehicles	3										0
	PICKUPS	Pickup Trucks	2										0
	TOTAL AUTO		35	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	2										0
	Total		222	0	0	0	0	0	0	0	2	15	17

Table 3.17 – McDonald Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	CONV_E	Convenience Store (engineered)	1										0
	TOTAL COM		1	0	0	0	0	0	0	0	0	0	0
IND	LT_E	Light Manufacturing (engineered)	4										0
	TOTAL IND		4	0	0	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1										0
	TOTAL PUB		1	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	80									9	9
	2SWB	Two Story With Basement	64								1	4	5
	TLWB	Tri-Level With Basement	35								1	2	3
	TOTAL RES		179	0	0	0	0	0	0	0	2	15	17
AUTO	SEDAN	Sedan style	26										0
	SPORTS	Sport Cars	2										0
	MINI	Mini Vans	2										0
	SUV	Sports Utility Vehicles	3										0
	PICKUPS	Pickup Trucks	2										0
	TOTAL AUTO		35	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	2										0
	Total		222	0	0	0	0	0	0	0	2	15	17

Table 3.18 – McDonald Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	COM_D	Direct Depth Damage Data	1									1	1
	TOTAL COM		1	0	0	0	0	0	0	0	0	0	0
IND	LT_E	Light Manufacturing (engineered)	1									1	1
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	210	1	1	1	1	1	1	12	136	28	164
	2SWB	Two Story With Basement	117						1	10	65	22	87
	BLWB	Bi-Level With Basement	6								6		6
	TLWB	Tri-Level With Basement	80							2	62	9	71
	TOTAL RES		413	1	1	1	1	1	2	24	269	59	328
AUTO	SEDAN	Sedan style	56							1	17	21	38
	SPORTS	Sport Cars	8								3		3
	MINI	Mini Vans	4								3		3
	SUV	Sports Utility Vehicles	5								2	1	3
	PICKUPS	Pickup Trucks	5								2	2	4
	TOTAL AUTO		78	0	0	0	0	0	0	1	27	24	51
TRAFFIC		Direct Depth Damage Data	2									2	2
	Total		495	1	1	1	1	1	2	25	296	85	381

Table 3.19 – Weller Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
COM	COM_D	Direct Depth Damage Data	1									1	1
	TOTAL COM		1	0	0	0	0	0	0	0	0	0	0
IND	LT_E	Light Manufacturing (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	210	1	1	1	1	1	1	48	140	25	165
	2SWB	Two Story With Basement	117						1	30	70	7	77
	BLWB	Bi-Level With Basement	6								6		6
	TLWB	Tri-Level With Basement	80							6	63	8	71
	TOTAL RES		413	1	1	1	1	1	2	84	279	40	319
AUTO	SEDAN	Sedan style	56						1	1	21	18	39
	SPORTS	Sport Cars	8								3	1	4
	MINI	Mini Vans	4								3		3
	SUV	Sports Utility Vehicles	5								2	1	3
	PICKUPS	Pickup Trucks	5								3	1	4
	TOTAL AUTO		78	0	0	0	0	0	1	1	32	21	53
TRAFFIC		Direct Depth Damage Data	2										2
	Total		495	1	1	1	1	1	3	85	311	61	374

Table 3.20 – Weller Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	78							1	1	7	8
	TOTAL APT		78	0	0	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1										0
	CLOTH_P	Clothing Store (pre-engineered)	5							1	1		1
	CONV_E	Convenience Store (engineered)	5										0
	ELEC_E	Electronics Retailer (engineered)	3										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	HOSP_E	Hospital (engineered)	2										0
	MED_E	Medical Office (engineered)	5					1	1	1	1	1	2
	OFF_E	Office Building - One Story (engineered)	16									1	1
	REST_E	Restaurant (engineered)	7										0
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	12									2	2
	COM_D	Direct Depth Damage Data	7									1	1
	TOTAL COM		68	0	0	0	0	1	1	2	2	5	8
IND	LT_E	Light Manufacturing (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	5						1	1	1		1
	SCH_E	School (engineered)	3										0
	TOTAL PUB		9	0	0	0	0	0	1	1	1	0	1
RES	1SNB	One Story No Basement	113							2	2	5	7
	1SWB	One Story With Basement	154		1	2	2	4	4	5	5	2	7
	2SNB	Two Story No Basement	86					1	1	5	5	16	21
	2SWB	Two Story With Basement	456				5	14	24	35	41	95	136
	BLNB	Bi-Level No Basement	1										0
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	53							1	1	2	3
	TOTAL RES		864	0	1	2	7	19	29	48	54	120	174
AUTO	SEDAN	Sedan style	115									15	15
	SPORTS	Sport Cars	11									2	2
	MINI	Mini Vans	12										0
	SUV	Sports Utility Vehicles	12										0
	PICKUPS	Pickup Trucks	7									1	1
	TOTAL AUTO		157	0	0	0	0	0	0	0	0	18	18
TRAFFIC		Direct Depth Damage Data	6									1	1
	Total		1183	0	1	2	7	20	31	51	58	144	202

Table 3.21 – Farmer-Prairie Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	78							1	1	7	8
	TOTAL APT		78	0	0	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1										0
	CLOTH_P	Clothing Store (pre-engineered)	5							1	1		1
	CONV_E	Convenience Store (engineered)	5										0
	ELEC_E	Electronics Retailer (engineered)	3										0
	FFR_E	Fast Food Restaurant (engineered)	2										0
	FURN_E	Furniture Store (engineered)	1										0
	GROC_E	Grocery Store (engineered)	1										0
	HOSP_E	Hospital (engineered)	2										0
	MED_E	Medical Office (engineered)	5					1	1	1	1	1	2
	OFF_E	Office Building - One Story (engineered)	16									1	1
	REST_E	Restaurant (engineered)	7										0
	REST_P	Restaurant (pre-engineered)	1										0
	SERV_E	Service Related Business (engineered)	12									2	2
	COM_D	Direct Depth Damage Data	7									1	1
	TOTAL COM		68	0	0	0	0	1	1	2	2	5	7
IND	LT_E	Light Manufacturing (engineered)	1										0
	TOTAL IND		1	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	1										0
	RF_E	Religious (engineered)	5						1	1	1		1
	SCH_E	School (engineered)	3										0
	TOTAL PUB		9	0	0	0	0	0	1	1	1	0	1
RES	1SNB	One Story No Basement	113							2	2	5	7
	1SWB	One Story With Basement	154		1	2	2	4	4	5	5	2	7
	2SNB	Two Story No Basement	86					1	1	5	5	16	21
	2SWB	Two Story With Basement	456				5	14	24	35	41	95	136
	BLNB	Bi-Level No Basement	1										0
	TLNB	Tri-Level No Basement	1										0
	TLWB	Tri-Level With Basement	53							1	1	2	3
	TOTAL RES		864	0	1	2	7	19	29	48	54	120	174
AUTO	SEDAN	Sedan style	115									15	15
	SPORTS	Sport Cars	11									2	2
	MINI	Mini Vans	12										0
	SUV	Sports Utility Vehicles	12										0
	PICKUPS	Pickup Trucks	7									1	1
	TOTAL AUTO		157	0	0	0	0	0	0	0	0	18	18
TRAFFIC		Direct Depth Damage Data	6									1	1
	Total		1183	0	1	2	7	20	31	51	57	144	201

Table 3.22 – Farmer-Prairie Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	32									3	3
	TOTAL APT		32	0	0	0	0	0	0	0	0	0	0
COM	FFR_E	Fast Food Restaurant (engineered)	1										0
	HTL_E	Hotel (engineered)	1								1		1
	OFF_E	Office Building - One Story (engineered)	5								3	1	4
	OFF_P	Office Building - One Story (pre-engineered)	1								1		1
	REST_E	Restaurant (engineered)	2										0
	COM_D	Direct Depth Damage Data	6									1	1
	TOTAL COM		16	0	0	0	0	0	0	0	5	2	7
IND	WH_P	Warehouse (pre-engineered)	1										0
	IND_D	Direct Depth Damage Data	2										0
	TOTAL IND		3	0	0	0	0	0	0	0	0	0	0
PUB	REC_E	Recreational (engineered)	2										0
	TOTAL PUB		2	0	0	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	67								6	3	9
	2SWB	Two Story With Basement	12										0
	TLWB	Tri-Level With Basement	21								1	1	2
	TOTAL RES		100	0	0	0	0	0	0	0	7	4	11
AUTO	SEDAN	Sedan style	11										0
	SPORTS	Sport Cars	1										0
	MINI	Mini Vans	2										0
	SUV	Sports Utility Vehicles	2										0
	PICKUPS	Pickup Trucks	2										0
	TOTAL AUTO		18	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	7									5	5
	Total		178	0	0	0	0	0	0	0	12	11	23

Table 3.23 – Willow-Higgins Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	32								3	10	13
	TOTAL APT		32	0	0	0	0	0	0	0	3	10	13
COM	FFR_E	Fast Food Restaurant (engineered)	1									1	1
	HTL_E	Hotel (engineered)	1								1		1
	OFF_E	Office Building - One Story (engineered)	5								5		5
	OFF_P	Office Building - One Story (pre-engineered)	1								1		1
	REST_E	Restaurant (engineered)	2									1	1
	COM_D	Direct Depth Damage Data	6									2	2
	TOTAL COM		16	0	0	0	0	0	0	0	7	4	11
IND	WH_P	Warehouse (pre-engineered)	1								1		1
	IND_D	Direct Depth Damage Data	2										0
	TOTAL IND		3	0	0	0	0	0	0	0	1	0	1
PUB	REC_E	Recreational (engineered)	2									1	1
	TOTAL PUB		2	0	0	0	0	0	0	0	0	1	1
RES	1SWB	One Story With Basement	67								9	12	21
	2SWB	Two Story With Basement	12								2		2
	TLWB	Tri-Level With Basement	21								2	2	4
	TOTAL RES		100	0	0	0	0	0	0	0	13	14	27
AUTO	SEDAN	Sedan style	11										0
	SPORTS	Sport Cars	1										0
	MINI	Mini Vans	2										0
	SUV	Sports Utility Vehicles	2										0
	PICKUPS	Pickup Trucks	2										0
	TOTAL AUTO		18	0	0	0	0	0	0	0	0	0	0
TRAFFIC		Direct Depth Damage Data	7									7	7
	Total		178	0	0	0	0	0	0	0	24	36	60

Table 3.24 – Willow-Higgins Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	6							2	3	1	4
	TOTAL APT		6	0	0	0	0	0	0	2	3	1	4
COM	CONV_E	Convenience Store (engineered)	2					1	1	1	1		1
	ELEC_E	Electronics Retailer (engineered)	1						1	1	1		1
	FFR_E	Fast Food Restaurant (engineered)	3								0		
	HOSP_E	Hospital (engineered)	1						1	1	1		1
	MED_E	Medical Office (engineered)	4							1	1		1
	OFF_E	Office Building - One Story (engineered)	32		1	1	1	1	2	2	9	4	13
	REST_E	Restaurant (engineered)	4						3	3	3		3
	SERV_E	Service Related Business (engineered)	6		1	1	1	1	2	2	4		4
	COM_D	Direct Depth Damage Data	4									4	4
	TOTAL COM		57	0	2	2	2	3	10	11	20	8	28
IND	LT_E	Light Manufacturing (engineered)	7							1	2	1	3
	LT_P	Light Manufacturing (pre-engineered)	1										1
	WH_P	Warehouse (pre-engineered)	1										0
	IND_D	Direct Depth Damage Data	10									10	10
	TOTAL IND		19	0	0	0	0	0	0	1	2	11	14
PUB	REC_E	Recreational (engineered)	3										
	RF_E	Religious (engineered)	1										
	TOTAL PUB		4	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	260	5	8	23	40	68	103	118	139	35	174
	1SWB	One Story With Basement	589	1	4	12	25	53	106	134	182	77	259
	2SNB	Two Story No Basement	17			4	6	6	8	8	10	2	12
	2SWB	Two Story With Basement	92					10	29	35	53	19	72
	BLNB	Bi-Level No Basement	1							1	1		1
	BLWB	Bi-Level With Basement	8						1	2	2	1	3
	TLWB	Tri-Level With Basement	37			1	3	8	14	16	18	3	21
	TOTAL RES		1004	6	12	40	74	145	261	314	405	137	542
AUTO	SEDAN	Sedan style	153		1	2	5	5	11	15	19	10	29
	SPORTS	Sport Cars	10					1	2	2	2	1	3
	MINI	Mini Vans	11						1	1	2		2
	SUV	Sports Utility Vehicles	9									1	1
	PICKUPS	Pickup Trucks	10					1	2	3	4		4
	TOTAL AUTO		193	0	1	2	5	7	16	21	27	12	39
TRAFFIC		Direct Depth Damage Data	7									7	7
	Total		1290	6	15	44	81	155	287	349	457	176	633

Table 3.25 – Silver Creek Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	6							2	3	1	4
	TOTAL APT		6	0	0	0	0	0	0	2	3	1	4
COM	CONV_E	Convenience Store (engineered)	2					1	1	1	1		1
	ELEC_E	Electronics Retailer (engineered)	1						1	1	1		1
	FFR_E	Fast Food Restaurant (engineered)	3							0	0		0
	HOSP_E	Hospital (engineered)	1					0	1	1	1		1
	MED_E	Medical Office (engineered)	4							1	1	1	2
	OFF_E	Office Building - One Story (engineered)	32		1	1	1	1	2	2	9	5	14
	REST_E	Restaurant (engineered)	4						3	3	3		3
	SERV_E	Service Related Business (engineered)	6		1	1	1	1	2	2	4		4
	COM_D	Direct Depth Damage Data	4										0
	TOTAL COM		57	0	2	2	2	3	10	11	20	6	26
IND	LT_E	Light Manufacturing (engineered)	7							1	2	1	3
	LT_P	Light Manufacturing (pre-engineered)	1										
	WH_P	Warehouse (pre-engineered)	1										
	IND_D	Direct Depth Damage Data	10									10	10
	TOTAL IND		19	0	0	0	0	0	0	1	2	11	13
PUB	REC_E	Recreational (engineered)	3										
	RF_E	Religious (engineered)	1								0		0
	TOTAL PUB		4	0	0	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	260	5	8	23	40	67	104	118	139	35	174
	1SWB	One Story With Basement	589	1	4	12	25	54	106	134	182	77	259
	2SNB	Two Story No Basement	17			4	6	6	8	8	10	2	12
	2SWB	Two Story With Basement	92					10	29	35	53	19	72
	BLNB	Bi-Level No Basement	1						1	1	1		1
	BLWB	Bi-Level With Basement	8						1	2	2	1	3
	TLWB	Tri-Level With Basement	37			1	3	8	14	16	18	3	21
	TOTAL RES		1,004	6	12	40	74	145	263	314	405	137	542
AUTO	SEDAN	Sedan style	153		1	2	5	5	11	15	19	10	29
	SPORTS	Sport Cars	10					1	2	2	2	1	3
	MINI	Mini Vans	11						1	1	2		2
	SUV	Sports Utility Vehicles	9									1	1
	PICKUPS	Pickup Trucks	10					1	3	3	4		4
	TOTAL AUTO		193	0	1	2	5	7	17	21	27	12	39
TRAFFIC		Direct Depth Damage Data	7									7	7
	Total		1,290	6	15	44	81	155	290	349	457	178	635

Table 3.26 – Silver Creek Potentially Damaged Structures – 2020 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	288	0	2	12	25	43	62	81	123	134	257
	TOTAL APT		288	0	2	12	25	43	62	81	123	134	257
COM	CLOTH_E	Clothing Store (engineered)	1								1		1
	CONV_E	Convenience Store (engineered)	6					1	2	2	4	2	6
	ELEC_E	Electronics Retailer (engineered)	4						1	1	3	1	4
	FFR_E	Fast Food Restaurant (engineered)	16			1	3	4	5	7	9	7	16
	FURN_E	Furniture Store (engineered)	2					1	1	1	1		1
	HOSP_E	Hospital (engineered)	7								3	3	6
	HTL_E	Hotel (engineered)	9						1	1	5	4	9
	MED_E	Medical Office (engineered)	7						2	4	4	2	6
	OFF_E	Office Building - One Story (engineered)	87			2	12	23	32	39	64	21	85
	REST_E	Restaurant (engineered)	24			1	1	4	6	7	18	5	23
	SERV_E	Service Related Business (engineered)	57			3	5	9	18	27	43	9	52
	TOTAL COM		220	0	0	7	21	42	68	89	155	54	209
IND	LT_E	Light Manufacturing (engineered)	70					1	7	14	39	26	65
	LT_P	Light Manufacturing (pre-engineered)	1								1		1
	WH_E	Warehouse (engineered)	19					1	2	7	12	6	18
	WH_P	Warehouse (pre-engineered)	5						2	2	2	3	5
	WHR_E	Warehouse Refrigerated (engineered)	1						1	1	1		1
	TOTAL IND		96	0	0	0	0	2	12	24	55	35	90
PUB	PS_E	Protective Services (engineered)	4							1	1	3	4
	REC_E	Recreational (engineered)	11				1	2	2	4	5	6	11
	RF_E	Religious (engineered)	8			2	3	3	4	4	5	1	6
	SCH_E	School (engineered)	9		1	1	1	2	2	3	5	4	9
	TOTAL PUB		32	0	1	3	5	7	8	12	16	14	30
RES	1SNB	One Story No Basement	288			4	17	47	75	197	217	62	279
	1SWB	One Story With Basement	1,722		2	14	52	161	297	453	742	605	1,347
	2SNB	Two Story No Basement	240			2	4	19	53	78	120	36	156
	2SWB	Two Story With Basement	638		3	14	37	66	97	148	267	252	519
	BLWB	Bi-Level With Basement	32				2	6	18	18	18	11	29
	TLNB	Tri-Level No Basement	26			1	1	4	8	10	14	11	25
	TLWB	Tri-Level With Basement	274			5	10	32	51	70	116	116	232
	TOTAL RES		3,220	0	5	40	123	335	599	974	1,494	1,093	2,587
AUTO	SEDAN	Sedan style	451	1	5	18	25	35	59	68	122	329	451
	SPORTS	Sport Cars	53	1	1	2	2	4	7	8	13	40	53
	MINI	Mini Vans	41					1	3	5	5	36	41
	SUV	Sports Utility Vehicles	41			1	2	4	5	5	9	32	41
	PICKUPS	Pickup Trucks	41		1	2	2	3	4	8	14	27	41
	TOTAL AUTO		627	2	7	23	31	47	78	94	163	464	627
TRAFFIC		Direct Depth Damage Data	44									44	44
	Total		4,527	2	15	85	205	476	827	1,274	2,006	1,838	3,844

Table 3.27 – Des Plaines Mainstem (IL) Potentially Damaged Structures – 2010 Conditions

Category Code	Occupancy Code	DESCRIPTION	Inventoried Structures	Structures Damaged by Annual Chance of Exceedance								Structures Identified by Uncertainty	Total Damaged Structures
				99%	50%	20%	10%	4%	2%	1%	0.2%		
APT	APT_E	Apartment/Condo (engineered)	288		3	14	26	48	68	87	129	128	257
	TOTAL APT		288	0	3	14	26	48	68	87	129	128	257
COM	CLOTH_E	Clothing Store (engineered)	1								1		1
	CONV_E	Convenience Store (engineered)	6					1	2	2	4	2	6
	ELEC_E	Electronics Retailer (engineered)	4					1	1	1	3	1	4
	FFR_E	Fast Food Restaurant (engineered)	16			1	3	5	5	7	9	7	16
	FURN_E	Furniture Store (engineered)	2					1	1	1	1	1	2
	HOSP_E	Hospital (engineered)	7								3	3	6
	HTL_E	Hotel (engineered)	9						1	1	6	3	9
	MED_E	Medical Office (engineered)	7						3	4	4	2	6
	OFF_E	Office Building - One Story (engineered)	87			3	14	26	35	47	72	13	85
	REST_E	Restaurant (engineered)	24			1	1	6	6	9	18	5	23
	SERV_E	Service Related Business (engineered)	57			3	5	12	20	29	44	8	52
	TOTAL COM		220	0	0	8	23	52	74	101	165	45	210
IND	LT_E	Light Manufacturing (engineered)	70					3	12	15	46	19	65
	LT_P	Light Manufacturing (pre-engineered)	1								1		1
	WH_E	Warehouse (engineered)	19					2	4	7	12	6	18
	WH_P	Warehouse (pre-engineered)	5					1	2	2	2	3	5
	WHR_E	Warehouse Refrigerated (engineered)	1						1	1	1		1
	TOTAL IND		96	0	0	0	0	6	19	25	62	28	90
PUB	PS_E	Protective Services (engineered)	4						1	1	1	3	4
	REC_E	Recreational (engineered)	11			1	1	2	3	4	6	5	11
	RF_E	Religious (engineered)	8			2	3	3	4	4	5	1	6
	SCH_E	School (engineered)	9		1	1	1	2	3	4	5	4	9
	TOTAL PUB		32	0	1	4	5	7	11	13	17	13	30
RES	1SNB	One Story No Basement	288			5	25	53	167	203	218	59	277
	1SWB	One Story With Basement	1,722		2	28	70	206	345	498	805	493	1,298
	2SNB	Two Story No Basement	240			2	4	30	69	89	122	77	199
	2SWB	Two Story With Basement	638		4	17	44	73	114	168	286	243	529
	BLWB	Bi-Level With Basement	32				2	6	18	18	18	10	28
	TLNB	Tri-Level No Basement	26			1	1	5	8	11	14	10	24
	TLWB	Tri-Level With Basement	274			8	16	37	56	82	121	110	231
	TOTAL RES		3,220	0	6	61	162	410	777	1,069	1,584	1,002	2,586
AUTO	SEDAN	Sedan style	451	1	6	21	27	46	62	78	142	309	451
	SPORTS	Sport Cars	53	1	2	2	2	5	7	9	17	36	53
	MINI	Mini Vans	41					2	4	5	11	30	41
	SUV	Sports Utility Vehicles	41			1	3	5	5	5	12	29	41
	PICKUPS	Pickup Trucks	41		1	2	2	3	4	8	17	24	41
	TOTAL AUTO		627	2	9	26	34	61	82	105	199	428	627
TRAFFIC		Direct Depth Damage Data	44									44	44
	Total		4,527	2	19	113	250	584	1,031	1,400	2,156	1,688	3,844

Table 3.28 – Des Plaines Mainstem (IL) Potentially Damaged Structures – 2020 Conditions

Watershed	APT	COM	IND	PUB	RES	AUTO	TRAFFIC	TOTAL
Brighton Creek	0	0	0	0	34	0	0	34
Dutch Gap Canal	0	0	0	0	10	0	0	10
Center Creek	0	0	0	0	1	0	0	1
Kilbourn Road Ditch	0	0	0	0	2	0	0	2
Jerome Creek	0	0	0	0	10	0	0	10
Des Plaines River Mainstem (WI)	0	0	0	0	8	0	18	8
Newport Ditch	0	0	1	0	29	7	4	37
Mill Creek	8	28	10	5	496	104	13	651
Bull Creek	0	4	0	2	69	16	4	91
Indian Creek	1	4	1	0	138	31	6	175
Buffalo-Wheeling Creek	37	80	31	6	1,089	211	13	1,454
McDonald Creek	0	1	4	1	179	35	2	220
Weller Creek	0	1	1	0	413	78	2	493
Farmer-Prairie Creek	78	68	1	9	864	157	6	1,177
Willow-Higgins Creek	32	16	3	2	100	18	7	171
Silver Creek	6	57	19	4	1,004	193	7	1,283
Des Plaines River Mainstem (IL)	288	220	96	32	3,220	627	44	4,483
TOTAL	450	479	167	61	7,666	1,477	126	10,300

Table 3.29 – Summary of Structures in Inventory

Watershed	APT	COM	IND	PUB	RES	AUTO	TRAFFIC	TOTAL
Brighton Creek	0	0	0	0	34	0	0	34
Dutch Gap Canal	0	0	0	0	10	0	0	10
Center Creek	0	0	0	0	1	0	0	1
Kilbourn Road Ditch	0	0	0	0	2	0	0	2
Jerome Creek	0	0	0	0	10	0	0	10
Des Plaines River Mainstem (WI)	0	0	0	0	8	0	18	26
Newport Ditch	0	0	0	0	2	1	2	5
Mill Creek	1	11	8	2	22	3	6	53
Bull Creek	0	0	0	2	41	5	2	50
Indian Creek	0	3	0	0	49	4	3	59
Buffalo-Wheeling Creek	25	20	8	0	734	119	7	913
McDonald Creek	0	0	0	0	17	0	0	17
Weller Creek	0	0	1	0	328	51	2	381
Farmer-Prairie Creek	0	7	0	1	174	18	1	202
Willow-Higgins Creek	0	7	0	0	11	0	5	23
Silver Creek	4	28	13	0	542	39	7	633
Des Plaines River Mainstem (IL)	257	209	90	30	2,587	627	44	3,844
TOTAL	287	285	120	35	4,572	867	97	6,263

Table 3.30 – Summary of 2010 Condition Potentially Damaged Structures

Watershed	APT	COM	IND	PUB	RES	AUTO	TRAFFIC	TOTAL
Brighton Creek	0	0	0	0	34	0	0	34
Dutch Gap Canal	0	0	0	0	10	0	0	10
Center Creek	0	0	0	0	1	0	0	1
Kilbourn Road Ditch	0	0	0	0	2	0	0	2
Jerome Creek	0	0	0	0	10	0	0	10
Des Plaines River Mainstem (WI)	0	0	0	0	8	0	18	26
Newport Ditch	0	0	0	0	2	1	2	5
Mill Creek	1	11	8	2	22	3	7	54
Bull Creek	0	0	0	8	41	5	2	56
Indian Creek	0	0	0	0	49	4	3	56
Buffalo-Wheeling Creek	0	16	0	0	736	119	7	878
McDonald Creek	0	0	0	0	17	0	0	17
Weller Creek	0	0	0	0	319	53	2	374
Farmer-Prairie Creek	0	8	0	1	174	18	1	202
Willow-Higgins Creek	13	11	1	1	27	0	7	60
Silver Creek	4	30	13	0	542	39	7	635
Des Plaines River Mainstem (IL)	257	210	90	30	2,586	627	44	3,844
TOTAL	275	286	112	42	4,580	869	100	6,264

Table 3.31 – Summary of 2020 Condition Potentially Damaged Structures

The location of damage in buildings can provide information about impacts to the structure from flooding. Using first floor and flood elevation data, the number of structures damaged only below the first floor elevation for each modeled flood event was tabulated. Since the data is only shows the number of structures with impacts below the first floor the count of structures at lower frequencies will not be additive. If a structure is flooded due to a low water entry point below the first floor the frequency at which that occurs with register a count for that structure. The table will continue to register this count at each frequency until the flood depth hits the first flood. When a flood depth reaches or surpass the structure's first floor the count will drop off the tabulation. This summary is shown in Table 3.32 through Table 3.59.

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SNB	One Story No Basement	12		1	1	6	9	10	12	12
	1SWB	One Story With Basement	12		2	2	11	12	12	12	12
	2SNB	Two Story No Basement	3				1	2	2	3	3
	2SWB	Two Story With Basement	1					1	1	1	1
	BLNB	Bi-Level No Basement	1				1	1	1	1	1
	BLWB	Bi-Level With Basement	5				3	4	5	5	5
	TOTAL RES		34	0	3	3	22	29	31	34	34
	Total		34	0	3	3	22	29	31	34	34

Table 3.32 – Brighton Creek Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SNB	One Story No Basement	4				2	4	4	4	4
	2SNB	Two Story No Basement	1				1	1	1	1	1
	2SWB	Two Story With Basement	2				2	2	2	2	2
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1
	RES_D	Direct Depth Damage Data	2				1	1	2	2	2
	TOTAL RES		10	0	1	1	7	9	10	10	10
	Total		10	0	1	1	7	9	10	10	10

Table 3.33 – Dutch Gap Canal Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	1					1	1	1	1
	TOTAL RES		1	0	0	0	0	1	1	1	1
	Total		1	0	0	0	0	1	1	1	1

Table 3.34 – Center Creek Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	1		1	1	1	1	1	1	1
	RES_D	Direct Depth Damage Data	1					1	1	1	1
	TOTAL RES		2	0	1	1	1	2	2	2	2
	Total		2	0	1	1	1	2	2	2	2

Table 3.35 – Kilbourn Road Ditch Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SNB	One Story No Basement	6				1	3	4	6	6
	1SWB	One Story With Basement	2		1	1	1	2	2	2	2
	2SNB	Two Story No Basement	1							1	1
	BLWB	Bi-Level With Basement	1		1	1	1	1	1	1	1
	TOTAL RES		10	0	2	2	3	6	7	10	10
	Total		10	0	2	2	3	6	7	10	10

Table 3.36 – Jerome Creek Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	4		1	1	1	2	3	4	4
	BLWB	Bi-Level With Basement	1							1	1
	RES_D	Direct Depth Damage Data	3					2	2	3	3
	TOTAL RES		8	0	1	1	1	4	5	8	8
	Total		8	0	1	1	1	4	5	8	8

Table 3.37 – Des Plaines River Mainstem (WI) Structures Damaged Below FFE

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	TLNB	Tri-Level No Basement	1							1	
	TOTAL RES		1	0	0	0	0	0	0	1	0
	Total		1	0	0	0	0	0	0	1	0

Table 3.38 – Newport Drainage Ditch Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	TLNB	Tri-Level No Basement	1							1	
	TOTAL RES		1	0	0	0	0	0	0	1	0
	Total		1	0	0	0	0	0	0	1	0

Table 3.39 – Newport Drainage Ditch Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	1								
	FURN_P	Furniture Store (pre-engineered)	1								1
	OFF_E	Office Building - One Story (engineered)	4								
	SERV_E	Service Related Business (engineered)	2								
	TOTAL COM		9	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_P	Warehouse (pre-engineered)	4								
	TOTAL IND		7	0	0	0	0	0	0	0	0
PUB	SCH_E	School (engineered)	2								
	TOTAL PUB		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	6								4
	1SWB	One Story With Basement	4					1	1	1	2
	2SWB	Two Story With Basement	3							1	2
	TLWB	Tri-Level With Basement	1						1	1	1
	TOTAL RES		14					1	2	3	9
	Total		32	0	0	0	0	1	2	3	10

Table 3.40 – Mill Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	1								
	FURN_P	Furniture Store (pre-engineered)	1								1
	OFF_E	Office Building - One Story (engineered)	4								
	SERV_E	Service Related Business (engineered)	2								
	TOTAL COM		9	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_P	Warehouse (pre-engineered)	4								
	TOTAL IND		7	0	0	0	0	0	0	0	0
PUB	SCH_E	School (engineered)	2								
	TOTAL PUB		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	7								4
	1SWB	One Story With Basement	4					1	1	1	2
	2SWB	Two Story With Basement	4							1	3
	TLWB	Tri-Level With Basement	1					1	1	1	1
	TOTAL RES		16					2	2	3	10
	Total		34	0	0	0	0	2	2	3	11

Table 3.41 – Mill Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
PUB	REC_E	Recreational (engineered)	1								
	SCH_E	School (engineered)	1								
	TOTAL PUB		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2				1				
	1SWB	One Story With Basement	9					1		3	3
	2SNB	Two Story No Basement	1								
	2SWB	Two Story With Basement	20					1	6	3	3
	BLNB	Bi-Level No Basement	1								1
	TLWB	Tri-Level With Basement	2					2	1	1	1
	TOTAL RES		35	0	0	0	1	4	7	7	8
	Total		37	0	0	0	1	4	7	7	8

Table 3.42 – Bull Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
PUB	REC_E	Recreational (engineered)	1								
	SCH_E	School (engineered)	1								
	TOTAL PUB		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2				1				
	1SWB	One Story With Basement	9					1		3	3
	2SNB	Two Story No Basement	1								
	2SWB	Two Story With Basement	20					1	6	3	3
	TLWB	Tri-Level With Basement	2				1	2	1	1	1
	TOTAL RES		34	0	0	0	2	4	7	7	7
	Total		36	0	0	0	2	4	7	7	7

Table 3.43 – Bull Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	OFF_E	Office Building - One Story (engineered)	1								
	SERV_E	Service Related Business (engineered)	1								1
	TOTAL COM		2	0	0	0	0	0	0	0	1
RES	1SWB	One Story With Basement	3						1	1	2
	2SWB	Two Story With Basement	32		1	1	2	3	6	8	28
	TLWB	Tri-Level With Basement	1								
	TOTAL RES		36	0	1	1	2	3	7	9	30
	Total		38	0	1	1	2	3	7	9	31

Table 3.44 – Indian Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	OFF_E	Office Building - One Story (engineered)	1								
	SERV_E	Service Related Business (engineered)	1								1
	TOTAL COM		2	0	0	0	0	0	0	0	1
RES	1SWB	One Story With Basement	3						1	1	2
	2SWB	Two Story With Basement	32		1	1	2	3	6	8	28
	TLWB	Tri-Level With Basement	1								
	TOTAL RES		36	0	1	1	2	3	7	9	30
	Total		38	0	1	1	2	3	7	9	31

Table 3.45 – Indian Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	20								
	TOTAL APT		20	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	FFR_E	Fast Food Restaurant (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	8								1
	REST_P	Restaurant (pre-engineered)	1								
	SERV_E	Service Related Business (engineered)	2								
	TOTAL COM		13	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	2								
	WH_P	Warehouse (pre-engineered)	1								
	TOTAL IND		6	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	341				1	10	17	51	41
	1SWB	One Story With Basement	140						9	18	70
	2SNB	Two Story No Basement	136					1	1	5	13
	2SWB	Two Story With Basement	10							2	5
	TLNB	Tri-Level No Basement	27					1			
	TLWB	Tri-Level With Basement	4								4
	TOTAL RES		658	0	0	0	1	12	27	76	133
	Total		697	0	0	0	1	12	27	76	134

Table 3.46 – Buffalo-Wheeling Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	20								
	TOTAL APT		20	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	FFR_E	Fast Food Restaurant (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	8								1
	REST_P	Restaurant (pre-engineered)	1								
	SERV_E	Service Related Business (engineered)	2								
	TOTAL COM		13	0	0	0	0	0	0	0	1
IND	LT_E	Light Manufacturing (engineered)	2								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	2								
	WH_P	Warehouse (pre-engineered)	1								
	TOTAL IND		6	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	343				1	11	20	65	40
	1SWB	One Story With Basement	140						9	25	70
	2SNB	Two Story No Basement	139					1	3	6	12
	2SWB	Two Story With Basement	10							2	5
	TLNB	Tri-Level No Basement	27					1			
	TLWB	Tri-Level With Basement	4								4
	TOTAL RES		663	0	0	0	1	13	32	98	131
	Total		702	0	0	0	1	13	32	98	132

Table 3.47 – Buffalo-Wheeling Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	2SWB	Two Story With Basement	1								1
	TLWB	Tri-Level With Basement	1								1
	TOTAL RES		2	0	0	0	0	0	0	0	2
	Total		2	0	0	0	0	0	0	0	2

Table 3.48 – McDonald Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	2SWB	Two Story With Basement	1								1
	TLWB	Tri-Level With Basement	1								1
	TOTAL RES		2	0	0	0	0	0	0	0	2
	Total		2	0	0	0	0	0	0	0	2

Table 3.49 – McDonald Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	136							10	64
	2SWB	Two Story With Basement	65						1	9	31
	BLWB	Bi-Level With Basement	6								6
	TLWB	Tri-Level With Basement	62							2	10
	TOTAL RES		269	0	0	0	0	0	1	21	111
	Total		269	0	0	0	0	0	1	21	111

Table 3.50 – Weller Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
RES	1SWB	One Story With Basement	140							45	61
	2SWB	Two Story With Basement	70							28	31
	BLWB	Bi-Level With Basement	6								6
	TLWB	Tri-Level With Basement	63							6	7
	TOTAL RES		279	0	0	0	0	0	0	79	105
	Total		279	0	0	0	0	0	0	79	105

Table 3.51 – Weller Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	1								
	TOTAL APT		1	0	0	0	0	0	0	0	0
COM	CLOTH_P	Clothing Store (pre-engineered)	1								
	MED_E	Medical Office (engineered)	1								
	TOTAL COM		2	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1								
	TOTAL PUB		1	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2							1	1
	1SWB	One Story With Basement	5		1	1	1	3	3	3	3
	2SNB	Two Story No Basement	5					1	1	3	3
	2SWB	Two Story With Basement	41				5	14	24	32	33
	TLWB	Tri-Level With Basement	1								
	TOTAL RES		54	0	1	1	6	18	28	39	40
	Total		58	0	1	1	6	18	28	39	40

Table 3.52 – Farmer-Prairie Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	1								
	TOTAL APT		1	0	0	0	0	0	0	0	0
COM	CLOTH_P	Clothing Store (pre-engineered)	1								
	MED_E	Medical Office (engineered)	1								
	TOTAL COM		2	0	0	0	0	0	0	0	0
PUB	RF_E	Religious (engineered)	1								
	TOTAL PUB		1	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	2							1	1
	1SWB	One Story With Basement	5		1	1	1	3	3	3	3
	2SNB	Two Story No Basement	5					1	1	3	3
	2SWB	Two Story With Basement	41				5	14	24	32	33
	TLWB	Tri-Level With Basement	1								
	TOTAL RES		54	0	1	1	6	18	28	39	40
	Total		58	0	1	1	6	18	28	39	40

Table 3.53 – Farmer-Prairie Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
COM	HTL_E	Hotel (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	3								
	OFF_P	Office Building - One Story (pre-engineered)	1								
	TOTAL COM		5	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	6								6
	TLWB	Tri-Level With Basement	1								1
	TOTAL RES		7	0	0	0	0	0	0	0	7
	Total		12	0	0	0	0	0	0	0	7

Table 3.54 – Willow-Higgins Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	3								
	TOTAL APT		3	0	0	0	0	0	0	0	0
COM	HTL_E	Hotel (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	5								1
	OFF_P	Office Building - One Story (pre-engineered)	1								
	TOTAL COM		7	0	0	0	0	0	0	0	1
IND	WH_P	Warehouse (pre-engineered)	1								
	TOTAL IND		1	0	0	0	0	0	0	0	0
RES	1SWB	One Story With Basement	9								8
	2SWB	Two Story With Basement	2								2
	TLWB	Tri-Level With Basement	2								1
	TOTAL RES		13	0	0	0	0	0	0	0	11
	Total		24	0	0	0	0	0	0	0	12

Table 3.55 – Willow-Higgins Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	3								
	TOTAL APT		3	0	0	0	0	0	0	0	0
COM	CONV_E	Convenience Store (engineered)	1								
	ELEC_E	Electronics Retailer (engineered)	1								
	HOSP_E	Hospital (engineered)	1								
	MED_E	Medical Office (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	9						1	1	3
	REST_E	Restaurant (engineered)	3								
	SERV_E	Service Related Business (engineered)	4								
	TOTAL COM		20	0	0	0	0	0	1	1	3
IND	LT_E	Light Manufacturing (engineered)	2								
	TOTAL IND		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	139	4	6	18	30	43	53	45	44
	1SWB	One Story With Basement	182	1	4	8	14	30	73	97	131
	2SNB	Two Story No Basement	10			3	4	2	4	1	2
	2SWB	Two Story With Basement	53					10	29	35	53
	BLNB	Bi-Level No Basement	1							1	1
	BLWB	Bi-Level With Basement	2						1	2	2
	TLWB	Tri-Level With Basement	18			1	3	4	9	10	9
	TOTAL RES		405	5	10	30	51	89	169	191	242
	Total		430	5	10	30	51	89	170	192	245

Table 3.56 – Silver Creek Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	3								
	TOTAL APT		3	0	0	0	0	0	0	0	0
COM	CONV_E	Convenience Store (engineered)	1								
	ELEC_E	Electronics Retailer (engineered)	1								
	HOSP_E	Hospital (engineered)	1								
	MED_E	Medical Office (engineered)	1								
	OFF_E	Office Building - One Story (engineered)	9						1	1	3
	REST_E	Restaurant (engineered)	3								
	SERV_E	Service Related Business (engineered)	4								
	TOTAL COM		20	0	0	0	0	0	1	1	3
IND	LT_E	Light Manufacturing (engineered)	2								
	TOTAL IND		2	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	139	4	6	18	30	42	53	45	44
	1SWB	One Story With Basement	182	1	4	8	14	31	72	97	131
	2SNB	Two Story No Basement	10			3	4	2	4	1	2
	2SWB	Two Story With Basement	53					10	29	35	53
	BLNB	Bi-Level No Basement	1						1	1	1
	BLWB	Bi-Level With Basement	2						1	1	2
	TLWB	Tri-Level With Basement	18			1	3	4	9	10	8
	TOTAL RES		405	5	10	30	51	89	169	191	241
	Total		430	5	10	30	51	89	170	192	244

Table 3.57 – Silver Creek Structures Damaged Below FFE 2020

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	123								
	TOTAL APT		123	0	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	4								
	ELEC_E	Electronics Retailer (engineered)	3								
	FFR_E	Fast Food Restaurant (engineered)	9								
	FURN_E	Furniture Store (engineered)	1								
	HOSP_E	Hospital (engineered)	3								
	HTL_E	Hotel (engineered)	5								
	MED_E	Medical Office (engineered)	4								
	OFF_E	Office Building - One Story (engineered)	64							1	1
	REST_E	Restaurant (engineered)	18								
	SERV_E	Service Related Business (engineered)	43								
	TOTAL COM		171	0	0	0	0	0	0	1	1
IND	LT_E	Light Manufacturing (engineered)	39								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	12								
	WH_P	Warehouse (pre-engineered)	2								
	WHR_E	Warehouse Refrigerated (engineered)	1								
	TOTAL IND		64	0	0	0	0	0	0	0	0
PUB	PS_E	Protective Services (engineered)	1								
	REC_E	Recreational (engineered)	5								
	RF_E	Religious (engineered)	5								
	SCH_E	School (engineered)	5								
	TOTAL PUB		17	0	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	217	0	0	2	13	13	15	13	5
	1SWB	One Story With Basement	742	0	2	12	49	138	240	363	482
	2SNB	Two Story No Basement	120	0	0	0	0	2	9	8	13
	2SWB	Two Story With Basement	267	0	3	14	33	53	72	108	178
	BLWB	Bi-Level With Basement	18	0	0	0	2	6	7	3	0
	TLNB	Tri-Level No Basement	14	0	0	1	0	3	3	2	2
	TLWB	Tri-Level With Basement	116	0	0	5	8	17	25	35	51
	TOTAL RES		1630	1494	0	0	0	0	0	0	0
	Total		1843	0	5	34	105	232	371	532	731

Table 3.58 – Des Plaines River Mainstem (IL) Structures Damaged Below FFE 2010

Category Code	Occupancy Code	DESCRIPTION	Total Structures Damaged	Structures Damaged Below First Floor Elevation by Annual Chance of Exceedance							
				99%	50%	20%	10%	4%	2%	1%	0.2%
APT	APT_E	Apartment/Condo (engineered)	129								
	TOTAL APT		146	129	0	0	0	0	0	0	0
COM	CLOTH_E	Clothing Store (engineered)	1								
	CONV_E	Convenience Store (engineered)	4								
	ELEC_E	Electronics Retailer (engineered)	3								
	FFR_E	Fast Food Restaurant (engineered)	9								
	FURN_E	Furniture Store (engineered)	1								
	HOSP_E	Hospital (engineered)	3								
	HTL_E	Hotel (engineered)	6								
	MED_E	Medical Office (engineered)	4								
	OFF_E	Office Building - One Story (engineered)	72						1	1	1
	REST_E	Restaurant (engineered)	18								
	SERV_E	Service Related Business (engineered)	44								
	TOTAL COM		175	165	0	0	0	0	1	1	1
IND	LT_E	Light Manufacturing (engineered)	46								
	LT_P	Light Manufacturing (pre-engineered)	1								
	WH_E	Warehouse (engineered)	12								
	WH_P	Warehouse (pre-engineered)	2								
	WHR_E	Warehouse Refrigerated (engineered)	1								
	TOTAL IND		69	62	0	0	0	0	0	0	0
PUB	PS_E	Protective Services (engineered)	1								
	REC_E	Recreational (engineered)	6								
	RF_E	Religious (engineered)	5								
	SCH_E	School (engineered)	5								
	TOTAL PUB		18	17	0	0	0	0	0	0	0
RES	1SNB	One Story No Basement	218	0	0	3	16	12	16	9	3
	1SWB	One Story With Basement	805	0	2	26	67	176	274	389	509
	2SNB	Two Story No Basement	122	0	0	0	0	5	10	12	11
	2SWB	Two Story With Basement	286	0	4	16	39	53	86	123	189
	BLWB	Bi-Level With Basement	18	0	0	0	2	5	3	2	0
	TLNB	Tri-Level No Basement	14	0	0	1	0	3	2	2	2
	TLWB	Tri-Level With Basement	121	0	0	7	11	20	27	39	48
	TOTAL RES		1839	1584	0	6	53	135	274	418	576
	Total		1957	0	6	53	135	274	418	577	763

Table 3.59 – Des Plaines River Mainstem (IL) Structures Damaged Below FFE 2020

3.4 Transportation Damages

As discussed in Section 2.2, the transportation damage category consists of the cost of traffic delays due to flooded road crossings. The number of crossings inventoried and assigned depth-damage functions, as well as the number potentially damaged by HEC-FDA simulations in 2010 and 2020 scenarios are included in Tables 3.1 through 3.28. Simulation of flood induced delays and detours were obtained from the VISTA transportation modeling. For each scenario and flood frequency, VISTA calculated the cumulative effect of the road closure to the network in terms of additional miles traveled by each vehicle and the additional time it takes each vehicle to get to its destination.

Throughout this report 2010 has been the assumed baseline year. This assumption is based on the implementation of the Des Plaines River Phase I projects within the hydrology and hydraulic modeling. At the time the transportation model was developed, the most current data available was for 2006. Thus data used in the baseline conditions of the transportation model is from this year.

Transportation damage locations were identified by overlaying the Chicago Metropolitan Agency for Planning (CMAP) network on top of the stream/floodplain network for this study. Illinois road closure data was developed from HEC-RAS rating curves and HEC-1 hydrograph data. This dataset provided the depth and duration of flooding for the baseline and future condition scenarios. SEWRPC provided similar flooded road crossing information for sites in Wisconsin. Using this data, USACE calculated the duration of closure for each of the identified roads (see Appendix A – Hydrology & Hydraulics Appendix for more details). The identified roads represent the main arteries for the study area. Once the without project data had been created and calibrated, the contractor created scenario runs for each of the annual exceedance probabilities (1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, and 1/500) using 2006 traffic demand and future traffic demands in 2020. VISTA a cumulative effect of the road closure to the network from these scenarios in terms of additional miles traveled by each vehicle and the additional time it takes each vehicle to get from its origination to its destination.

From each scenario and flood frequency, VISTA calculated the cumulative effect of the road closures to the network in terms of additional miles traveled by each vehicle and the additional time it takes each vehicle to get from its origin to its destination. Table 3.60 details the computed time delay output for the baseline and future conditions. Table 3.61 details the computed distance delay output. These values were monetized as discussed in Section 2.2.3. This section also provides some insight as to why damages decrease for the 1% flood event. As a result of the dynamic nature of the traffic model's response to the spatial distribution and temporal duration of road closures the overall transportation network had improved time savings over the fifty year event. This is counter intuitive for the typical flood risk management analysis where river stages increase with decreasing frequency of the event. Under the typical study the damages are static structures that do not move. Damages for a transportation study need to account for decisions made by drives that are moving about the watershed.

Modeled baseline (2010) conditions without flooding were calibrated to existing conditions using Chicago Metropolitan Agency for Planning (CMAP) data. The modeled delays were reviewed by the Transportation sub-committee of the Project Delivery Team to verify that the projected distribution of delays and detours corresponds with actual impacts experienced in the watershed during past flood events. The average annual baseline damages calculated by the HEC-FDA model using depth damage relationships developed from the VISTA model results are $39,653,000.

Future (2020) conditions were modeled using projected demand data and planned changes to the area roadway network. Modeled future conditions, however, resulted in extreme estimates of delays and resulting damages: initial damage calculations totaled as much as $333 million. A revision of assumptions such as improved driver knowledge of the network did not yield more reasonable results. The modelers noted that the high total delays resulted from a small number of vehicles experiencing extremely long delays, as much as 12 or 13 hours. As these extreme delays would generally not be tolerated by drivers, the resolution identified by the modelers was to truncate vehicle delays to exclude these unrealistic results. The truncation procedure is detailed in the May 2011 modeling report. Mainstem damages calculated in HEC-FDA using these revised total delays are $52,723,000, an increase of 33% over the baseline damages.

However, due to uncertainty in the assumptions used to generate the future condition model and the challenges associated with verifying and calibrating the resulting delays and damages at individual roads, damages in the future condition were related to the depth damage functions developed for the baseline condition. In lieu of modeled future condition depth damage functions, 10% was added to the baseline condition damages used to calculate depth damage functions. This index of 10% corresponds to the projected traffic demand increase 2006 to the 2020 projected by CMAP.

The HEC-FDA result total $54,932,000 equivalent annual damages for the future conditions. The future condition results were increased by only 10% over the baseline data. The effect of the 10% increase over the baseline conditions does not translate to a 10% increase in transportation damages in the future. Changes in future condition flood stages that are also part of the future condition HEC-FDA model will increase the transportation damages. This approach accounts for expected impacts to the road network resulting from projected increases in urbanization within the study area, while maintaining reviewed relationships between high volume roadways and delays resulting from flood-induced road closures.

Upper Des Plaines River Watershed - With Floods

Vehicle Distribution by Delay Bracket - System Wide Results

		Time Savings						No Change	Time Delays					
		> 15 minutes		5 to 15 minutes		0 to 5 minutes		0 min	0 to 5 minutes		5 to 15 minutes		> 15 minutes	
Flood Event	Vehicle Type	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes	Vehicle Count	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes	Vehicle Count	Average Minutes
1-year	Passenger Car	30,441	29.9	37,644	8.9	230,926	0.6	23,838,870	257,038	0.7	27,528	8.8	19,288	49.7
	Commercial Truck	1,164	26.6	1,521	8.5	19,351	0.5	2,153,969	24,932	0.5	876	8.6	367	48.8
2-year	Passenger Car	69,988	29.7	76,332	9.0	569,105	0.6	55,468,736	712,544	0.9	74,691	9.0	59,319	134.8
	Commercial Truck	2,734	26.5	3,500	8.5	49,130	0.5	5,010,509	68,390	0.6	2,667	9.0	1,490	114.3
5-year	Passenger Car	126,272	31.0	116,133	9.1	1,085,869	0.6	94,227,783	1,754,402	1.4	233,719	9.0	222,762	200.5
	Commercial Truck	5,552	29.3	6,391	8.7	91,769	0.5	8,484,067	189,265	1.4	17,212	8.5	14,464	143.4
10-year	Passenger Car	142,328	31.1	130,087	9.1	1,461,321	0.6	116,956,428	2,700,635	1.5	415,593	8.9	402,283	282.0
	Commercial Truck	6,508	29.4	7,739	8.7	118,756	0.5	10,533,476	279,165	1.5	35,649	8.5	29,607	187.8
25-year	Passenger Car	185,267	31.3	162,869	9.1	1,865,867	0.6	147,123,936	3,845,779	1.7	691,473	8.6	922,464	220.2
	Commercial Truck	8,821	30.2	10,095	8.8	152,336	0.5	13,263,505	397,335	1.7	58,061	8.3	56,987	179.2
50-year	Passenger Car	199,776	31.6	163,452	9.2	2,079,013	0.6	160,829,268	4,617,895	1.7	955,034	8.4	2,247,707	215.6
	Commercial Truck	9,415	30.9	10,780	8.8	168,808	0.5	14,550,806	473,693	1.7	87,885	8.3	113,873	179.0
100-year	Passenger Car	194,501	31.8	156,960	9.1	2,091,251	0.6	158,259,939	4,837,327	1.7	1,067,781	8.3	4,484,386	319.5
	Commercial Truck	9,115	31.1	10,570	8.8	171,338	0.5	14,407,332	502,489	1.7	98,497	8.2	215,919	347.3
500-year	Passenger Car	232,932	30.7	221,171	9.0	2,408,623	0.6	184,332,381	5,854,986	1.8	1,436,924	8.3	9,194,108	364.7
	Commercial Truck	10,813	30.5	13,130	8.7	205,061	0.5	16,947,204	615,151	1.8	134,591	8.1	425,550	406.8

Table 3.60 – VISTA Time Delay – Baseline Conditions

Upper Des Plaines River Watershed **Additional Vehicle Miles Traveled - System Wide Results**									
	Without Floods		**With Floods**		**Difference**				
Flood Event	Passenger Cars Miles	Commercial Trucks Miles	Passenger Cars Miles	Commercial Trucks Miles	Passenger Cars Miles	Commercial Trucks Miles	Passenger Cars Percent	Commercial Trucks Percent	Flood Duration Days
1-year	163,431,932	16,012,936	163,395,811	16,013,054	-36,121	118	-0.022%	0.001%	3
2-year	381,341,174	37,363,517	381,234,568	37,365,141	-106,606	1,625	-0.028%	0.004%	7
5-year	653,727,727	64,051,743	653,900,984	64,115,456	173,257	63,713	0.027%	0.099%	12
10-year	817,159,659	80,064,679	817,427,830	80,196,586	268,171	131,907	0.033%	0.165%	15
25-year	1,035,068,902	101,415,260	1,035,921,985	101,642,381	853,084	227,121	0.082%	0.224%	19
50-year	1,144,023,523	112,090,551	1,143,404,044	112,387,335	-619,479	296,784	-0.054%	0.265%	21
100-year	1,144,023,523	112,090,551	1,126,154,896	111,177,715	-17,868,627	-912,836	-1.562%	-0.814%	21
500-year	1,361,932,765	133,441,132	1,314,272,575	131,014,269	-47,660,190	-2,426,863	-3.499%	-1.819%	25

Table 3.61 – VISTA Distance Delay – Baseline Conditions

3.5 Equivalent Annual Damages

ER 1105-2-100, Section 3.3.c provides the framework by which flood damage reduction is evaluated. The NED evaluation process requires the determination of existing and future, if the available, flood damages. Average annual damages for future damages must be discounted to the base year, reported as equivalent annual damages herein.

Tables 3.62 and Table 3.63 were created from output generated from the USACE HEC-FDA model. For all tributaries the analysis was conducted using a discount rate of 3.75% and converted to the current FY13. The index used to convert from FY10 to FY13 is 1.06 for the structural features and 0.95 for the transportation features.

Most data collection occurred during 2008 and used price levels current at that time. A price level update was conducted using the Engineering News Record Economic Construction Cost Index for Chicago on the valuation of the structure and the valuation of transportation (using the "All Items" category).

Attachment 4 provides both a tabular and GIS-based presentation of the damages in each watershed. Equivalent annual damages are broken down by damage reach and category. Maps in this attachment depict the relative degree of damage, by size of the symbol, and location within the FEMA designated Special Flood Hazard Area. Attachment 6 provides additional details, showing damages in each watershed by reach.

Watershed	Equivalent Annual Damages ($1,000)		
	STRUCTURAL	TRANSPORTATION	TOTAL
Brighton Creek	$138	$0	$138
Dutch Gap Canal	$32	$0	$32
Center Creek	$3	$0	$3
Kilbourn Road Ditch	$43	$0	$43
Jerome Creek	$31	$0	$31
Des Plaines River Mainstem (WI)	$42	$160	$202
Newport Ditch	$0	$0	$0
Mill Creek	$190	$77	$267
Bull Creek	$125	$16	$141
Indian Creek	$38	$48	$87
Buffalo-Wheeling Creek	$364	$8	$371
McDonald Creek	$0	$0	$0
Weller Creek	$147	$3	$150
Farmer-Prairie Creek	$148	$4	$152
Willow-Higgins Creek	$22	$21	$43
Silver Creek	$934	$218	$1,151
Des Plaines River Mainstem (IL)	$7,385	$41,996	$49,381
TOTAL	$9,642	$42,551	$52,192

(FY2013 Price Level, 3.75% Federal Discount Rate)

Table 3.62 – Watershed Equivalent Annual Damages by Damage Type

Watershed	Equivalent Annual Damages ($1,000)							
	APT	AUTO	COM	IND	PUB	RES	TRAFFIC	TOTAL
Brighton Creek	$0	$0	$0	$0	$0	$138	$0	$138
Dutch Gap Canal	$0	$0	$0	$0	$0	$32	$0	$32
Center Creek	$0	$0	$0	$0	$0	$3	$0	$3
Kilbourn Road Ditch	$0	$0	$0	$0	$0	$43	$0	$43
Jerome Creek	$0	$0	$0	$0	$0	$31	$0	$31
Des Plaines River Mainstem (WI)	$0	$0	$0	$0	$0	$42	$160	$202
Newport Ditch	$0	$0	$0	$0	$0	$0	$0	$0
Mill Creek	$0	$0	$12	$17	$126	$35	$77	$267
Bull Creek	$0	$0	$0	$0	$42	$82	$16	$141
Indian Creek	$0	$0	$0	$0	$0	$38	$48	$87
Buffalo-Wheeling Creek	$13	$6	$31	$10	$0	$304	$8	$371
McDonald Creek	$0	$0	$0	$0	$0	$0	$0	$0
Weller Creek	$0	$1	$0	$0	$0	$146	$3	$150
Farmer-Prairie Creek	$0	$0	$2	$0	$15	$131	$4	$152
Willow-Higgins Creek	$0	$0	$20	$0	$0	$2	$21	$43
Silver Creek	$1	$3	$56	$2	$0	$871	$218	$1,151
Des Plaines River Mainstem (IL)	$871	$95	$1,432	$355	$1,545	$3,088	$41,996	$49,381
TOTAL	$885	$105	$1,553	$384	$1,728	$4,986	$42,551	$52,192

(FY2013 Price Level, 3.75% Federal Discount Rate)

Table 3.63 – Watershed Without Project Equivalent Annual Damages by Damage Categories

CHAPTER 4 – FLOOD RISK MANAGEMENT PLAN FORMULATION

Plan formulation is an iterative process that involves cycling through the formulation, evaluation, and comparison steps of the planning process to develop a reasonable range of alternative plans, thus narrowing those plans to a final array for plan selection and design and implementation. Evaluating with and without-project conditions for each alternative is necessary to establish plan benefits. Flood damage reduction plans are evaluated based on monetary-based contributions to the nation's economy or National Economic Development (NED) account.

As detailed in the main report, due to policy considerations, three flood risk management plans, listed below, were developed for this study. Each plan maximizes net benefits.

1. *Full Plan:* A plan that fully responds to the study authority and includes all economically justified, environmentally acceptable separable features evaluated during the course of the study.
2. *CAP Plan:* All policy compliant, economically justified, environmentally acceptable separable features of such scope that they could reasonably be implemented under the Continuing Authorities Program (CAP).
3. *NED Plan:* All policy compliant, economically justified, environmentally acceptable separable features of such scope that they could not be implemented under CAP.

The main report and Appendix B: Flood Risk Management Plan Formulation detail the plan formulation process including the procedures for screening and evaluating the many initially identified alternatives and the process for formulating the NED Plan.

4.1 Flood Risk Management Plans

Each alternative project will provide some level of damage reduction, however; only a project that demonstrates a positive net benefit is considered a justified project. The net benefit criterion requires that the project not only reduce damages, but the project provides more monetary benefits than the cost to construct. Many projects will provide a higher degree of protection (less residual annual damages), but with a correspondingly higher degree of cost to implement and maintain when compared to the benefits the project provides.

After each project has been studied as a stand-alone project, those projects which have positive net benefits are then analyzed for effectiveness as a group of projects, the last added analysis. Last added analysis demonstrates the economic effectiveness of projects that have hydrologic and hydraulic connectivity. Projects that have hydrologic and hydraulic connectivity have the potential to steal damage reduction benefits and residual damages from each other as each project is added to the project study. The project(s) with the highest net benefits are used as a comparison plan and net benefits are

calculated with each individually justified element added to that plan. If there is an increase in net benefits, the combinations are justified. The combination resulting in the highest net benefits becomes the new comparison plan, and new net benefit calculations are performed with each remaining individually justified project added to that new plan. This process continues until either all elements are added or the addition of new elements to the plan results in a decrease in net benefits.

A discussion of the last added analysis procedure and results can be found in Appendix B (NED Plan Formulation). The Plans resulting from the last added analysis are summarized in Table 4.1.

Plan	Sites	Benefits ($1,000)	Costs ($1,000)	Net Benefits ($1,000)	BCR
Full	DPBM04 + DPLV04 + DPLV05 + DPLV09 + ACRS08 + DPLV01 + FPCI01 + non-structural measures (15 communities)	$15,213	$5,510	$9,702	2.2
NED	ACRS08 + DPLV04 + DPLV05 + DPLV09 + ACRS08 + non-structural measures (10 communities)	$10,371	$4,332	$6,039	2.4
CAP	DPLV01	$432	$275	$157	1.6

Includes adjustments in Flood Insurance Administration Costs, Flood Fighting Prevented, and Recreation Benefits (see Section 4.2)
Benefits (FY2013 Price Level, 3.75% Federal Discount Rate)

Table 4.1 – Flood Risk Management Plan Benefits, Costs, and Net

4.2 Additional Flood Risk Management Benefits and Costs

Flood Warning and Response

The majority of the watershed's residual damages are located along the Des Plaines River; therefore, a revision of the Des Plaines River Phase I Flood Warning and Response plan will be forthcoming.

Adjustments in Flood Insurance Administration Costs

The Flood Insurance Administration (FIA) expends significant time and effort administering each flood insurance policy under the National Flood Insurance Program (NFIP). The estimated average annual cost of this time and effort is $192 (per USACE Economic Guidance Memo 06-04). For the economic analysis, this estimate is used to calculate a decrease in aggregate NFIP administrative expenditures for each with-project alternative where structures are removed from the floodplain. Structures in the floodplain are assumed to be covered by a flood insurance policy.

Removal of structures from floodplain from implementation of sites DPLV09 and DPLV01 as well as non-structural sites were identified. The cost savings in flood insurance administration costs for the structures protected by each measure will be added to the

benefits for that project. As shown in Table 4.2, DPLV09 removes 991 structures, DPLV01 removes 122, and several additional sites are removed through the implementation of non-structural measures.

Flood Risk Management Project	Structures Removed from FEMA designated Special Flood Hazard Area	Annual Flood Insurance Expenditures Reduced[6] ($1,000)
Levee 9	807	$155
Levee 5	200	$38
Levee 4	182	$35
Levee 1	122	$23
Elevation (policy compliant)	218	$42
Dry Floodproofing (policy compliant)	81	$16
Ring Levee (policy compliant)	37	$7
Elevation (non-policy compliant)	76	$15
Dry Floodproofing (non-policy compliant)	4	$1
Ring Levee (non-policy compliant)	16	$3
Full Plan Total	1,545	$297
CAP Total	122	$23
NED Total	1,327	$255

Table 4.2 – Structures Removed from Floodplain by Proposed FRM Projects

Floodfighting

There are additional costs borne by local municipalities associated with flood events that are not included in the structural and transportation damage category estimates presented thus far. Additional costs incurred during flood emergencies include flood fighting, debris removal, evacuation, temporary housing, medical supplies, food, clothing and reoccupation. Reliably estimating these costs is difficult given the scale of this study.

Available data from recent flood events – August 2007 (FEMA-1722-DR-IL) and September 2008 (FEMA-1800-DR-IL) – was reviewed to determine whether a relationship between depth of flooding and floodfighting costs could be established. $3.8 million and $4.4 million were provided to state and local agencies as reimbursements for floodfighting measures during the respective events. These data, however, only include a portion of the communities within the watershed and do not provide a clear relationship between flood probability and costs.

Rather than develop a watershed-wide relationship between floodfighting and particular flood events, projects such as levees were evaluated to determine whether implementation would reduce these costs in a particular community. At the section of the Des Plaines River that will be protected by DPLV09, the community of Des Plaines

[6] EGM 06-04 (Fiscal Year 2006) was the last reported value from FEMA. Price level of this document was assumed to be 2006.

has spent a significant amount of money on floodfighting. Due to uncertainty in the flood warning system and the severity of potential flood damages, emergency flood protection measures are mobilized for most events. In August 2007, a 20% chance event at the Des Plaines gage, the community claimed $[redacted] for emergency flood protection and debris removal. In September 2008, a 10% chance event at the Des Plaines gage, the community claimed approximately $[redacted]. These costs were therefore used a baseline for flood protection costs in the community that would be mobilized during flood events starting with the 10% chance event. The percentage of this total corresponding to the portion of the community along the riverbank that would be protected by the levee, approximately one third, was used as the baseline of reduced floodfighting costs. This cost was annualized over the period of analysis, to determine the average annual benefits. The total annualized reduction in flood fighting costs associated with DPLV09 is $60,000.

Recreation Benefits

The potential to enhance the recreational experience along the Des Plaines River is analyzed for its economic feasibility. At site DPLV09, a recreation trail connecting to the existing Des Plaines River trail is included in the proposed site design. Benefits for this trail are calculated as described in ER 1105-2-100 (Planning Guidance Notebook), Appendix E, Section VII and points and values are attributed as required by EGM 12-03 (Unit Day Values for Recreation for Fiscal Year 2012).

The proposed recreation trail is located in the City of Des Plaines located on the west side of the Des Plaines River between Miner Street and Oakton Avenue. The existing Des Plaines River Trail runs along the eastern side of the Des Plaines River. Access to the established Des Plaines River Trail is at Miner Street, Algonquin Road, and Oakton Road. Residents can currently access the Des Plaines River Trail via these routes and sidewalks along Des Plaines River Road. The City of Des Plaines notes the safety concerns about residents crossing Des Plaines River Road at this location on their website: "In addition, the safety of the Algonquin and Oakton crossings were improved with additional signage, striping and proposed pedestrian actuated flashing beacons (Oakton)."[7]

The proposed design would include a pedestrian footpath along the eastern side of the Des Plaines River Road between Ashland Road and Oakton Road. The footpath would be wider and set back from the roadway, providing a safer and scenic recreation trail with access to the 50 miles of trails along the Des Plaines River that extend from River Forest in Illinois to the Wisconsin border.

Criteria	
1. Is a regional model available?	No
2. If "No", do uses affected involve specialized recreation activities?	No
3. If "No", do expected annual visits affected exceed 750,000?	No
4. Do specific annual Federal recreation costs exceed $1,000,000 (FY82 price levels)?	No

[7] http://www.desplaines.org/index.aspx?nid=224 (accessed on May 8th, 2013)

5. If "No", then use UDV's for evaluating recreation benefits resulting from the proposed Project.

Table 4.3 Criteria for selecting an appropriate recreation evaluation procedure

Evaluation criteria for the selection of recreation benefit evaluation methods and evaluation procedures are provided in ER 1105-2-100. Table 4.3 provides the steps used in the selection of the Unit Day Valuation method for the computation of NED benefits for the project.

Federal interest for participating in this proposed recreation plan was evaluated based upon ER 1105-2- 100 and Economic Guidance Memorandum 13-03 (UDV method). This method is appropriate given the above referenced Guidelines. The UDV method assigns point values (convertible to dollar values) for recreational facility attributes including recreation experience, availability, carrying capacity, accessibility, and environmental/aesthetic quality.

Determination of Unit Day Values. Unit day value points are determined for both the existing Without Project and the proposed With Project conditions. Because of the activities possible at the proposed trail facilities, estimation of UDVs was determined for general recreational activities. Activities will include walking, running, biking, in-line skating, and other general activities. The UDV increases were based upon the comparison of General Recreation Criteria (EGM 13-03) in the existing condition versus the improved With Project condition, as follows. Table 4.4 displays the UDV points assigned to each category for the Without Project and the proposed With Project conditions.

Recreation Experience. The City of Des Plaines currently has west bank pedestrian sidewalk with access to the Des Plaines River Trail along Miner Street, Algonquin Road, and Oakton Road. This pedestrian system does not provide a sufficient and safe venue for general activities and provides limited walking, biking, running, and in-line skating along a narrow path next to a busy two lane road. The proposed recreational feature would enhance the general recreation activity on the east side of Des Plaines River Road. These activities will be enjoyed in an aesthetically improved river walk destination as opposed to the current residential pedestrian sidewalk along a busy road.

Availability of Opportunity. The facility quality of recreational activities available in the Without and With-Project condition can be found within a half hour of the proposed project.

Carrying Capacity. In the without project condition the trail system offers adequate facilities to conduct general recreation activities. The proposed trail along the west bank of the river will provide optimum facilities with which to conduct a variety of high-quality general recreational activities. The new trail segment will be a significant upgrade from the existing conditions due to the re-routed location on the riverbank and protected from road traffic.

Accessibility. The proposed recreation feature will not affect accessibility to the trail.

Environmental. Users of the proposed recreation facility with a river setting will experience a greatly improved esthetic quality and vastly safer recreational path compared to the without project condition of a trail adjacent to Des Plaines River Road.

User Day Values (UDVs) were assigned using the point values shown in Table 4.4. The total point value corresponds to a UDV of $5.41 for the without project and $8.64 for the recreation trail. To determine the annual benefits, the UDV is multiplied by the expected number of users annually. The current usage of the public sidewalk, between Ashland Road and Oakton, to access the Des Plaines River Trail was determined by the population within approximately a half mile of the proposed site. There are approximately 500 residential structures within this distance. A conservative assumption is that residents within this distance are willing to visit the Des Plaines River Trail; crossing at Miner, Algonquin, or Oakton; at least once a year. The without project annual benefits are $2,705.

Since the proposed site is located on the eastern bank of the Des Plaines River, visitors from the existing Des Plaines River recreational trail, located along the western bank of the river, would have to divert from the trail to access this site. The amenities are such that it would draw walkers, joggers, and bikers to divert from the main trail. The proposed asphalt trail would provide a loop for local trail users and access to the trail system along the eastern bank of the river.

UDV Categories	Without Project	Levee 9 Recreation Feature
Recreation Experience	6	7
Availability of Opportunity	3	3
Carrying Capacity	5	13
Accessibility	7	17
Environmental	5	18
Total	26	58
Conversion of Points to $ Value	$5.41	$8.64

(FY2013 PL)

Table 4.3 – Estimated UDV Points for Recreation Trail at site DPLV09

User counts for a section of trail along the Des Plaines in the nearby community of Wheeling were used as a basis for the estimated number of users. Based on these counts, average daily use could be expected to be approximately 400 visitors for weekends during the warm weather months. Annually, the average daily use per week could be approximately 200 visitors with annual use at about 22,000 visitors a year. For 22,000 users with a value of $8.64 each, the total annual benefits are $190,080.

	Without Project	Proposed Recreation Trail
Annual Users	500	22,000
Unit Day Value	$5.41	$8.64
Annual Benefits	$3,000	$190,000
Incremental Difference		$187,000
Project Cost Estimate		
Interest During Construction Total First Cost Annualized First Cost Annualized OMRR&R		
Total Annualized Cost		$8,000
BCR		24
Net Benefits		$179,000

Note: All costs and benefits are rounded to neared $1,000.
(FY2013 Price Level and 3.75% Discount Rate)

Table 4.4 Annual Cost and Benefit Analysis

Construction and Operation & Maintenance cost are detailed in the Civil and Cost Engineering appendix and are at October 2012 (FY13) price levels. A discount rate of 3.75% was applied to the total first cost and amortized over a period of 50 year project life. The potential recreation feature has a healthy benefit to cost ratio of 24 and net benefits of $179,497.

Figure 4.1 Levee 9 Recreation Trail

4.3 Residual Annual Damages

With implementation of the Flood Risk Management Plans, residual risk of flood damages exists throughout the watershed. The tables below present the EAD calculated in each watershed both with and without project. As shown in the tables, implementation of the plan reduces the risk of damages, but over the period of analysis, flood damages are still expected to occur in the watershed. Tables 4.4 through 4.7 show expected residual damages for after implementation of the structural portion of the Full, NED, and CAP plans.

Damage Category	EAD		Benefits	% Change
	Without Project	With Project		
APT	$870,990	$151,945	$719,045	83%
AUTO	$94,785	$51,506	$43,279	46%
COM	$1,431,740	$1,203,790	$227,950	16%
IND	$354,945	$249,441	$105,504	30%
PUB	$1,544,840	$1,551,440	-$6,600	0%
RES	$3,088,470	$2,319,440	$769,030	25%
TRAFFIC	$41,994,600	$33,519,200	$8,475,400	20%
Total	$49,380,400	$39,046,800	$10,333,600	21%

(FY2013 Price Level and 3.75% Discount Rate)

Table 4.5 – Des Plaines Mainstem Residual Damages – Full Plan (Structural)

Damage Category	EAD		Benefits	% Change
	Without Project	With Project		
APT	$164	$164		
AUTO				
COM	$1,534	$1,534		
IND				
PUB	$13,520	$13,520		
RES	$124,288	$17,288	$107,000	86%
TRAFFIC	$4,041	$4,041		
Total	$143,547	$36,547	$107,000	75%

(FY2013 Price Level and 3.75% Discount Rate)

Table 4.6 – Farmer-Prairie Creek Residual Damages – Full Plan (Structural)

Damage Category	EAD		Benefits	% Change
	Without Project	With Project		
APT	$870,990	$151,952	$719,038	83%
AUTO	$94,785	$51,507	$43,278	46%
COM	$1,431,740	$1,203,790	$227,950	16%
IND	$354,945	$249,441	$105,504	30%
PUB	$1,544,840	$1,551,440	-$6,600	0%
RES	$3,088,470	$2,319,470	$769,000	25%
TRAFFIC	$41,994,600	$37,671,800	$4,322,800	10%
Total	$49,380,400	$43,199,400	$6,181,000	13%

(FY2013 Price Level and 3.75% Discount Rate)

Table 4.7 – Des Plaines Mainstem Residual Damages – NED Plan (Structural)

Damage Category	EAD		Benefits	% Change
	Without Project	With Project		
APT	$829,615	$522,726	$306,889	37%
AUTO	$94,845	$94,787	$58	0%
COM	$1,361,610	$1,361,610		
IND	$338,999	$338,999		
PUB	$1,465,060	$1,464,840	$220	0%
RES	$2,937,700	$2,857,070	$80,630	3%
TRAFFIC	$47,021,900	$47,021,900		
Total	$54,049,800	$53,662,000	$387,800	1%

(FY2013 Price Level and 3.75% Discount Rate)

Table 4.8 – Des Plaines Mainstem Residual Damages – CAP Plan (Structural)

4.4 Plan Performance

A detailed explanation of evaluation procedure of the alternative measures is provided in the Planning Appendix and Hydrologic Appendix. HEC-FDA runs were used to determine the equivalent annual benefits of each plan.

CHAPTER 5 – NED/NER COMBINED PLAN SELECTION

The Corps Environmental Operating Principles (EOPs) strive to achieve environmental sustainability by seeking balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another. This Phase II study builds upon these principles by the formulation of plans that serve both flood damage reduction and ecosystem restoration purposes. Corps Planning Guidance promotes the formulation of combined plans that serve economic and environmental purposes whenever possible. Unfortunately, a specific procedure for formulating and evaluating combined NED/NER plans does not exist and are currently under development. Without specific guidance available, the study team has developed the following methodology for use in this Phase II study.

5.1 Tradeoff Analysis

There are three major formulation options when developing plans with elements that serve NED and NER purposes. The options depend on whether elements within the plan are physically or functionally interdependent versus independent. Combined NED/NER plans that have interdependent elements either share the same physical location or functions. Interdependent elements can sometimes negatively impact each other or compete for the same resources. In those cases, the outputs from the elements that impact each other or are in competition for benefits with each other must be traded off. Trade offs are not necessary for outputs from those elements that do not impact or even benefit each other. Plans that have independent elements are formulated separately into individual NED and NER plans. The third formulation option involves adding limited ecosystem restoration features to a NED plan that are not claimed for NER contributions. These limited ecosystem restoration features are added to reduce impacts and/or enhance the ecological output of a structural measure otherwise devoid of environmental characteristics. Below is a summary of the three formulation options:

a. Physically and/or functionally *interdependent* (combined NED/NER plan)
    - Without trade-offs (no impacts on each other)
    - With trade-offs (impacts on or competition with each other)
b. Physically and functionally *independent* (separate NED and NER plans)
c. Addition of limited ecosystem restoration features to NED plan

In order to formulate a combined NED/NER plan, single purpose NED and NER plans must be formulated and evaluated separately in order to form the basis for a trade-off analysis if needed and to ensure the plan that maximized net economic and environmental outputs is identified. The respective NED and NER plans are determined to be the most efficient, effective, complete and acceptable plans. Combined NED/NER plans result in the “best” recommended plan so that no alternative plan or scale has higher NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects are based on a combination of NED benefit-cost analysis and NER benefits analysis, including cost

effectiveness and incremental cost analysis, performed using the Institute for Water Resources (IWR) Planning Suite.

According to ER 1105-2-100, when formulating plans that have interdependent elements where there is competition for resources, meaning more of one output (say, NER) can only be obtained by accepting less of another (say, NED), a trade-off analysis is required. Tradeoffs between NED outputs and NER outputs are permissible and should be made as long as the value of what is gained exceeds its implementation cost plus the value of what is foregone. In other words, it is acceptable to trade NED benefits in favor of NER outputs as long as the incremental value of the NER outputs exceeds the sum of NED benefits foregone plus incremental costs. Since the unit of measure is different between NED and NER accounts, a method is needed to normalize the units in order to compare benefits and perform tradeoffs where necessary. Corps guidance dictates the use of the Separable Cost-Remaining Benefit Method (SC-RB) for obtaining an equitable distribution of the costs of a multipurpose project among the purposes served. Incremental costs equal added cost necessary to realize added environmental outputs less reduced cost permitted by reduced NED outputs. Trades of one output for another shall be made until it is not possible to make further trades improving the total project. Naturally the potential trades go in both directions, more NER output for less NED output and more NED output for less NER output. This is a formulation-evaluation process by which the optimal combined NED/NER Plan is developed.

The study team has developed the following process for formulating, evaluating, and comparing multipurpose plans. Essentially single purpose plans are initially formulated and evaluated by identifying and screening potential sites, developing and screening management measures for each site, and formulating and analyzing alternatives from screened measures. The goal of these steps is to identify individual NED and NER plans that can then be compared to determine interdependency and the need for determining tradeoffs. If tradeoffs are not required, the Combined NED/NER Plan consists of the individual NED and NER plans. If a tradeoff analysis is necessary, the Combined NED/NER Plan is determined by the process described in the previous paragraph. A flowchart describing this process is shown in Figure 5.1 below.

One the single purpose NED and NER plans were selected the plans were compared and it was determined that they are not interdependent. Therefore, a tradeoff analysis was not required and the combined plan is simply a combination of all elements of both the NED and NER plans.

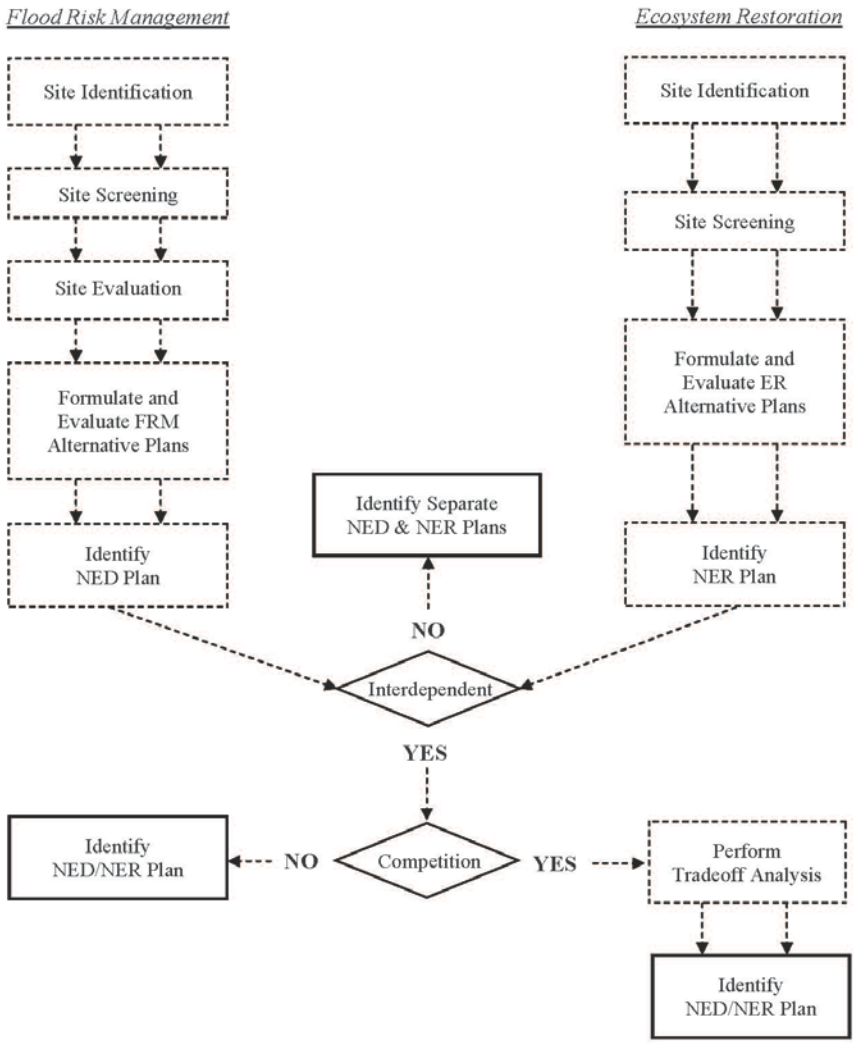

Figure 5.1 – Plan Formulation Process for Determining Combined NED/NER Plan

5.2 Cost Allocation

Costs for each element of the combined plan are allocating according to that site's purpose. As there are no multi-purpose sites, there is no distribution of costs between purposes within any one site.

CHAPTER 6 – ECONOMIC UPDATE PROCEDURES

Plans for economic updates are required under ER 1105-2-100 (Appendix D). Update procedures are not intended to revisit the procedural aspects of the economic analysis. Instead the procedure will resample the baseline economic data to provide an update to the data used in the benefit cost analysis performed during plan formulation.

Three major areas of update will occur during a limited re-evaluation of the economics: Structure Valuation, Automobile Counts and Cost, and Transportation monetization. The recent volatility in the housing markets would indicate the prudent course of action is to resample after a period of 3-5 years. A representative and random sample of ten percent of the structures will provide sufficient statistical data to develop a new index between the county assessor's valuation and an independent depreciated replacement value calculated using GeoFIT/MEANS valuation. Updates to the automobile valuation will follow the most recent EGM. Finally, the monetization for mileage and time will be updated to reflect current valuation.

Depending on when the economic update occurs, projects will be in various stages of design and construction. Any preliminary engineering and design (PED) costs expended at that time will be sunk costs and will not be included in the calculation of the updated benefit-to-cost ratio.

In 2012 a depreciation valuation check of the commercial, industrial, and public structures was conducted.

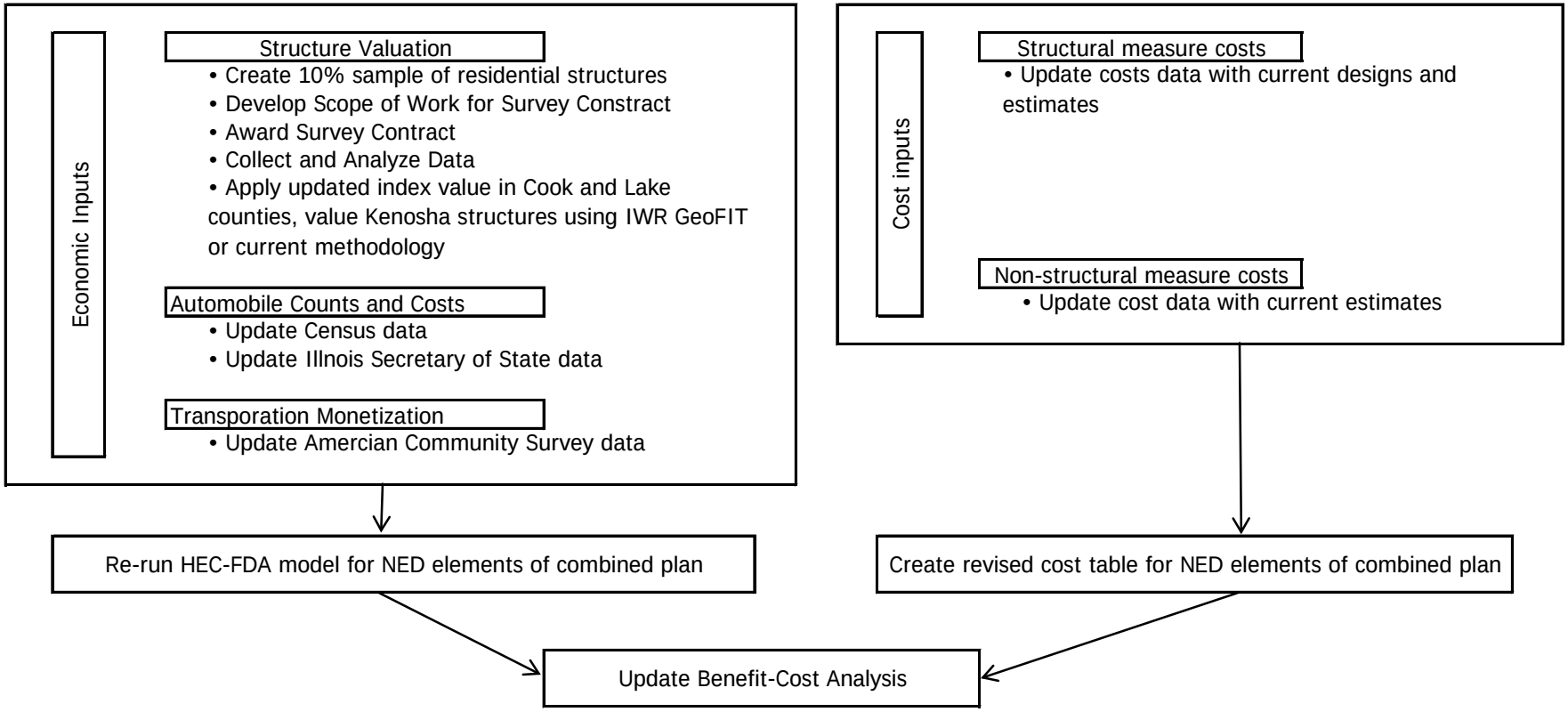

Figure 6.1 – Economic Update Procedure

GLOSSARY OF TERMS

Annual Exceedance Probability (AEP) – The probability that a flood event will be exceeded in any given year considering the full range of possible annual floods.

Digital Flood Insurance Rate Maps (DFIRM) – A FIRM that has been prepared as a digital product, which may involve converting an existing manually produced FIRM to digital format, or creating a product from new digital data sources using a GIS environment. The DFIRM product allows for the creation of interactive, multi-hazard digital maps. Linkages are built into an associated database to allow users options to access the engineering backup material used to develop the DFIRM, such as hydrologic and hydraulic models, flood profiles, data tables, Digital Elevation Models, and structure-specific data, such as digital elevation certificates and digital photographs of bridges and culverts.

Expected Annual Damages – The statistical average amount of damages expected from flooding for an "average" year as calculated for either baseline or future condition.

Equivalent Annual Damages – The discounted damage value associated with present worth of the future without-or-with project condition over the analysis period (project life) considering changes in hydrology, hydraulics, and flood damage conditions over the life of the project.

Flood Insurance Rate Maps (FIRM) - The insurance and floodplain management map produced by FEMA that identifies, based on detailed or approximate analyses, the areas subject to flooding during a 1-percent-annual-chance flood event in a community. Flood Insurance risk zones, which are used to compute actuarial flood insurance rates, also are shown. In areas studied by detailed analyses, the FIRM shows base flood elevations to reflect the elevations of the 1-percent-annual-chance flood. For many communities, when detailed analyses are performed, the FIRM also may show areas inundated by 0.2-percent-annual-chance flood and regulatory floodway areas.

GeoFIT - A tool developed to answer one of the most costly, time consuming and error-prone aspects of flood damage analysis: the process of building field inventory and valuation process. The software is designed to automate the business process of inventory collection and valuation of structures for individual flood damage feasibility studies. Each study carried out with this application will use unique sets of data that must be loaded onto personal computers hosting a GeoFIT installation. The data will vary in size, geographic location, spatial coordinates and attribution. But the basic required data layers will be identical in structure for every study conducted with the GeoFIT application.

HEC-FDA - Corps of Engineers Hydrologic Engineering Center's Flood Damage Analysis - provides the capability to perform an integrated hydrologic engineering and economic analysis during the formulation and evaluation of flood risk management plans. HEC-FDA is designed to assist U.S. Army Corps of Engineers (USACE) study members in using risk analysis procedures for formulating and evaluating flood risk management measures

(EM 1110-2-1619, ER 1105-2-101). Also, HEC-FDA will assist USACE staff in analyzing the economics of flood risk management projects. The software, 1) stores hydrologic and economic data necessary for an analysis, 2) provides tools to visualize data and results, 3) computes expected annual damage (EAD) and equivalent annual damages, 4) computes annual exceedance probability (AEP) and conditional non-exceedance probability as required for levee certification, and, 5) implements the risk analysis procedures described in EM 1110-2-1619

National Economic Development (NED) – National Economic Development is the Federal objective of water and related land resources project planning as detailed in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies 10 March 1983. A plan recommending Federal action is to be the alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment.

National Ecosystem Restoration (NER) – Ecosystem restoration is one of the primary missions of the US Army Corps of Engineers Civil Works program. Contributions to national ecosystem restoration are increases in the net quantity and/or quality of desired ecosystem resources.

Q3 – Early GIS version of the FEMA Flood Insurance Rate Maps

RS Means - A division of Reed Business Information that has tabulated and publishes manuals which provides information to private and public sector to aid in construction estimates and projections for their project costs. It is a data standard for pricing in government work in addition to Marshall and Swift.

ACRONYMS AND ABBREVIATIONS

AEP	Annual Exceedance Probability
CCHD	Cook County Highway Department
CMAP	Chicago Metropolitan Agency for Planning
DFIRM	Digital Flood Insurance Rate Map
EAD	Equivalent Annual Damages
EGM	Economic Guidance Memorandum
EM	Engineering Manual
EOP	Environmental Operating Principles
ER	Engineering Regulation
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FPDCC	Forest Preserve District of Cook County
FRM	Flood Risk Management
GIS	Geographic Information Systems
HEC-FDA	Hydrologic Engineering Center – Flood Damage Analysis
HEC-RAS	Hydrologic Engineering Center – River Analysis System
H&H	Hydrology and Hydraulics
IDNR	Illinois Department of Natural Resources
IWR-USACE	USACE Institute for Water Resources
LCFPD	Forest Preserve District Lake County
LCSMC	Lake County Stormwater Management Commission
LiDAR	Light Detection and Ranging
LRR	Limited Reevaluation Report
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NED	National Economic Development
NER	National Ecosystem Restoration
NIPC	Northern Illinois Planning Council
OMB	Office of Management and Budget
PDT	Project Delivery Team
SC-RB	Separable Cost – Remaining Benefit
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SIBA	System Impacts-Based Aggregation
USFWS	U.S. Fish and Wildlife Service
USACE	U.S. Army Corps of Engineers
VISTA	Visual Interactive System for Transportation Algorithms