Watershed Specific Release Rate Analysis: Cook County, Illinois

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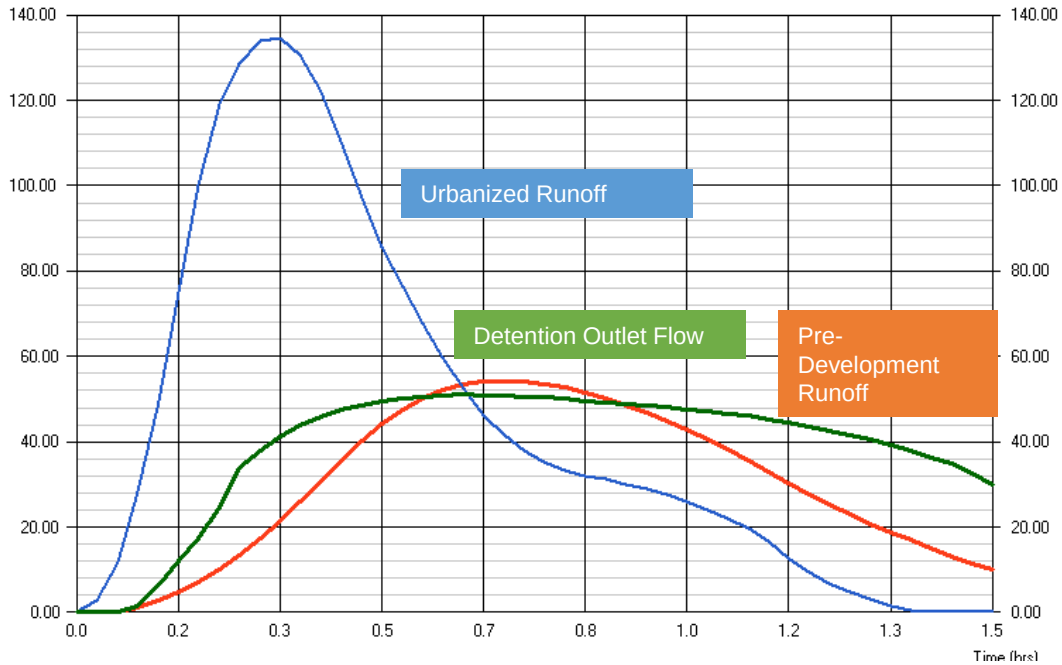
Project Objective

Release rate selection objective:
Determine regulatory release rates that mitigate the impacts of development by maintaining the 1% annual-chance flood event elevations at or below current levels.

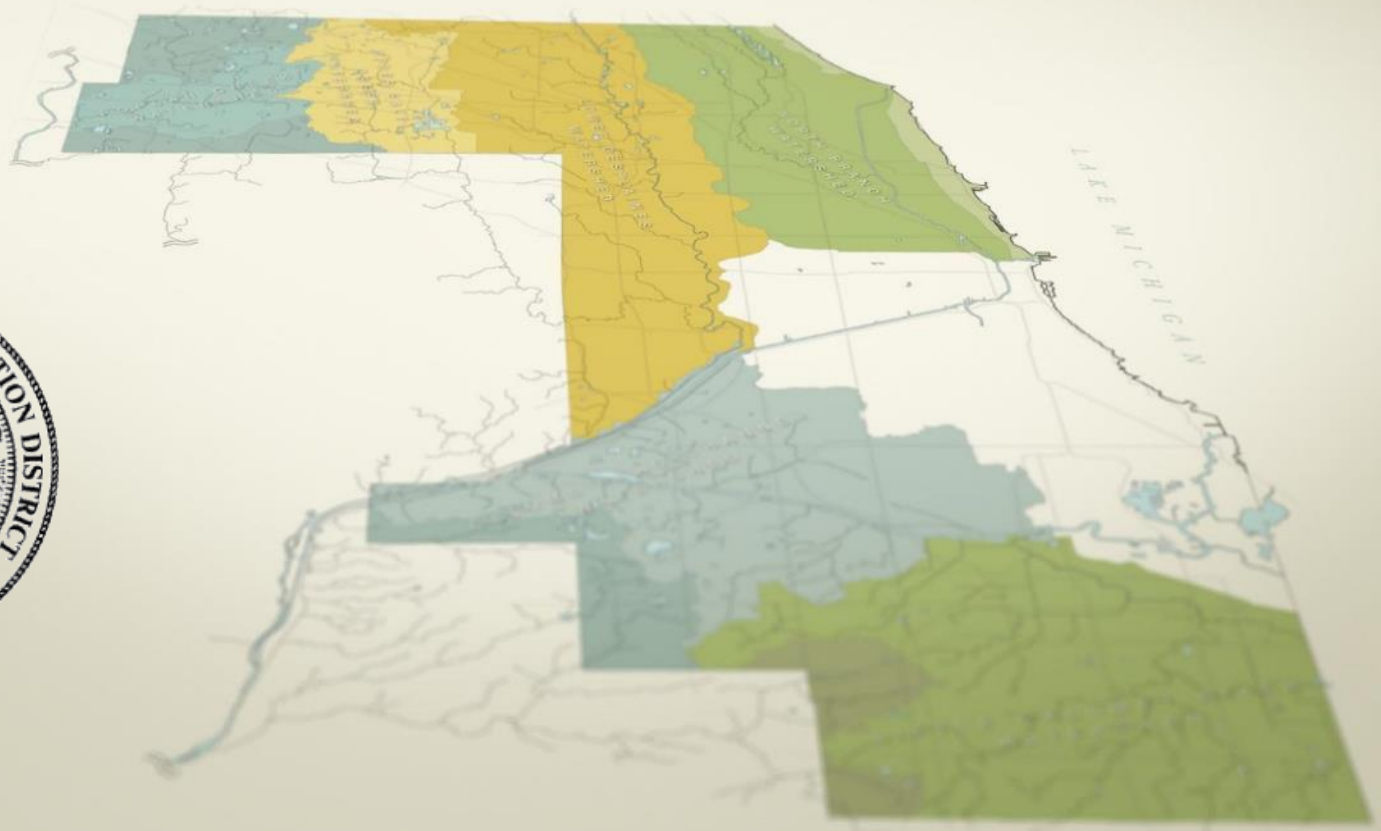
Development impact on hydrology

Three ways future development impacts hydrology:

1. Release rate compared to existing runoff rate
2. Watershed timing
3. Increased runoff volume / restrictive structures



Spatial Extents of Release Rate Analysis

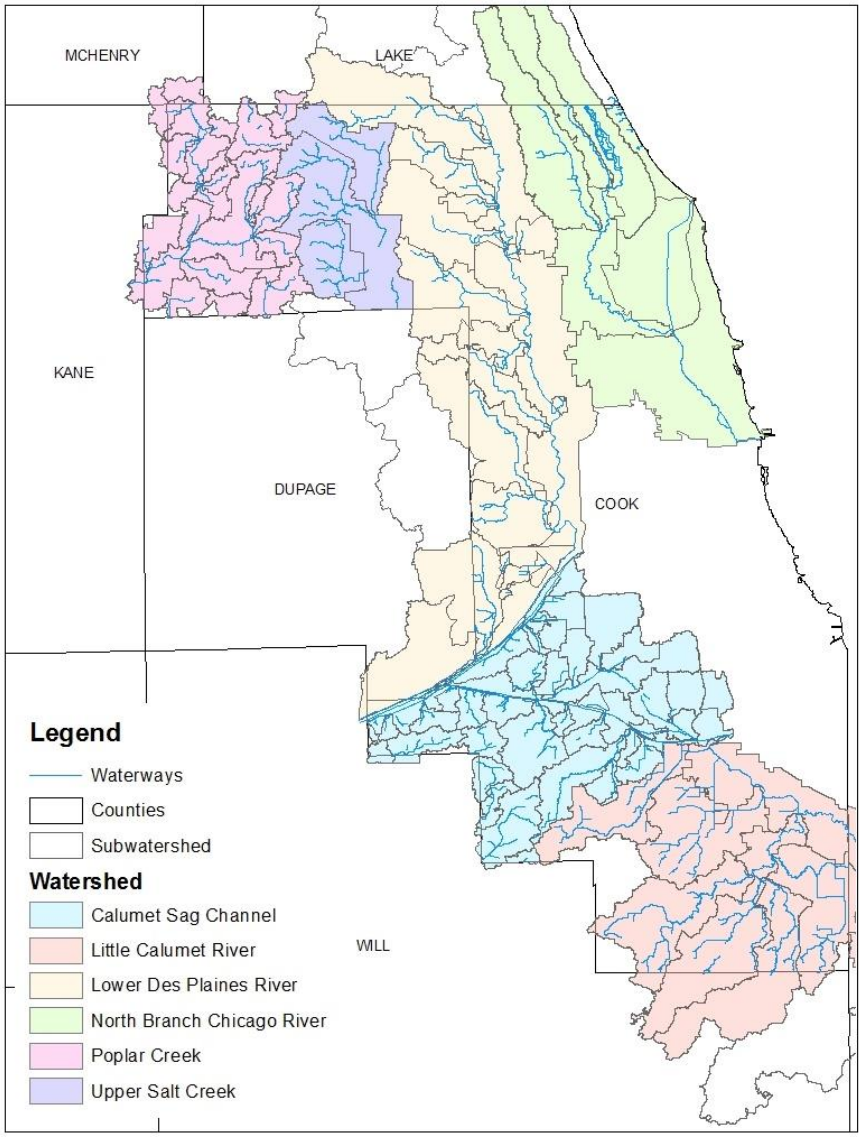


Methodology

- Phase I
  - Evaluate two pilot study areas
  - Develop streamlined methodology and set of assumptions
  - Evaluate release rates for pilot study areas and garner technical feedback

Phase II

  - Apply the methodology developed in Phase I in each Watershed Management Area
  - Evaluate release rates for watersheds under WMO regulation



Basis of Methodology

Base Condition:

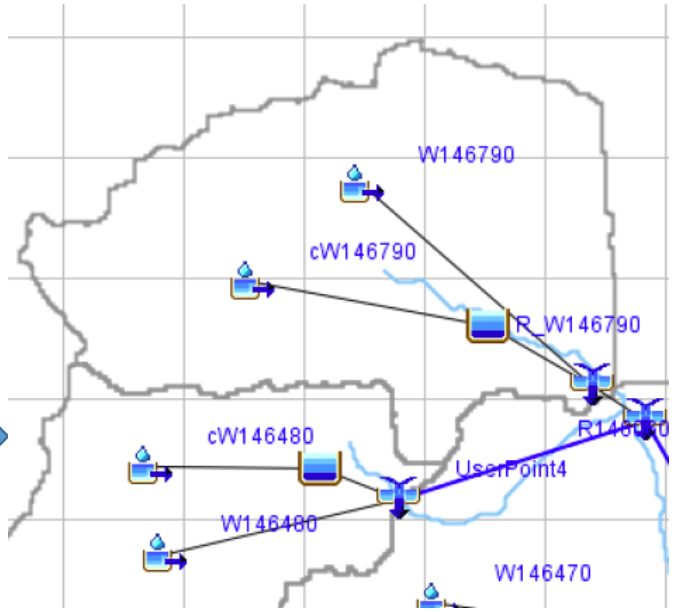
DWP H&H

with some updates

Future Condition:

Increased Development

WMO Requirement



Model Elements

- Watershed
- Subwatershed
- Subbasin

Subwatershed Selection

- Identify key, selection controlling subwatersheds based on Phase 1 results
- Unnecessary to model every last acre

Watershed Specific Release Rate Study

Assessing the Methodology

- Evaluate Assumptions & Validate Model
  - Sensitivity to critical duration
  - Sensitivity to future Curve Number selection
  - Sensitivity to transformation parameters
  - Validation of volume control modeling results
  - Validation of future detention volume
  - Validation of future development rates and patterns
- Efficient Application
  - Programming completed to apply future hydrology edits and run hydraulic modeling
  - Map and hydrograph products automated to assist with analysis

Landuse Evolution and impact Assessment Model (LEAM)

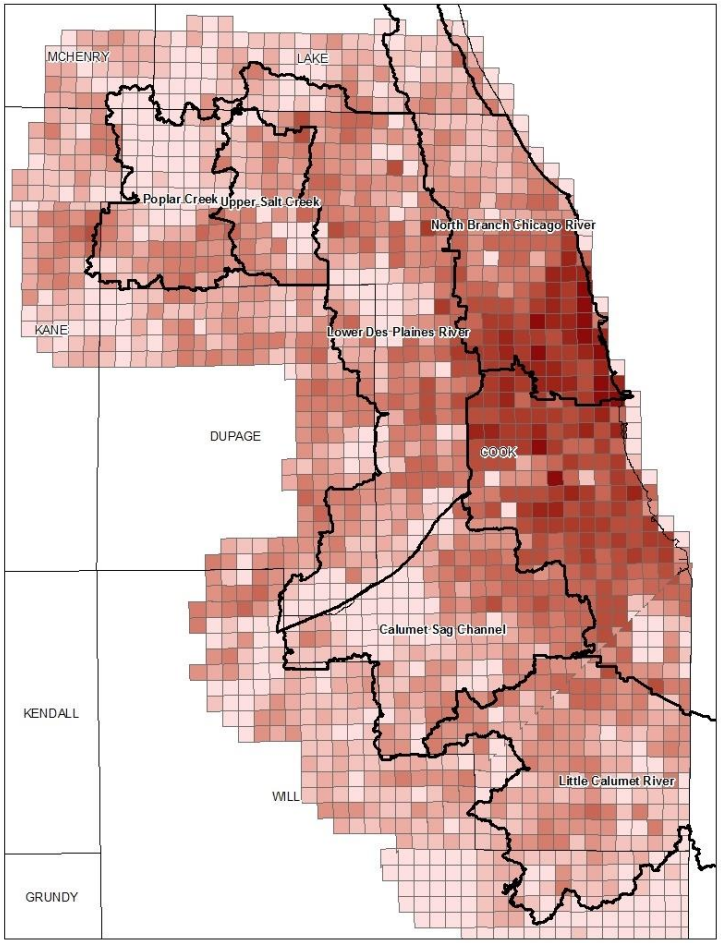
GOTO 2040 Agricultural Preservation Strategies

The University of Illinois at Urbana-Champaign LEAM Laboratory and the Chicago Metropolitan Agency for Planning

October 23, 2008

landuse leam model impact assessment HTTP://WWW.LEAM.UIUC.EDU

2050 Population Projection (in households)



Selected Methodology

- **Base Model**
  - DWP Unsteady State HEC-HMS and HEC-RAS Models, analyzed at critical duration
- **Future Development**
  - Uniform 40% Development/Redevelopment Meeting the WMO (with adjustments for preserve lands)
- **Detention**
  - Modeled reservoirs meeting various Watershed Release Rates for the 100-year 24-hour storm with separate control volume
- **Release Rate**
  - 0.15, 0.2, 0.25, and 0.3 cfs/acre were analyzed

- Updated for recent major stormwater projects
- Uniform development was selected to evaluate release rates. 40% was supported by land use change analysis
- Linear hydrograph modeled with storage-discharge functions.
- Outside of the WMO regulatory area the release rate of the adjoining jurisdiction was applied

Watershed Specific Release Rate Analysis:
North Branch Chicago River Watershed

Base Model Summary

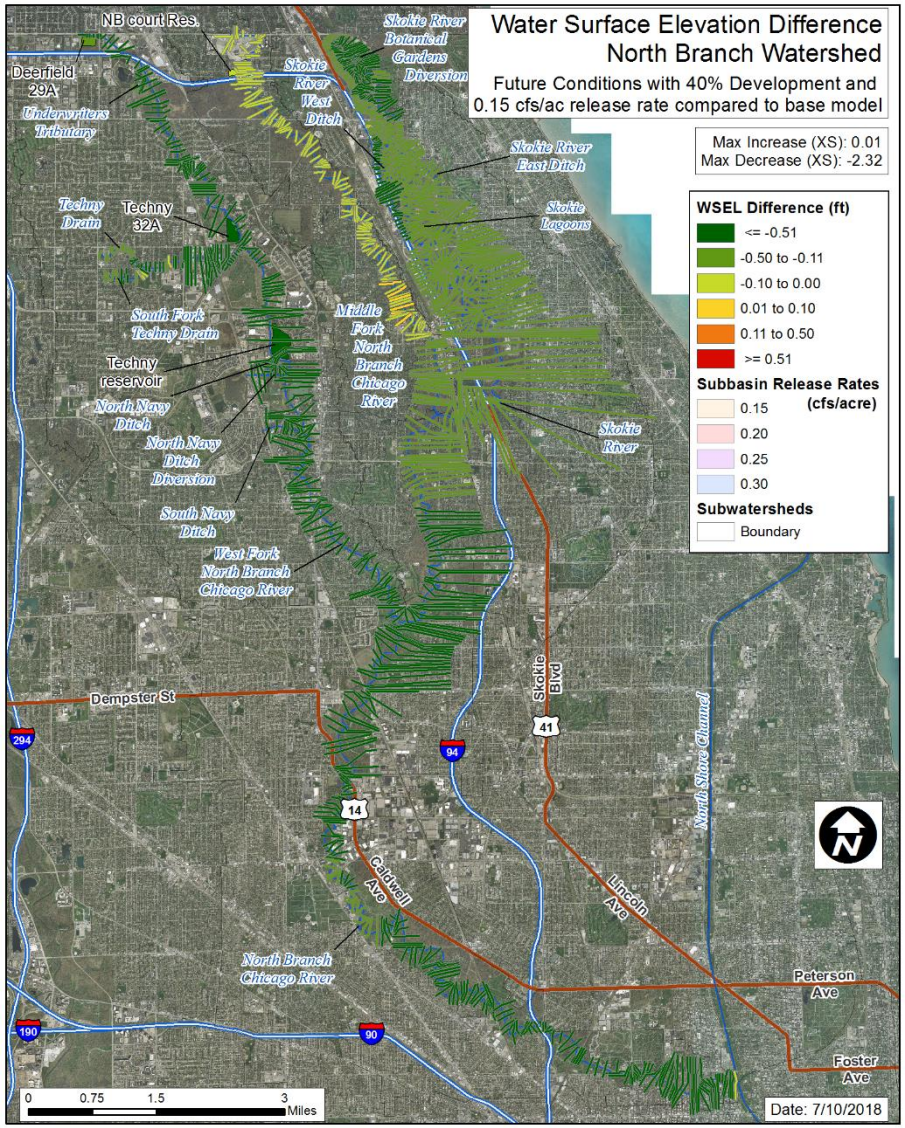
Modeled Subwatersheds:

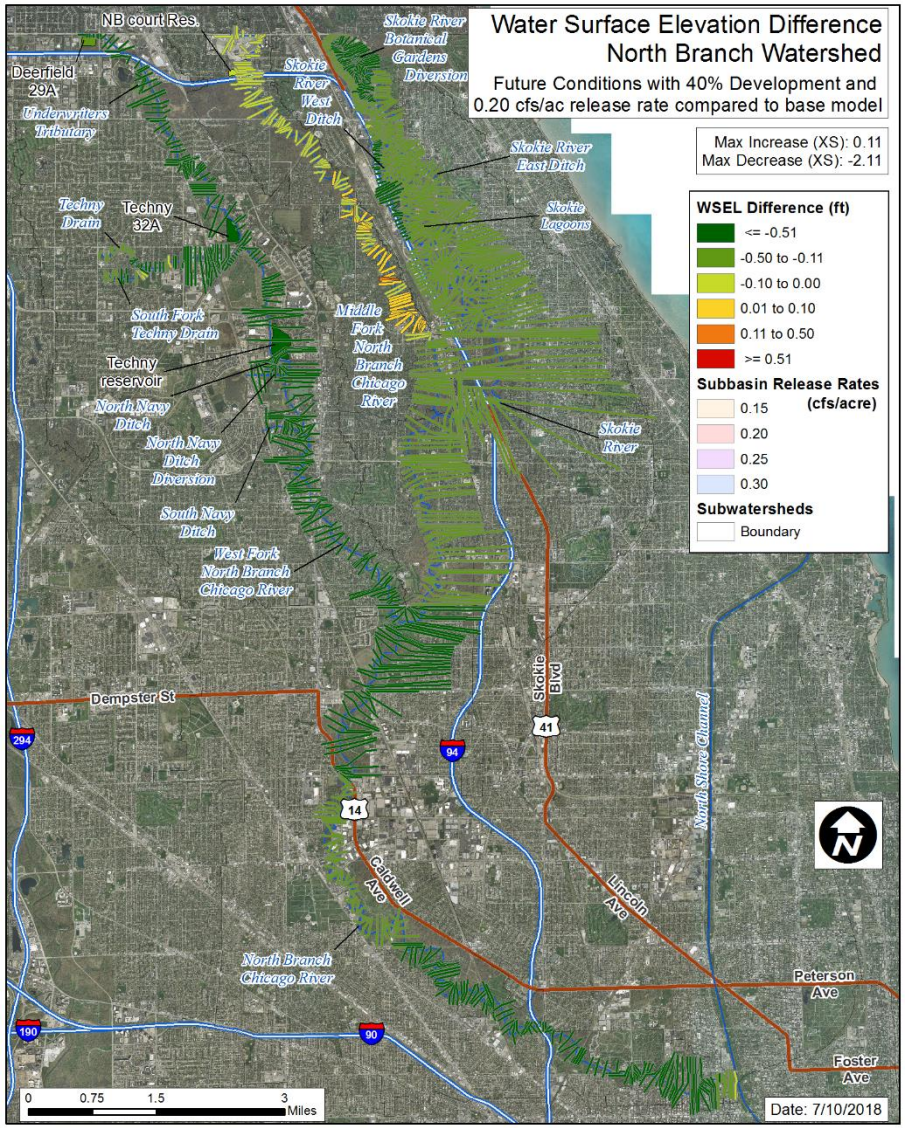
- North Branch Chicago River (Upstream of North Shore Channel)
- West Fork North Branch Chicago River
- Middle Fork North Branch Chicago River
- Skokie River

Base Runoff Rates

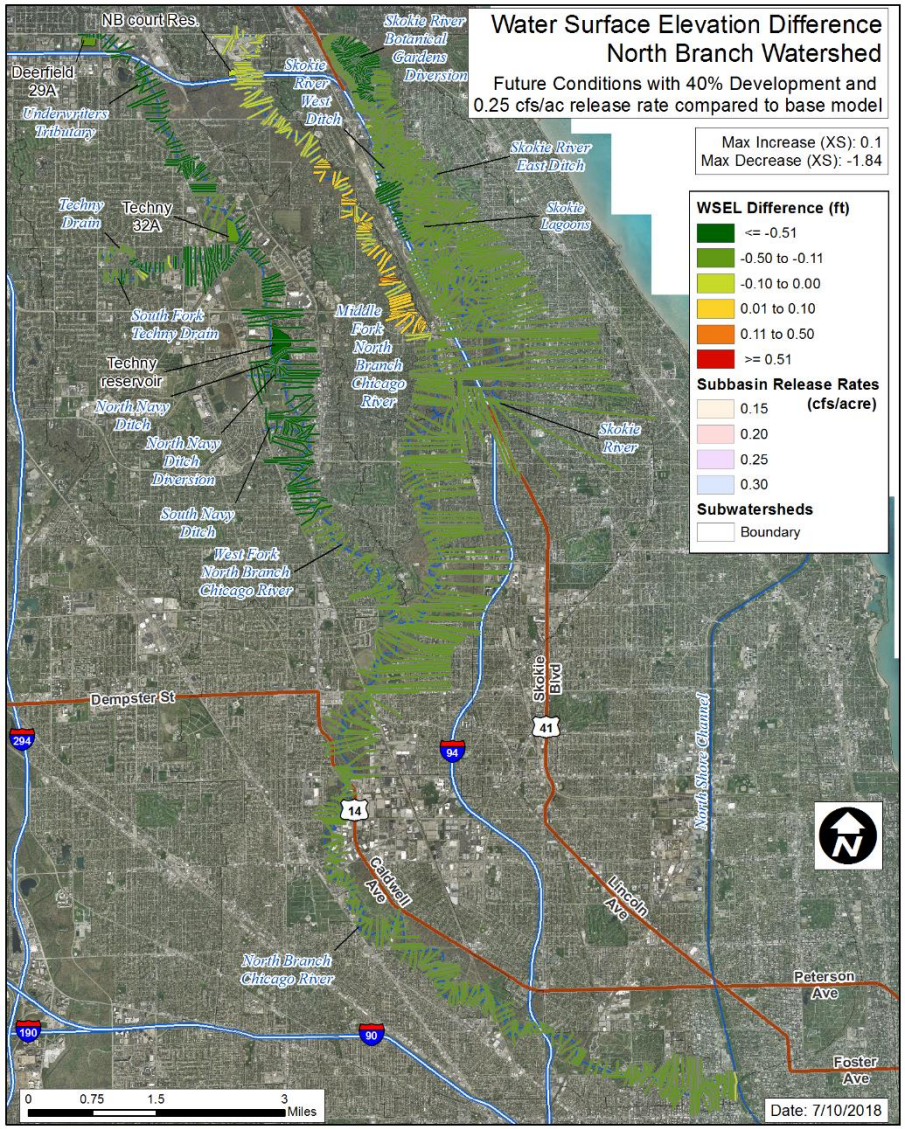
		24 hour		
	Subwatershed	**Average Base Conditions Peak Runoff Rate (cfs/acre)**	**Subbasin Base Conditions Peak Runoff Rate Range (cfs/acre)**	**Critical duration event**
North Branch Chicago River	West Fork	0.41	0.21 - 0.76	24 hr
	Middle Fork	0.32	0.13 - 0.59	24 hr
	Skokie	0.27	0.12 - 0.62	24 hr
	North Branch US	0.32	0.17 - 0.51	24 hr

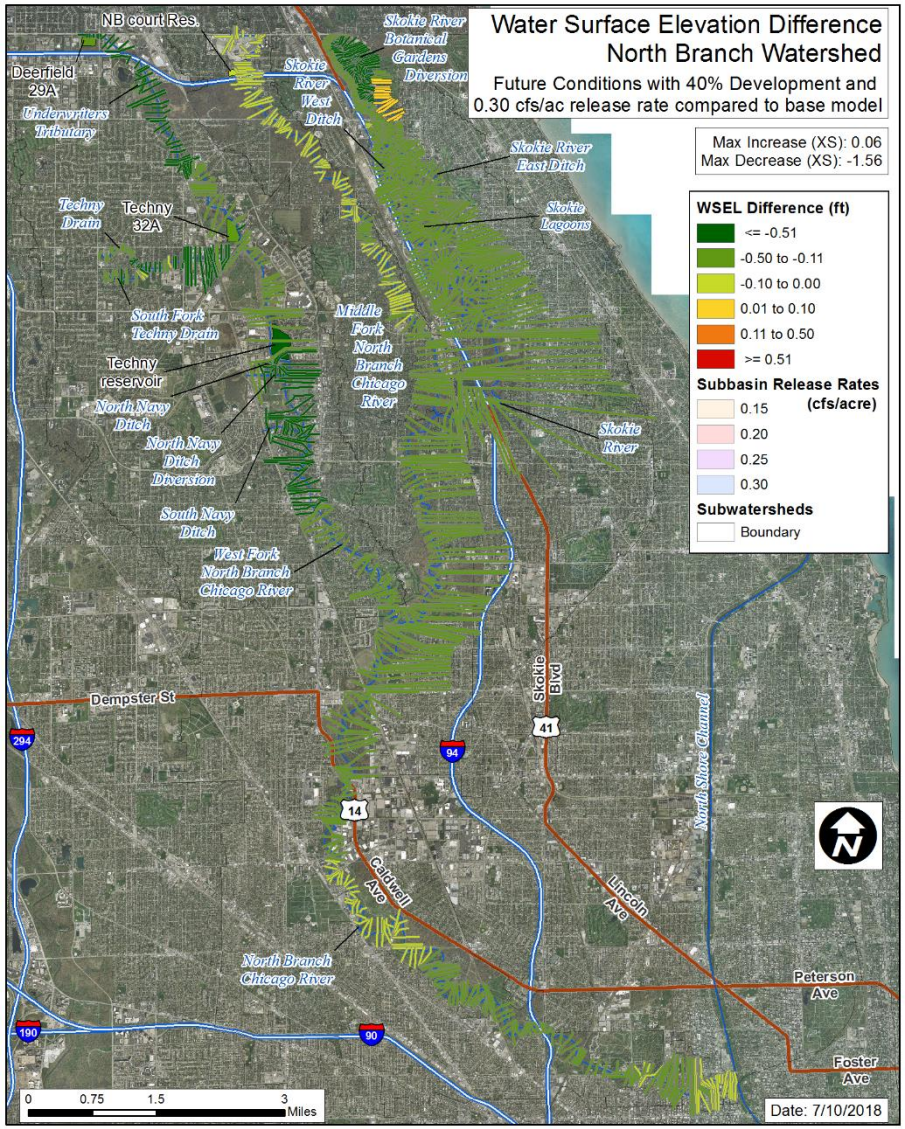
Future Model Results





Future Model Results





Watershed Specific Release Rate Analysis:
Poplar Creek Watershed

Base Model Summary

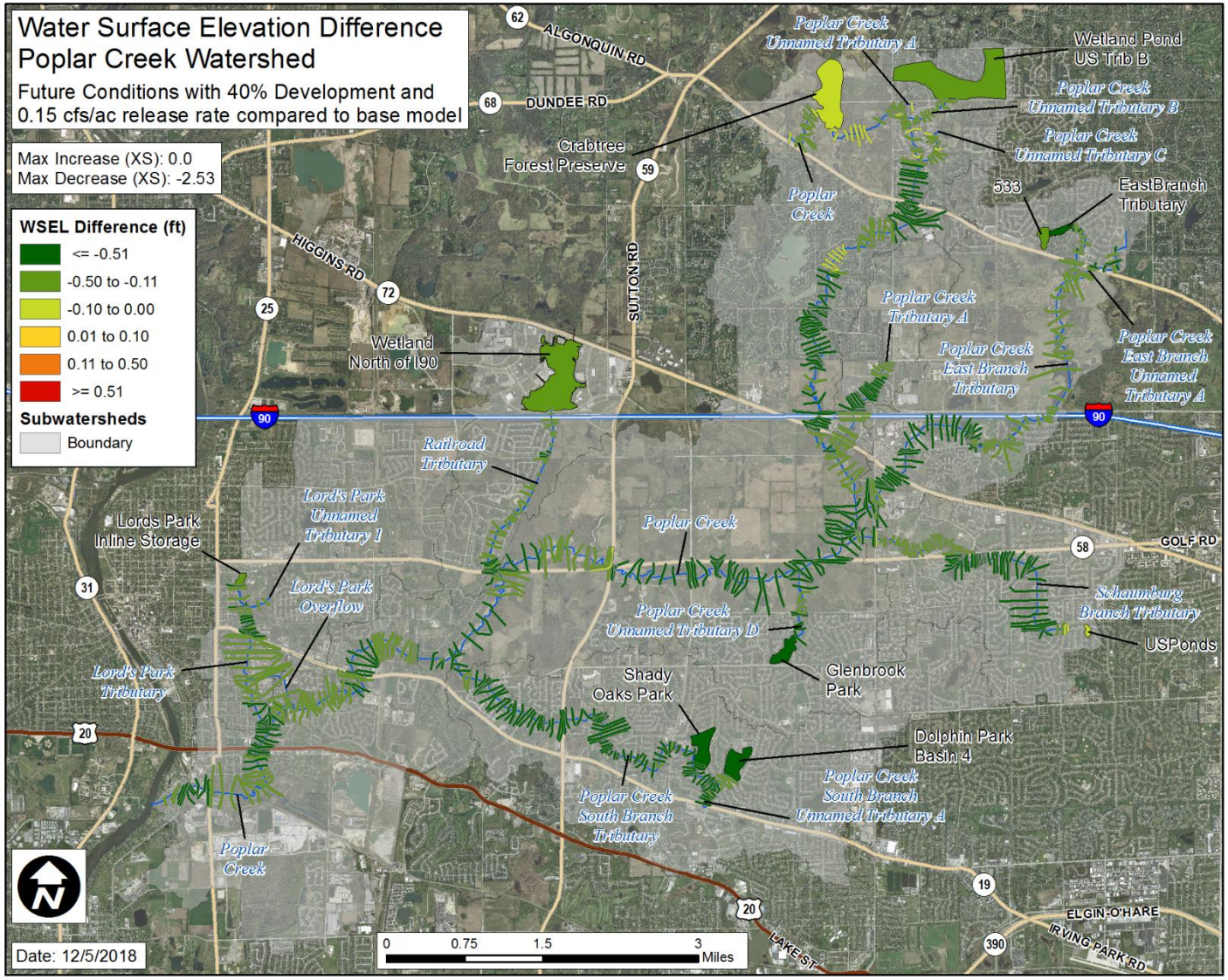
Modeled Subwatersheds:

- Poplar Creek
- Poplar Creek South Branch
- Poplar Creek Lord's Park Tributary
- Poplar Creek Railroad Tributary
- Poplar Creek Schaumburg Branch
- Poplar Creek East Branch
- Poplar Creek Tributary A

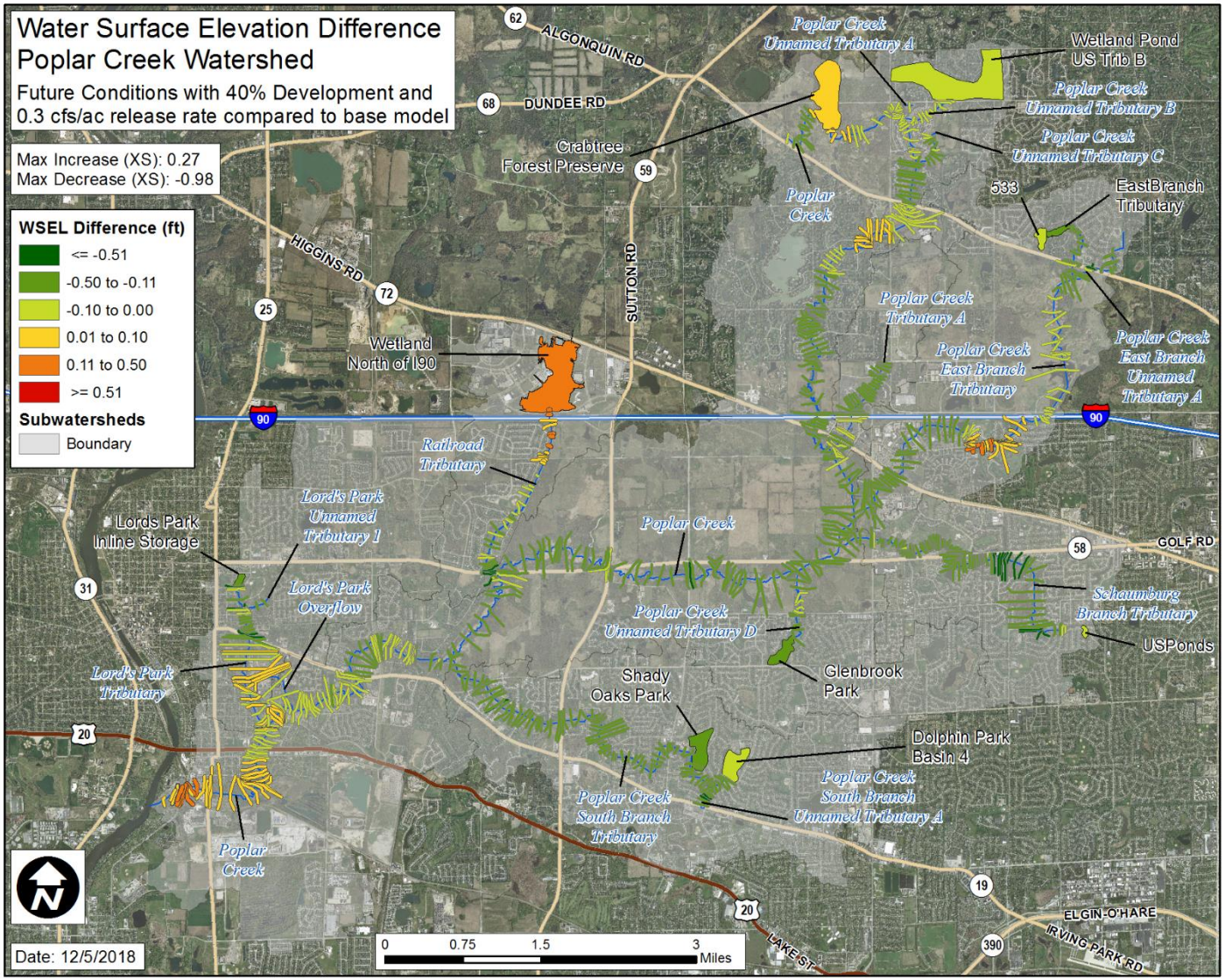
Base Runoff Rates

		24 hour		
	Subwatershed	**Average Base Conditions Peak Runoff Rate (cfs/acre)**	**Subbasin Base Conditions Peak Runoff Rate Range (cfs/acre)**	**Critical duration event**
Poplar Creek	Tributary A	0.43	0.27 - 0.73	24 hr
	East Branch	0.44	0.22 - 0.67	24 hr
	Schaumburg	0.55	0.38 - 0.74	24 hr
	Railroad Tributary	0.35	0.27 - 0.71	24 hr
	South Branch	0.49	0.24 - 0.75	24 hr
	Lord's Park Tributary	0.39	0.29 - 0.71	24 hr
	Main stem Poplar Creek	0.37	0.14 - 0.67	24 hr

Future Model Results



Future Model Results



Watershed Specific Release Rate Analysis:
Upper Salt Creek Watershed

Base Model Summary

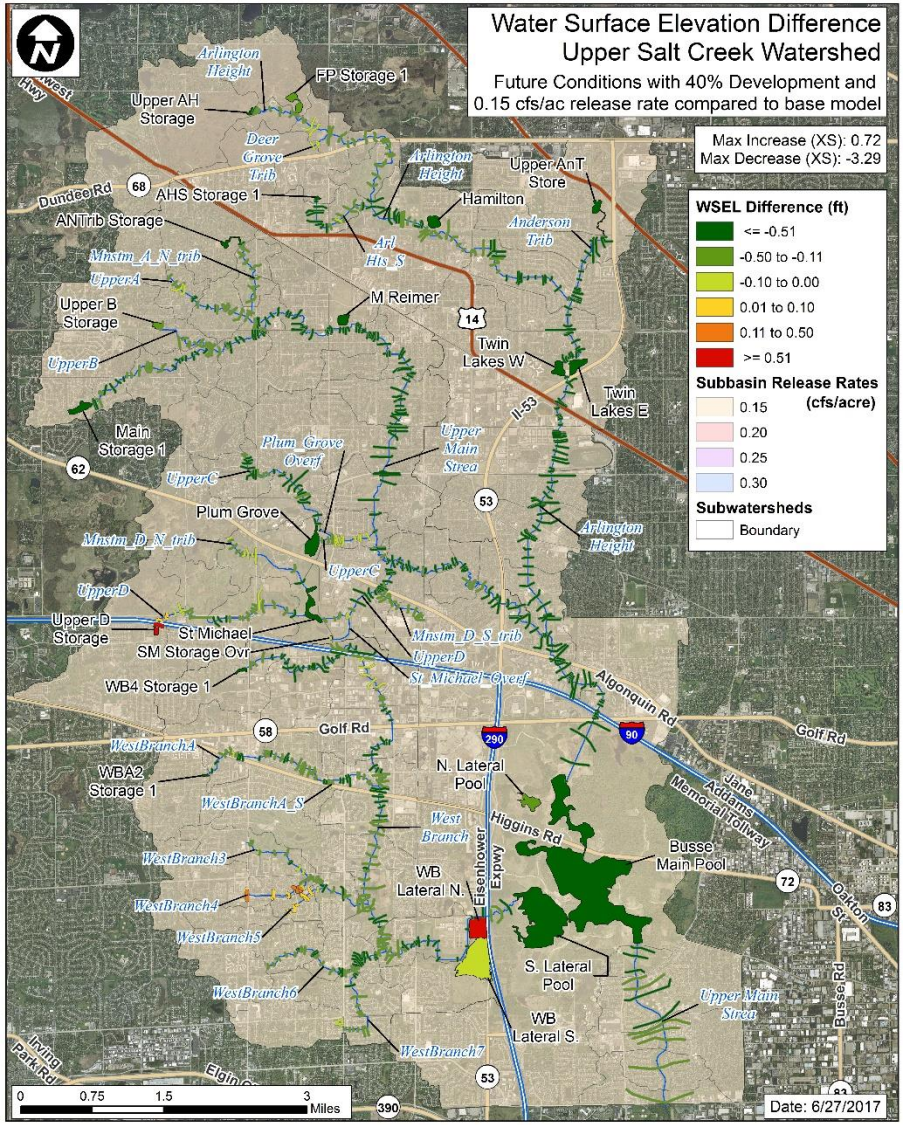
Modeled Subwatersheds:

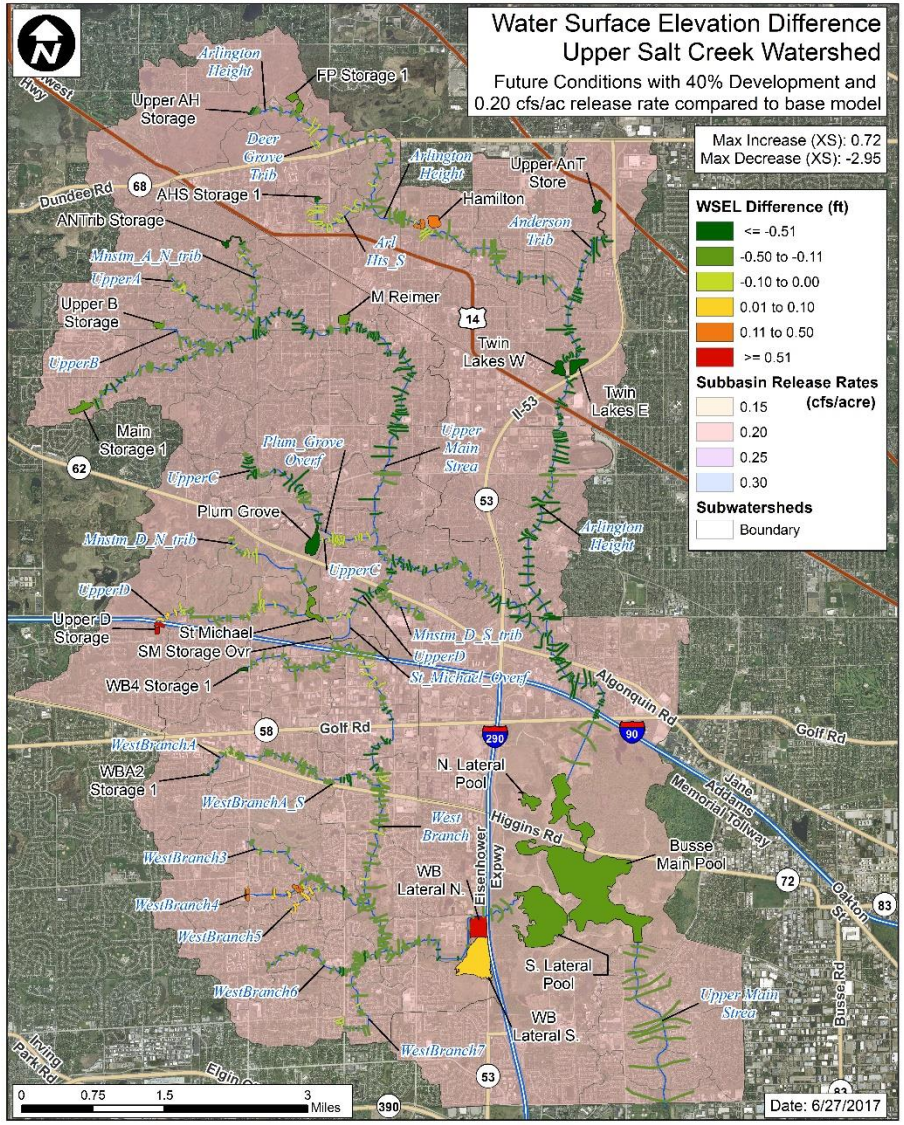
- Upper Salt Creek Mainstem
- Upper Salt Creek West Branch
- Upper Salt Creek Arlington Heights Branch

Base Runoff Rates

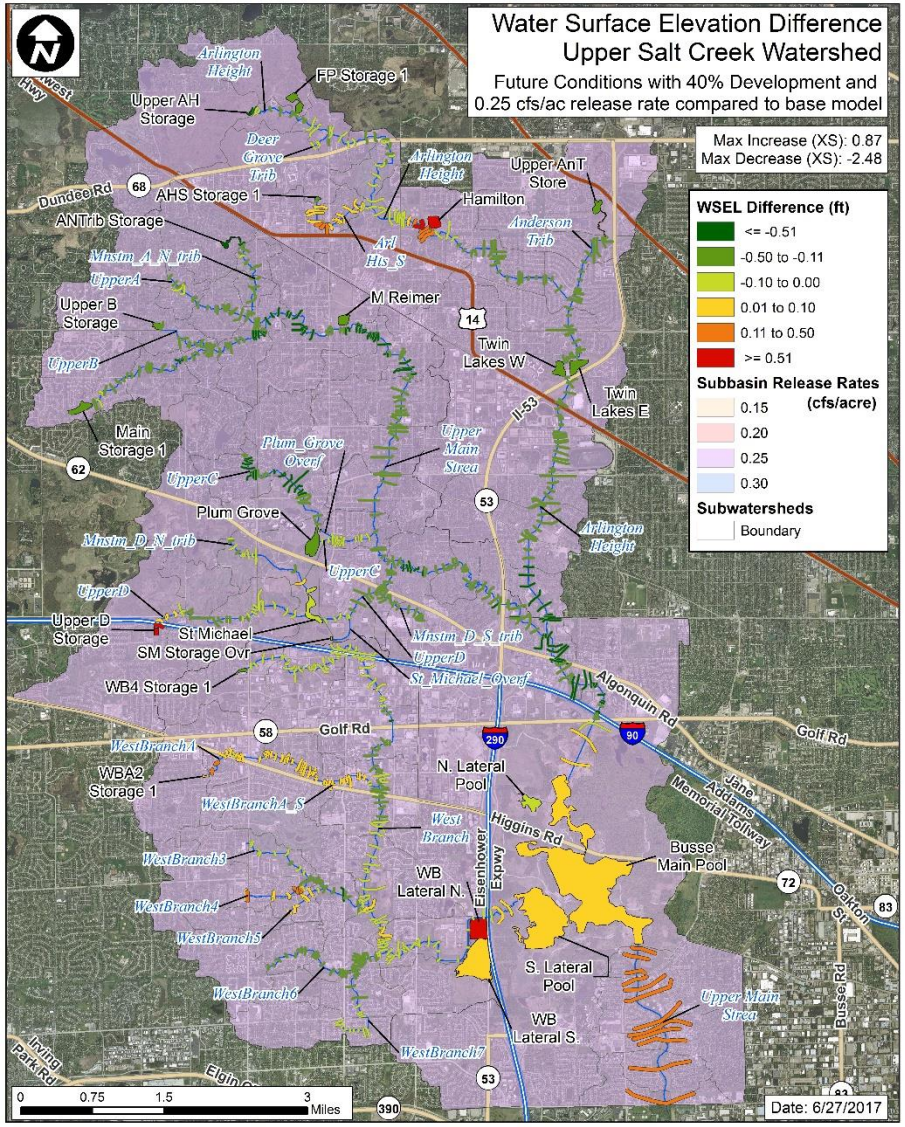
		24 hour		
	Subwatershed	**Average Base Conditions Peak Runoff Rate (cfs/acre)**	**Subbasin Base Conditions Peak Runoff Rate Range (cfs/acre)**	**Critical duration event**
Upper Salt Creek	Upper Salt Creek Mainstem	0.36	0.11 - 0.68	24 hr
	Arlighton Heights Branch	0.35	0.14 - 0.63	24 hr
	West Branch	0.26	0.11 - 0.55	24 hr

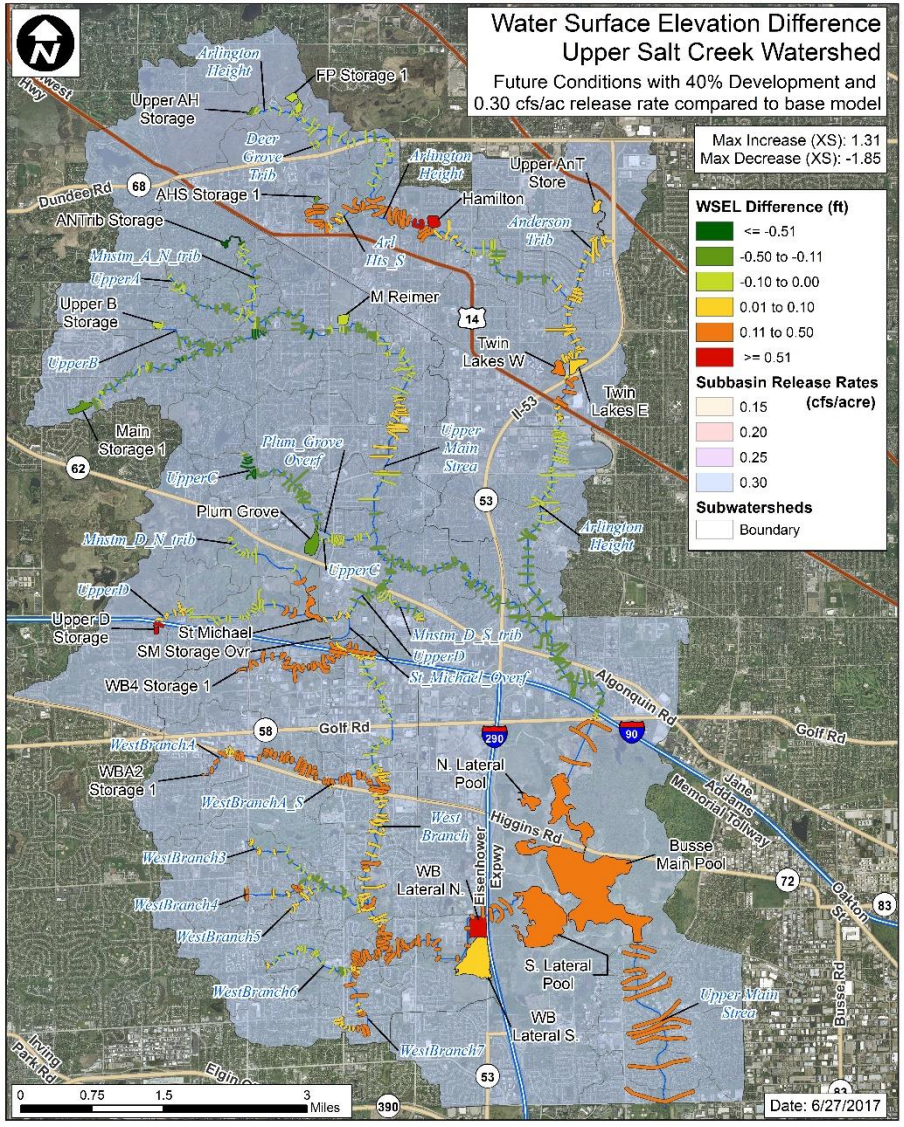
Future Model Results





Future Model Results





Results:
Considerations for Watershed Specific Release Rates

Analysis of Effect of Release Rates

Cal-Sag Watershed	Criteria	WMO release rate				Total Stream length
		0.15 cfs/ac	0.20 cfs/ac	0.25 cfs/ac	0.30 cfs/ac	
	Stream length with increase in peak WSEl> 0.1’ (ft)	0	0	0	0	166,027
	Stream length with increase in peak WSEl> 0.1’ (%)	0.0%	0.0%	0.0%	0.0%	
	Reservoirs in RAS model with increases > 0.5'	0	0	0	0	

North Branch Chicago River Watershed	Criteria	WMO release rate				Total Stream length
		0.15 cfs/ac	0.20 cfs/ac	0.25 cfs/ac	0.30 cfs/ac	
	Stream length with increase in peak WSEl> 0.1’ (ft)	0	108	108	0	286,663
	Stream length with increase in peak WSEl> 0.1’ (%)	0.0%	0.0%	0.0%	0.0%	
	Reservoirs in RAS model with increases > 0.5'	0	0	0	0	

Analysis of Effect of Release Rates

Poplar Creek Watershed	Criteria	WMO release rate				Total Stream length
		0.15 cfs/ac	0.20 cfs/ac	0.25 cfs/ac	0.30 cfs/ac	
	Stream length with increase in peak WSEl> 0.1’ (ft)	0	0	0	2,448	203,498
	Stream length with increase in peak WSEl> 0.1’ (%)	0.0%	0.0%	0.0%	1.2%	
	Reservoirs in RAS model with increases > 0.5'	0	0	0	0	

Little Calumet River Watershed	Criteria	WMO release rate				Total Stream length
		0.15 cfs/ac	0.20 cfs/ac	0.25 cfs/ac	0.30 cfs/ac	
	Stream length with increase in peak WSEl> 0.1’ (ft)	1,066	1,066	1,066	10,796	256,719
	Stream length with increase in peak WSEl> 0.1’ (%)	0.4%	0.4%	0.4%	4.2%	
	Reservoirs in RAS model with increases > 0.5'	0	1	0	1	

Analysis of Effect of Release Rates

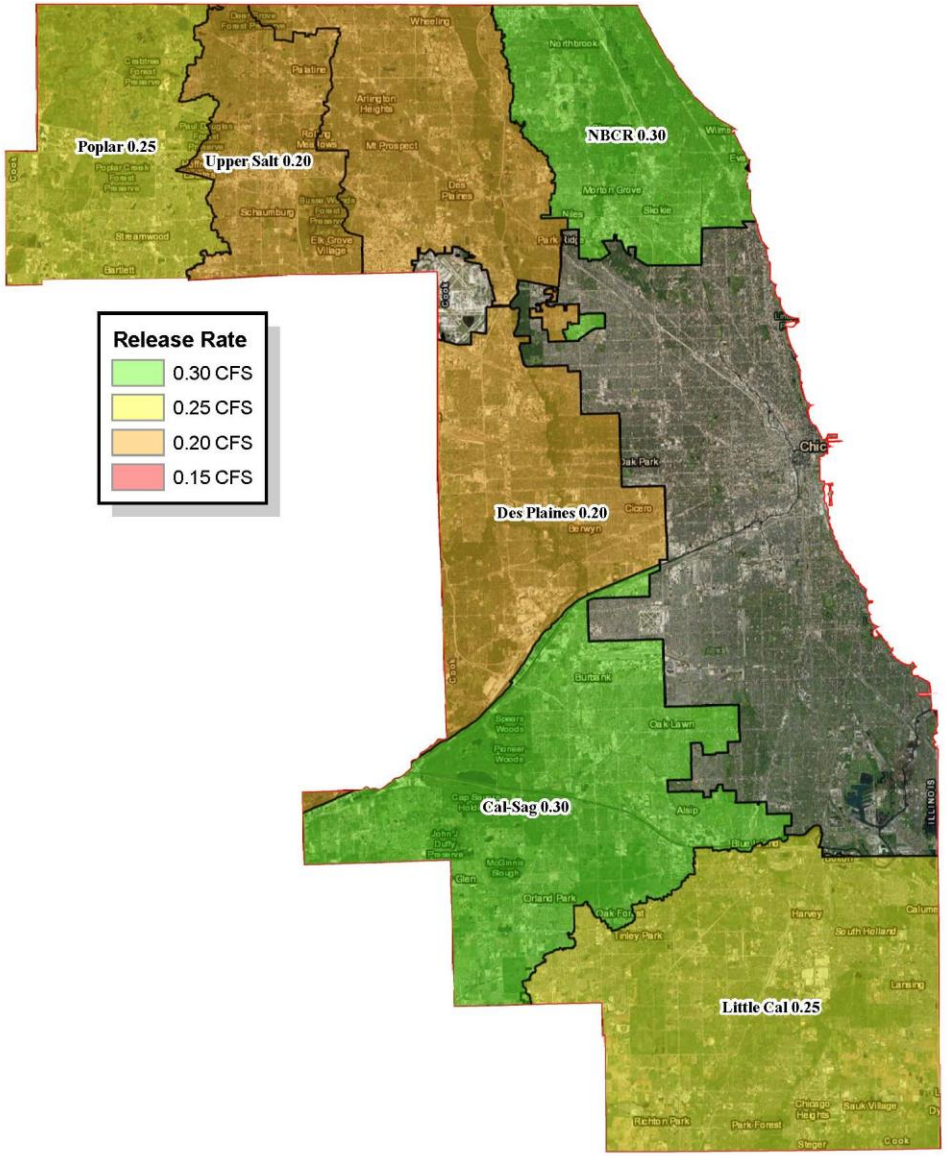
Upper Salt Creek Watershed	Criteria	WMO release rate				Total Stream length
		0.15 cfs/ac	0.20 cfs/ac	0.25 cfs/ac	0.30 cfs/ac	
	Stream length with increase in peak WSEl> 0.1’ (ft)	2,200	2,530	15,794	83,964	282,780
	Stream length with increase in peak WSEl> 0.1’ (%)	0.8%	0.9%	5.6%	29.7%	
	Reservoirs in RAS model with increases > 0.5'	2	2	3	3	

Des Plaines River Watershed	Criteria	WMO release rate				Total Stream length
		0.15 cfs/ac	0.20 cfs/ac	0.25 cfs/ac	0.30 cfs/ac	
	Tributary stream length with increase in peak WSEl> 0.1’ (ft)	0	0	9,727	52,483	530,318
	Tributary stream length with increase in peak WSEl> 0.1’ (%)	0.0%	0.0%	1.8%	9.9%	
	Reservoirs with increases > 0.5'	0	0	0	2	

WMO Appendix B – Watershed Specific Release Rates

(Based on Watershed Planning Areas depicted in Appendix E)

- *Calumet Sag Channel:* 0.30 cfs/acre
- *North Branch:* 0.30 cfs/acre
- *Little Calumet River:* 0.25 cfs/acre
- *Poplar Creek:* 0.25 cfs/acre
- *Upper Salt Creek:* 0.20 cfs/acre
- *Lower Des Plaines:* 0.20 cfs/acre



Additional Study Specified in WMO § 208

Summary

- **Methodology**
  - Provides a robust, consistent, and objective tool for evaluating Watershed Specific Release Rates

- **Key Findings**
  - Selection of Watershed Release Rates are able to mitigate future increases in water surface elevation due to future development in some watersheds

  - The study results support the principles of the 1991 NIPC study
    - The effectiveness of detention decreases with watershed size
    - Urbanization without detention causes dramatic increases in flooding
    - Runoff volume is not significantly impacted by release rate

- **Basis for Future Management Decisions**
  - The results provide a tool for the District to consider stormwater and watershed management strategies consistent with the goal of the WMO

Contact Information

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ISWS Contract Report 2019-06:
Watershed Specific Release Rate Analysis: Cook County
http://hdl.handle.net/2142/103416

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