Then and Now: A Hydrologic History of the Land of 10,000 Lakes (Metro Area)

Bruce Wilson (RESPEC)
Marvin Bauer (University of Minnesota)
Settlement of West & American Exceptionalism:
Joseph Nicollet explored area in 1830’s

“He will triumph who understands how to conciliate and to combine with the greatest will the benefits of the past with the demands of the future”

The past 175 years have shaped today’s landscape (city configurations, land cover, impervious surfaces, artificial drainage and altered aquatic habitats) with broad influences extending into the distant future.
Population: 1820-2040

<table>
<thead>
<tr>
<th>Year</th>
<th>Minneapolis</th>
<th>St. Paul</th>
<th>Twin Cities Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1820</td>
<td>195,833</td>
<td>140,292</td>
<td>1,000</td>
</tr>
<tr>
<td>1840</td>
<td>380,582</td>
<td>234,698</td>
<td>10,000</td>
</tr>
<tr>
<td>1885</td>
<td>492,370</td>
<td>287,736</td>
<td>400,000</td>
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<tr>
<td>1920</td>
<td>521,717</td>
<td>311,349</td>
<td>629,215</td>
</tr>
<tr>
<td>1940</td>
<td>434,400</td>
<td>309,980</td>
<td>878,834</td>
</tr>
<tr>
<td>1950</td>
<td></td>
<td></td>
<td>1,031,916</td>
</tr>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td>1,874,600</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td>2,652,062</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td>2,849,567</td>
</tr>
<tr>
<td>2040</td>
<td></td>
<td></td>
<td>3,675,660</td>
</tr>
</tbody>
</table>

~ 3.7 million in 200 years!
H.W. Longfellow’s *Song of Hiawatha* (1857)

Inspired thousands of tourists and settlers over next decades
Wilson Family Photo (1900)

One Century (1820 – 1920) of Horsepower!
(If 1 horse per 10 people, ~ 40,000 in Twin Cities)
Modifying the Mississippi River

• 1858 Minnesota becomes 32nd state
  • 1861-1865 American Civil War
• 1868 Companies construct dam at St. Anthony Falls
• 1882 First hydroelectric plant
  • Riparian forests cleared for steam ship fuel
• Late 1880’s: Army Corps maintains 4.5 foot channel, wing dams installed
  • Early 1900’s: 9 foot channel + more wing dams
• 1900-1920: Drainage ditches encouraged.
• 1917 Lock & Dam 1 (St. Paul) receives \( \sim 65 \text{ mgd} \) sewage
• 1930-1937: Lock & Dam 2 (Hastings) + L/D 3-8 constructed
Mighty Mississippi
Sewage & Stormwater & Garbage Disposal

**Early St. Paul Resolution (circa 1890’s)** - Dump all garbage and pig manure into river at City downstream boundary
- Late 1880’s Minneapolis dumped 500 tons garbage on ice; St. Paul same
- 1880’s: 2.5 miles of sewers (Minneapolis), sewage noted in streets

**1820-1938:** All Twin Cities area sewage & stormwater runoff discharged to Mississippi River
- Combined sewage & storm sewers - egg shaped sewers
- Public Health issues mount: floating islands of sewage, scums, Typhoid fever outbreaks, abundance of dead fish & odors offensive blocks away
- Untreated Mississippi River water (north station) to MPLS residents until 1911

**1938: Pigs Eye Wastewater Treatment Plant Opens**
- Overflow regulators diverted wet flows to River
- Wastewater discharged into river below St. Paul

**Regional issues continue**
- **Metropolitan Council established 1967**
- Met Wastewater system replaced 14 outdated community wastewater plants
- Massive CSO separation 1986-1996: all of St. Paul, 95% of MPLS
- Minneapolis and Met Council efforts continue; last of CSO separation
Transportation & Development

1840’s: Few thousand people

1880’s: 400,000 population Minneapolis/St. Paul
  • Worker homes huddled near jobs & city centers
  • Elite households - carriage rides to pleasant surroundings

1891: Electric streetcars begin access & development of nearby farmlands (suburbia begins)

1918-1950
  • Multiple streetcar lines post WWI to 1950’s. Development begins on larger scale
  • 1920’s+: new suburbs, bigger lots, bigger streets, driveways, and garages

Age of the Automobile:
  • Post WWII: interstate highways and much larger development to outlying areas.
  • Repetition of above, but on far grander scale
Development Case Study: Evolution of Minneapolis International Airport (MSP) 1937

Snelling Speedway became Minneapolis Aero Club ~1920, airport quickly evolved post WWI
MSP Today (2013)
2011 U MN Land Cover and Impervious Cover
### Mississippi River Monthly Flows

**St. Paul USGS Site 05331000**

*From USGS 2013 Annual Report*  
*WY = Water Year*  
*Flows in Cubic Feet per Second*

<table>
<thead>
<tr>
<th></th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
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<tbody>
<tr>
<td>Max</td>
<td>45,690</td>
<td>28,300</td>
<td>16,080</td>
<td>13,680</td>
<td>14,700</td>
<td>46,300</td>
<td>96,590</td>
<td>70,430</td>
<td>57,170</td>
<td>73,590</td>
<td>42,550</td>
<td>34,380</td>
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**Peak flows relatively recent years**

<table>
<thead>
<tr>
<th></th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
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<th>Apr</th>
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<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
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<tbody>
<tr>
<td>Min (WY)</td>
<td>1937</td>
<td>1937</td>
<td>1935</td>
<td>1935</td>
<td>1895</td>
<td>1940</td>
<td>1895</td>
<td>1934</td>
<td>1934</td>
<td>1934</td>
<td>1934</td>
<td>1934</td>
</tr>
<tr>
<td>Min</td>
<td>1,289</td>
<td>1,348</td>
<td>1,277</td>
<td>1,097</td>
<td>1,300</td>
<td>1,757</td>
<td>3,421</td>
<td>3,085</td>
<td>1,980</td>
<td>1,272</td>
<td>864</td>
<td>1,143</td>
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</tbody>
</table>

**Minimum flows: Dust bowl dominated years**

**Next Major Drought?**
Mississippi River Sites
Annual Mean Flows (cfs)

Cubic Feet per Second

Year

Mississippi River Sites
Annual Mean Flows (cfs)

Grand Rapids
Brooklyn Park
St. Paul
Prescott
Increasing Annual Temperature
Average Number of Thaws per Month (1950-2009)
10 year smoothing MPLS Airport
Analysis by Pete Boulay & Bruce Wilson
Minnesota DNR Climatology Office

Increasing # Thaws & Runoff Potential
Opportunities for infiltration with due care.
Minneapolis - St. Paul IAP Growing Season
Dates between last spring and first autumn days 32 Degree F.
- Summer Storm Runoff Generation
- Opportunities for Vegetated Interception & Evapotranspiration
**New Atlas 14 Precipitation Data for MSP International Airport**

*Precipitation in inches*

<table>
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<tr>
<th>Duration</th>
<th>Average recurrence interval (years)</th>
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<tr>
<td></td>
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<tr>
<td>24-hr</td>
<td>2.47</td>
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<tr>
<td>2-day</td>
<td>2.87</td>
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<td>3-day</td>
<td>3.15</td>
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<td>4-day</td>
<td>3.37</td>
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<tr>
<td>7-day</td>
<td>3.88</td>
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<tr>
<td>10-day</td>
<td>4.37</td>
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24 Hour Storms & Back-To-Back Storm Wet Periods
AVERAGE RUNOFF PER SQUARE MILE

MDNR Waters Division Graphic from late 1990’s
Provided by Greg Kruse
Take-Aways

• City street designs last... forever!

• Rapid growth of Twin Cities & impervious cover
  • Cities not designed for water quantity/quality
  • Public health and water quality realities
    • Avoided Cuyahoga River Syndrome
    • Continued development & increased imperviousness due to transportation needs (car habitat).

• Climate has changed requiring adaptation of stormwater best practices. Advances in robotics and automation will continue to revolutionize approaches.

• Increasing Mississippi River peak and annual flows
  • Increasing withdrawal of groundwater supplies - discharged as wastewater.
Thank You!

Phalen Lake 1923
2011 Land Cover

Wetlands
- Lakes & Ponds
- Emergent Wetlands
- Forested Wetlands
- Shrub Wetlands
- Rivers

Uplands
- Deciduous Forest
- Conifer Forest
- Mixed Forest
- Managed Grass
- Grassland
- Row Crops
- Hay and Pasture
- Small Grains
- Extraction

Urban / Developed

1 % Impervious 100
Regional Ground Water

- **Metro:**
  Groundwater flow in the upper aquifer units is towards the major rivers.

- Generally the deeper Mt. Simon – Hinckley aquifer flows towards the major rivers.

- About 30% of public water supply demand is met by surface water; 70% by groundwater.

Graphic from Met Council, 2013.
Table 1.—Population of political subdivisions

<table>
<thead>
<tr>
<th>Name</th>
<th>Population 1950</th>
<th>Population 1940</th>
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<tbody>
<tr>
<td>Minneapolis</td>
<td>521,717</td>
<td>492,370</td>
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<tr>
<td>St. Paul</td>
<td>311,349</td>
<td>287,736</td>
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<tr>
<td>St. Louis Park</td>
<td>22,644</td>
<td>7,737</td>
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<td>Richfield</td>
<td>17,502</td>
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<td>South St. Paul</td>
<td>15,909</td>
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<td>Robbinsdale</td>
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<td>Edina</td>
<td>9,744</td>
<td>5,855</td>
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<td>Columbia Heights</td>
<td>8,175</td>
<td>6,035</td>
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<tr>
<td>West St. Paul</td>
<td>7,955</td>
<td>5,733</td>
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<tr>
<td>Stillwater</td>
<td>7,674</td>
<td>7,013</td>
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<td>Hopkins</td>
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<td>4,100</td>
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<td>Anoka</td>
<td>7,396</td>
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<td>Hastings</td>
<td>6,560</td>
<td>5,662</td>
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<tr>
<td>Crystal</td>
<td>5,713</td>
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<td>Golden Valley</td>
<td>5,551</td>
<td>2,048</td>
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<tr>
<td>Hennepin County</td>
<td>676,579</td>
<td>568,899</td>
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<tr>
<td>Ramsey County</td>
<td>355,332</td>
<td>309,935</td>
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