Water Demands in the Rock River Water Supply Planning Region

Draft Report on Water Demand Scenarios

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Illinois State Water Survey

Middle Illinois Regional Water Supply Planning Committee
May 30, 2018
Project purpose and scope

- To develop water-demand scenarios (2015-2060) for all major user sectors Rock River Region
Analytical Approach

- Translate the projections of population and economic (including agricultural) growth into associated water supply needs.
- Account for current (2010 base year) and historical water withdrawals within each county.
- Future demand scenarios based on assumptions about future values of “drivers” and “explanatory variables.”
Five Major Sectors of Water Users

- Public water supply (PWS)
- Self-supplied domestic (DOM)
- Thermoelectric power generation (PG)
- Self-supplied industrial and commercial (IC)
- Irrigation, livestock, and environmental (ILE)
Data Sets and Levels

- Water use data from Illinois Water Inventory Program (IWIP) and USGS
- Historical water use and explanatory variable data for public water supply and at system level
- Facility-specific data for self-supplied thermoelectric power generation
- County-level data for self-supplied industrial/commercial, irrigation/livestock/environmental, self-supplied domestic sectors
Illinois Water Inventory Program (IWIP)

- Annual water use reporting program for major water users (> 100,000 gallons per day) in Illinois since 1978
- IWIP collects point source water withdrawals data from 3 sectors:
  1. Public Water Supply
  2. Self-Supplied Industrial-Commercial
  3. Agricultural Irrigation (since 2015)
  4. About 3,200 active facilities
- Prior to 2010, reporting was voluntary; now mandatory
- Periodic summaries of data published
Determinants of PWS Water Demand: (Derived from 1990-2010 data)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median household income</td>
<td>-0.198</td>
</tr>
<tr>
<td>Marginal price of water</td>
<td>+0.122</td>
</tr>
<tr>
<td>Employment/population ratio</td>
<td>+0.503</td>
</tr>
<tr>
<td>Precipitation – growing season</td>
<td>-0.060</td>
</tr>
<tr>
<td>Maximum daily temperature</td>
<td>+1.133</td>
</tr>
<tr>
<td>Conservation trend</td>
<td>-0.004</td>
</tr>
</tbody>
</table>

Table 2.5
Other Drivers of Future Demand

- Strong increasing trend in irrigated cropland
  - 4.3% per year between 1987 and 2012 (USDA)
- Projected industrial growth (employment)
- Median household income expected to grow
- Retail (real) prices of water are increasing
- Water efficiency in PWS is improving
Forecast Scenarios

Developed 3 sets of scenario assumptions

- Scenario 1:
  Baseline scenario (or Current Trends - CT)

- Scenario 2:
  Low growth (or Less Resource Intensive - LRI)

- Scenario 3:
  High growth (or More Resource Intensive - MRI)
## Scenario Assumptions

<table>
<thead>
<tr>
<th>Factor</th>
<th>Scenario 1 - Current Trends (CT) or Baseline</th>
<th>Scenario 2 - Less Resource Intensive (LRI)</th>
<th>Scenario 3 – More Resource Intensive (MRI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population</td>
<td>IDPH and trend-based projections</td>
<td>IDPH and trend-based projections</td>
<td>IDPH and trend-based projections</td>
</tr>
<tr>
<td>Median household income</td>
<td>Existing projections of 1.0%/year growth</td>
<td>Existing projections of 0.7%/year growth</td>
<td>Higher growth of 1.2%/years</td>
</tr>
<tr>
<td>Water conservation</td>
<td>50% lower rate than historical trend</td>
<td>Continuation of historical trend</td>
<td>No extension of historical trend</td>
</tr>
<tr>
<td>Future water prices</td>
<td>Recent increasing trend (0.8%/year) will continue</td>
<td>Higher future price increases (1.6%/year)</td>
<td>Prices held at 2010 level in real terms</td>
</tr>
<tr>
<td>Irrigated land</td>
<td>Constant cropland, increasing golf courses</td>
<td>Decreasing cropland, no increase in golf courses</td>
<td>Constant cropland, increasing golf courses</td>
</tr>
<tr>
<td>Livestock</td>
<td>Baseline USDA growth rates</td>
<td>Baseline USDA growth rates</td>
<td>Baseline USDA growth rates</td>
</tr>
</tbody>
</table>

Table 1.1
Using average of IPCC models to predict changes in temperature and precipitation in the region by 2035 and 2060:

Relative to “normal” values 1971-2000

Drought defined as 40% deficit in growing season precipitation

<table>
<thead>
<tr>
<th>Climate Parameter</th>
<th>2035 Period</th>
<th>2060 Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hot/Dry</td>
<td>Central</td>
</tr>
<tr>
<td>Change in Annual Avg. Temperature (°F)</td>
<td>3.4°</td>
<td>2.8°</td>
</tr>
<tr>
<td>Change in Annual Precipitation (%)</td>
<td>-0.3%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>
Rock River Water Supply Planning Region
Results
2010 Demand: Rock River WSPR

- Self-Supplied Domestic: 11 Mgd (1%)
- Self-Supplied Industrial and Commercial: 28 Mgd (2%)
- Self-Supplied Irrigation, Livestock, and Environmental: 52 Mgd (4%)
- Public Supply: 79 Mgd (6%)
- Self-Supplied Thermoelectric Power Generation: 1,160 Mgd (87%)

Mgd = million gallons per day

67 Mgd consumed
Public Water Supplies

- 255 systems
- 679,000 served
- 42 dominant systems
- 137,000 on domestic wells
Public Water Supplies: Source Water

- Surface water (rivers)
  - All in Rock Island County: Mississippi River
  - Major systems: Rock Island, Moline, East Moline

- Remainder on groundwater
  - Shallow sand and gravel aquifers
  - Bedrock aquifers
    - Sandstone
    - Carbonates
### Public Water Supplies: Historic Data (example)

#### Population Served

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Winnebago County</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL American – S. Beloit</td>
<td>4,100</td>
<td>4,200</td>
<td>6,000</td>
<td>4,700</td>
<td>7,800</td>
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<tr>
<td>Loves Park</td>
<td>15,653</td>
<td>17,452</td>
<td>20,040</td>
<td>22,767</td>
<td>24,700</td>
</tr>
<tr>
<td>North Park PWD</td>
<td>22,229</td>
<td>24,000</td>
<td>26,000</td>
<td>30,000</td>
<td>34,737</td>
</tr>
<tr>
<td>Rockford</td>
<td>140,000</td>
<td>149,000</td>
<td>155,000</td>
<td>156,000</td>
<td>162,296</td>
</tr>
<tr>
<td>Rockton</td>
<td>2,928</td>
<td>4,300</td>
<td>4,900</td>
<td>7,875</td>
<td>7,440</td>
</tr>
<tr>
<td>Winnebago Co. Residual</td>
<td>15,540</td>
<td>17,886</td>
<td>20,559</td>
<td>23,593</td>
<td>39,300</td>
</tr>
</tbody>
</table>

#### Water Use (Mgd)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Winnebago County</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>IL American – S. Beloit</td>
<td>0.684</td>
<td>0.616</td>
<td>0.569</td>
<td>0.607</td>
<td>0.765</td>
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<tr>
<td>Loves Park</td>
<td>3.112</td>
<td>3.157</td>
<td>2.223</td>
<td>3.424</td>
<td>3.182</td>
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<tr>
<td>North Park PWD</td>
<td>1.848</td>
<td>2.283</td>
<td>2.735</td>
<td>3.651</td>
<td>3.477</td>
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<tr>
<td>Rockford</td>
<td>27.190</td>
<td>26.323</td>
<td>24.575</td>
<td>25.639</td>
<td>20.221</td>
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<tr>
<td>Rockton</td>
<td>0.539</td>
<td>0.715</td>
<td>0.695</td>
<td>0.914</td>
<td>0.807</td>
</tr>
<tr>
<td>Winnebago Co. Residual</td>
<td>1.772</td>
<td>3.544</td>
<td>2.211</td>
<td>2.693</td>
<td>2.348</td>
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</table>
## Projected Population

**Table 2.8**

<table>
<thead>
<tr>
<th>County</th>
<th>Reported Population</th>
<th>Projected Population</th>
<th>2010-2060 Change</th>
<th>2010-2060 Change (%)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2010(^1)</td>
<td>2020(^2)</td>
<td>2040(^3)</td>
<td>2060(^3)</td>
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<tr>
<td>Boone</td>
<td>54,144</td>
<td>61,504</td>
<td>69,084</td>
<td>76,814</td>
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<tr>
<td>Bureau</td>
<td>34,905</td>
<td>33,681</td>
<td>33,681</td>
<td>33,681</td>
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<tr>
<td>Carroll</td>
<td>15,364</td>
<td>14,169</td>
<td>14,169</td>
<td>14,169</td>
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<tr>
<td>Henry</td>
<td>50,432</td>
<td>48,233</td>
<td>48,233</td>
<td>48,233</td>
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<tr>
<td>Jo Daviess</td>
<td>22,660</td>
<td>22,137</td>
<td>22,137</td>
<td>22,137</td>
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<tr>
<td>Lee</td>
<td>35,970</td>
<td>36,066</td>
<td>36,349</td>
<td>36,645</td>
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<tr>
<td>Ogle</td>
<td>53,448</td>
<td>54,316</td>
<td>56,417</td>
<td>58,521</td>
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<tr>
<td>Rock Island</td>
<td>147,632</td>
<td>147,267</td>
<td>152,651</td>
<td>158,035</td>
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<tr>
<td>Stephenson</td>
<td>47,680</td>
<td>46,242</td>
<td>46,242</td>
<td>46,242</td>
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<td>Whiteside</td>
<td>58,472</td>
<td>55,267</td>
<td>55,267</td>
<td>55,267</td>
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<tr>
<td>Winnebago</td>
<td>295,151</td>
<td>302,258</td>
<td>311,687</td>
<td>321,297</td>
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<tr>
<td><strong>REGIONAL TOTAL</strong></td>
<td>815,858</td>
<td>821,140</td>
<td>845,916</td>
<td>871,040</td>
</tr>
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</table>

Data from U.S. Census Bureau and Illinois Department of Public Health
## PWS Demand Scenario (CT)

<table>
<thead>
<tr>
<th>Year</th>
<th>Population Served</th>
<th>Demand gpcd</th>
<th>Demand Mgd</th>
<th>Locally Sourced (Mgd)</th>
<th>Imported (Mgd)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ground Water</td>
<td>Surface Water</td>
</tr>
<tr>
<td>2010</td>
<td>678,746</td>
<td>117.2</td>
<td>79.52</td>
<td>62.93</td>
<td>15.83</td>
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<tr>
<td>2015</td>
<td>688,454</td>
<td>120.5</td>
<td>82.98</td>
<td>65.84</td>
<td>16.34</td>
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<tr>
<td>2020</td>
<td>696,742</td>
<td>118.9</td>
<td>82.82</td>
<td>65.83</td>
<td>16.19</td>
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<tr>
<td>2025</td>
<td>704,514</td>
<td>117.4</td>
<td>82.72</td>
<td>65.87</td>
<td>16.05</td>
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<tr>
<td>2030</td>
<td>709,471</td>
<td>116.0</td>
<td>82.29</td>
<td>65.60</td>
<td>15.90</td>
</tr>
<tr>
<td>2035</td>
<td>715,935</td>
<td>114.6</td>
<td>82.03</td>
<td>65.48</td>
<td>15.76</td>
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<tr>
<td>2040</td>
<td>722,399</td>
<td>113.2</td>
<td>81.76</td>
<td>65.36</td>
<td>15.61</td>
</tr>
<tr>
<td>2045</td>
<td>728,862</td>
<td>111.8</td>
<td>81.48</td>
<td>65.23</td>
<td>15.47</td>
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<tr>
<td>2050</td>
<td>735,326</td>
<td>110.4</td>
<td>81.21</td>
<td>65.10</td>
<td>15.33</td>
</tr>
<tr>
<td>2055</td>
<td>741,789</td>
<td>109.1</td>
<td>80.92</td>
<td>64.96</td>
<td>15.19</td>
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<tr>
<td>2060</td>
<td>748,254</td>
<td>107.8</td>
<td>80.63</td>
<td>64.81</td>
<td>15.05</td>
</tr>
<tr>
<td>2010-2060 Change</td>
<td>69,508</td>
<td>-9.4</td>
<td>1.11</td>
<td>1.88</td>
<td>-0.77</td>
</tr>
<tr>
<td>2010-2060 Change (%)</td>
<td>10.2</td>
<td>-8.0</td>
<td>1.4</td>
<td>3.0</td>
<td>-4.9</td>
</tr>
</tbody>
</table>

Table 2.13
PWS Current Trends Scenario

![Population Served Over Time](chart)

- **Total**
- **Groundwater**
- **Surface Water**

Population Served (log scale):
- 660,000 to 760,000

Demand (Mgd):
- 60 to 80

Years:
- 2000 to 2070
## Large Thermoelectric Power Plants in Rock River Region

Modified from Table 4.2

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Lee Energy (Natural Gas)</td>
<td>Lee</td>
<td>814</td>
<td>No data</td>
<td>No data</td>
<td>Not determined</td>
</tr>
<tr>
<td>Exelon - Byron Station (Nuclear)</td>
<td>Ogle</td>
<td>2,450</td>
<td>20,848,498</td>
<td>55.52</td>
<td>0.973</td>
</tr>
<tr>
<td>Cordova Energy (Natural Gas)</td>
<td>Rock Island</td>
<td>611</td>
<td>161,452</td>
<td>0.26</td>
<td>0.592</td>
</tr>
<tr>
<td>Exelon - Quad Cities Station (Nuclear)</td>
<td>Rock Island</td>
<td>2,019</td>
<td>14,565,059</td>
<td>1,103.87</td>
<td>27.682</td>
</tr>
<tr>
<td>NRG Rockford I &amp; II (Natural Gas)</td>
<td>Winnebago</td>
<td>484</td>
<td>No data</td>
<td>No data</td>
<td>Not determined</td>
</tr>
</tbody>
</table>
Future Demands for Thermoelectric Plants

- Used unit-coefficient method = gross generation at the plant times the rate of water demand per unit of generated electricity
  - Once-through plants: 29 gallons/kWh
  - Closed loop plants: 1.0 gallon per kWh

- Future electricity demand in region estimated to be 10.14 MWh/capita-year (IL Commerce Commission for 2006)

- Assumptions for CT Scenario
  - Future generation in the existing thermoelectric power plants will continue at 2010 levels of gross generation.
  - No new thermoelectric power plants (with steam turbines that require water-based cooling) will be added through the end of the study period in 2060

- Water Demand = 1,160 Mgd per year
Industrial-Commercial Sector

- Self-supplied Mining
  - 6.9 Mgd in 2010
  - About ¾ mining use in Bureau and Rock Island Counties
IC Sector: Mining
Industrial-Commercial Sector

- Self-supplied Non-mining
  - 21.5 Mgd in 2010
  - Primarily Rock Island County (11.2 Mgd)
  - Carroll (2.2 Mgd) and Stephenson (2.1 Mgd) next most important

- IC Facilities also purchase water from PWSs
  - 25.7 Mgd in 2010

- Because IC encompasses many different types of facilities and water uses, determining demands is a challenge
IC Sector: Non-Mining

![Map of the IC Sector: Non-Mining area with annotations for Rock River WSPR, County Boundary, Major River, No Demand, and Self-supplied IC demand for non-mining uses (Mgd)].

- Rock River WSPR
- County Boundary
- Major River
- No Demand
- Self-supplied IC demand for non-mining uses (Mgd):
  - < 1.0
  - 1.0 to 5.0
  - > 5.0

The map includes counties such as Jo Daviess, Stephenson, Winnebago, Boone, Ogle, Carroll, Whiteside, Lee, Rock Island, Henry, and Bureau.
Industrial-Commercial Water Use: Non-Mining
Estimating Future Industrial-Commercial Demands

- Main driver of future IC water demand assumed to be the future output of goods and services
- Assumed long-term rates of labor productivity growth to be 1.0 - 1.5 % per year
- Use projected employment data and labor productivity
  - IL Dept. Employment Security
  - U.S. Dept. of Labor Bureau of Statistics
Estimating Future Industrial-Commercial Demands

Assumptions:

- Total county employment will follow published projections
- Self-supplied IC demand for each county will remain at percentage computed from 2010 totals
- Groundwater and surface water proportions will not change
- Major unknown is if water-intensive facilities, such as ethanol and biodiesel plants, are located within the region in the future
  - Not included, but could be simulated
IC Future Demand (CT)

45% increase
Irrigated Cropland, Acres

USDA Data
Irrigation Center Pivots

Center Pivots
- 2014
- 2012
- Rock River Region
- Counties
- Major Rivers

Map showing the distribution of irrigation center pivots across different counties and regions.
ILE Future Demands (CT)
Demand Scenarios – Rock River (without Thermoelectric)
Demand Scenarios – Middle Illinois (without Thermoelectric)
Changes in Demand due to Climate Change and Drought

- Hot & Dry climate scenario relative to CT “normal” climate:
  - Public supply: +8.7%
  - Self-supplied domestic: +8.8%
  - Cropland irrigation: +10.1%

- Drought year with 40% deficit in precipitation:
  - Public supply: +8.7%
  - Self-supplied domestic: +9.0%
  - Cropland irrigation: +34.0%
Summary (1)

Not including Thermoelectric Demand

Total demand projected to change by 2060 from 210 Mgd (normalized) in 2010 to:

- 201 Mgd under the LRI scenario, 4% decrease
- 261 Mgd under the CT scenario, 24% increase
- 351 Mgd under the MRI scenario, 67% increase

Under CT scenario, the 2010-2060 increase of 51 Mgd includes:

- Increase of 1.1 Mgd in PWS demand
- Decrease of 1.6 Mgd in self-supplied domestic demand
- Increase of 7.5 Mgd in IC demand
- Increase of 44.0 Mgd in ILE demand
Summary (2)

- Projected increase in demand caused by increase in projected employment from 275,269 in 2010 to 324,277 in 2060 (20% increase) mostly in Winnebago County.

- Effects of future climate appear to be modest (<10% increase in demand).

- Scenario results could be adjusted based on input from Regional Water Supply Planning Committee.
Input from the Committee

- Information on:
  - Power generating plants
  - New water-intensive industries
  - Growth in irrigation
  - Mining operation status

- Update water purchase map:
  
  https://www.isws.illinois.edu/illinois-water-supply-planning/interactive-maps
  
  Click on: "Statewide Municipal Water Use and Water Purchase Interactive Map"
Thank you!