‘Creating’ More Water in the Catawba

CW-WMG – Catawba River Water Supply Master Plan

WRF & CW-WMG – Safe Yield Research Project
Catawba-Wateree Water Management Group
(19 Members with Intakes in the 11 Reservoirs and Main Stem of the Catawba)

- Belmont, NC
- Camden, SC
- Catawba River Water Supply Project
- Charlotte, NC
- Chester Metro, SC
- Duke Energy
- Gastonia, NC
- Granite Falls, NC
- Hickory, NC
- Lenoir, NC
- Lincoln County, NC
- Longview, NC
- Lugoff-Elgin Water Auth., SC
- Mooresville, NC
- Morganton, NC
- Mount Holly, NC
- Rock Hill, NC
- Statesville, NC
- Valdese, NC
CW-WMG is Leading Research & Planning Efforts to Ensure Sustainable Water Supply

- Safe Yield Research Project
- Sedimentation Study
- Conservation Study
- Catawba River Water Supply Master Plan
- States’ Settlement Agreement
  - Water Supply Study Update
  - CHEOPS Modeling Update
  - Future Planning
  - Funding by CW-WMG, NC, and SC
Background Information
Catawba-Wateree River Basin

Basin Characteristics Impacting Available Water Yield

- Size, shape
- Multi-use, multi-reservoir
- Population location
- Reservoir storage
- Return flows
- NC-SC Border
Water Yield is Constrained by Intake Levels

Defining Failure

Existing municipal and industrial intakes located at relatively shallow depths in the reservoirs
Net Water Withdrawals Projected to More Than Double in Next 50 Years (Current vs. 2058, cfs)

Figure ES.2 - Current vs. 2058 Net Outflow Comparison (in cfs)
Water Demand Projected to Exceed Available Yield by 2048 (2002 Drought ...2007 Drought)

Table ES-3. Safe Yield Evaluation - Summary

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Safe Yield Projection Year [Associated Withdrawal Projection (mgd)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Critical Intake</td>
</tr>
<tr>
<td>James</td>
<td>2048 (34)</td>
</tr>
<tr>
<td>Rhodhiss</td>
<td>2048 (40)</td>
</tr>
<tr>
<td>Hickory</td>
<td>2048 (37)</td>
</tr>
<tr>
<td>Lookout Shoals</td>
<td>2048 (12)</td>
</tr>
<tr>
<td>Norman</td>
<td>2038 (133)</td>
</tr>
<tr>
<td>Mountain Island</td>
<td>2038 (192)</td>
</tr>
<tr>
<td>Wylie</td>
<td>2068 (171)</td>
</tr>
<tr>
<td>Fishing Creek</td>
<td>&gt; 2078 (&gt; 225)</td>
</tr>
<tr>
<td>Great Falls-Dearborn</td>
<td>2058 (2)</td>
</tr>
<tr>
<td>Cedar Creek</td>
<td>2058 (1)</td>
</tr>
<tr>
<td>Wateree</td>
<td>&gt; 2078 (&gt; 74)</td>
</tr>
</tbody>
</table>

Notes: 1. Withdrawal flows associated with years given may not match exactly with flows outlined in Section 3 and Appendix C. Baseline safe yield analysis was completed in January 2005, prior to minor updates of the withdrawal/return projections.
2. No critical boat access constraint elevation.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Triggers</th>
<th>Action Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Storage Index (SI) below Target Storage Index (TSI), but greater than 90% of TSI; or US Drought Monitor &gt; 0; or USGS Stream Gauges ≤ 85% of long term average (must have two)</td>
<td><strong>Licensee</strong> - Activate Catawba-Wateree Drought Management Advisory Group (CW-DMAG).</td>
</tr>
<tr>
<td>1</td>
<td>SI at or below 90% TSI, but greater than 75% of TSI; and US Drought Monitor ≥ 1; or USGS Stream Gauges ≤ 78% of long term average</td>
<td><strong>Licensee</strong> - Reduce downstream, bypass, recreation flows and Normal Minimum Elevations. &lt;br&gt;<strong>Public Water Suppliers (PWS)</strong> – Voluntary water use restrictions, 2 day/wk irrigation, reduce vehicle washing; water reduction goal of 3-5%.&lt;br&gt;<strong>Other Large Water Intake (LWI) Owners</strong> – Notify employees and customers and request voluntary cutbacks.</td>
</tr>
<tr>
<td>2</td>
<td>SI at or below 75% TSI, but greater than 57% of TSI; and US Drought Monitor ≥ 2; or USGS Stream Gauges ≤ 65% of long term average</td>
<td><strong>Licensee</strong> – Further reduce flows and Normal Minimum Elevations. Eliminate recreation flows. &lt;br&gt;<strong>PWS</strong> – Mandatory water use restrictions, 2 day/wk irrigation, eliminate vehicle washing; water reduction goal of 5-10%.&lt;br&gt;<strong>Other LWI Owners</strong> – Notify employees and customers and request voluntary cutbacks.</td>
</tr>
<tr>
<td>3</td>
<td>SI at or below 57% TSI, but greater than 42% of TSI; and US Drought Monitor ≥ 3; or USGS Stream Gauges ≤ 55% of long term average</td>
<td><strong>Licensee</strong> - Reduce downstream and bypass flows to critical flows, and further reduce Normal Minimum Elevations. &lt;br&gt;<strong>PWS</strong> – Mandatory water use restrictions, 1 day/wk irrigation, limit other outdoor water uses; water reduction goal of 10-20%.&lt;br&gt;<strong>Other LWI Owners</strong> – Notify employees and customers and request voluntary cutbacks.</td>
</tr>
<tr>
<td>4</td>
<td>SI at or below 42% TSI; and US Drought Monitor = 4; or USGS Stream Gauges ≤ 40% of long term average</td>
<td><strong>Licensee</strong> – Maintain downstream and bypass flows to critical flows, and reduce Normal Minimum Elevations to critical elevations. &lt;br&gt;<strong>PWS</strong> – Restrict all outdoor water use, implement emergency restrictions; water reduction goal of 20-30%.&lt;br&gt;<strong>Other LWI Owners</strong> – Notify employees and customers and request voluntary cutbacks.</td>
</tr>
</tbody>
</table>
Safe Yield Research Project
(co-funded by WRF and CW-WMG)
Research Team Delivers Global Experts to Catawba Water Supply Challenges

- **Water Research Foundation**
  - Jennifer Warner, PM

- **Research Team – HDR Engineering**
  - Kevin Mosteller, Mike Benchich, Mary Knosby, Chris Ey, Joel Bilodeau

- **Project Advisory Committee (PAC)**
  - Alison Adams (Tampa Bay Water, FL)
  - Mark Woodbury (Riverside Technology, Fort Collins, CO)
  - David Yates (National Center for Atmospheric Research, CO)

- **Technical Advisory Committee (TAP)**
  - Bill Holman (Nicholas Institute, Duke University)
  - Neil Grigg (Colorado State University)
  - Peter Sutherland (GHD- Australia)
  - Ken Choffel (HDR- Texas)

- **Other participants**
  - Catawba-Wateree Water Management Group (18 municipalities and Duke Energy)
Research Outcomes

- Best practice guidance for defining water supply water yields in multi-use, multi-reservoir systems
- Defined approach for integrating the impacts of climate change on future water yield estimates
- Strategies for increasing safe yield from similar reservoir systems
- Quantitative and qualitative review of the financial, environmental, and public impacts of selected strategies
Candidate River Systems Evaluated

- Danube River
- Mekong River
- San Francisco River
- Mahaweli River
- Murray-Darling River
- Waikato River

See Fig 2.2
Candidate River Systems Evaluated
Findings from Comparison System Review

1. Water yield analysis – function of stress level
2. Yield typically evaluated with computer models
3. Assumptions, data, and elements used in models vary due to differing characteristics of water supply
4. Shared supplies require excellent communication, coordination, and organization
5. Demand-side management is focus of extending available water supply
6. Yield analysis for Catawba-Wateree among the best
# Yield Strategies Simulated
*(High/Medium Priority Ranking)*

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Anticipated Result Compared to Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL – 01</td>
<td>Baseline For Comparison to Yield Scenarios</td>
<td>-</td>
</tr>
<tr>
<td>CC – 01</td>
<td>Low Impact of Climate Change on Water Supply</td>
<td>Lower yield</td>
</tr>
<tr>
<td>CC - 02</td>
<td>High Impact of Climate Change on Water Supply</td>
<td>Lower yield</td>
</tr>
<tr>
<td>YS – 01</td>
<td>Lower Existing Intakes in the Upper Catawba Basin</td>
<td>Greater yield for areas of greatest vulnerability</td>
</tr>
<tr>
<td>YS – 02</td>
<td>Lower Existing Intakes in Middle Catawba Basin</td>
<td>Greater yield</td>
</tr>
<tr>
<td>YS – 03</td>
<td>Re-route Existing Effluent (i.e. Return) Flows Upstream</td>
<td>Greater yield for areas of greatest vulnerability</td>
</tr>
<tr>
<td>YS – 04</td>
<td>Reduce Per Capita Water Demands for Public Water Supplies</td>
<td>Delay in reaching yield</td>
</tr>
<tr>
<td>YS – 05</td>
<td>Increase Off-Stream Storage in middle Catawba Basin</td>
<td>Greater yield for areas of greatest vulnerability</td>
</tr>
<tr>
<td>YS – 06</td>
<td>Raise target operating levels in reservoirs</td>
<td>Greater yield</td>
</tr>
<tr>
<td>YS – 07</td>
<td>Utilize inter-basin transfer during drought</td>
<td>Greater yield</td>
</tr>
<tr>
<td>YS – 08</td>
<td>Reduced impact of sedimentation in reservoirs</td>
<td>Greater yield</td>
</tr>
</tbody>
</table>
## Yield Strategies Not Evaluated
(\textit{Low Priority Ranking})

<table>
<thead>
<tr>
<th>Priority</th>
<th>Description</th>
<th>Rationale for Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Develop demand-side interconnections for at-risk systems</td>
<td>Prior analysis did not indicate significant opportunity</td>
</tr>
<tr>
<td>Low</td>
<td>Increase return flows to surface waters (e.g. stormwater)</td>
<td>Impractical from environmental, financial perspective</td>
</tr>
<tr>
<td>Low</td>
<td>Evaluate cloud seeding (i.e. increased precipitation)</td>
<td>Impractical from environmental, financial perspective, and not advantageous given basin configuration</td>
</tr>
<tr>
<td>Low</td>
<td>Reduce critical flows from Lake Wyle (i.e. Duke licensed flows)</td>
<td>Critical flows determined through extensive negotiation during recent relicensing effort</td>
</tr>
<tr>
<td>Low</td>
<td>Cover select reservoirs to reduce evaporation</td>
<td>Impractical from environmental, financial, and public acceptance perspective</td>
</tr>
<tr>
<td>Low</td>
<td>Use groundwater supply to supplement during drought</td>
<td>Not advantageous due to basin hydro geologic conditions</td>
</tr>
</tbody>
</table>
### BL-01 Preliminary Simulation Results

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Projected Range of Safe Yield Values (mgd)</th>
<th>Associated Year Withdrawal is Projected to be Reached</th>
</tr>
</thead>
<tbody>
<tr>
<td>James</td>
<td>15 – 32</td>
<td>2038 – 2048</td>
</tr>
<tr>
<td>Rhodhiss</td>
<td>36 – 40</td>
<td>2038 – 2048</td>
</tr>
<tr>
<td>Hickory</td>
<td>30 – 37</td>
<td>2038 – 2048</td>
</tr>
<tr>
<td>Lookout Shoals</td>
<td>10 – 12</td>
<td>2038 – 2048</td>
</tr>
<tr>
<td>Norman</td>
<td>133 – 169</td>
<td>2038 – 2048</td>
</tr>
<tr>
<td>Mountain Island</td>
<td>192 – 207</td>
<td>2038 – 2048</td>
</tr>
<tr>
<td>Wylie</td>
<td>130 – 141</td>
<td>2038 – 2048</td>
</tr>
<tr>
<td>Fishing Creek</td>
<td>&gt;238</td>
<td>&gt;2078</td>
</tr>
<tr>
<td>Great Falls – Dearborn</td>
<td>&gt;3</td>
<td>&gt;2078</td>
</tr>
<tr>
<td>Rocky Creek – Cedar Creek</td>
<td>&gt;1</td>
<td>&gt;2078</td>
</tr>
<tr>
<td>Wateree</td>
<td>&gt;74</td>
<td>&gt;2078</td>
</tr>
</tbody>
</table>

**592 MGD**
Wylie Reservoir Operational Details
for Scenario 'ModMG_05_05', 2002 Hydrology

Inflows
Outflows
Elevations
Target Elevations
Minimum Elevations

Change Plant
Change Year

Flow (cfs)
Elevation (ft)

1-Jan 31-Jan 1-Mar 1-Apr 1-May 1-Jun 1-Jul 31-Jul 31-Aug 30-Sep 31-Oct 30-Nov

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

560.0 561.0 562.0 563.0 564.0 565.0 566.0 567.0 568.0 569.0 570.0

Red Inflows
Blue Outflows
Green Elevations
Black Target Elevations
Yellow Minimum Elevations
<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Total Basin Change in Water Yield (mgd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL – 01</td>
<td>Baseline For Comparison to Yield Scenarios</td>
<td>-</td>
</tr>
<tr>
<td>CC – 01</td>
<td>Low Impact of Climate Change on Water Supply</td>
<td>74</td>
</tr>
<tr>
<td>CC - 02</td>
<td>High Impact of Climate Change on Water Supply</td>
<td>0</td>
</tr>
<tr>
<td>YS – 01</td>
<td>Lower Existing Intakes in the Upper Catawba Basin</td>
<td>159</td>
</tr>
<tr>
<td>YS – 02</td>
<td>Lower Existing Intakes in Middle Catawba Basin</td>
<td>0</td>
</tr>
<tr>
<td>YS – 03</td>
<td>Re-route Existing Effluent Flows Upstream</td>
<td>251+</td>
</tr>
<tr>
<td>YS – 04</td>
<td>Reduce Per Capita Water Demands for Public Water Supplies</td>
<td>~20 year extension of sustainable demand</td>
</tr>
<tr>
<td>YS – 05</td>
<td>Increase Off-Stream Storage in middle Catawba Basin</td>
<td>0</td>
</tr>
<tr>
<td>YS – 06</td>
<td>Raise target operating levels in reservoirs</td>
<td>137</td>
</tr>
<tr>
<td>YS – 07</td>
<td>Utilize inter-basin transfer during drought</td>
<td>0</td>
</tr>
<tr>
<td>YS – 08</td>
<td>Reduced impact of sedimentation in reservoirs</td>
<td>0</td>
</tr>
</tbody>
</table>
Preliminary Findings/Results (Provocative Results)

- Low Inflow Protocol (LIP) implementation is extremely influential in determining water yield
- Reservoir elevation minimums (intermediate and critical – based on LIP) and their relationship to intake levels are limiting
- Reservoir operations and water use patterns tend to naturally divide the Basin into two sections
- Climate Change impacts can be mitigated
Catawba-Wateree Water Supply Master Plan
(co-funded by CW-WMG and Others)
Catawba-Wateree Water Supply Plan

- Project Scope
  - Secure funding assistance
  - Manage stakeholder process
  - Refine future water demand projections
  - Develop future modeling scenarios
  - Review/Revise LIP drought management plan
  - Identify water demand/water conservation opportunities
  - Identify water supply regionalization opportunities
  - Other (public education, regulatory, public ed.)
  - Water Supply Master Plan development
Key Issues for Successful Master Plan

- Funding
- Schedule
- Maintaining Momentum in ‘Normal’ Years
- Defining Modeling Scenarios
- Stakeholder Input
- Regional Consensus Support of Recommendations
### Table ES-3. Safe Yield Evaluation - Summary

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>2048 Baseline</th>
<th>2048 Mutual Gains</th>
<th>2008 Mutual Gains</th>
<th>2078 Mutual Gains</th>
</tr>
</thead>
<tbody>
<tr>
<td>James</td>
<td>2048 (34)</td>
<td>2048 (32)</td>
<td>&gt; 2078 (&gt; 44)</td>
<td></td>
</tr>
<tr>
<td>Rhodhiss</td>
<td>2048 (40)</td>
<td>2048 (40)</td>
<td>&gt; 2078 (&gt; 52)</td>
<td></td>
</tr>
<tr>
<td>Hickory</td>
<td>2048 (37)</td>
<td>2048 (37)</td>
<td>&gt; 2078 (&gt; 54)</td>
<td></td>
</tr>
<tr>
<td>Lookout Shoals</td>
<td>2048 (12)</td>
<td>2048 (12)</td>
<td>&gt; 2078 (&gt; 15)</td>
<td></td>
</tr>
<tr>
<td>Norman</td>
<td>2038 (133)</td>
<td>2048 (169)</td>
<td>2068 (202)</td>
<td>&gt; 2078 (&gt; 223)</td>
</tr>
<tr>
<td>Mountain Island</td>
<td>2038 (192)</td>
<td>2048 (207)</td>
<td>2068 (131)</td>
<td>&gt; 2078 (&gt; 272)</td>
</tr>
<tr>
<td>Wylie</td>
<td>2068 (171)</td>
<td>2048 (141)</td>
<td>2008 (95)</td>
<td>&gt; 2078 (&gt; 189)</td>
</tr>
<tr>
<td>Fishing Creek</td>
<td>&gt; 2078 (&gt; 225)</td>
<td>&gt; 2078 (&gt; 238)</td>
<td>&gt; 2078 (&gt; 238)</td>
<td>&gt; 2078 (&gt; 238)</td>
</tr>
<tr>
<td>Great Falls - Dearborn</td>
<td>2058 (2)</td>
<td>&gt; 2078 (&gt; 3)</td>
<td>&gt; 2078 (&gt; 3)</td>
<td></td>
</tr>
<tr>
<td>Cedar Creek</td>
<td>2058 (1)</td>
<td>&gt; 2078 (&gt; 1)</td>
<td>2008 (1)</td>
<td>&gt; 2078 (&gt; 1)</td>
</tr>
<tr>
<td>Wateree</td>
<td>&gt; 2078 (&gt; 74)</td>
<td>&gt; 2078 (&gt; 74)</td>
<td>&gt; 2078 (&gt; 74)</td>
<td>&gt; 2078 (&gt; 74)</td>
</tr>
</tbody>
</table>

Notes: 
1. Withdrawal flows associated with years given may not match exactly with flows outlined in Section 3 and Appendix C. Baseline safe yield analysis was completed in January 2005, prior to minor update of withdrawal/return projections.
2. No critical boat access constraint elevation.
CW-WMG is working very effectively as a regional water supply planning organization, building a comprehensive long-range water supply plan from the foundation established in relicensing, and looks forward to partnering with the States and Commission to complete and implement the Plan.
Discussion/Questions
Climate Change Impacts in the Catawba

- Changes in precipitation
  - Amounts, intensity
  - Streamflow, inflow dataset
  - Temporal effects
- Increased evaporation
  - Temperature
  - Wind
  - Transpiration
- Changes in demand
CC-01: Climate Change – Low Impact

- Assume moderate increase in temperature of 5 °F to 2078, corresponding to 3.33% increase in reservoir evaporation rate per °F.
- Temperature increase applied gradually.
- No changes to inflow or water use
- Expected to decrease water yield
Multi-Use, Multi-Reservoir System

- 13 Hydroelectric Stations
- 11 Interconnected Reservoirs
- 831 MW Hydropower
- 8,167 MW Nuclear and Fossil
- Drinking water for 1.5 million people
- FERC Licensed Hydro Project
Assume aggressive increase in temperature of 9 °F to 2078, corresponding to 3.33% increase in reservoir evaporation rate per °F.

Inflow decrease by 1% per decade to 2078 for higher evapo-transpiration rates outside of reservoirs.

Temperature, inflow changes applied gradually.

No changes to water use.

Expected to decrease water yield.
Drought Management Advisory Group Works Collaboratively to Extend Water Supply

Resource Agencies
- NCDENR
- NCWRC
- SCDNR
- SCDHEC
- USGS

Public Water Suppliers
City of Marion
City of Morganton
Town of Granite Falls
City of Lenoir
Town of Valdese
City of Hickory
Town of Long View
Charlotte-Mecklenburg Utilities
Lincoln County
City of Newton
City of Gastonia
City of Mount Holly
City of Belmont
Bessemer City
City of Cherryville
Town of Dallas
City of Lincolnton
City of Rock Hill
Catawba River Water Supply Project
Chester Metropolitan District
City of Camden
Lugoff-Elgin Water Authority
City of Statesville
Town of Mooresville

Industries
Siemens Westinghouse
American & Efird
Bowater
SCANA
International Paper
The Greens of Rock Hill
Clariant Corporation
Invista

Duke Energy