Oklahoma Comprehensive Water Plan

OCWP

# Technical Studies Update:
# OCWP Planning Tools for Now and the Future

**John Rehring – CDM**

*Oklahoma Governor's Water Conference*
*November 4, 2009*
*Midwest City, Oklahoma*

State of Oklahoma OWRB Water Resources Board the water agency

US Army Corps of Engineers

CDM

# Presentation Overview

- Results from 2008
  Public Water Provider Survey

- Three Key Planning Tools Developed for the OCWP
  - *Supply/Demand Gap Tool*
  - *Reservoir Yield Model*
  - *Climate Demand Model*

- Other Ongoing OCWP Technical Studies

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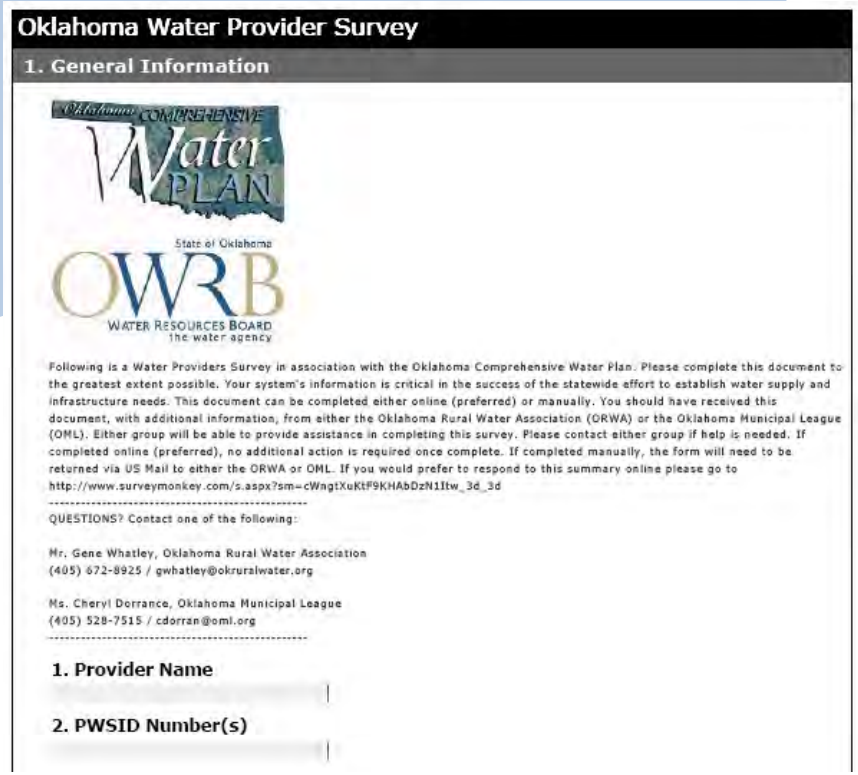
# Water Provider Survey – Fall 2008

- Sent to 785 providers
- Distribution/collection facilitated by OML and ORWA
- Questions included:
  - *water provider basics*
  - *water conservation*
  - *demand projections*
  - *purchased water supplies*
  - *local water supplies*
  - *existing infrastructure*
  - *reuse*
  - *additional comments*



**Oklahoma Water Provider Survey**

**1. General Information**

Oklahoma Comprehensive Water Plan

State of Oklahoma OWRB Water Resources Board the water agency

Following is a Water Providers Survey in association with the Oklahoma Comprehensive Water Plan. Please complete this document to the greatest extent possible. Your system's information is critical in the success of the statewide effort to establish water supply and infrastructure needs. This document can be completed either online (preferred) or manually. You should have received this document, with additional information, from either the Oklahoma Rural Water Association (ORWA) or the Oklahoma Municipal League (OML). Either group will be able to provide assistance in completing this survey. Please contact either group if help is needed. If completed online (preferred), no additional action is required once complete. If completed manually, the form will need to be returned via US Mail to either the ORWA or OML. If you would prefer to respond to this summary online please go to http://www.surveymonkey.com/s.aspx?sm=cWngtXuKtf9KHAbDzN1Itw_3d_3d

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QUESTIONS? Contact one of the following:

Mr. Gene Whatley, Oklahoma Rural Water Association
(405) 672-8925 / gwhatley@okruralwater.org

Ms. Cheryl Dorrance, Oklahoma Municipal League
(405) 528-7515 / cdorran@oml.org

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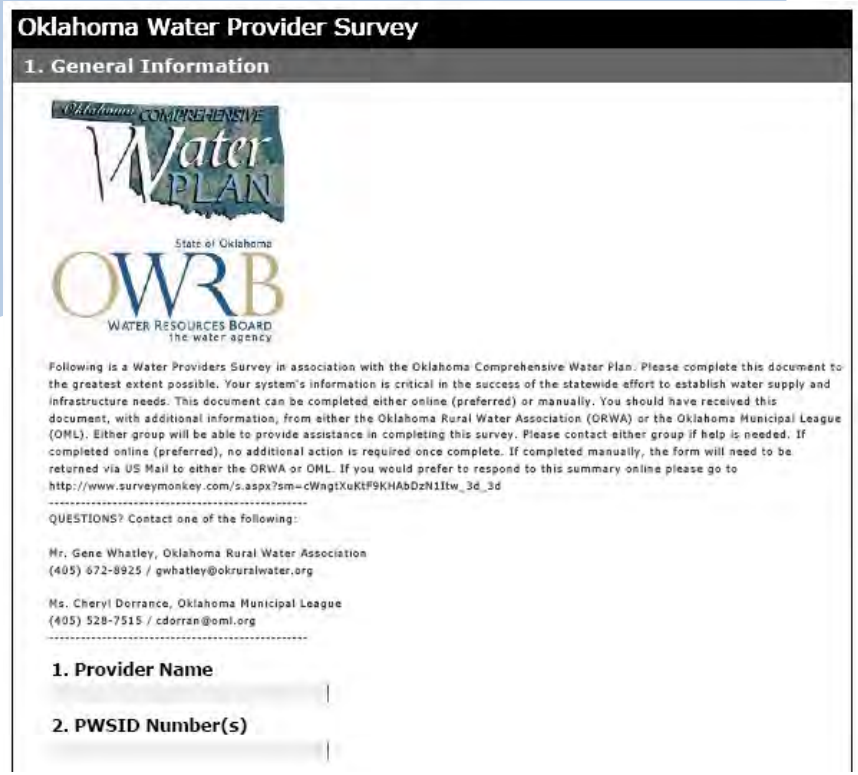
**1. Provider Name**

**2. PWSID Number(s)**

# Uses for Survey Data

- County- and Provider-level Demand Projections
- Per-capita demands
- Statewide assessment of public water supply systems
- Provider-specific supply and infrastructure information for the OCWP



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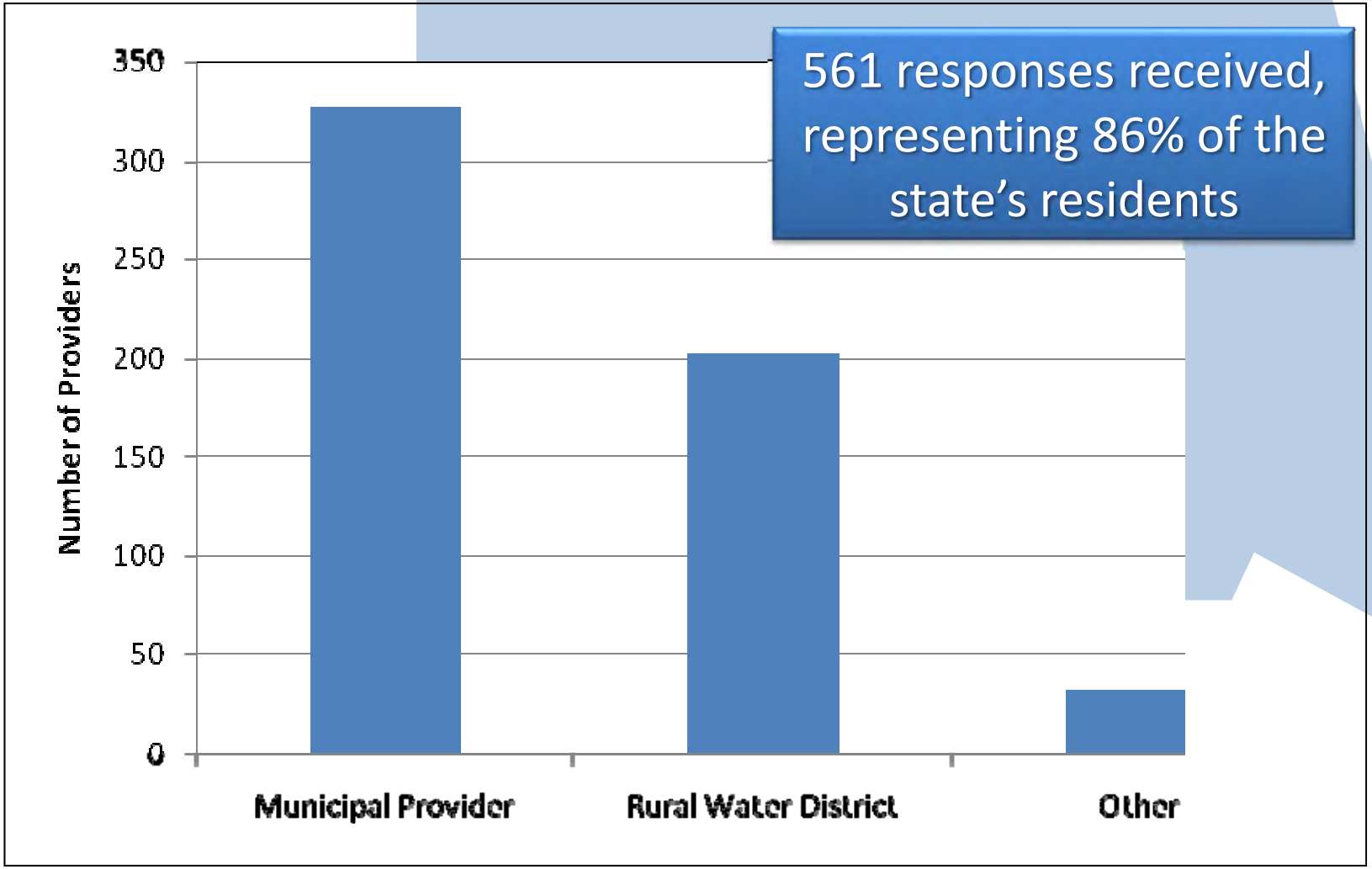
**2. PWSID Number(s)**

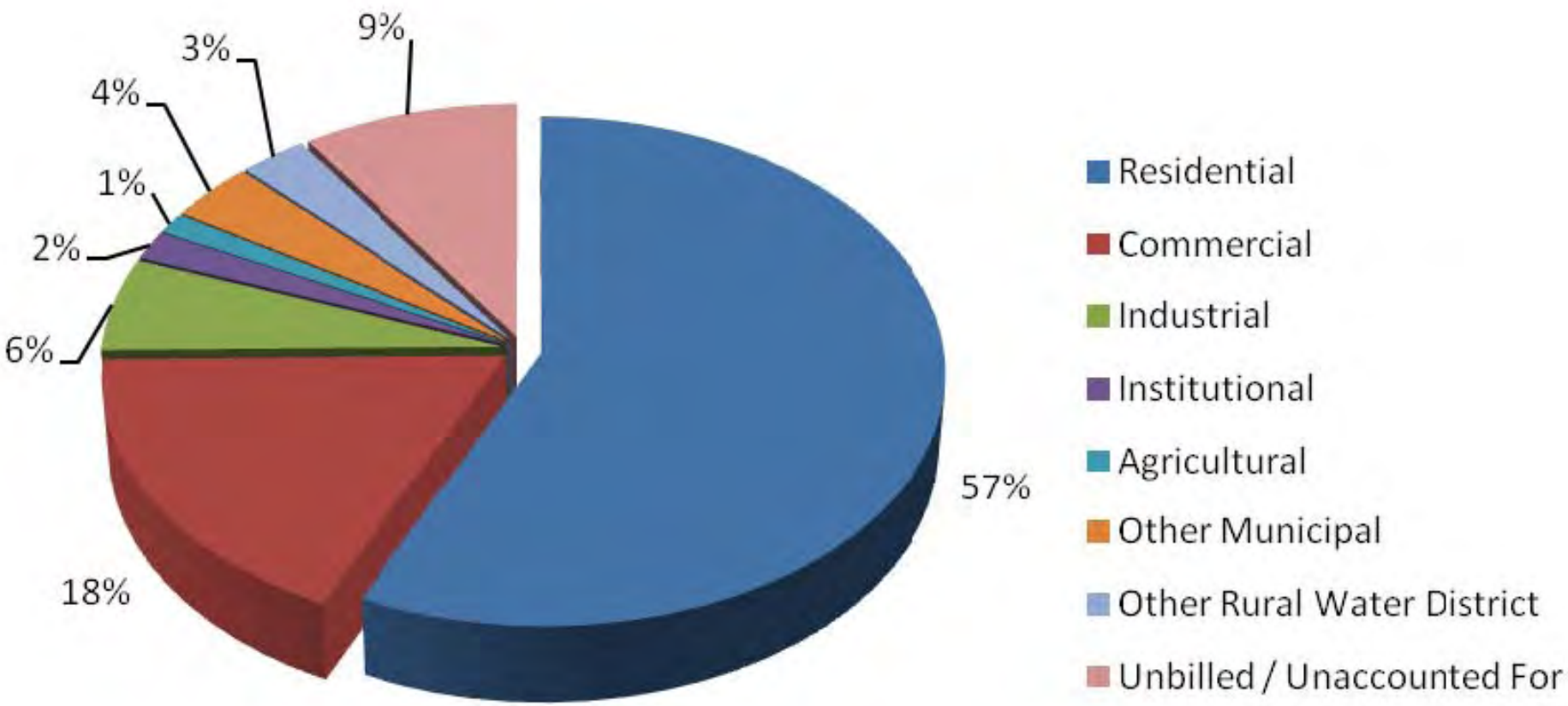
# Respondents by Type of Provider



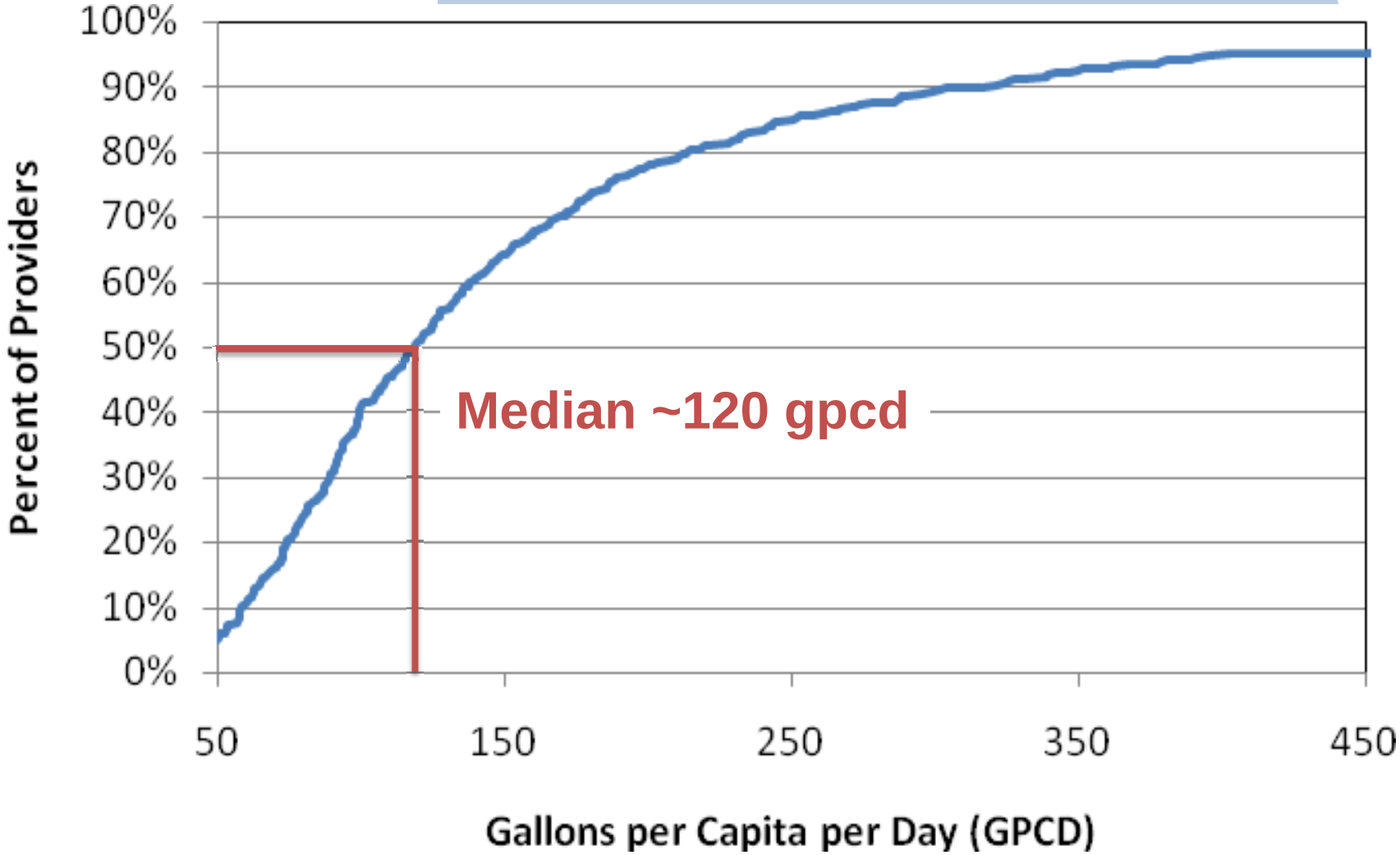
# Population Served by Respondents

| | Population < 1,000 | Population 1,000 - 10,000 | Population > 10,000 |
|---|---|---|---|
| Number of Responding Providers | 246 | 269 | 46 |
| Percentage of Responding Providers | 44% | 48% | 8% |
| Percentage of State Population Served | 3% | 22% | 61% |

# 2007 Demands Weighted by Provider Population



# Per Capita Demands in 2007 (Responding Providers)



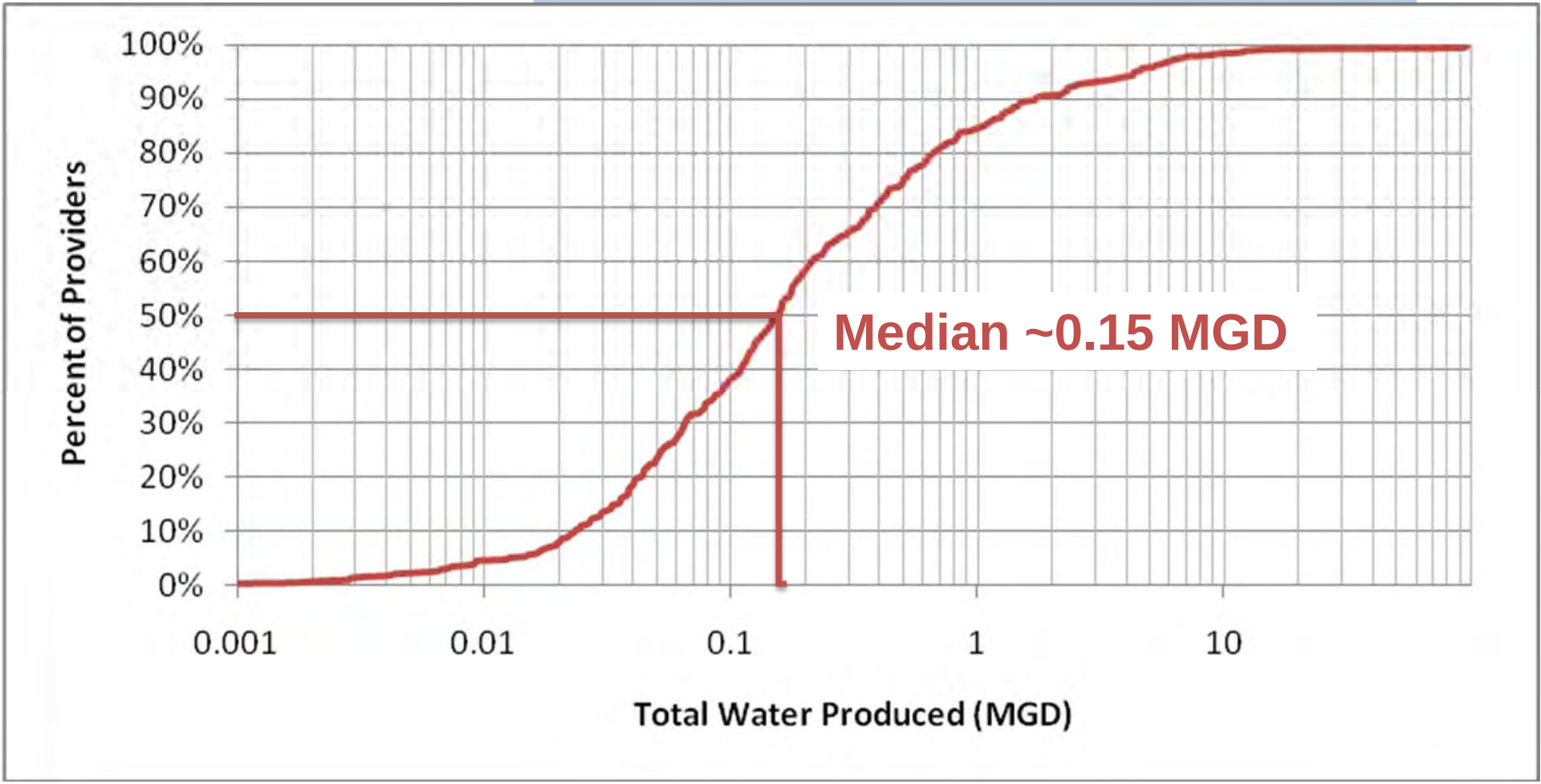
# Recent Water Supply Plans (Responding Providers)

| | Population < 1,000 | Population 1,000 - 10,000 | Population > 10,000 | Overall |
|---|---|---|---|---|
| Completed a water supply plan in the last 10 years | 3.4% | 6.1% | 26.1% | 6.7% |

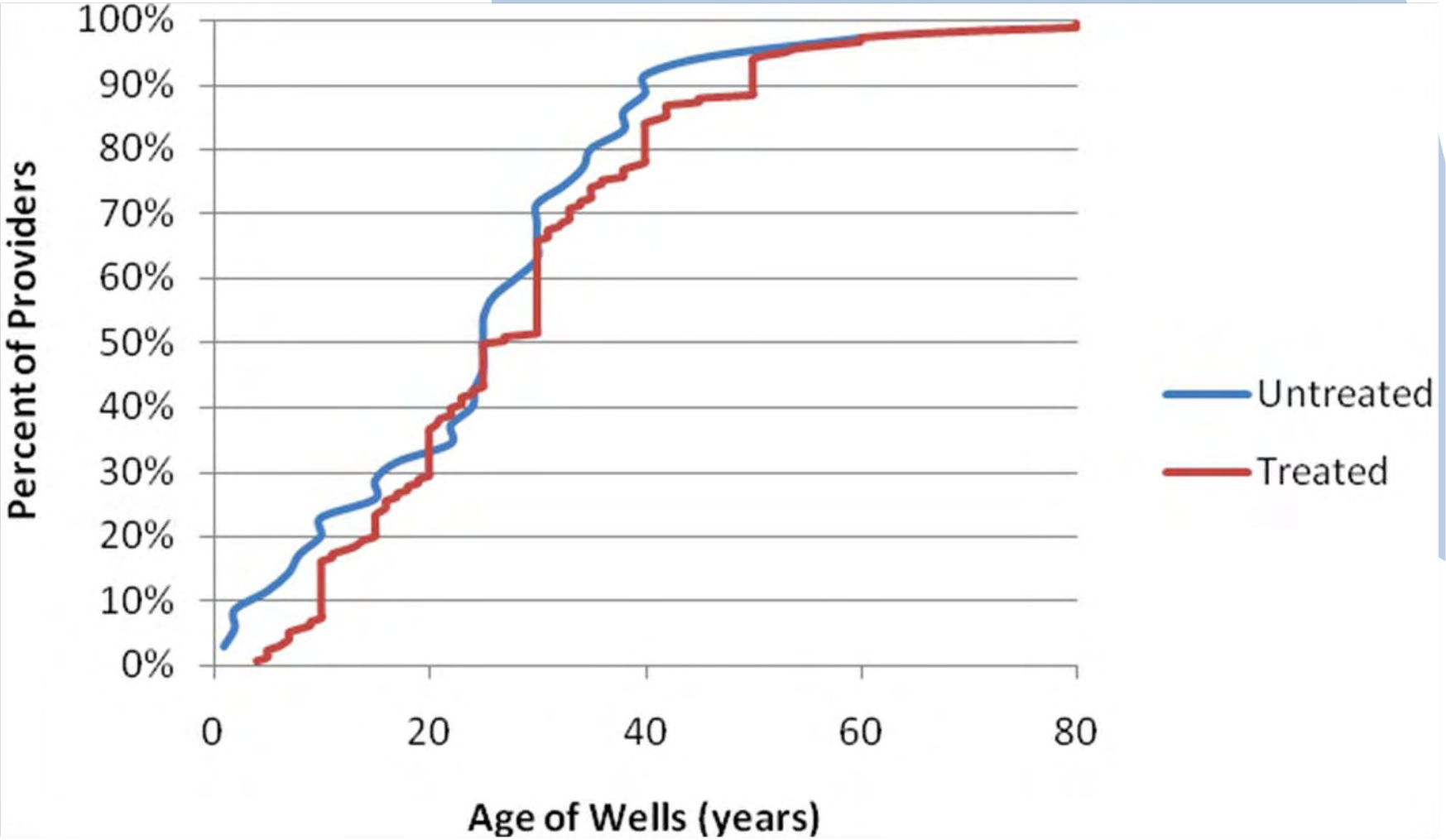
# Conservation Plans / Drought Management Plans (Responding Providers)

| | Percentage of Providers in Category | | | |
|---|---|---|---|---|
| | Population < 1,000 | Population 1,000 - 10,000 | Population > 10,000 | Overall |
| Conservation Plan | 4.3 % | 5.5% | 9.3% | 5.3% |
| Drought Management Plan | 2.6% | 3.5% | 16.7% | 4.2% |

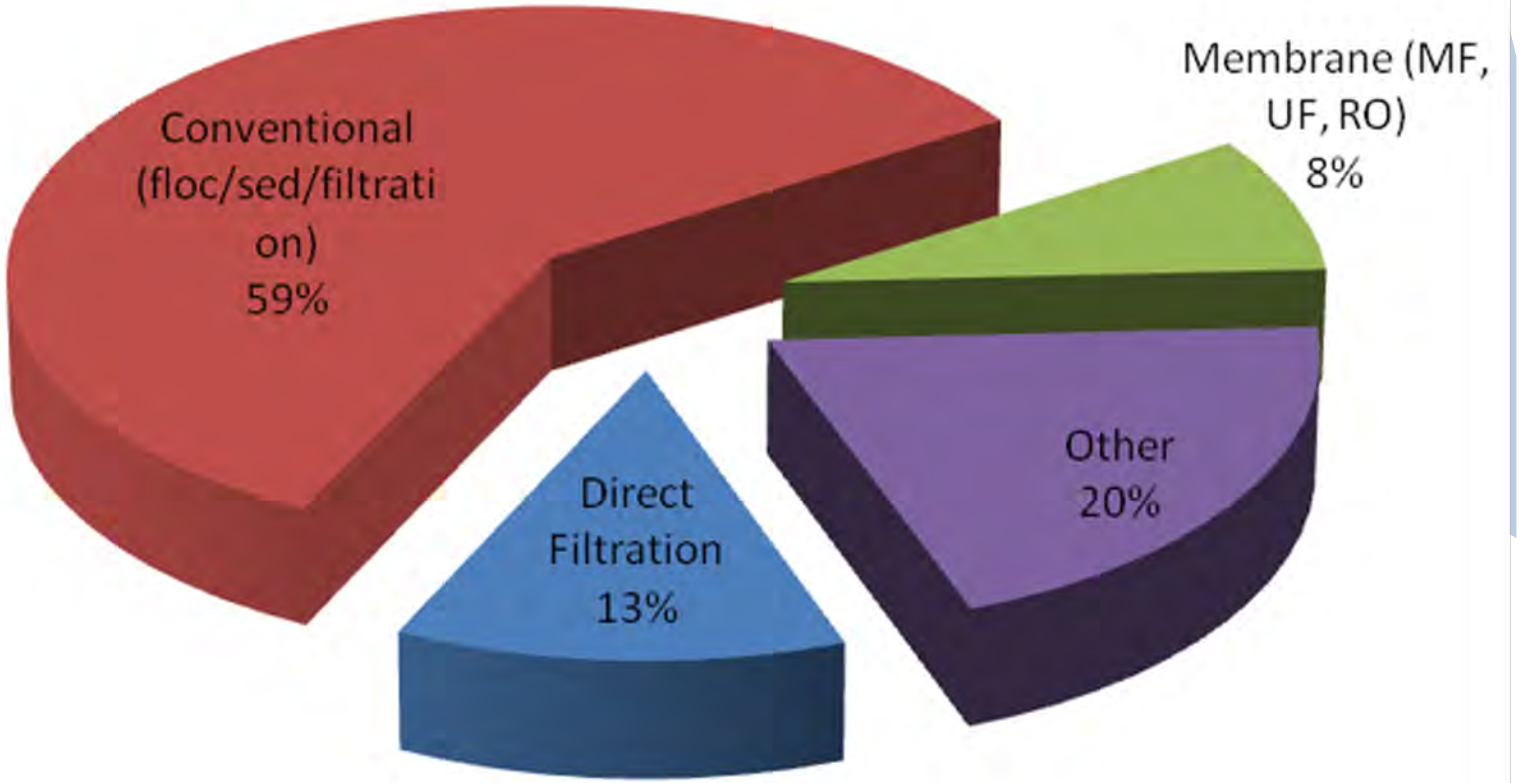
# 2007 Average Daily Water Production (Responding Providers)



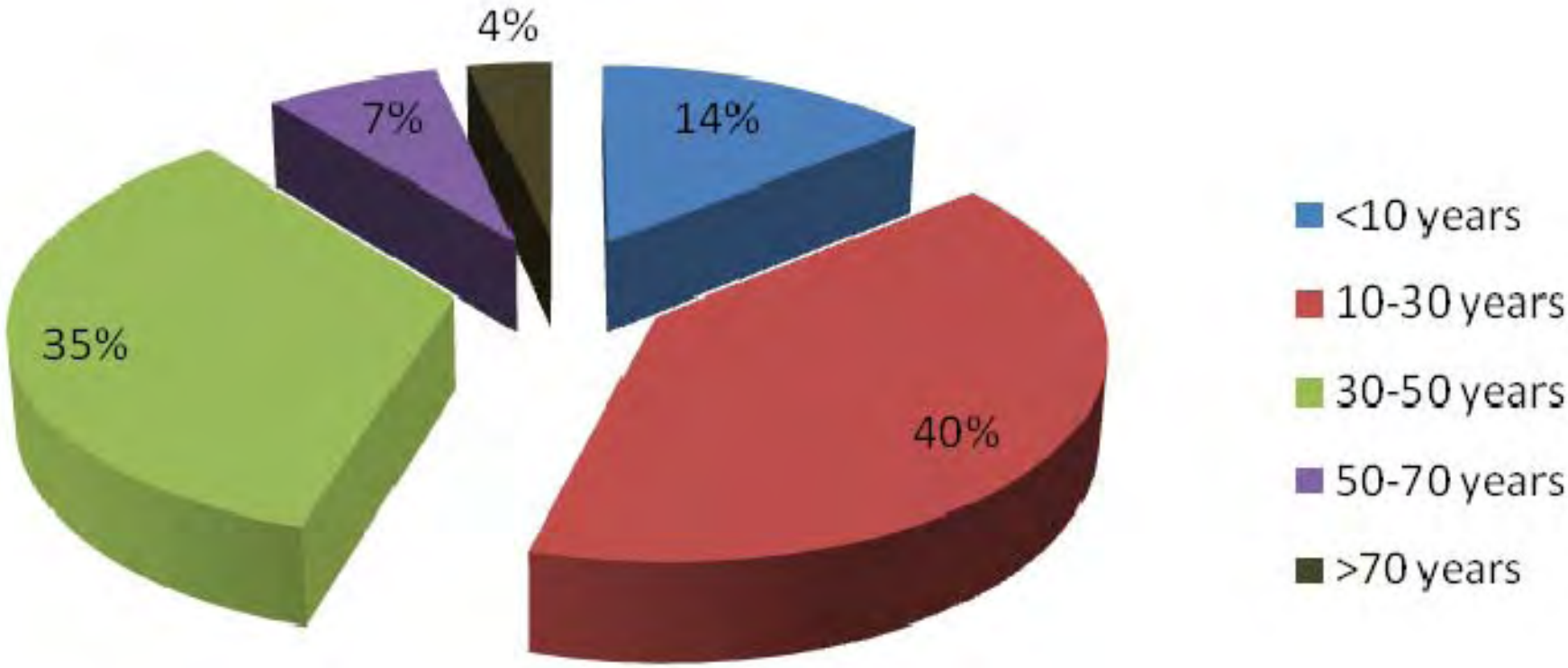
# Age of Existing Groundwater Wells (Responding Providers)



# Surface Water Treatment Processes (Responding Providers)



# Estimated Age of Distribution Piping (Responding Providers)



# Three Key Planning Tools Developed for the OCWP

Oklahoma H2O

Supply/Demand Gap Tool

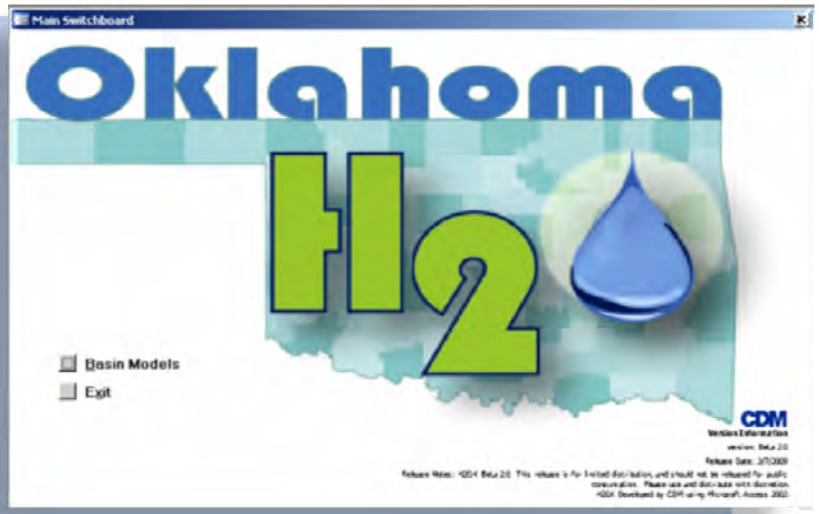
SWAM

Simplified Water Allocation Model

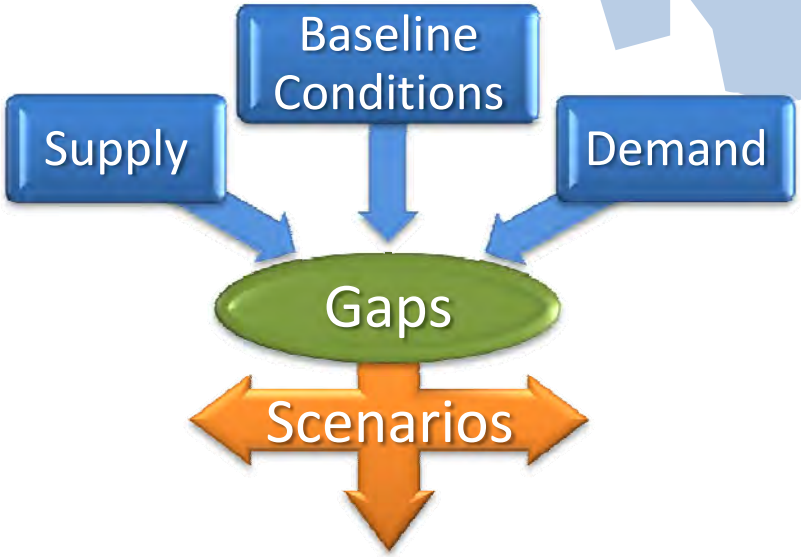
Reservoir Yield Model

Climate Demand Model

# Statewide Supply Availability Screening

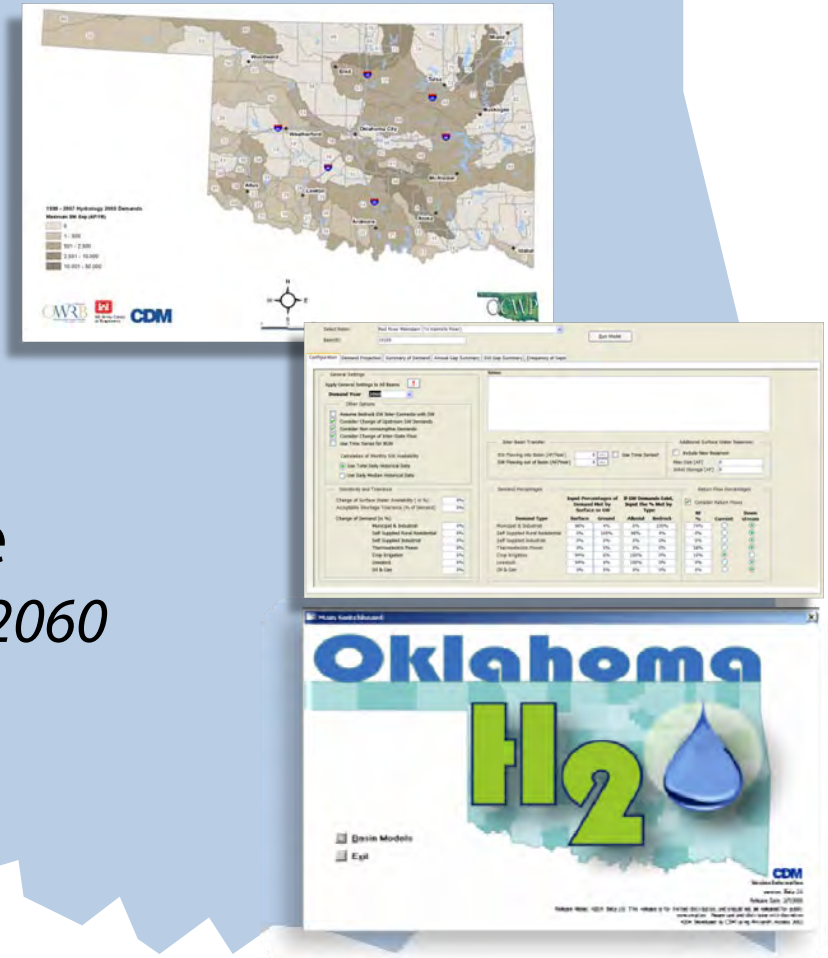



- Physical supply
- Statewide screening tool in *Access* and GIS
- Quickly perform "what-if" analyses and test different assumptions




- Planning alternatives and impacts of potential supply & demand variability

# "Gap Tool" Output

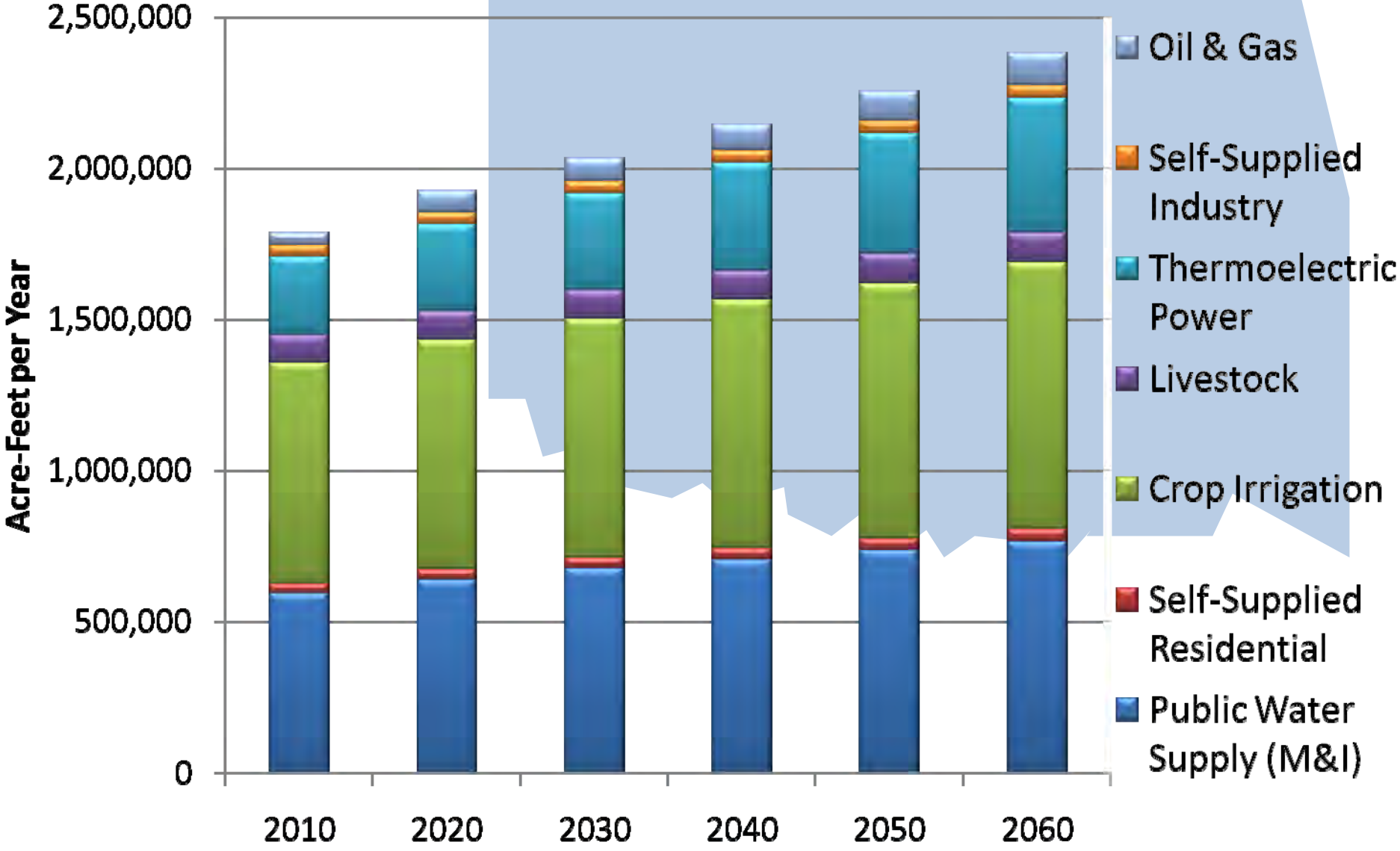



- Physical supply availability for each basin
- Supply shortages by decade
  - *2010, 2020, 2030, 2040, 2050, 2060*
- Supply shortages by source
  - *Surface water*
  - *Alluvial groundwater*
  - *Bedrock groundwater*
- Magnitude & frequency of shortages under period-of-record monthly hydrologies

# What Constitutes a Supply "Shortage"?

- Surface Water
  - *"Gap" – No flow at outlet of the basin in driest month(s)*
- Groundwater
  - *"Depletion" – Demand exceeds recharge rate*
  - *Water may still be available from storage*
  - *Not necessarily a short-term shortage*
  - *Indicative of long-term mining*

# Demand Projections Characterize the Need for Water



# Subdividing the State into Basins & Regions

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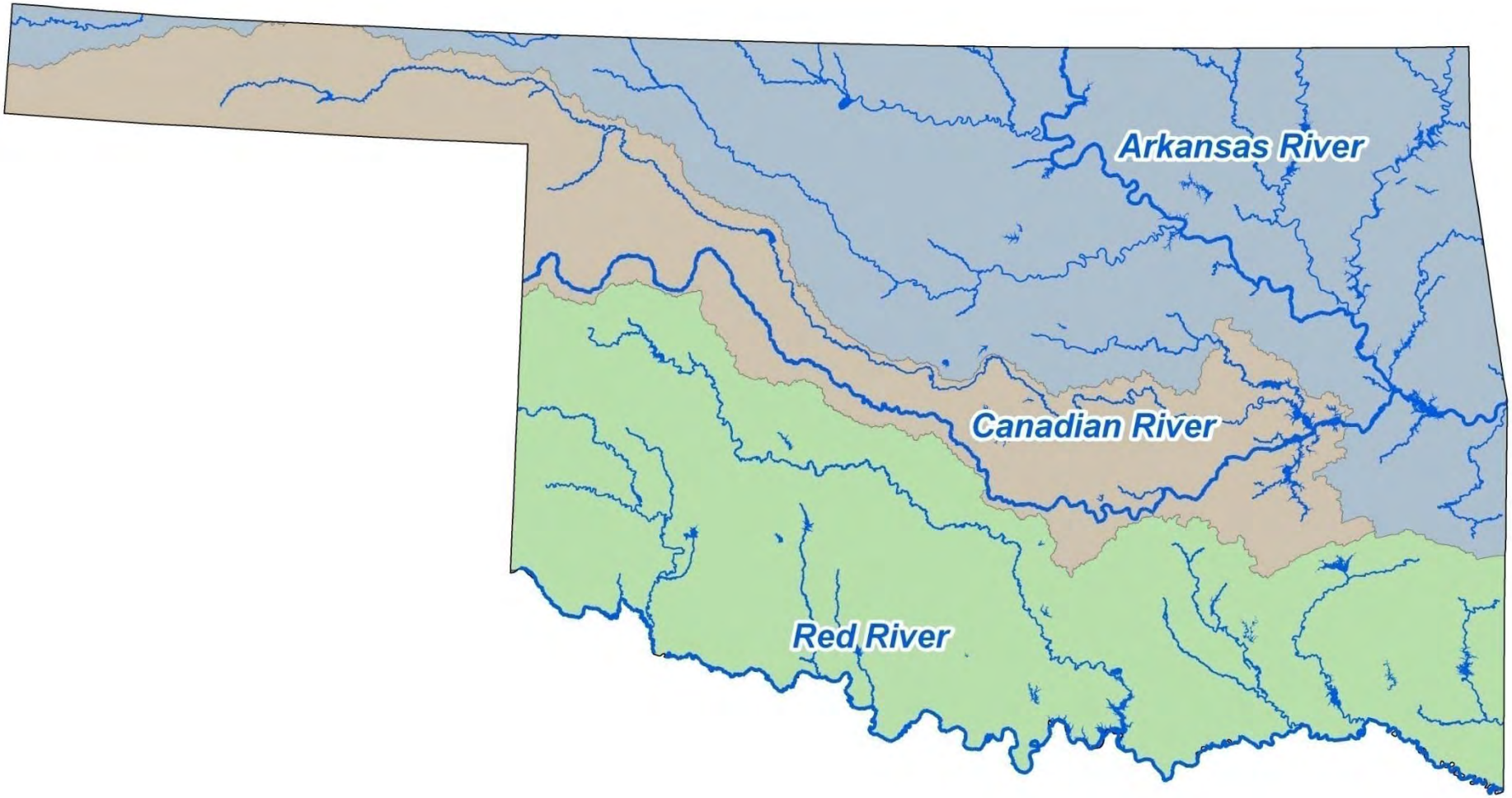

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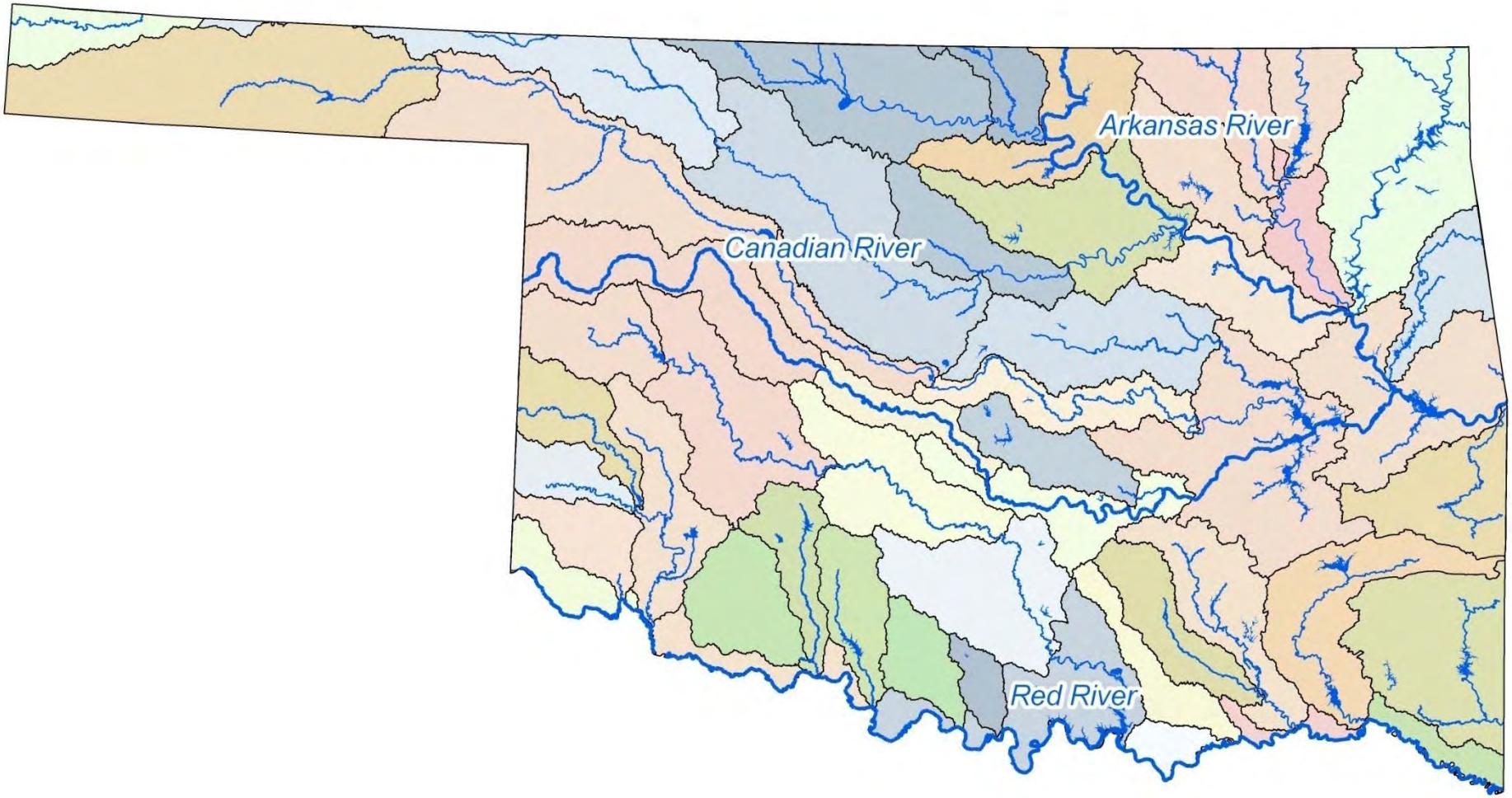
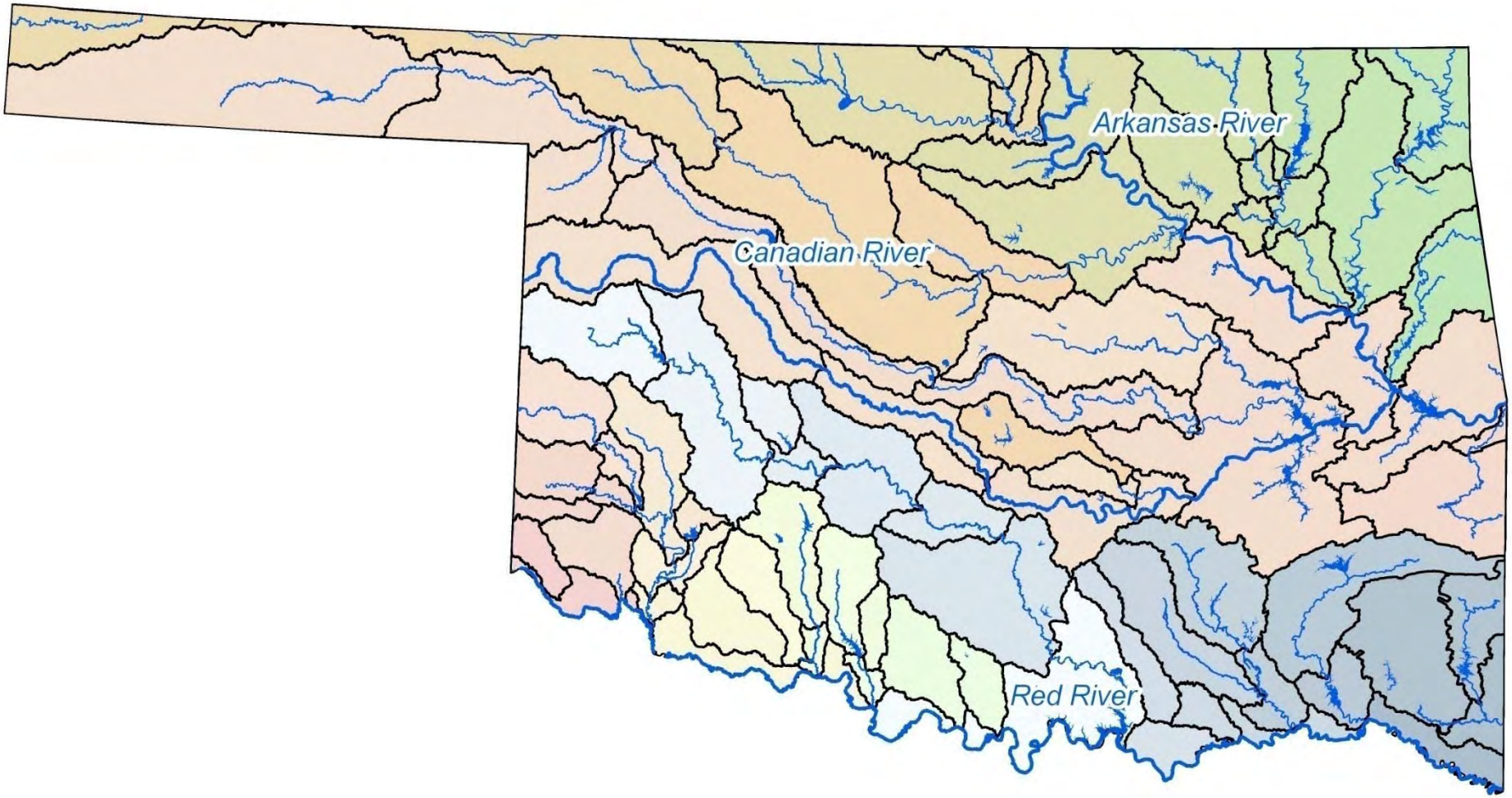
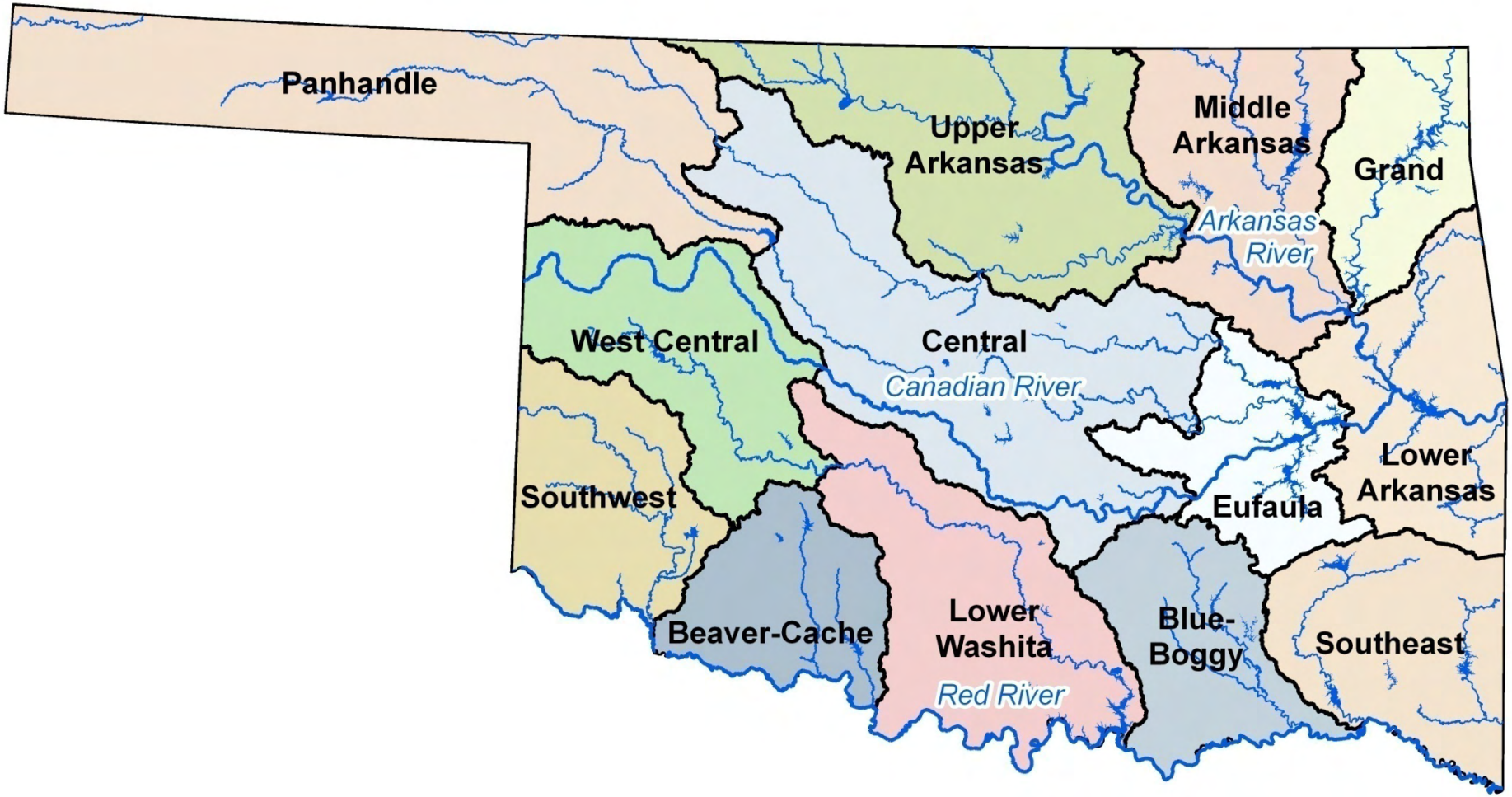


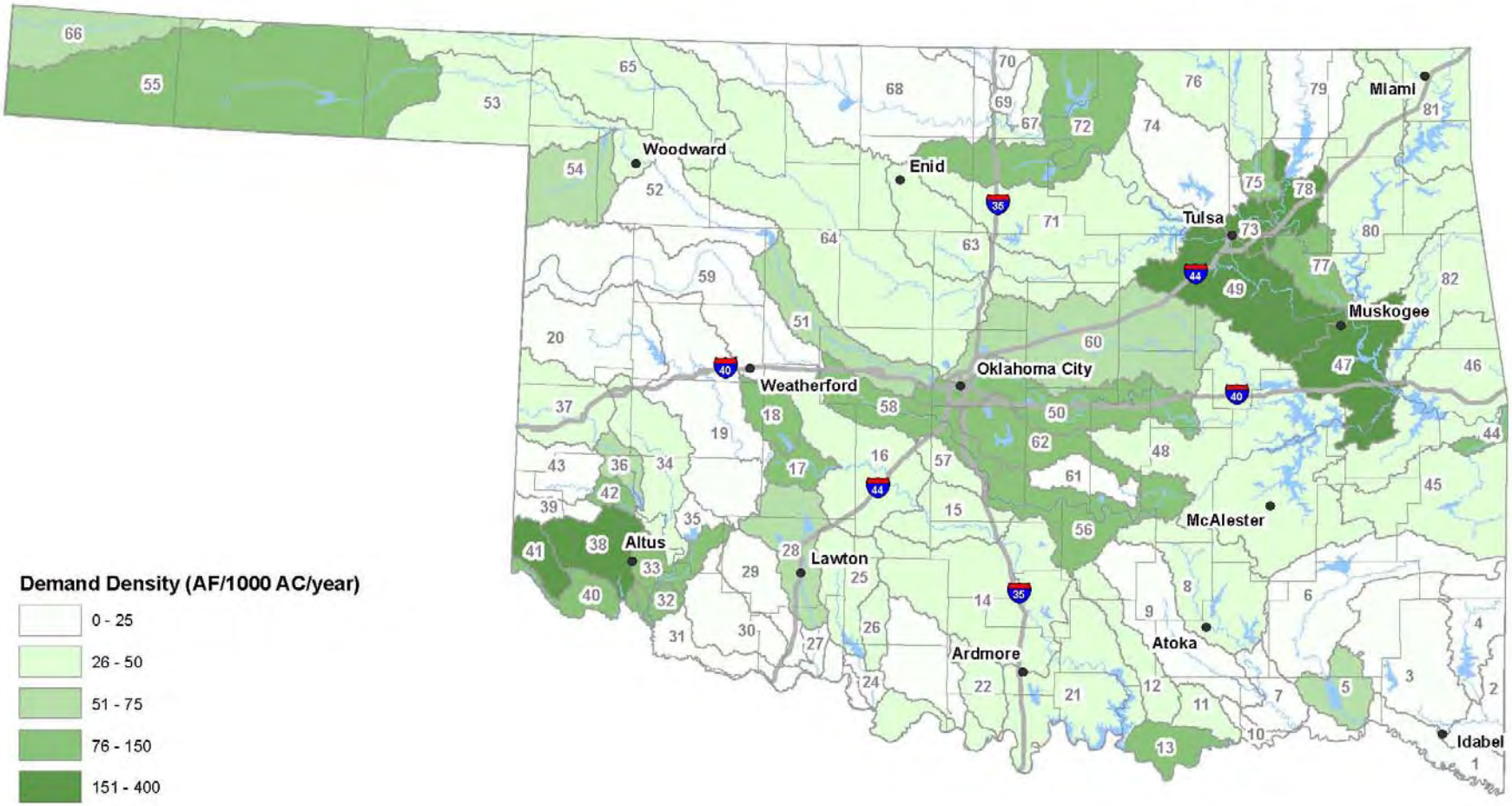
# 82 Basins for Detailed OCWP Analyses



# Aggregated into 13 Regions for Regional Supply Assessments



# Total Demands (2060)




N
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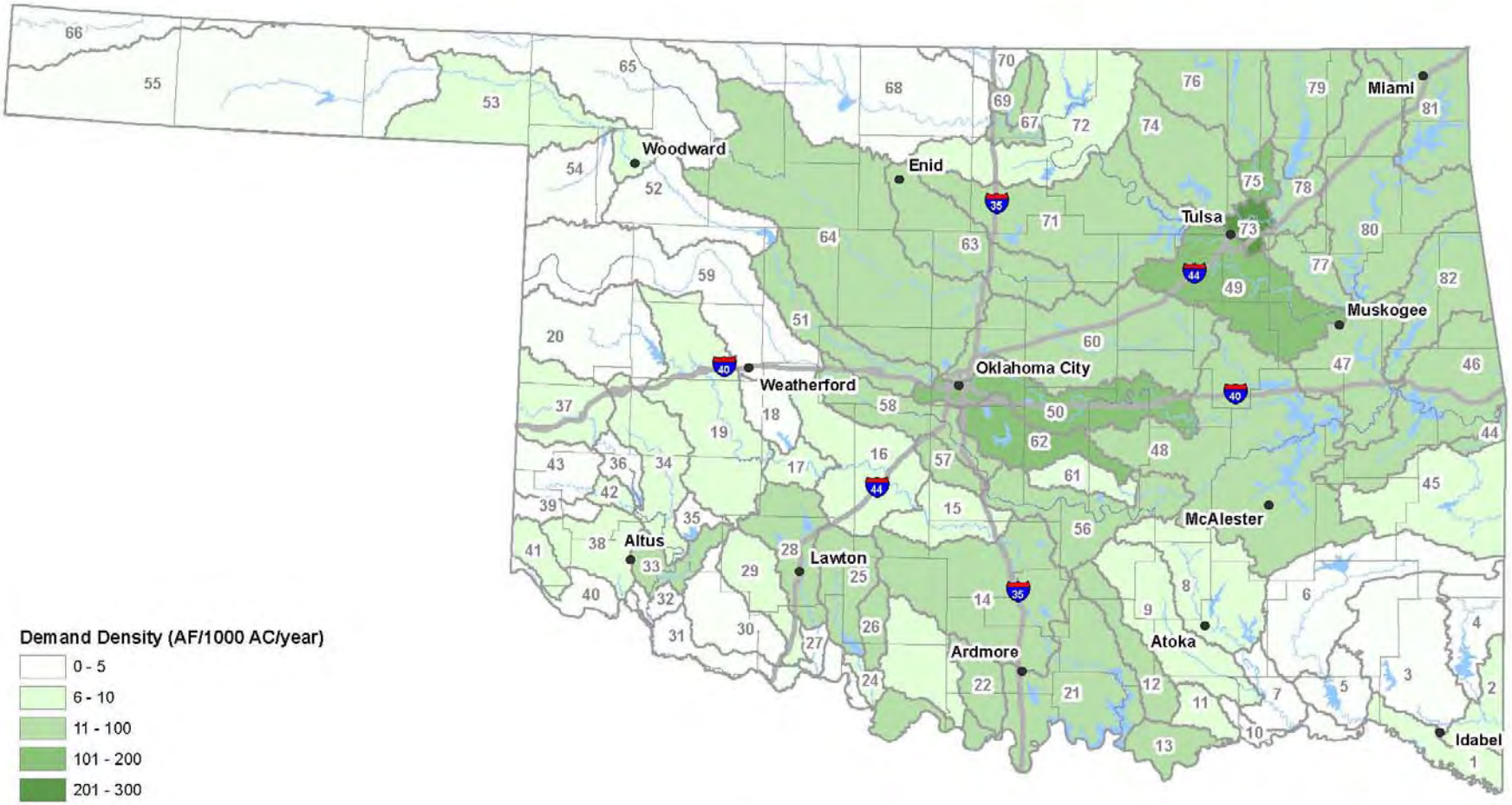
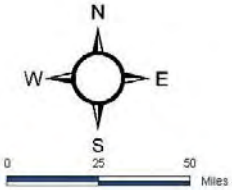
0 25 50 Miles

OWRB State of Oklahoma Water Resources Board
US Army Corps of Engineers
CDM
Oklahoma Comprehensive Water Plan OCWP

# Public Water Supply (M&I) Demands (2060)

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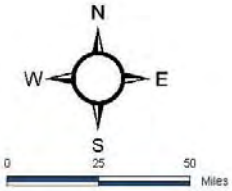
# Crop Irrigation Demands (2060)

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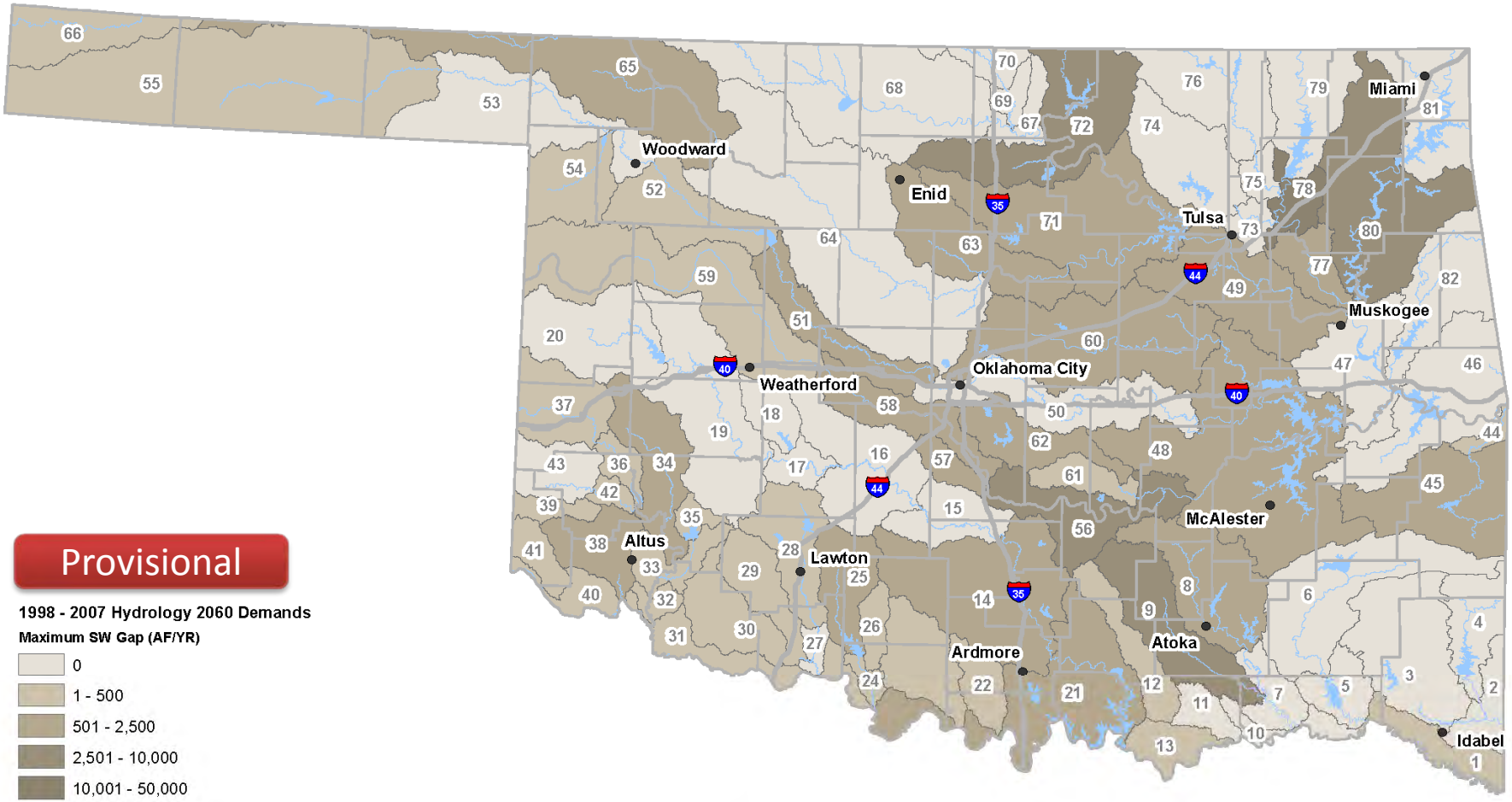
# Maximum Surface Water Gaps in 2060




Provisional

1998 - 2007 Hydrology 2060 Demands

Maximum SW Gap (AF/YR)

- 0
- 1 - 500
- 501 - 2,500
- 2,501 - 10,000
- 10,001 - 50,000

N
W E
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0 25 50 Miles

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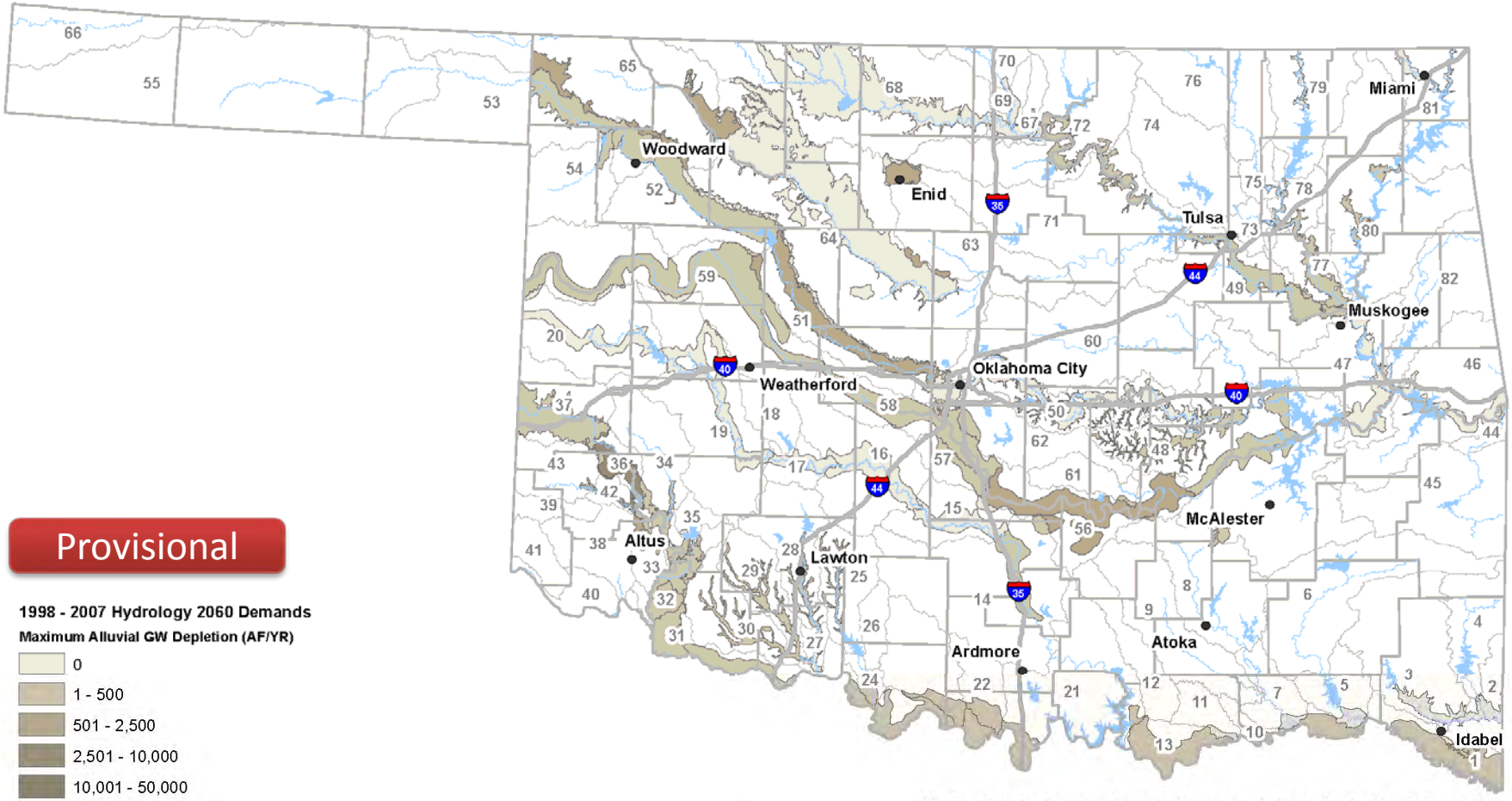
# Maximum Alluvial Groundwater Depletions in 2060




Provisional

**1998 - 2007 Hydrology 2060 Demands**

**Maximum Alluvial GW Depletion (AF/YR)**

- 0
- 1 - 500
- 501 - 2,500
- 2,501 - 10,000
- 10,001 - 50,000

Note: Areas in tan do not have a delineated alluvial aquifer.

N
W E
S

0 25 50 Miles

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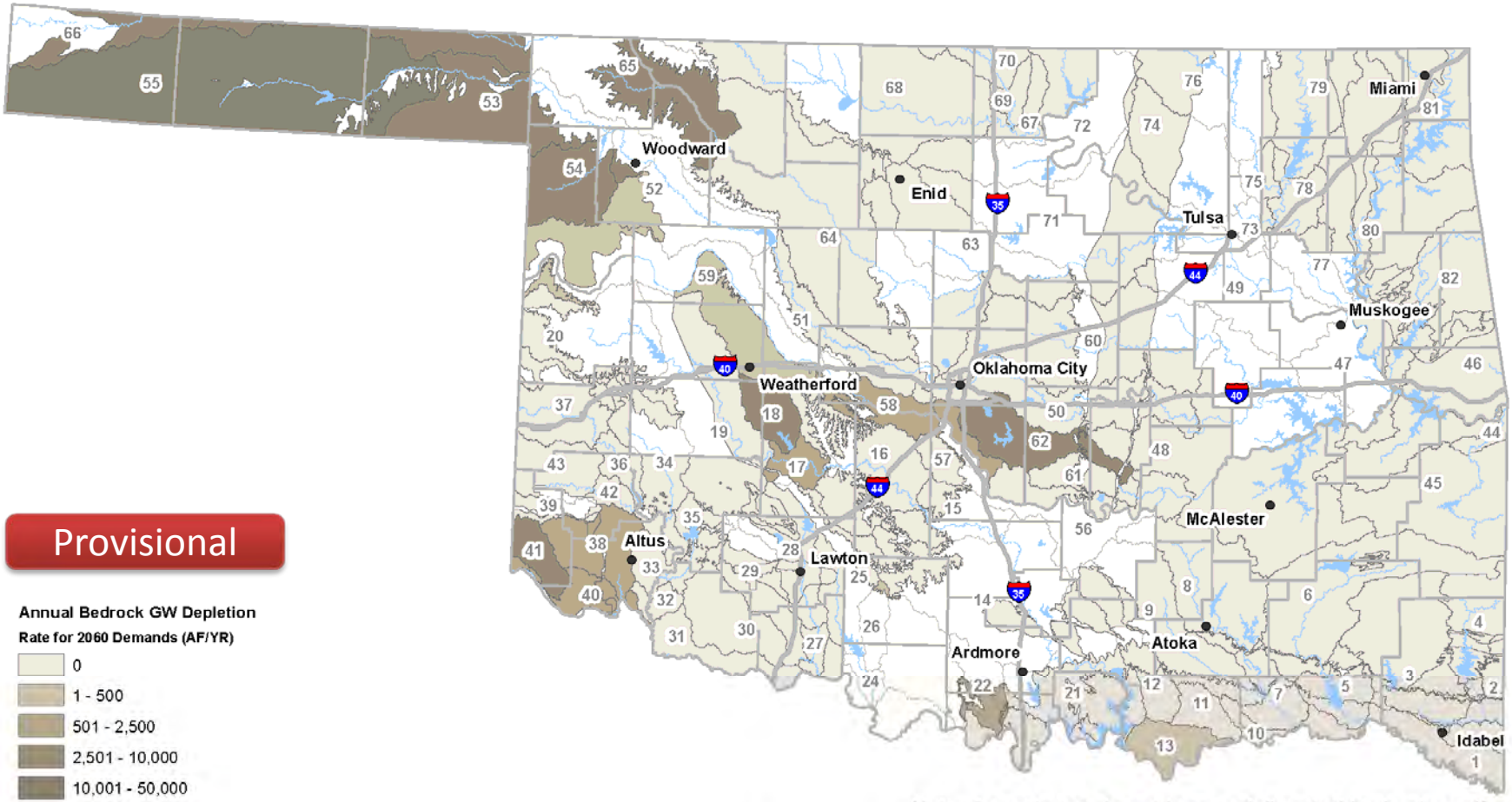
# Maximum Bedrock Groundwater Depletions in 2060




Provisional

**Annual Bedrock GW Depletion Rate for 2060 Demands (AF/YR)**

- 0
- 1 - 500
- 501 - 2,500
- 2,501 - 10,000
- 10,001 - 50,000

Note: Areas in tan do not have a delineated bedrock aquifer.

N
W E
S
0 25 50 Miles

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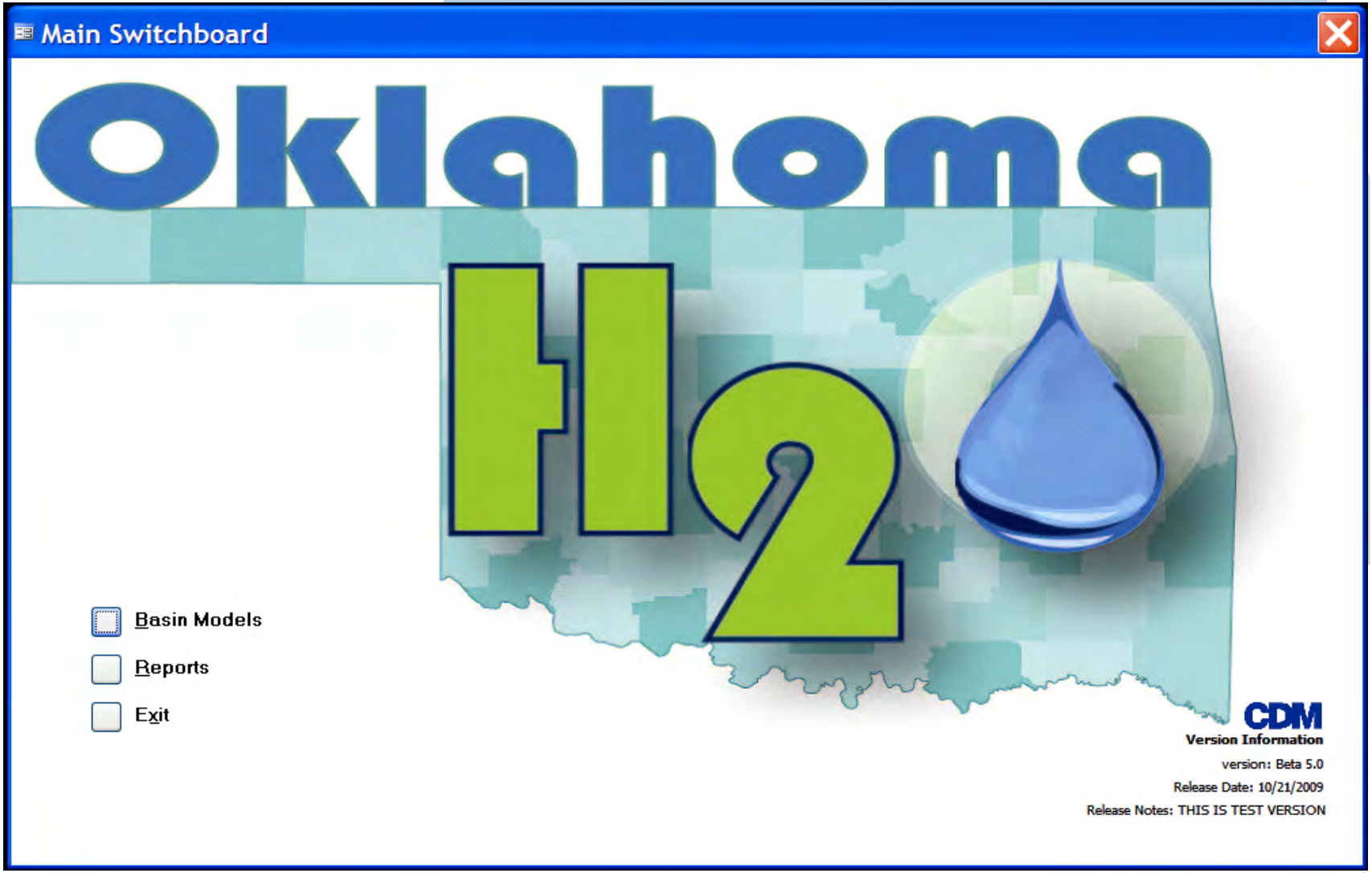
# Examples of How the Gap Tool is Used

1. What if demand increases by an additional 10 percent?
2. What if surface water supplies decrease by 10 percent?
3. If we use more groundwater and less surface water, would it alleviate gaps?

# Oklahoma $H_2O$ "Gap Tool" Overview



# Oklahoma $H_2O$ Inputs and Controls

Basin Gap Analysis

Select Basin: Deep Red River And West Cache Creek - 1

BasinID: 11321

Run Model

Configuration | Demand Projection | Summary of Demand | Annual Gap Summary | SW Gap Summary | Frequency of Gaps

Apply General Settings to All Basins

**Demand Year** 2060

Other Options

- [ ] Assume Bedrock GW Inter-Connects with SW
- [x] Consider Change of Upstream SW Demands
- [x] Consider Non-consumptive Demands
- [x] Consider Change of Inter-State Flow
- [ ] Use Time Series for BGW

Calculation of Monthly SW Availability

- (•) Use Total Daily Historical Data
- ( ) Use Daily Median Historical Data

Notes

Provisional Data

Inter-Basin Transfer

| | | |
|---|---|---|
| SW Flowing into Basin (AF/Year) | 0 | [ ] Use Time Series? |
| SW Flowing out of Basin (AF/Year) | 0 | |

Additional Surface Water Reservoir

- [ ] Include New Reservoir

| | |
|---|---|
| Max Size [AF] | 0 |
| Initial Storage [AF] | 0 |

Sensitivity and Tolerance

| | |
|---|---|
| Change of Surface Water Availability ( in %) | 0% |
| Acceptable Shortage Tolerance (% of Demand) | 0% |

Change of Demand (in %)

| | |
|---|---|
| Municipal & Industrial | 0% |
| Self Supplied Rural Residential | 0% |
| Self Supplied Industrial | 0% |
| Thermoelectric Power | 0% |
| Crop Irrigation | 0% |
| Livestock | 0% |
| Oil & Gas | 0% |

Demand Percentages

| Demand Type | Input Percentages of Demand Met by Surface or GW: Surface | Ground | If GW Demands Exist, Input the % Met by Type: Alluvial | Bedrock |
|---|---|---|---|---|
| Municipal & Industrial | 58% | 42% | 17% | 83% |
| Self Supplied Rural Residential | 0% | 100% | 65% | 35% |
| Self Supplied Industrial | 0% | 0% | 0% | 0% |
| Thermoelectric Power | 0% | 0% | 0% | 0% |
| Crop Irrigation | 25% | 75% | 60% | 40% |
| Livestock | 25% | 75% | 60% | 40% |
| Oil & Gas | 0% | 0% | 0% | 0% |

Return Flow Percentages

- [x] Consider Return Flows

| Demand Type | RF % | Current | Down stream |
|---|---|---|---|
| Municipal & Industrial | 35% | ( ) | (•) |
| Self Supplied Rural Residential | 0% | ( ) | (•) |
| Self Supplied Industrial | 0% | ( ) | (•) |
| Thermoelectric Power | 38% | ( ) | (•) |
| Crop Irrigation | 10% | (•) | ( ) |
| Livestock | 0% | ( ) | (•) |
| Oil & Gas | 0% | ( ) | (•) |

# Example Scenario 1: Additional 10% Increase in Demands (all Sectors)

Increase Demands by 10%

Sensitivity and Tolerance

| | |
|---|---|
| Change of Surface Water Availability ( in %) | 0% |
| Acceptable Shortage Tolerance (% of Demand) | 0% |
| Change of Demand (in %) | |
| Municipal & Industrial | 10% |
| Self Supplied Rural Residential | 10% |
| Self Supplied Industrial | 10% |
| Thermoelectric Power | 10% |
| Crop Irrigation | 10% |
| Livestock | 10% |
| Oil & Gas | 10% |

# Resulting Gaps from Increased Demands (Example Basin)

## 2060 Demands

Configuration | Demand Projection | Summary of Demand | Annual Gap Summary | SW (

| Water Year | SW | AGW | BGW | All |
|---|---|---|---|---|
| 1950 | 0 | 0 | 0 | 0 |
| 1951 | 0 | 0 | 0 | 0 |
| 1952 | 133 | 116 | 0 | 249 |
| 1953 | 101 | 25 | 0 | 125 |
| 1954 | 134 | 170 | 0 | 305 |
| 1955 | 146 | 31 | 0 | 176 |
| 1956 | 45 | 86 | 0 | 131 |
| 1957 | 0 | 10 | 0 | 10 |
| 1958 | 0 | 0 | 0 | 0 |
| 1959 | 12 | 6 | 0 | 19 |
| 1960 | 0 | 15 | 0 | 15 |
| 1961 | 0 | 0 | 0 | 0 |
| 1962 | 0 | 44 | 0 | 44 |
| 1963 | 41 | 91 | 0 | 132 |
| 1964 | 126 | 145 | 0 | 271 |
| 1965 | 0 | 0 | 0 | 0 |
| 1966 | 140 | 123 | 0 | 263 |
| 1967 | 0 | 0 | 0 | 0 |
| 1968 | 0 | 0 | 0 | 0 |
| 1969 | 0 | 0 | 0 | 0 |
| 1970 | 162 | 175 | 0 | 338 |
| 1971 | 128 | 100 | 0 | 228 |
| 1972 | 0 | 0 | 0 | 0 |
| 1973 | 0 | 0 | 0 | 0 |
| **Min** | **0** | **0** | **0** | **0** |
| **Max** | **254** | **213** | **0** | **467** |
| **Avg** | **41** | **44** | **0** | **85** |

## Increased 2060 Demands

Configuration | Demand Projection | Summary of Demand | Annual Gap Summary | SW

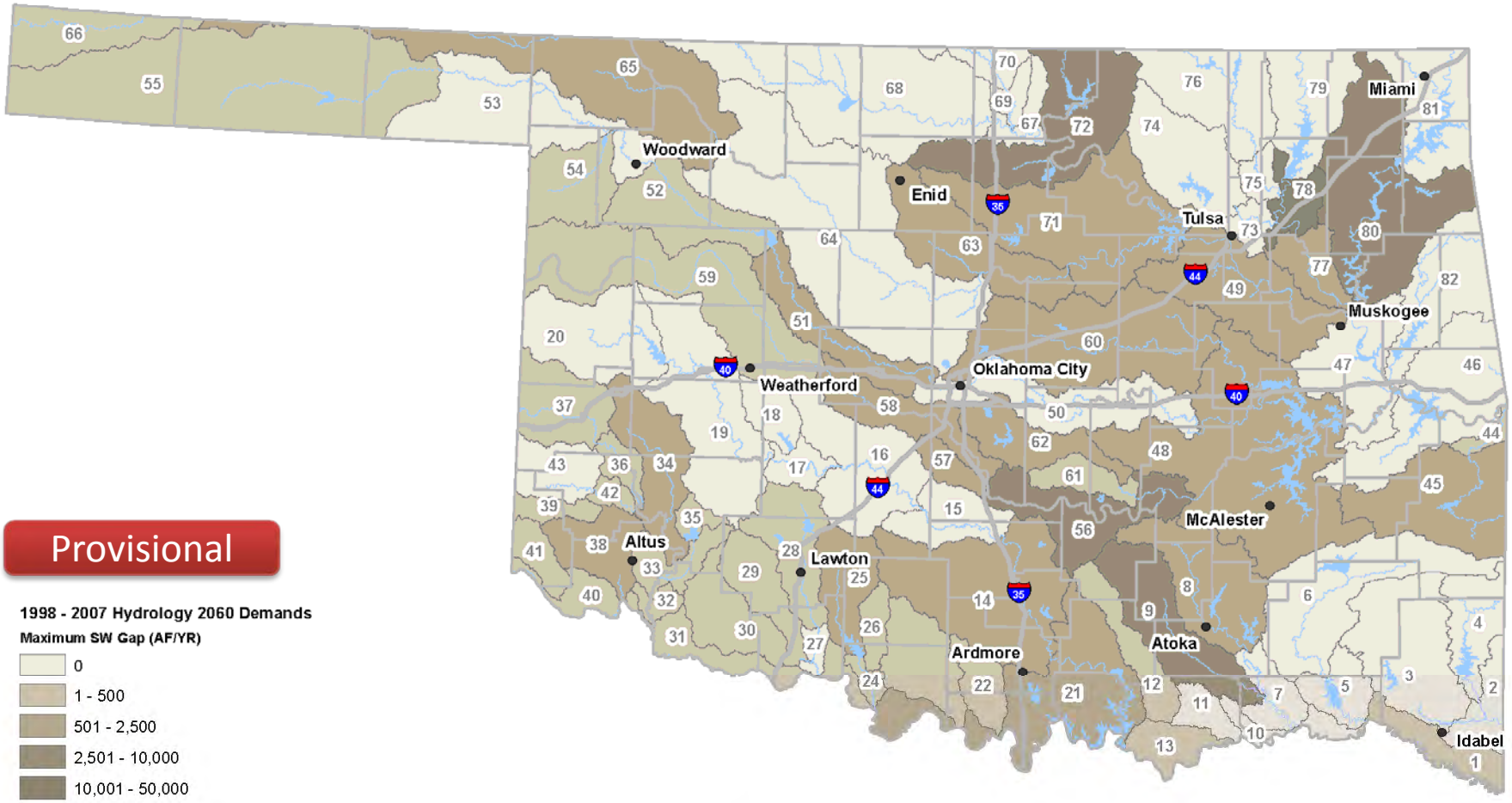
| Water Year | SW | AGW | BGW | All |
|---|---|---|---|---|
| 1950 | 0 | 0 | 0 | 0 |
| 1951 | 0 | 0 | 0 | 0 |
| 1952 | 184 | 156 | 0 | 340 |
| 1953 | 153 | 40 | 0 | 193 |
| 1954 | 198 | 275 | 0 | 473 |
| 1955 | 211 | 50 | 0 | 261 |
| 1956 | 67 | 181 | 0 | 248 |
| 1957 | 5 | 83 | 0 | 87 |
| 1958 | 0 | 0 | 0 | 0 |
| 1959 | 25 | 10 | 0 | 35 |
| 1960 | 8 | 35 | 0 | 43 |
| 1961 | 0 | 0 | 0 | 0 |
| 1962 | 0 | 106 | 0 | 106 |
| 1963 | 74 | 121 | 0 | 194 |
| 1964 | 187 | 254 | 0 | 441 |
| 1965 | 0 | 27 | 0 | 27 |
| 1966 | 193 | 165 | 0 | 358 |
| 1967 | 5 | 10 | 0 | 15 |
| 1968 | 5 | 10 | 0 | 15 |
| 1969 | 0 | 0 | 0 | 0 |
| 1970 | 226 | 234 | 0 | 460 |
| 1971 | 188 | 161 | 0 | 349 |
| 1972 | 0 | 0 | 0 | 0 |
| 1973 | 0 | 0 | 0 | 0 |
| **Min** | **0** | **0** | **0** | **0** |
| **Max** | **363** | **289** | **0** | **653** |
| **Avg** | **62** | **71** | **0** | **134** |

# Results from Example Scenario 1: Increase in Demands for Example Basin

Demand
10 %

- Maximum Surface Water Gap — 43%
- Maximum Alluvial Groundwater Depletion — 36%
- Bedrock Groundwater Depletion — None (no change)

# Maximum Surface Water Gaps in 2060 (Baseline Conditions)




Provisional

**1998 - 2007 Hydrology 2060 Demands**

**Maximum SW Gap (AF/YR)**

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N
W E
S

0 25 50 Miles

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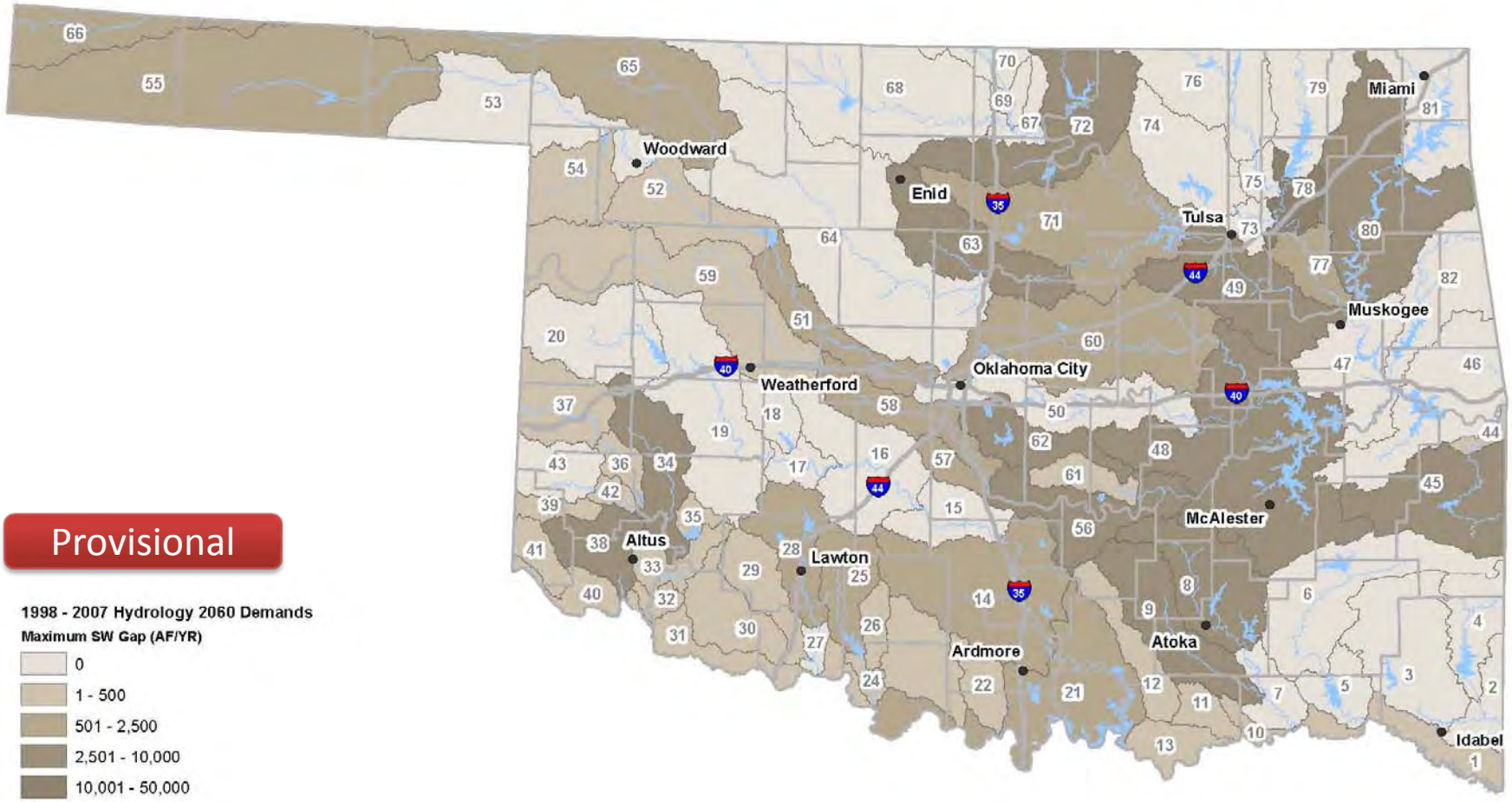
# Results from Example Scenario 1: 10% Increase in Demands (all Sectors)




Provisional

1998 - 2007 Hydrology 2060 Demands
Maximum SW Gap (AF/YR)

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W E
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CDM
Oklahoma Comprehensive Water Plan OCWP

# Example Scenario 2: 10% Decrease in Surface Water Supplies

Decrease Surface Water Supplies by 10%

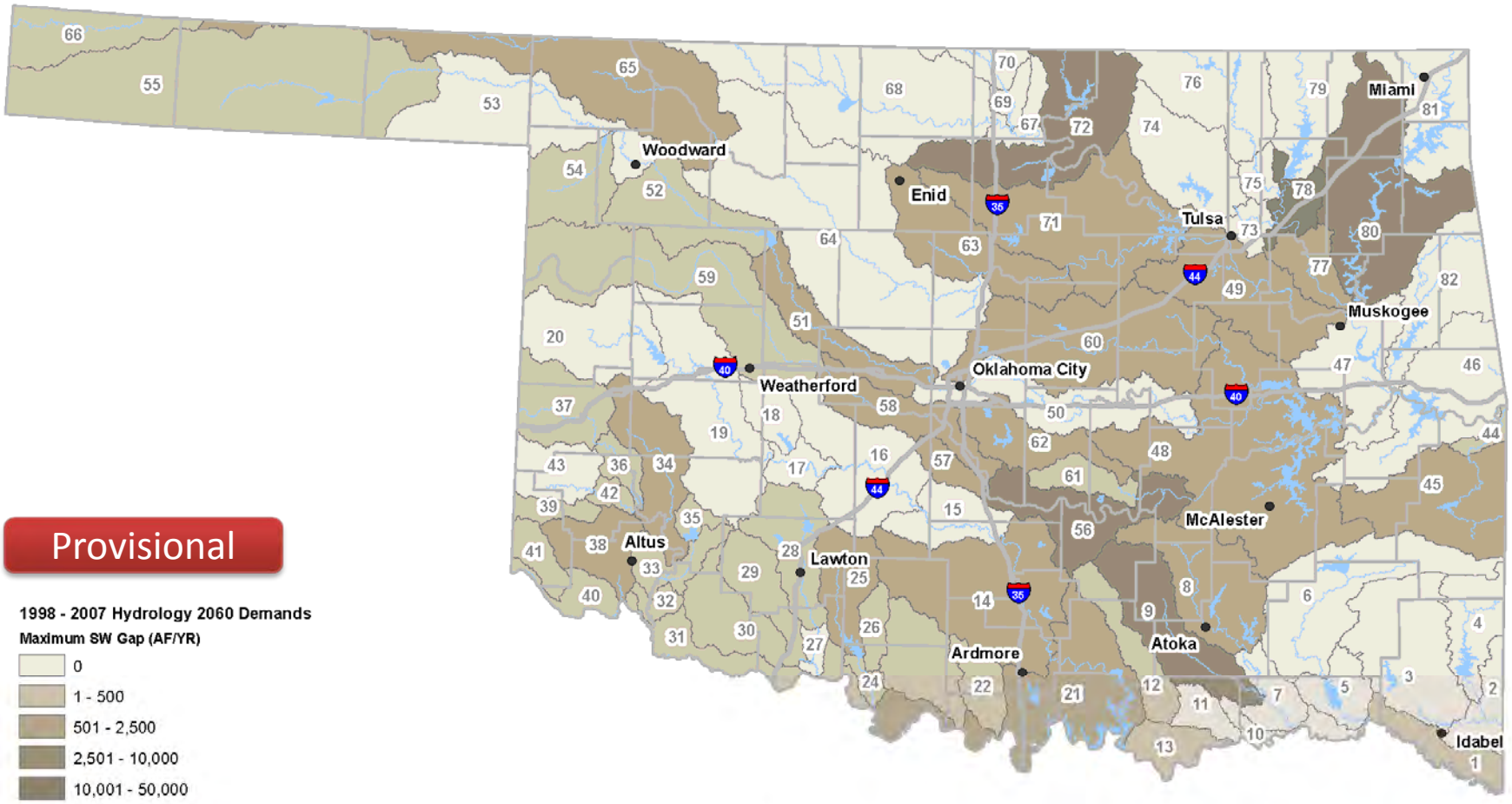
Sensitivity and Tolerance

| | |
|---|---|
| Change of Surface Water Availability ( in %) | -10% |
| Acceptable Shortage Tolerance (% of Demand) | 0% |

Change of Demand (in %)

| | |
|---|---|
| Municipal & Industrial | 0% |
| Self Supplied Rural Residential | 0% |
| Self Supplied Industrial | 0% |
| Thermoelectric Power | 0% |
| Crop Irrigation | 0% |
| Livestock | 0% |
| Oil & Gas | 0% |

# Maximum Surface Water Gaps in 2060 (Baseline Conditions)




Provisional

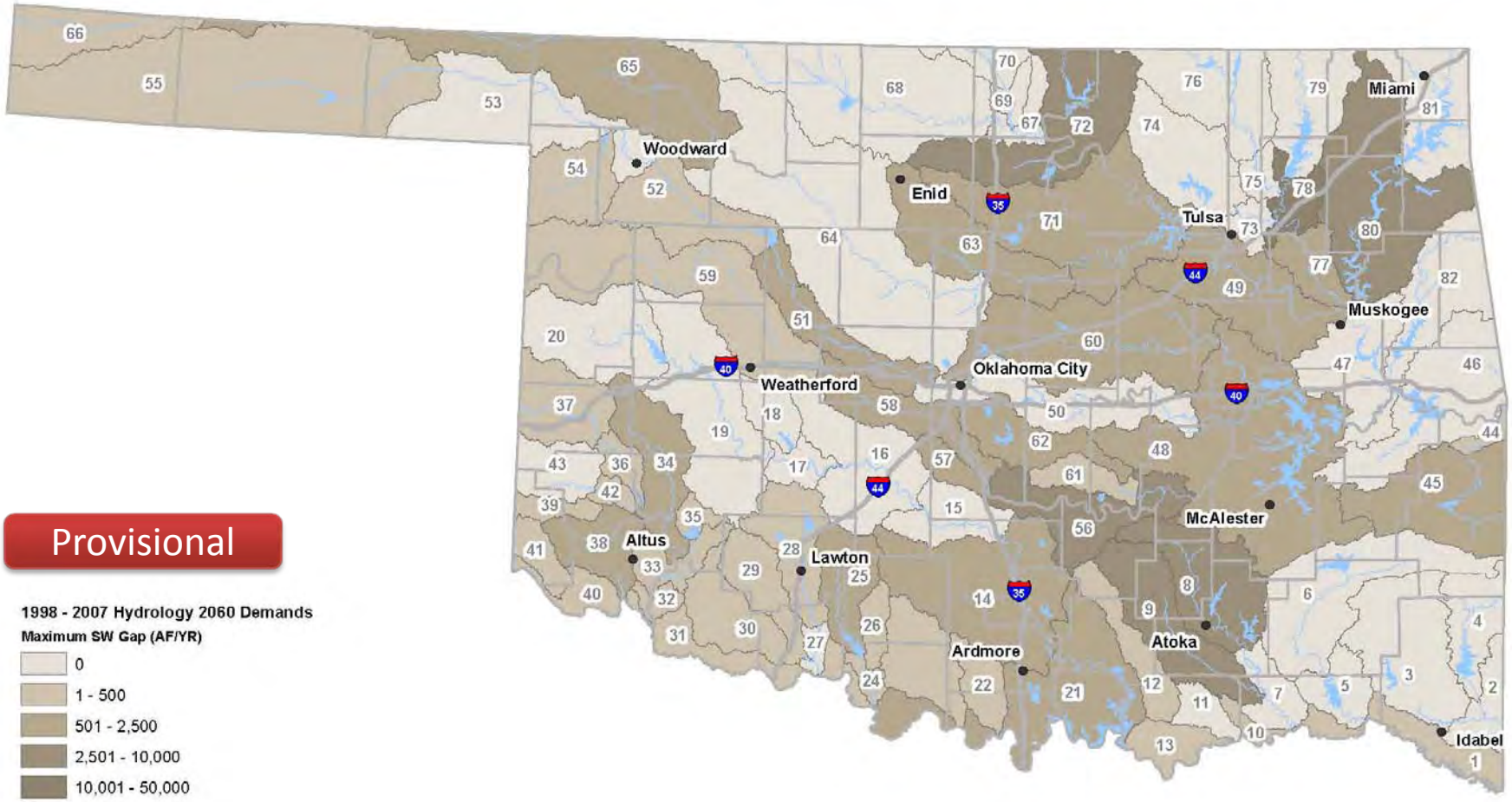
1998 - 2007 Hydrology 2060 Demands
Maximum SW Gap (AF/YR)

- 0
- 1 - 500
- 501 - 2,500
- 2,501 - 10,000
- 10,001 - 50,000

N
W E
S
0 25 50 Miles

State of Oklahoma OWRB Water Resources Board
US Army Corps of Engineers
CDM
Oklahoma Comprehensive Water Plan OCWP

# Results from Example Scenario 2: 10% Decrease in Surface Water Supplies




Provisional

1998 - 2007 Hydrology 2060 Demands
Maximum SW Gap (AF/YR)

- 0
- 1 - 500
- 501 - 2,500
- 2,501 - 10,000
- 10,001 - 50,000

N
W E
S
0 25 50 Miles

OWRB Water Resources Board
US Army Corps of Engineers
CDM
Oklahoma Comprehensive Water Plan OCWP

# Example Scenario 3: Modifying Supply Proportions

## Current Supply Proportions

Demand Percentages

| Demand Type | Input Percentages of Demand Met by Surface or GW | | If GW Demands Exist, Input the % Met by Type | |
|---|---|---|---|---|
| | Surface | Ground | Alluvial | Bedrock |
| Municipal & Industrial | 58% | 42% | 17% | 83% |
| Self Supplied Rural Residential | 0% | 100% | 65% | 35% |
| Self Supplied Industrial | 0% | 0% | 0% | 0% |
| Thermoelectric Power | 0% | 0% | 0% | 0% |
| Crop Irrigation | 25% | 75% | 60% | 40% |
| Livestock | 25% | 75% | 60% | 40% |
| Oil & Gas | 0% | 0% | 0% | 0% |

## Increased Groundwater Use

Demand Percentages

| Demand Type | Input Percentages of Demand Met by Surface or GW | | If GW Demands Exist, Input the % Met by Type | |
|---|---|---|---|---|
| | Surface | Ground | Alluvial | Bedrock |
| Municipal & Industrial | 20% | 80% | 20% | 80% |
| Self Supplied Rural Residential | 0% | 100% | 60% | 40% |
| Self Supplied Industrial | 0% | 0% | 0% | 0% |
| Thermoelectric Power | 0% | 0% | 0% | 0% |
| Crop Irrigation | 10% | 90% | 60% | 40% |
| Livestock | 10% | 90% | 60% | 40% |
| Oil & Gas | 0% | 0% | 0% | 0% |

# Resulting Gaps from Example Scenario 3: Modified Supply Proportions

## Current Supply Proportions

Configuration | Demand Projection | Summary of Demand | Annual Gap Summary | SW (

| Water Year | SW | AGW | BGW | All |
|---|---|---|---|---|
| 1950 | 0 | 0 | 0 | 0 |
| 1951 | | | | |
| 1952 | | | | |
| 1953 | | | | |
| 1954 | | | | |
| 1955 | | | | |
| 1956 | 45 | 86 | 0 | 131 |
| 1957 | 0 | 10 | 0 | 10 |
| 1958 | 0 | 0 | 0 | 0 |
| 1959 | 12 | | | |
| 1960 | 0 | | | |
| 1961 | 0 | | | |
| 1962 | 0 | | | |
| 1963 | 41 | | | |
| 1964 | 126 | 145 | 0 | 271 |
| 1965 | 0 | 0 | 0 | 0 |
| 1966 | 140 | 123 | 0 | 263 |
| 1967 | 0 | 0 | 0 | |
| 1968 | 0 | 0 | 0 | |
| 1969 | 0 | 0 | 0 | |
| 1970 | 162 | 175 | 0 | |
| 1971 | 128 | 100 | 0 | |
| 1972 | 0 | 0 | 0 | 0 |
| 1973 | 0 | 0 | 0 | 0 |
| **Min** | **0** | **0** | **0** | **0** |
| **Max** | **254** | **213** | **0** | **467** |
| **Avg** | **41** | **44** | **0** | **85** |

## Modified Supply Proportions

Configuration | Demand Projection | Summary of Demand | Annual Gap Summary | SW (

| Water | SW | AGW | BGW | All |
|---|---|---|---|---|
| 50 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 |
| | 49 | 146 | 0 | 195 |
| | 38 | 38 | 0 | 66 |
| | 49 | 162 | 0 | 211 |
| | 48 | 54 | 0 | 102 |
| 6 | 16 | 61 | 0 | 77 |
| 1957 | 0 | 0 | 0 | 0 |
| 1958 | 0 | 0 | 0 | 0 |
| | | | 0 | 4 |
| | | | 0 | 0 |
| | | | 0 | 0 |
| | | | 0 | 10 |
| | | | 0 | 98 |
| 1964 | 40 | 54 | 0 | 174 |
| 1965 | 0 | 0 | | 0 |
| 1966 | 51 | 155 | | 206 |
| | | | | 0 |
| | | | | 0 |
| | | | | |
| | | | | 271 |
| | | | | 162 |
| 1972 | 0 | 0 | | 0 |
| 1973 | 0 | 0 | | 0 |
| **Min** | **0** | **0** | **0** | **0** |
| **Max** | **76** | **273** | **0** | **349** |
| **Avg** | **11** | **46** | **0** | **57** |

Surface Water Gap
254 AFY → 76 AFY

Alluvial GW Depletions
213 AFY → 273 AFY

Still No Bedrock GW Depletions

# Three Key Planning Tools Developed for the OCWP

Oklahoma H2O

Supply/Demand Gap Tool

SWAM

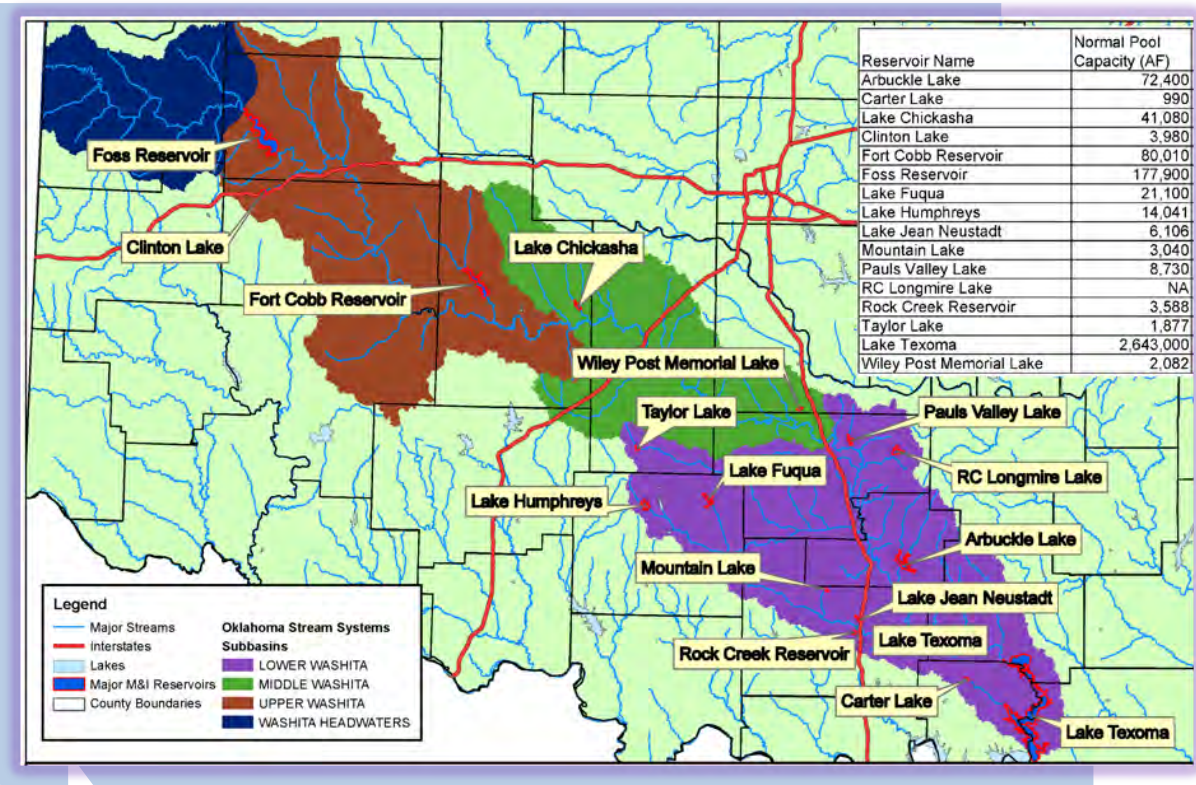
Simplified Water Allocation Model

Reservoir Yield Model

Climate Demand Model

# Firm Yield Estimates

- Maximum amount of water that can be withdrawn through a drought of record




| Reservoir Name | Normal Pool Capacity (AF) |
|---|---|
| Arbuckle Lake | 72,400 |
| Carter Lake | 990 |
| Lake Chickasha | 41,080 |
| Clinton Lake | 3,980 |
| Fort Cobb Reservoir | 80,010 |
| Foss Reservoir | 177,900 |
| Lake Fuqua | 21,100 |
| Lake Humphreys | 14,041 |
| Lake Jean Neustadt | 6,106 |
| Mountain Lake | 3,040 |
| Pauls Valley Lake | 8,730 |
| RC Longmire Lake | NA |
| Rock Creek Reservoir | 3,588 |
| Taylor Lake | 1,877 |
| Lake Texoma | 2,643,000 |
| Wiley Post Memorial Lake | 2,082 |

- Goal: Identify and test a standardized method for estimating reservoir yields
- Investigated all major Washita Basin reservoirs
  - *Method and results of firm yield estimates*
  - *Selected two test reservoirs for yield method*

# Reservoir Yields

## LAKE JEAN NEUSTADT

- Bureau of Reclamation
- Built in 1969
- Municipal water supply
- Normal pool capacity 358,336 AF
- Flood pool capacity 474,200 AF
- Used to test OWRB Reservoir Yield Model
- Used to validate OWRB Reservoir Yield Model

SWAM Jean Neustadt.xlsm - Microsoft Excel

Home | Insert | Page Layout | Formulas | Data | Review | View | Add-Ins | Acrobat

Normal | Page Layout | Page Break Preview | Custom Views | Full Screen | Workbook Views

Ruler | Formula Bar | Gridlines | Headings | Message Bar | Show/Hide

Zoom | 100% | Zoom to Selection | Zoom

New Window | Arrange All | Freeze Panes | Split | Hide | Unhide | View Side by Side | Synchronous Scrolling | Reset Window Position | Save Workspace | Switch Windows | Window

Macros | Macros

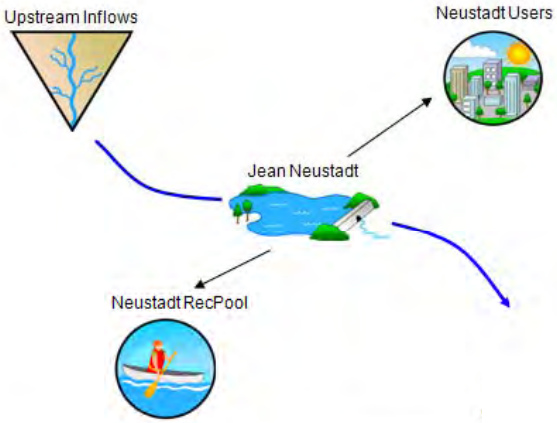
T48

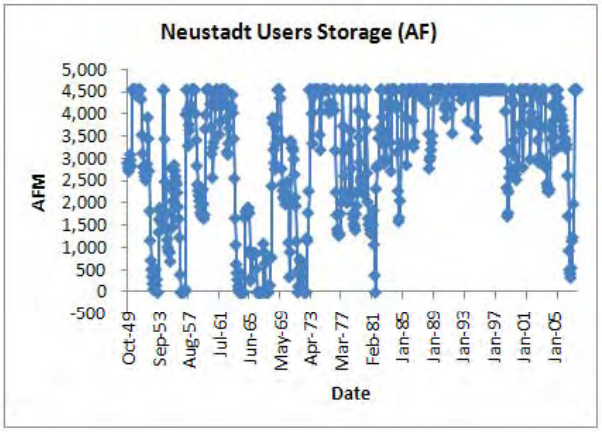
Object Palette

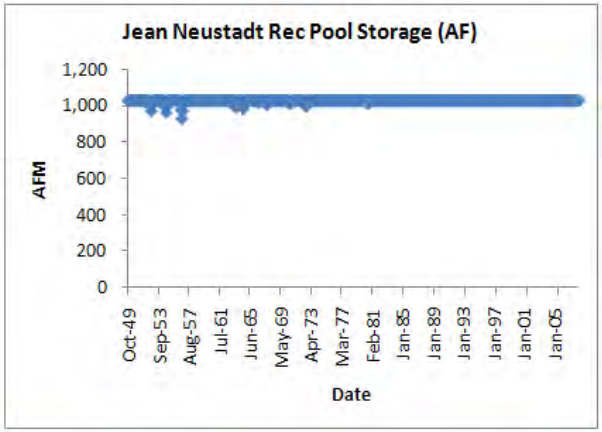
# Simplified Water Allocation Model (SWAM)

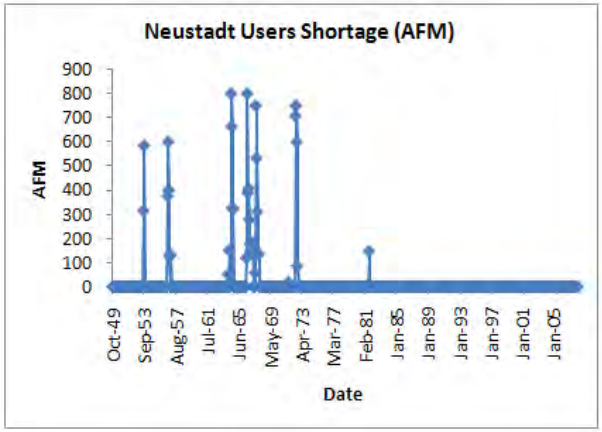
| Start Year (YYYY) | Start Month (MMM) | End Year (YYYY) | End Month (MMM) |
|---|---|---|---|
| 1949 | Oct | 2007 | Sep |

Run (ctrl R)



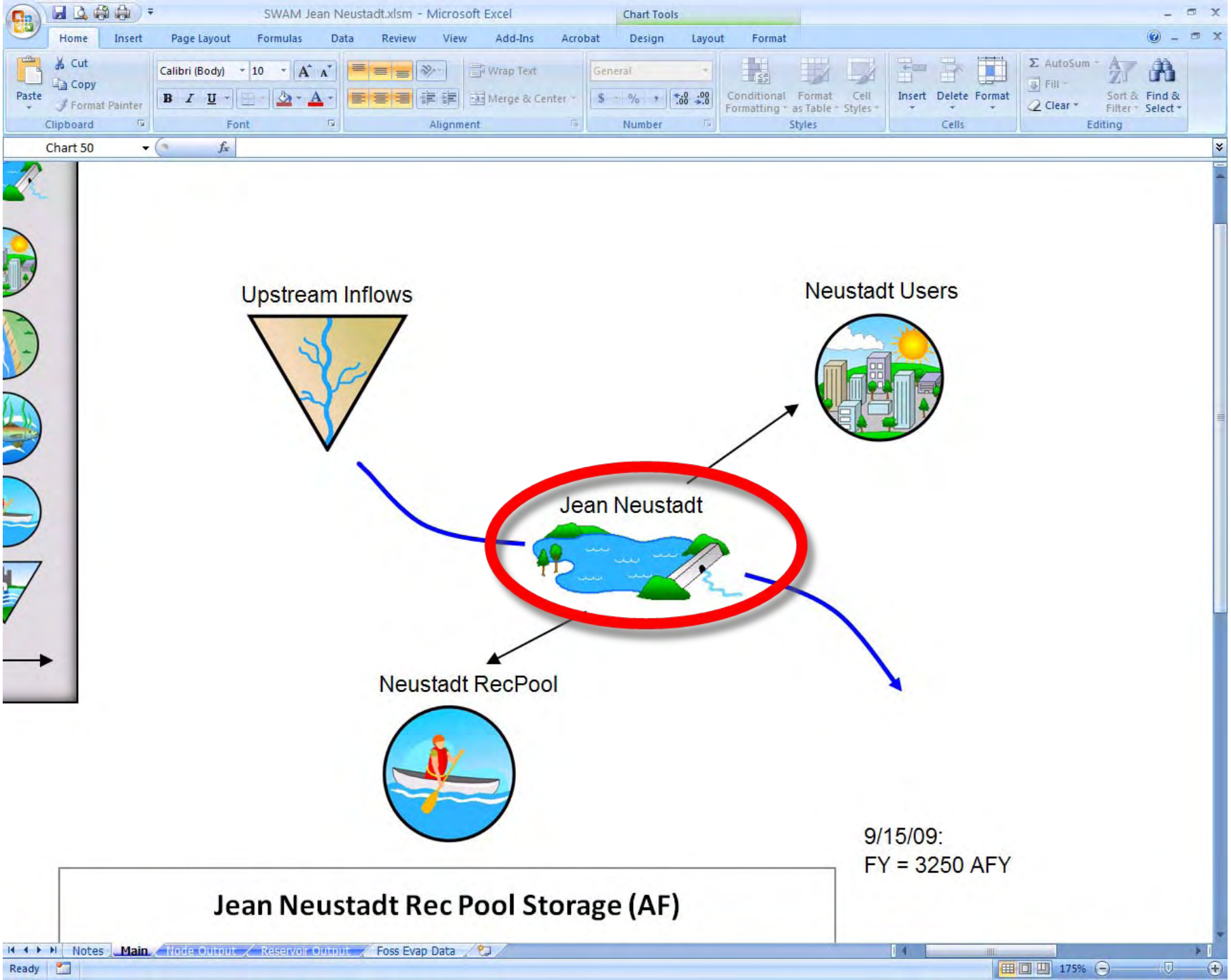



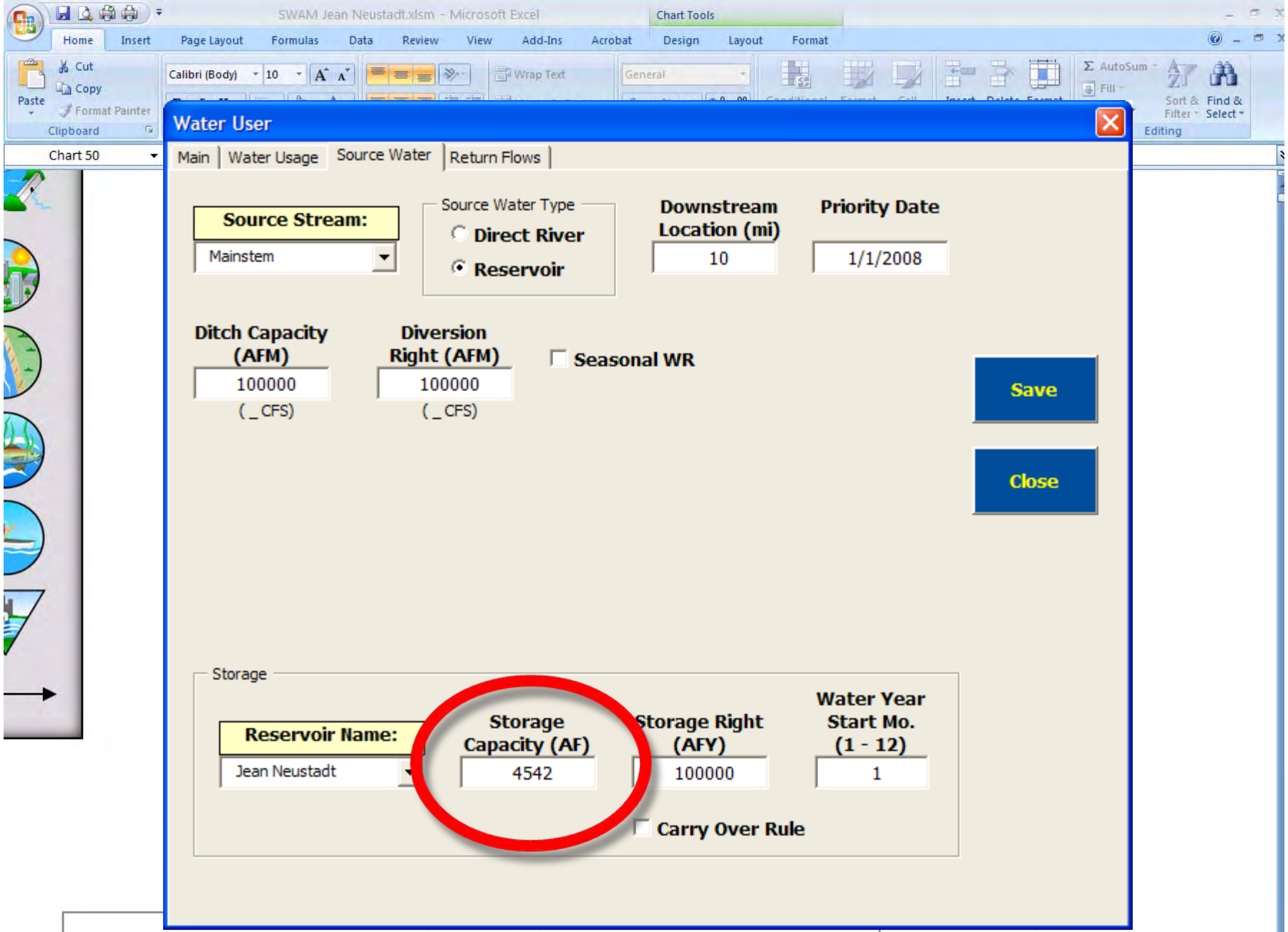




Notes | Main | Node Output | Reservoir Output | Foss Evap Data

Ready | 90%


SWAM Jean Neustadt.xlsm - Microsoft Excel
Chart Tools
Home
Insert
Page Layout
Formulas
Data
Review
View
Add-Ins
Acrobat
Design
Layout
Format
Chart 50
Upstream Inflows
Neustadt Users
Jean Neustadt
Neustadt RecPool
9/15/09:
FY = 3250 AFY
Jean Neustadt Rec Pool Storage (AF)
Notes
Main
Foss Evap Data
Ready




Jean Neustadt Rec Pool Storage (AF)

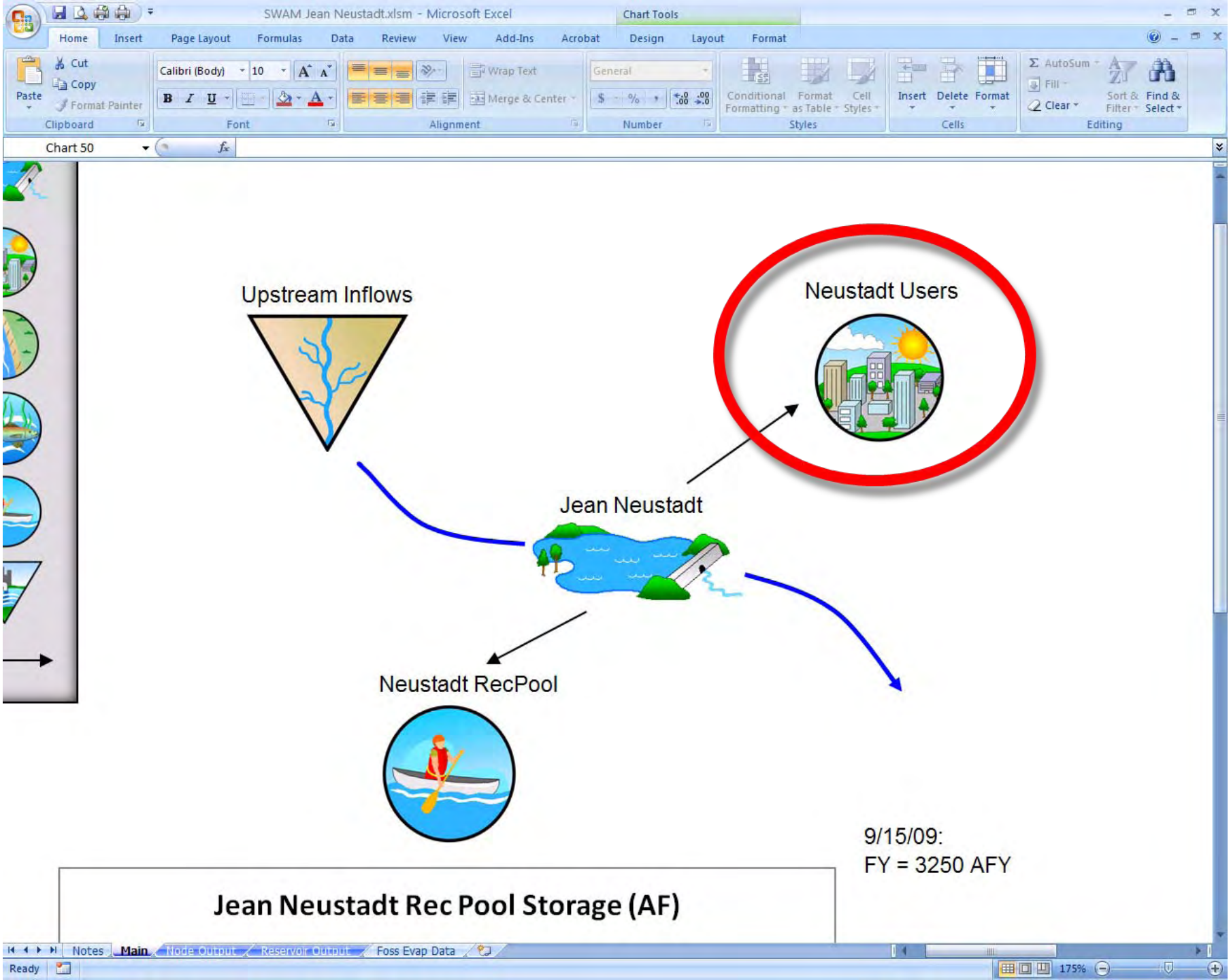

SWAM Jean Neustadt.xlsm - Microsoft Excel
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Chart 50
Upstream Inflows
Neustadt Users
Jean Neustadt
Neustadt RecPool
9/15/09:
FY = 3250 AFY
Jean Neustadt Rec Pool Storage (AF)
Notes
Main
Foss Evap Data
Ready

SWAM Jean Neustadt.xlsm - Microsoft Excel

Chart Tools

Home | Insert | Page Layout | Formulas | Data | Review | View | Add-Ins | Acrobat | Design | Layout | Format

Chart 50

## Water User

Main | Water Usage | Source Water | Return Flows

Monthly User Distribution

- Manual
- M&I
- Agriculture

Total Annual Use (AFY): 5000

Distribute

Monthly Baseline Usage

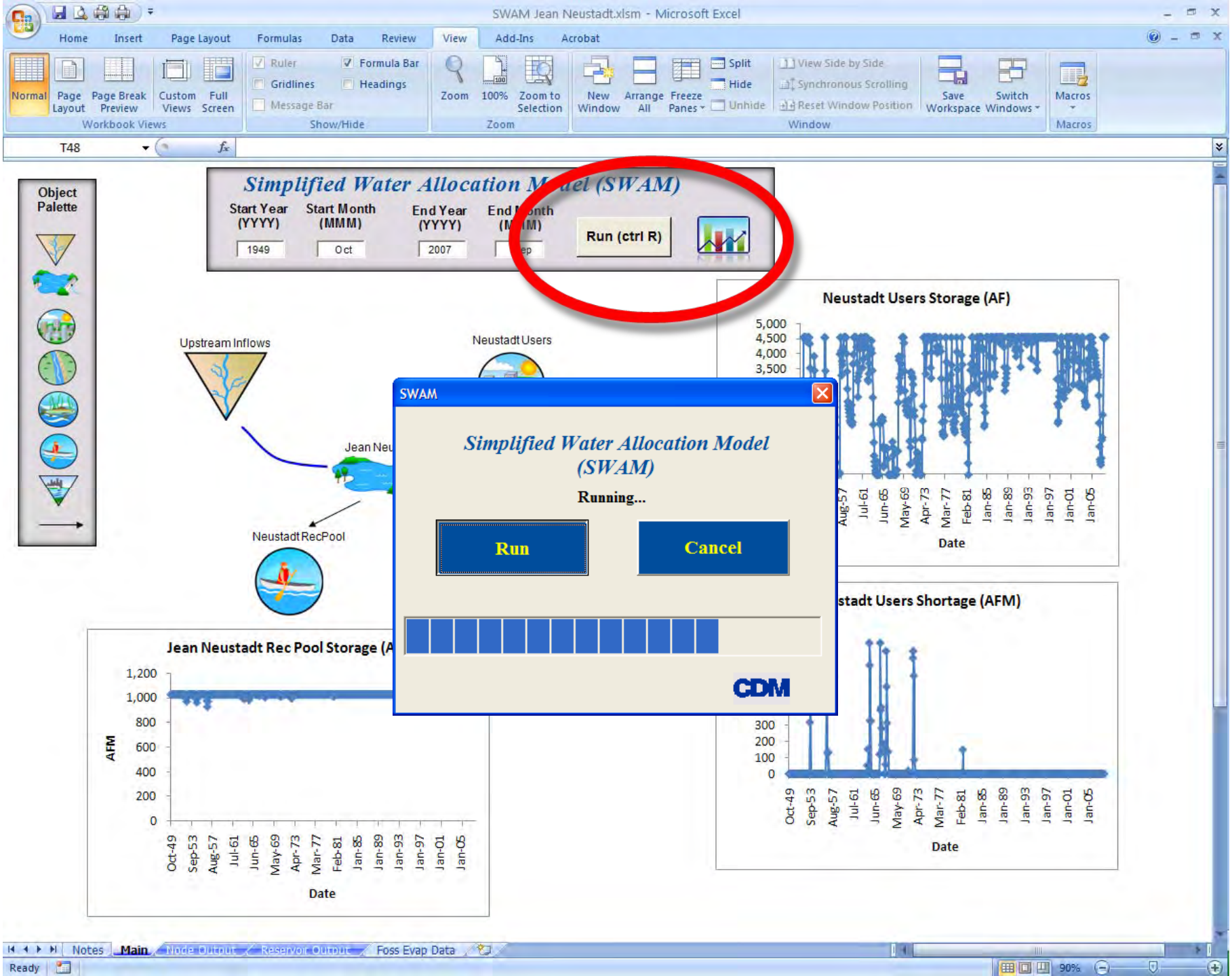
| Month | Monthly Usage (AF) | % Indoor Use | % CU Indoor | % CU Outdoor |
|---|---|---|---|---|
| Jan | 200 | 100 | 5 | 5 |
| Feb | 200 | 100 | 5 | 5 |
| Mar | 200 | 100 | 5 | 50 |
| Apr | 300 | 67 | 5 | 60 |
| May | 500 | 40 | 5 | 70 |
| Jun | 650 | 31 | 5 | 80 |
| Jul | 800 | 25 | 5 | 85 |
| Aug | 750 | 27 | 5 | 80 |
| Sep | 600 | 33 | 5 | 70 |
| Oct | 400 | 50 | 5 | 50 |
| Nov | 200 | 100 | 5 | 50 |
| Dec | 200 | 100 | 5 | 5 |

Save | Close

Notes | Main | Node Output | Reservoir Output | Foss Evap Data

Ready

175%


SWAM Jean Neustadt.xlsm - Microsoft Excel
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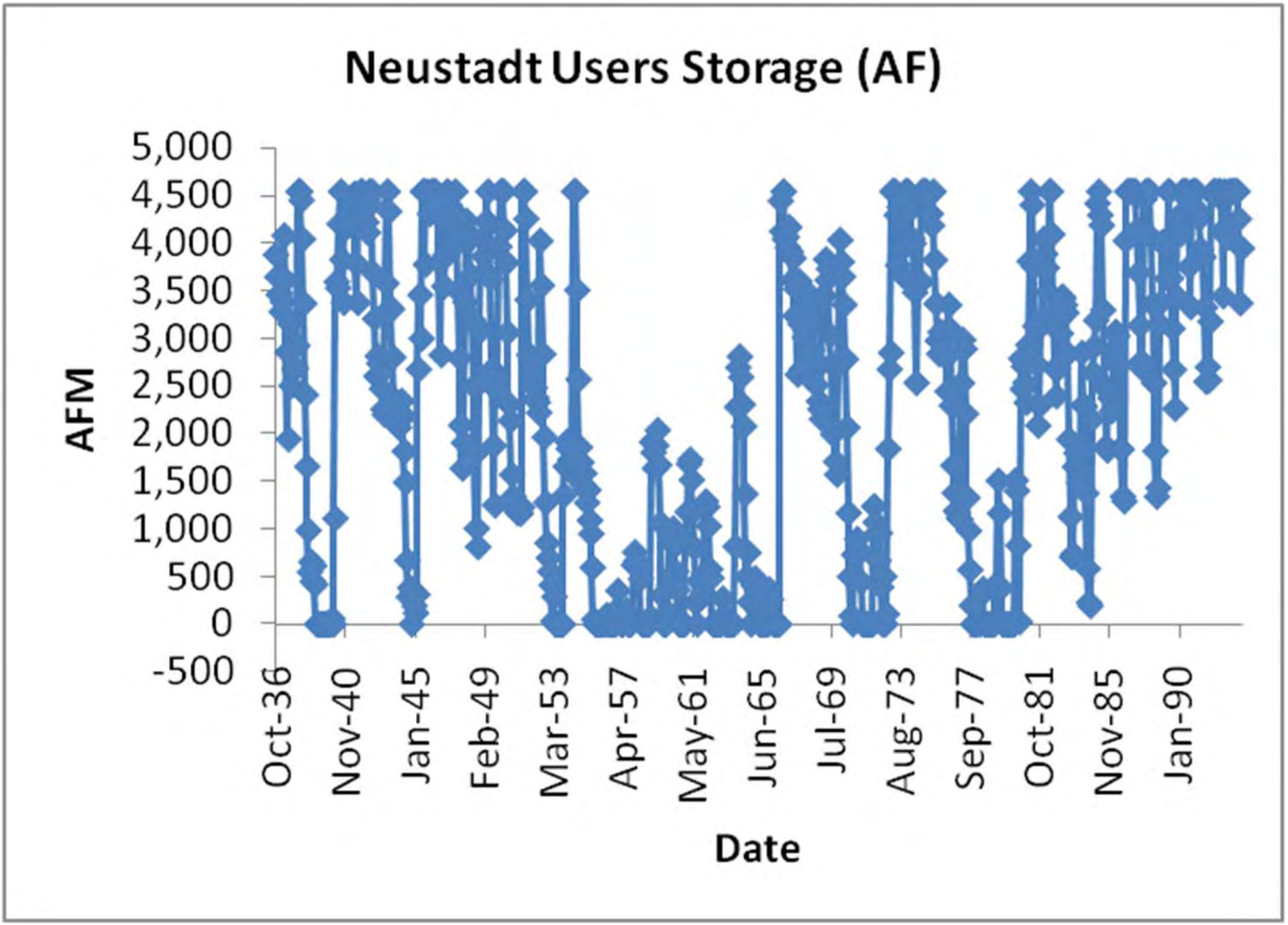
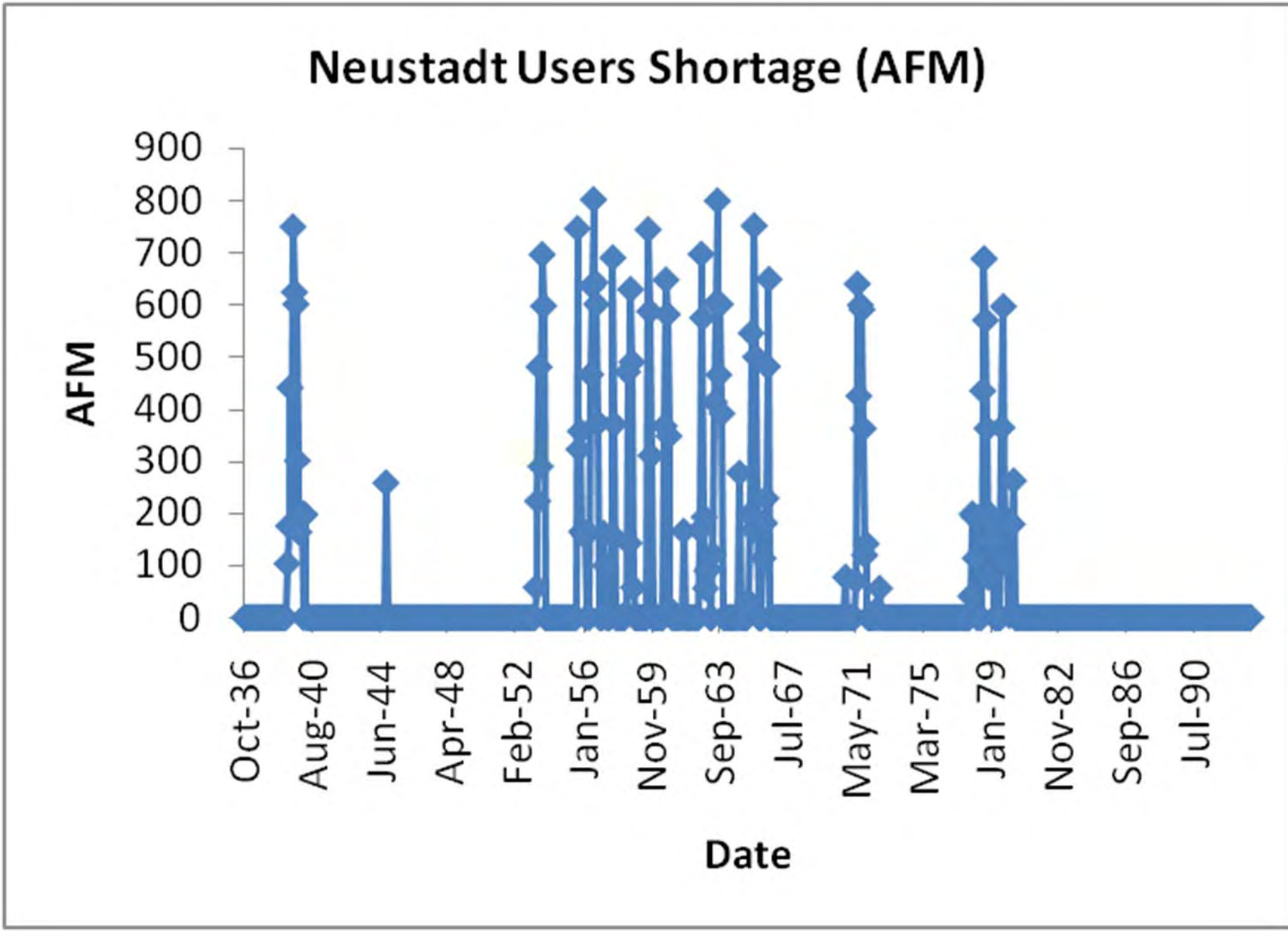
Add-Ins
Acrobat
Normal
Page Layout
Page Break Preview
Custom Views
Full Screen
Workbook Views
Ruler
Gridlines
Message Bar
Formula Bar
Headings
Show/Hide
Zoom
100%
Zoom to Selection
Zoom
New Window
Arrange All
Freeze Panes
Split
Hide
Unhide
View Side by Side
Synchronous Scrolling
Reset Window Position
Save Workspace
Switch Windows
Window
Macros
T48
Object Palette
Simplified Water Allocation Model (SWAM)
Start Year (YYYY)
Start Month (MMM)
End Year (YYYY)
End Month (MMM)
1949
Oct
2007
Run (ctrl R)
Upstream Inflows
Neustadt Users
Jean Neu
Neustadt RecPool
Neustadt Users Storage (AF)
5,000
4,500
4,000
3,500
Date
SWAM
Simplified Water Allocation Model (SWAM)
Running...
Run
Cancel
CDM
Jean Neustadt Rec Pool Storage (A
1,200
1,000
800
600
400
200
0
AFM
Oct-49
Sep-53
Aug-57
Jul-61
Jun-65
May-69
Apr-73
Mar-77
Feb-81
Jan-85
Jan-89
Jan-93
Jan-97
Jan-01
Jan-05
Date
stadt Users Shortage (AFM)
300
200
100
0
Date
Notes
Main
Node Output
Reservoir Output
Foss Evap Data
Ready
90%


Neustadt Users Storage (AF)
AFM
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-500
Oct-36
Nov-40
Jan-45
Feb-49
Mar-53
Apr-57
May-61
Jun-65
Jul-69
Aug-73
Sep-77
Oct-81
Nov-85
Jan-90
Date


Neustadt Users Shortage (AFM)
AFM
900
800
700
600
500
400
300
200
100
0
Oct-36
Aug-40
Jun-44
Apr-48
Feb-52
Jan-56
Nov-59
Sep-63
Jul-67
May-71
Mar-75
Jan-79
Nov-82
Sep-86
Jul-90
Date

SWAM Jean Neustadt.xlsm - Microsoft Excel

Chart Tools

Home | Insert | Page Layout | Formulas | Data | Review | View | Add-Ins | Acrobat | Design | Layout | Format

Chart 50

## Water User

Main | Water Usage | Source Water | Return Flows

Monthly User Distribution

- Manual
- M&I
- Agriculture

Total Annual Use (AFY): 2260

Distribute

Monthly Baseline Usage

| Month | Monthly Usage (AF) | % Indoor Use | % CU Indoor | % CU Outdoor |
|---|---|---|---|---|
| Jan | 90.4 | 100 | 5 | 5 |
| Feb | 90.4 | 100 | 5 | 5 |
| Mar | 90.4 | 100 | 5 | 50 |
| Apr | 135.6 | 67 | 5 | 60 |
| May | 226 | 40 | 5 | 70 |
| Jun | 293.8 | 31 | 5 | 80 |
| Jul | 361.6 | 25 | 5 | 85 |
| Aug | 339 | 27 | 5 | 80 |
| Sep | 271.2 | 33 | 5 | 70 |
| Oct | 180.8 | 50 | 5 | 50 |
| Nov | 90.4 | 100 | 5 | 50 |
| Dec | 90.4 | 100 | 5 | 5 |

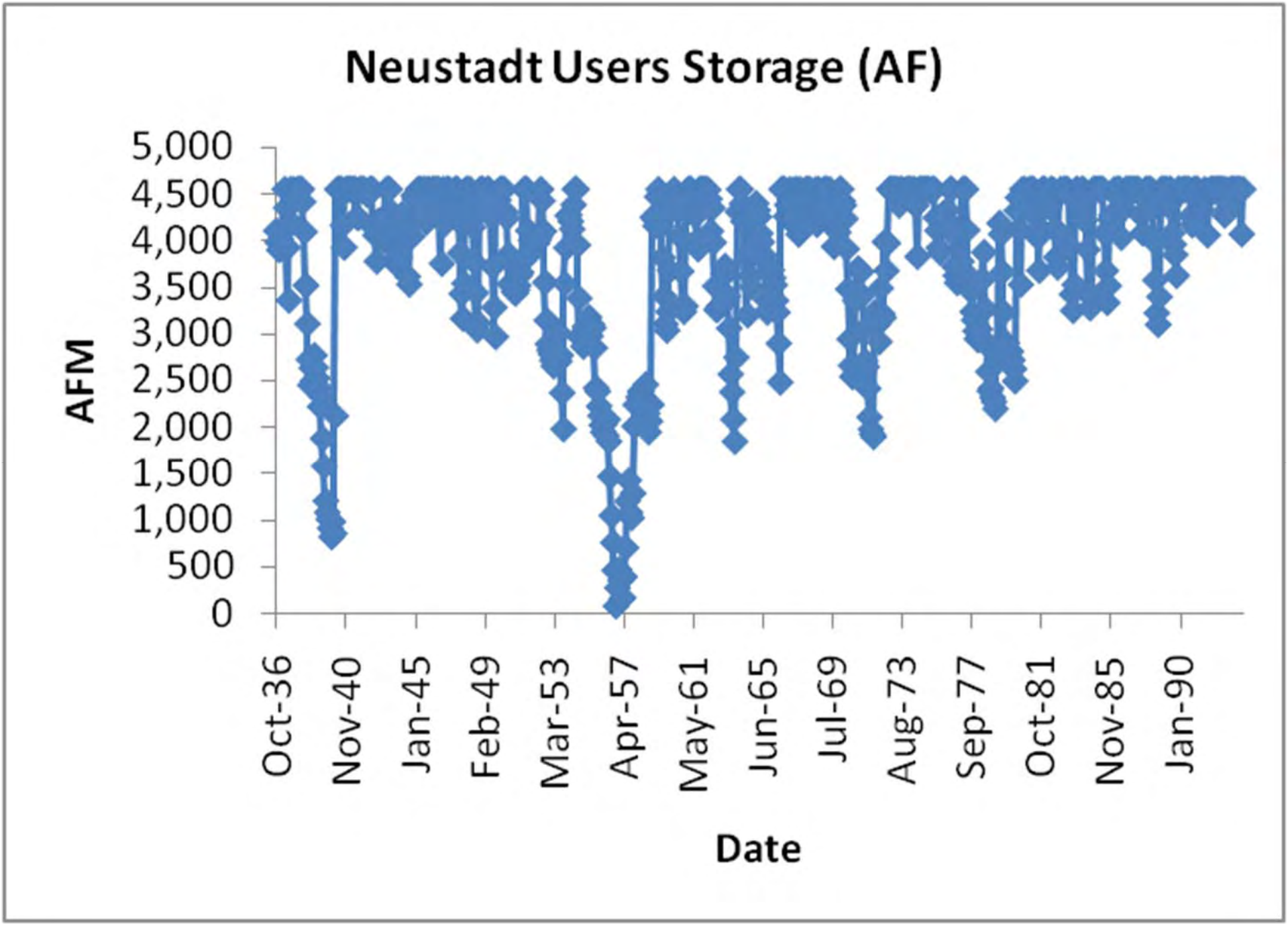
Save | Close

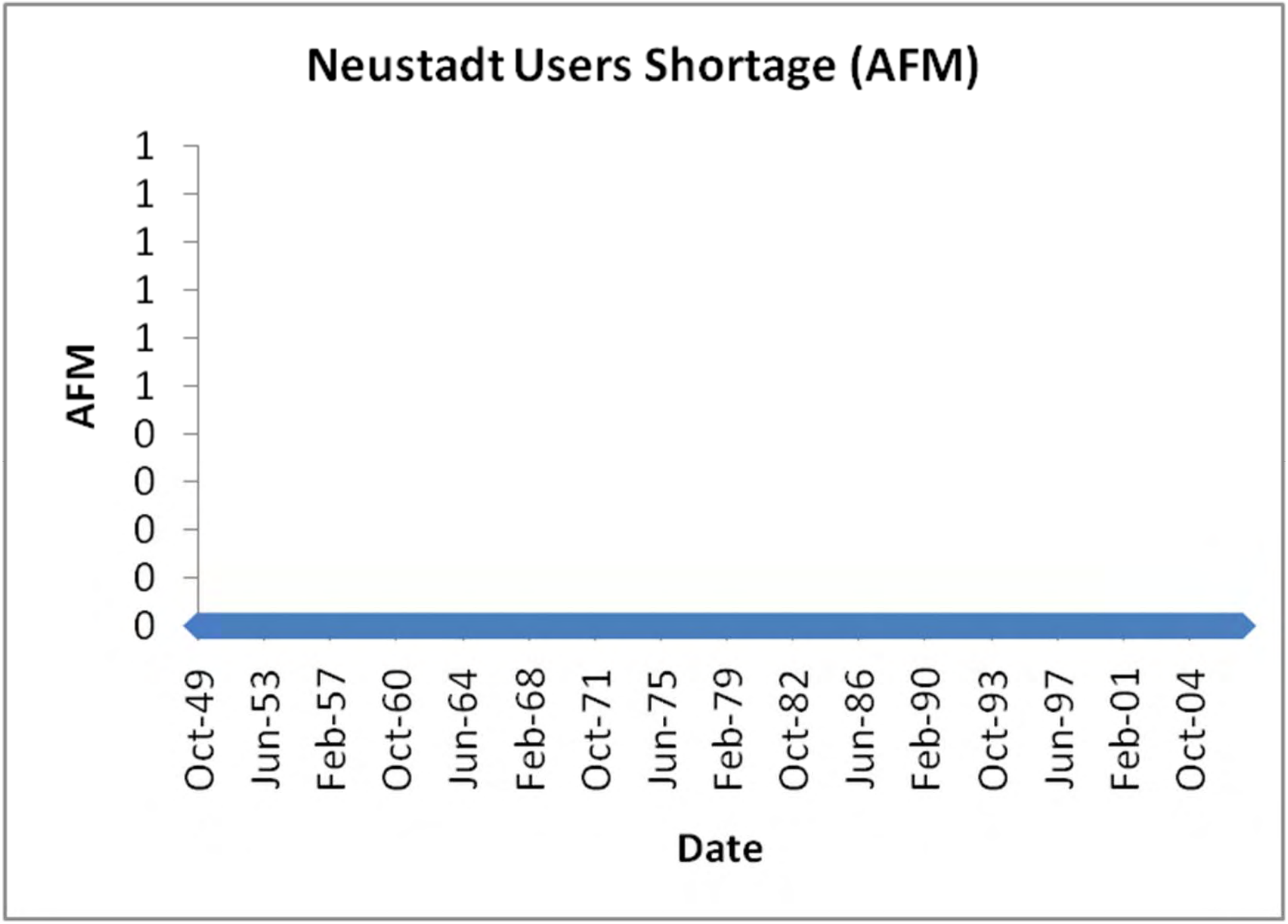
Jean Neustadt Rec Pool Storage (AF)

Notes | Main | Node Output | Reservoir Output | Foss Evap Data

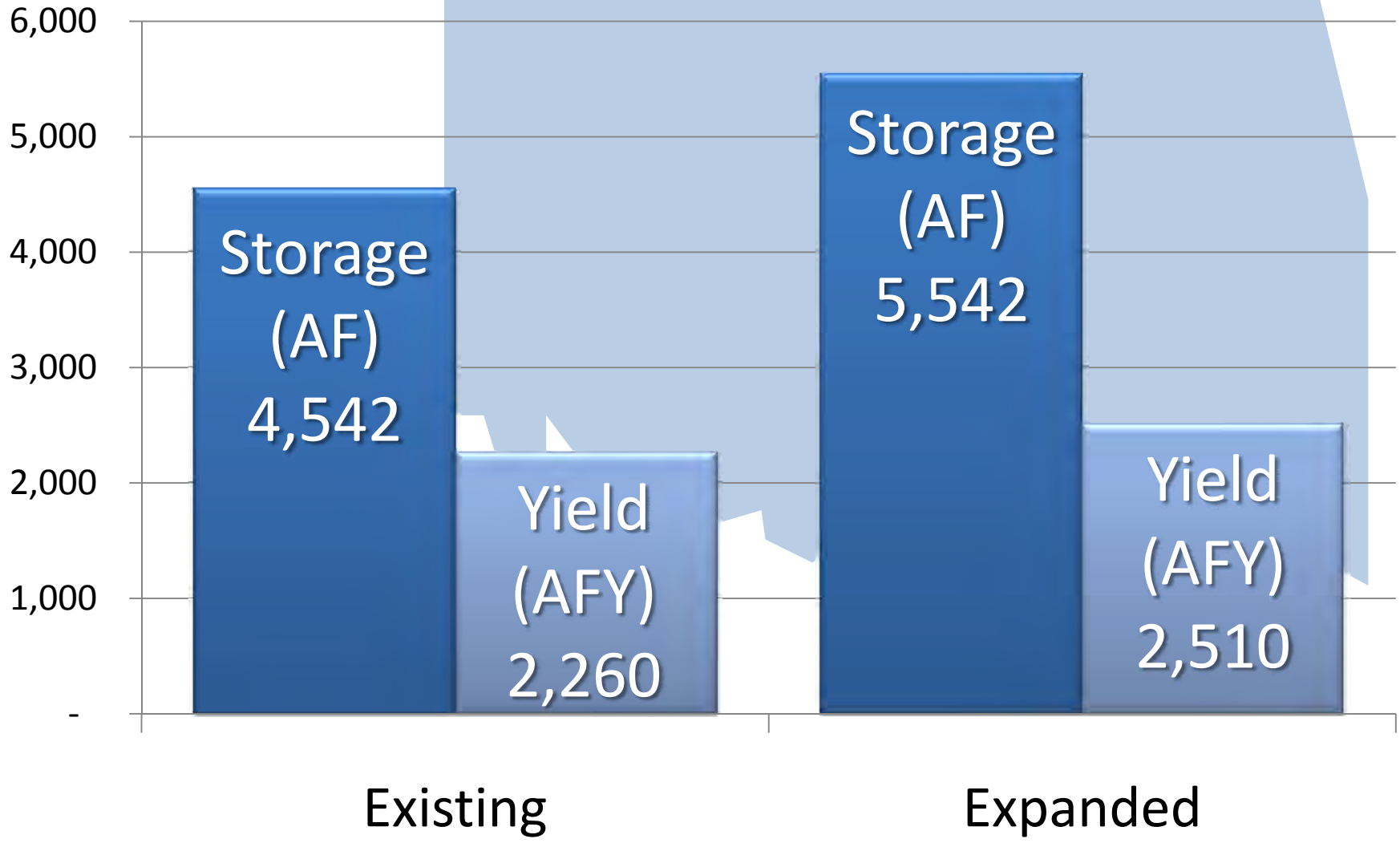
Ready

175%

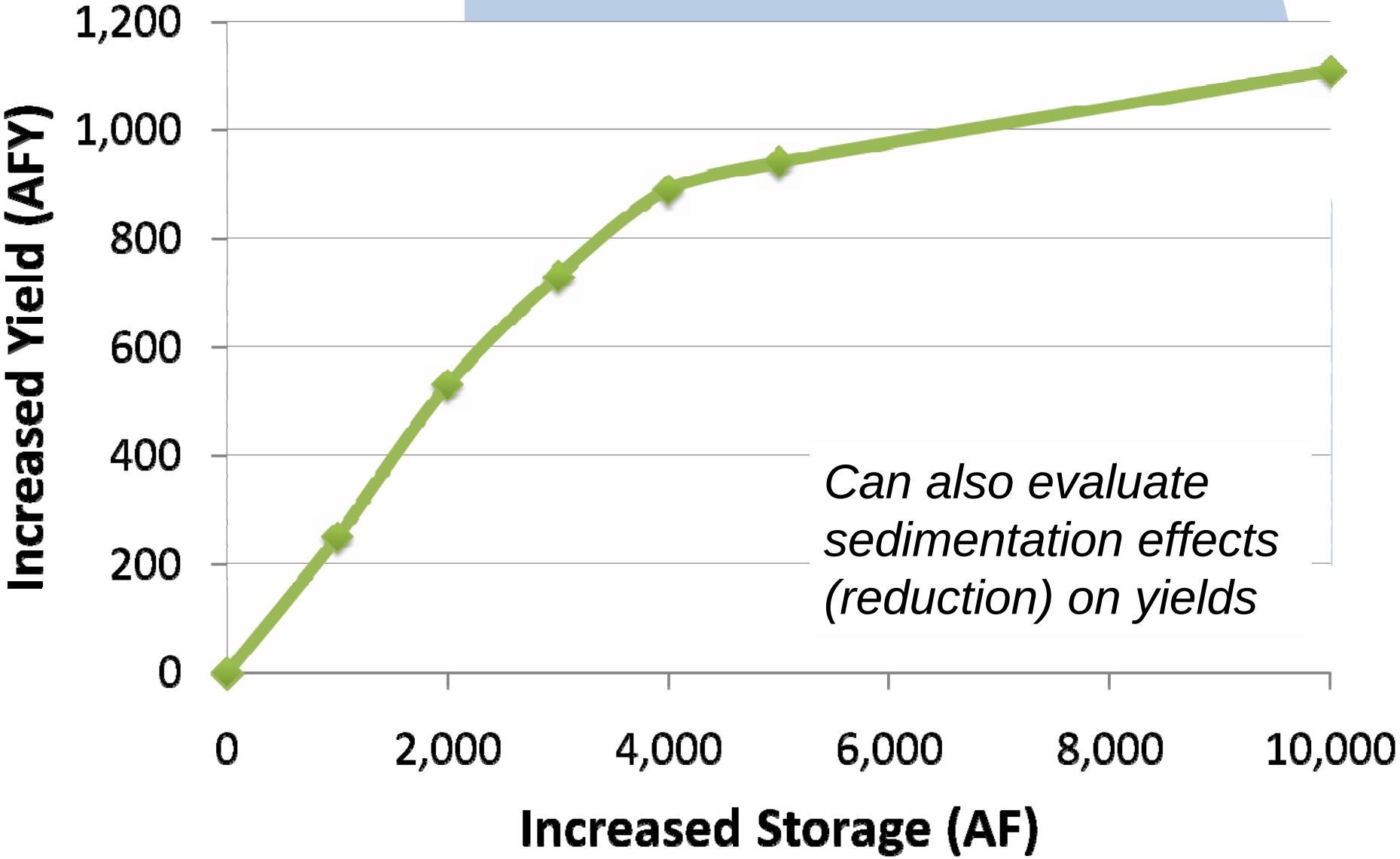

Neustadt Users Storage (AF)
AFM
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Oct-36
Nov-40
Jan-45
Feb-49
Mar-53
Apr-57
May-61
Jun-65
Jul-69
Aug-73
Sep-77
Oct-81
Nov-85
Jan-90
Date


Neustadt Users Shortage (AFM)
AFM
1
1
1
1
1
1
0
0
0
0
0
Oct-49
Jun-53
Feb-57
Oct-60
Jun-64
Feb-68
Oct-71
Jun-75
Feb-79
Oct-82
Jun-86
Feb-90
Oct-93
Jun-97
Feb-01
Oct-04
Date

# Assess Benefits of Increased Storage



# Effects of Increased Storage on Yield



# Three Key Planning Tools Developed for the OCWP

Oklahoma H2O

Supply/Demand Gap Tool

SWAM

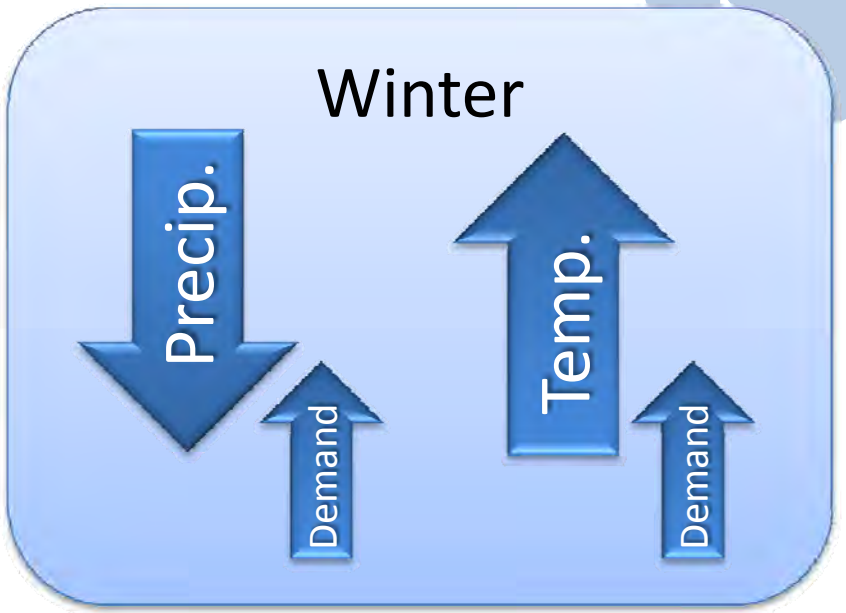
Simplified Water Allocation Model

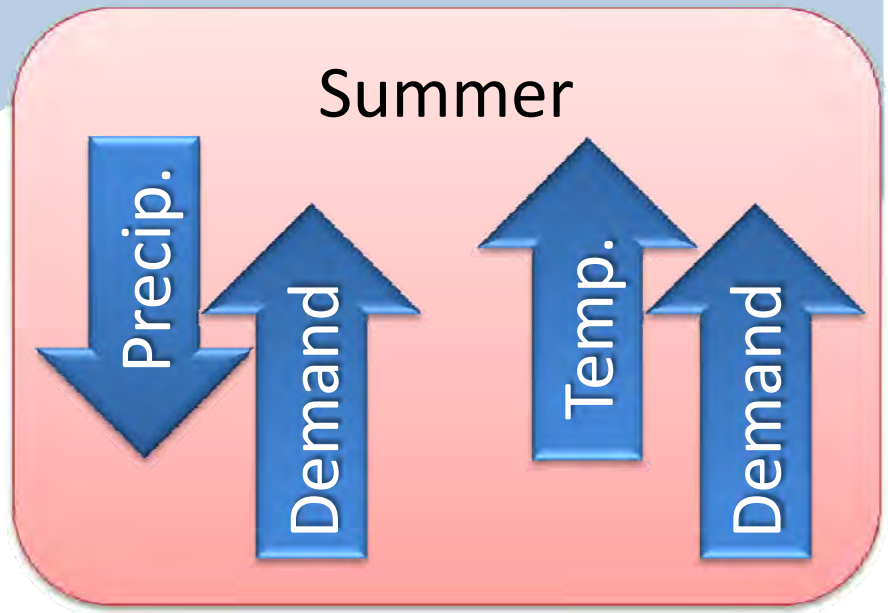
Reservoir Yield Model

Climate Demand Model

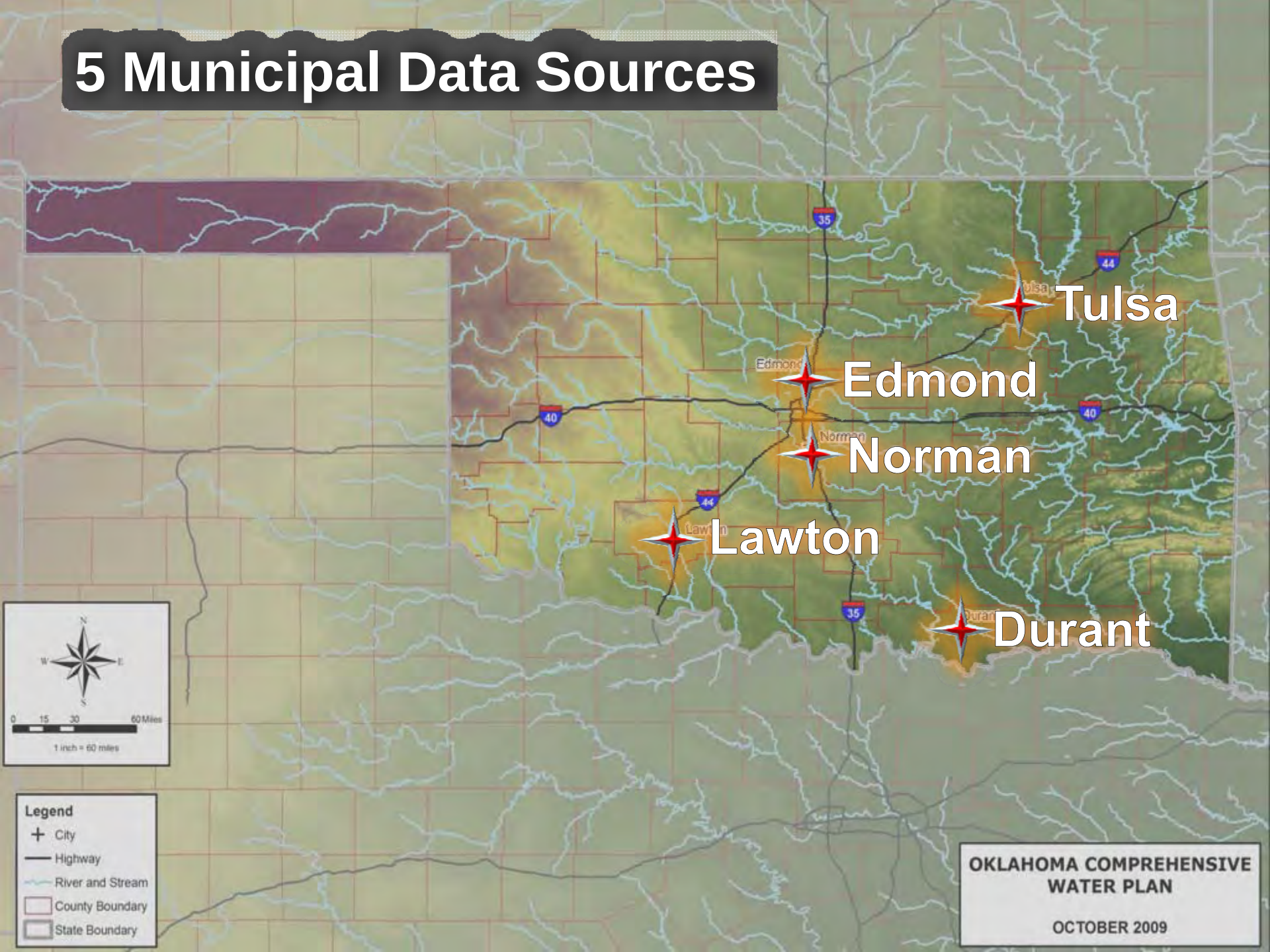
# Climate Demand Model

- How do municipal demands react to weather?
- Regression analysis of historical water use and weather data
- Applicable to short or long-term variability



# 5 Municipal Data Sources



*Baseline Inputs*

| | |
|---|---|
| Annual Demand (AFY) | 3000 |
| Monthly Demand Distribution Pattern | manual |

*Climate Inputs*

| | |
|---|---|
| Historical Avg Max Daily Temperature (°F) | manual |
| Historical Avg Monthly Precipitation (in) | manual |
| Avg Max Daily Temperature Change (°F) | 1.0 |
| Avg Monthly Precipitation Change (%) | -5 |

**OCWP Climate Demand Model**

Calculate

| | Baseline Demand | | | Baseline Climate | | Modified Climate | | Modified Demand | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | (AF) | (MG) | (MGD) | Historical Avg. Max. Daily Temp. (° F) | Historical Avg Monthly Precip. (in.) | Projected Avg. Max. Daily Temp. (° F) | Projected Avg. Monthly Precip. (in.) | (AF) | (MG) | (MGD) | % Change |
| Jan | 197.4 | 64.3 | 2.075 | 52.5 | 1.7 | 57.5 | 1.7 | 201.9 | 65.8 | 2.123 | 2% |
| Feb | 178.1 | 58.0 | 2.073 | 55.0 | 1.4 | 60.0 | 1.4 | 178.1 | 58.0 | 2.073 | 0% |
| Mar | 204.0 | 66.5 | 2.145 | 64.8 | 3.2 | 69.8 | 3.2 | 204.0 | 66.5 | 2.145 | 0% |
| Apr | 223.5 | 72.8 | 2.427 | 74.5 | 4.2 | 79.5 | 4.2 | 236.9 | 77.2 | 2.573 | 6% |
| May | 259.1 | 84.4 | 2.723 | 82.0 | 5.6 | 87.0 | 5.6 | 259.1 | 84.4 | 2.723 | 0% |
| Jun | 284.0 | 92.5 | 3.085 | 89.4 | 5.8 | 94.4 | 5.8 | 304.5 | 99.2 | 3.307 | 7% |
| Jul | 356.7 | 116.2 | 3.749 | 94.9 | 3.7 | 99.9 | 3.7 | 421.7 | 137.4 | 4.433 | 18% |
| Aug | 354.4 | 115.5 | 3.725 | 94.4 | 3.2 | 99.4 | 3.2 | 411.8 | 134.2 | 4.328 | 16% |
| Sep | 284.6 | 92.7 | 3.091 | 85.1 | 4.2 | 90.1 | 4.2 | 317.6 | 103.5 | 3.449 | 12% |
| Oct | 249.2 | 81.2 | 2.619 | 76.5 | 3.8 | 81.5 | 3.8 | 249.2 | 81.2 | 2.619 | 0% |
| Nov | 208.6 | 68.0 | 2.266 | 64.9 | 2.4 | 69.9 | 2.4 | 208.6 | 68.0 | 2.266 | 0% |
| Dec | 200.3 | 65.2 | 2.105 | 55.2 | 2.4 | 60.2 | 2.4 | 200.3 | 65.2 | 2.105 | 0% |
| Annual Total | 3000 | 977.5 | 2.678 | 74.1 | 41.3 | 79.1 | 41.3 | 3193.7 | 1040.6 | 2.845 | 6% |

# Input Baseline Conditions

***Baseline Inputs***

**Annual Demand (AFY)** 3000

**Monthly Demand Distribution Pattern** manual

Durant
Edmond
Lawton
Norman
Tulsa
manual

**OCWP Climate Demand Model**

# Input Test Scenario Conditions

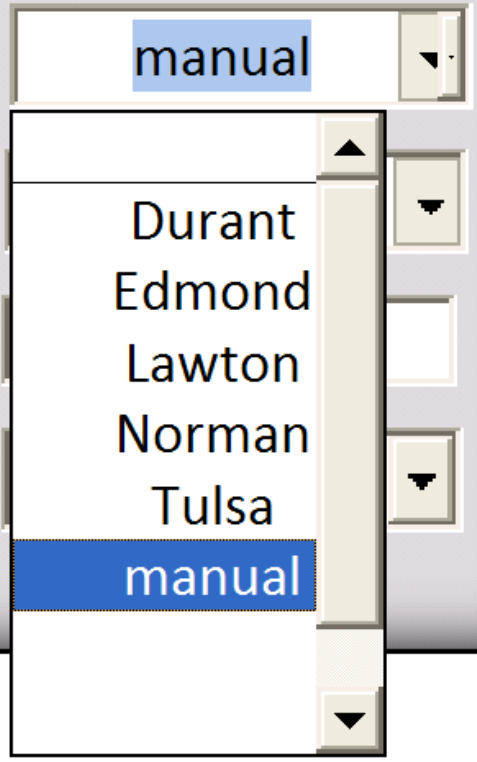
*Climate Inputs*

**Historical Avg Max Daily Temperature (°F)**

**Historical Avg Monthly Precipitation (in)**

**Avg Max Daily Temperature Change (°F)**

**Avg Monthly Precipitation Change (%)**



# Input Test Scenario Conditions

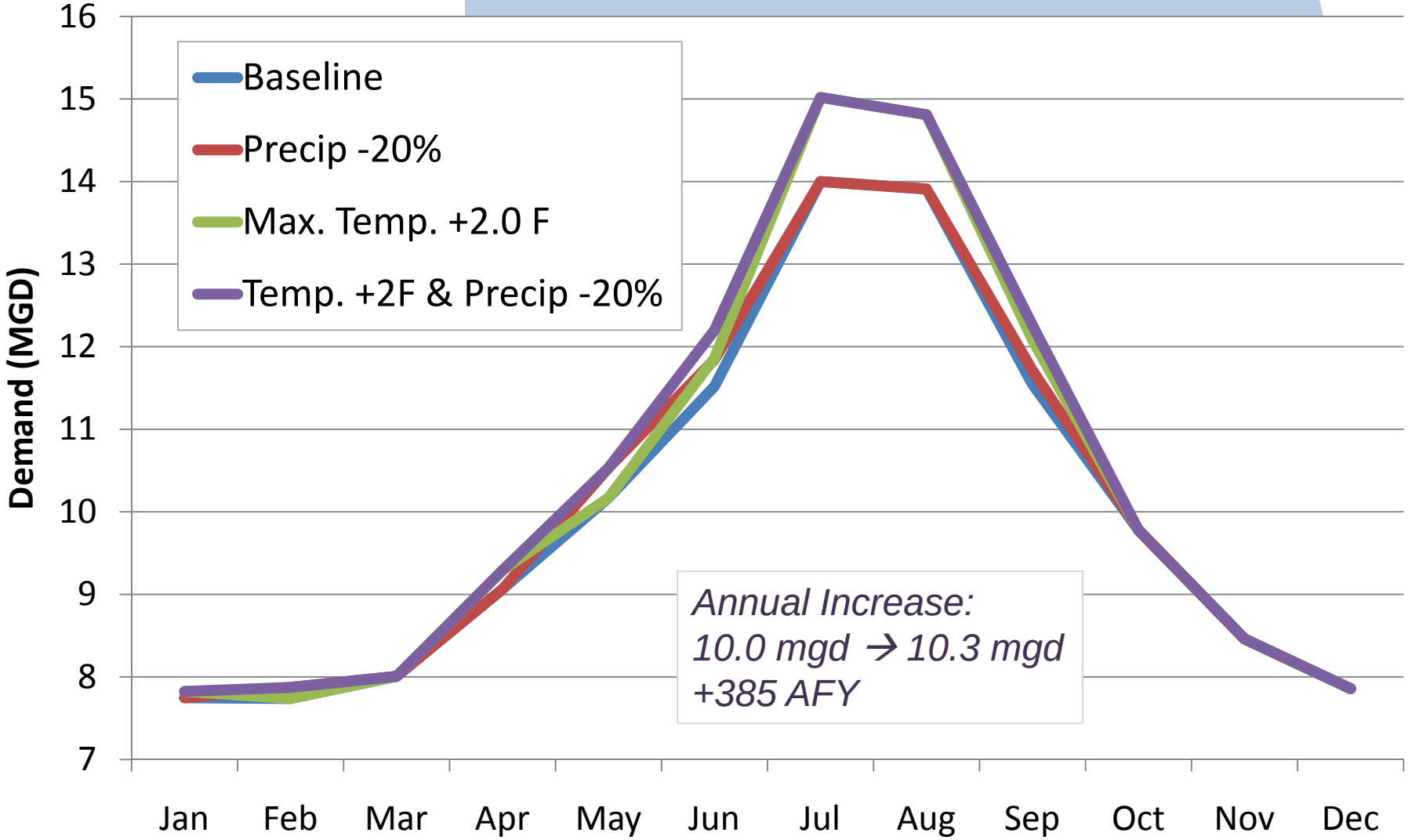
*Climate Inputs*

| | |
|---|---|
| **Historical Avg Max Daily Temperature (°F)** | manual |
| **Historical Avg Monthly Precipitation (in)** | manual |
| **Avg Max Daily Temperature Change (°F)** | 0.5 |
| **Avg Monthly Precipitation Change (%)** | -5 |

# Tabulation of Output

| | Modified Climate | | Modified Demand | | | |
|---|---|---|---|---|---|---|
| Month | Projected Avg. Max. Daily Temp. (° F) | Projected Avg. Monthly Precip. (in.) | (AF) | (MG) | (MGD) | % Change |
| Jan | 51.0 | 1.3 | 199.4 | 65.0 | 2.096 | 1% |
| Feb | 56.0 | 1.6 | 179.6 | 58.5 | 2.089 | 1% |
| Mar | 63.8 | 3.0 | 204.0 | 66.5 | 2.145 | 0% |
| Apr | 73.3 | 2.6 | 229.1 | 74.7 | 2.488 | 3% |
| May | 80.7 | 4.2 | 263.4 | 85.8 | 2.769 | 2% |
| Jun | 88.0 | 4.2 | 296.4 | 96.6 | 3.219 | 4% |
| Jul | 93.9 | 2.6 | 382.7 | 124.7 | 4.022 | 7% |
| Aug | 93.6 | 2.6 | 377.4 | 123.0 | 3.966 | 6% |
| Sep | 85.1 | 3.0 | 300.0 | 97.7 | 3.258 | 5% |
| Oct | 75.2 | 2.7 | 249.2 | 81.2 | 2.619 | 0% |
| Nov | 61.4 | 2.3 | 208.6 | 68.0 | 2.266 | 0% |
| Dec | 52.0 | 2.0 | 200.3 | 65.2 | 2.105 | 0% |
| Annual Total | 72.8 | 32.3 | 3090.0 | 1006.8 | 2.754 | 3% |

# Example Implications



# Presentation Overview

- Results from 2008 Public Water Provider Survey
- Three Key Planning Tools Developed for the OCWP
  - *Supply/Demand Gap Tool*
  - *Reservoir Yield Model*
  - *Climate Demand Model*
- Other Ongoing OCWP Technical Studies

# On-Going and Upcoming Technical Studies

- Legislative Work Groups –
  Aquifer Recharge & Marginal Quality Water
- Environmental Flows – Oklahoma and Western States' programs and Work Group Dialogue
- Water Allocation Modeling
- Reservoir Site Inventory
- Updating Costs for East-West Pipeline
- Potential Climate Variability Implications
- Legal, Infrastructure, and Water Quality Assessments
- Basin Supply Fact Sheets and Regional Supply Assessments

Oklahoma Comprehensive Water Plan

OCWP

# Technical Studies Update:
# OCWP Planning Tools for Now and the Future

**John Rehring – CDM**

*Oklahoma Governor's Water Conference*
*November 4, 2009*
*Midwest City, Oklahoma*

State of Oklahoma OWRB Water Resources Board the water agency

US Army Corps of Engineers

CDM