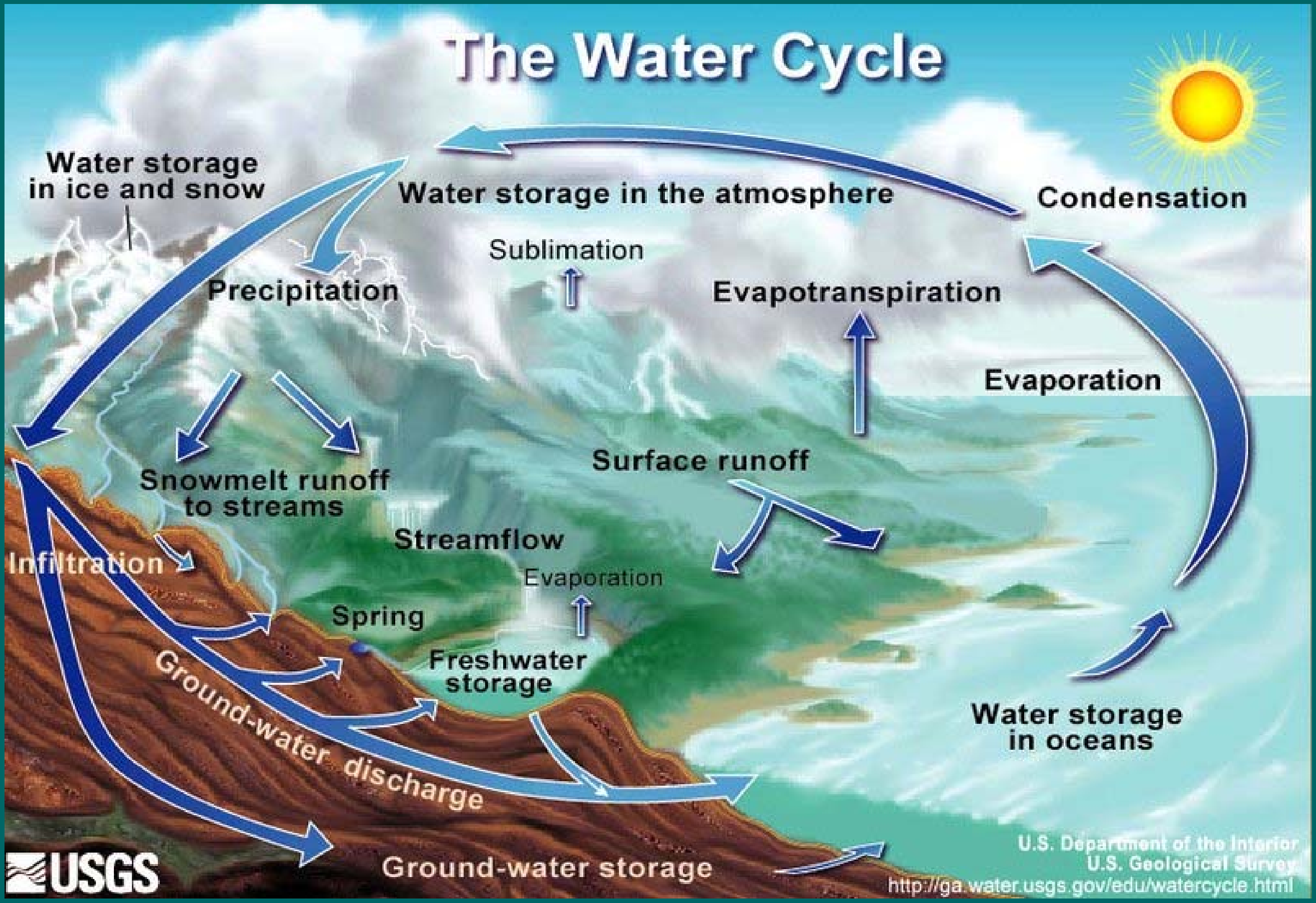
# *Oklahoma Water Resources Board*

## *Water Availability Determinations*

**Robert Fabian – Technical Section**
**OWRB Planning & Management Division**

# Hydrologic Cycle




# Overview
# *Oklahoma Groundwater Law*

- Groundwater is considered <u>private property</u> that belongs to the overlying surface owner, although it is subject to reasonable regulation:
  - The amount of groundwater apportioned is based upon the amount of land owned, generally 2 acre-feet of water per acre of land.

# Overview Oklahoma Groundwater Law

- To Obtain a Permit to Use Groundwater in Oklahoma an Applicant Needs to Establish:
  - That they own or lease the land surface
  - The land overlies a fresh groundwater basin
  - The proposed use is beneficial
  - Waste will not occur

# Overview
# *Oklahoma Stream Water Law*

- Stream water is considered to be <u>publicly-owned</u> and subject to appropriation:
  - "First in time, first in right": first person to apply for the water right establishes a right superior to later appropriators.

# Overview
# Oklahoma Stream Water Law

- Beneficial use is a key consideration.
- Another is avoiding speculation (after permit issued). This accomplished by various means, but primarily through forfeiture due to non-use.
  - Use-it-or-lose-it (7-year default):
    - requires full use of the annually authorized amount within 7 years of permit issuance and at least once in any continuous 7-year period thereafter;
    - Schedule of Use (exception for large projects) allows phased-in use over a specified period of time (lose if fail to keep schedule).

# Oklahoma's Water Resources

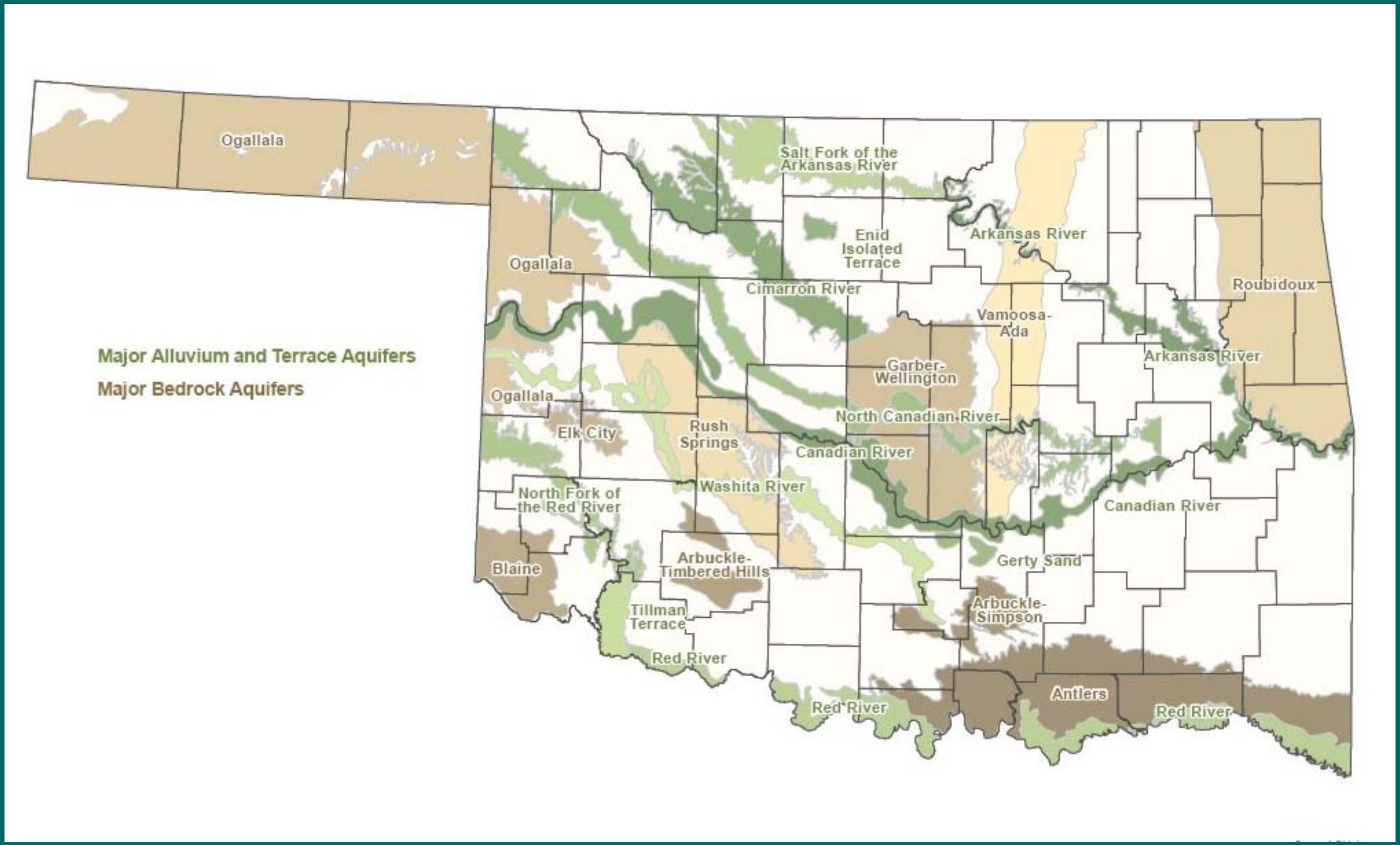
- 10,662 groundwater permits:
  - allocate 3.49 million ac-ft/year
- 2,360 stream water use permits:
  - appropriate 2.73 million ac-ft/year

# Oklahoma's Water Resources

- Irrigation is the #1 use of water in Oklahoma:
  - Irrigation accounts for 49 percent of total withdrawals:
    - water supply = 32 percent
    - stock watering = 8 percent
  - Irrigation accounts for 80 percent of groundwater withdrawals.

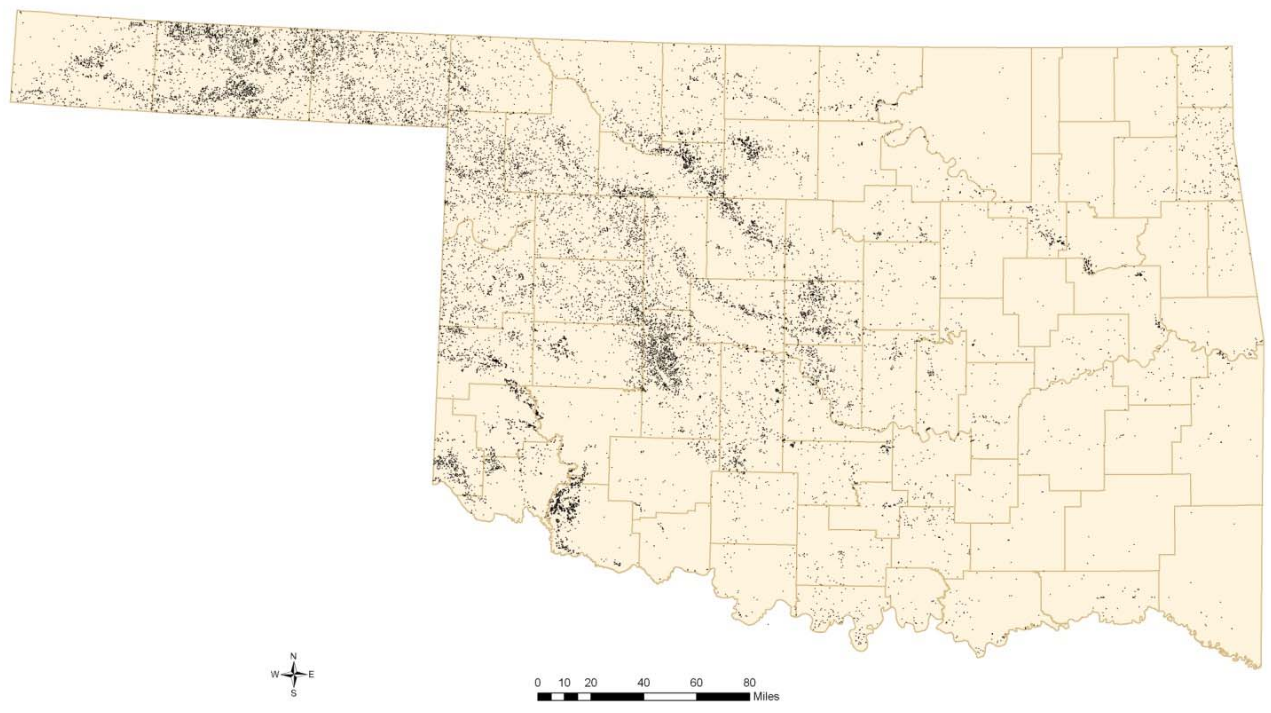
# Oklahoma's Water Resources

- 23 major groundwater aquifers store an estimated 320 million acre-feet of water



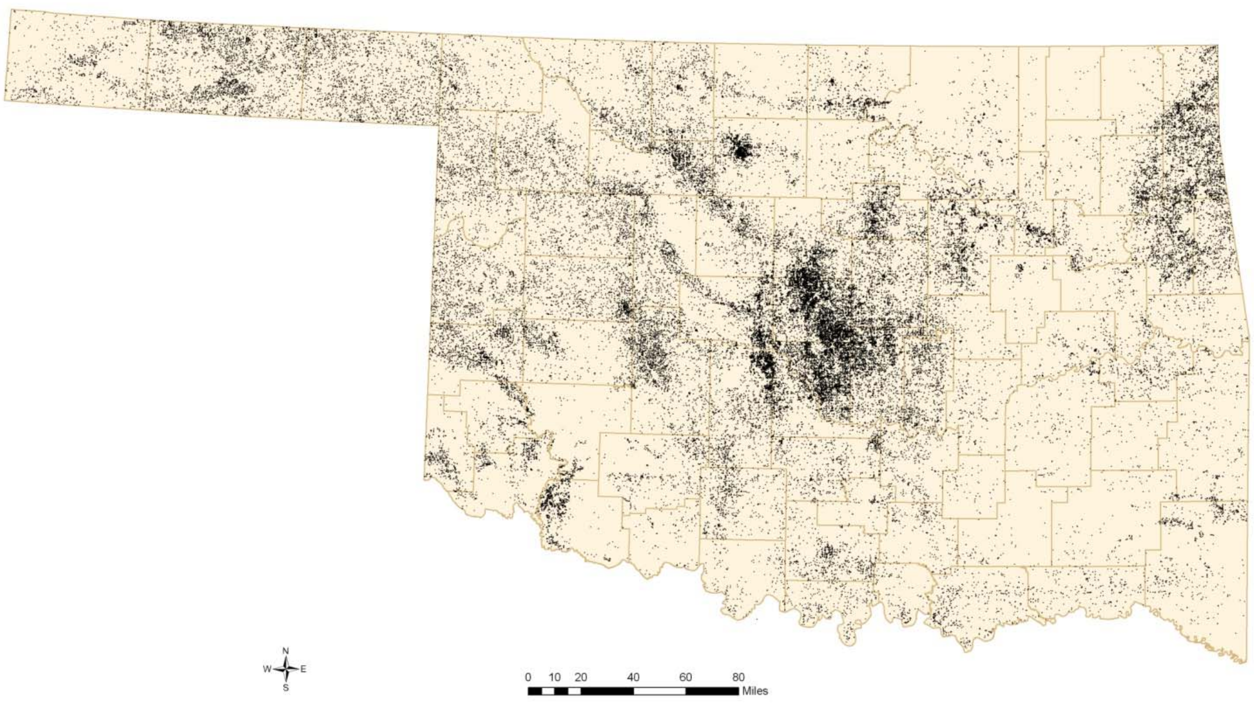
# Groundwater Wells

| Well USE (GW) | No. of Wells |
|---|---|
| Agriculture (non-irr) | 2,747 |
| Commercial | 300 |
| Industrial | 5,005 |
| Institutional | 59 |
| Irrigation | 9,193 |
| Mining | 1,345 |
| Power | 60 |
| Public Water Supply | 2,176 |
| Other | 2,561 |
| **TOTAL** | **23,446** |




***Water Well Log Database***

# Groundwater Wells




***Water Well Log Database***

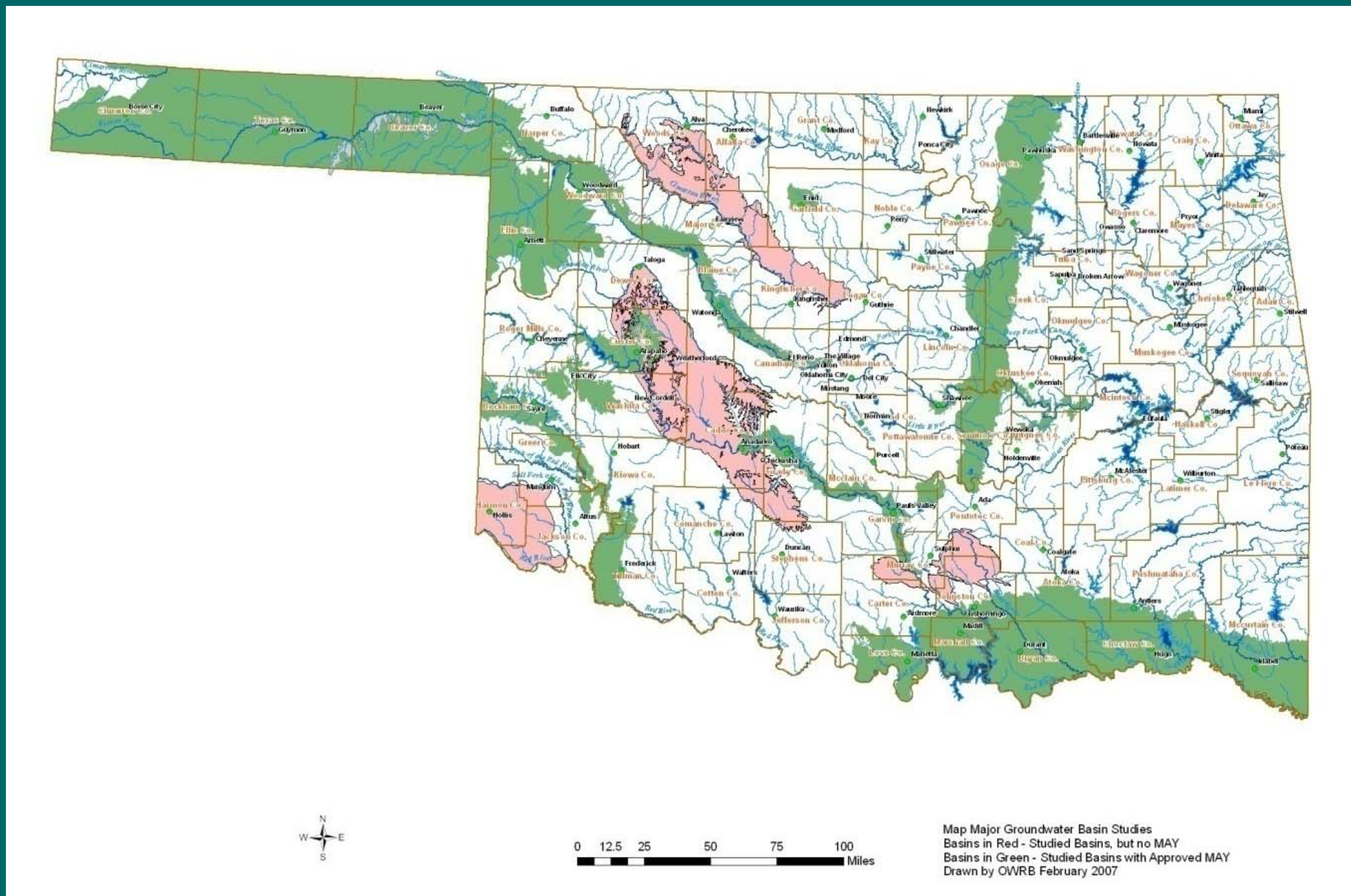
| Well USE (GW) | No. of Wells |
|---|---|
| Agriculture (non-irr) | 2,747 |
| Commercial | 300 |
| Industrial | 5,005 |
| Institutional | 59 |
| Irrigation | 9,193 |
| Mining | 1,345 |
| Power | 60 |
| Public Water Supply | 2,176 |
| Other | 2,561 |
| Domestic | 53,100 |
| **TOTAL** | **76,546** |

# Overview
# Oklahoma Groundwater Law

- The amount of groundwater apportioned is based upon the amount of land owned. For unstudied aquifer that is generally two acre-feet of water per acre of land:

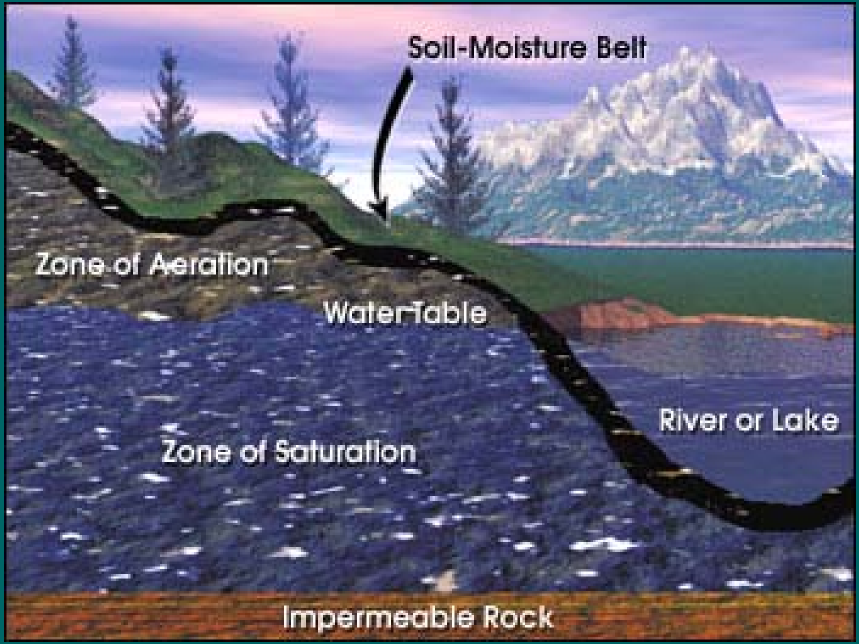
- Once a hydrologic survey is completed for a groundwater basin the maximum annual yield is determined.  The amount of the equal proportionate share is typically the same or less than the non-studied basins.

# Groundwater Studies

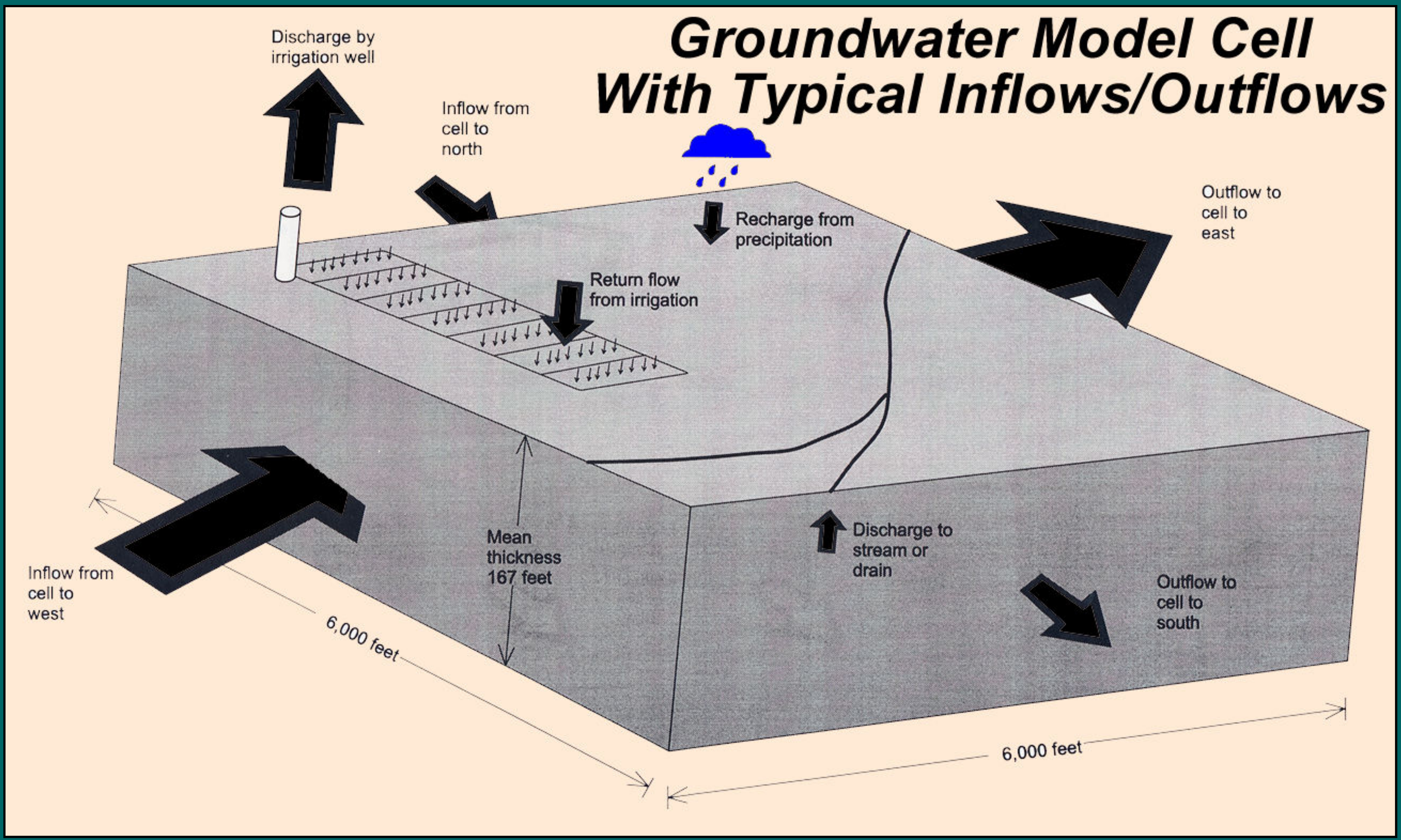


# Groundwater Studies Major Basins

- Total Land Area Overlying the Basin
- Amount of Water in Storage
- Rate of Recharge
- Transmissivity of the Basin
- Possibility of Pollution of the Basin from Natural Sources
- Determination of Maximum Annual Yield



# Groundwater Flow Models



# What is a Groundwater Flow Model?

- Attempts to represent the hydrologic system by means of a mathematical simulation:
  - Simulates groundwater flow in the aquifer.
  - Accounts for the most important features of the hydrologic system:
    - groundwater recharge/withdrawals
    - aquifer physical & hydrologic characteristics
    - groundwater and stream water interactions
  - Outputs include calculated groundwater levels for the aquifer and flow rates in streams.
- The goal is to obtain an understanding of the cause and effect relations of a particular hydrologic system.

# Why Do We Use Groundwater Models?

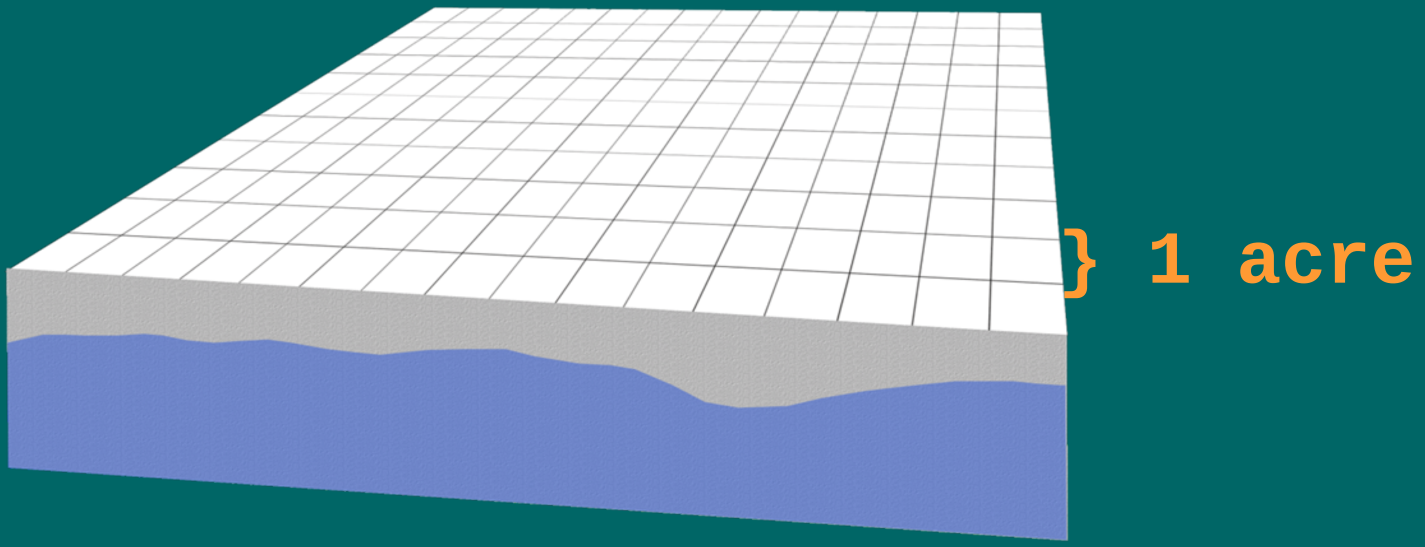
- Models can be used to provide a basis for simulation of water-management options and possible future conditions.
- They are an essential tool that provides critical information needed by resource managers to help formulate policy and to make sound management decisions.

# Maximum Annual Yield Determinations

- Maximum annual yield
  - Total amount of fresh groundwater that can be produced annually from the groundwater basin.

# Equal Proportionate Share Determinations

- Equal Proportionate Share
  - The maximum annual yield is allocated proportionately to each acre of land overlying the basin.

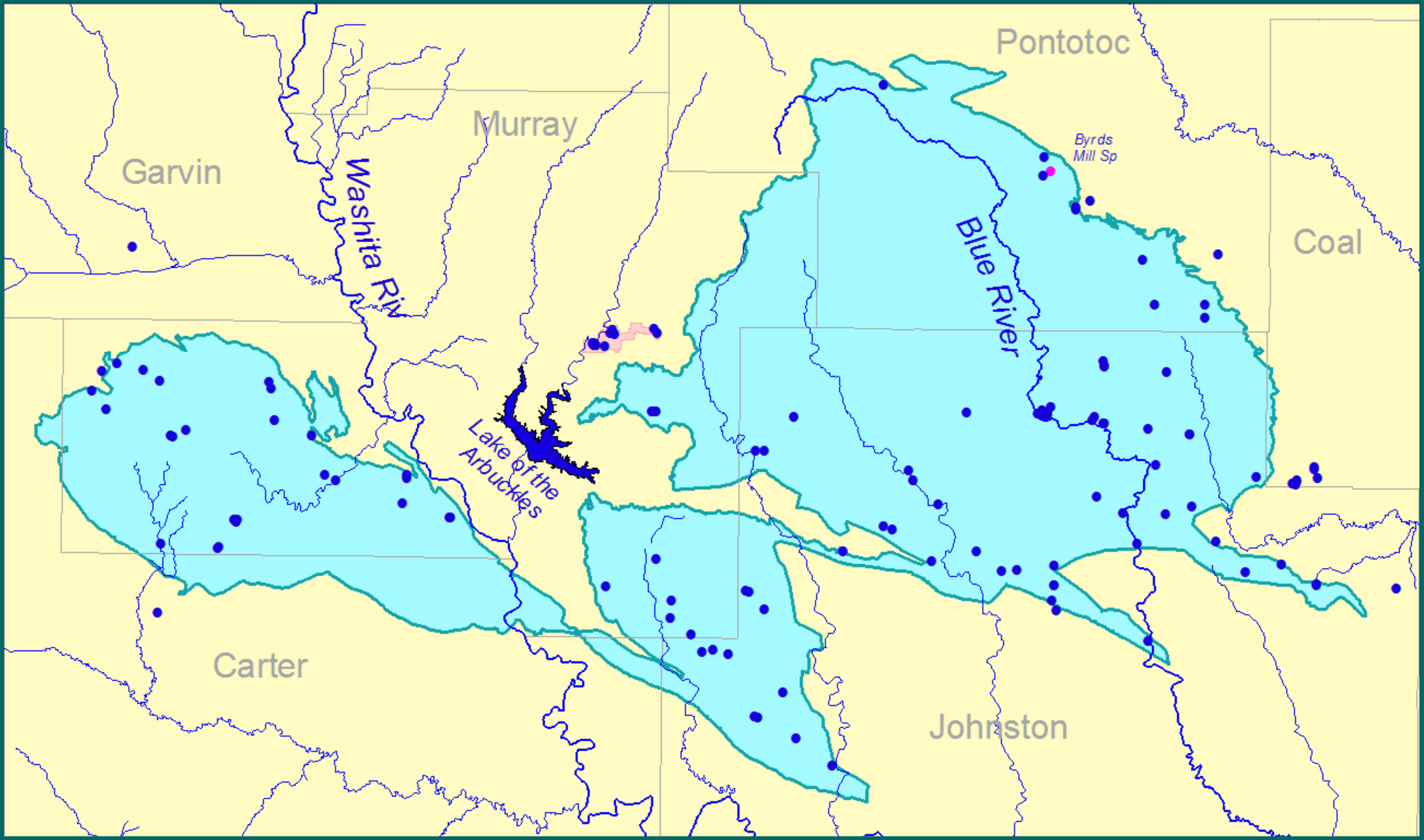


# Maximum Annual Yields

## Major Groundwater Basins

| Groundwater Basin | Date of Final Order | EPS | MAY |
|---|---|---|---|
| Tillman Terrace | 12/12/1978 | 1 | 189,760 |
| North Fork of Red River A&T | 09/08/1981 | 1 | 343,042 |
| Elk City Sandstone | 11/09/1982 | 0.5 | 26,000 |
| Enid Isolated Terrace | 11/09/1982 | 1 | 157,440 |
| North Canadian River A&T – Phase 1 | 08/08/1983 | 1 | 426,000 |
| Gerty Sand Isolated Terrace | 09/12/1989 | 0.65 | 28,112 |
| North Canadian River A&T – Phase 2 | 04/10/1990 | 1 | 211,840 |
| Washita River A&T – Reach 1 | 11/13/1990 | 2 | 120,320 |
| Washita River A&T – Reach 4 | 11/13/1990 | 1.5 | 81,840 |
| Washita River A&T – Reach 3 | 11/13/1990 | 1 | 46,935 |
| Vamoosa-Ada | 05/06/1991 | 2 | 2,968,000 |
| North Canadian River A&T – Phase 3A | 02/14/1995 | 0.8 | 48,128 |
| North Canadian River A&T – Phase 3B | 02/14/1995 | 1.3 | 138,944 |
| Antlers Sandstone | 02/14/1995 | 2.1 | 5,913,600 |
| Ogallala –Northwest Region | 03/12/2002 | 1.4 | 1,198,512 |
| Ogallala – Panhandle Region | 03/12/2002 | 2 | 2,285,212 |

# Arbuckle Simpson Aquifer
## A New Approach



# *Arbuckle Simpson Aquifer*
## *A New Approach*

- Approve a <u>maximum annual yield</u> that will not reduce the natural flow of water from springs or streams emanating from the basin (SB288).

- Emphasis changed to managing groundwater withdrawals to protect stream flows for Sole Source Aquifers.

# Groundwater Studies
## Minor Basins

- Present and Reasonably Foreseeable Future Use In The Basin
- Total Recharge and Total Discharge
- Geographical Region
- Other Relevant Factors (i.e., area of basin, transmissivity, storage)
- Determination of Maximum Annual Yield

# Groundwater Studies
## Minor Basins

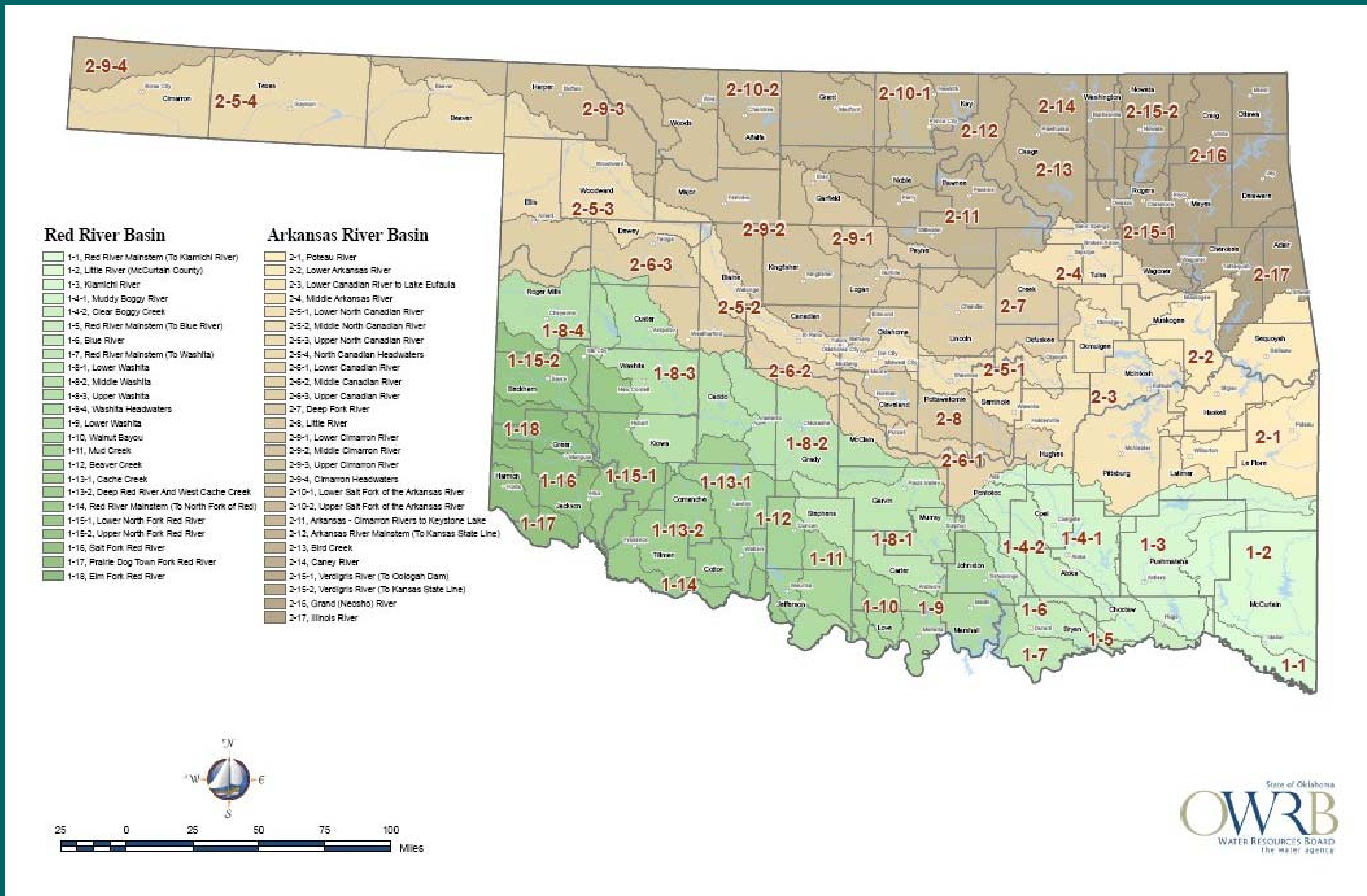
- Present and Reasonably Foreseeable Future Use In The Basin
- Total Recharge and Total Discharge
- Geographical Region
- Other Relevant Factors (i.e., area of basin, transmissivity, storage)
- Determination of Maximum Annual Yield

# Maximum Annual Yields

## Minor Groundwater Basins

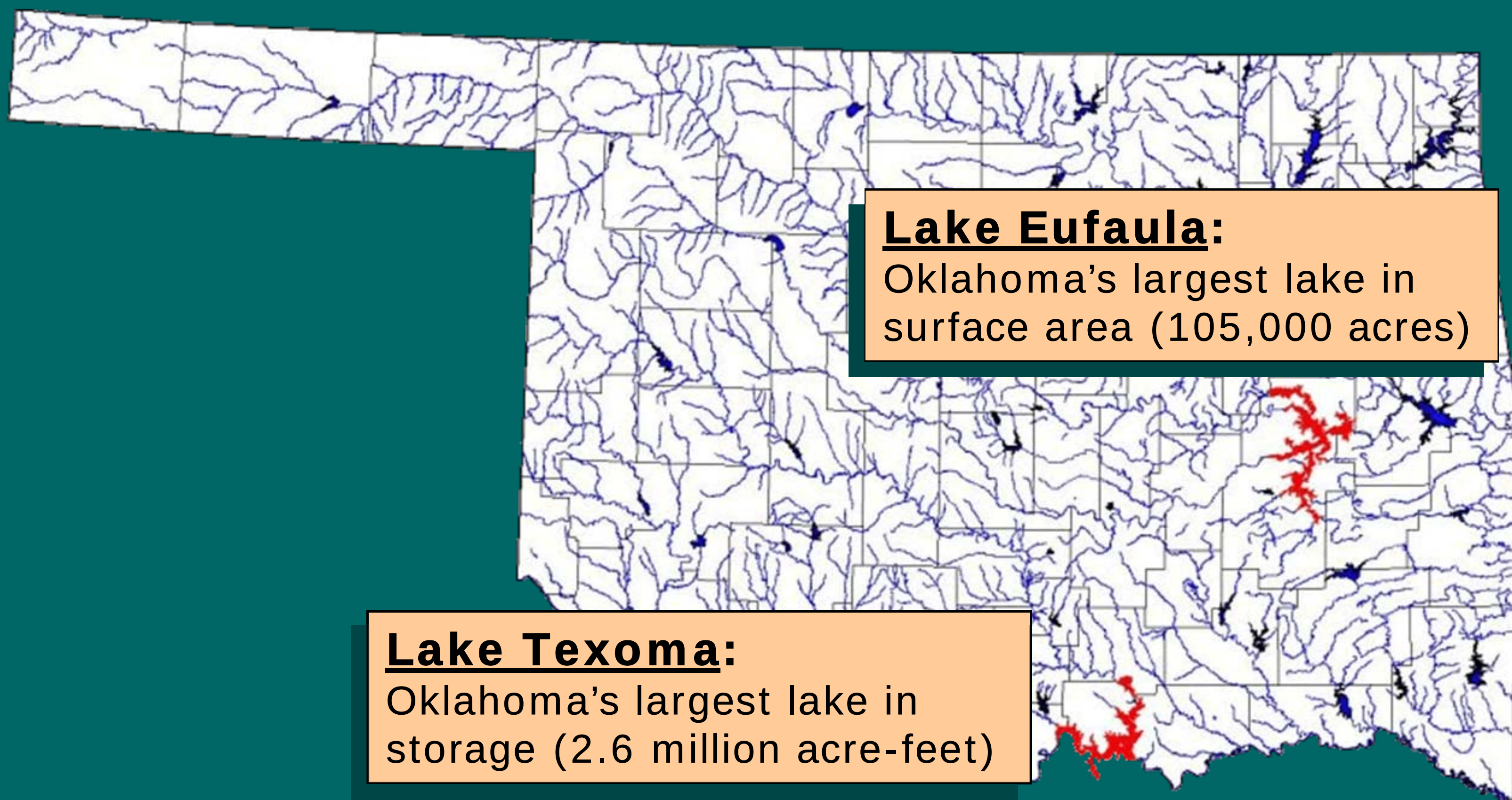
| Groundwater Basin | Date of Final Order | EPS | MAY |
|---|---|---|---|
| Beaver Creek A&T | 06/13/2000 | 1 | 18,662 |
| Hennessey-Garber | 06/13/2000 | 1.6 | 550,400 |
| Post Oak | 06/13/2000 | 2 | 42,560 |
| Cache Creek A&T | 07/11/2000 | 1 | 92,435 |
| Haworth Isolated Terrace – Region 1 | 01/09/2001 | 1 | 8,979 |
| Haworth Isolated Terrace – Region 2 | 01/09/2001 | 1 | 6,885 |
| Little River A&T | 02/13/2001 | 1 | 87,680 |
| | | | |

# Stream Systems in Oklahoma



# ***Oklahoma's Lakes***

- 34 major reservoirs store 13 million acre-feet of water



# Overview
# Oklahoma Stream Water Law

- Five Points of Stream Water Law:
  - unappropriated water is available in amount applied for;
  - there is a present or future need for the water:
  - the use is beneficial;
  - use will not interfere with domestic or existing uses; and,
  - use will not interfere with uses within stream system of origin.

# Hydrologic Investigations

- Is there unappropriated water available in the amount applied for by the applicant?
  - Is there available water within the stream system?
    - Available water within the stream system in question has historically been determined by conducting hydrologic investigations on the stream systems.
    - Recently have begun utilizing stream water allocation modeling.

# Hydrologic Investigations

STREAM SYSTEM 1-6 : BLUE RIVER BASIN

**General Information**

Stream system area - 678 mi$^2$
Hydrologic Unit Code -

| | |
|---|---|
| 1114 0102 010 | 113 mi$^2$ |
| 1114 0102 020 | 205 mi$^2$ |
| 1114 0102 030 | 360 mi$^2$ |

Stream system area - 678 mi$^2$
Major tributaries - Sandy Creek, Caddo Creek, Bokchito Creek
Mean annual runoff based on adjusted gage flow - 9.65 inches
Mean annual net lake evaporation for stream system - 10 inches
Estimated reservoir refill factor ($\alpha$) for stream system - 1.8

**Estimated Available Water**

USGS gage 07332500 Blue River near Blue, OK
Gauge Location: Between Sec 27 and Sec.36, -T6S-R10EIM, Bryan County - 476 mi$^2$ drainage area
Water years 1936 through 1996:
Mean annual gage flow - 325 cfs; 235,352 acre-feet/year
Mean annual gage flow adjusted for upstream water use - 245,112 acre-feet/year
Mean annual runoff for 202 mi$^2$ below USGS gage - 104,018 acre-feet/year

**Total Estimated Available Water - 349,130 acre-feet/year**

**Table of monthly mean flows (acre-feet) from USGS gage 07332500 (WY 1936-1996)**

| Month | Acre-feet | Month | Acre-feet | Month | Acre-feet | Month | Acre-feet |
|---|---|---|---|---|---|---|---|
| January | 13,592 | April | 34,938 | July | 9,410 | October | 14,884 |
| February | 20,665 | May | 40,839 | August | 4,945 | November | 15,237 |
| March | 28,230 | June | 26,605 | September | 9,940 | December | 15,807 |

**Total Estimated Available Water - 349,130 acre-feet/year**
**Total Estimated Storage/Dependable Yields - 0 acre-feet/year**
**Adjusted Total Estimated Available Water - 349,130 acre-feet/year**

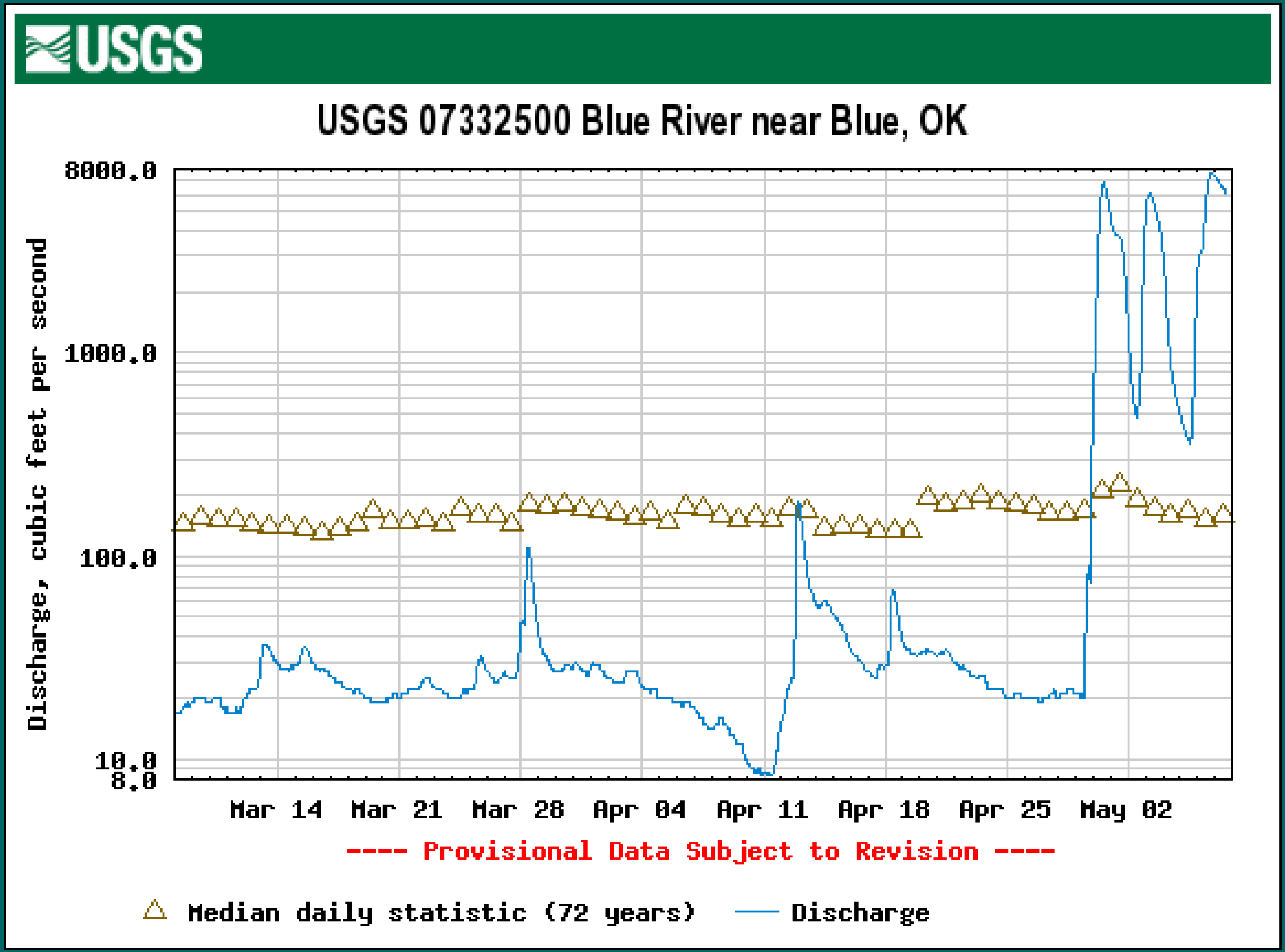
| Watershed Code | Area | Adjusted Total Estimated Available Water |
|---|---|---|
| 1114 0102 010 | 113 mi$^2$ | 58,188.33 acre-feet/year |
| 1114 0102 020 | 205 mi$^2$ | 105,562.9 acre-feet/year |
| 1114 0102 030 | 360 mi$^2$ | 185,378.8 acre-feet/year |

1998 Hydrologic Investigation Report

| Total Available Stream Water | HUC10 Watershed | HUC12 Sub-watershed | Low Flow Season (June-Oct.) | High Flow Season (Nov.-May) | Total (Annual) |
|---|---|---|---|---|---|
| **1-6 Blue River** | | | **91,200** | **252,300** | **343,500** |
| Upper Blue River Watershed | 1114010201 | | 47,800 | 122,500 | 170,200 |
| Limestone Creek - Blue River | | 111401020101 | 2,700 | 6,100 | 8,800 |
| West Little Blue Creek | | 111401020102 | 3,100 | 7,200 | 10,300 |
| 111403030103 - Blue River | | 111401020103 | 2,300 | 5,300 | 7,500 |
| Little Blue Creek - Blue River | | 111401020104 | 8,600 | 19,500 | 28,000 |
| Pecan Creek - Blue River | | 111401020105 | 6,100 | 14,000 | 20,100 |
| Desperado Spring Falls - Blue River | | 111401020106 | 8,300 | 18,100 | 26,400 |
| Sandy Creek | | 111401020107 | 4,900 | 15,900 | 20,800 |
| Little Sandy Creek - Blue River | | 111401020108 | 3,900 | 10,600 | 14,500 |
| Reeder Creek - Blue River | | 111401020109 | 3,900 | 12,700 | 16,600 |
| Bois d' Arc Creek - Blue River | | 111401020110 | 4,100 | 13,000 | 17,100 |
| Lower Blue River Watershed | 1114010202 | | 43,400 | 129,800 | 173,300 |
| Mineral Bayou | | 111401020201 | 5,600 | 15,700 | 21,400 |
| Little Blue River - Blue River | | 111401020202 | 6,200 | 15,800 | 22,000 |
| Kanola Creek - Blue River | | 111401020203 | 4,700 | 15,300 | 20,000 |
| Caddo Creek | | 111401020204 | 5,000 | 16,300 | 21,300 |
| J&N Creek - Blue River | | 111401020205 | 4,800 | 14,100 | 18,900 |
| Bokehito Creek | | 111401020206 | 4,400 | 14,300 | 18,700 |
| Sulphur Creek | | 111401020207 | 3,700 | 12,200 | 15,900 |
| Cherokee Lake - Blue River | | 111401020208 | 4,200 | 12,500 | 16,600 |
| Lower Blue River | | 111401020209 | 4,800 | 13,600 | 18,500 |

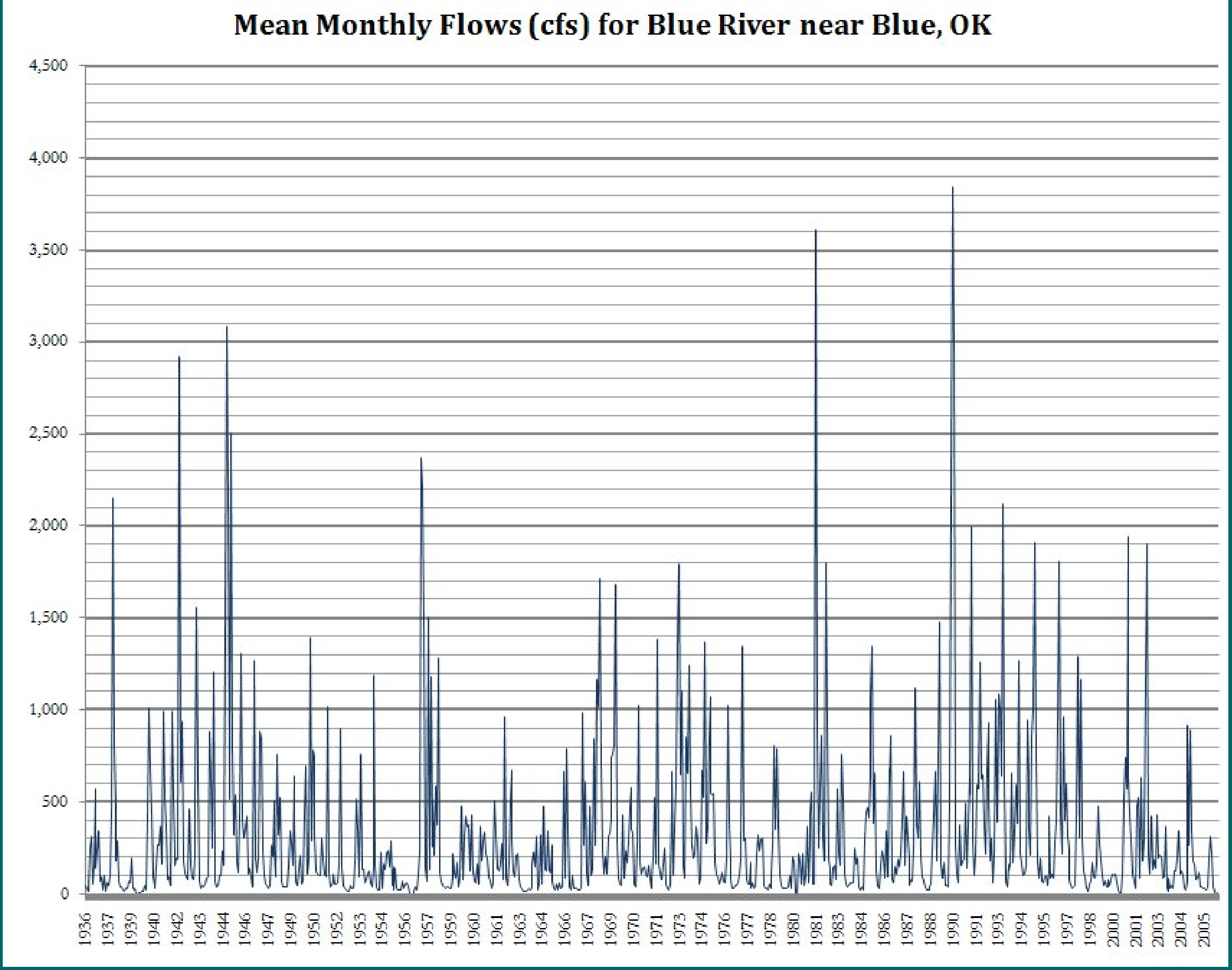
2009 Hydrologic Investigation Report

# Hydrologic Investigations
## Data Issues



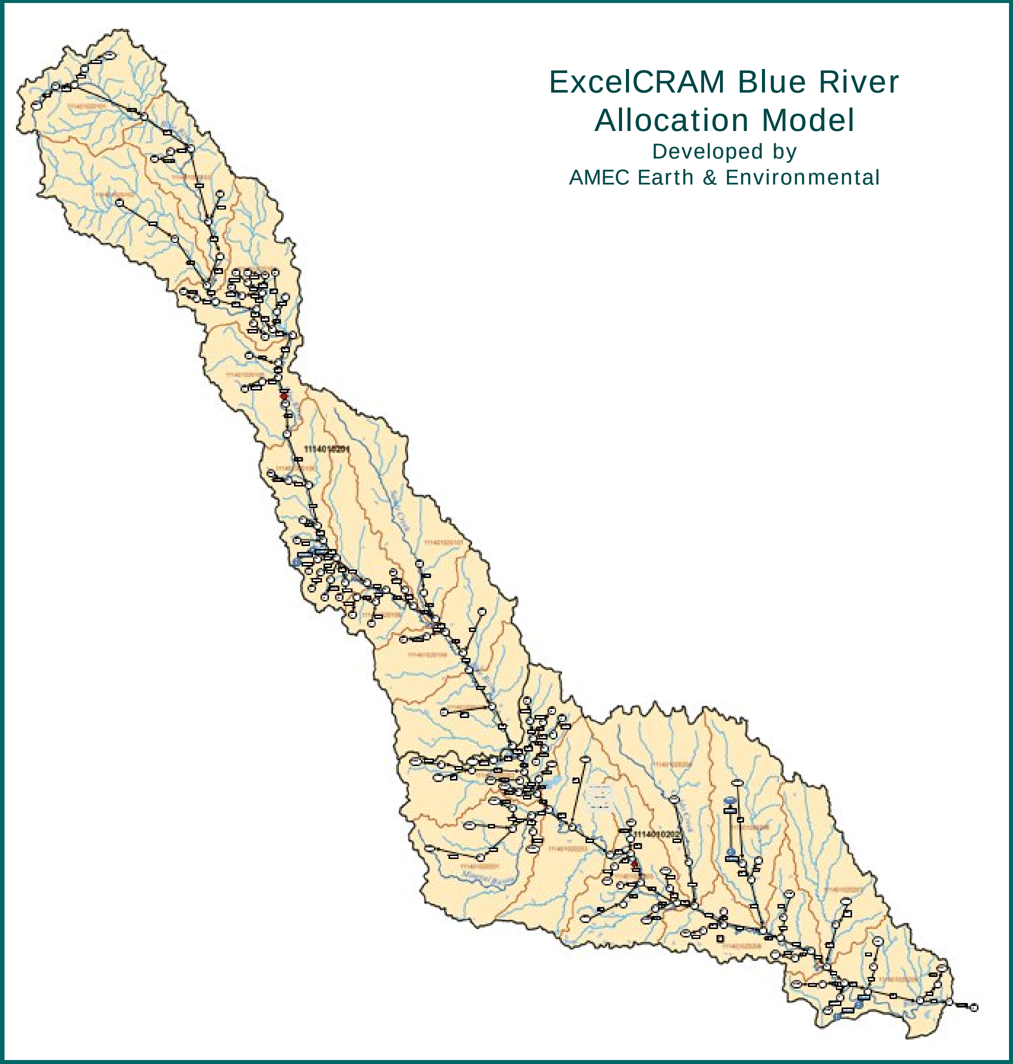
# Hydrologic Investigations

## Data Issues



# Stream Water Allocation Modeling

- Computer Construct of Blue River Stream System



# Allocation Modeling Data Needs

- Hydrologic Data
  - Stream gage data
  - Lake evaporation data
  - Change in lake levels
- Permit Information
  - Date water right was filed
  - Amount of water authorized
  - Beneficial use for water right
  - Reported water use of water right

# Network Schematic

# Demand Patterns

## Monthly Demands

*Because of the monthly timestep, demands are modeled as consumptive use, not as the amount diverted.*

**Demand Patterns (monthly %) - CHANGE ONLY IN THE INPUT CONTROLS SHEET!!!**

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation Pattern | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 25.00% | 29.20% | 29.20% | 16.70% | 0.00% | 0.00% | 0.00% |
| M & I Pattern | 7.30% | 7.30% | 7.30% | 9.10% | 9.10% | 10.90% | 10.90% | 10.90% | 9.10% | 7.30% | 5.50% | 5.50% |
| Other Pattern | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% | 8.33% |

**Consumptive use - CHANGE ONLY IN THE INPUT CONTROLS SHEET!!!**

| | |
|---|---|
| *Irrigation* | *70.00%* |
| *M&I* | *85.00%* |
| *Other* | *75.00%* |

**Consumptive Use Patterns (monthly %) - THESE ARE CALCULATED, DO NOT CHANGE!!!**

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation Pattern | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| M & I Pattern | 6.21% | 6.21% | 6.21% | 7.74% | 7.74% | 9.27% | 9.27% | 9.27% | 7.74% | 6.21% | 4.68% | 4.68% |
| Other Pattern | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% |

**RSFABIAN:**
Permit 19360076 is consumptive. Water is used for fish hatchery.

**Monthly consumptive use percent - CHANGE THESE FOR INDIVIDUAL PERMITS IF NEEDED**

| Demand Number | Permit # | Tot_acre_ft | Purpose | Entity Name | MI or IRR Pattern | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 19360076 | 6445 | Recreation, Fish, WL | Wildlife Conservation, Dept of | OTHER | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% |
| 14 | 19400050 | 1842 | Public Supply | Durant, City of | MI | 6.21% | 6.21% | 6.21% | 7.74% | 7.74% | 9.27% | 9.27% | 9.27% | 7.74% | 6.21% | 4.68% | 4.68% |
| 4 | 19660144 | 34 | Irrigation | Potter, Thomas G | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 23 | 19660587 | 66 | Irrigation | Durant Wholesale Nursery | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 40 | 19670320 | 25 | Agriculture | Woods, Bruce & Michele | OTHER | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% | 6.25% |
| 2 | 19710226 | 45 | Irrigation | Raney, Rick & Linda | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 3 | 19710253 | 25 | Irrigation | Calhoun, Clyde D | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 28 | 19710296 | 200 | Irrigation | McGlocklin, Bobby | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 43 | 19710362 | 12 | Industrial | Unimin Corporation | MI | 6.21% | 6.21% | 6.21% | 7.74% | 7.74% | 9.27% | 9.27% | 9.27% | 7.74% | 6.21% | 4.68% | 4.68% |
| 17 | 19710554 | 4500 | Public Supply | Durant, City of | MI | 6.21% | 6.21% | 6.21% | 7.74% | 7.74% | 9.27% | 9.27% | 9.27% | 7.74% | 6.21% | 4.68% | 4.68% |
| 45 | 19720166 | 10 | Irrigation | Gray, Odessa | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 24 | 19770025 | 639 | Public Supply | Rural Water, Sewer & SW Mgmt Dist#2 | MI | 6.21% | 6.21% | 6.21% | 7.74% | 7.74% | 9.27% | 9.27% | 9.27% | 7.74% | 6.21% | 4.68% | 4.68% |
| 37 | 19780104 | 129 | Irrigation | Duncan, Joe S | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 21 | 19780140 | 6000 | Public Supply | Durant, City of | MI | 6.21% | 6.21% | 6.21% | 7.74% | 7.74% | 9.27% | 9.27% | 9.27% | 7.74% | 6.21% | 4.68% | 4.68% |
| 16 | 19790054 | 300 | Public Supply | Rural Water, Sewer & SW Mgmt Dist#2 | MI | 6.21% | 6.21% | 6.21% | 7.74% | 7.74% | 9.27% | 9.27% | 9.27% | 7.74% | 6.21% | 4.68% | 4.68% |
| 29 | 19800180 | 320 | Irrigation | Murray State College | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 35 | 19800185 | 250 | Irrigation | Easterling, Eugene | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 22 | 19800190 | 56 | Irrigation | Durant Wholesale Nursery | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |
| 41 | 19810082 | 320 | Irrigation | Barnett, Walter L | IRR | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 17.50% | 20.44% | 20.44% | 11.69% | 0.00% | 0.00% | 0.00% |

# Outputs

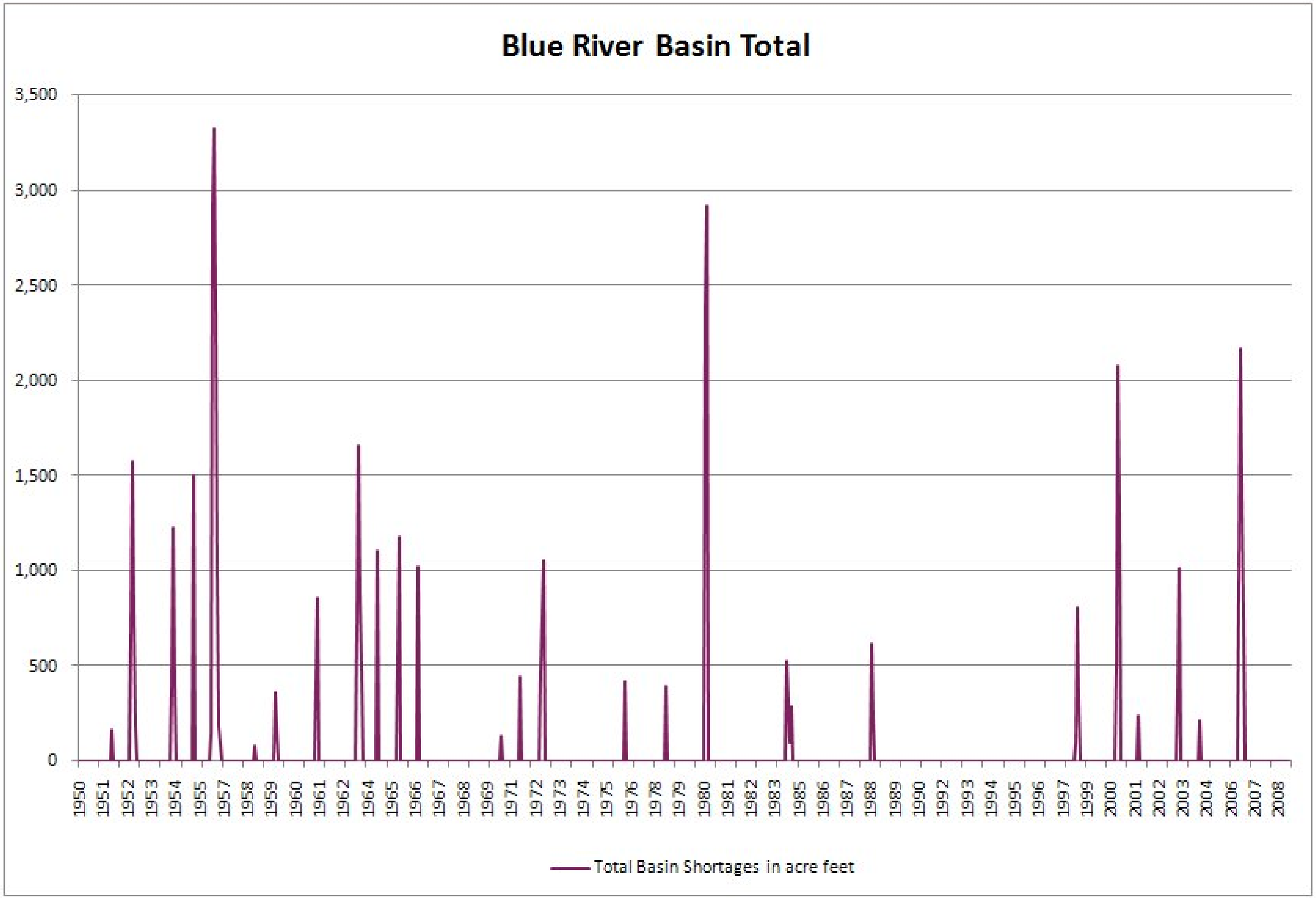
| | | | |
|---|---|---|---|
| Basin: | Blue River | Scenario | 2 |
| Station Name: | Total Basin Shortages in acre feet | | |
| Excel Model Element: | | | 0 |
| Run Comment: | | | 0 |
| Year Column: | 0 | | |
| Output Worksheet: | Blue River Basin Totals | | |
| Column Offset: | 5 | | |
| Title for Graph: | Total Basin Shortages in acre feet □0 | | |

**Total Basin Shortages in acre feet**

**Shortage in acre-feet**

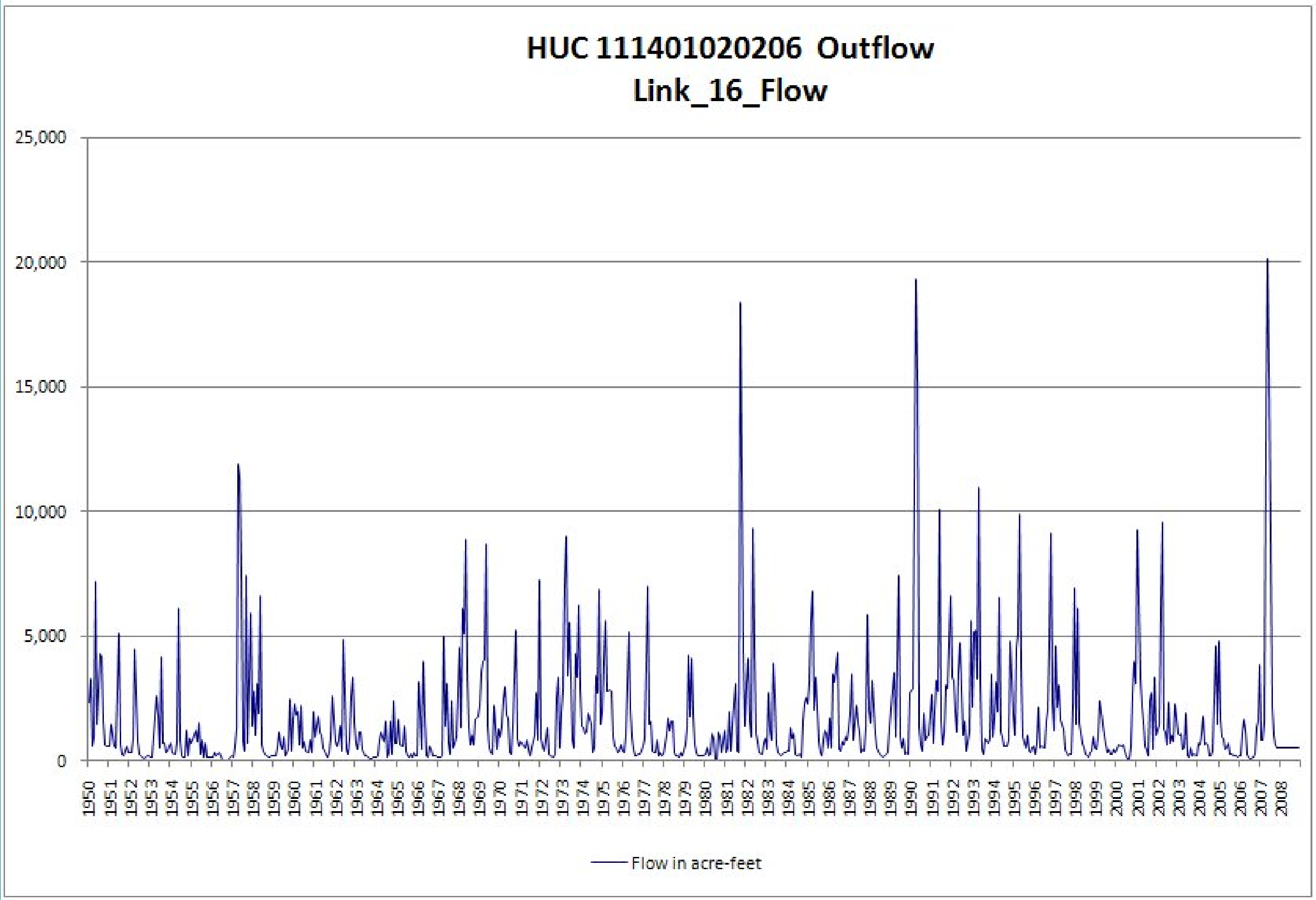
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1951 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 163 | 0 | 0 | 0 | 0 | 163 |
| 1952 | 0 | 0 | 0 | 0 | 0 | 0 | 666 | 1,575 | 774 | 179 | 0 | 0 | 3,194 |
| 1953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1954 | 0 | 0 | 0 | 0 | 0 | 0 | 388 | 1,229 | 391 | 0 | 0 | 0 | 2,008 |
| 1955 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,498 | 0 | 0 | 0 | 0 | 1,498 |
| 1956 | 0 | 0 | 0 | 0 | 0 | 137 | 2,939 | 3,323 | 2,368 | 961 | 181 | 0 | 9,909 |
| 1957 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1958 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 83 | 0 | 0 | 0 | 0 | 83 |
| 1959 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 366 | 0 | 0 | 0 | 0 | 366 |
| 1960 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1961 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 857 | 0 | 0 | 0 | 0 | 857 |
| 1962 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1963 | 0 | 0 | 0 | 0 | 0 | 0 | 719 | 1,660 | 877 | 481 | 0 | 0 | 3,737 |
| 1964 | 0 | 0 | 0 | 0 | 0 | 0 | 1,101 | 0 | 0 | 0 | 0 | 0 | 1,101 |
| 1965 | 0 | 0 | 0 | 0 | 0 | 0 | 564 | 1,178 | 0 | 0 | 0 | 0 | 1,742 |
| 1966 | 0 | 0 | 0 | 0 | 0 | 0 | 1,025 | 0 | 0 | 0 | 0 | 0 | 1,025 |
| 1967 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1968 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1969 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1970 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 132 | 0 | 0 | 0 | 0 | 132 |
| 1971 | 0 | 0 | 0 | 0 | 0 | 0 | 445 | 0 | 0 | 0 | 0 | 0 | 445 |
| 1972 | 0 | 0 | 0 | 0 | 0 | 0 | 478 | 1,057 | 0 | 0 | 0 | 0 | 1,535 |
| 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1975 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 424 | 0 | 0 | 0 | 0 | 424 |
| 1977 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1978 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 395 | 0 | 0 | 0 | 0 | 395 |
| 1979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Graphs



Blue River Basin Total
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1950 1951 1952 1953 1954 1955 1957 1958 1959 1960 1961 1962 1964 1965 1966 1967 1968 1969 1971 1972 1973 1974 1975 1976 1978 1979 1980 1981 1982 1983 1985 1986 1987 1988 1989 1990 1992 1993 1994 1995 1996 1997 1999 2000 2001 2002 2003 2004 2006 2007 2008
Total Basin Shortages in acre feet

# Graphs


HUC 111401020206 Outflow
Link_16_Flow
25,000
20,000
15,000
10,000
5,000
0
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
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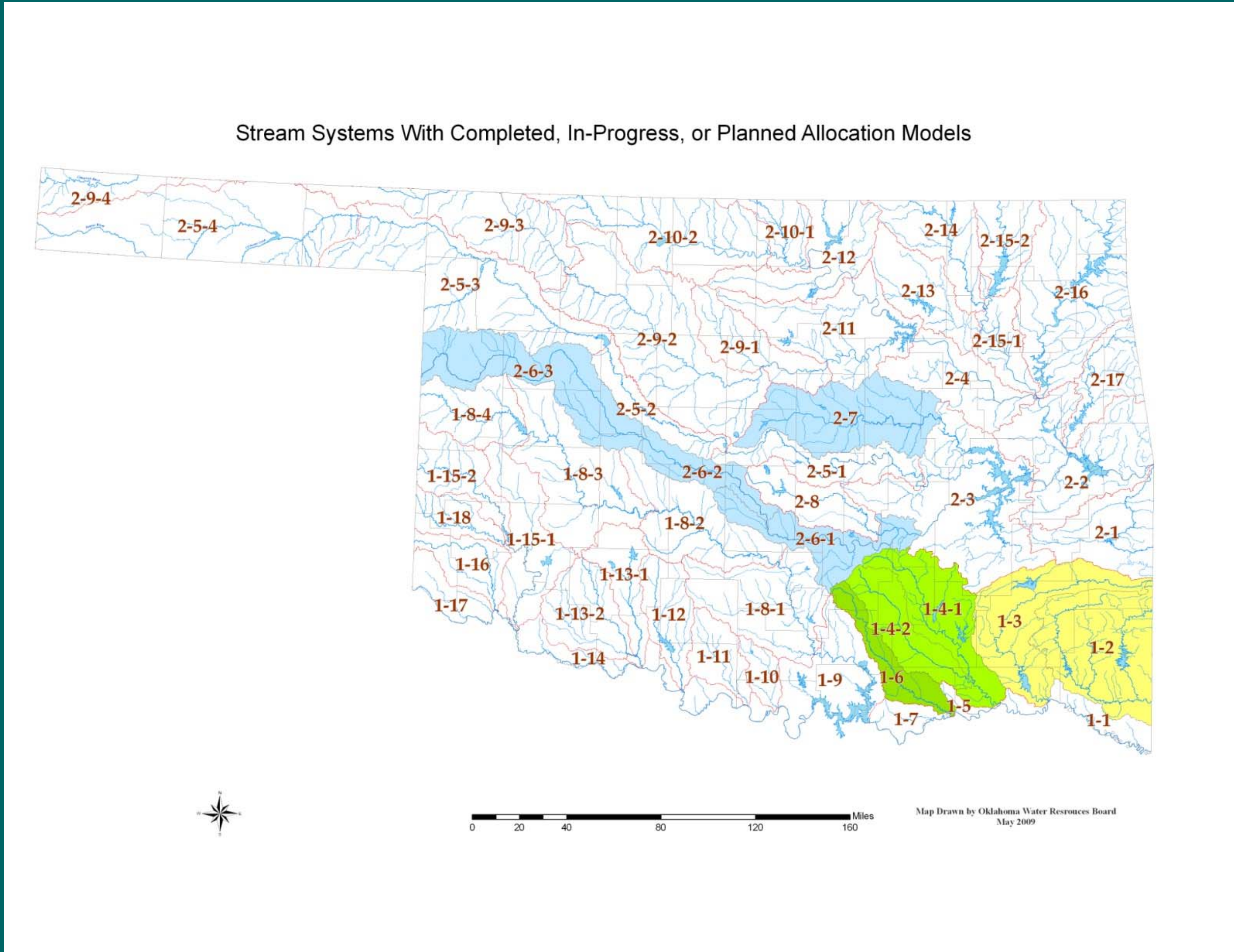
2000
2001
2002
2003
2004
2005
2006
2007
2008
Flow in acre-feet

# Stream Systems Modeled



# *Application Water Availability*

- Is there water available at the proposed diversion point in the amount needed?
  - Calculations based on average annual runoff over the watershed above proposed diversion point (Application Watershed Model).
  - All appropriations, estimated domestic uses, and reservoir dependable yields are subtracted out.

# Application Watershed Delineation

# *Application Available Water Calculation*

- Delineated Watershed of Application
  - Area of watershed
  - Estimated rate of surface flow within watershed
  - Estimated domestic use within water
  - Existing water rights within watershed
  - Existing NRCS lake storage within watershed
- Estimated Available Water
  - (Area x Run-off) – Domestic Use – Existing Water Rights – NRCS Lake Storage – Unappropriated Lake Yields = Available Water

# Application Available Water Evaluation

- On an annual basis is there water available?
  - If not then how much water is available?
- Does the proposed water right interfere with existing downstream domestic use?
  - If there is interference then is there an amount of water use the applicant can use that will not interfere?

# Application Available Water Evaluation

- Finally is the question of Will the proposed applications use interference with existing water rights?
  - If there is the possibility of interference is there some quantity of water available that won't cause interference.

# *Water Availability from a Lake or Pond*

- From a lake which has had a dependable yield analysis conducted.
  - The dependable yield is the amount of water available.
  - These are primarily the Federal lakes

# Water Availability from a Lake or Pond

- For a lake or pond without a dependable yield analysis
  - Use the following formula to estimate the amount of water the pond's watershed can provide to refill the pond.
    - $W_{aval} = (\text{Storage} – (1-(R_{age}/R_{life}))) * \alpha$
      - Where: $W_{aval}$ is the available water; St is the normal storage of the pond or lake; $R_{age}$ is the age of the structure; $R_{life}$ is the life of the project, typically either 50 years or 100 years; and $\alpha$ is the refill factor.
    - $\alpha = (F_{80} \text{ x } A) / (\text{Evap X Surf})$
      - Where: $\alpha$ is the refill factor; $F_{80}$ is the 80% exceedance run-off into the pond; A is the area of the pond's watershed; Evap is the net lake evaporation of the pond; and Surf is the surface area of the pond.

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## Oklahoma's Water Agency

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# Hydrologic Investigations
## Data Issues