OKLAHOMA COMPREHENSIVE WATER PLAN

Technical Studies Update:
Methods, Provisional Results to Date, & Next Steps

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Basic Water Science Seminar
May 15, 2009
Oklahoma City, Oklahoma

Agenda for This Morning

- *Opening Remarks*
- *OCWP Technical Studies Overview*
- *OCWP Programmatic Work Plan*
- *Planning Workshops Supply & Demand Handbook*
- *Provisional Water Demand Projections*

-- Break --

- *Oklahoma's Water Resources*
- *Physical Water Supply Availability*
- *On-going & Upcoming Technical Studies*
- *Water Allocation Modeling*

OCWP Technical Studies Overview

Partnerships for Successful Planning

- Oklahoma Water Resources Board
- US Army Corps of Engineers
  Tulsa District

- Bureau of Reclamation
- Other State and Federal Agencies
- OWRRI – public/policy lead
- CDM – lead technical consultant

Looking Ahead to Meet our Future Needs

How are we using our water resources today?

2009

- **Infrastructure**
- **Efficiencies**
- **Funding & Finance**

How do we want to use our water resources in the future?

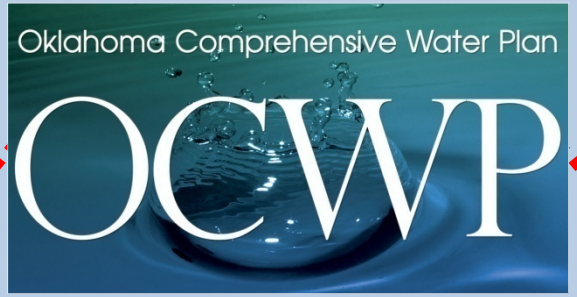
2060

Goals of the OCWP

1) *Characterize Demands by Water Use Sector*
2) *Identify Reliable Supplies to Meet Forecasted Demands*
3) *Perform technical studies in support of ensuring reliable supplies*
4) *Engage comprehensive stakeholder involvement to make recommendations regarding the management of Oklahoma's water resources*
5) *Make "implementable" recommendations regarding the future of water management in Oklahoma based upon technical evaluations and stakeholder input*

Oklahoma COMPREHENSIVE Water PLAN

A “Good” Plan vs.
The “Right” Plan

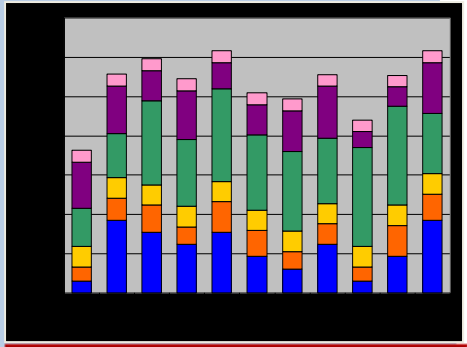


Robust Public Participation

Expert Technical Evaluation

Public/Policy Interaction

Reliable Data for Informed Decision-making



Policy Development (Public Input)

Information & Analysis

Technical Studies

Technical Analysis of Public / Policy Concepts

Attributes of the Water Plan

- Reliable information
- Consistent methods, comparable results
- Practical, understandable, useable
- Consistent with existing policy
- Forward-looking
- Robust management of supplies
- The "go-to" source of water information for water users, planners, and media

Planning for a Reliable Supply

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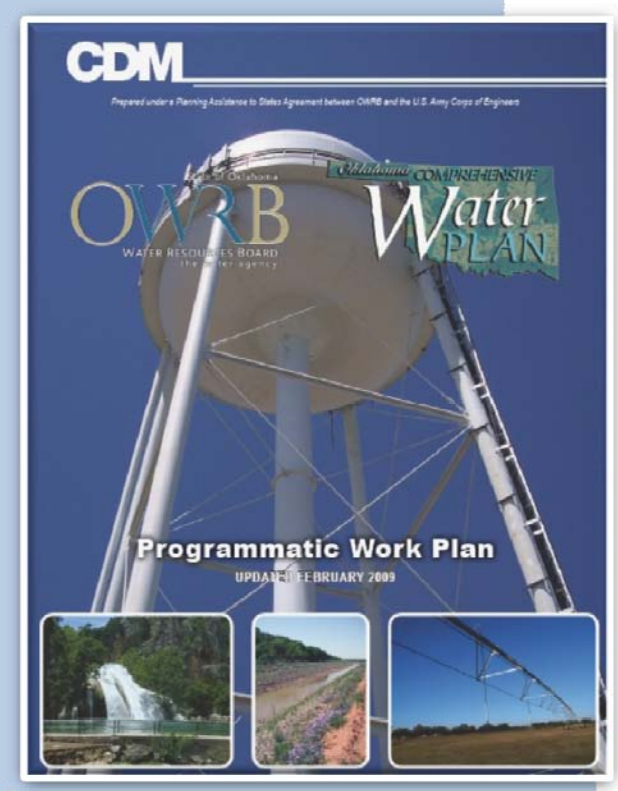
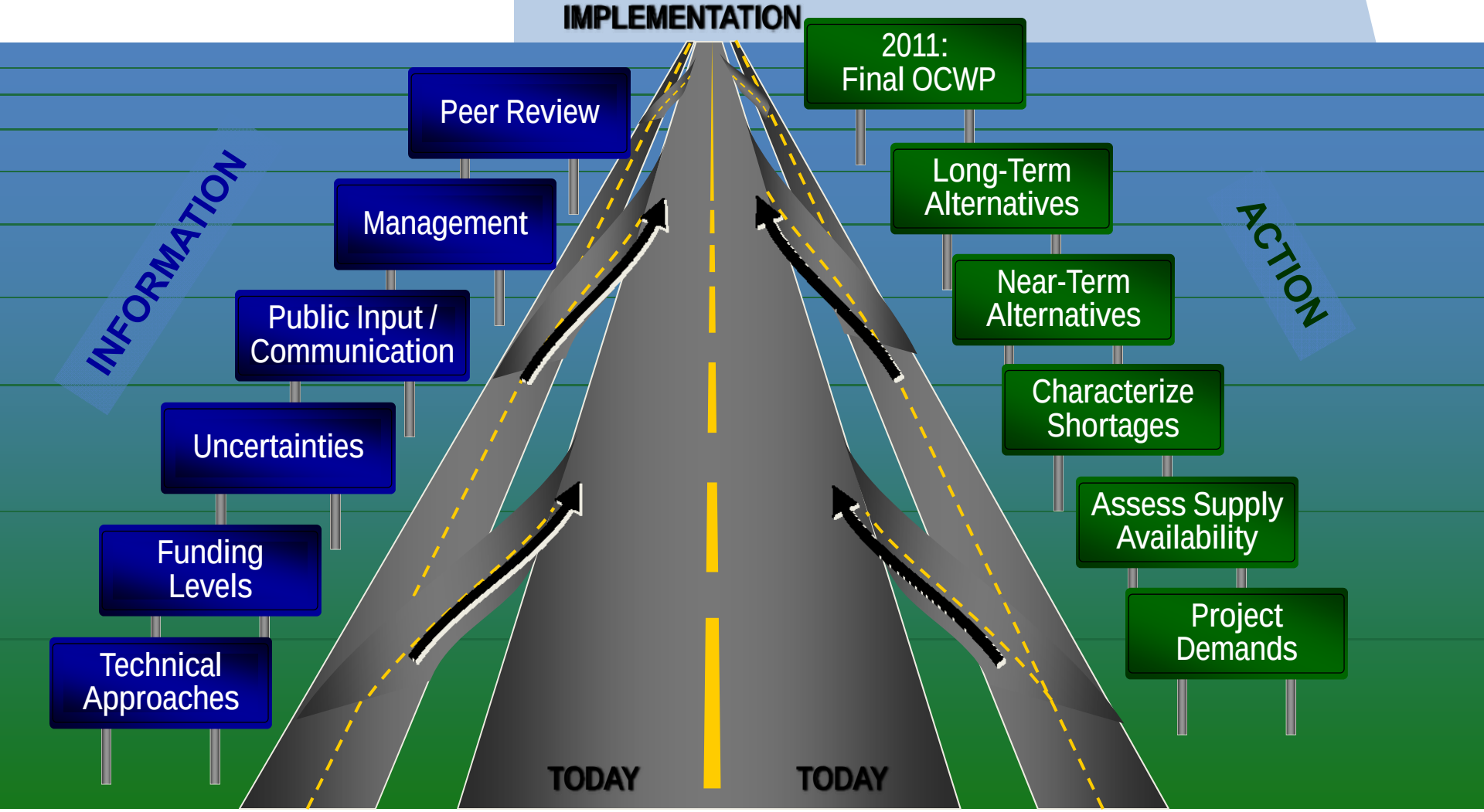
OCWP
Programmatic Work Plan

Programmatic Work Plan

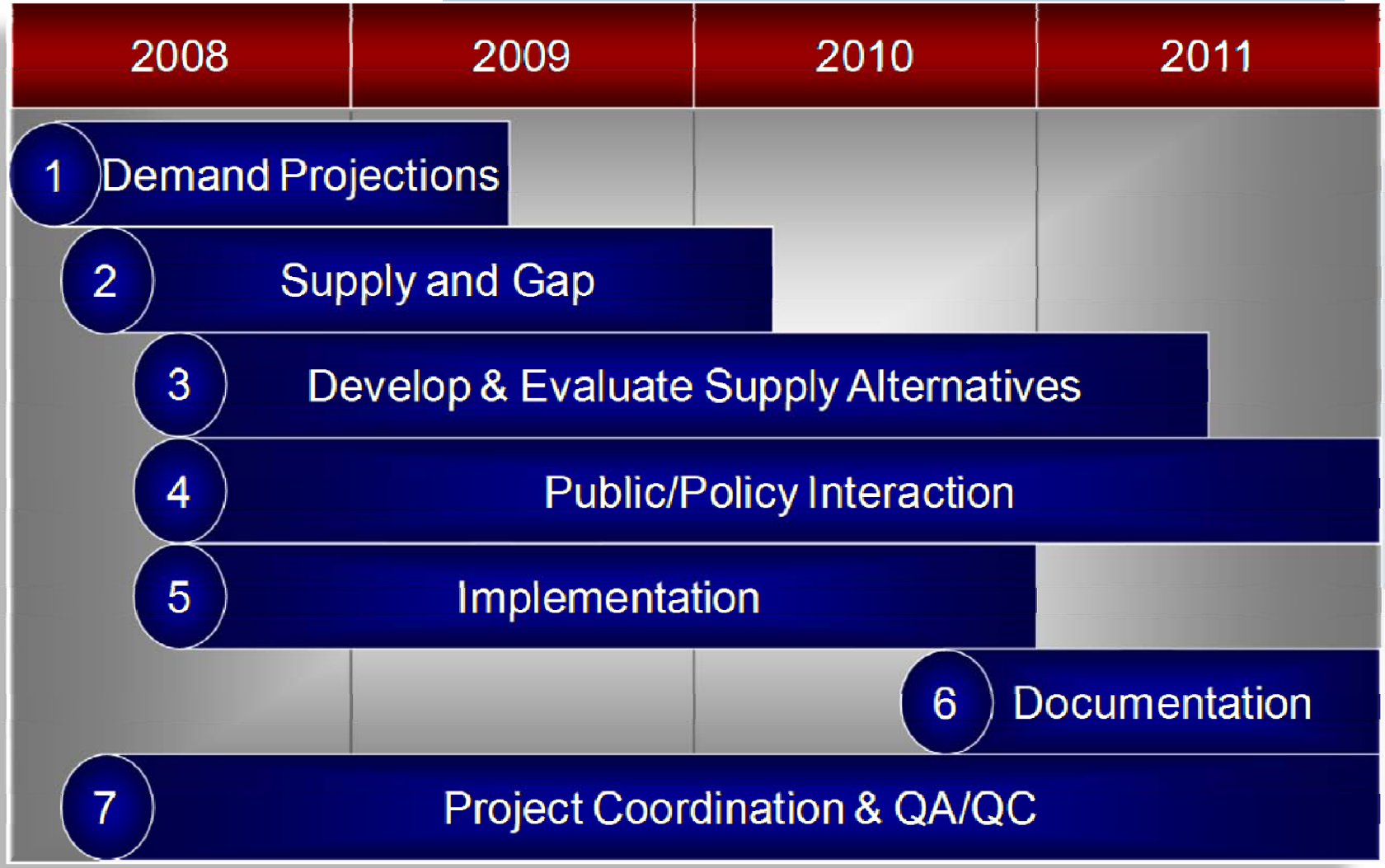


- Living document as a technical work roadmap
- On web: www.owrb.ok.gov
- 2008-2009 Technical Work
  - *Co-funded by OWRB and U.S. Army Corps of Engineers*
  - *Focus on defining demands and projecting supply shortfalls*
- Technical Work 2009-2011: identifying solutions on a watershed and provider level
- Not all PWP tasks will be completed by 2011

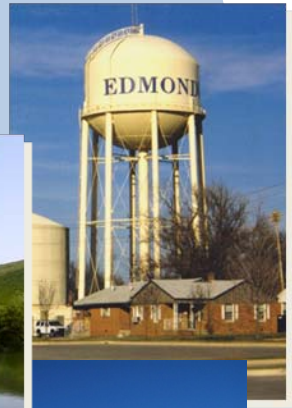
The Programmatic Work Plan: A Roadmap for Developing the Water Plan



Major Technical Work Elements



Foundational Technical Studies



- "Characterize the needs"
- Provide foundation for subsequent phases of OCWP development
- Preliminary assessment of supply gaps and "hot spots"

Task 1: Demand Projections

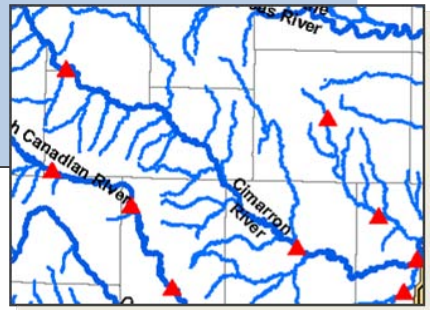
- All water use sectors
  - *Public water supply*
  - *Agriculture*
  - *Industry and power*
- Consumptive demands
  - *Updated model*
  - *County level*
  - *Disaggregation to provider level*
  - *Conservation status and potential*

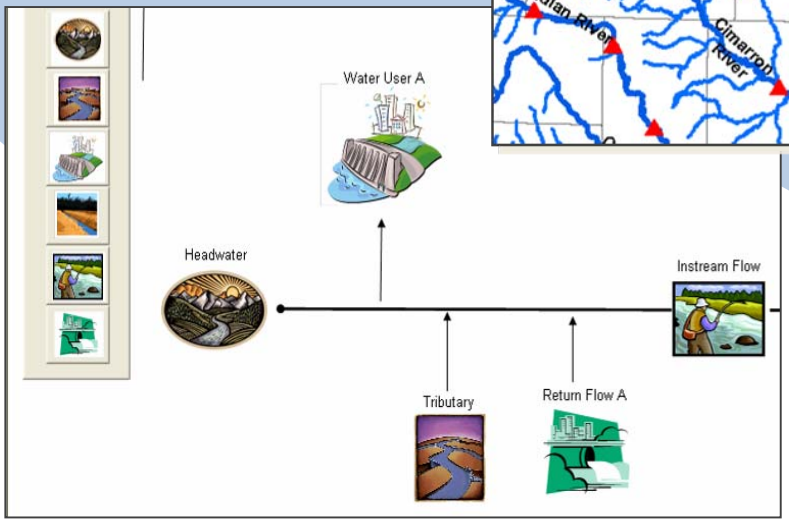
Task 1: Demand Projections

- Non-Consumptive Water Use (Environmental & Recreational)
  - *Policy framework & goals*
  - *Characterize existing programs*
  - *Prioritize streams / lakes / species for analysis*
  - *Supporting technical analysis*

Task 2: Supply and Gap

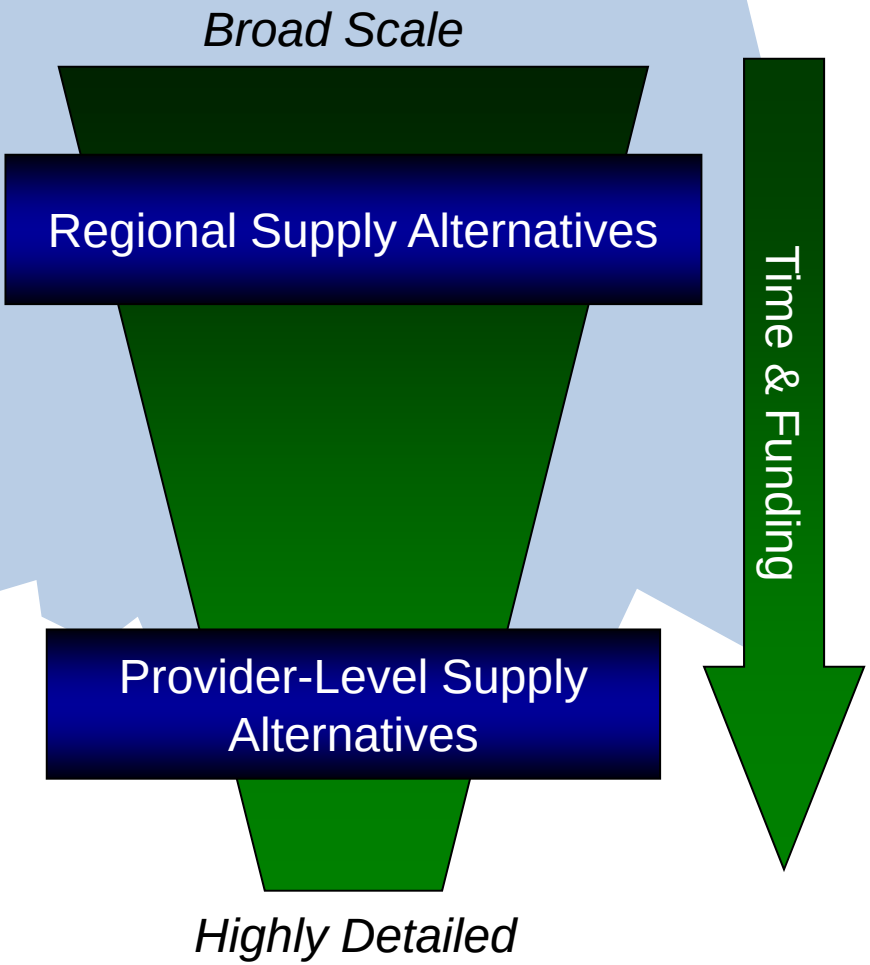
- Physical availability screening
- Infrastructure / legal availability screening
  - *Public water supplier survey*
  - *Water quality*
- Statewide screening to identify projected "hot spots"
- Water allocation modeling





Task 3: Develop & Evaluate Supply Alternatives

- Infrastructure & water supply alternatives
- Policy alternatives, e.g.:
  - *Conjunctive management*
  - *Instream flows*
  - *Others identified via public process*

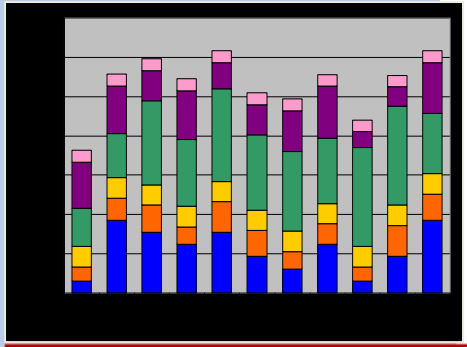


Task 4: Public/Policy Interaction

Reliable Data for Informed Decision-making

Policy Development (Public Input)

Information & Analysis



Technical Studies

Technical Analysis of Public / Policy Concepts

Task 5: Implementation

- Water rights administration system modernization
- GIS mapping of infrastructure
- Floodplain management
- Funding / financing programs & needs
- Drought preparedness
- Data gaps for future planning
- Conservation & education programs
- Additional special studies & investigations

Task 6 – Water Plan Documentation

- 2007 Water Atlas
- OCWP Report & Databases

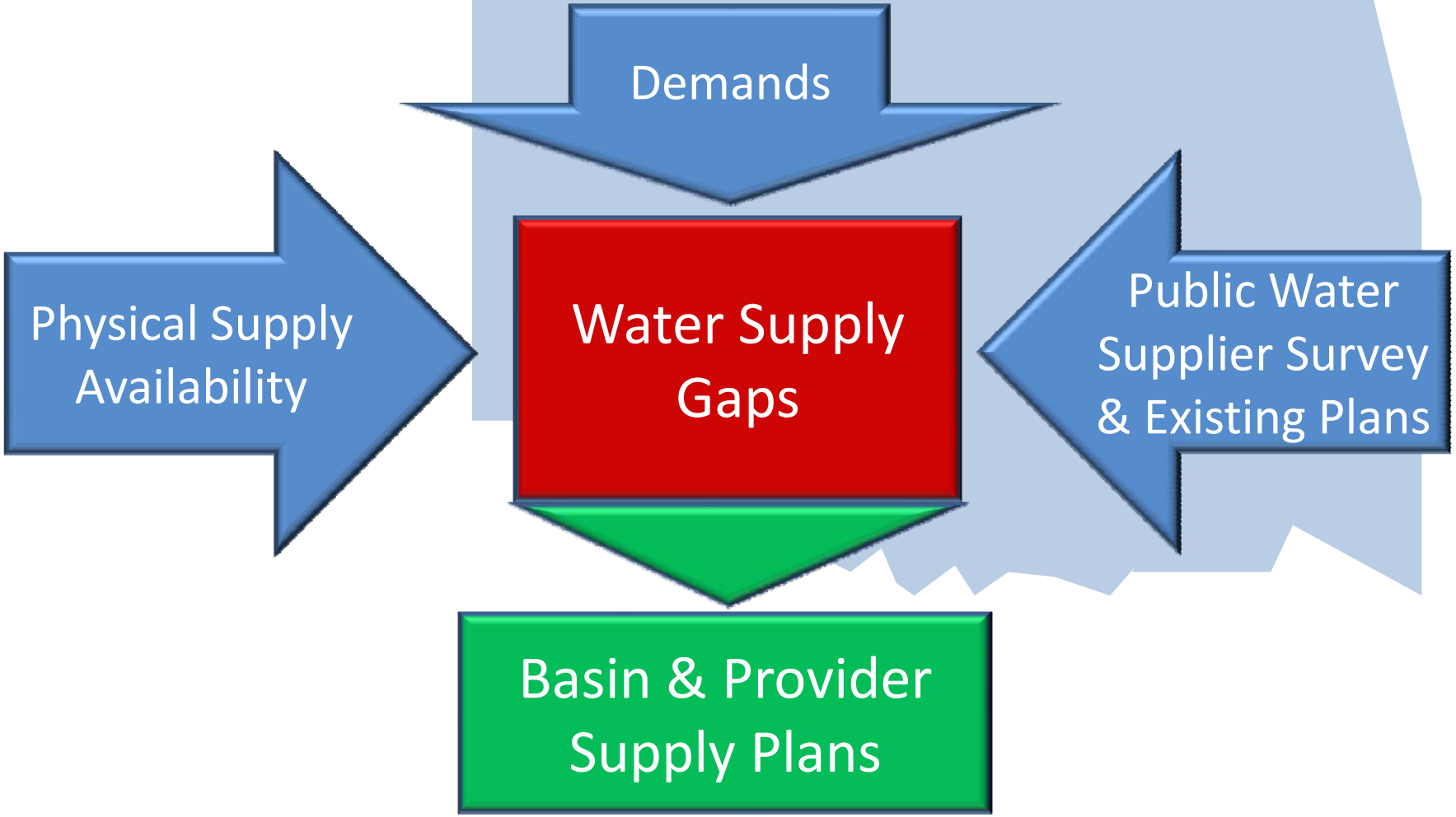
Task 7 – Project Coordination & QA/QC

- Program management & coordination
- Presentations and communication
- QA/QC and peer reviews

Phases of OCWP Development

- Foundational elements:
  - Demands, Supply Availability, & Shortages
- Analysis:
  - Water allocation modeling
  - What-if analyses and supply/demand uncertainties
  - Management & administration
- Supply Planning:
  - Regional needs and potential solutions
  - Detailed provider-level supply plans
- Implementation:
  - GIS mapping of supply infrastructure
  - Fill data gaps
  - Expanded financial assistance

Integrating the Technical Elements



OCWP Planning and Analysis Basins

- Comparison of supplies and future demands was conducted on a basin basis to facilitate estimation of available surface water
- Basins were adapted from existing OWRB stream system boundaries and USGS HUC 12 boundaries

Subdividing the State into Analysis Basins

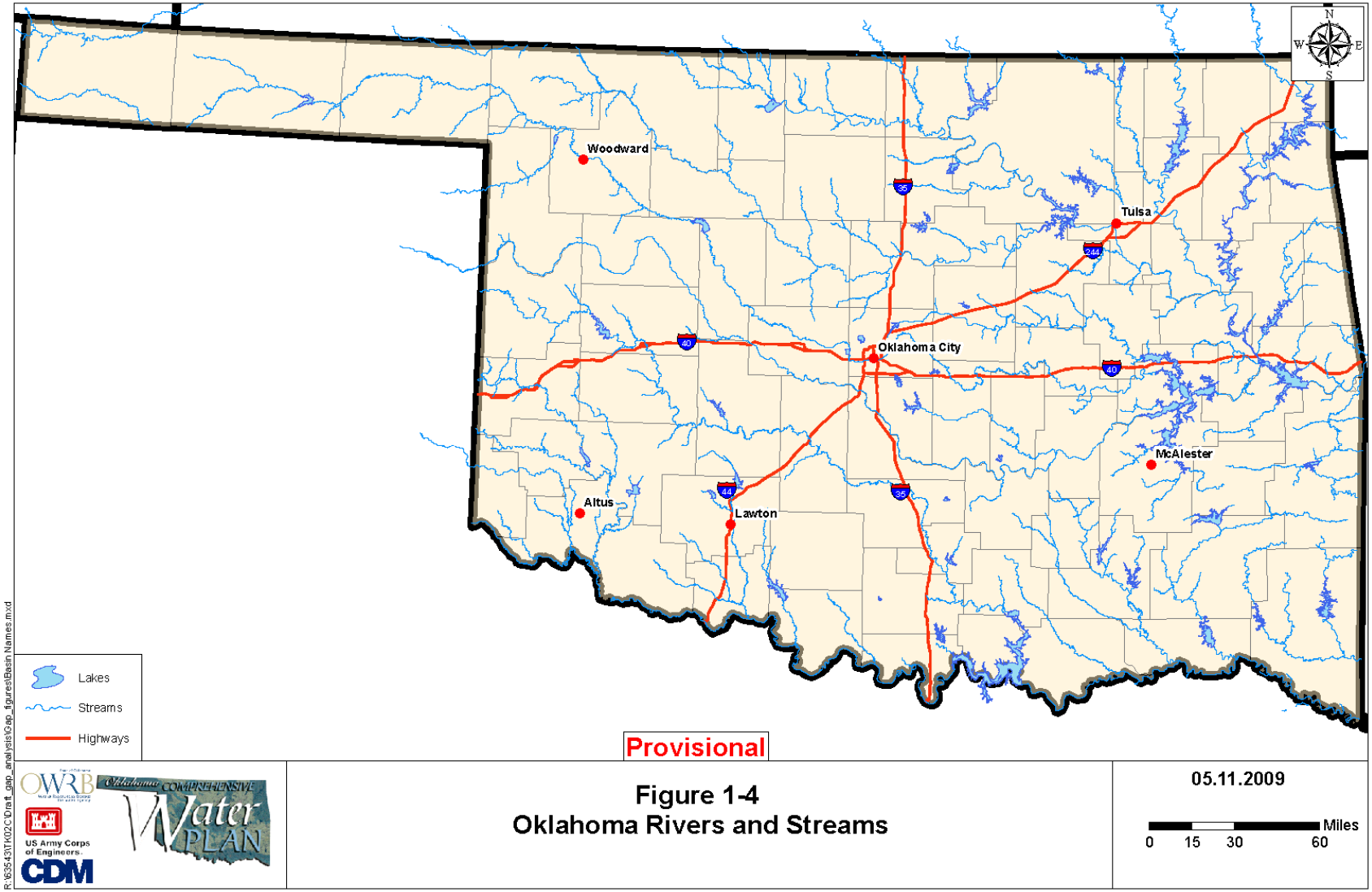


Figure 1-4
Oklahoma Rivers and Streams

Major River Basins

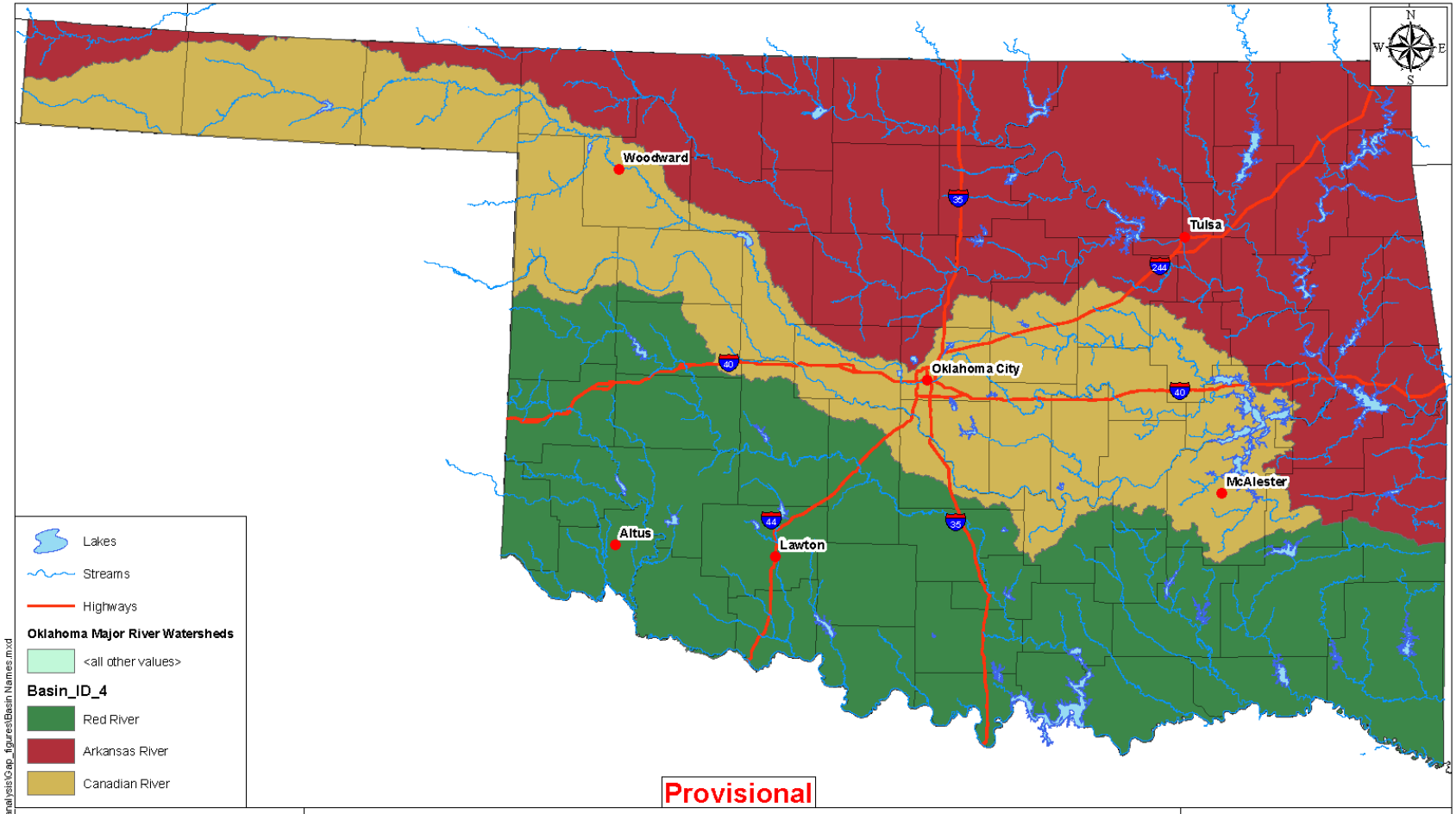


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Figure 1-5
Oklahoma Surface Water Basin Example
Potential Major Watersheds

05.11.2009

Miles
0 15 30 60

Major Watersheds

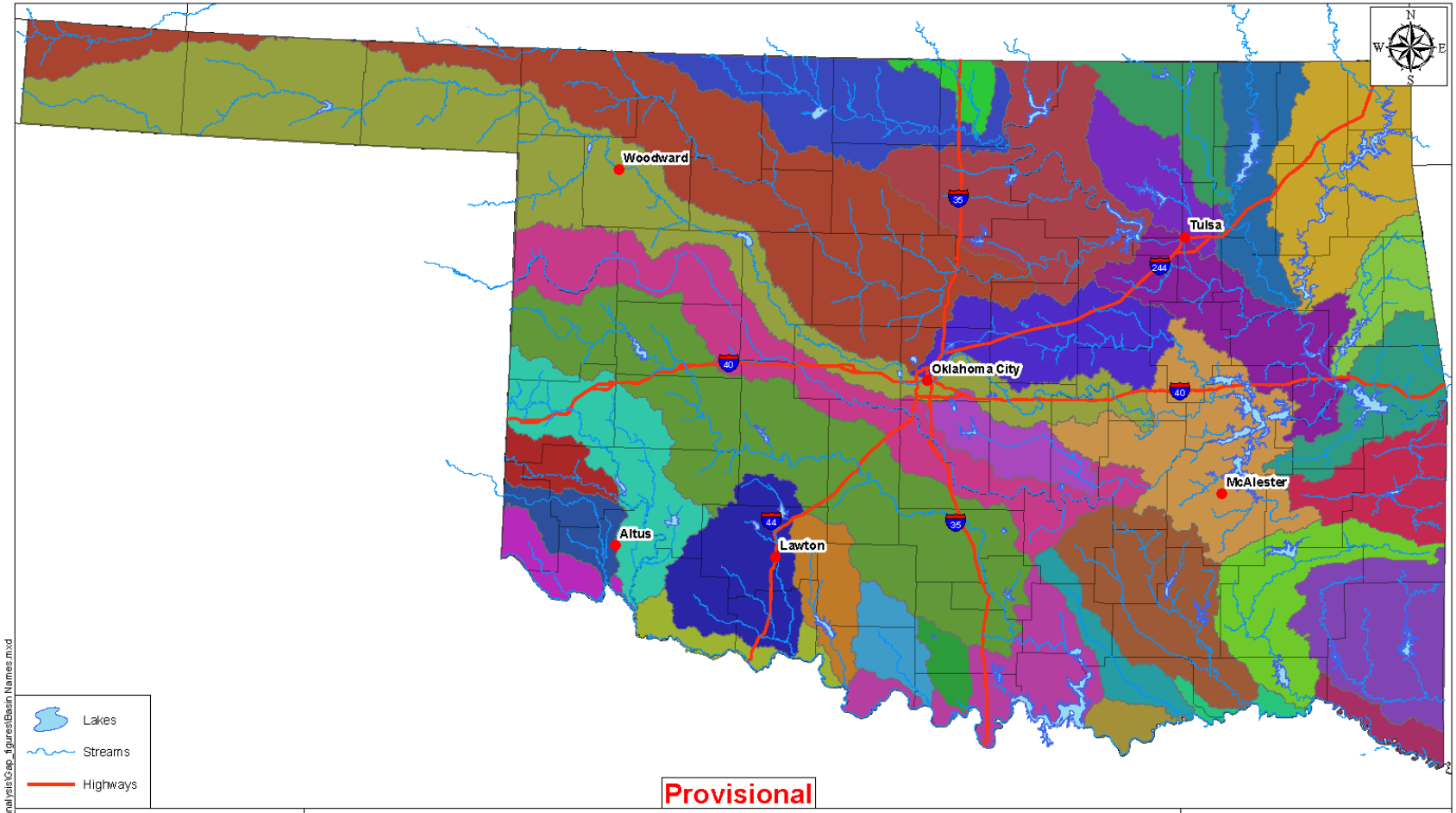

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Figure 1-6
Oklahoma Surface Water Basin Example
Major River and Stream System Basins

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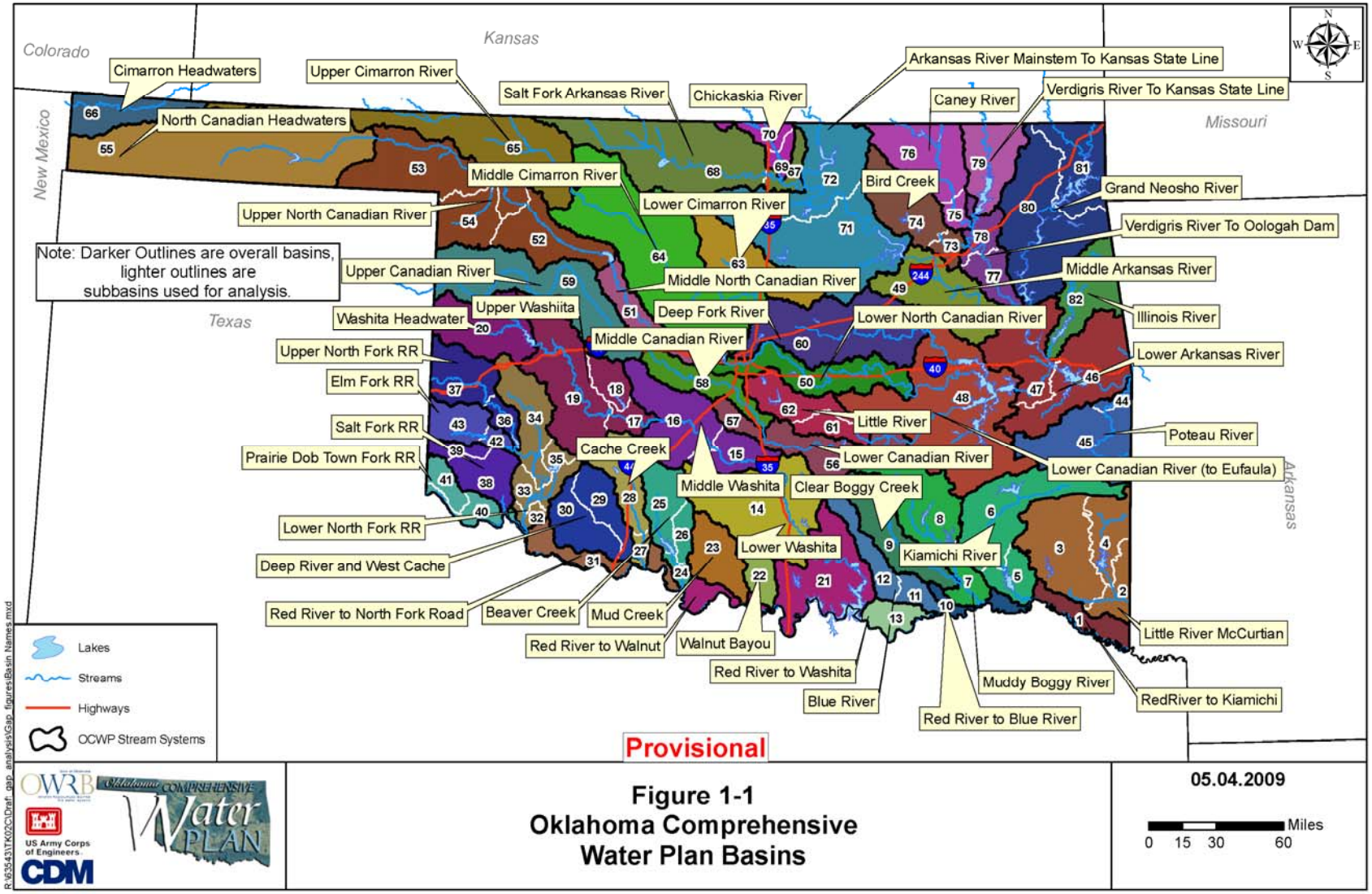
OCWP Stream Systems



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Oklahoma COMPREHENSIVE Water PLAN

Planning Workshops
Supply & Demand Handbook

Overview of Supply and Demand

- Projection of demands through 2060
- Characterization of surface water and groundwater supplies
- Hydrologic variability
- Reliability of supplies
- Location, magnitude, and frequency of gaps between supply and demand

Supply & Demand Handbook

- Provisional Demand Projections & Physical Supply Availability Findings
- Reference document for Policy Process
- Contents:
  - *Section 1: Introduction & Background*
  - *Section 2: Water Demand Projections*
  - *Section 3: Oklahoma's Water Resources*
  - *Section 4: Provisional Physical Water Supply Availability Results*
  - *Section 5: Ongoing and Upcoming Technical Studies*

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Oklahoma COMPREHENSIVE Water PLAN

Provisional Water Demand Projections

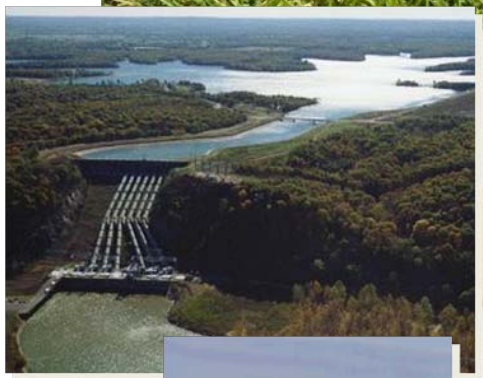
Demand Forecast Development Process

Step 1: Data collection
Step 2: Data analysis
Step 3: Develop water use models
Step 4: Prepare Provisional Forecasts
Step 5: Interim review (Work Groups)
Step 6: Provider-level validation
Step 7: Report

Major Water Use Sectors

Public Supply (M&I)

- Residential
- Commercial
- Industrial
- Self-Supplied Residential



Self Supplied Industrial

- Power Plants
- Oil and Gas
- Tribal Industries
- Other Large Industries

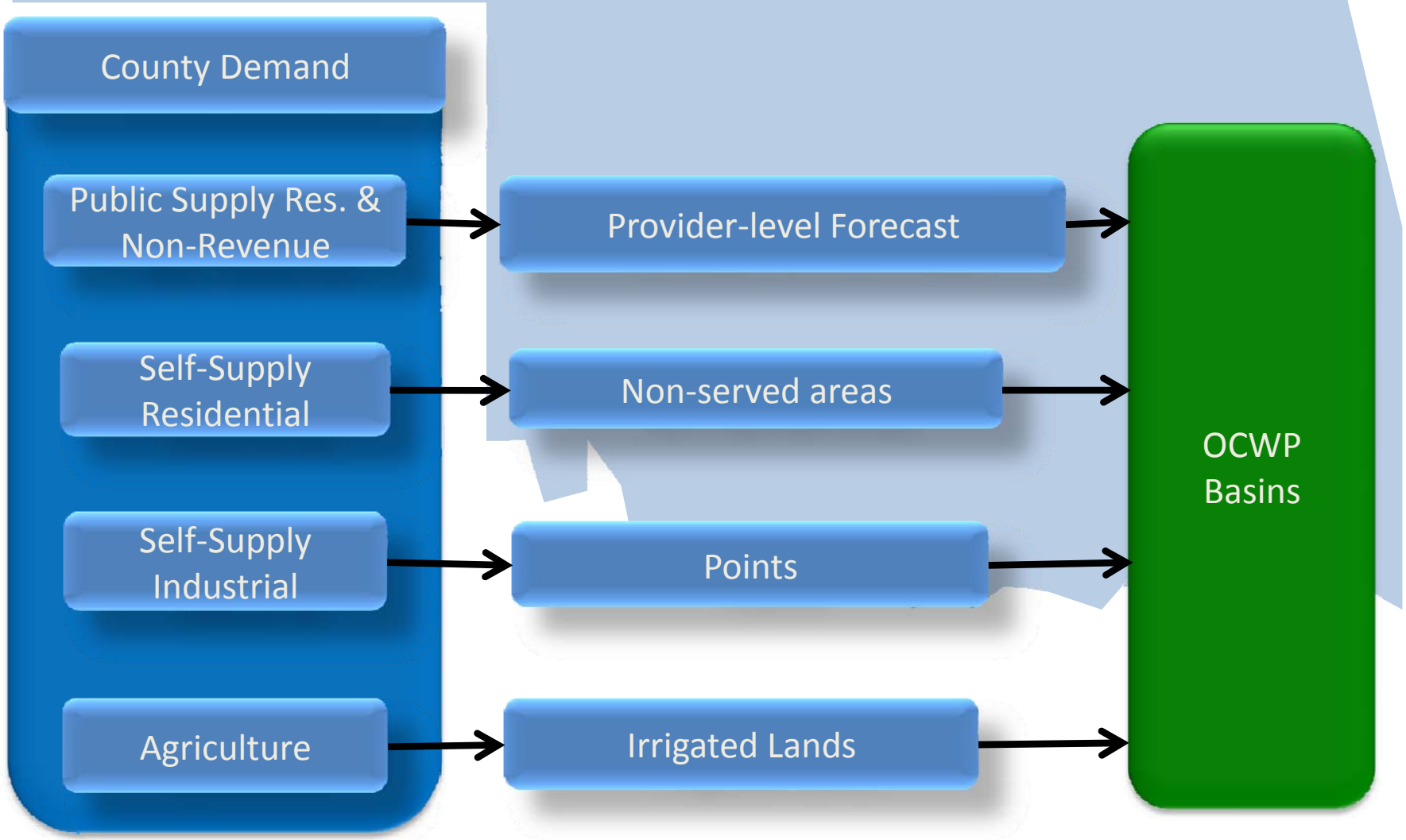
Agriculture

- Livestock
- Irrigated Crops

OCWP Water Demand Sectors

- Municipal and Industrial (M&I)
- Self-Supply Residential
- Self-Supply Industrial
- Oil and gas
- Livestock
- Agriculture (Crops)
- Thermoelectric Power

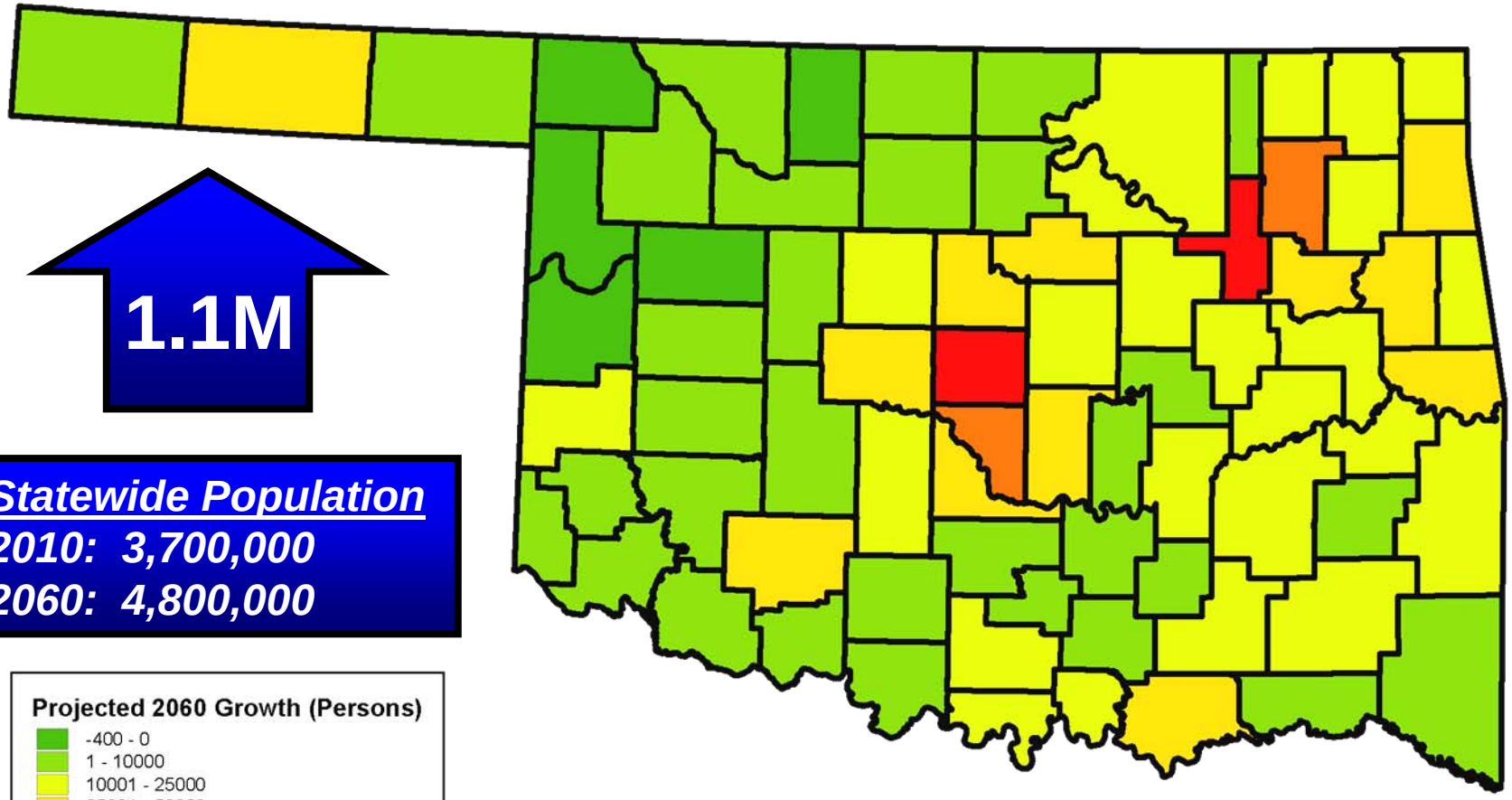
County to OCWP Basin Allocations



M&I (Public Supply) and Self-Supplied Rural Residential

- Population projections by county from ODOC
- Employment projections by industry code (NAICS) by county
- Residential gpcd by county from 2008 Provider Survey
- Nonresidential gallons/employee/day by NAICS from IWR-MAIN
- System loss by county from 2008 Provider Survey

Where Will Population Growth Occur?
(number of persons)

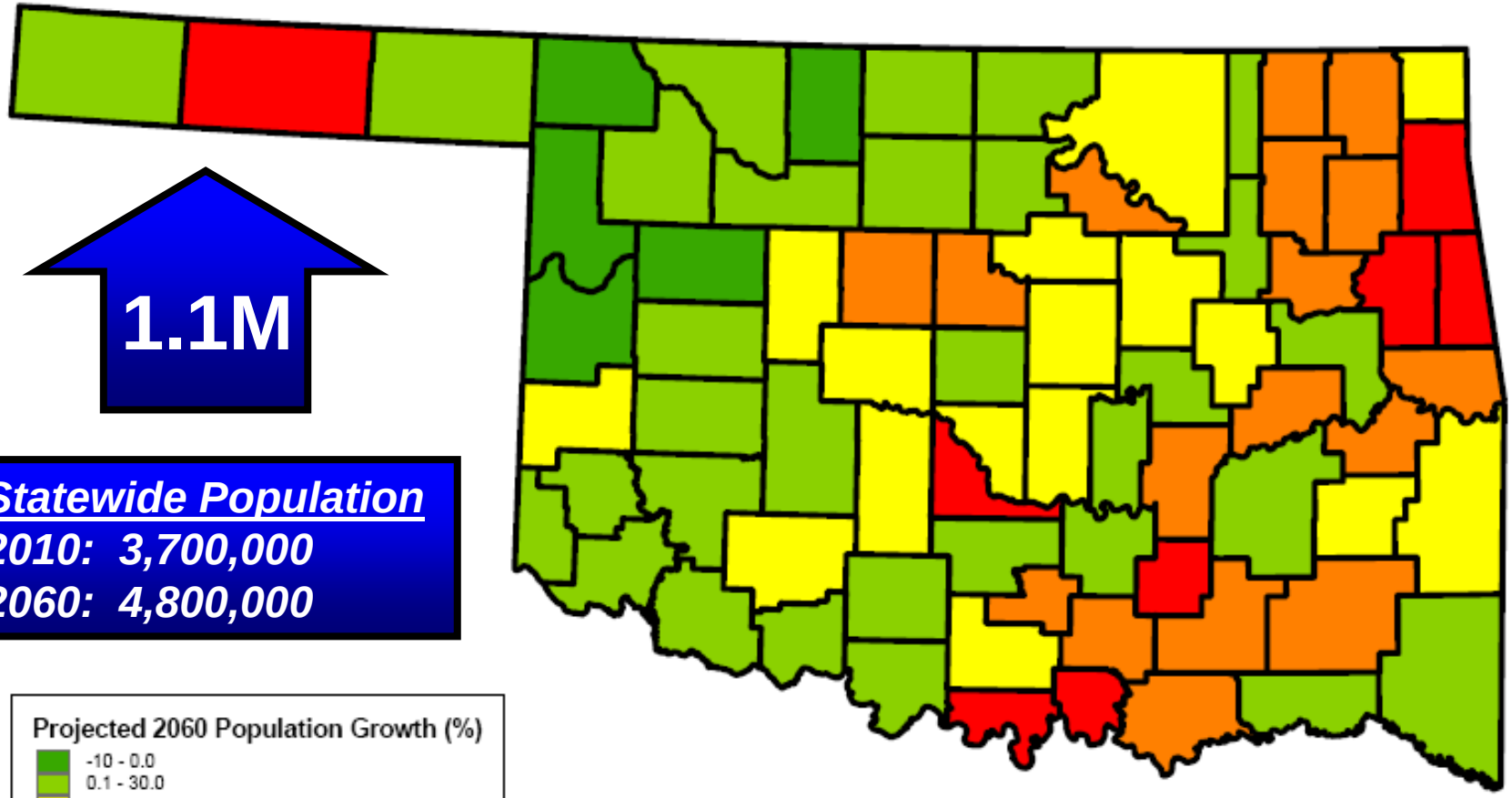


Statewide Population
2010: 3,700,000
2060: 4,800,000

Projected 2060 Growth (Persons)
- -400 - 0
- 1 - 10000
- 10001 - 25000
- 25001 - 50000
- 50001 - 100000
- 100001 - 175000

Source: ODOC 2002

Where Will Population Growth Occur?
(percent growth 2010-2060)



1.1M

Statewide Population
2010: 3,700,000
2060: 4,800,000

Projected 2060 Population Growth (%)
- -10 - 0.0
- 0.1 - 30.0
- 30.1 - 60.0
- 60.1 - 100.0
- >100

Source: ODOC 2002

NAICS	GED
11 Agriculture, forestry, fishing and hunting	111.8
21 Mining, quarrying, and oil and gas extraction	488.4
22 Utilities	28.4
23 Construction	66.6
31-33 Manufacturing	144.5
42 Wholesale trade	44.1
44-45 Retail trade	46.4
48-49 Transportation and warehousing	57.2
51 Information	28.0
52 Finance and insurance	59.8
53 Real estate and rental and leasing	163.5
54 Professional and technical services	68.6
55 Management of companies and enterprises	64.0
56 Administrative and waste services	41.2
61 Educational services	103.6
62 Health care and social assistance	84.7
71 Arts, entertainment, and recreation	446.6
72 Accommodation and food services	185.5
81 Other services, except public administration	271.3
92 Public Administration	125.4
99 Unclassified	122.9

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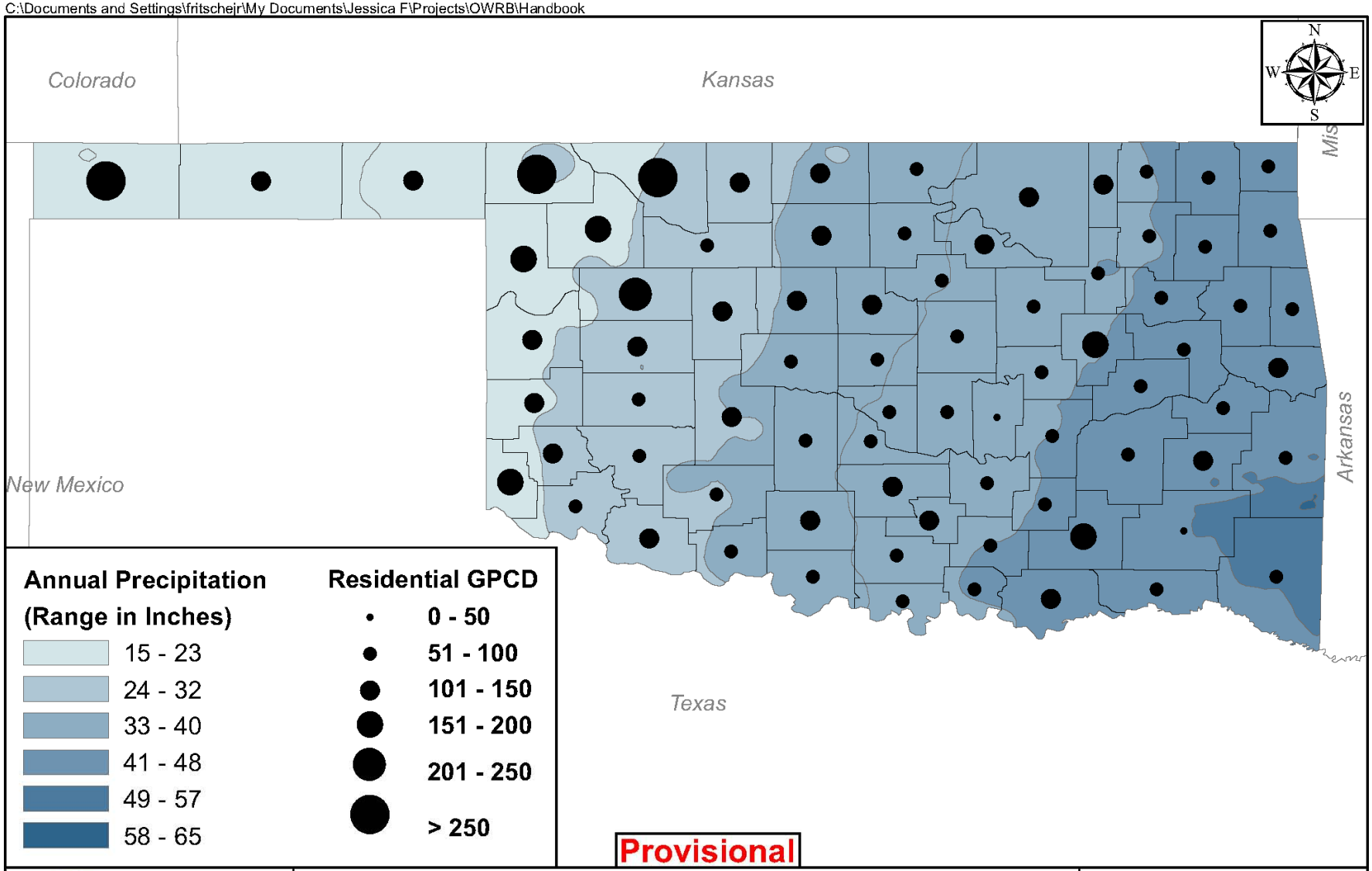

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Figure 2-1
Oklahoma Residential Per Capita Water Use Quantities and Patterns

05.04.2009

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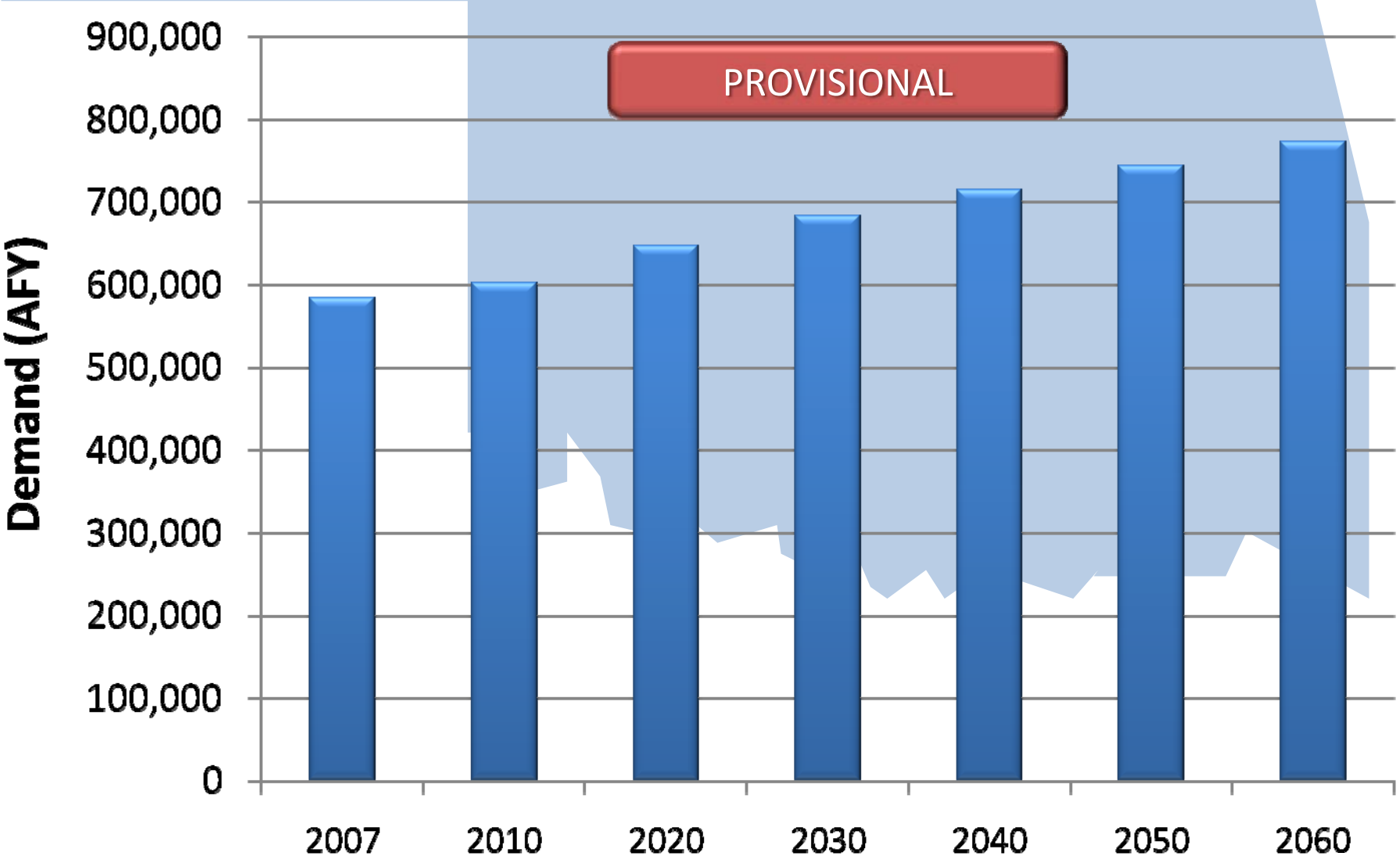
Statewide Municipal & Industrial Demands



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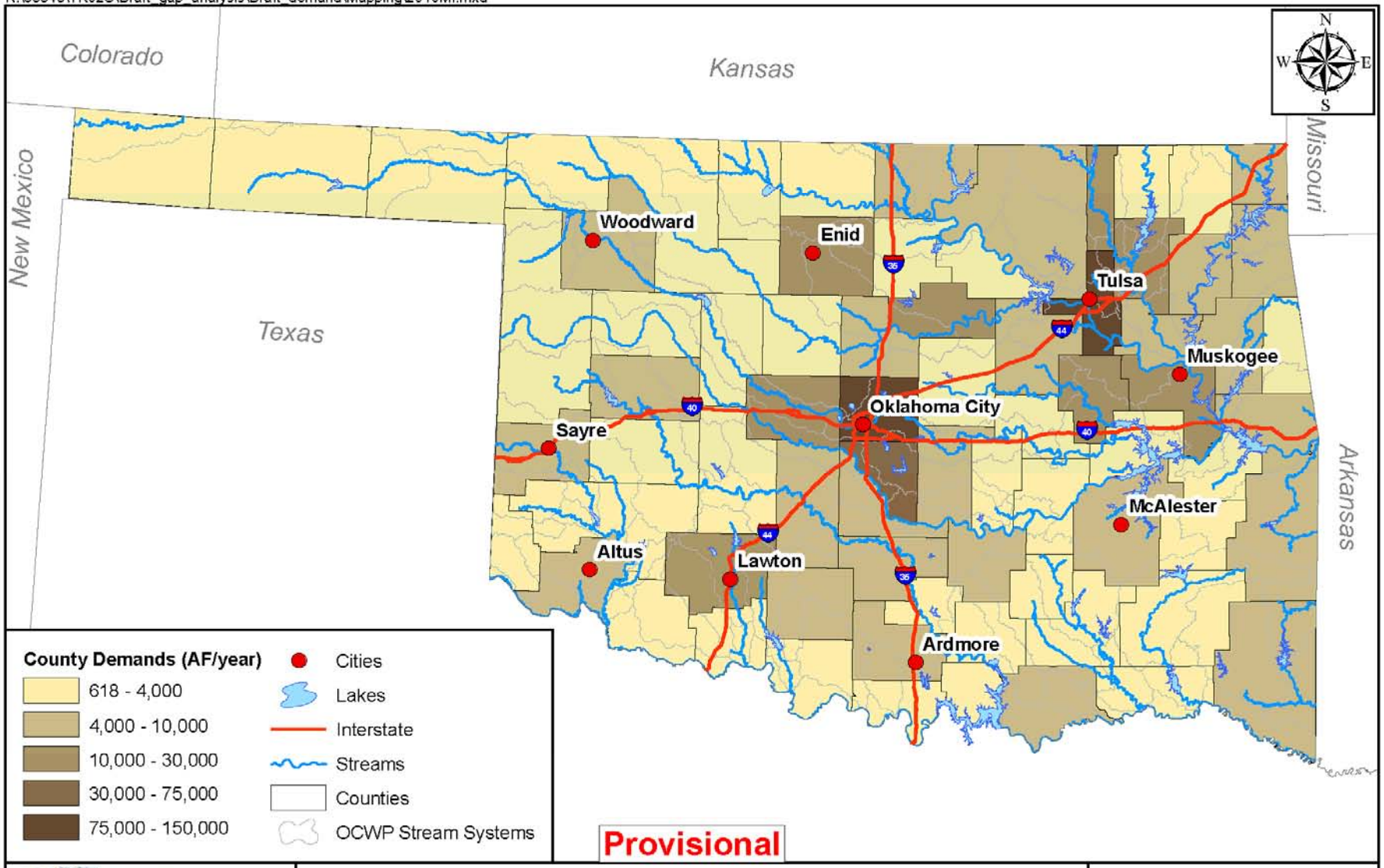

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Figure 2-2
2010 Municipal and Industrial County Demands

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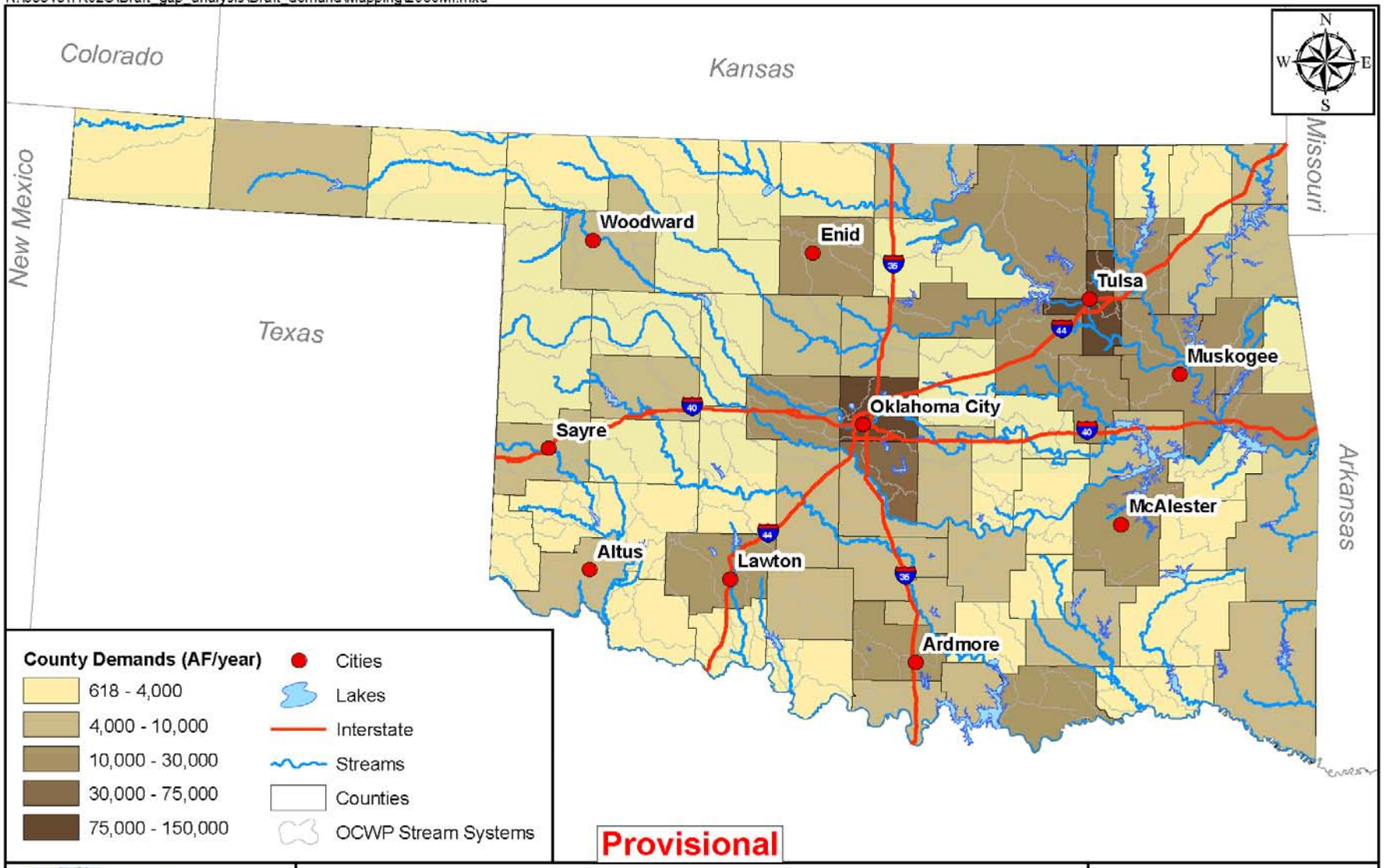

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Figure 2-3
2060 Municipal and Industrial County Demands

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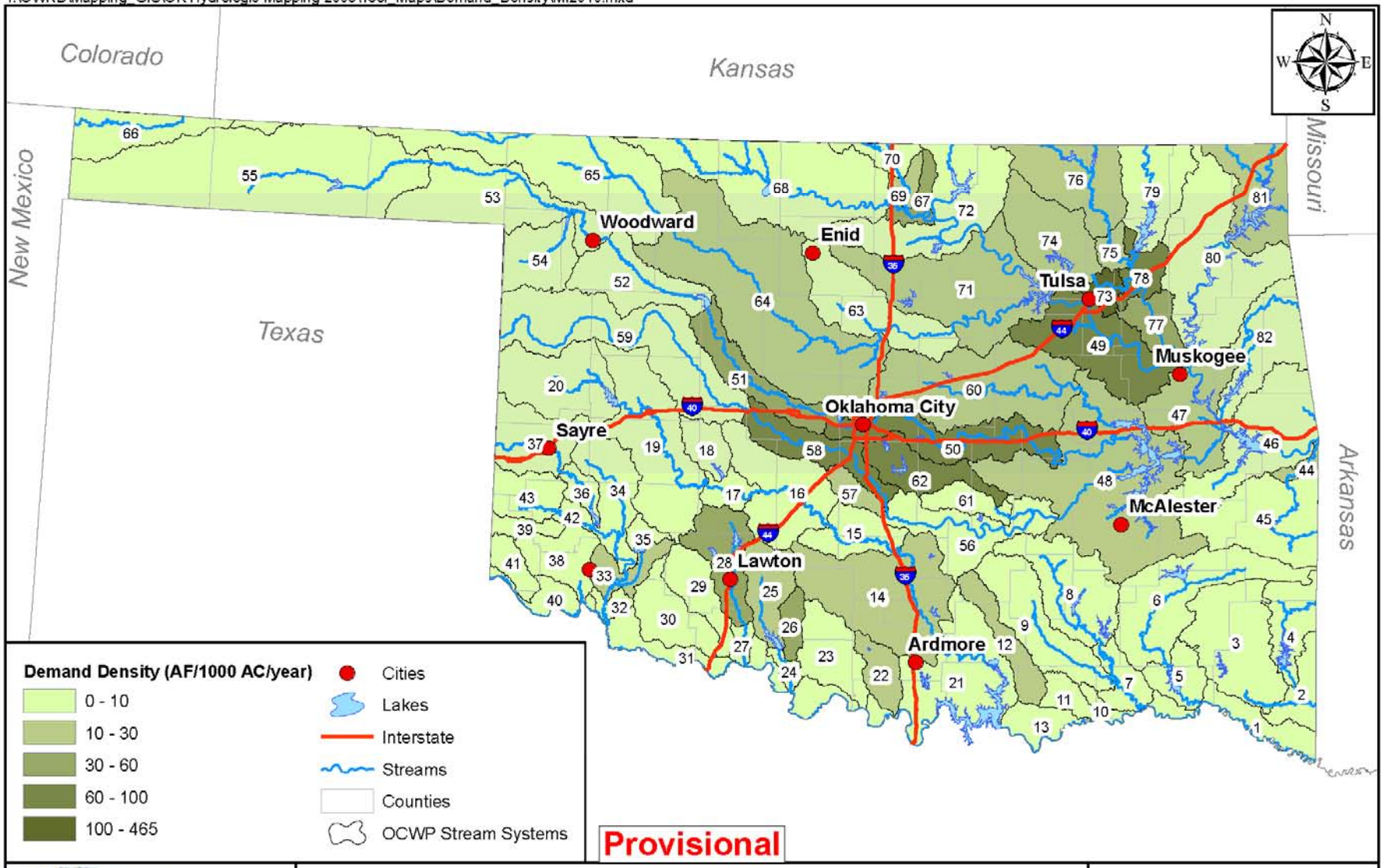

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Figure 2-16
2010 Municipal and Industrial Demand Density

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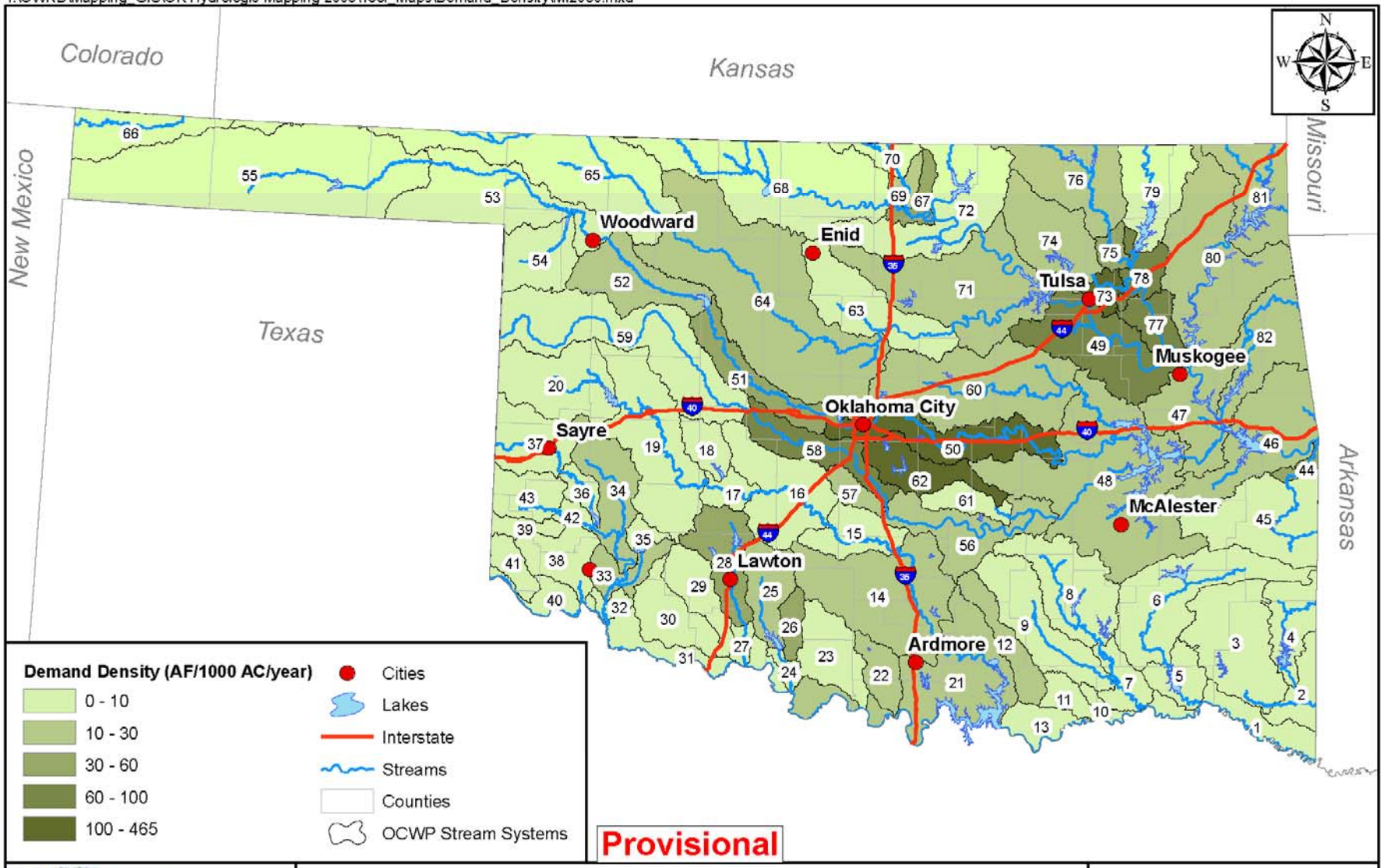

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Figure 2-17
2060 Municipal and Industrial Demand Density

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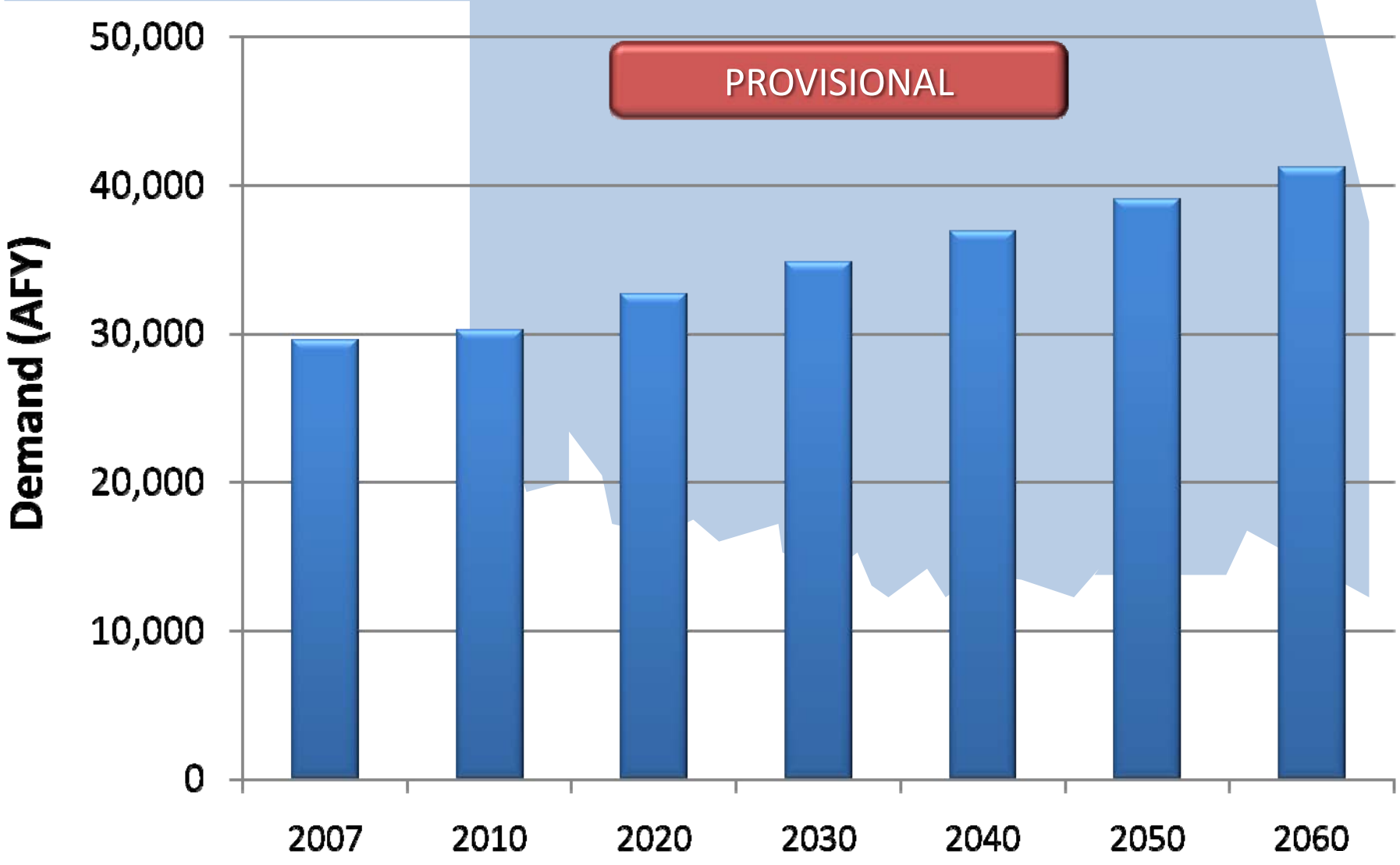
Statewide Self-Supplied Rural Residential Demands



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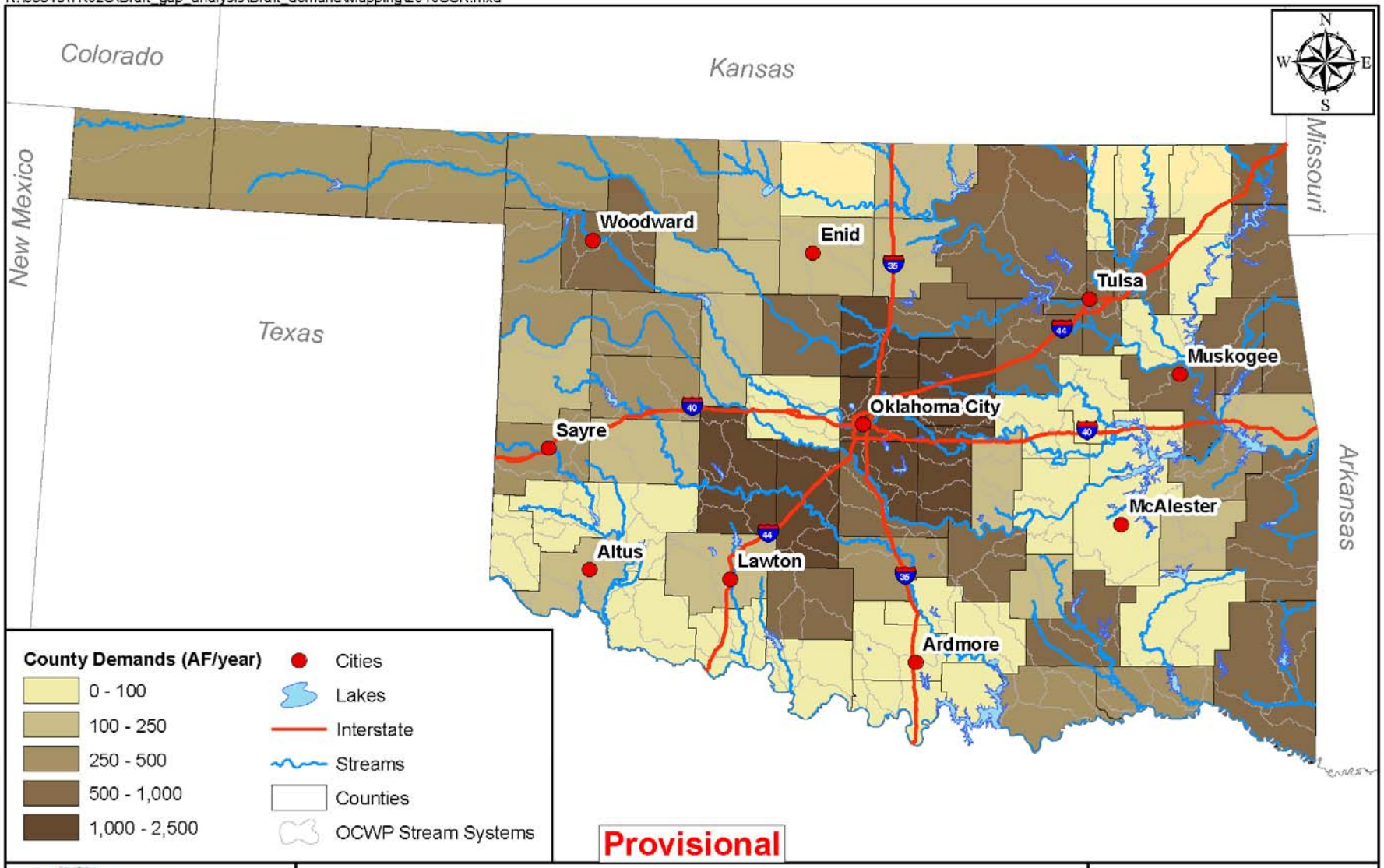

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Figure 2-4
2010 Self Supplied Rural Residential County Demands

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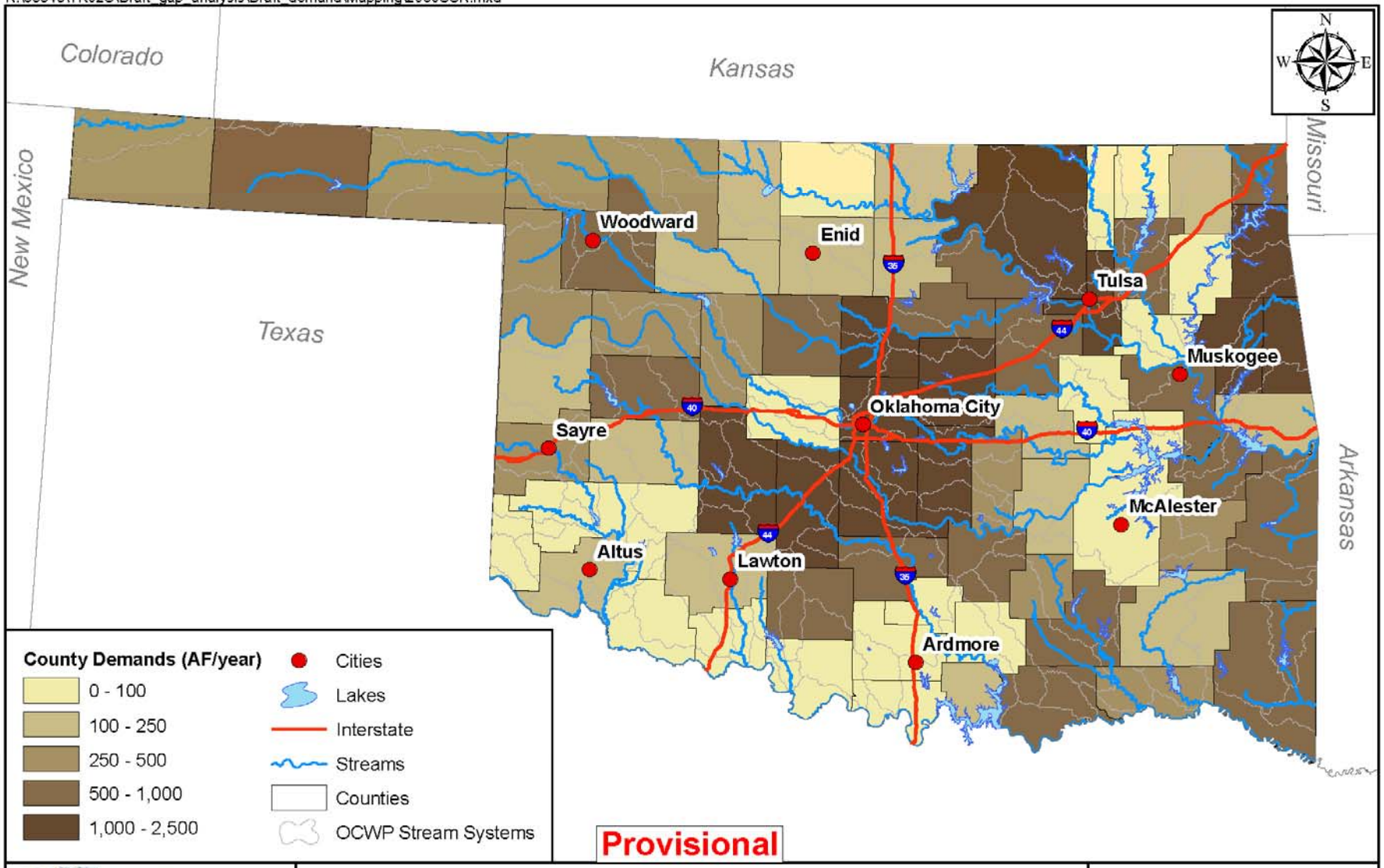

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Figure 2-5
2060 Self Supplied Rural Residential County Demands

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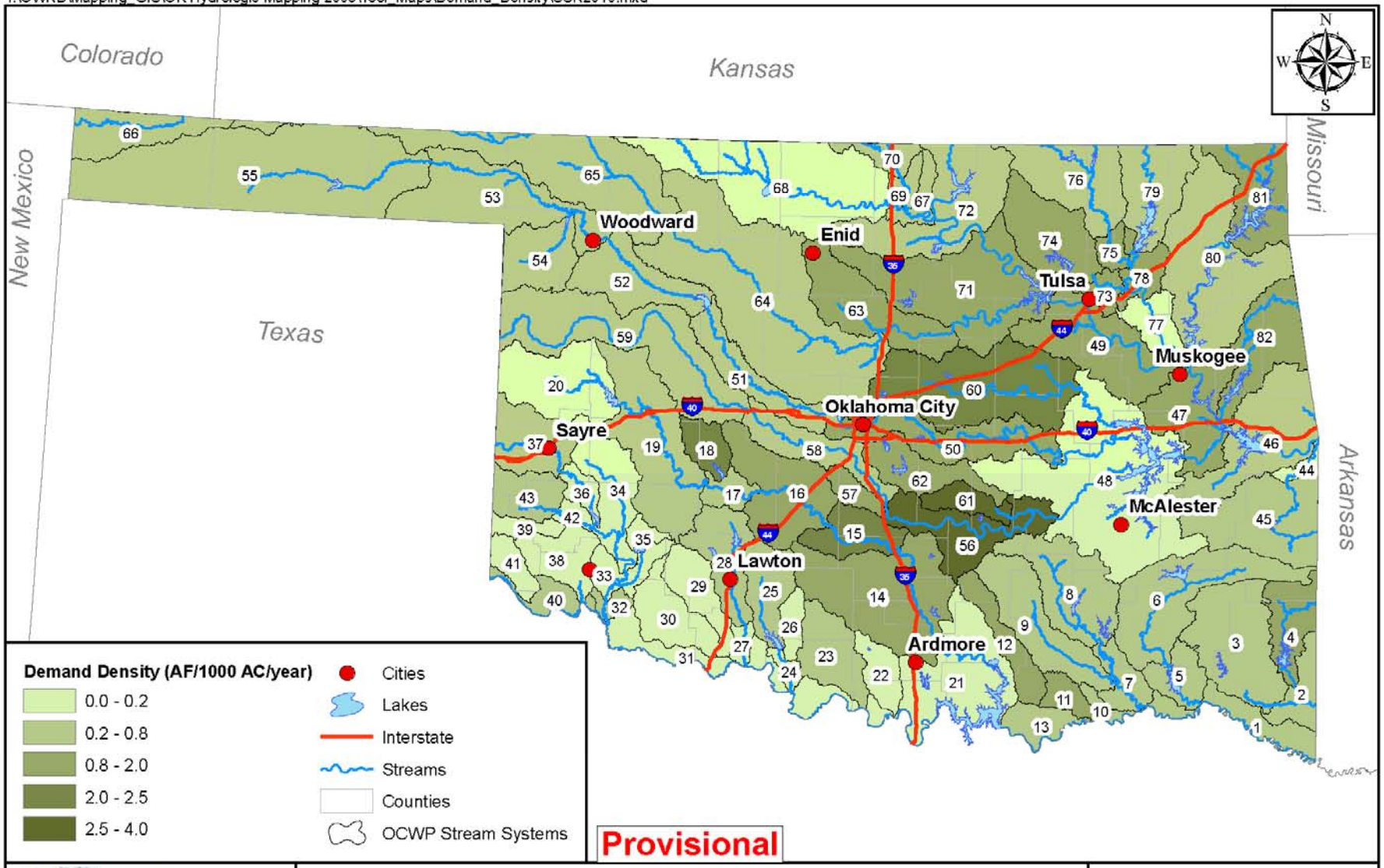

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Figure 2-18
2010 Self Supplied Rural Residential Demand Density

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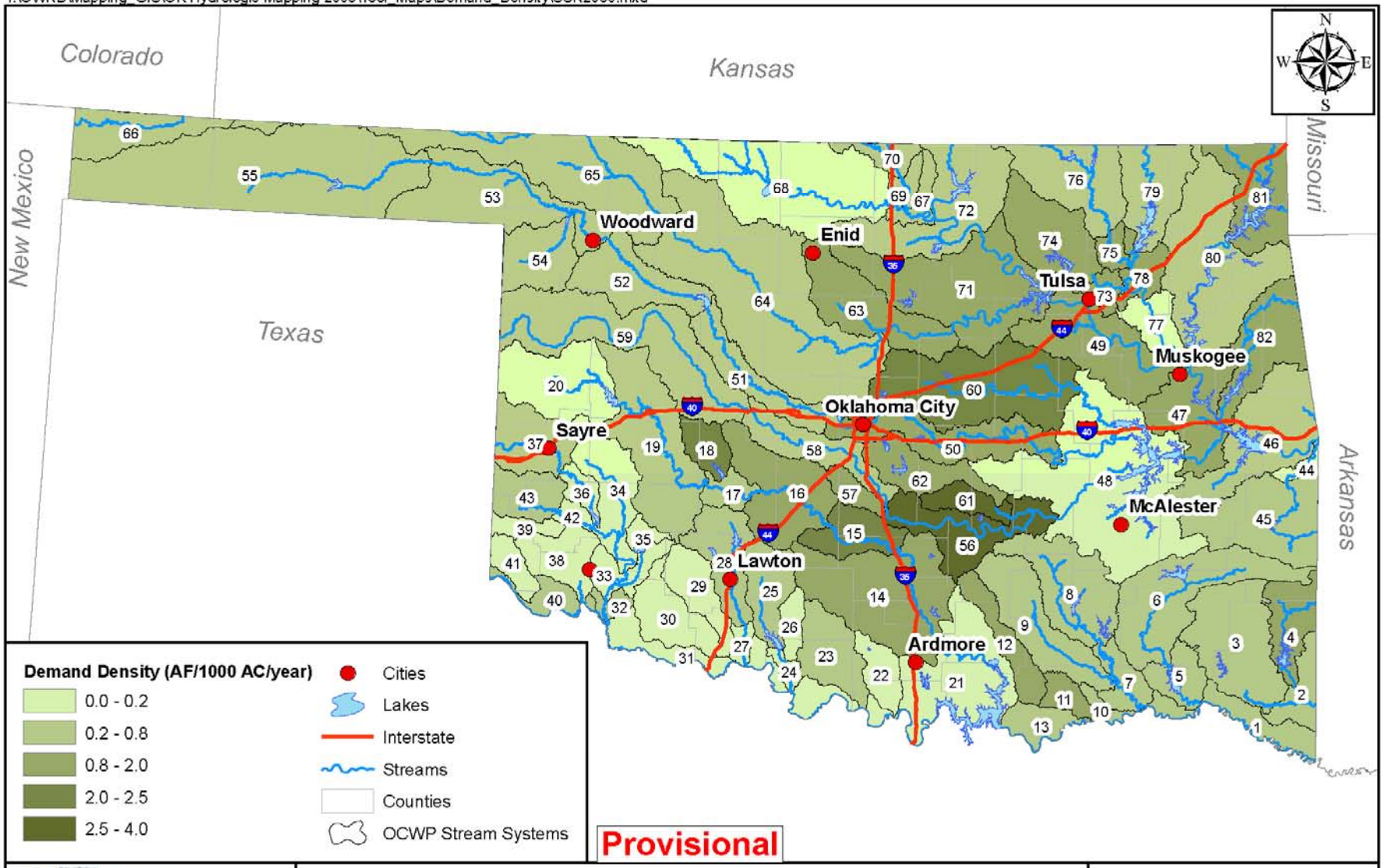

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Figure 2-19
2060 Self Supplied Rural Residential Demand Density

05.04.2009

Miles
0 25 50 75

Self-Supplied Industrial

- Large industrial water users that are not on a public water supply
- Existing users based on OWRB permit database and related sources of information
- Trends based on projected employment growth from the Oklahoma Employment Security Commission

Statewide Self-Supplied Industrial Demands

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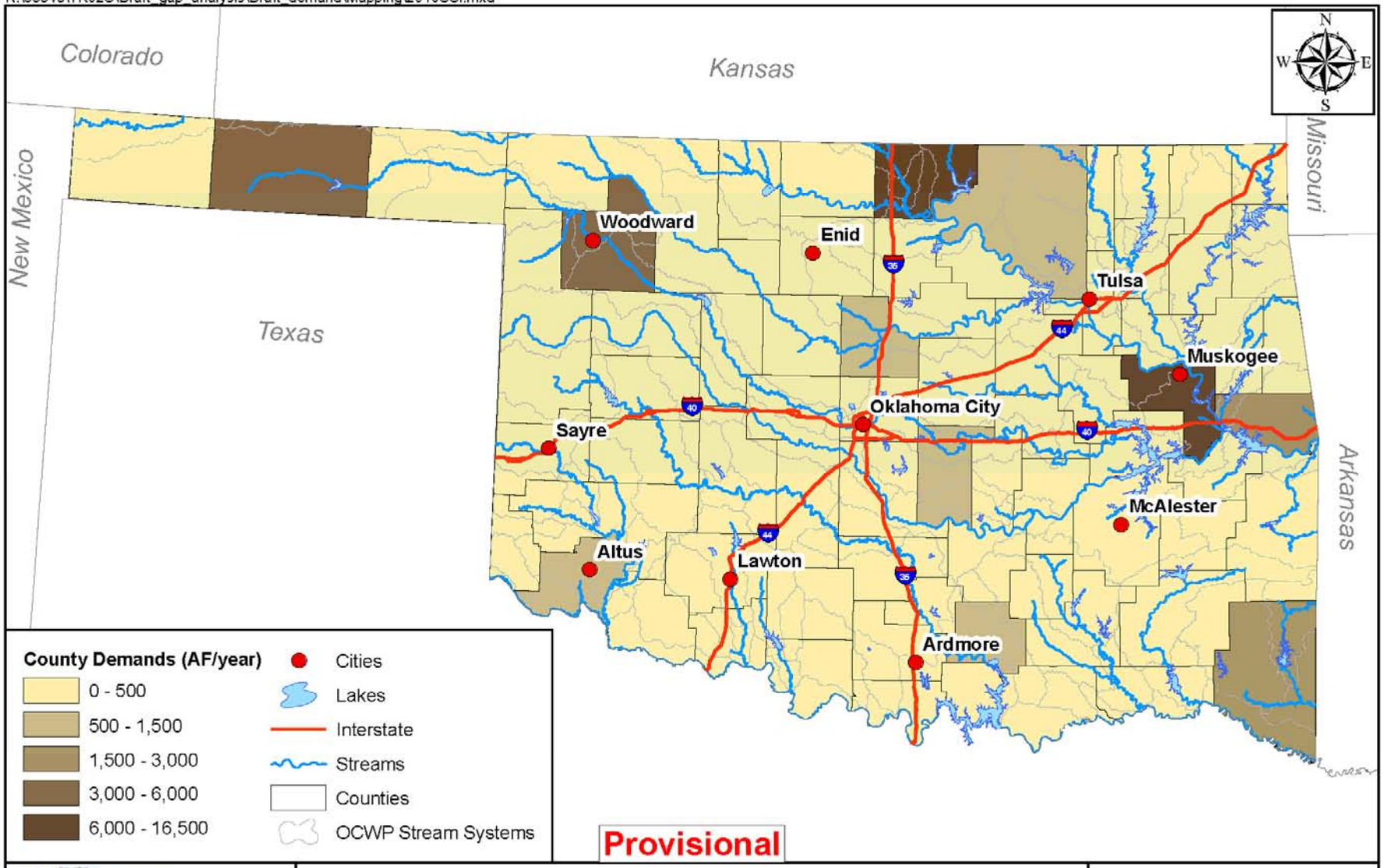

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Figure 2-6
2010 Self Supplied Industrial County Demands

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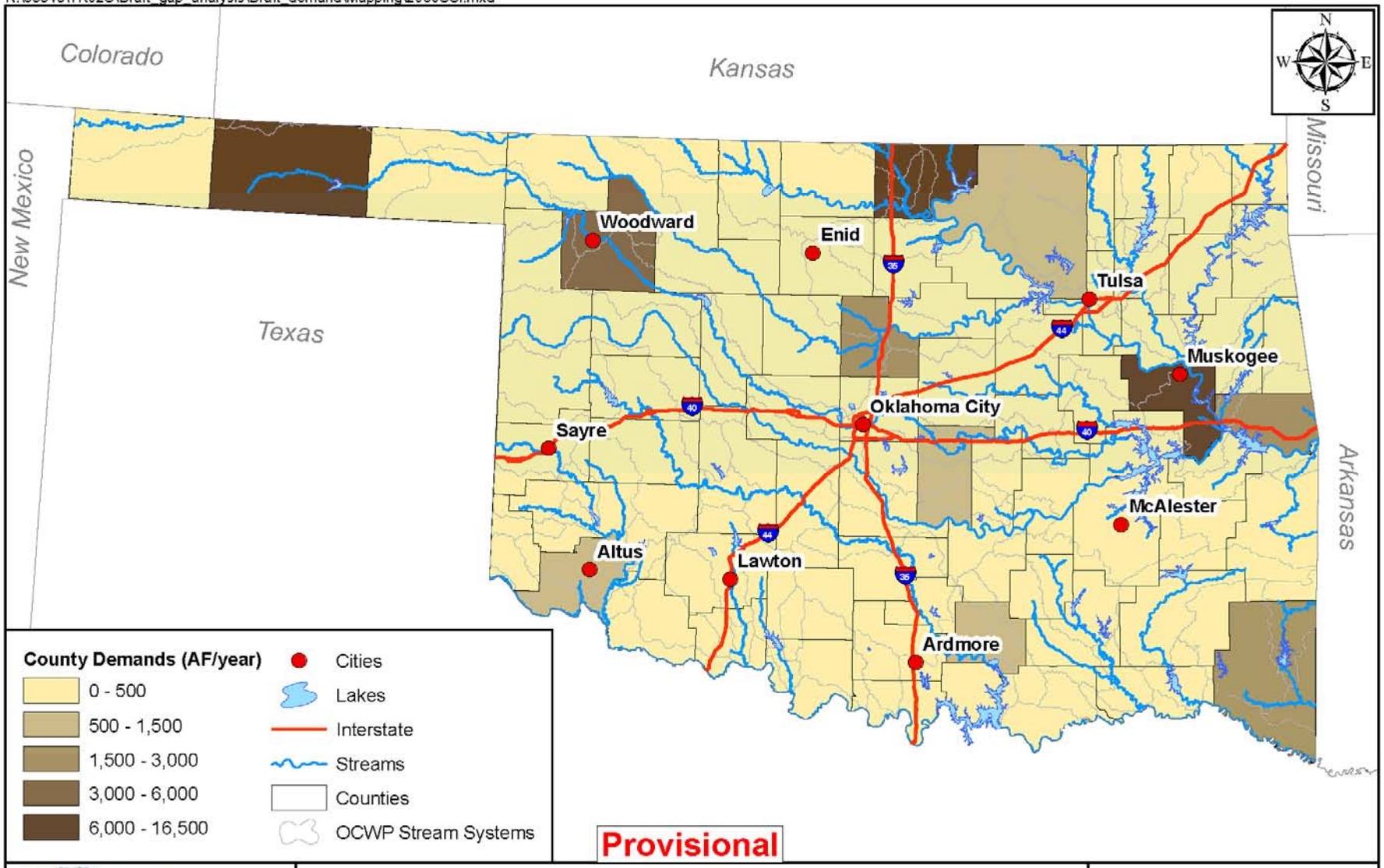

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Figure 2-7
2060 Self Supplied Industrial County Demands

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0 25 50 75

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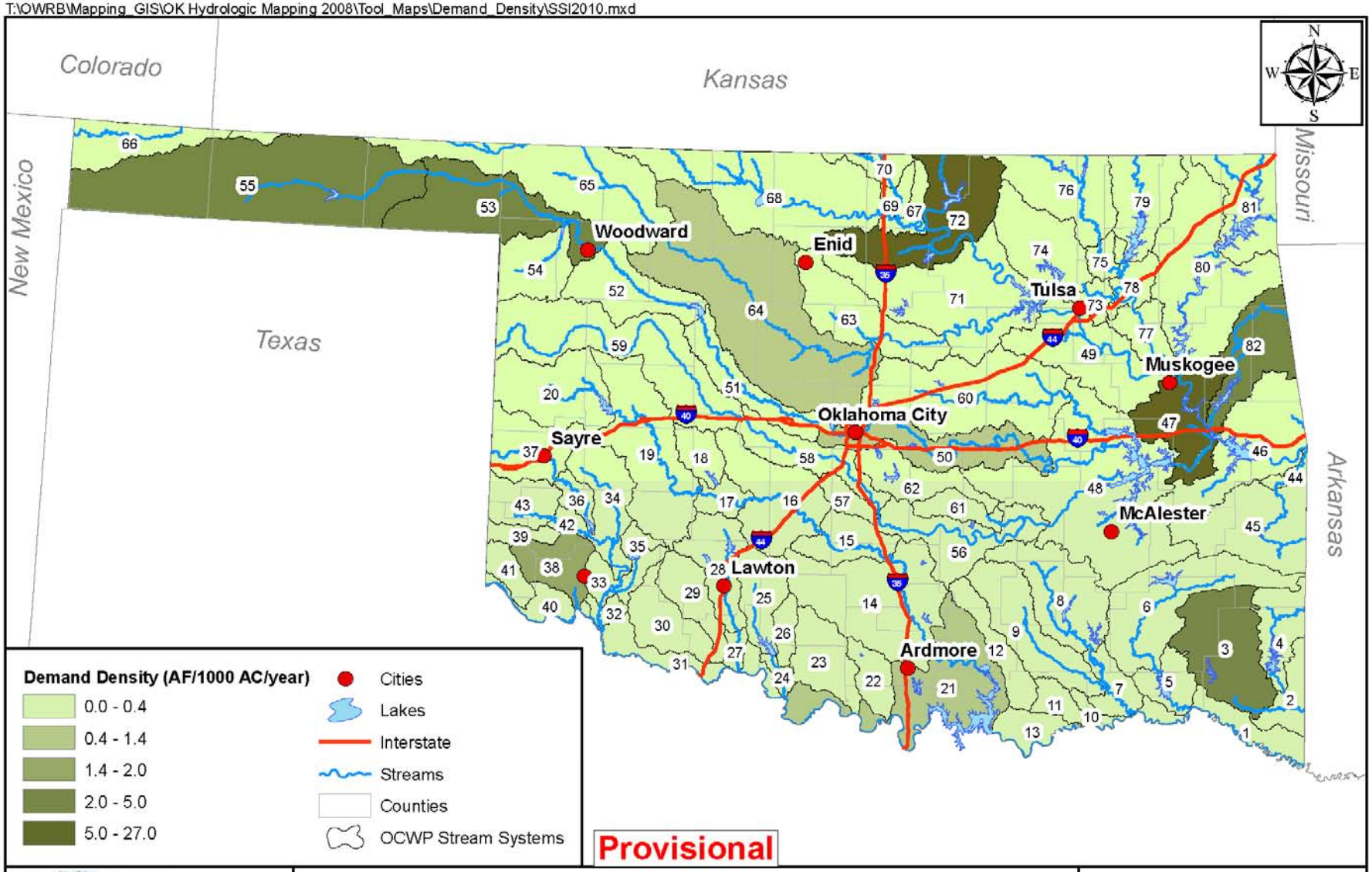

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Figure 2-20
2010 Self Supplied Industrial Demand Density

05.04.2009

Miles
0 25 50 75

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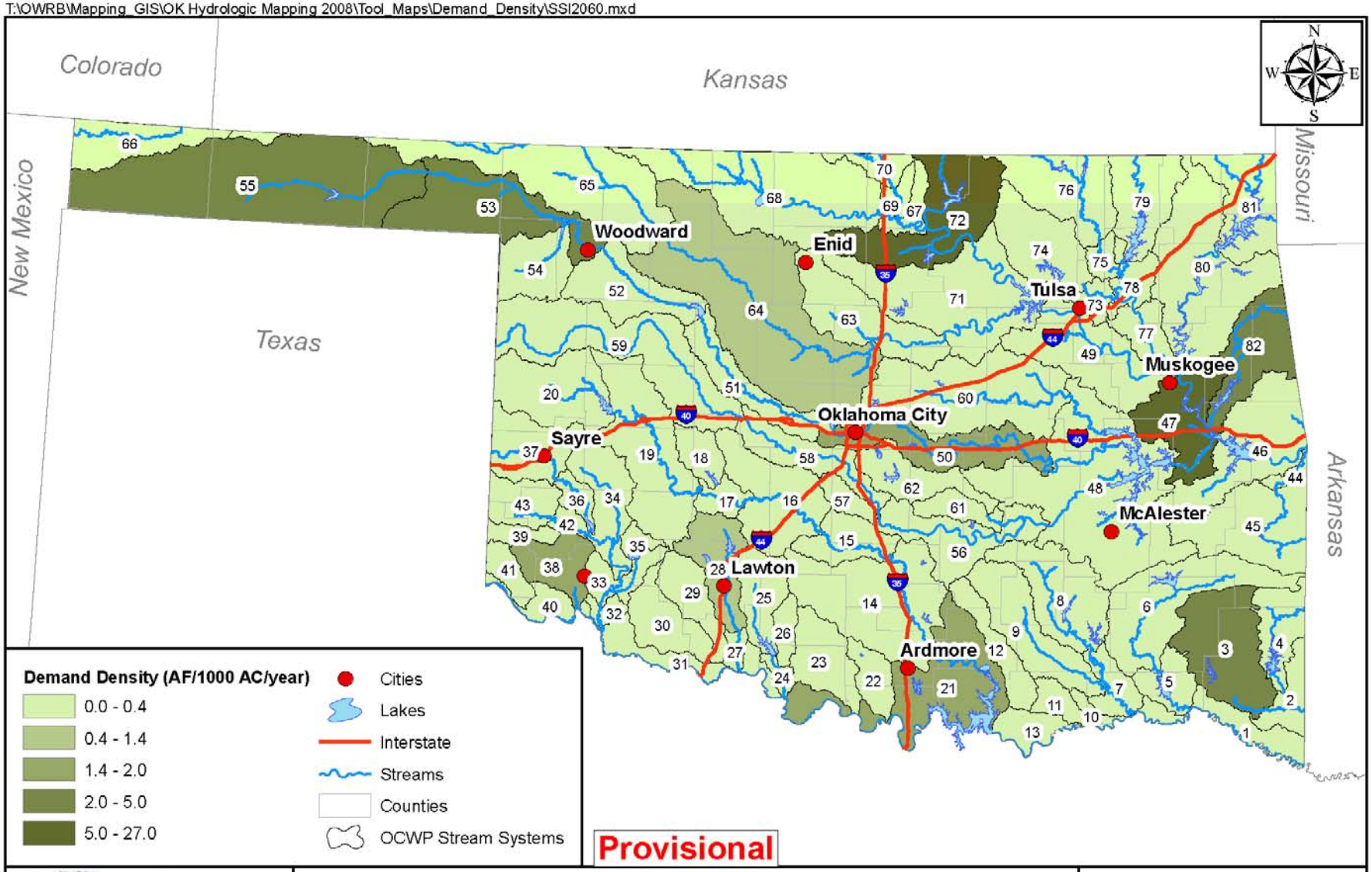

US Army Corps of Engineers
CDM

Figure 2-21
2060 Self Supplied Industrial Demand Density

05.04.2009

Miles
0 25 50 75

Thermoelectric Power

- Location and water use of existing power plants based on OWRB databases
- Future water use assumed to be 775 gallons per MWh based on industry data
- US Dept. of Energy projects 1.1% annual increase in power production
- 1.1% annual increase in water use assumed for power generation in Oklahoma in basins with existing power plants

Statewide Thermoelectric Power Demands

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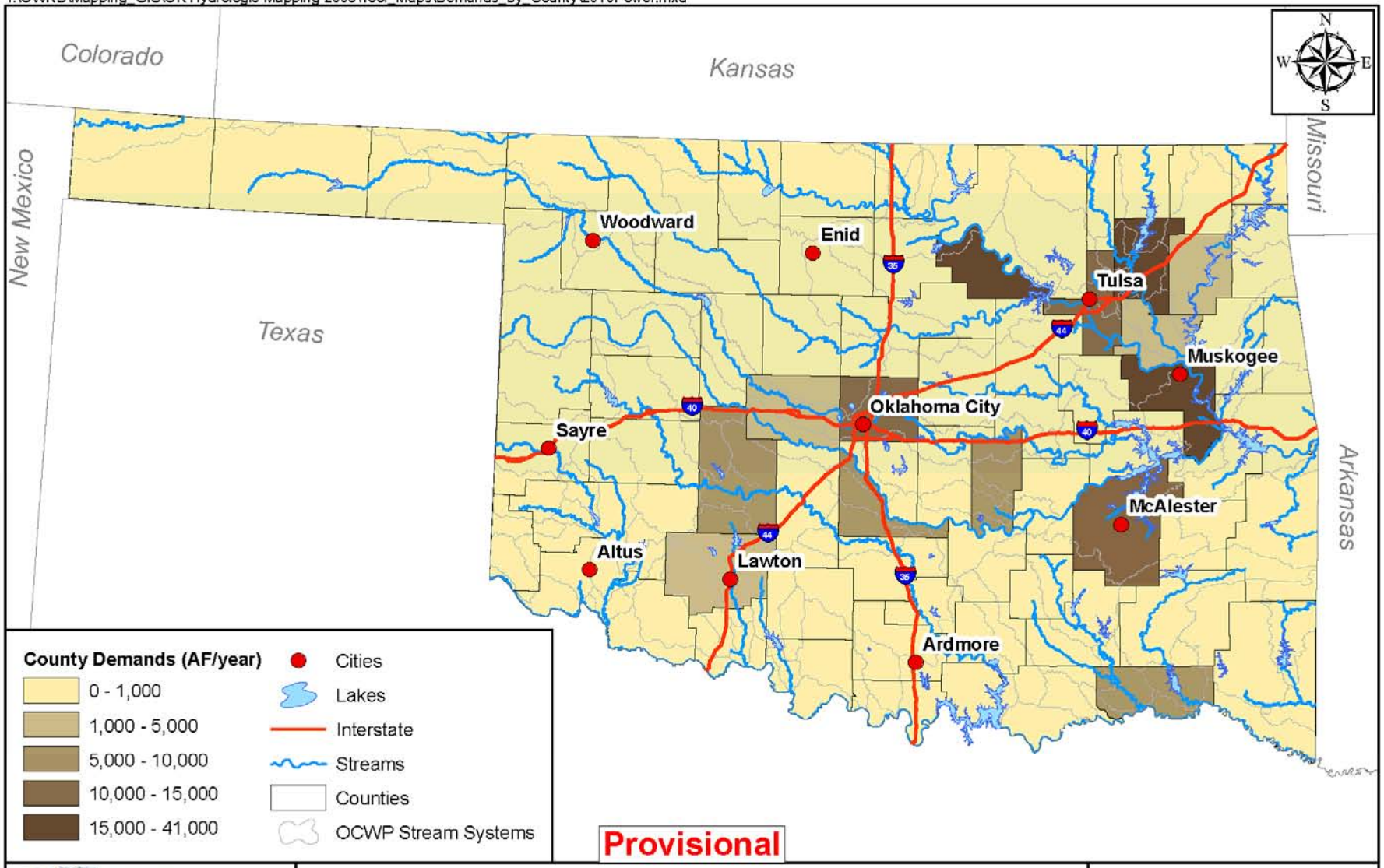

US Army Corps of Engineers
CDM

Figure 2-8
2010 Thermoelectric Power County Demands

05.04.2009

0 25 50 75 Miles

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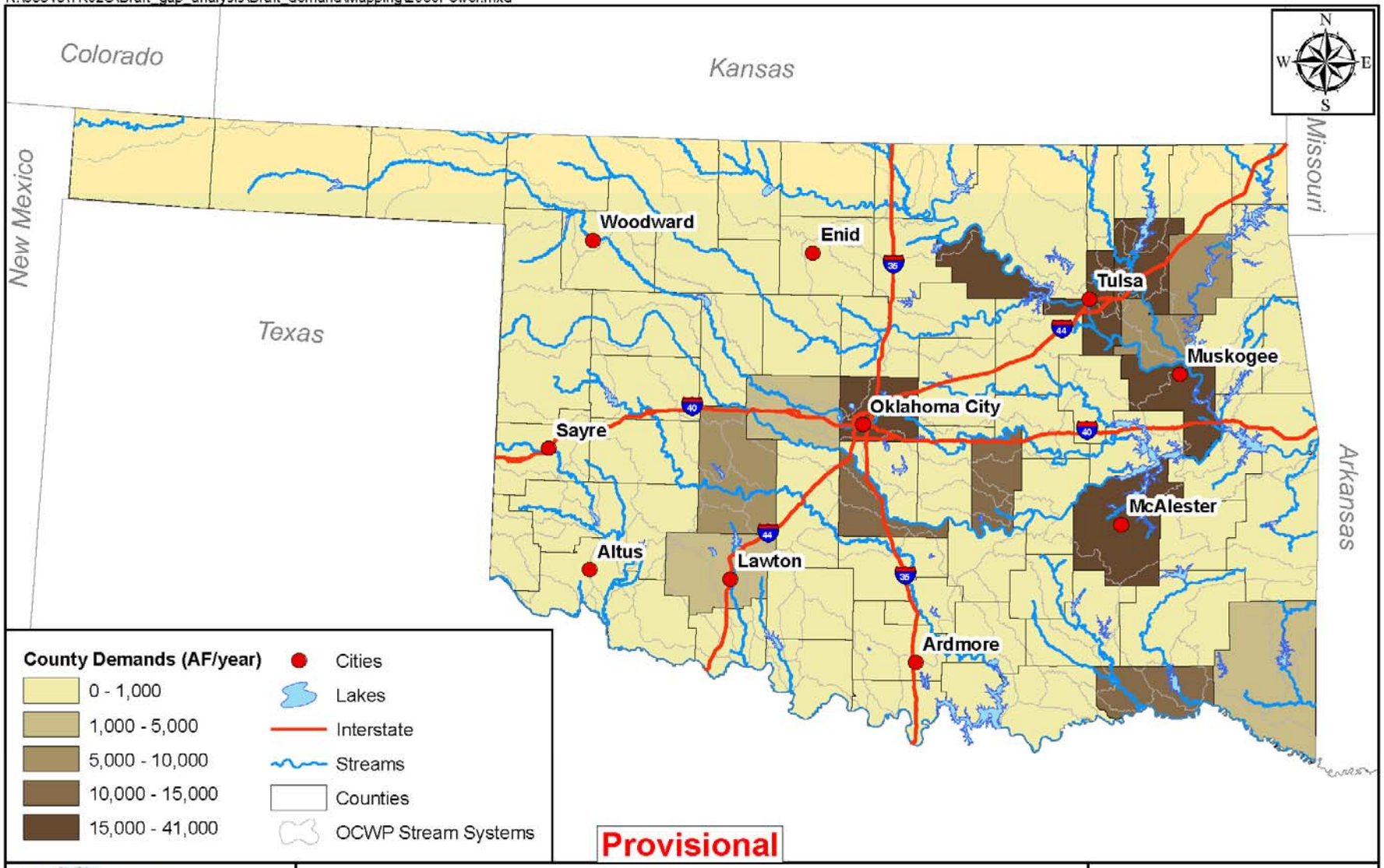

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Figure 2-9
2060 Thermoelectric Power County Demands

05.05.2009

Miles
0 25 50 75

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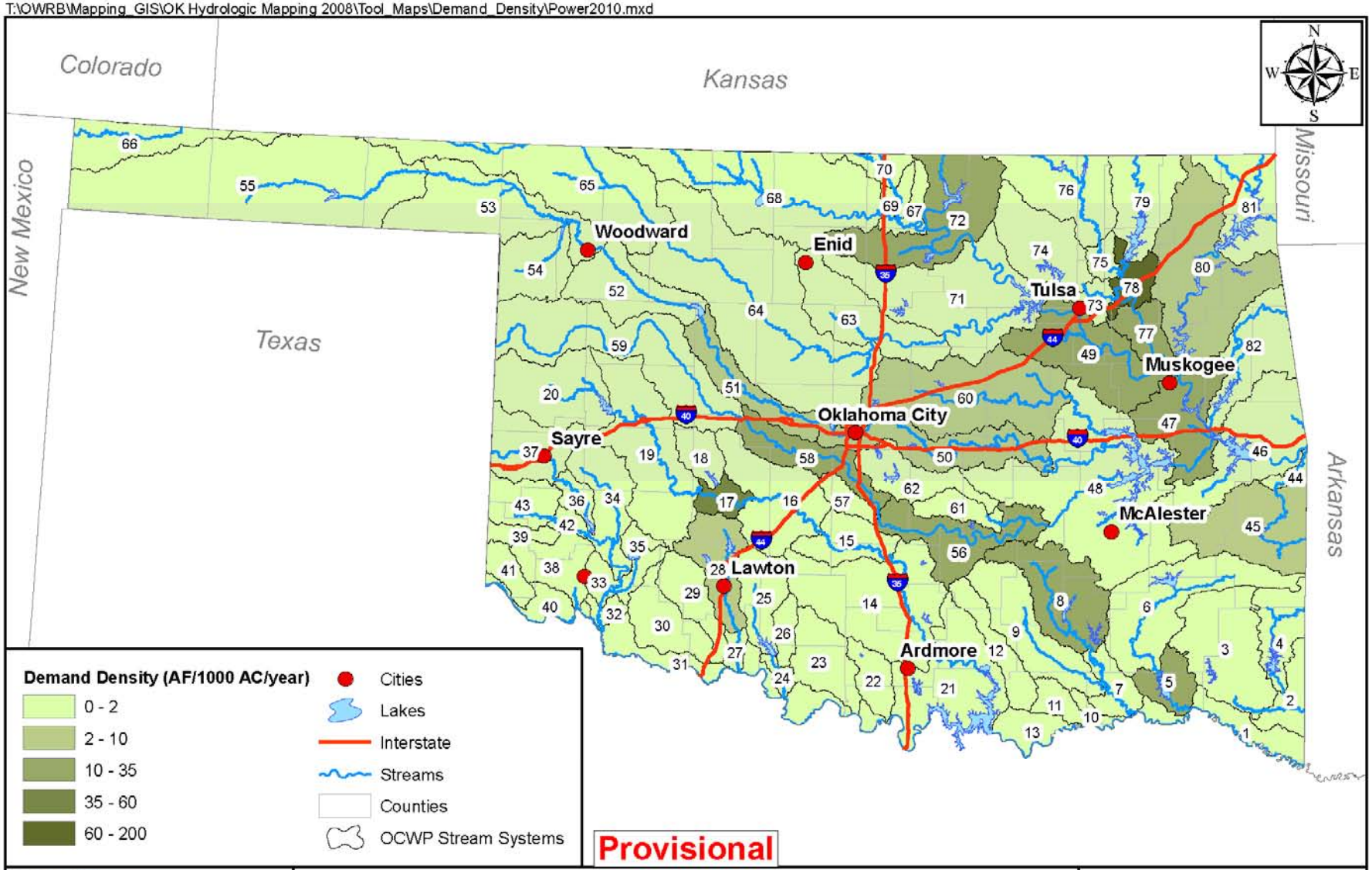

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Figure 2-22
2010 Thermoelectric Power Demand Density

05.04.2009

Miles
0 25 50 75

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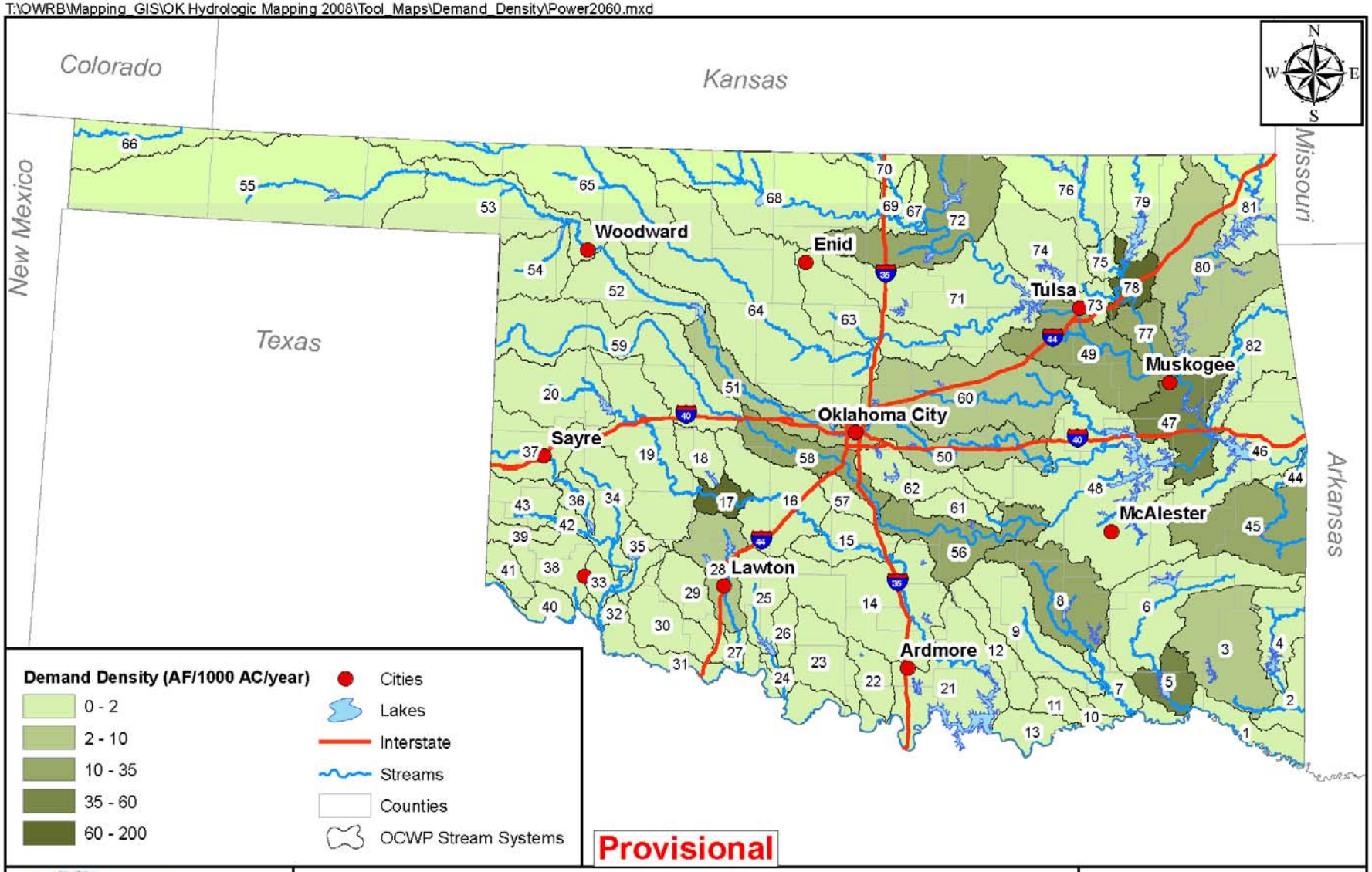

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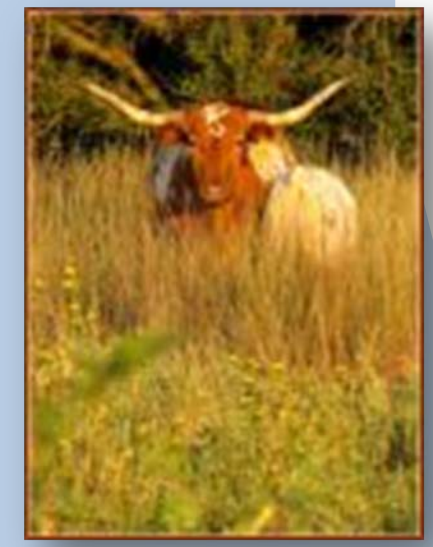
Figure 2-23
2060 Thermoelectric Power Demand Density

05.04.2009

Miles
0 25 50 75

Livestock



- Demands for watering and related uses
- Broken down by animal type
- OSU water use requirement data
- 2% growth anticipated between now and 2060 based on USDA projections

Daily Water Requirement

Cattle	17
Sheep	2
Hogs	3
Chickens	0.1

Statewide Livestock Demands

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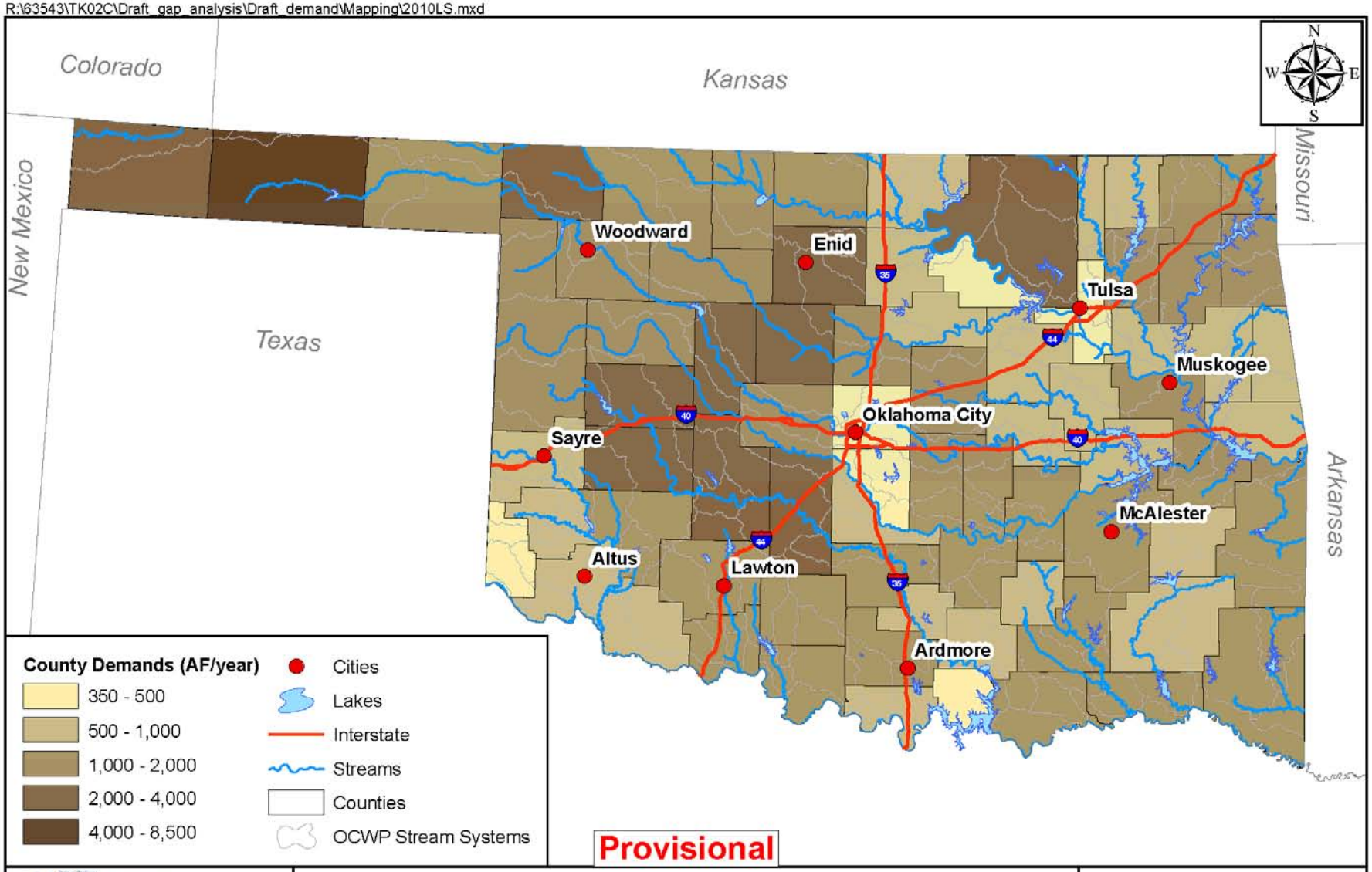

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Figure 2-10
2010 Livestock
County Demands

05.05.2009

Miles
0 25 50 75

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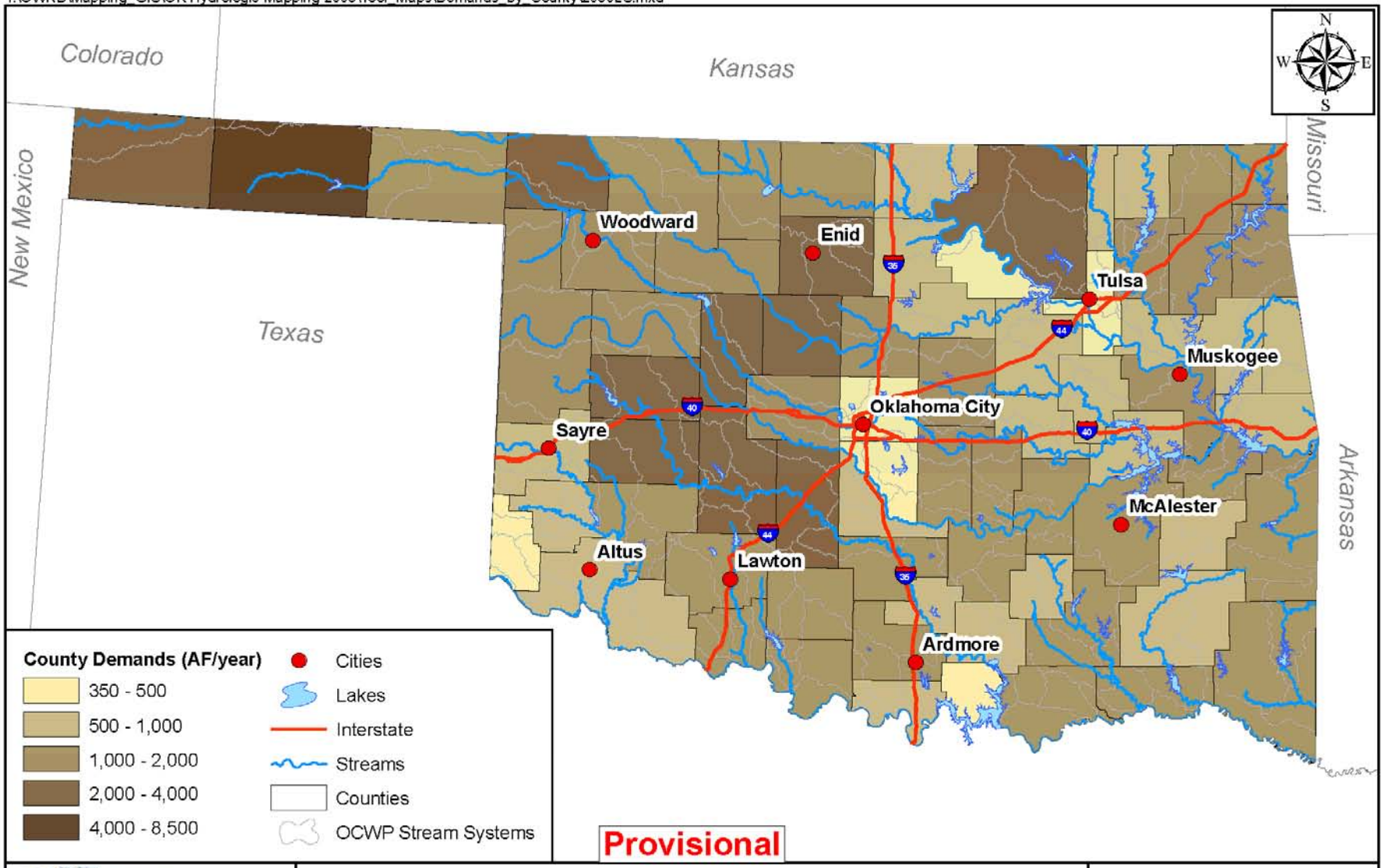

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Figure 2-11
2060 Livestock
County Demands

05.04.2009

Miles
0 25 50 75

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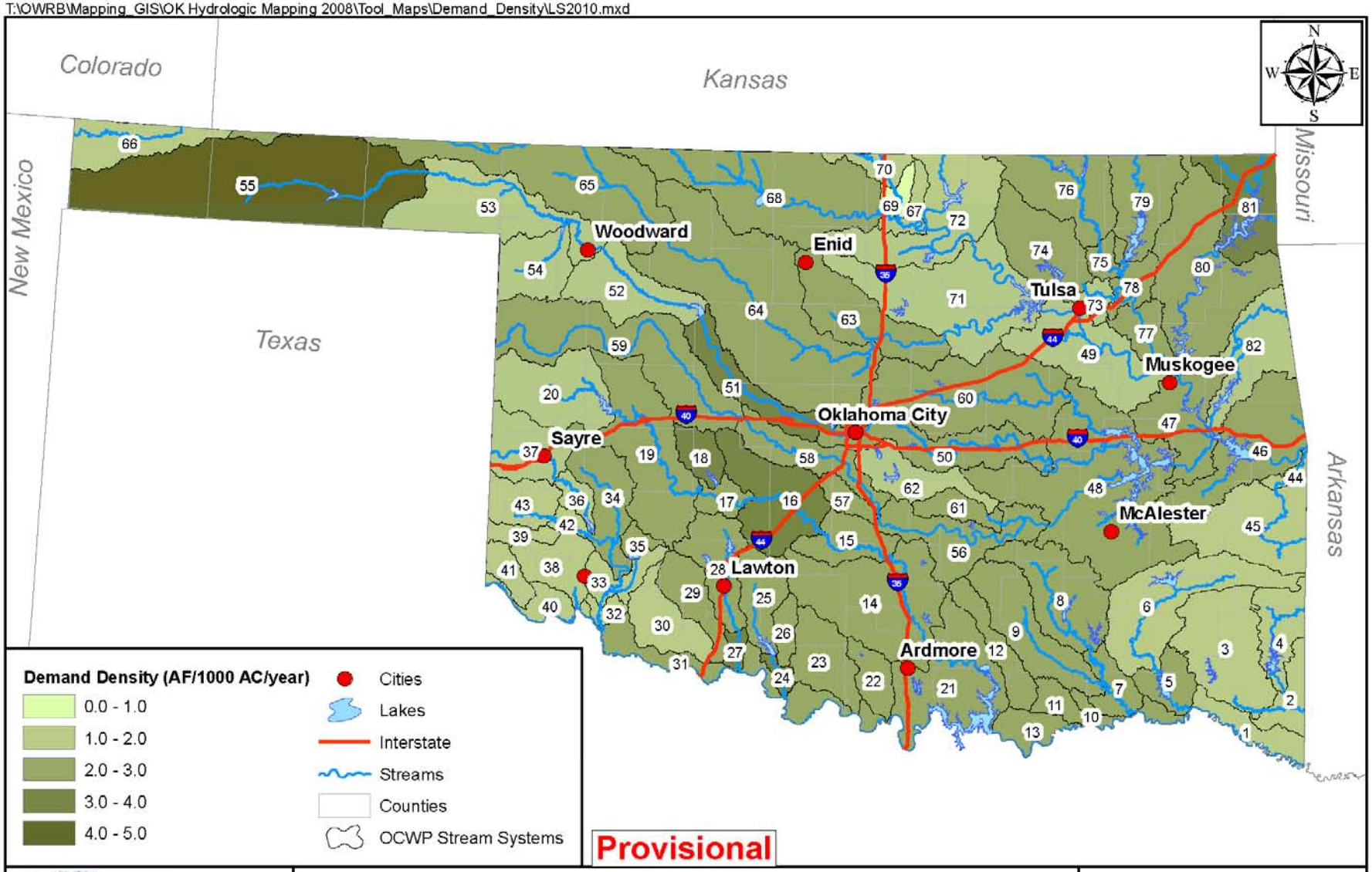

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Figure 2-24
2010 Livestock
Demand Density

05.04.2009

Miles
0 25 50 75

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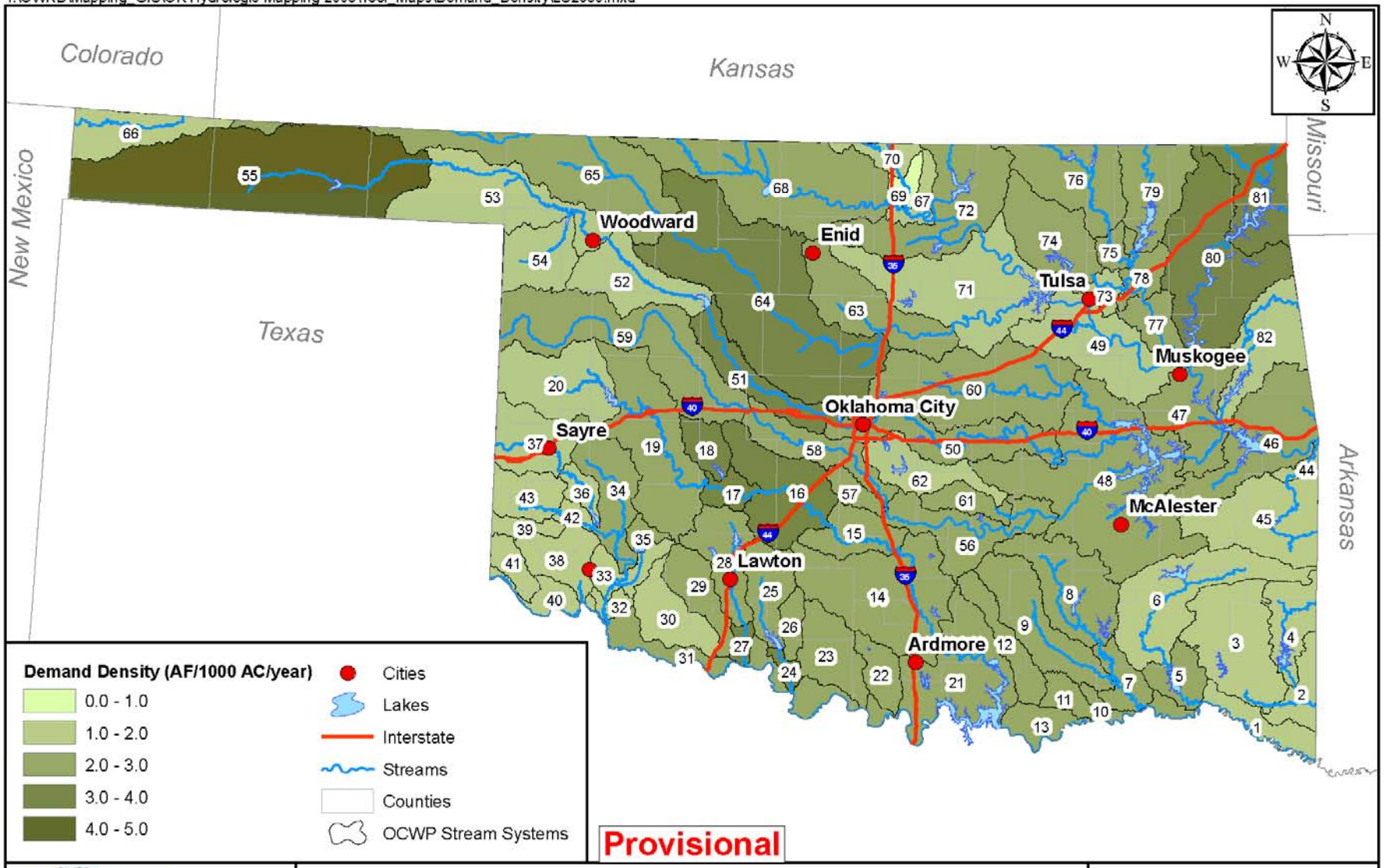

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Figure 2-25
2060 Livestock
Demand Density

04.28.2009

Miles
0 25 50 75

Irrigated Crops

- *Acres x water use requirement*
- NASS 2002 irrigated acres by county by crop
- USGS field application by county
  - *Sprinkler, surface, micro*
- NRCS irrigation requirements by crop type for 11 cities
- BR field application efficiency
- Projection of irrigated acres based on historical max

Statewide Crop Irrigation Demands

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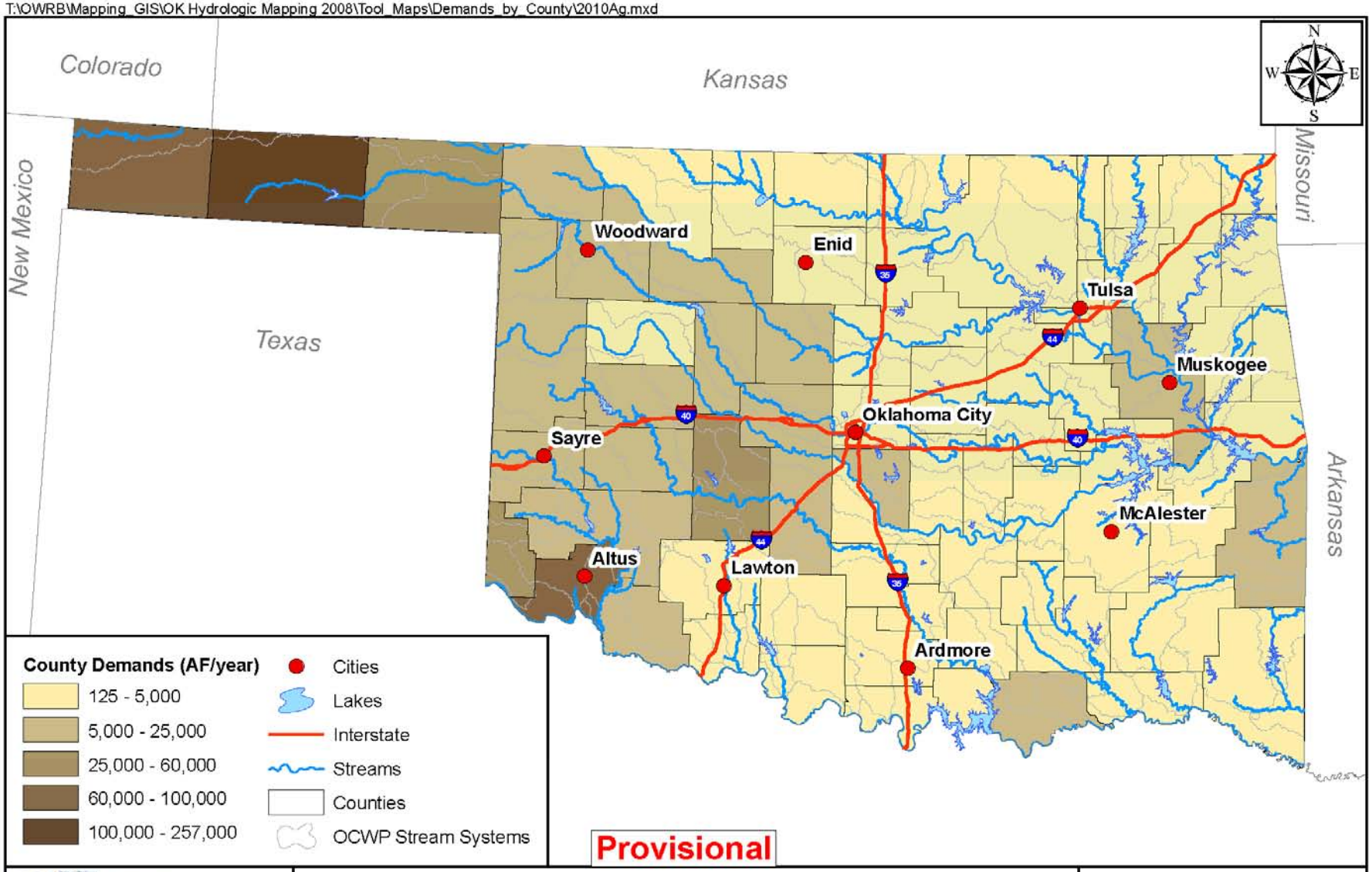

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Figure 2-12
2010 Crop Irrigation
County Demands

05.04.2009

Miles
0 25 50 75

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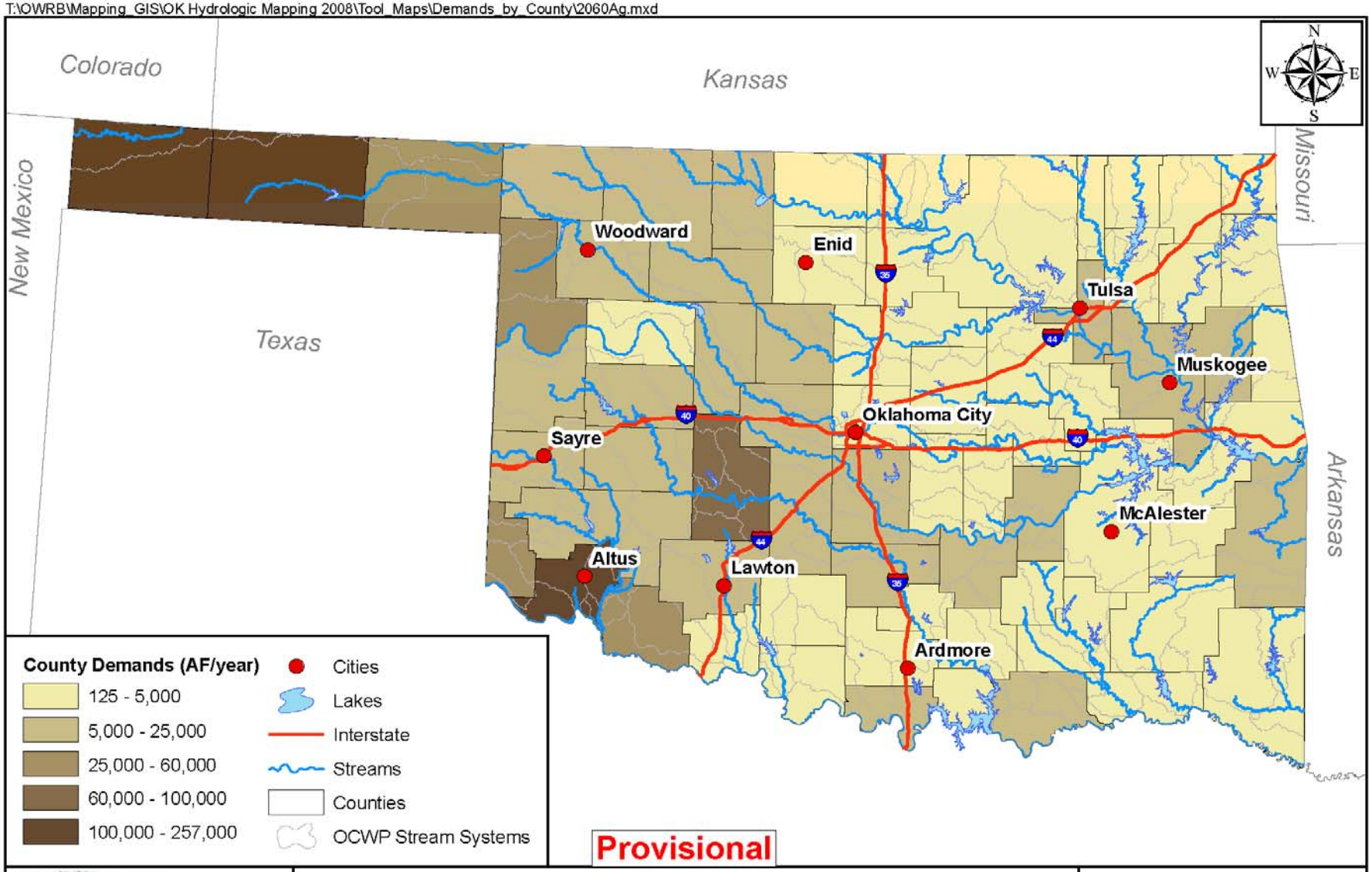

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Figure 2-13
2060 Crop Irrigation County Demands

05.04.2009

0 25 50 75 Miles

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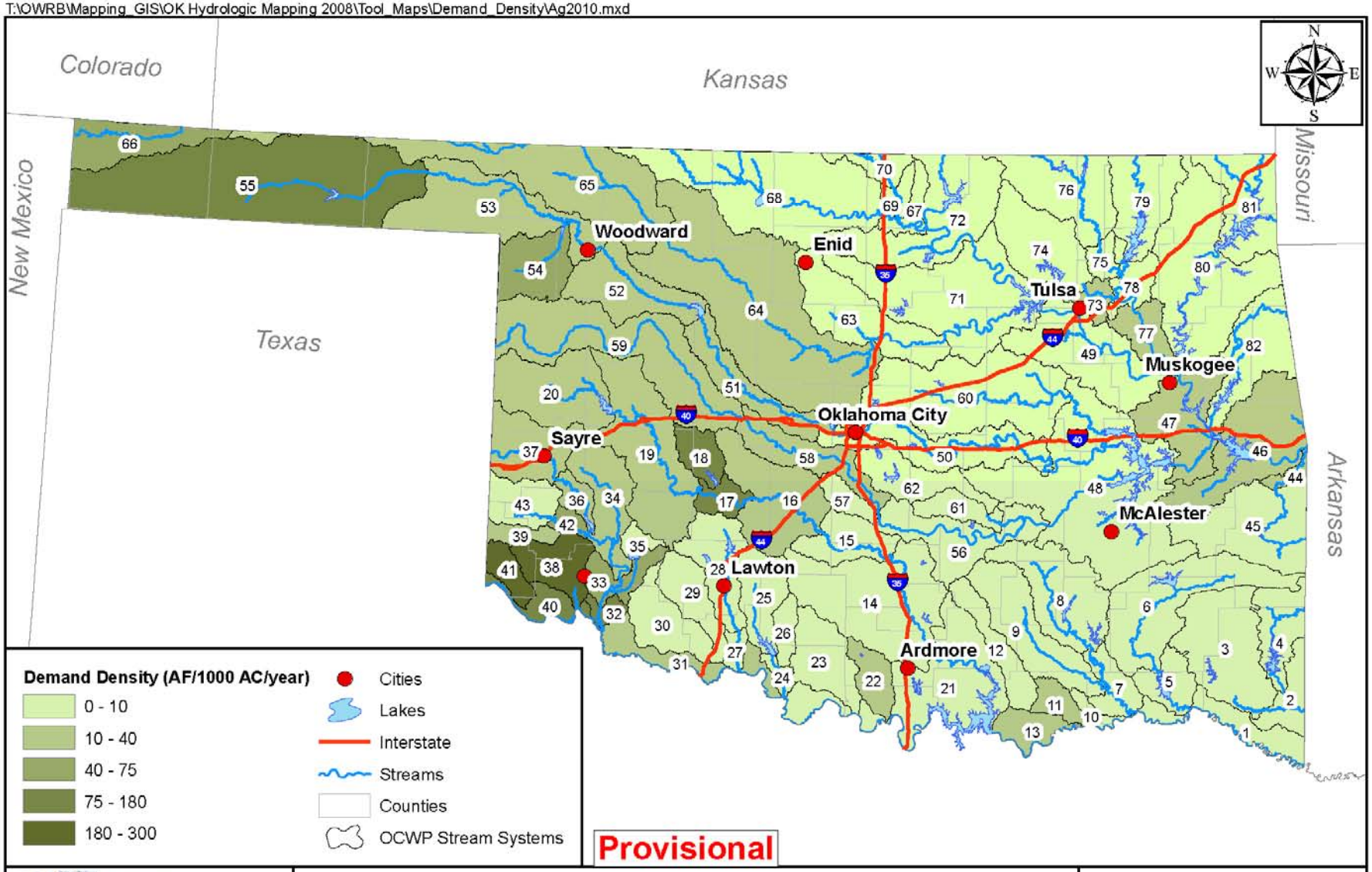

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Figure 2-26
2010 Crop Irrigation Demand Density

05.04.2009

Miles
0 25 50 75

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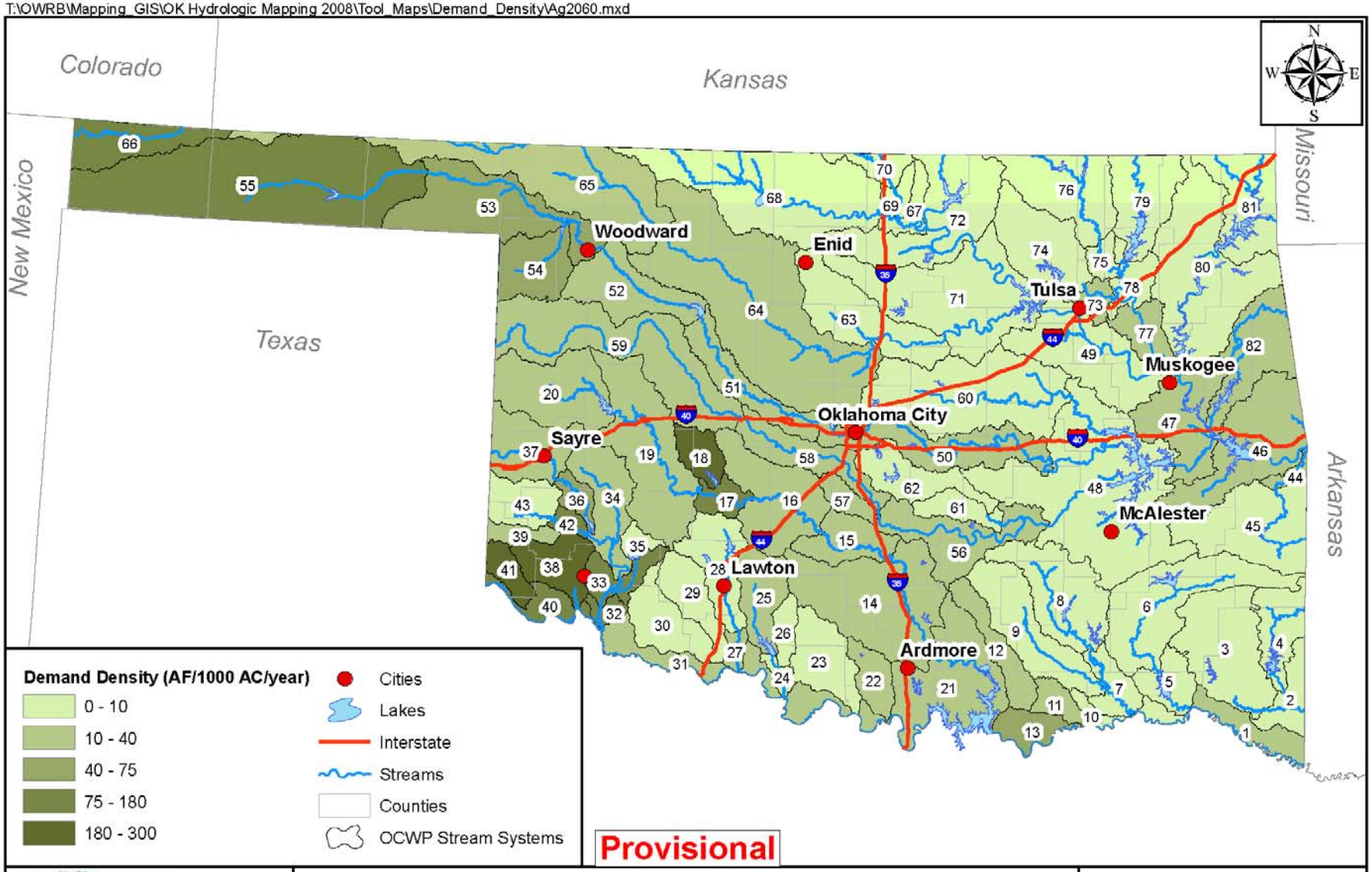

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Figure 2-27
2060 Crop Irrigation Demand Density

05.04.2009

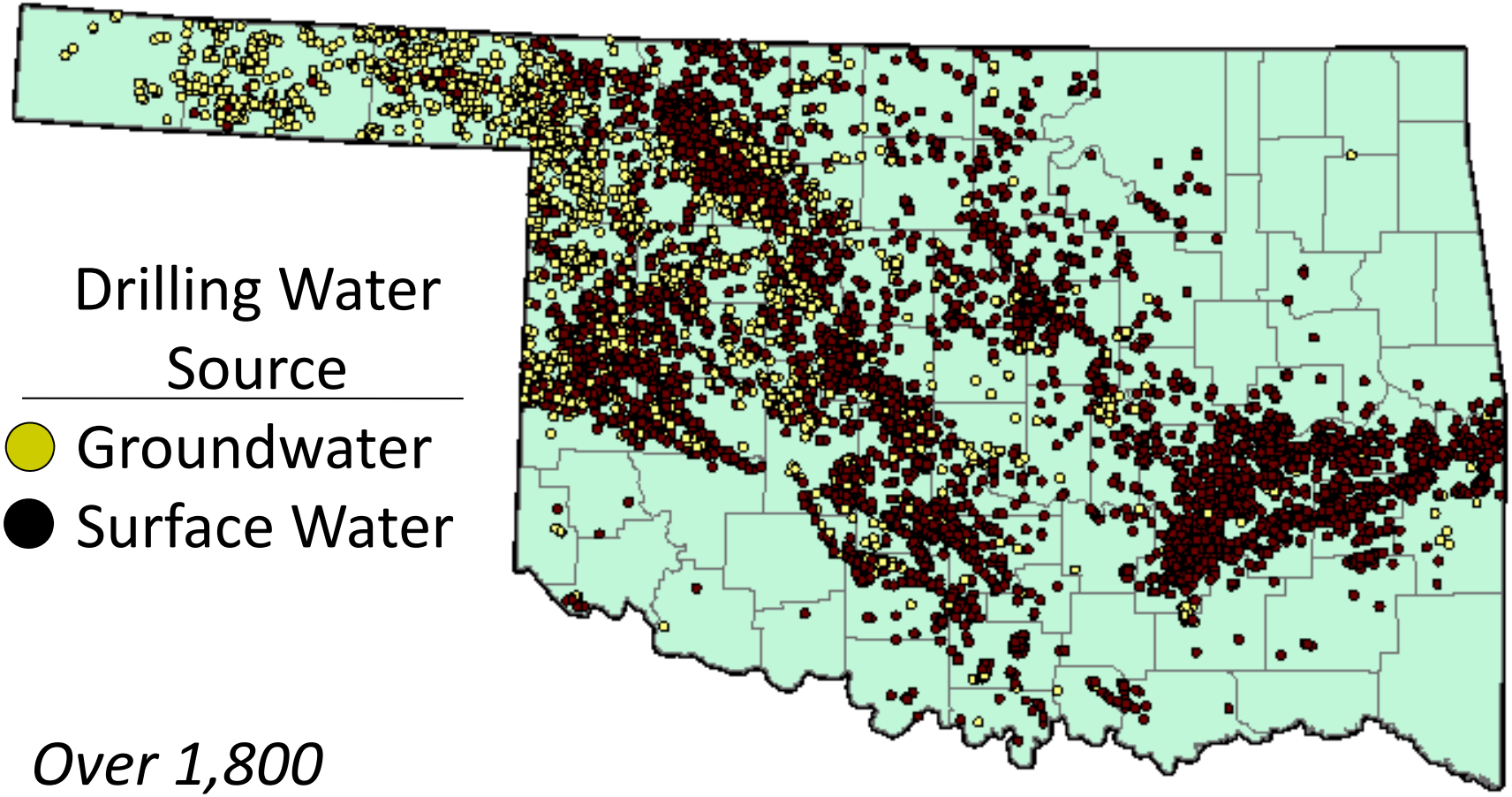
Miles
0 25 50 75

Oil & Gas

- Drilling and exploration water use (not refineries)
- Data from OWRB permit and water use databases, augmented by industry representatives' input
- Assumed 1% annual increase in demand
- Ongoing work group activities refining the provisional demand projections

Statewide Oil & Gas Demands

Oil and Gas Drilling Activity Since 2000

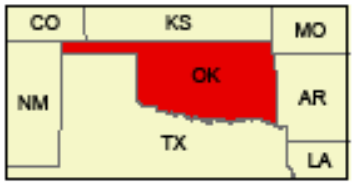


Drilling Water Source

- Groundwater
- Surface Water

Over 1,800 applications in 2008 alone

0 50 100 Miles



Data Source: OWRB Water Rights Database

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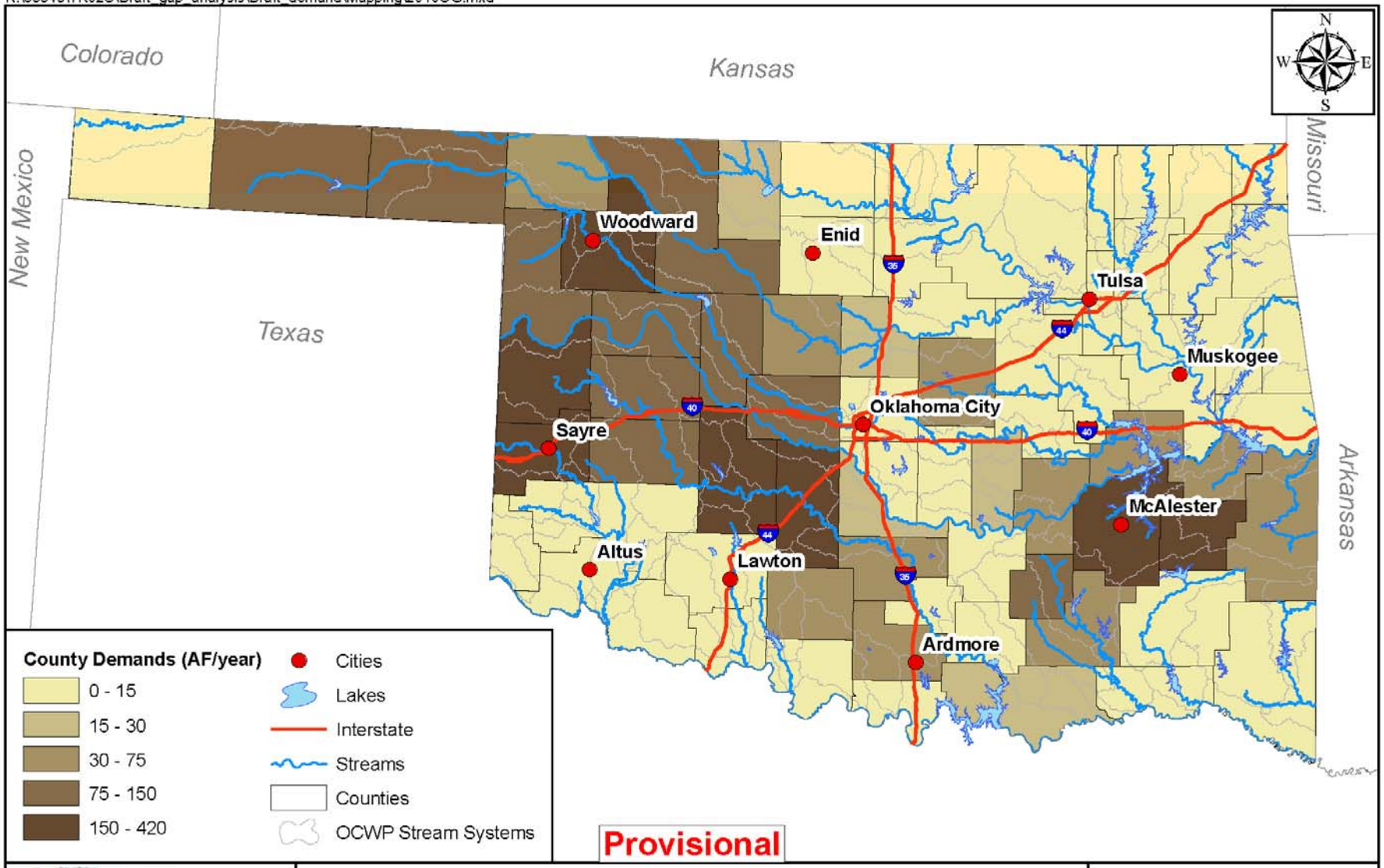

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Figure 2-14
2010 Oil and Gas
County Demands

05.05.2009

Miles
0 25 50 75

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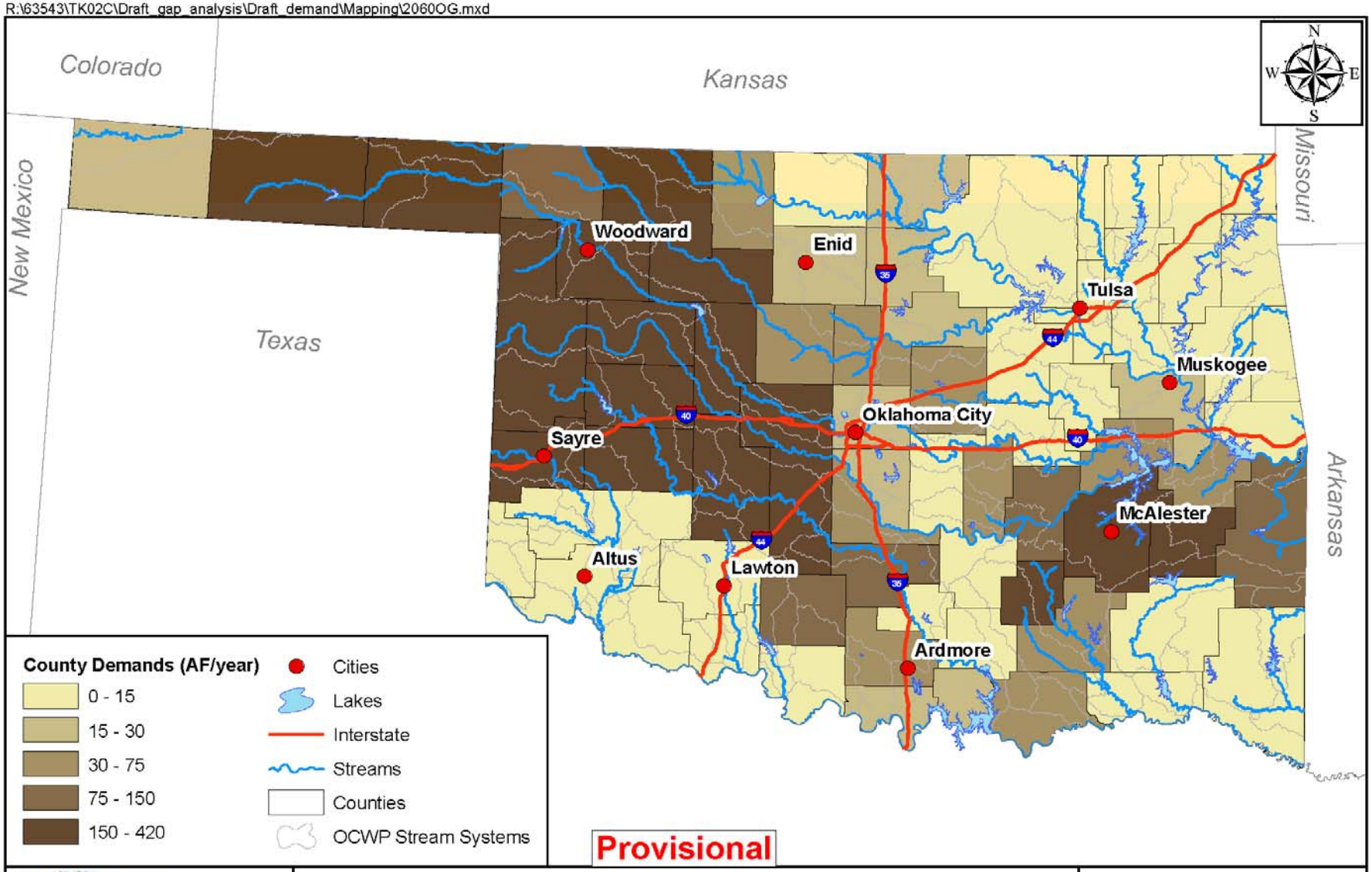

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Figure 2-15
2060 Oil and Gas
County Demands

05.05.2009

Miles
0 25 50 75

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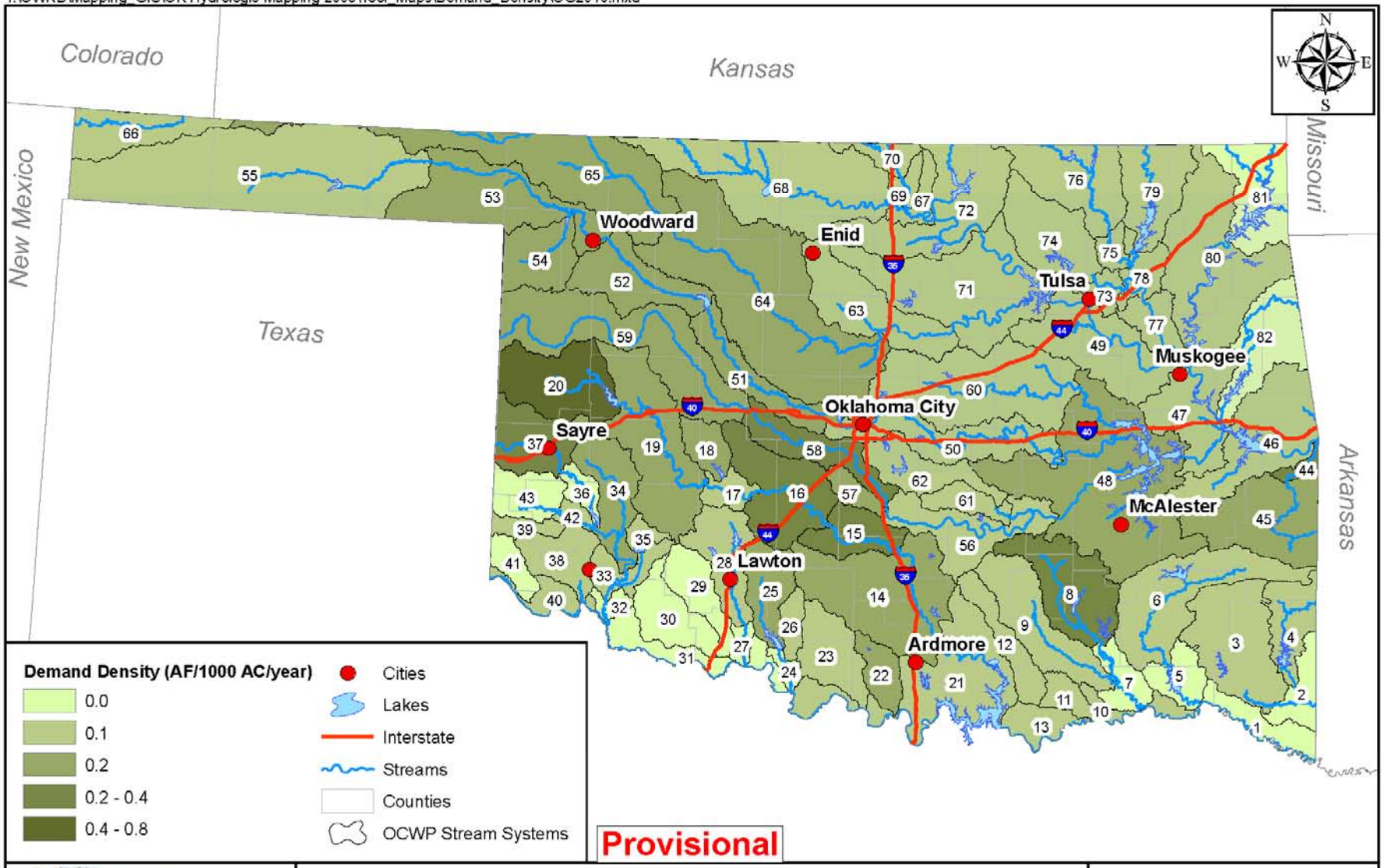

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Figure 2-28
2010 Oil and Gas Demand Density

05.04.2009

0 25 50 75 Miles

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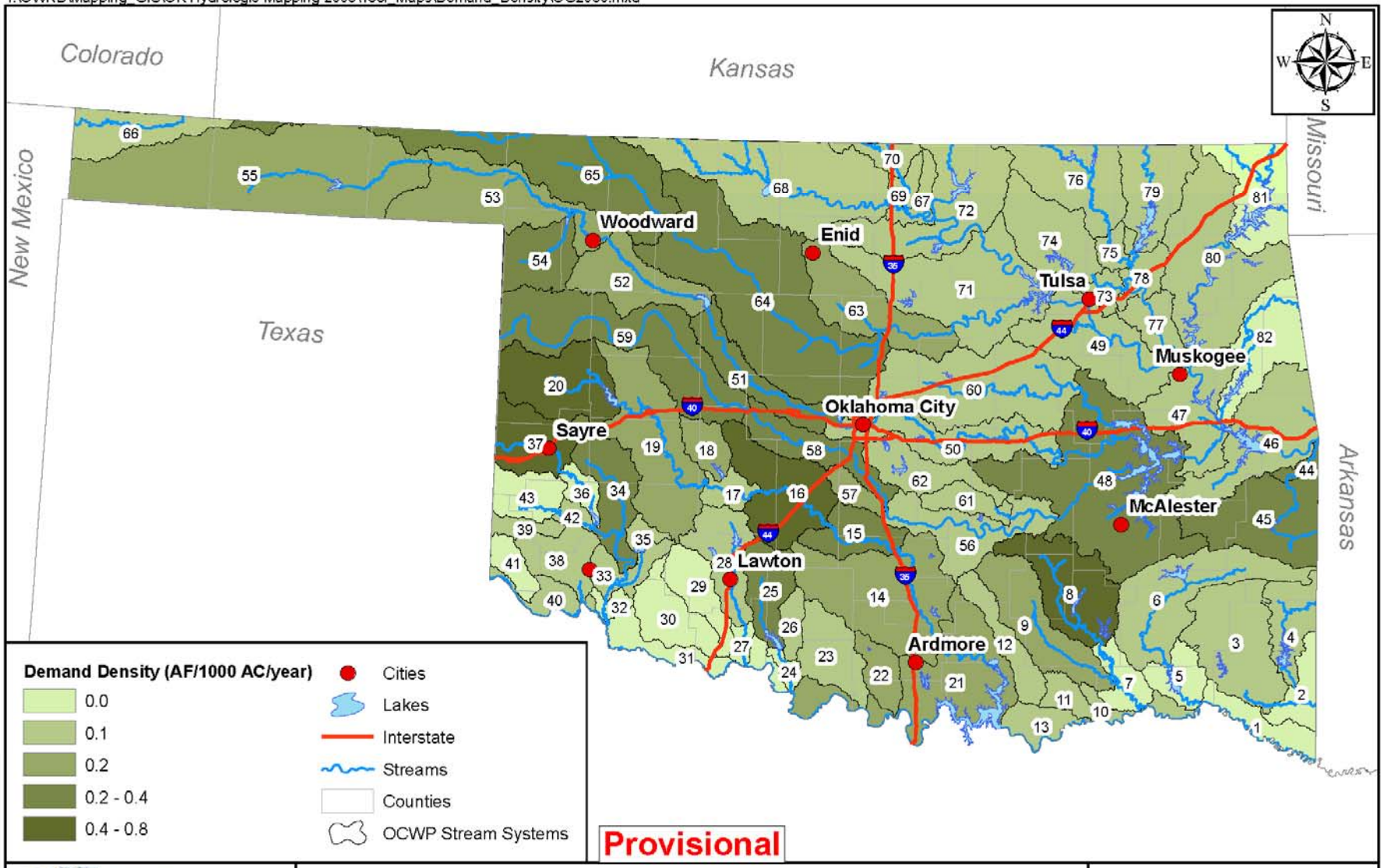

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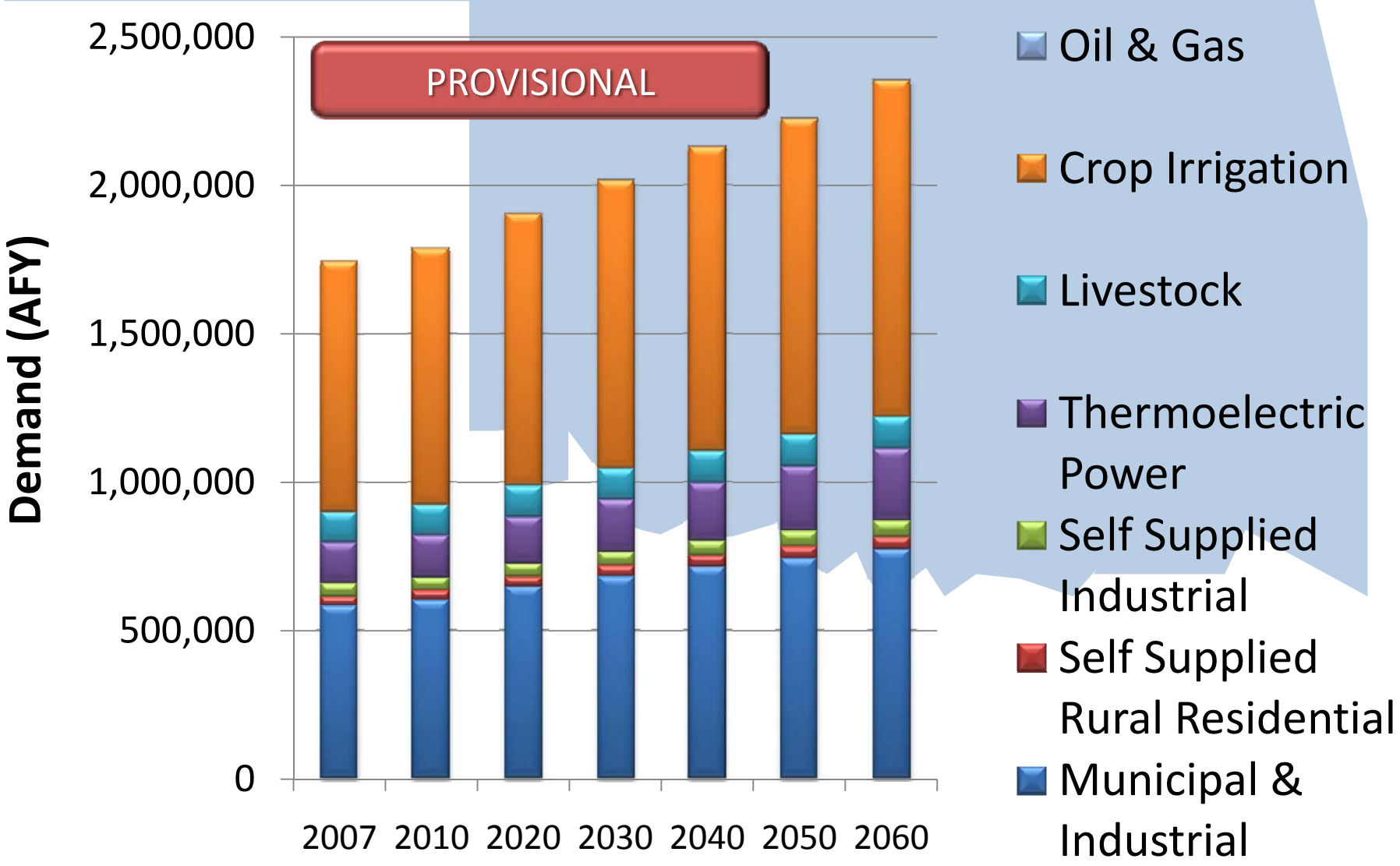
Figure 2-29
2060 Oil and Gas Demand Density

05.04.2009

0 25 50 75 Miles

Statewide Demands – All Sectors



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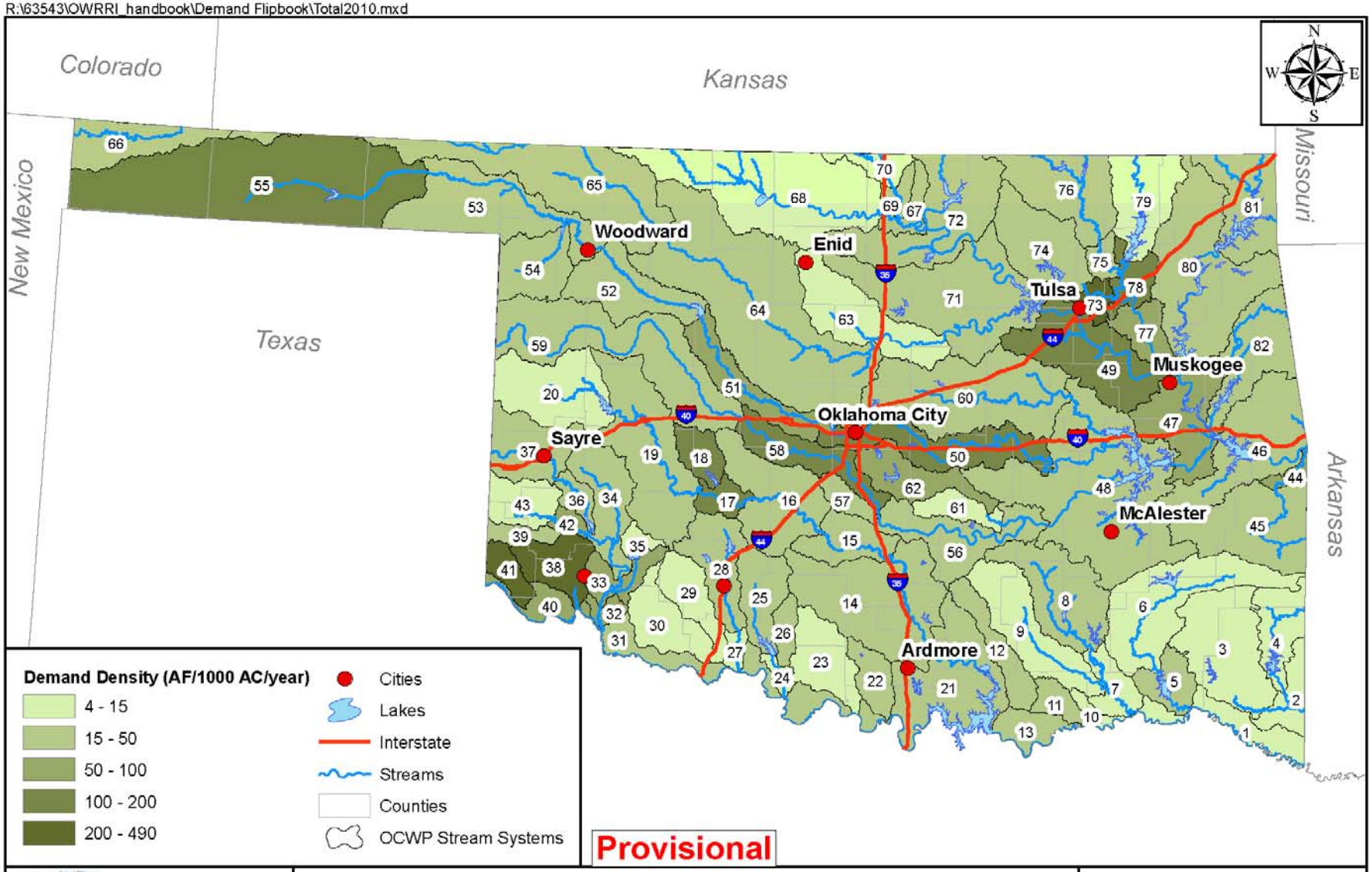

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2010 Total Demand Density

05.08.2009

0 25 50 75 Miles

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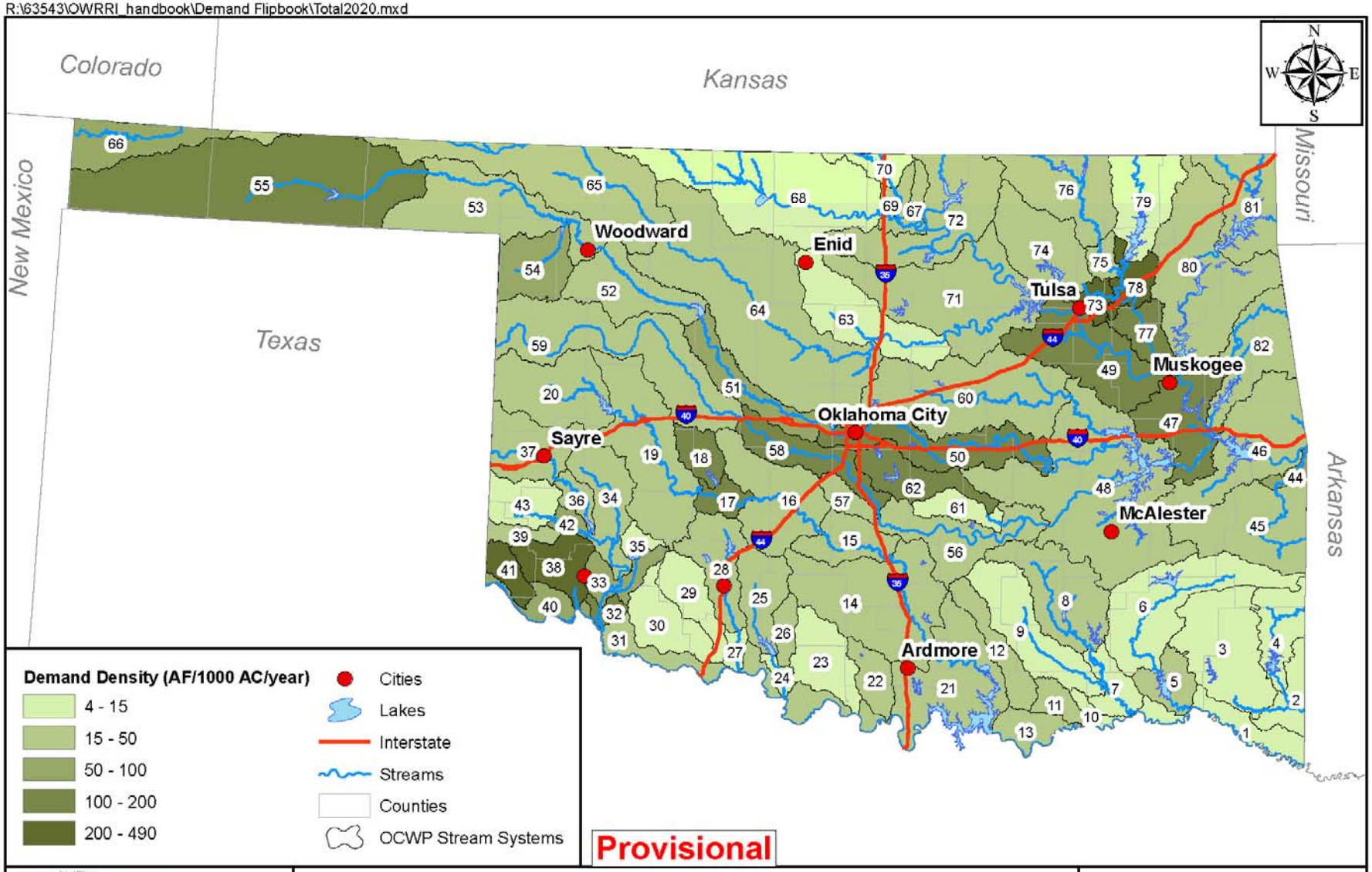

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2020 Total Demand Density

05.08.2009

0 25 50 75 Miles

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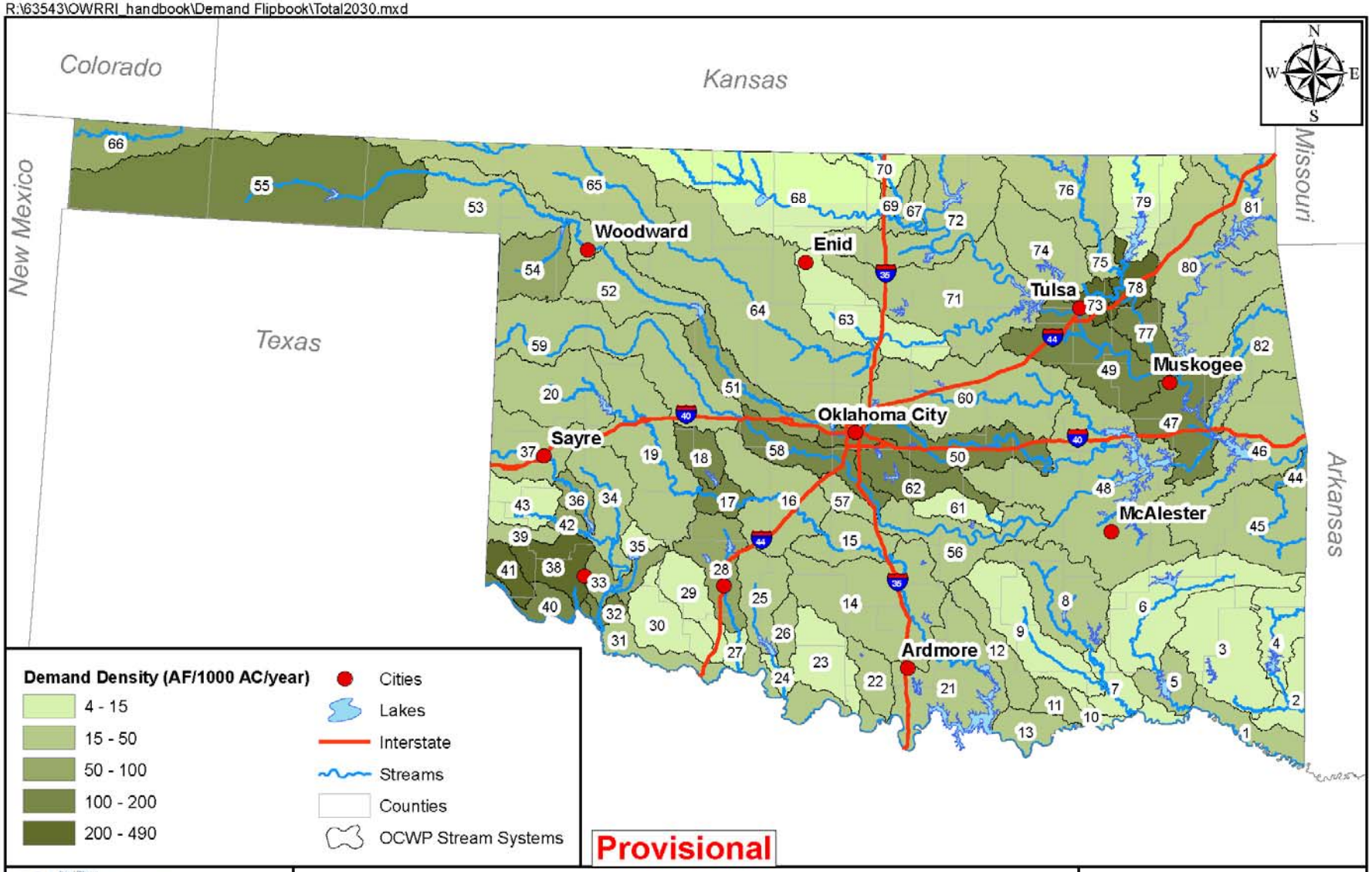

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2030 Total Demand Density

05.08.2009

0 25 50 75 Miles

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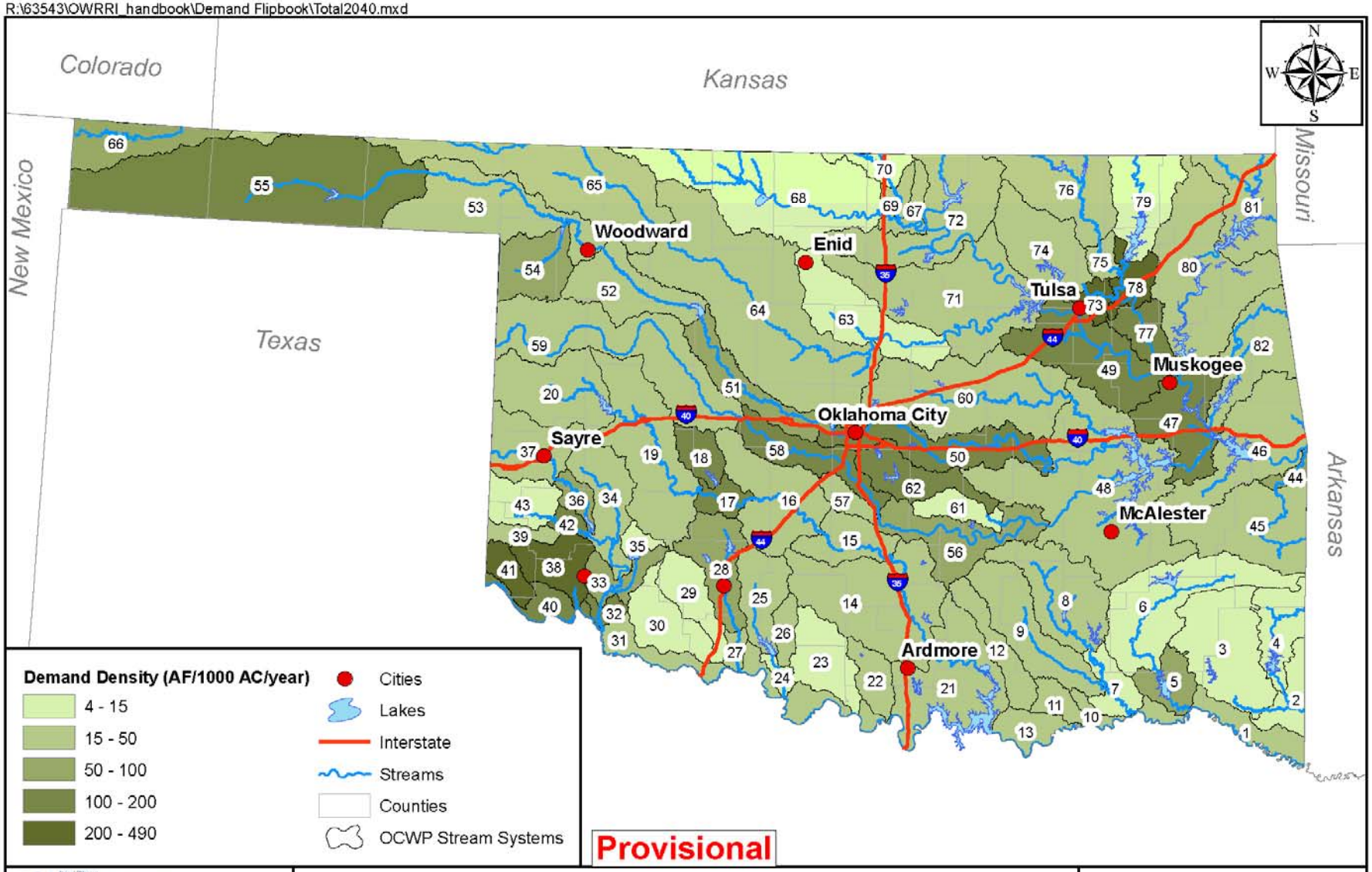

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2040 Total Demand Density

05.08.2009

0 25 50 75 Miles

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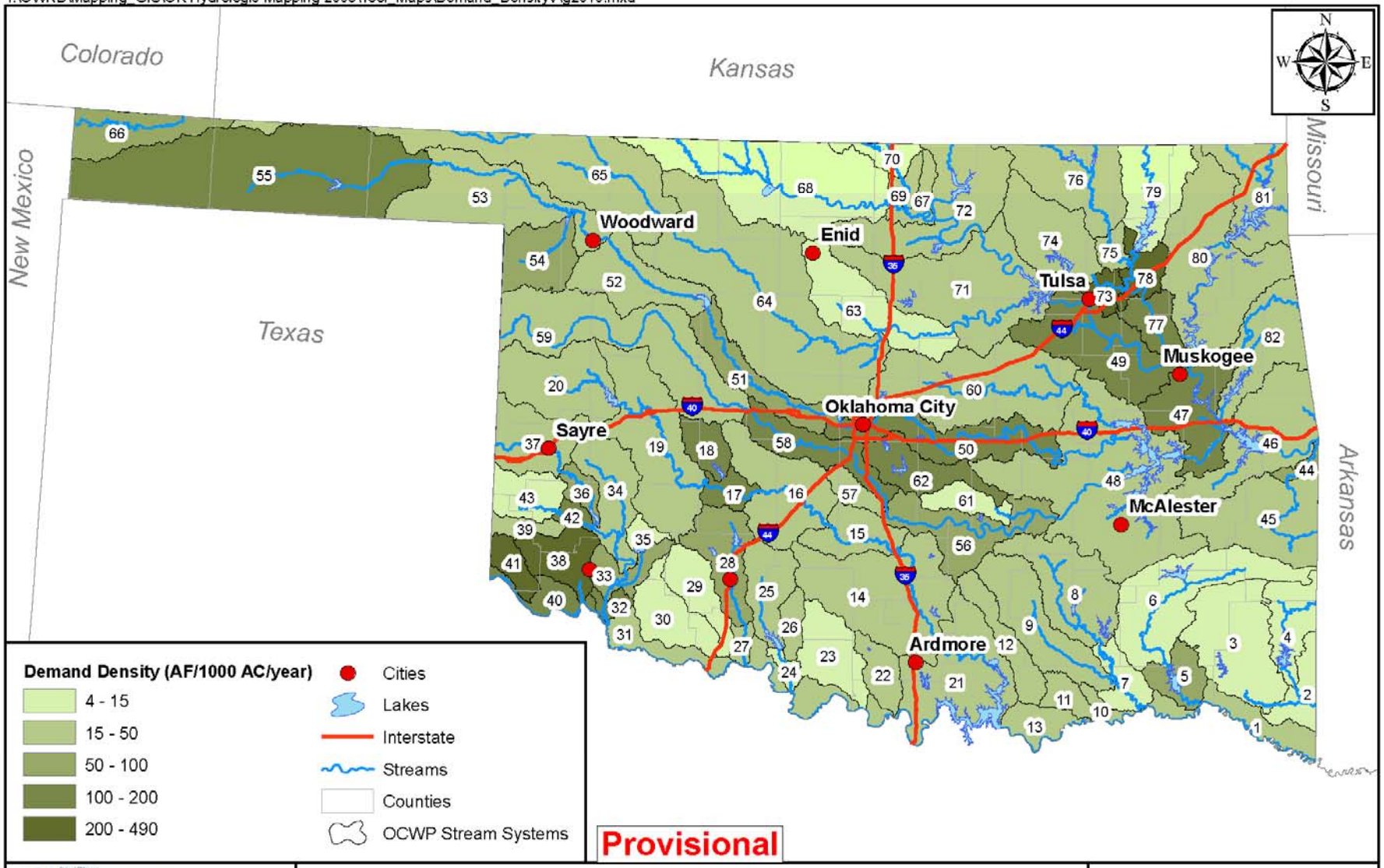

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2050 Total Demand Density

05.08.2009

0 25 50 75 Miles

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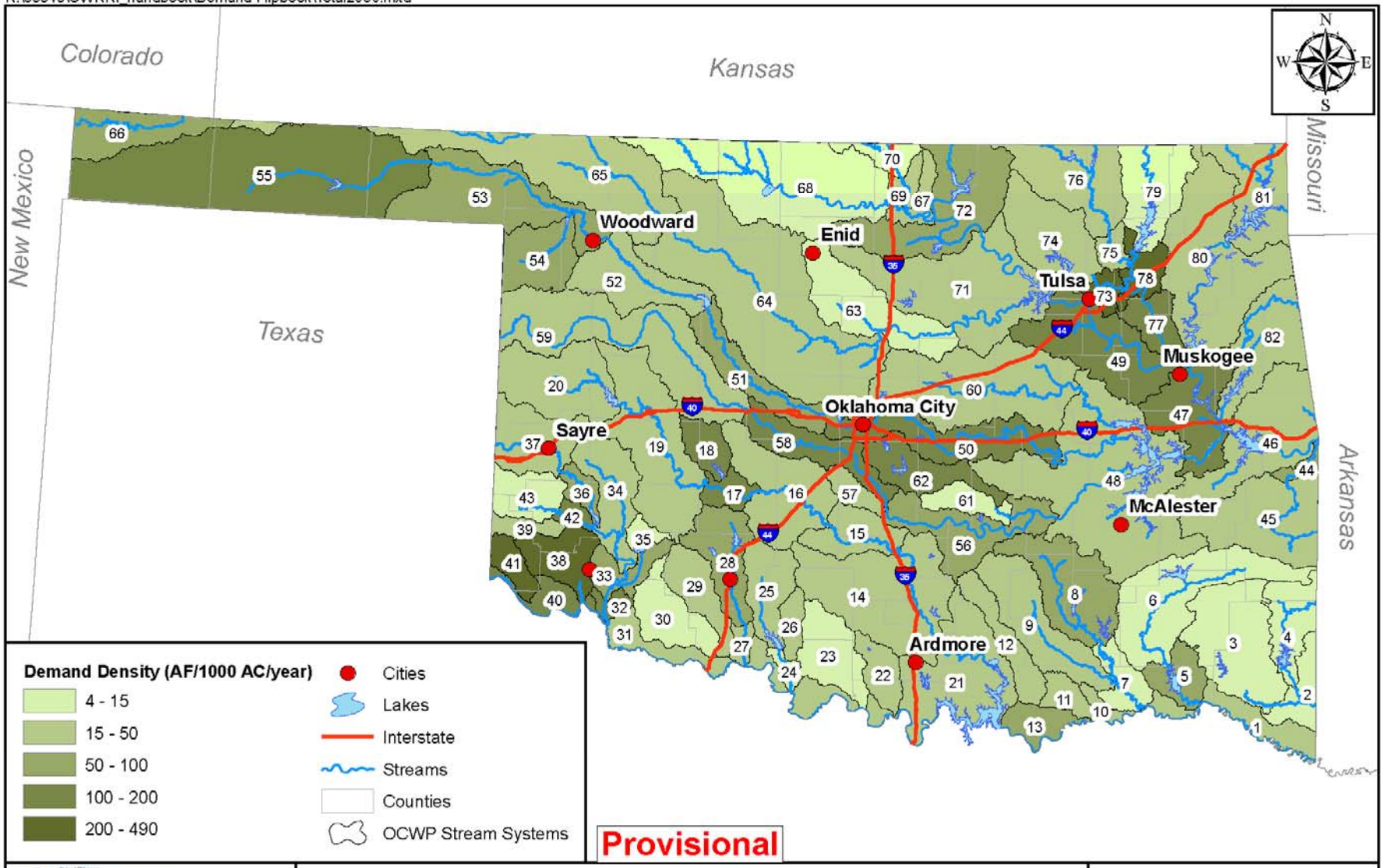

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2060 Total Demand Density

05.08.2009

0 25 50 75 Miles

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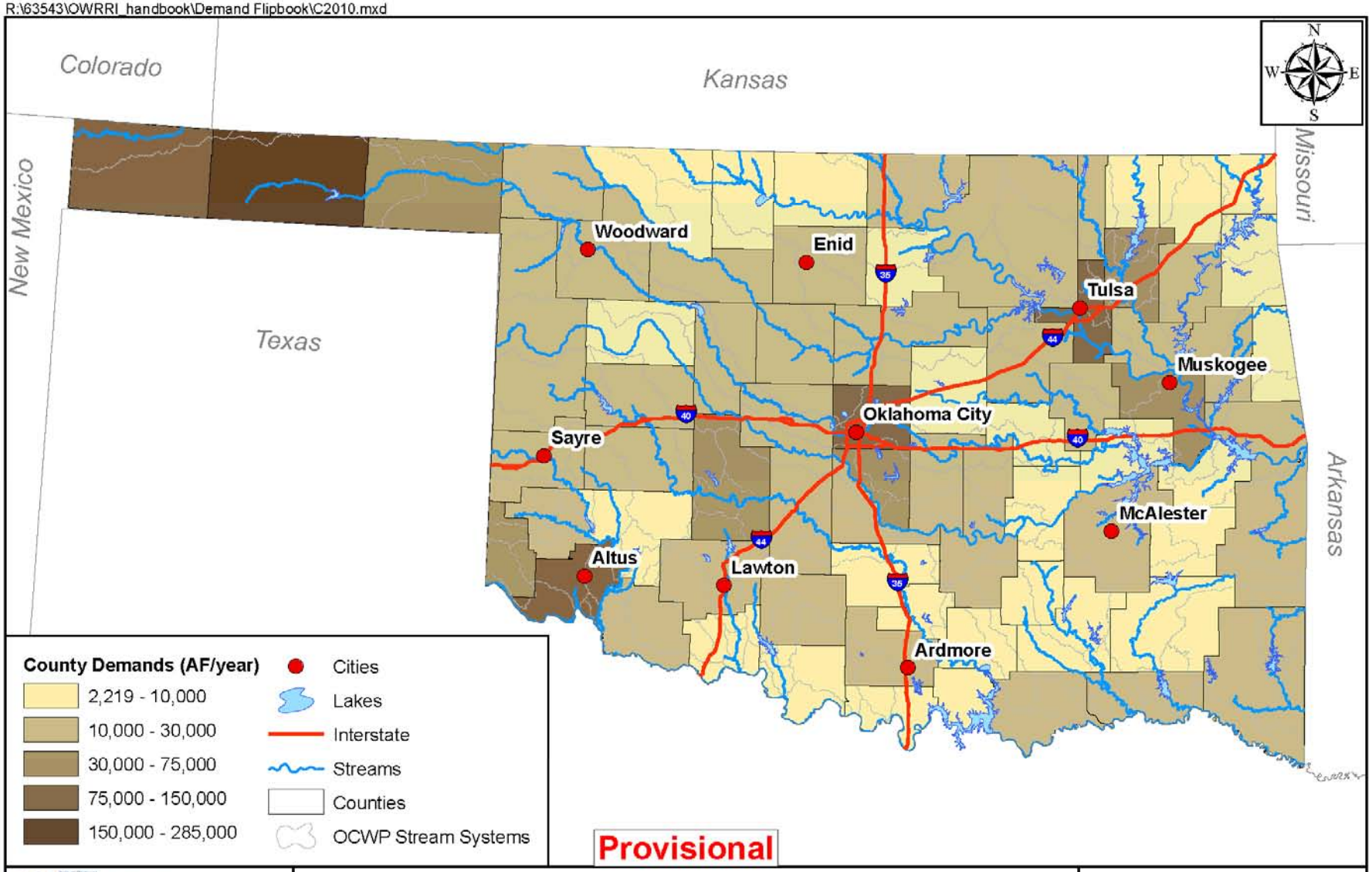

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2010 Total County Demands

05.08.2009

Miles

0 25 50 75

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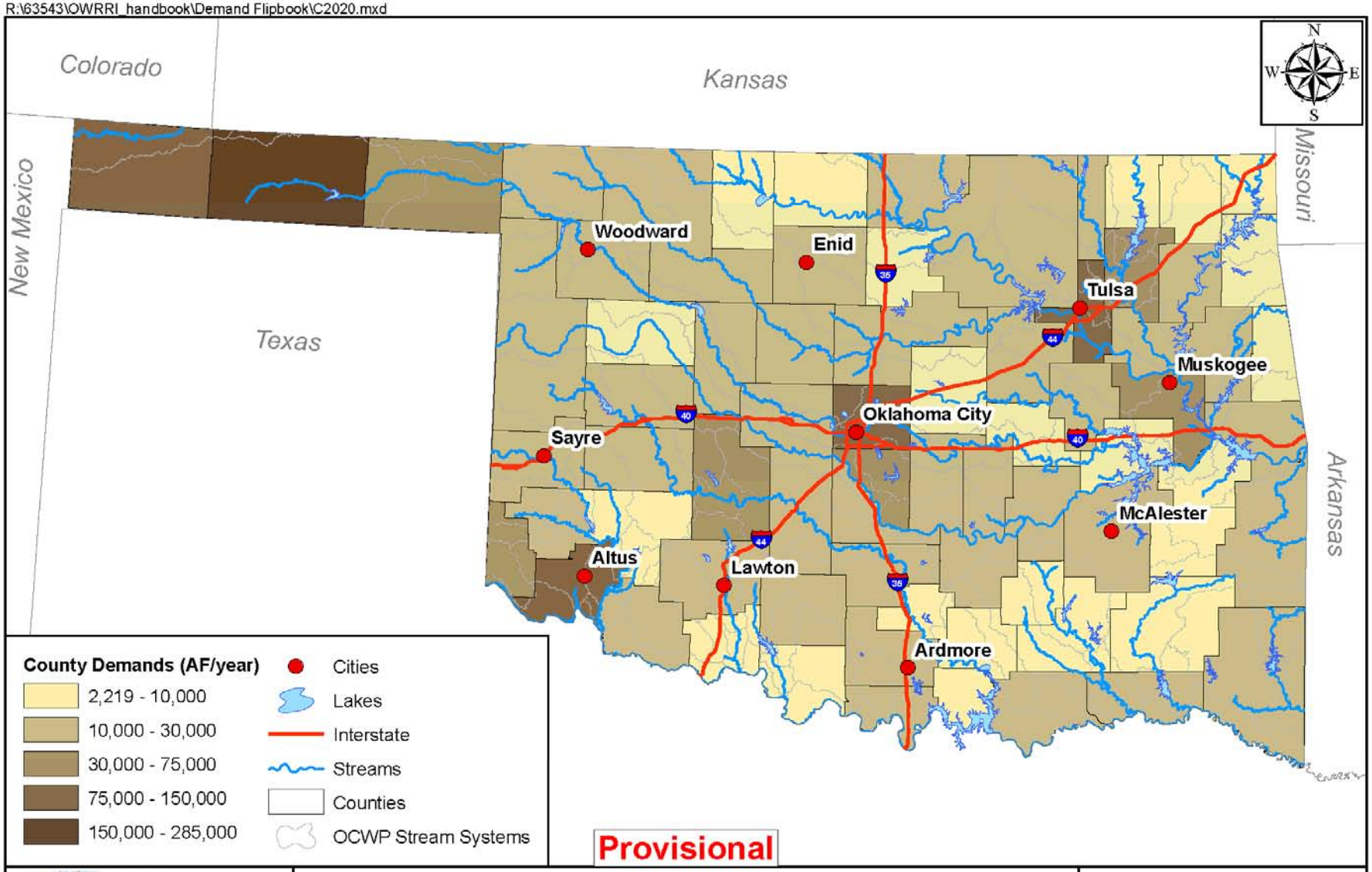

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2020 Total County Demands

05.08.2009

Miles

0 25 50 75

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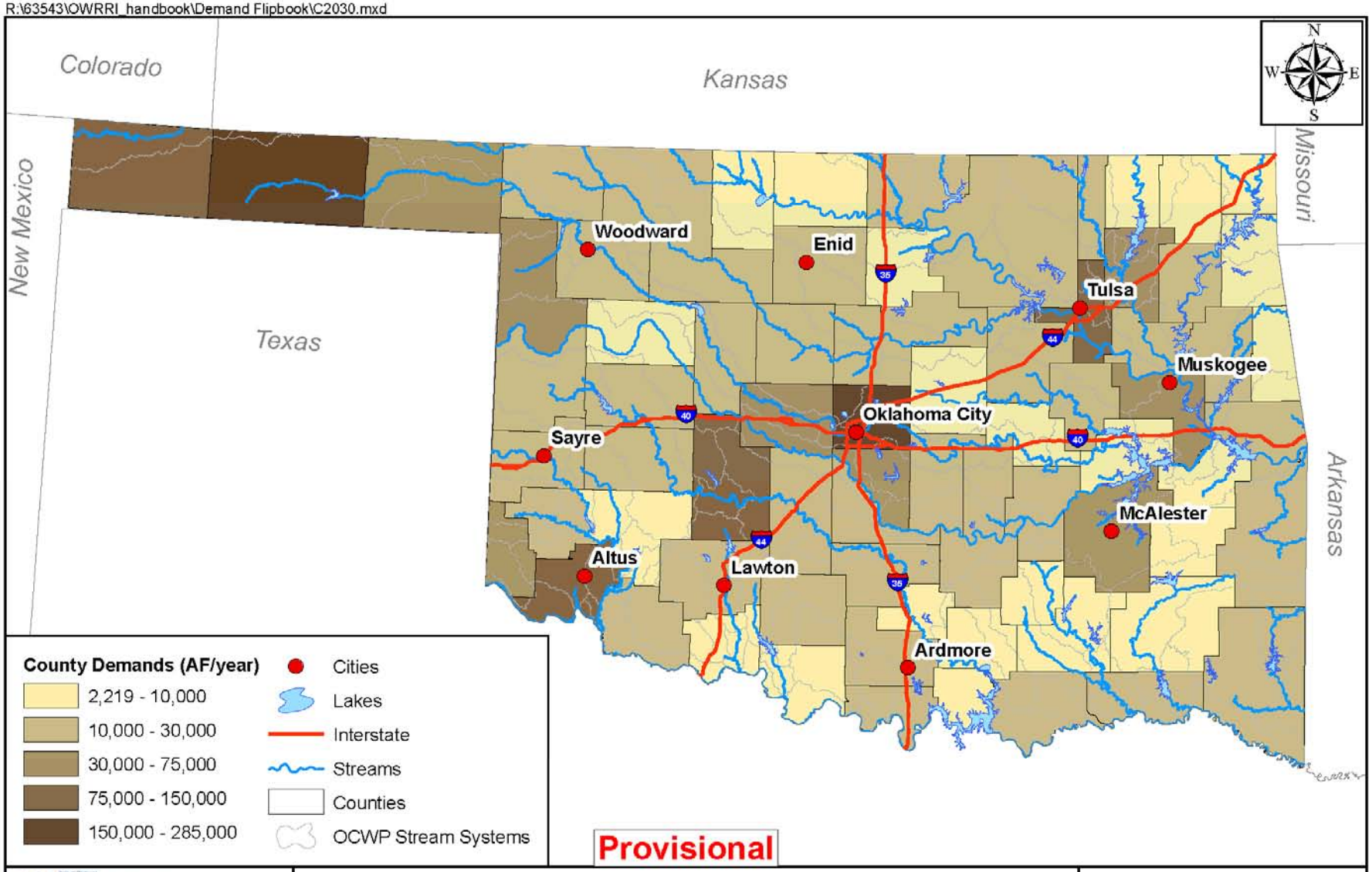

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2030 Total County Demands

05.08.2009

0 25 50 75 Miles

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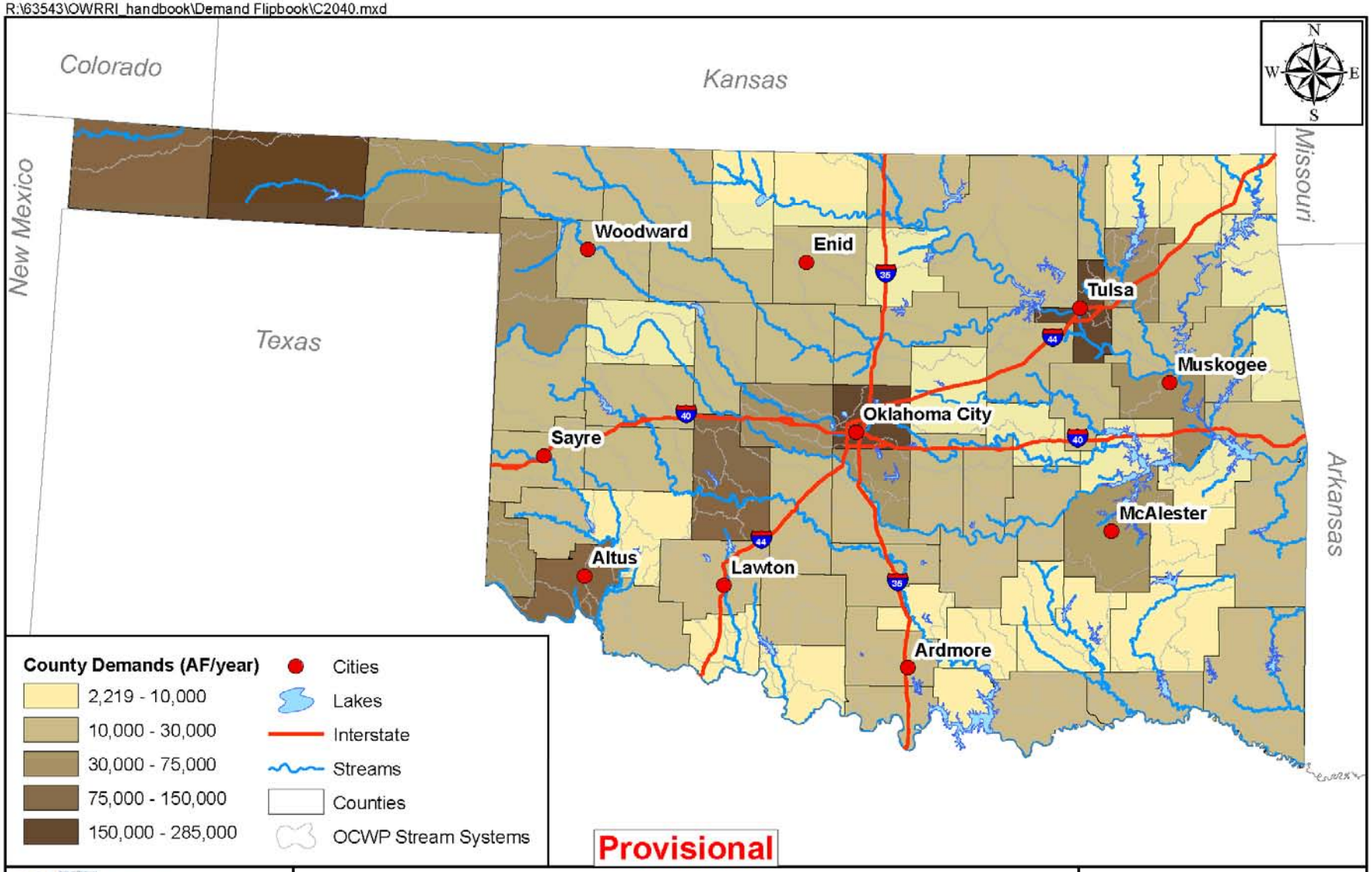

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2040 Total County Demands

05.08.2009

0 25 50 75 Miles

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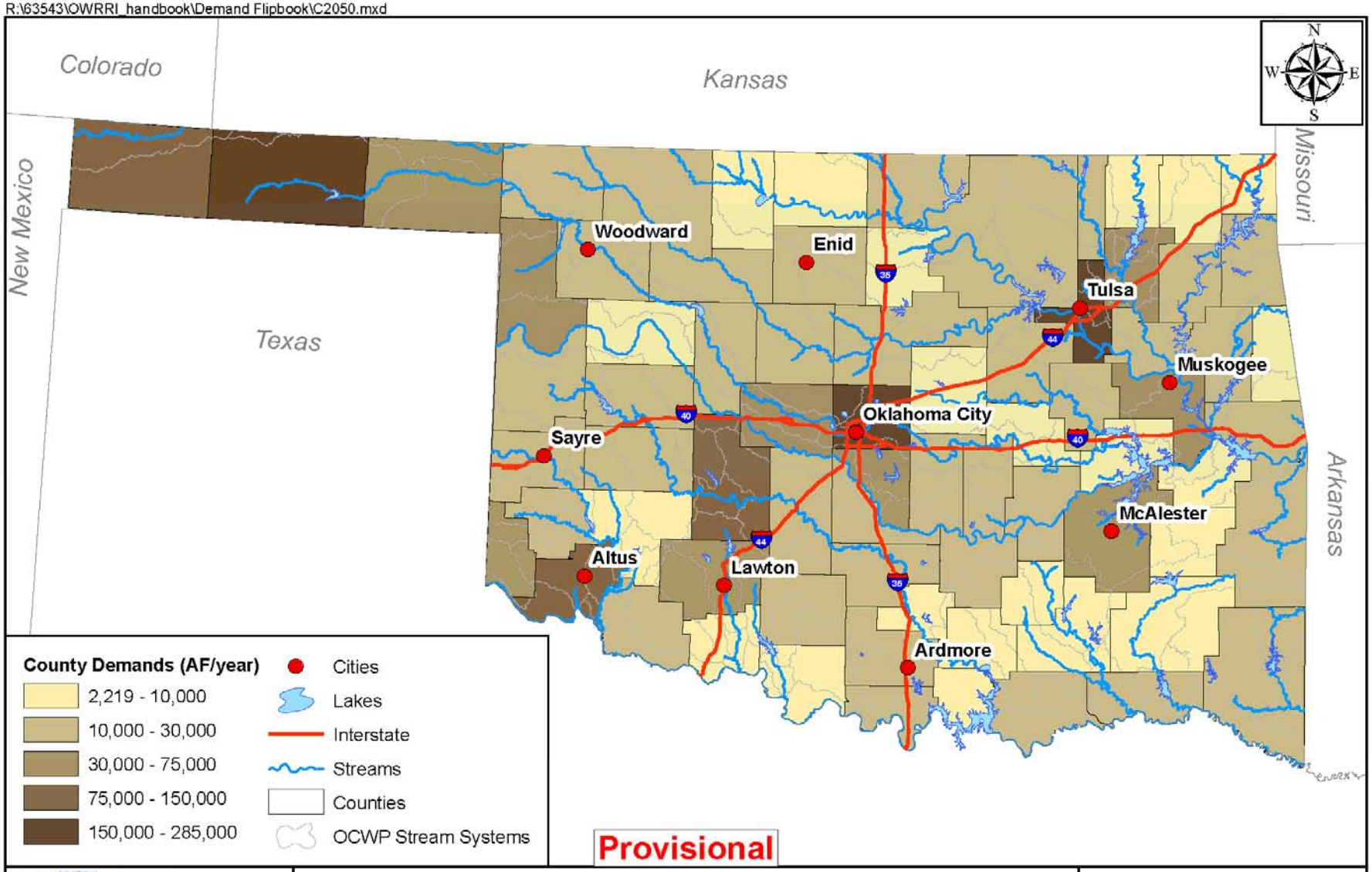

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2050 Total County Demands

05.08.2009

0 25 50 75 Miles

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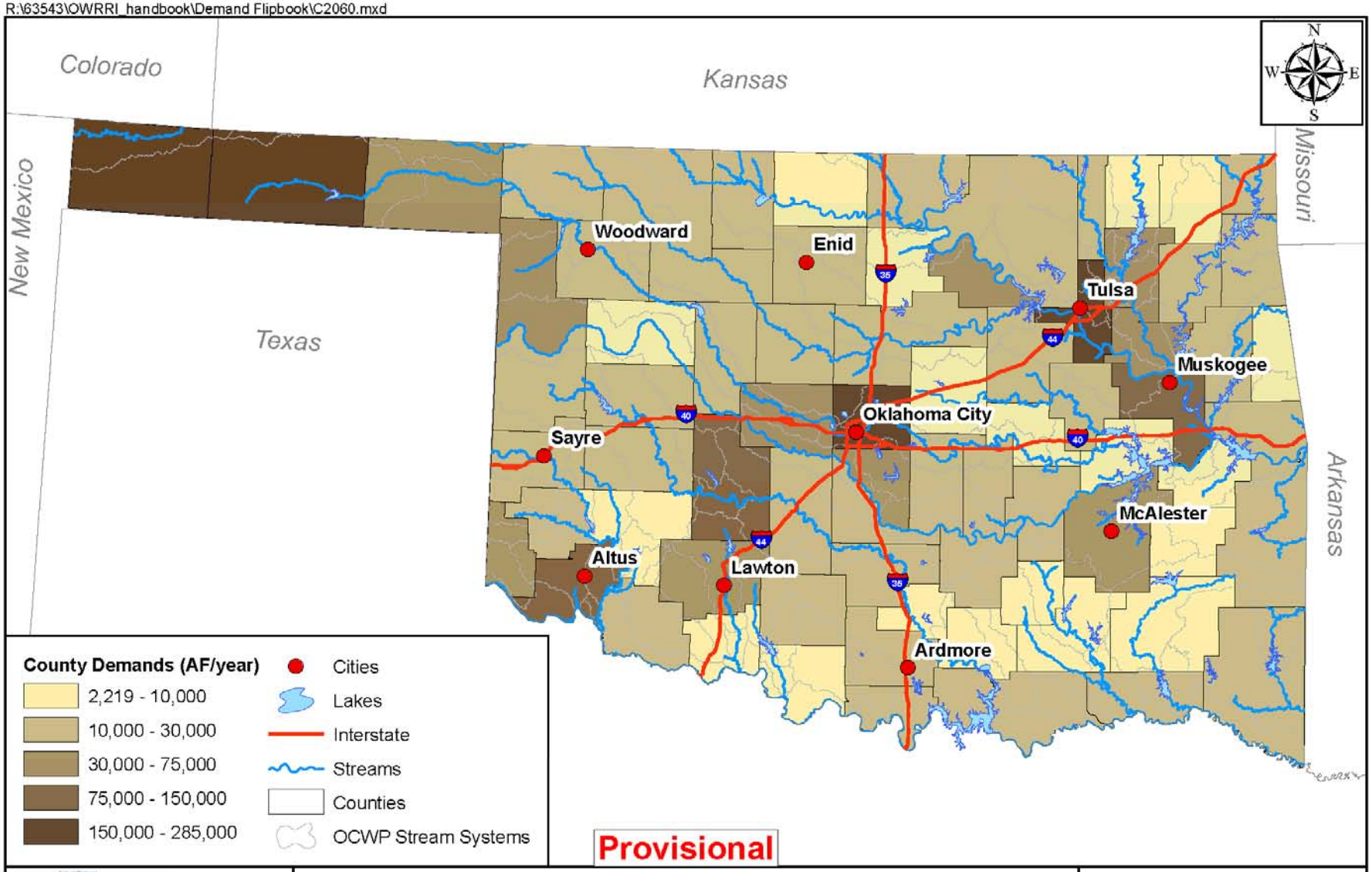

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2060 Total County Demands

05.08.2009

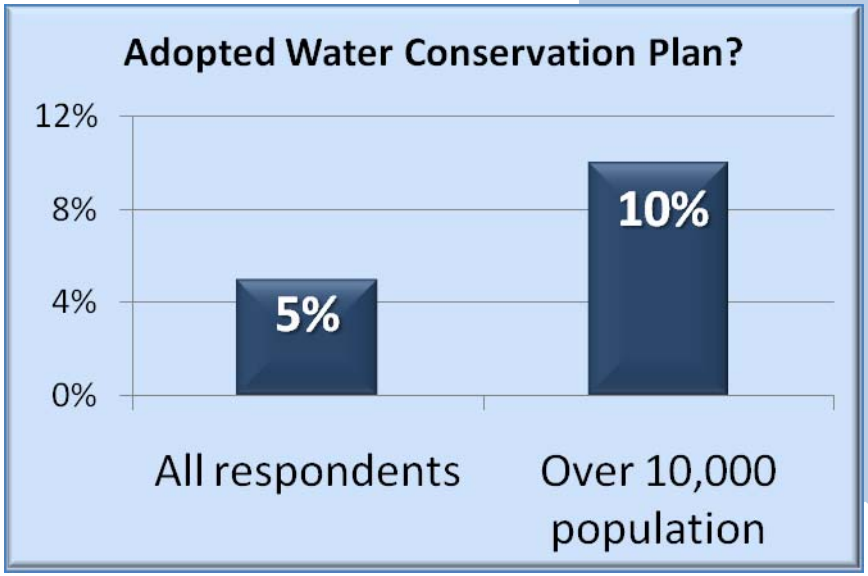
0 25 50 75 Miles

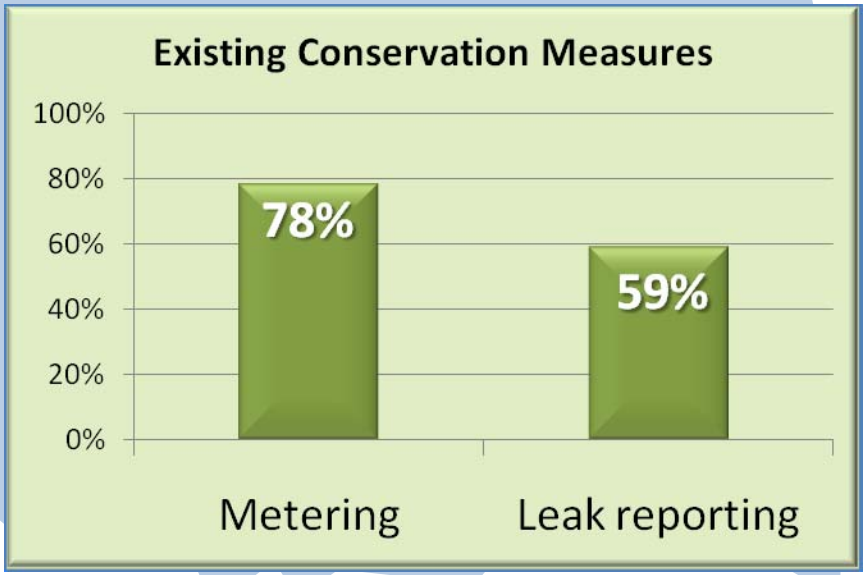
Demand Work Groups

- *Military Bases*
- *Oil & Gas Industry*
- *Tribal Nations*
- *Self-Supplied Industrial*
- *Agriculture*
- *Public water suppliers (via survey)*

Water Conservation in Oklahoma: OCWP Fall 2008 Public Water Supplier Survey

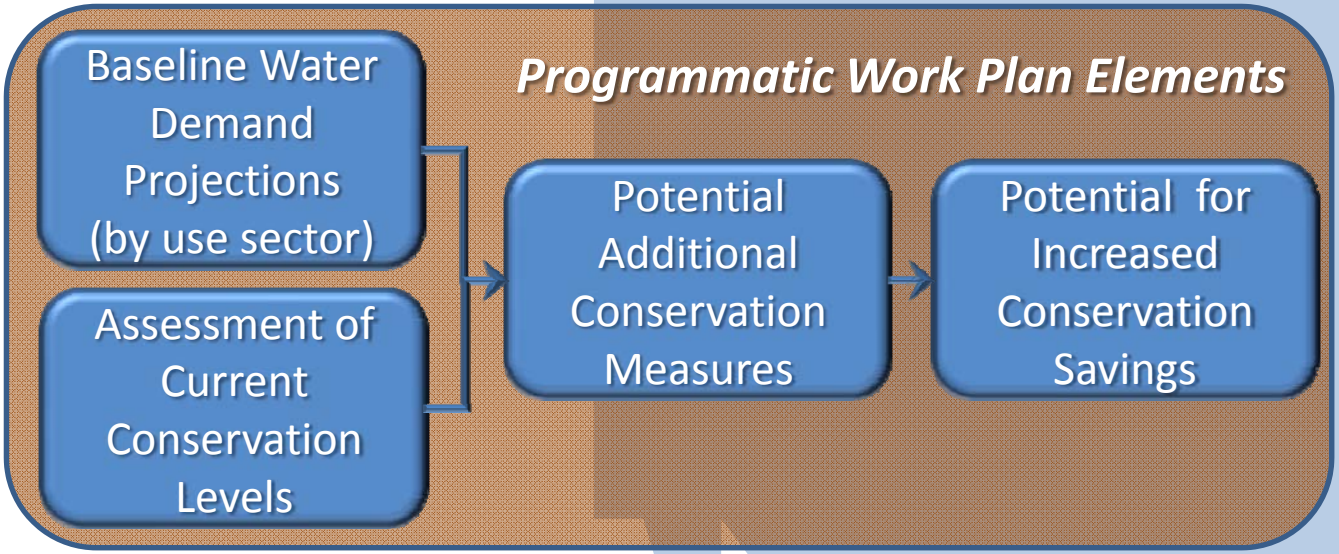
- Over 600 public water supplier respondents





- Rarely used measures (<5% of respondents):
  - *Rebates for high-efficiency toilets / washing machines*
  - *Landscape retrofit rebates or landscape audits*
  - *Commercial audits*
  - *Other measures*

Planned Evaluations: Conservation Status & Potential



- *Potential water savings, by geography*
- *Practical potential for implementation*
- *Example measures & associated savings:*
  - *Water-efficient fixtures*
  - *Irrigation equipment (drip, subsurface)*
  - *Pricing practices*
  - *Education and public outreach*

Good Regulations Gone Bad

Agenda for This Morning

- *Opening Remarks*
- *OCWP Technical Studies Overview*
- *OCWP Programmatic Work Plan*
- *Planning Workshops Supply & Demand Handbook*
- *Provisional Water Demand Projections*

-- Break --

- *Oklahoma's Water Resources*
- *Physical Water Supply Availability*
- *On-going & Upcoming Technical Studies*
- *Water Allocation Modeling*

Oklahoma COMPREHENSIVE Water PLAN

--- Break ---

Agenda for This Morning

- *Opening Remarks*
- *OCWP Technical Studies Overview*
- *OCWP Programmatic Work Plan*
- *Planning Workshops Supply & Demand Handbook*
- *Provisional Water Demand Projections*

-- Break --

- *Oklahoma's Water Resources*
- *Physical Water Supply Availability*
- *On-going & Upcoming Technical Studies*
- *Water Allocation Modeling*

Oklahoma's Water Resources

Supply Sources

Surface Water (SW)

- From USGS Streamflow Gages
- Reservoir Supplies

Alluvial Groundwater (AGW)

- Assumed to be represented in the streamflow

Bedrock Groundwater (BGW)

- Can be separate or connected to SW

Inter-basin Transfers

- Considered a “demand” on basin of origin

Components of Supply Availability Analysis: Surface Water

- Streamflows
- Reservoir storage and yield
- Hydrologic variability
  - *Average, wet, and dry conditions*
  - *Historical droughts*
  - *Climate variability*

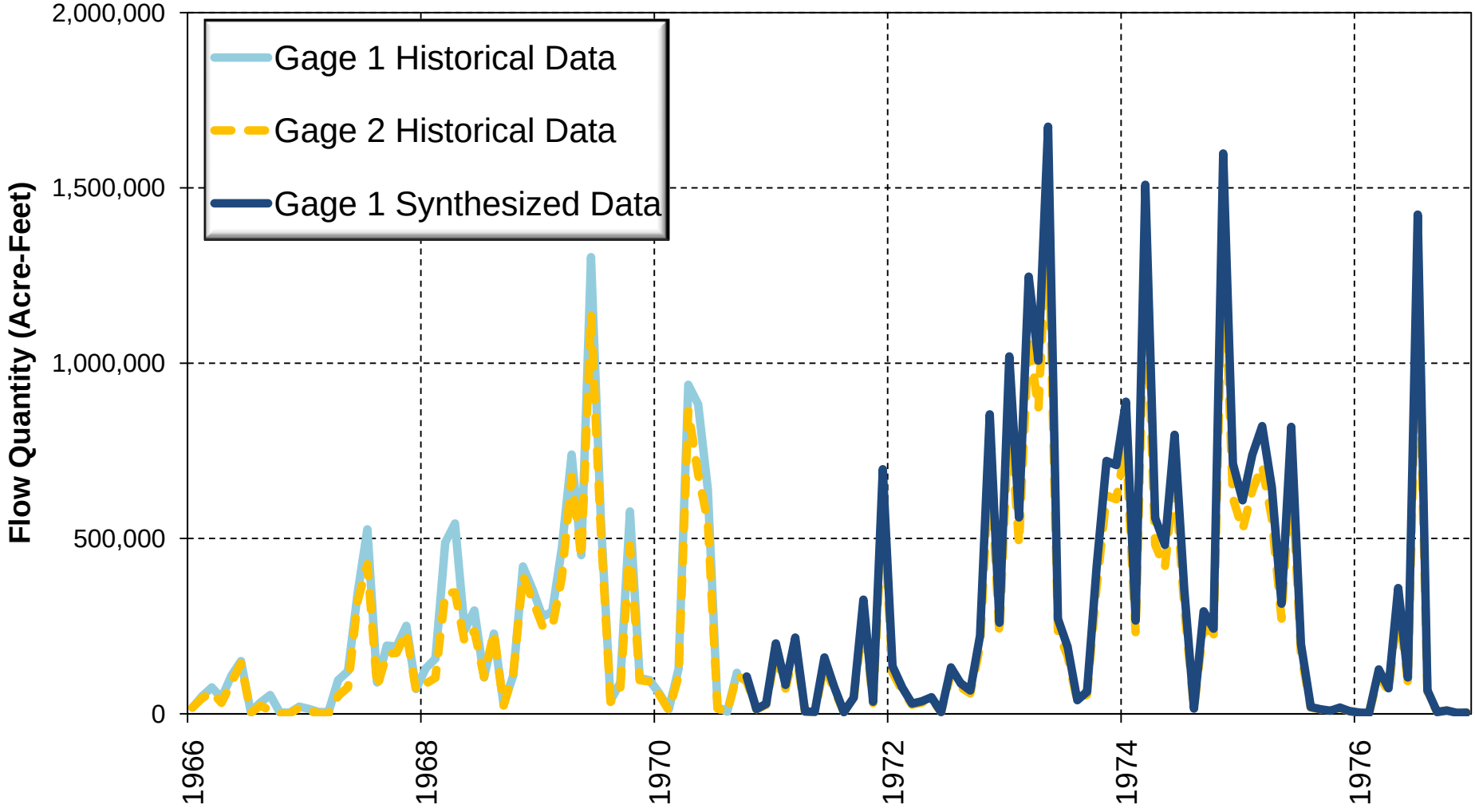
Surface Water Supply Analysis

- *Missing streamflow records were filled using statistical methods (Move.2).*
- *The SW supply from watersheds without a stream gage was determined based on the unit flow in representative nearby gaged watersheds.*
- *Reservoir operations are assumed to be included in the streamflow record*

Resolution of Missing Gage Data

- Purpose: Fill in missing data within the period of record for a given gage
- Approach: MOVE.2
  - *Basic idea: to preserve the statistical characteristics*
- 56 basins need to generate data
- 39 basins (70%) completed with generated data, each dataset covers at least from water year 1950 to 2007

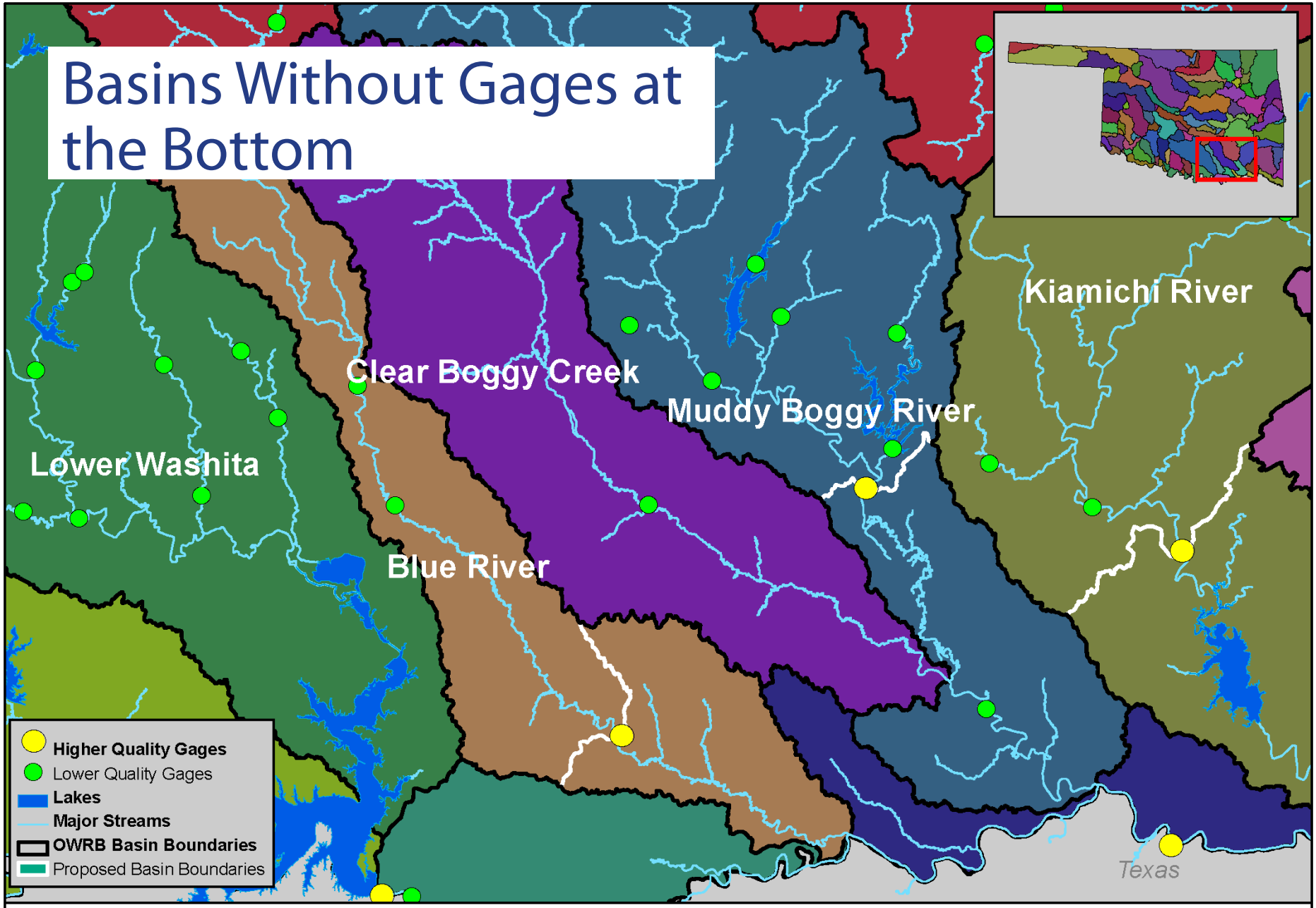
Example of MOVE.2 Application



Basins Without Gages at the Bottom

- Gage in the middle of the basin:
  - *Estimate flows using the area-weighted unit runoff method*
  - *Same method as used in OWRB water allocation modeling*
- No gage data in basin:
  - *Estimate flows using a reference gage, then use area-weighted unit runoff method*

Basins Without Gages at the Bottom



Basins Without Gages at the Bottom

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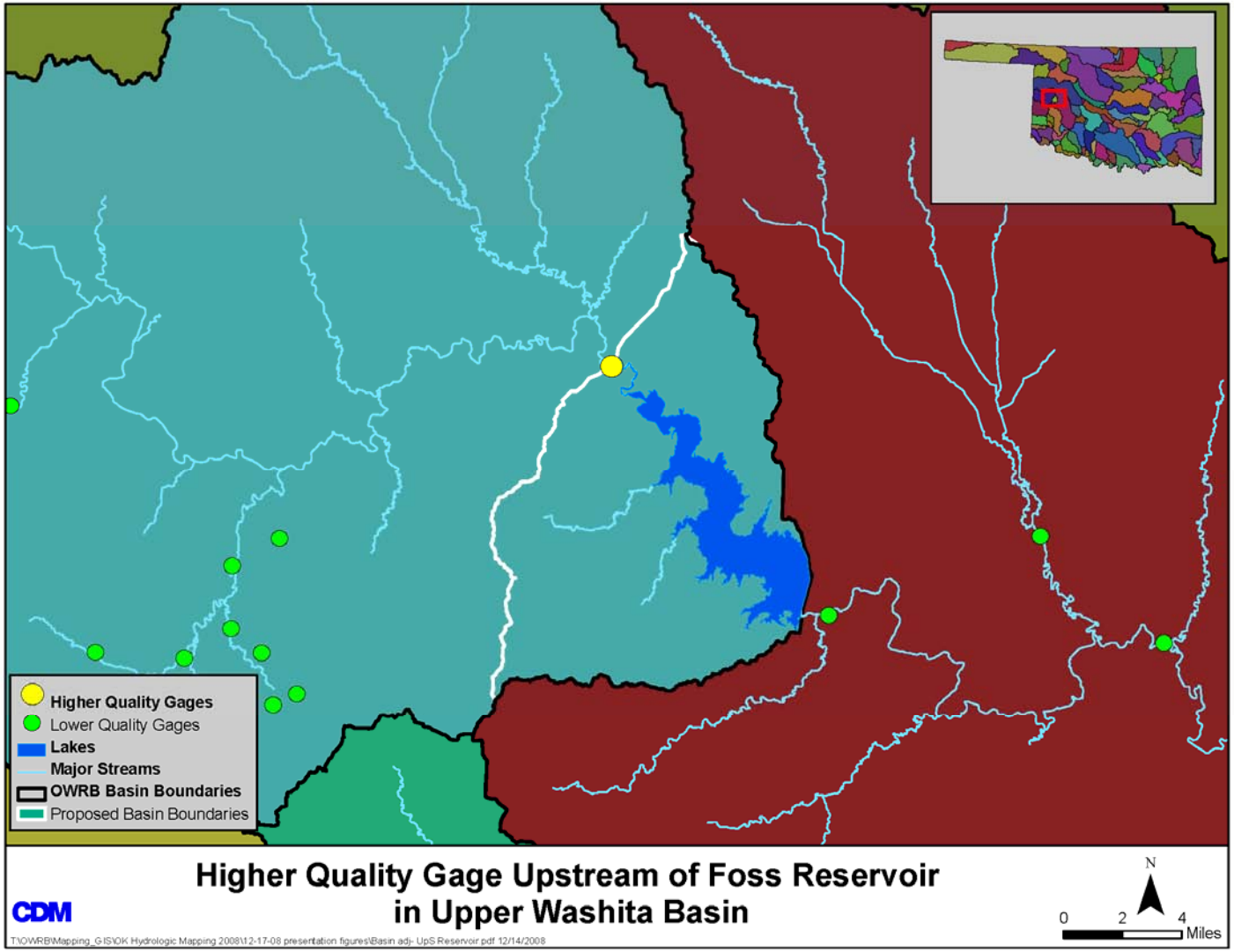
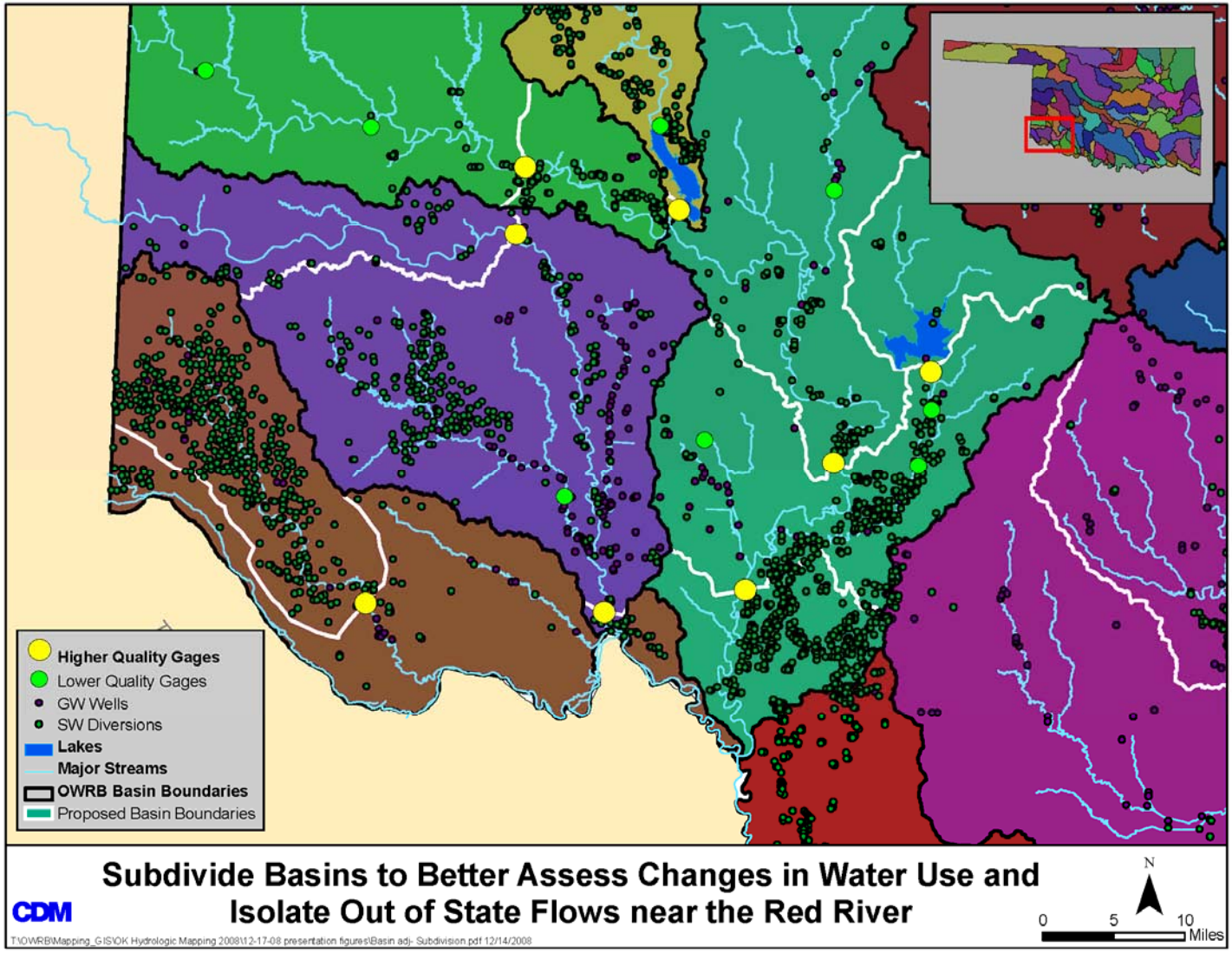
Reasons to Change a Basin:

Gage is Upstream of a Reservoir



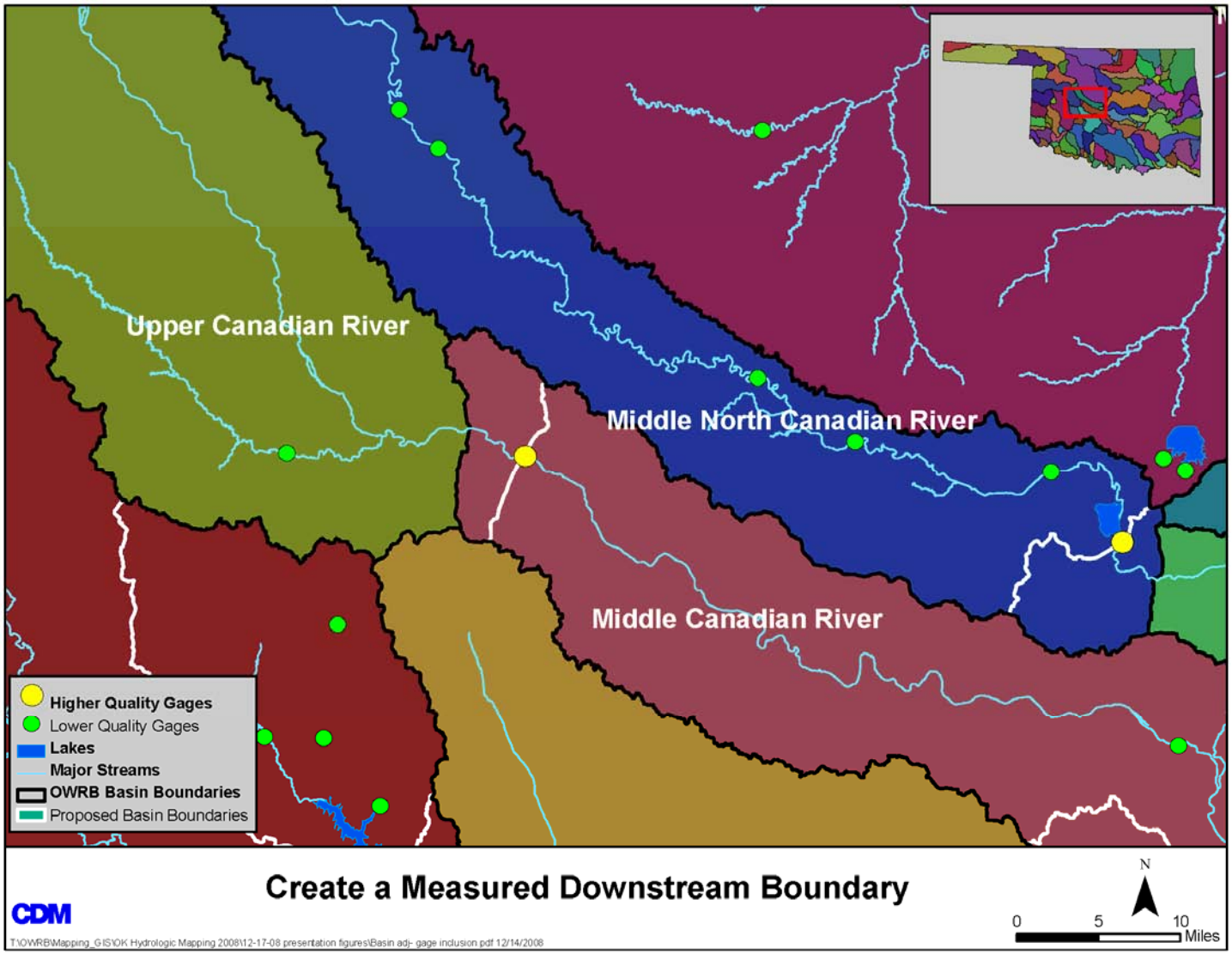
Reasons to Change a Basin:

Subdivide the Basin for Greater Detail



Reasons to Change a Basin:

Create a Measured Downstream Boundary



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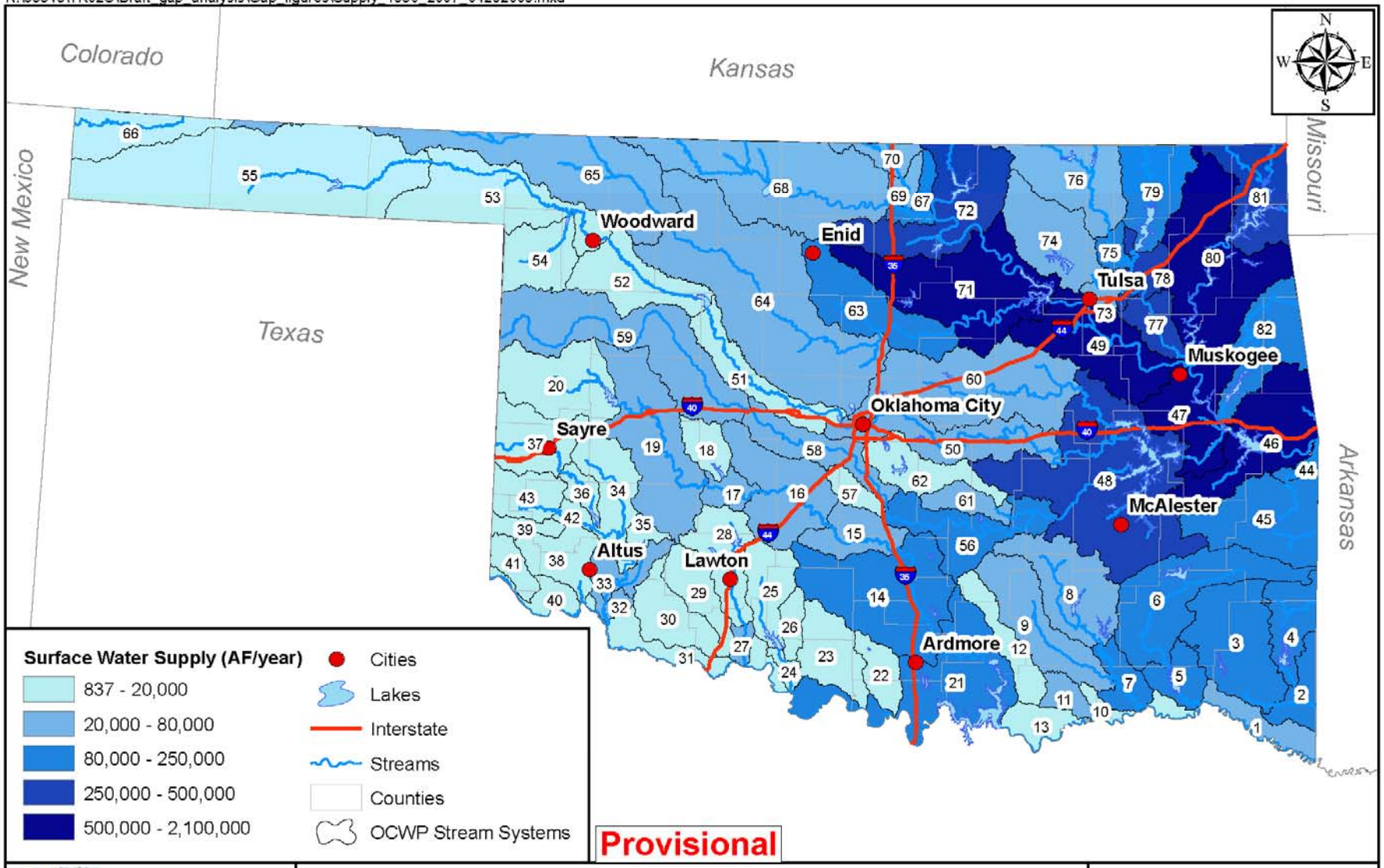

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Figure 3-1
Average Streamflow
for 1950 through 2007

05.05.2009

Miles
0 25 50 75

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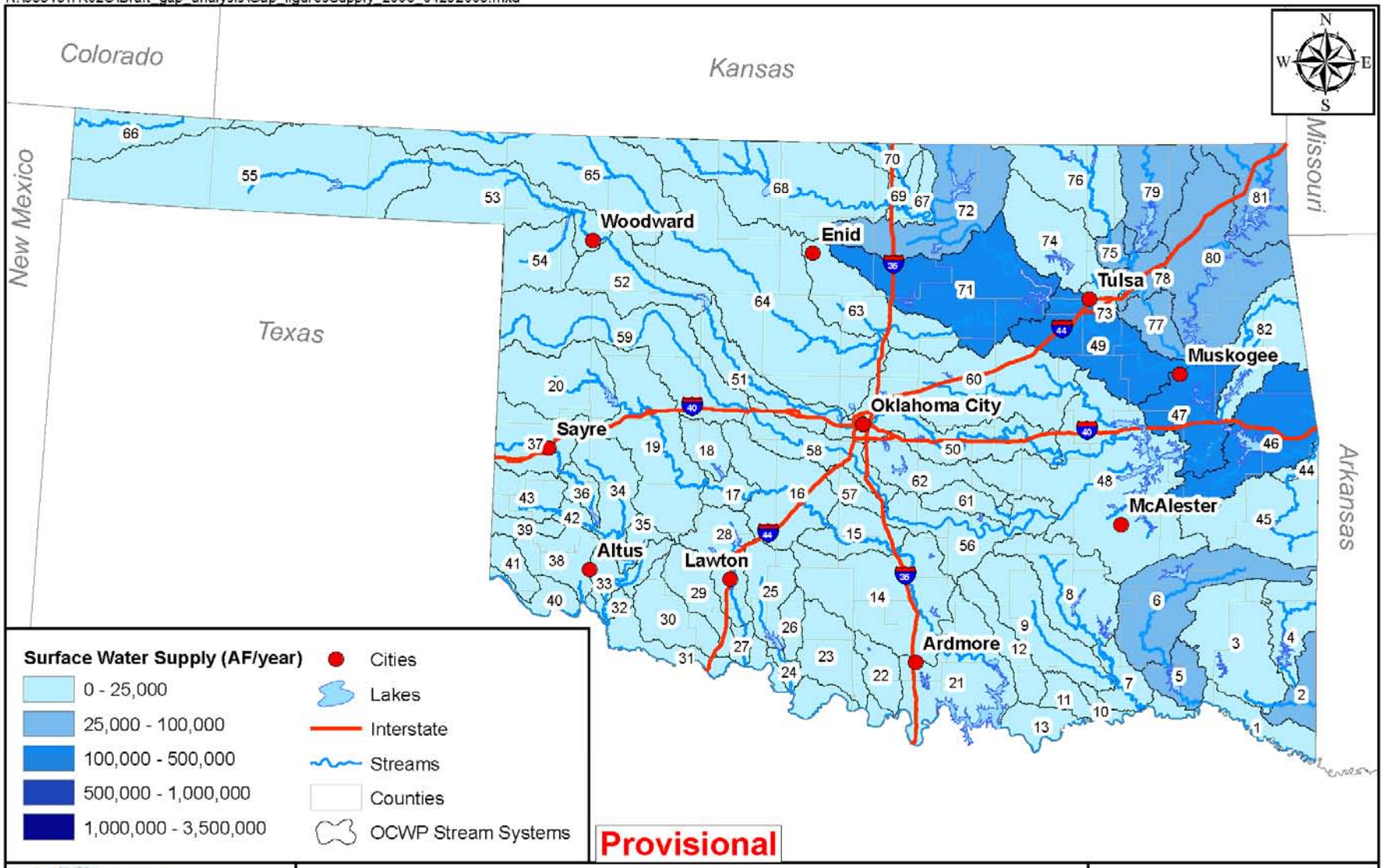

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Figure 3-2
Surface Water Supplies for Water Year 2006

05.05.2009

Miles
0 25 50 75

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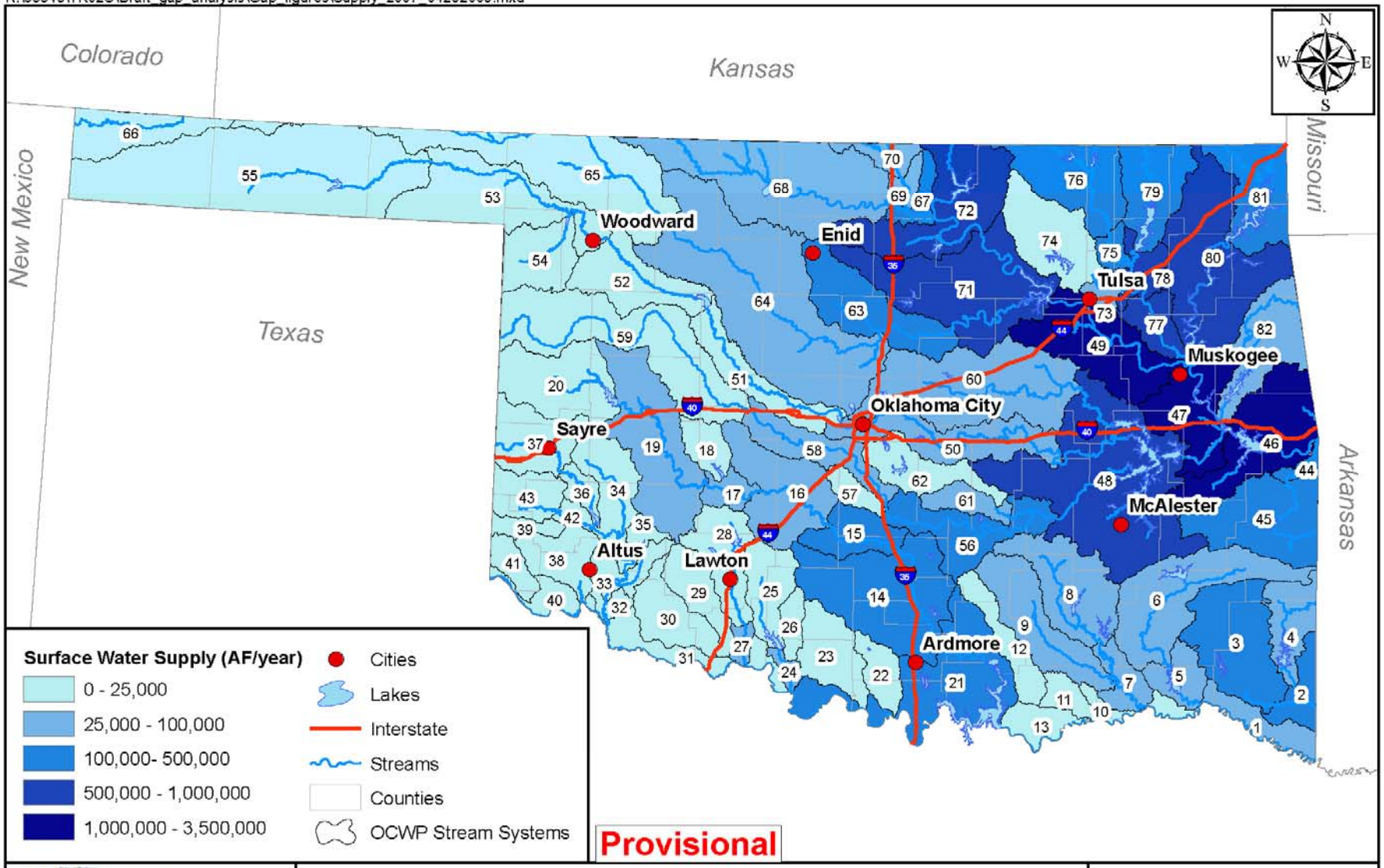

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Figure 3-3
Surface Water Supplies for Water Year 2007

05.05.2009

Miles
0 25 50 75

Groundwater Supply Availability

- Bedrock aquifers and alluvial and terrace aquifers
- Quantity in storage
- Current and projected rates of usage
- Estimated rates of recharge
- Enhancing the level of confidence in key aquifer parameters

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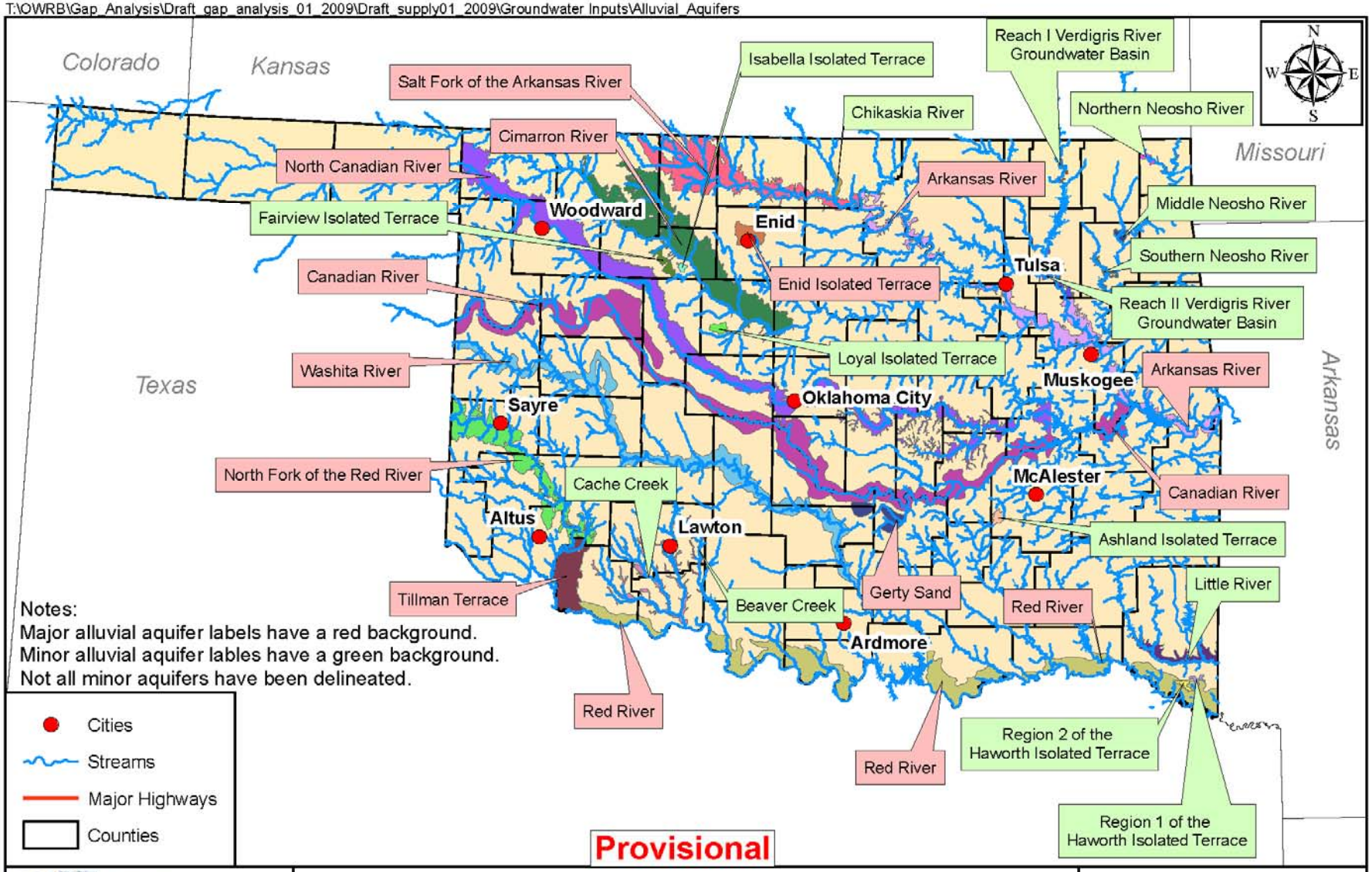

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Figure 3-4
Major and Minor Alluvial Aquifers

05.05.2009

Miles
0 25 50 75

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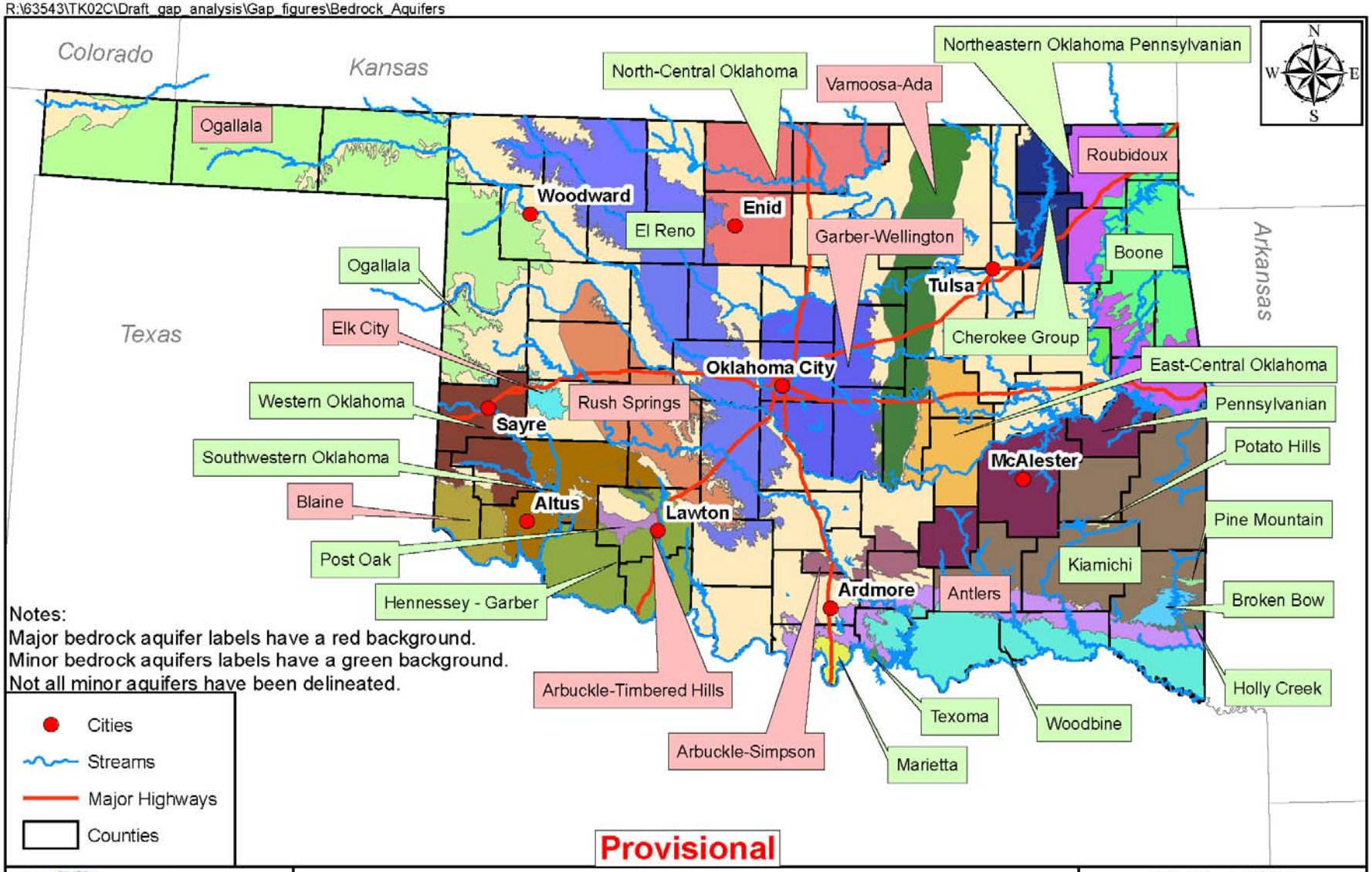

Notes:
Major bedrock aquifer labels have a red background.
Minor bedrock aquifers labels have a green background.
Not all minor aquifers have been delineated.

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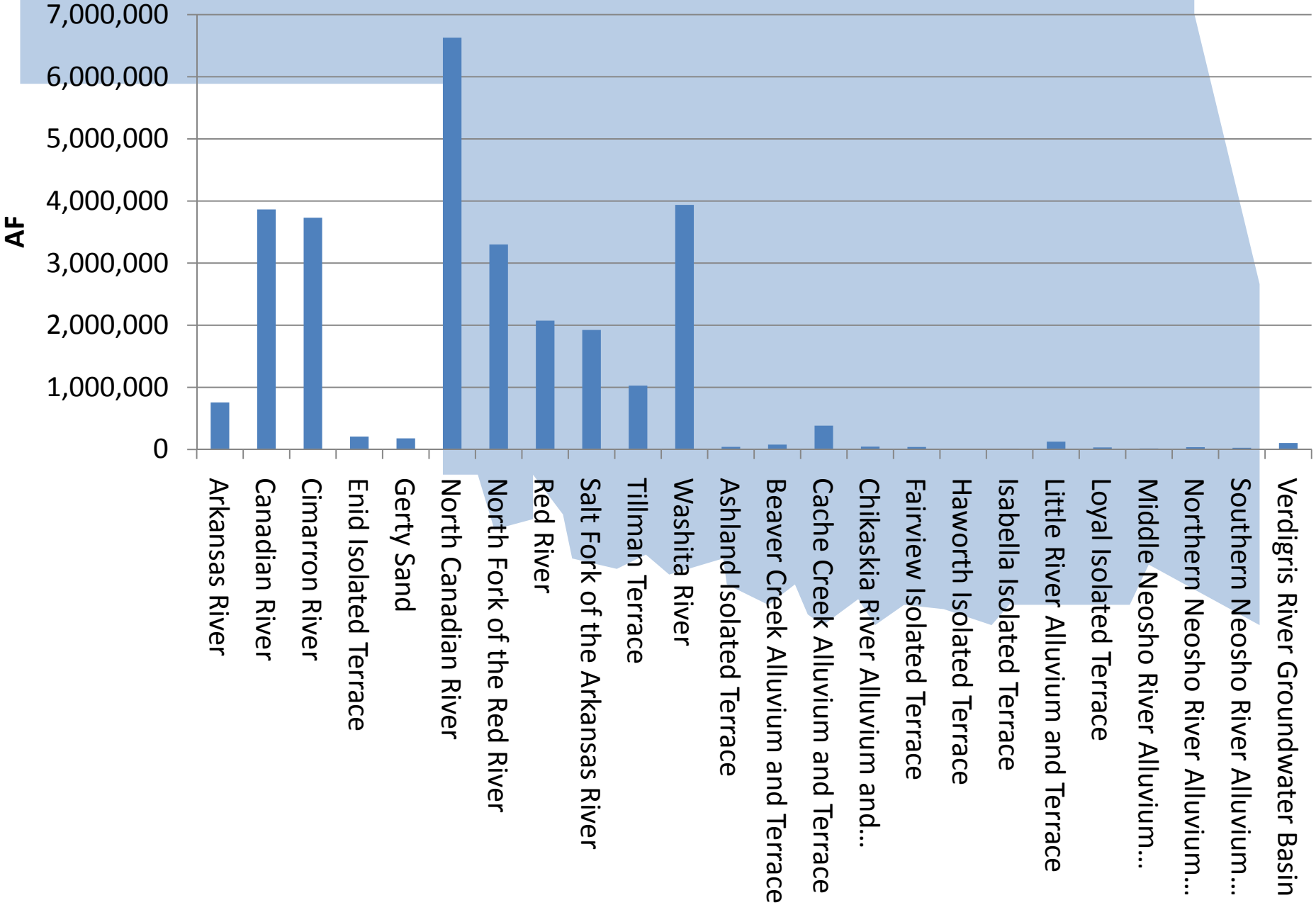
Figure 3-5
Major and Minor Bedrock Aquifers

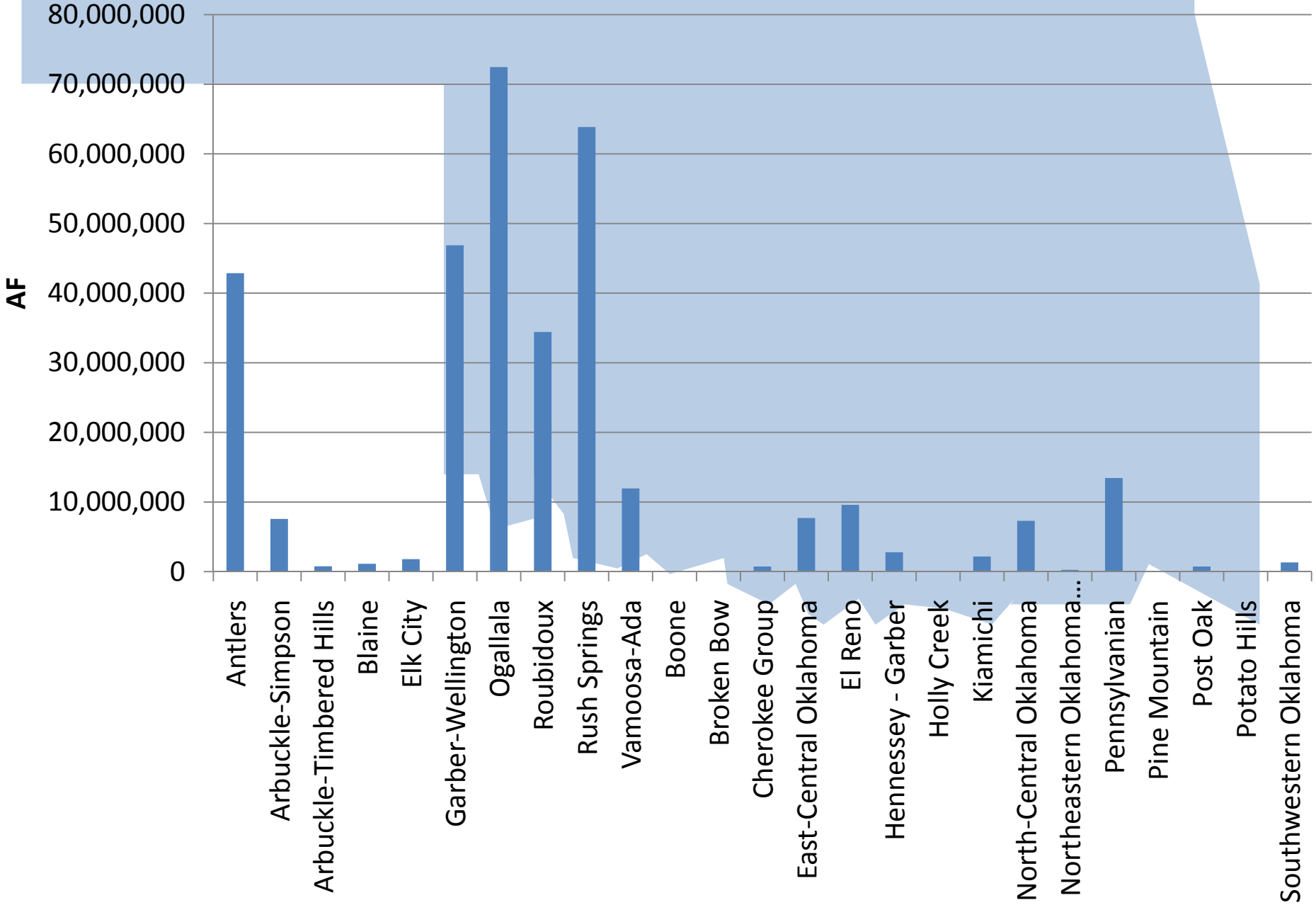
05.05.2009

0 25 50 75 Miles

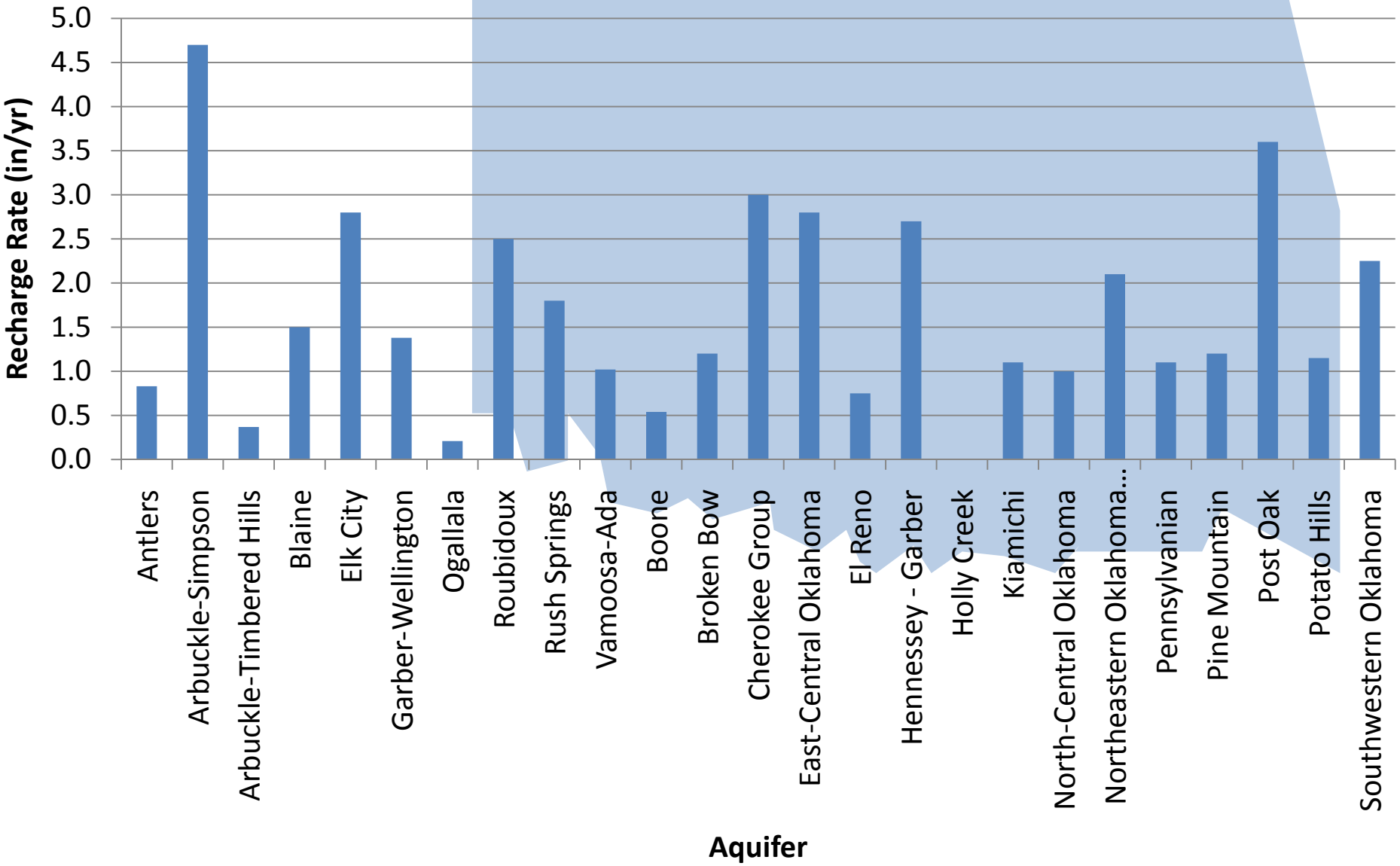
Alluvial Aquifer Recoverable Storage



Bedrock Aquifer Recoverable Storage



Average Bedrock Aquifer Recharge Rate



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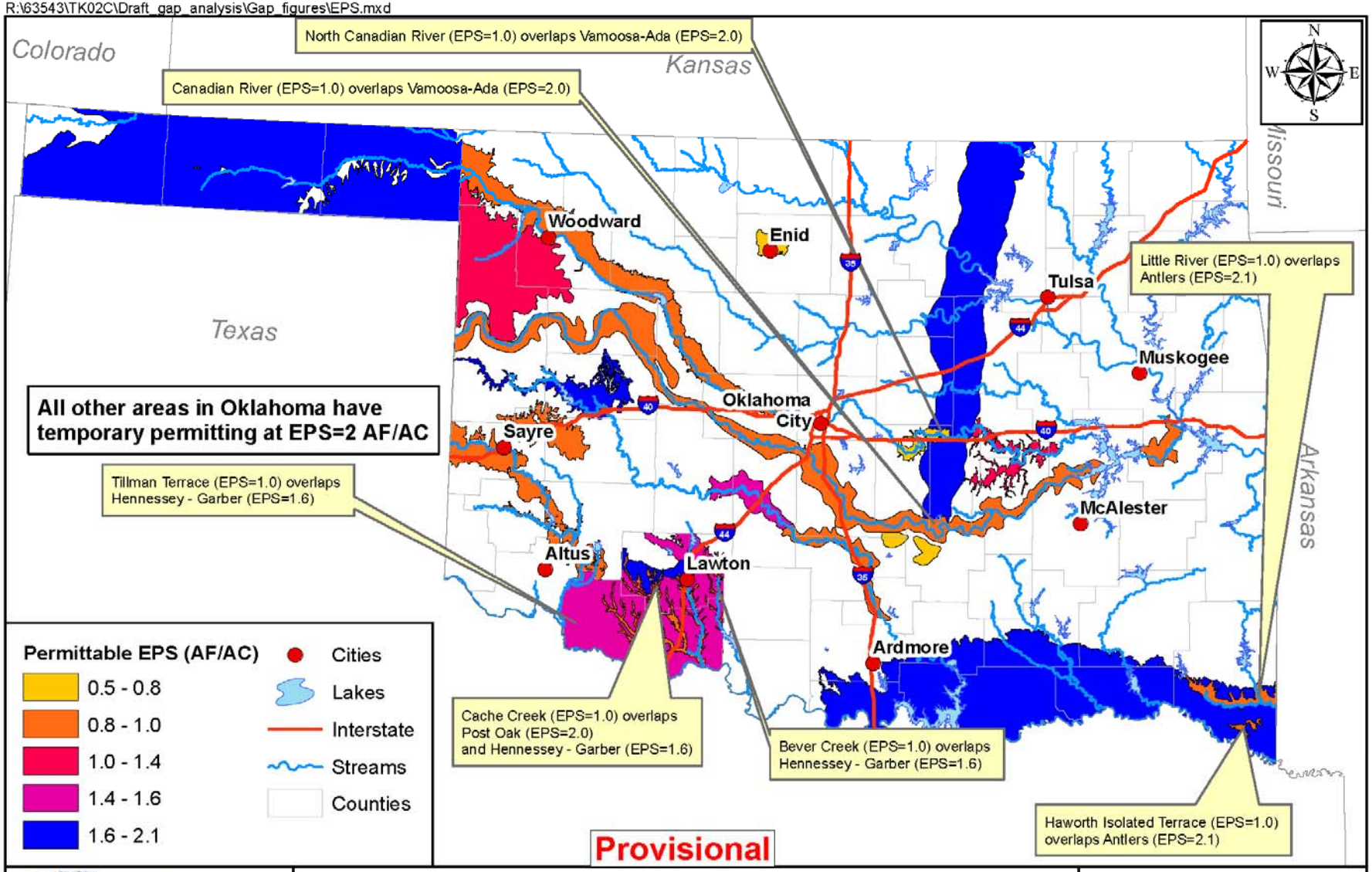

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Figure 3-6
Legal Groundwater Rights including Aquifer Equal Proportionate Share

05.05.2009

Miles
0 25 50 75

Agenda for This Morning

- *Opening Remarks*
- *OCWP Technical Studies Overview*
- *OCWP Programmatic Work Plan*
- *Planning Workshops Supply & Demand Handbook*
- *Provisional Water Demand Projections*

-- Break --

- *Oklahoma's Water Resources*
- *Physical Water Supply Availability*
- *On-going & Upcoming Technical Studies*
- *Water Allocation Modeling*

Oklahoma COMPREHENSIVE Water PLAN

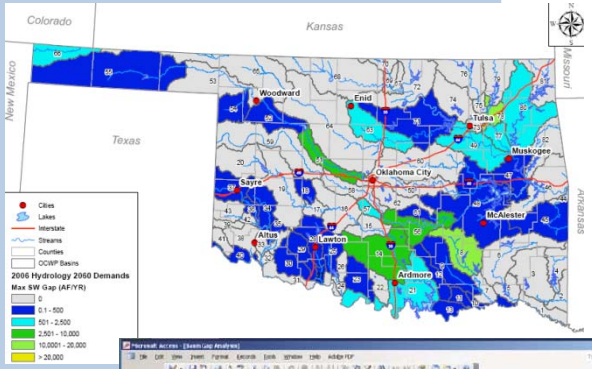
Physical Water Supply Availability

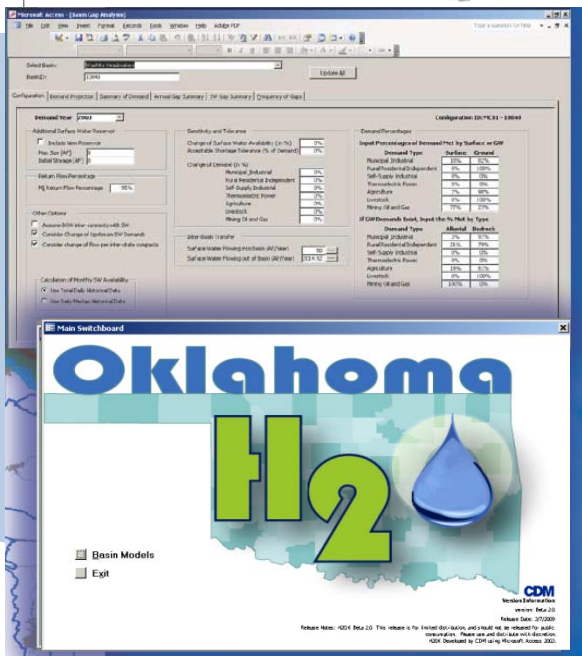
Statewide Supply Availability Screening Tool

- Statewide screening tool developed in Microsoft Access and GIS
- Compares water supply with water demand for different planning horizons and assumptions
- Allows the user to quickly perform "what-if" analysis and test different assumptions
- Will be used to develop planning alternatives and consider the impacts of climate change

"Gap" Tool Output

- Physical supply availability for each basin
- Supply shortages by year
  - *2010, 2020, 2030, 2040, 2050, 2060*
- Supply shortages by source
  - *Surface water, Alluvial groundwater, Bedrock groundwater*
- Magnitude & Frequency of Gaps Under Historical Range of Hydrologies





What Constitutes a “Gap”?

- SW/AGW
  - *No flow at outlet of the basin*
- GW
  - *GW is a depletion when demand exceeds recharge rate*
  - *Water may still be available from Storage; therefore not a short-term gap, but long-term mining*

Gap Tool: Key General Assumptions

- Water rights or permit obligations are not constraining
- Water quality, habitat, navigation, and other in-stream issues are not considered for physical supply avalability
- Initial gap assessment based on total withdrawals (conservatively ignoring return flows, except M&I); additional return flows to be evaluated in gap basins

Gap Tool: Key General Assumptions

- Initial projection of supplies serving each basin's demands equals current groundwater/surface water proportions
- Supplies to meet future demands are taken from the basin that generates the demand

Gap Tool: Key SW and GW Assumptions

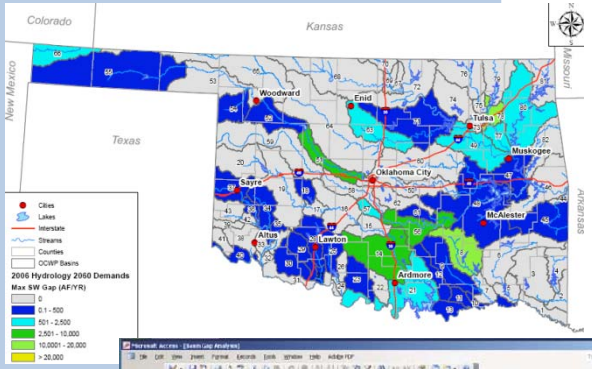
- Surface Water
  - *USGS streamgage data used to characterize existing SW supply (includes existing diversions, transfers, AGW/SW interaction, historical reservoir operations*
- Groundwater
  - *Recharge is assumed to be delivered to the aquifer in full during each month (no time-lag)*

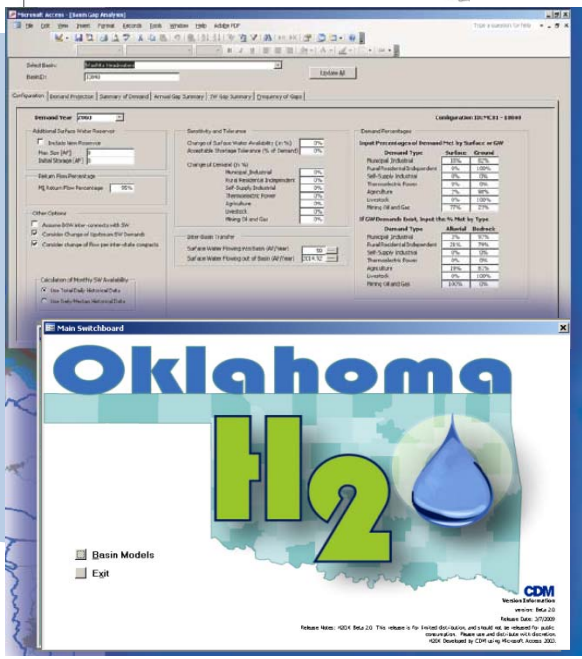
Effect of Upstream and Out-of-State Basins

- Available SW supply considers change in demand from upstream basins
  - *Adjusted streamflow is always >= 0*
- Interstate surface water basins
  - *Inflows: Future interstate inflow reduced by set percent to account for future out-of-state consumptive demand*
  - *Outflows: Compact obligations used as a check, not allocated upstream to tributaries*
- Groundwater availability does not consider out-of-basin depletions or supplies

Gap Tool Overview

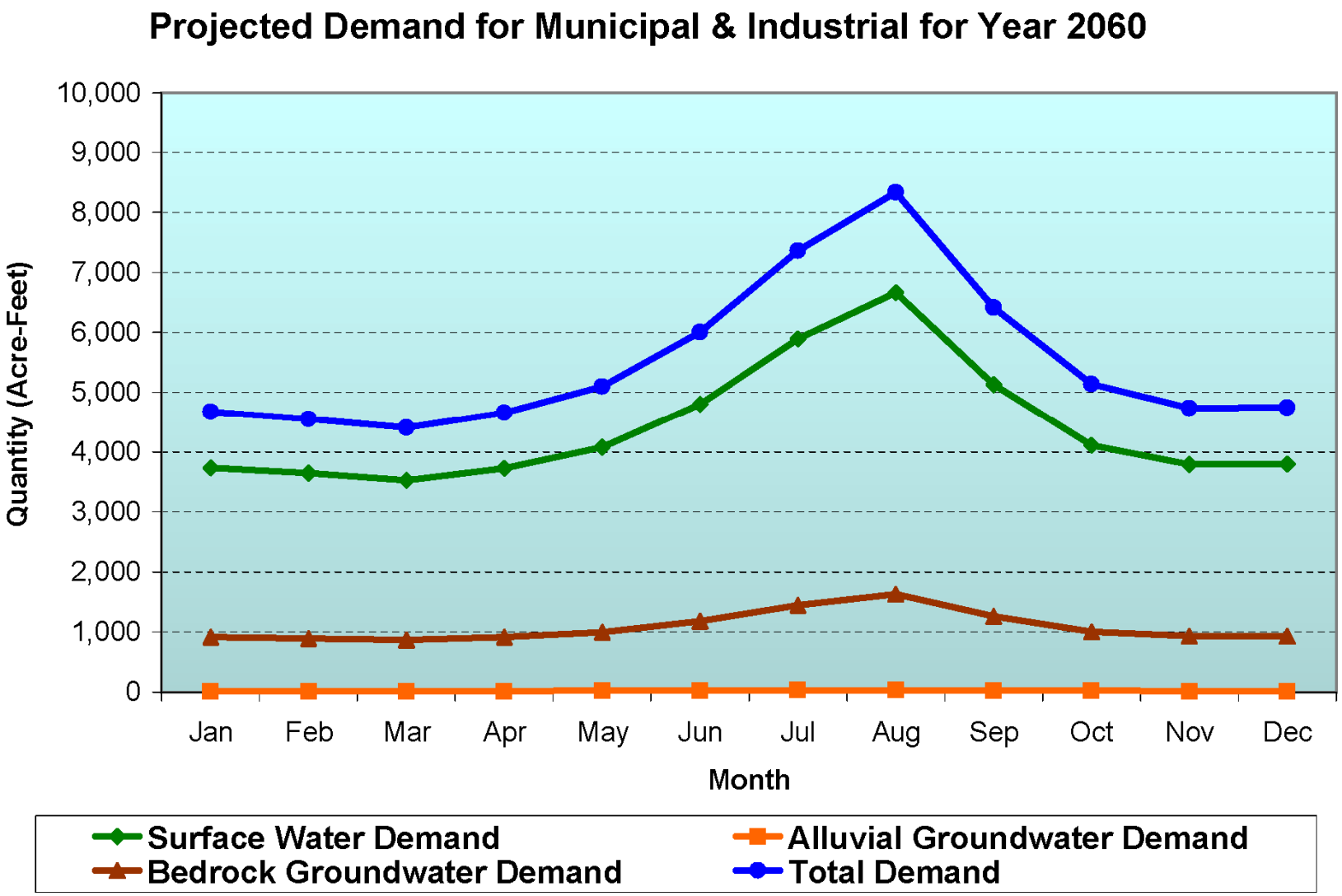
- Multiple inputs and outputs
- Provisional results
  - *Future scenario: Continued use of surface water & groundwater at today's proportions to meet 2010-2060 demands*
- Next steps





Key Demand Assumptions

- Demands were allocated from county or provider levels to basin level based on best available data.
- Annual demands were disaggregated to monthly demands based on patterns which may vary by basin. The patterns do not vary due to hydrologic conditions.


Projected Demand for Municipal & Industrial for Year 2060
Quantity (Acre-Feet)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Surface Water Demand
Alluvial Groundwater Demand
Bedrock Groundwater Demand
Total Demand

Analysis Options Used for Provisional Gaps

- M&I return flow
  - *Return flows are based on wastewater discharge practices in the basin (e.g., lagoon vs. septic vs. stream discharge)*
  - *Return flows are delivered as SW to the next downstream basin*
  - *Return flows are not currently computed for other demand types (e.g., ag or thermo-electric power)*
- The change in upstream demands affects the supply availability of a particular basin
  - *For example, return flows generated upstream, flow downstream until the supply is depleted.*

Analysis Options used for Provisional Gap (Continued)

- BGW is not hydrologically connected to SW
- Inter-basin transfers were accounted for up to their current permitted amount.
  - *Future demands are supplied by the basin of origin, and if there is not enough water available, these basins are displayed as "gaps"*

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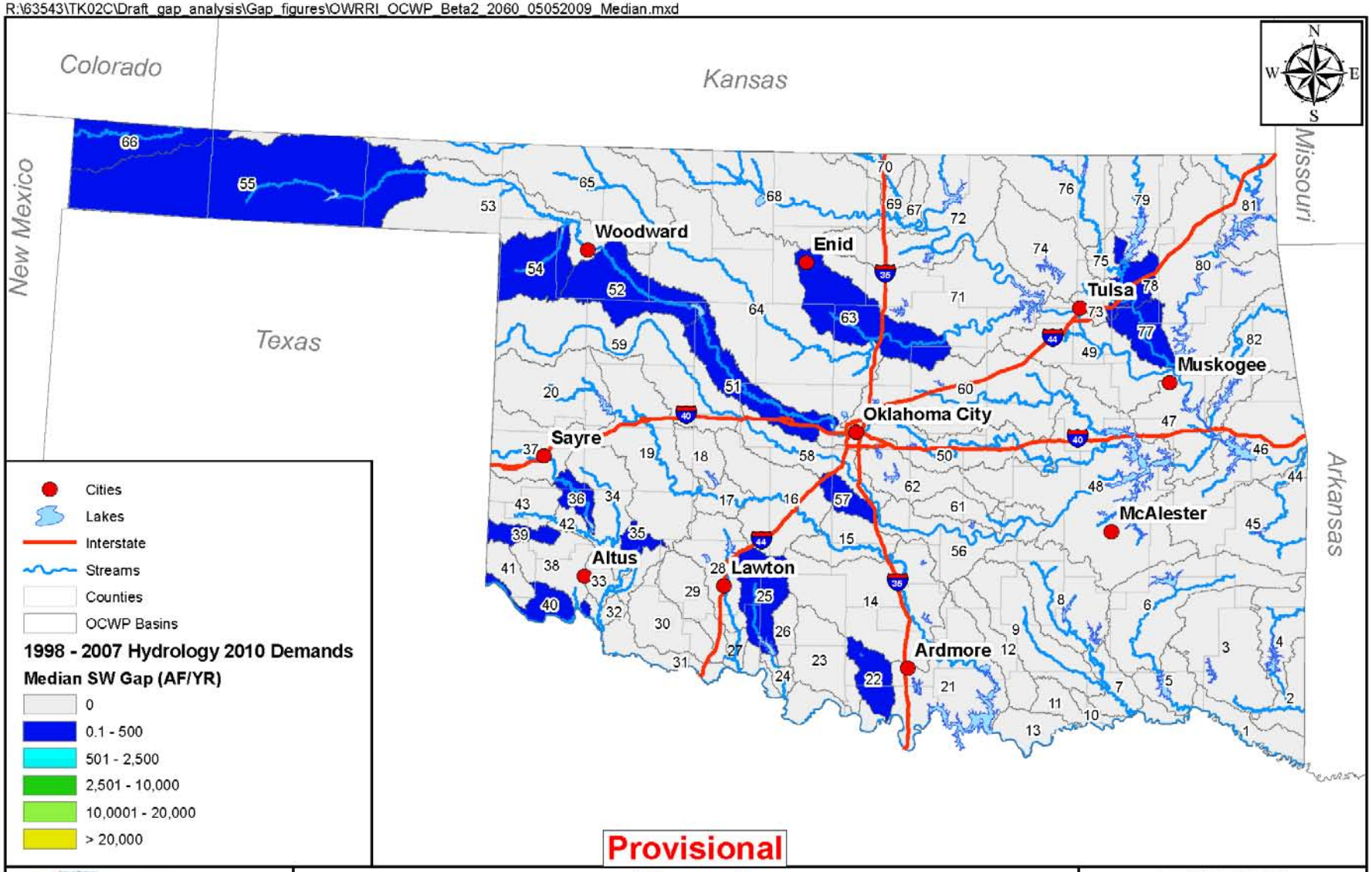

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Figure 4
Median Annual Surface Water Supply Availability Gaps for 1998 through 2007 Historical Hydrology and 2010 Demands

5.12.2009

0 25 50 75 Miles

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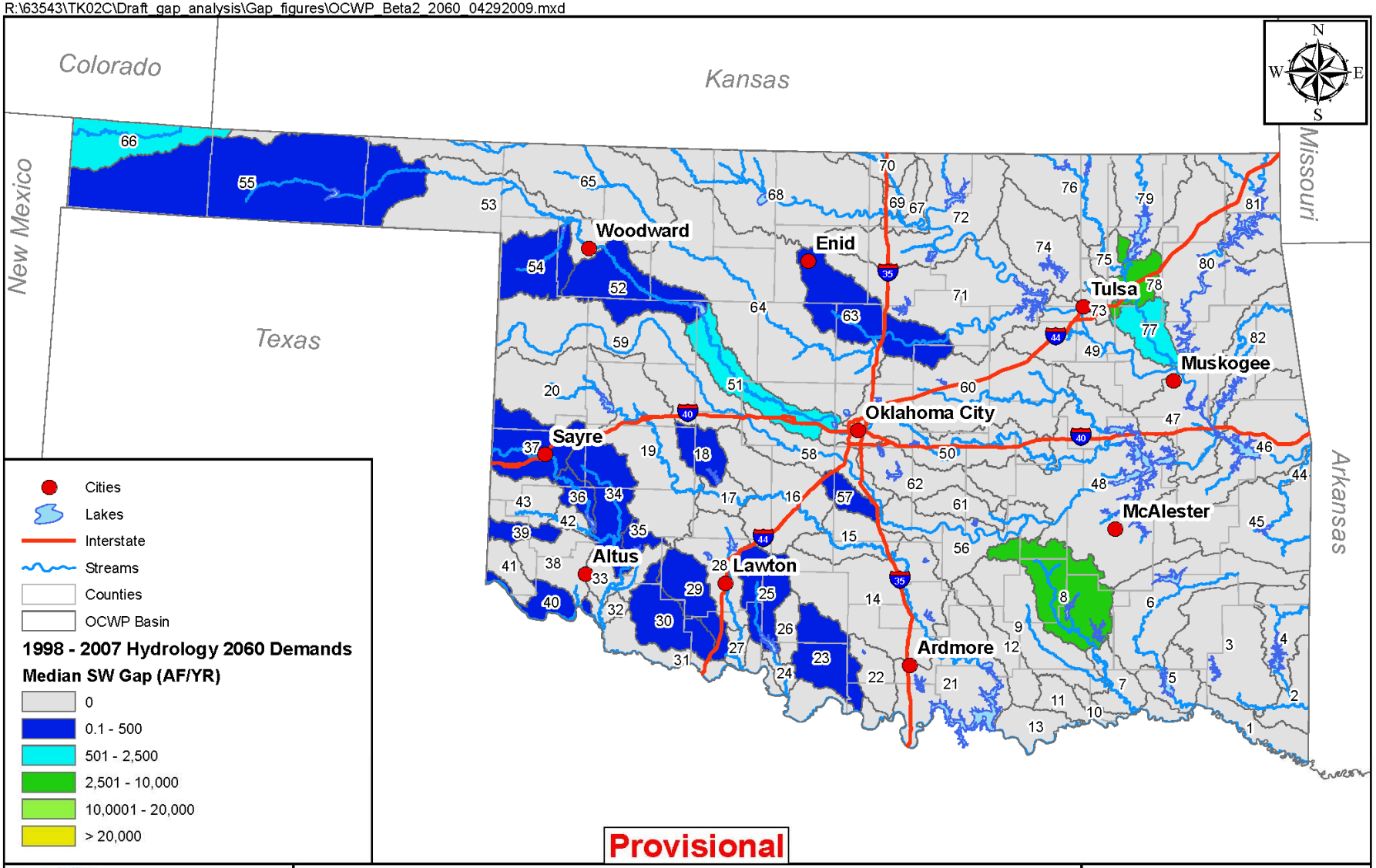

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Figure 5
Median Annual Surface Water Supply Availability Gaps for 1998 through 2007 Historical Hydrology and 2060 Demands

4.29.2009

Miles
0 25 50 75

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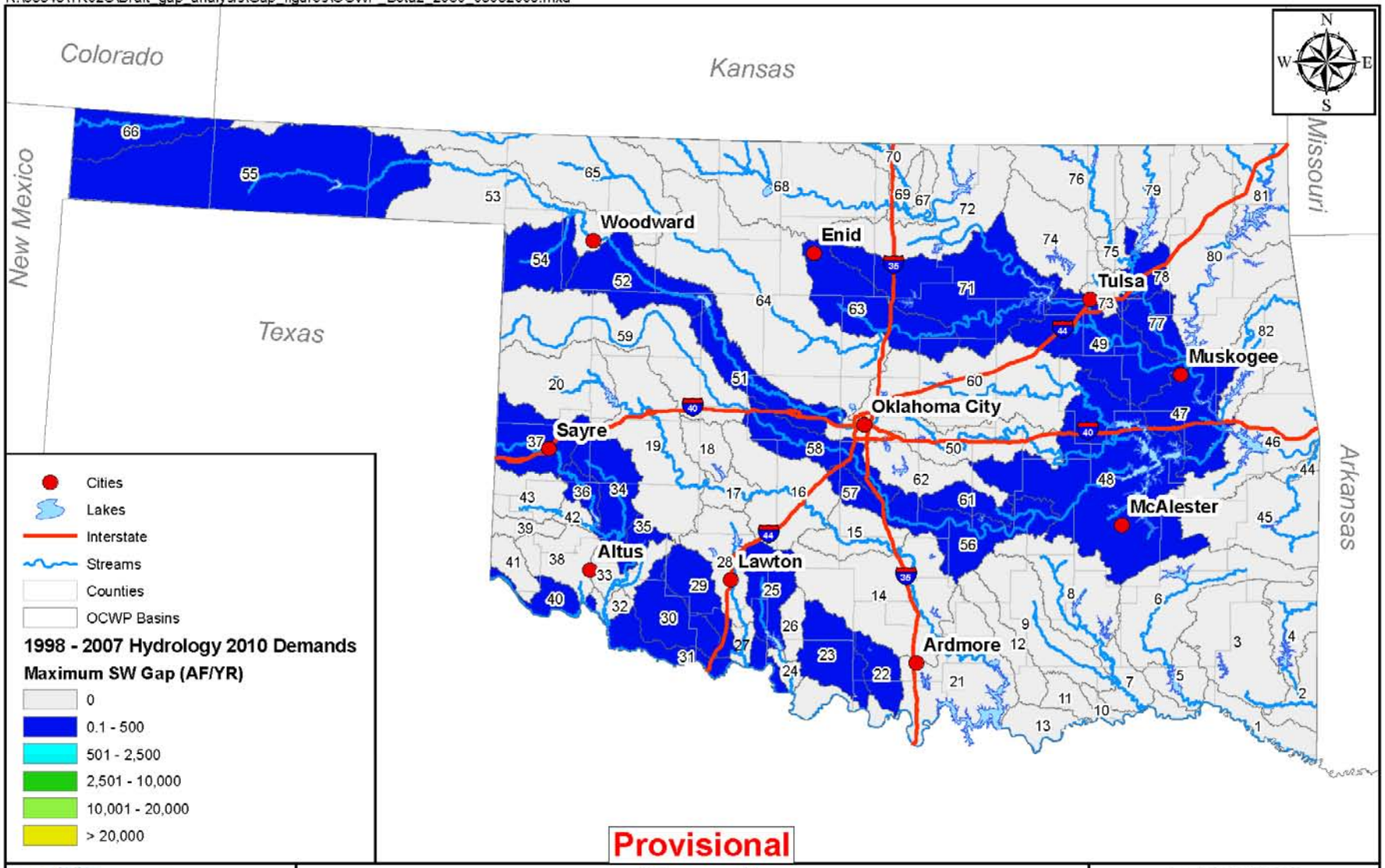

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Figure 6
Maximum Annual Surface Water Supply Availability Gaps for 1998 through 2007 Historical Hydrology and 2010 Demands

5.12.2009

0 25 50 75 Miles

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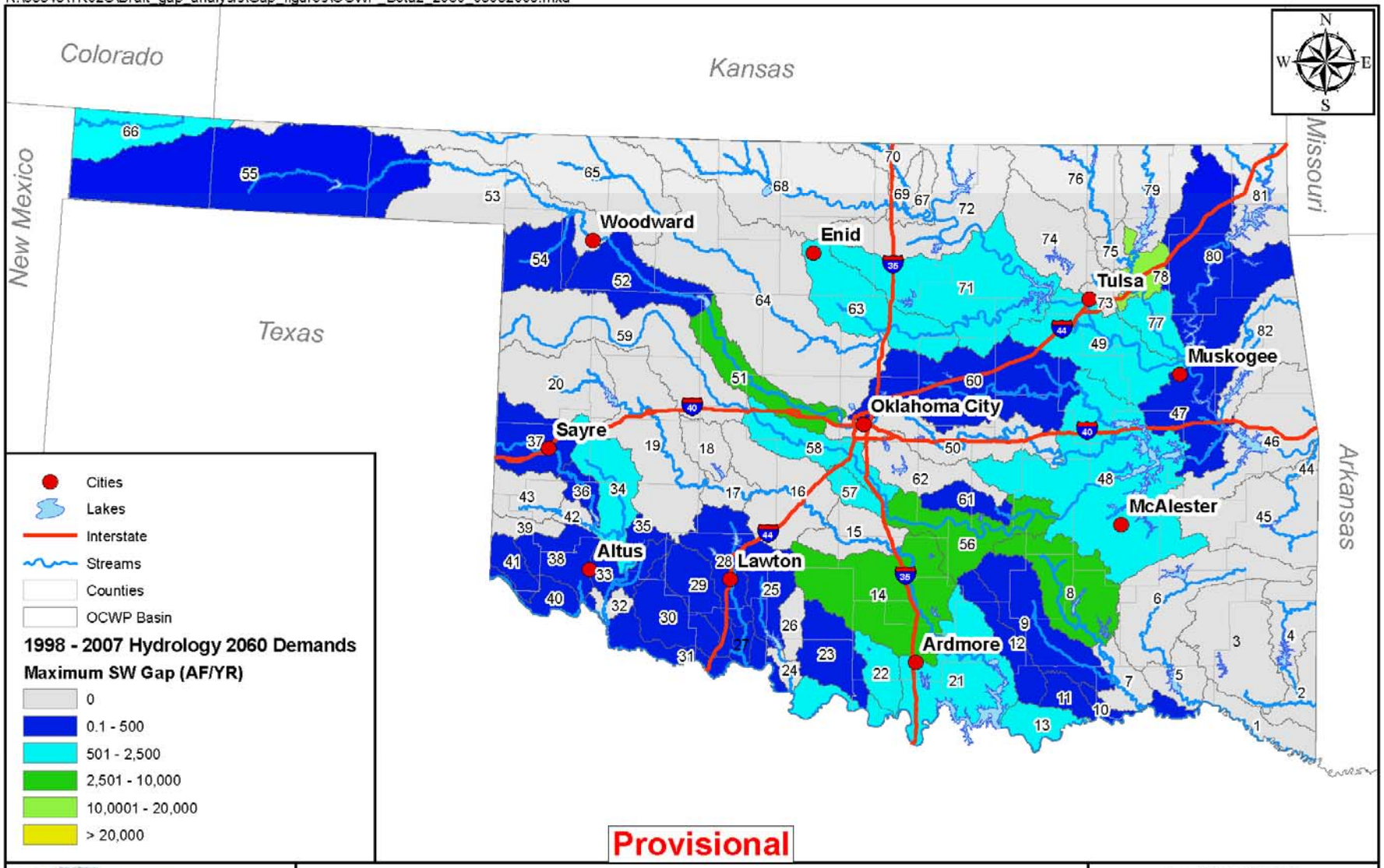

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Figure 7
Maximum Annual Surface Water Supply Availability Gaps for 1998 through 2007 Historical Hydrology and 2060 Demands

5.12.2009

Miles
0 25 50 75

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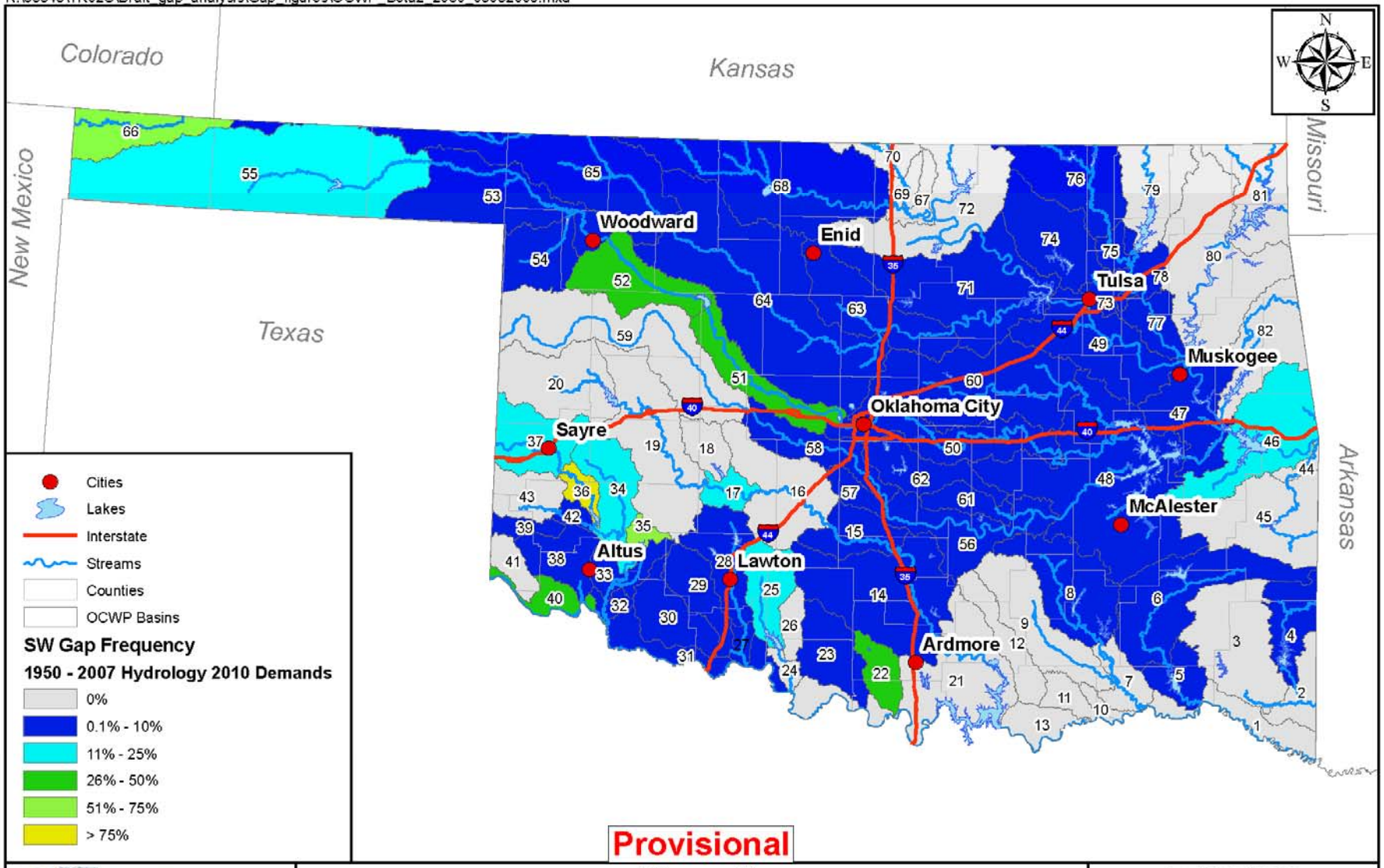

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Figure 8
Frequency of Annual Surface Water Supply Availability Gaps for 2010 Demands

5.12.2009

Miles
0 25 50 75

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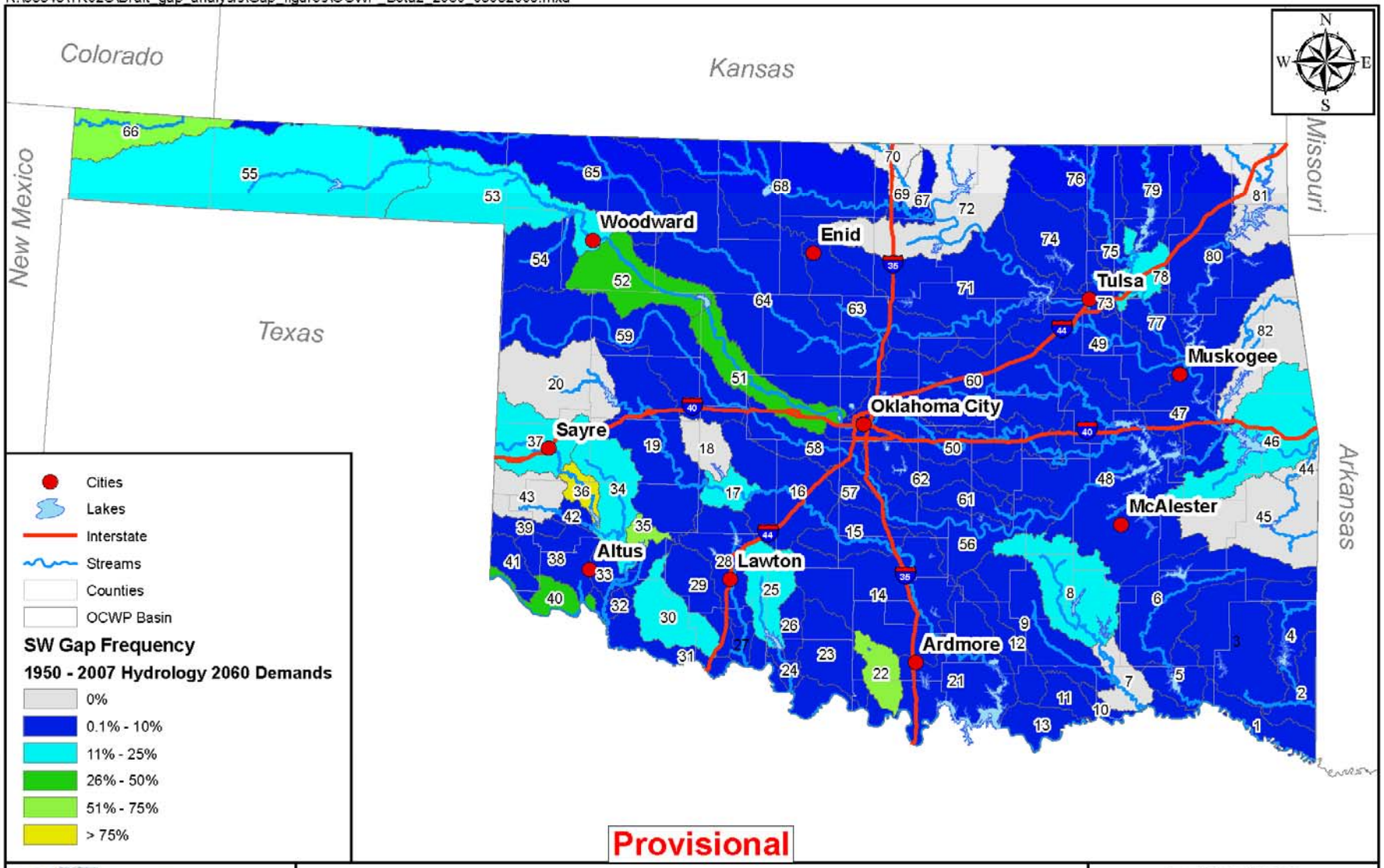

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Figure 9
Frequency of Annual Surface Water Supply Availability Gaps for 2060 Demands

5.12.2009

Miles
0 25 50 75

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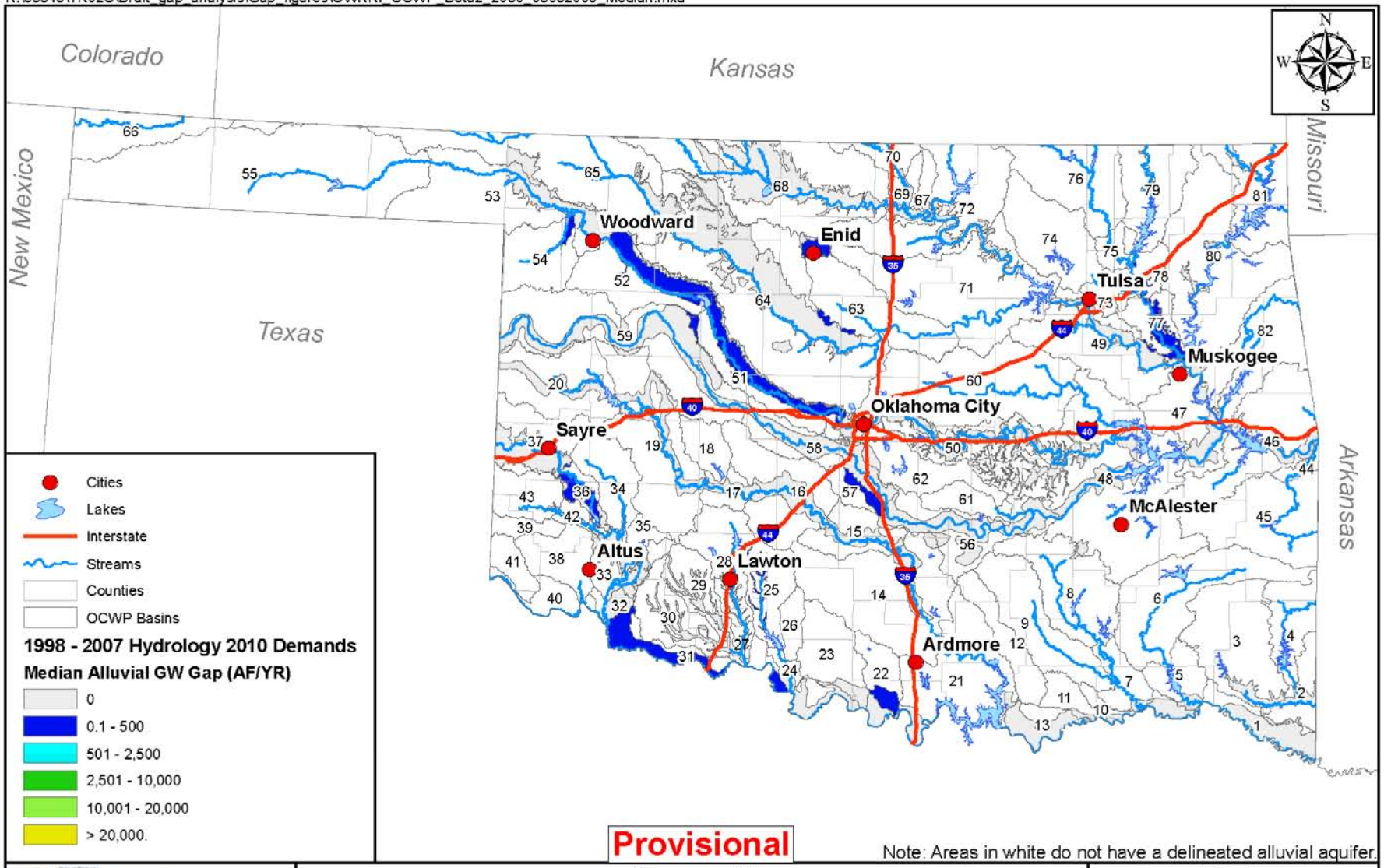

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Figure 14
Median Annual Alluvial Groundwater Supply Availability Gaps for 1998 through 2007 Historical Hydrology and 2010 Demands

5.12.2009

Miles
0 25 50 75

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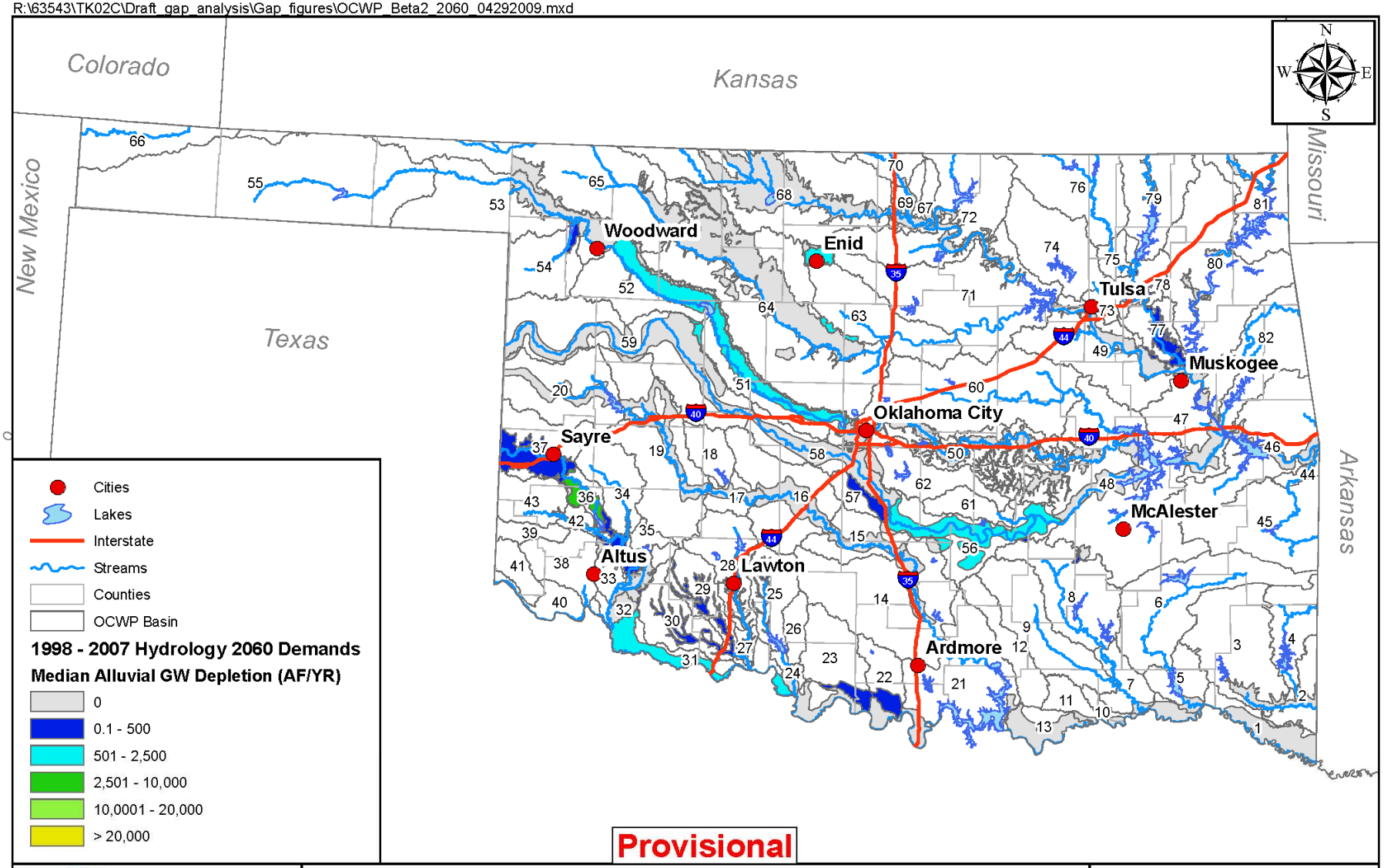

Figure 15
Median Annual Alluvial Groundwater Supply Availability Depletions for 1998 through 2007 Historical Hydrology and 2060 Demands

4.29.2009

Miles
0 25 50 75

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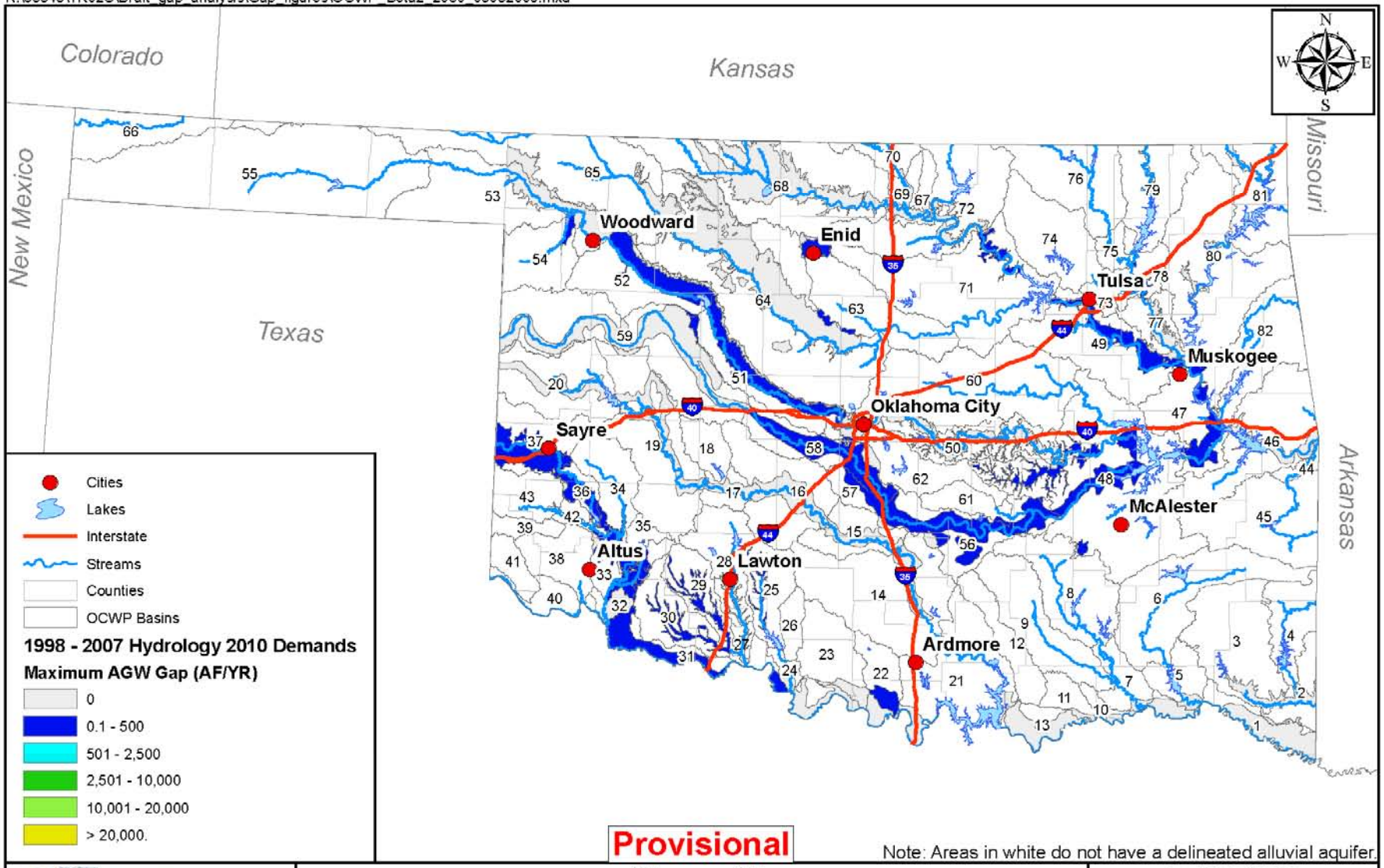

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Note: Areas in white do not have a delineated alluvial aquifer.

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Figure 16
Maximum Annual Alluvial Groundwater Supply Availability Gaps for1998 through 2007 Historical Hydrology and 2010 Demands

5.12.2009

Miles
0 25 50 75

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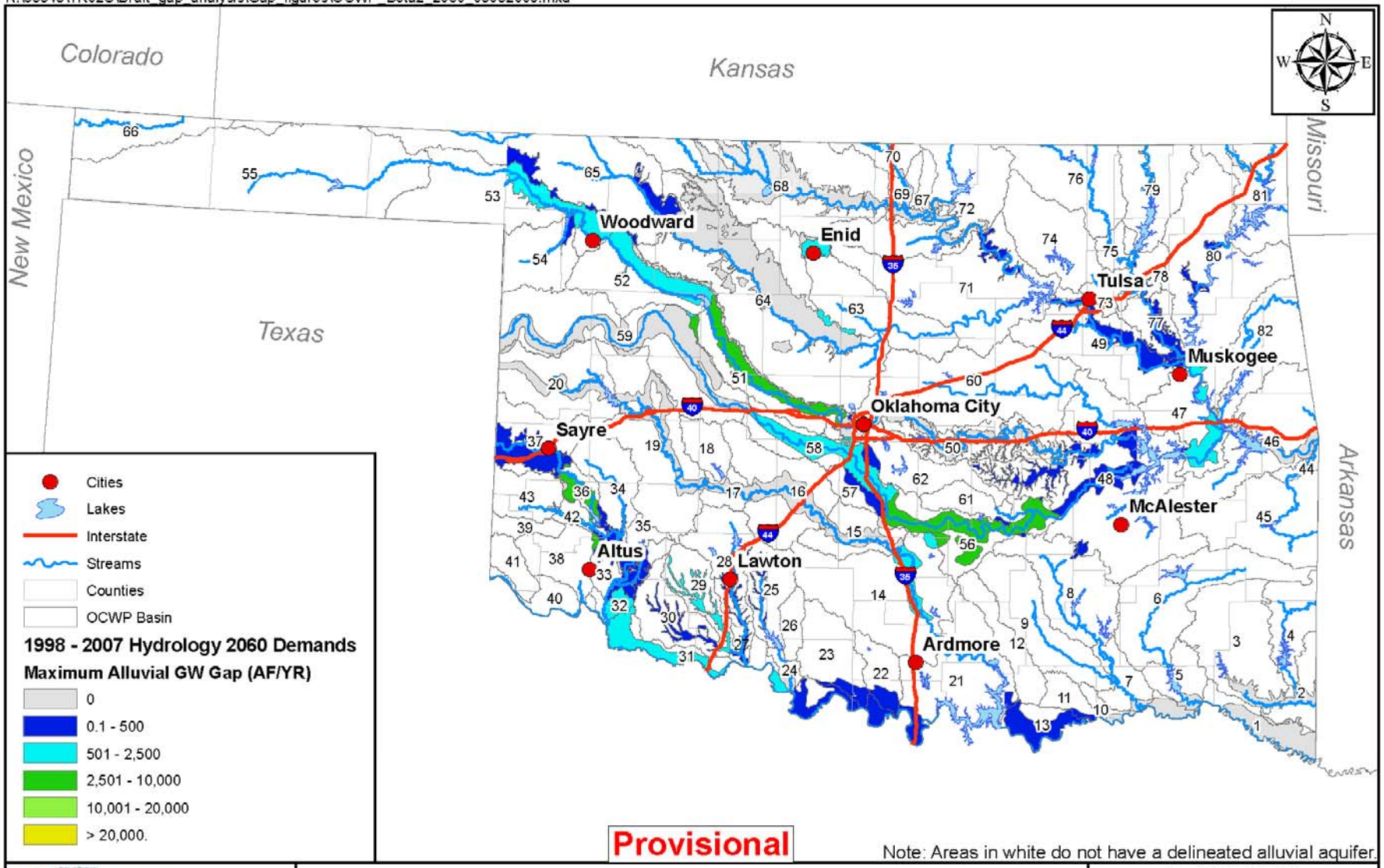

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Figure 17
Maximum Annual Alluvial Groundwater Supply Availability Gaps for1998 through 2007 Historical Hydrology and 2060 Demands

5.12.2009

Miles
0 25 50 75

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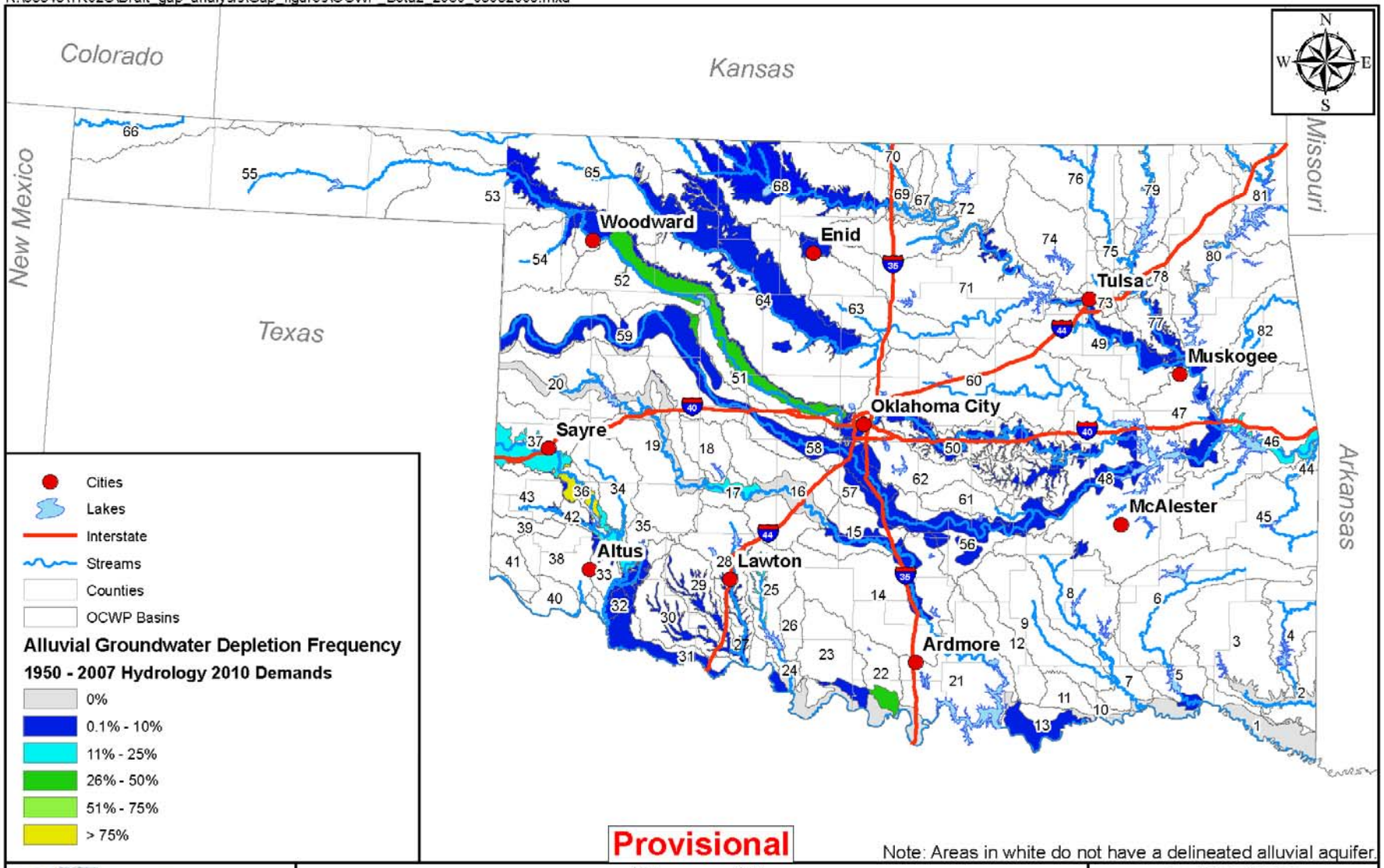

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Figure 18
Frequency of Annual Alluvial Groundwater Supply Availability Gaps for 2010 Demands

5.12.2009

Miles
0 25 50 75

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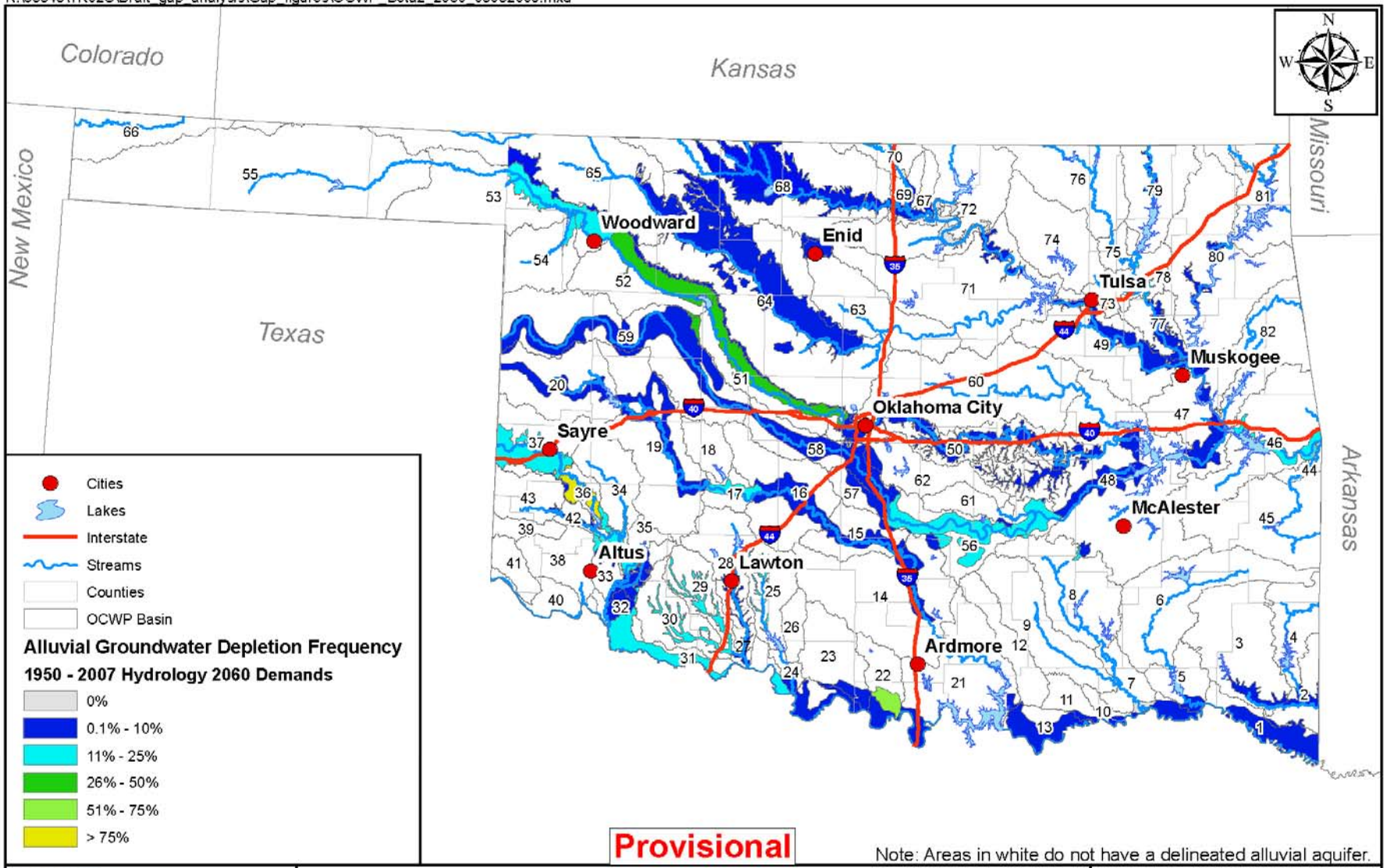

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Figure 19
Frequency of Annual Alluvial Groundwater Supply Availability Gaps for 2060 Demands

5.12.2009

Miles
0 25 50 75

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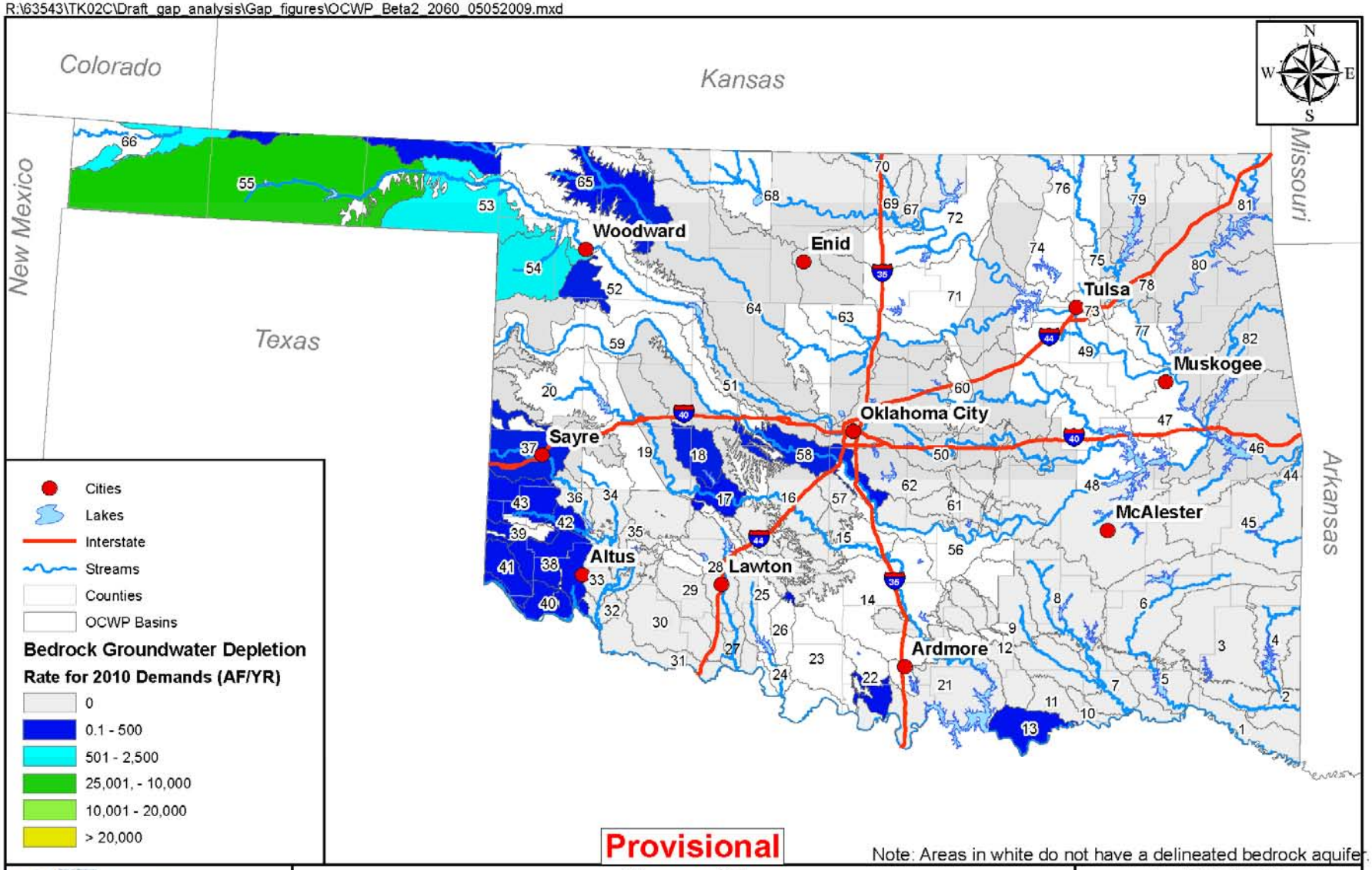

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Note: Areas in white do not have a delineated bedrock aquifer.

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Figure 21
Bedrock Groundwater Depletions in Excess of Recharge for 2010 Demands

5.12.2009

Miles
0 25 50 75

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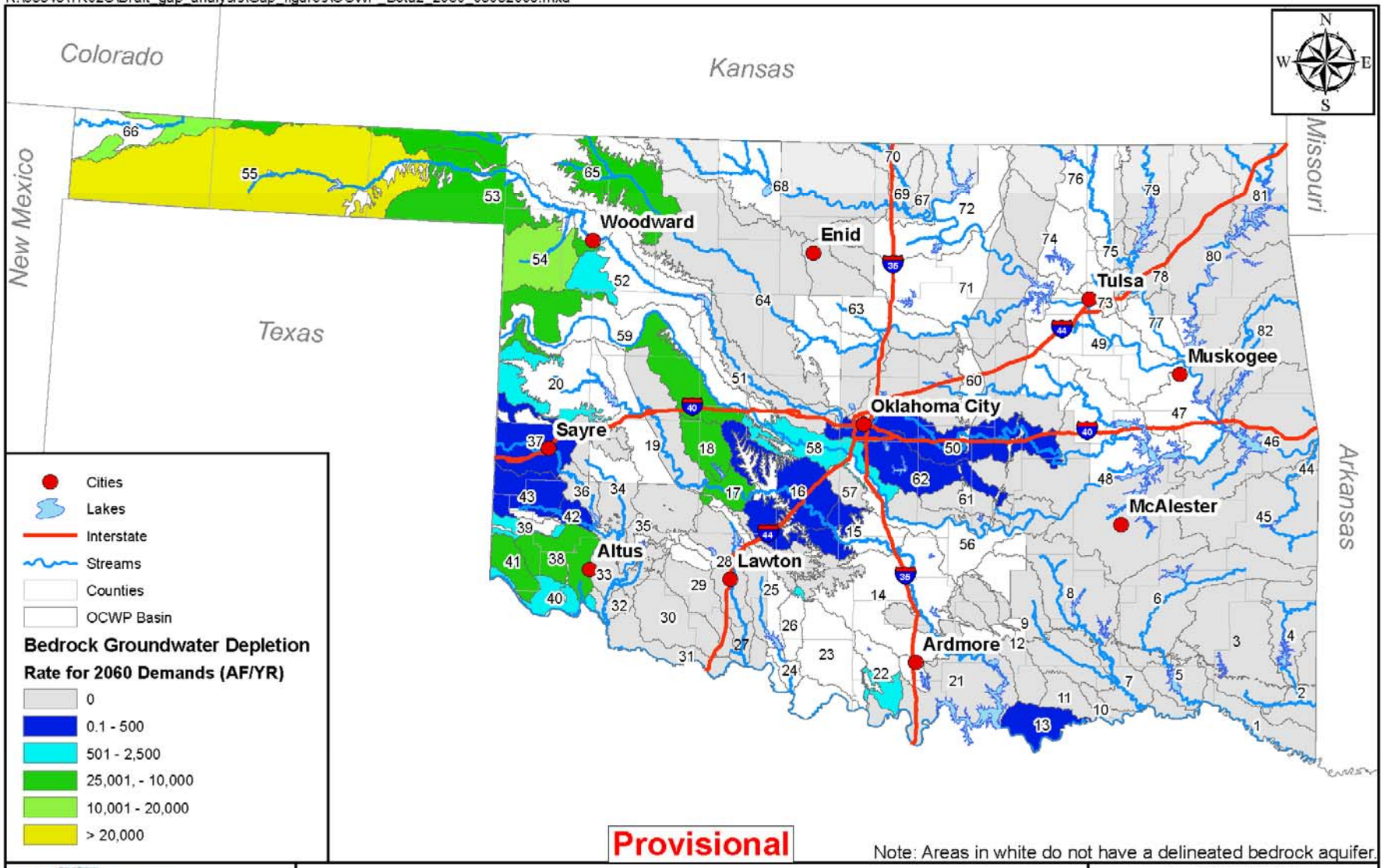

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Figure 22
Bedrock Groundwater Depletions in Excess of Recharge for 2060 Demands

5.12.2009

Miles
0 25 50 75

Known Issues

- The Red River is not considered a water supply source.
- GRDA contracts are not included in the analysis, but withdrawals were estimated from the OWRB water rights database.
- The statistical method used to estimate missing flow is not constrained to a minimum flow value; therefore periods of zero flow may be created ("false positive" gap)

Known Issues (Continued)

- Reservoirs may influence the timing or quantity of gaps, especially when the majority of consumptive use occurs upstream of the stream gage.
- Upstream states were assumed to use 60% of all available flow into Oklahoma.
- Downstream compact obligations do not constrain availability and will be analyzed separately as part of the legal availability analysis.

Agenda for This Morning

- *Opening Remarks*
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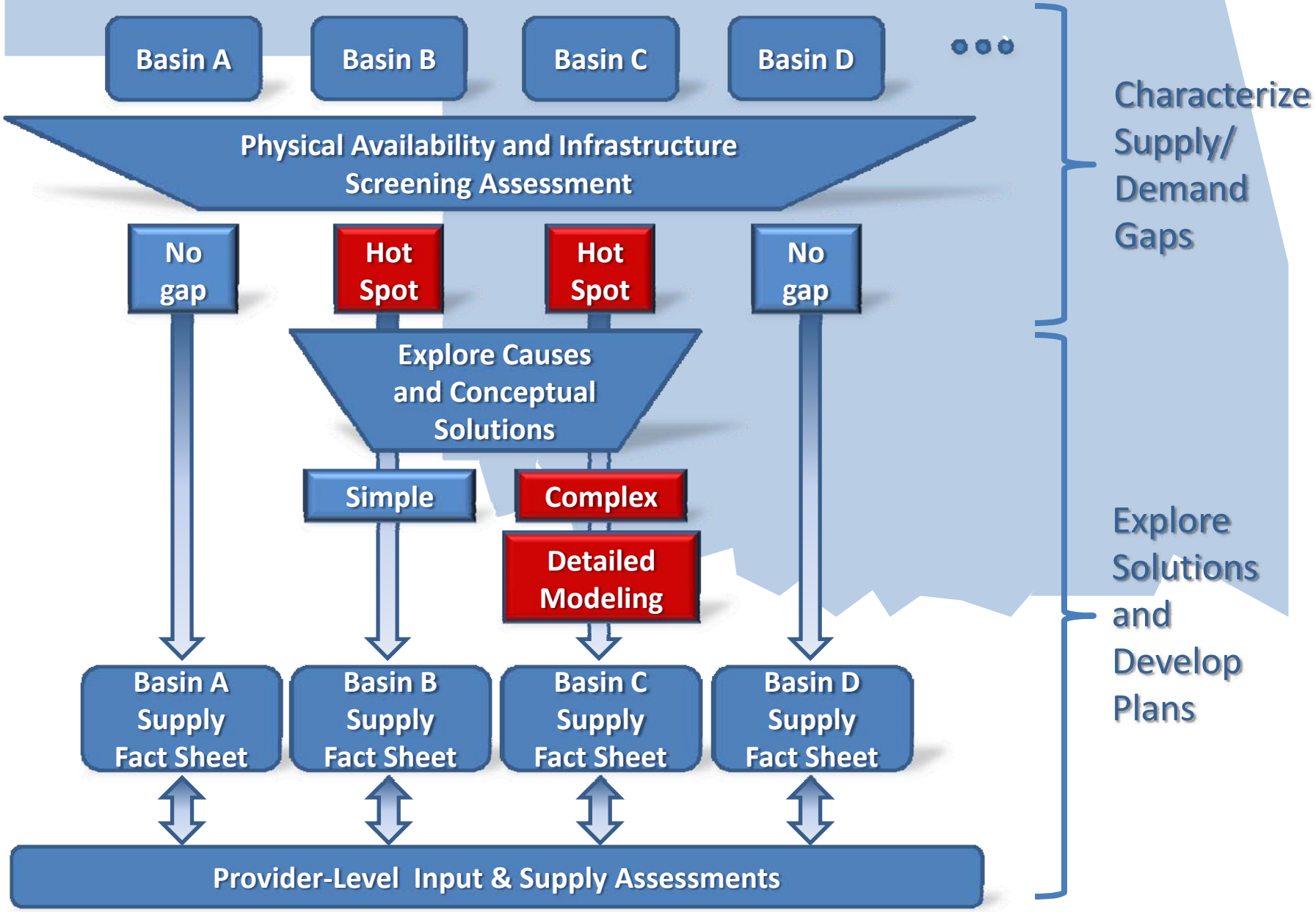
- *Oklahoma's Water Resources*
- *Physical Water Supply Availability*
- *On-going & Upcoming Technical Studies*
- *Water Allocation Modeling*

On-going & Upcoming Technical Studies

Focused Planning Process for OCWP



Overview of On-Going and Upcoming Technical Studies

- On-going Activities
  - *Legislative Work Groups – Aquifer Recharge & Marginal Quality Water*
  - *Environmental Flow Considerations*
  - *Water Allocation Modeling*
  - *Climate Variability Implications*
  - *Reservoir Yield Analyses*
  - *Technical Support to Public/Policy Process*
- Upcoming Activities
  - *Legal, Infrastructure, and Water Quality Assessments*
  - *Investigation of Causes of Physical Supply Gaps and Potential Solutions*
  - *Development of Basin Supply Fact Sheets*

Legislative Work Groups

- Aquifer Recharge (SB 1410)
  - *Screening process to identify candidate demonstration projects*
  - *Developing criteria for prioritization*
  - *Analyzing geohydrology data for candidate sites*
- Marginal Quality Water (SB1627)
  - *Defining Marginal Quality Water by source and characteristics*
  - *Identifying potential uses of MQ Water and constraints to its use*
  - *Characterizing potential for use in water-short areas*

Aquifer Recharge Workgroup: Goals and Overall Process

- Develop and implement criteria to prioritize potential locations throughout Oklahoma where aquifer recharge demonstration projects may be most feasible.

- Phase 1 will undertake a siting evaluation of potential recharge sites

- Phase 2 will implement one or more pilot studies on high-ranking sites from Phase 1, using site-specific factors to prioritize sites

Marginal Quality Water Workgroup: Goals and Overall Process

- Identify and characterize potential supplies and uses of marginal-quality waters, and make recommendations on how best to utilize marginal-quality water supplies to benefit Oklahoma's citizens, economy, and environment.

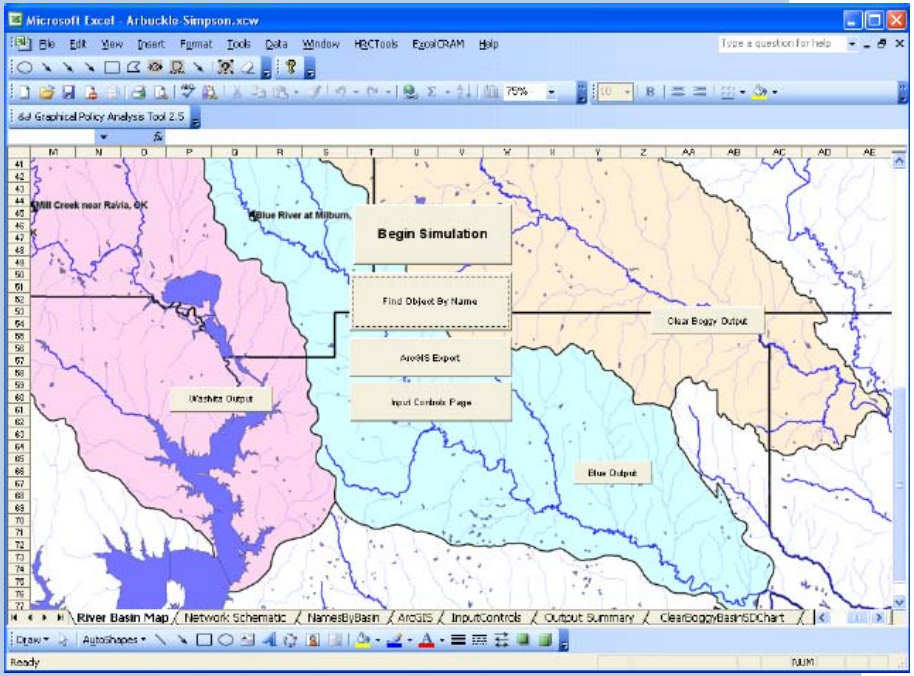
Definitions of Marginal Quality Water

- Surface or groundwater
- Water not typically used for public supply
- Treated wastewater effluent
- Stormwater runoff
- Brackish groundwater or surface water
- Produced water (or broader definition?)
- Waters with key parameters over identified thresholds

Environmental Flow Considerations

- Other States' Programs
  - *Characterizing western states' programs and approaches*
  - *Identifying a range of approaches to environmental flow issues*
- Existing Oklahoma Programs
  - *Characterizing existing programs and water administration with respect to environmental flows*
  - *Includes Scenic Rivers, compact obligations, domestic use reserve water, and others*
- Next Steps: Stakeholder Work Group dialogue

Water Allocation Modeling

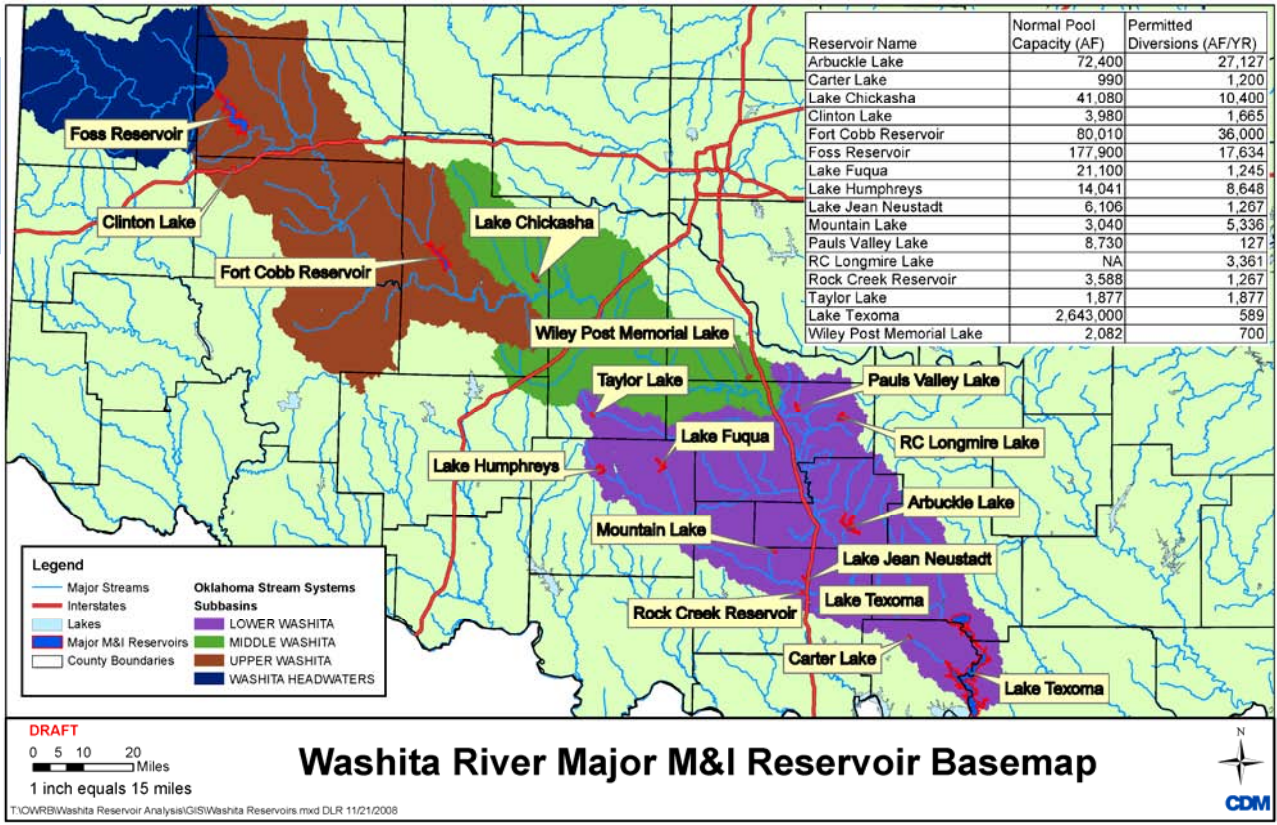


- Detailed modeling of Kiamichi River and Little River basins
- Conducted by AMEC Earth & Environmental
- Similar to ongoing modeling of Muddy Boggy, Clear Boggy, Blue, Middle/Lower Washita basins
- Considers supplies, demands, permits at multiple points throughout the watershed

Climate Variability Investigations

- Demands:
  - *Investigating correlation between historical public water demands and historical weather data*
  - *Resulting correlations can be applied to future climate predictions to predict range of potential demands*
- Supplies:
  - *Oklahoma Climate Survey studies underway to estimate implications on supply availability*
- *Application of Results:*
  - *Sensitivity analyses on supply gaps/depletions*

Reservoir Yield Analyses



Reservoir Name	Normal Pool Capacity (AF)	Permitted Diversions (AF/YR)
Arbuckle Lake	72,400	27,127
Carter Lake	990	1,200
Lake Chickasha	41,080	10,400
Clinton Lake	3,980	1,665
Fort Cobb Reservoir	80,010	36,000
Foss Reservoir	177,900	17,634
Lake Fuqua	21,100	1,245
Lake Humphreys	14,041	8,648
Lake Jean Neustadt	6,106	1,267
Mountain Lake	3,040	5,336
Pauls Valley Lake	8,730	127
RC Longmire Lake	NA	3,361
Rock Creek Reservoir	3,588	1,267
Taylor Lake	1,877	1,877
Lake Texoma	2,643,000	589
Wiley Post Memorial Lake	2,082	700

- Comparing yield methods
- Major public water supply reservoirs in the Washita Basin
- Federal, state, and locally owned reservoirs
- Will compare and evaluate methods for potential application as standardized yield estimation protocol in reservoirs statewide

Technical Support to Public/Policy Process

- Water Demand and Supply Handbook
- Basic Water Science Seminar (today)
- Planning Workshops (June – October 2009)
  - *Technical experts at each of three workshops*
  - *Question and answer support during and between workshops*
  - *Technical analysis of public/policy alternatives following each planning workshop*

Planning for a Reliable Supply

Legal / Permitting Availability

- How much surface water and groundwater can be permitted, by basin, under Oklahoma's administrative rules?
- Will that be sufficient to meet 2060 demands?

- How much water is obligated downstream under existing interstate compacts?
- Will Oklahoma's future demands conflict with those obligations?

Infrastructure Hot Spot Screening

- Identify future infrastructure needs
  - *Areas with projected additional demands*
  - *Providers without infrastructure to meet 2060 demands*
    - *Compare with existing and planned infrastructure*
- Characterize and quantify infrastructure hot spots by type
  - *Supply (diversion and storage)*
  - *Raw water conveyance*
  - *Water treatment and transmission*
- Develop alternatives and plans in future phases

Oklahoma Water Provider Survey

- Identify provider-specific constraints in meeting future water needs
- Enhanced understanding of infrastructure and permitting needs
- Determine county-level water use factors
- Validate OCWP projections of demands and limiting factors in meeting demands
  - *Rural Water Districts*
  - *Municipal Water Providers*

Areas Covered by Water Provider Survey

- Over 100 questions
- Areas covered
  - *General information*
  - *Conservation*
  - *Water demand*
  - *Purchased water supply information*
  - *Supply*
  - *Existing infrastructure*
  - *Reuse*
  - *Additional information and input*

Widespread Distribution

- The forms were distributed to a total of 761 water providers throughout Oklahoma

OKLAHOMA Municipal League
Champions For Effective Local Government

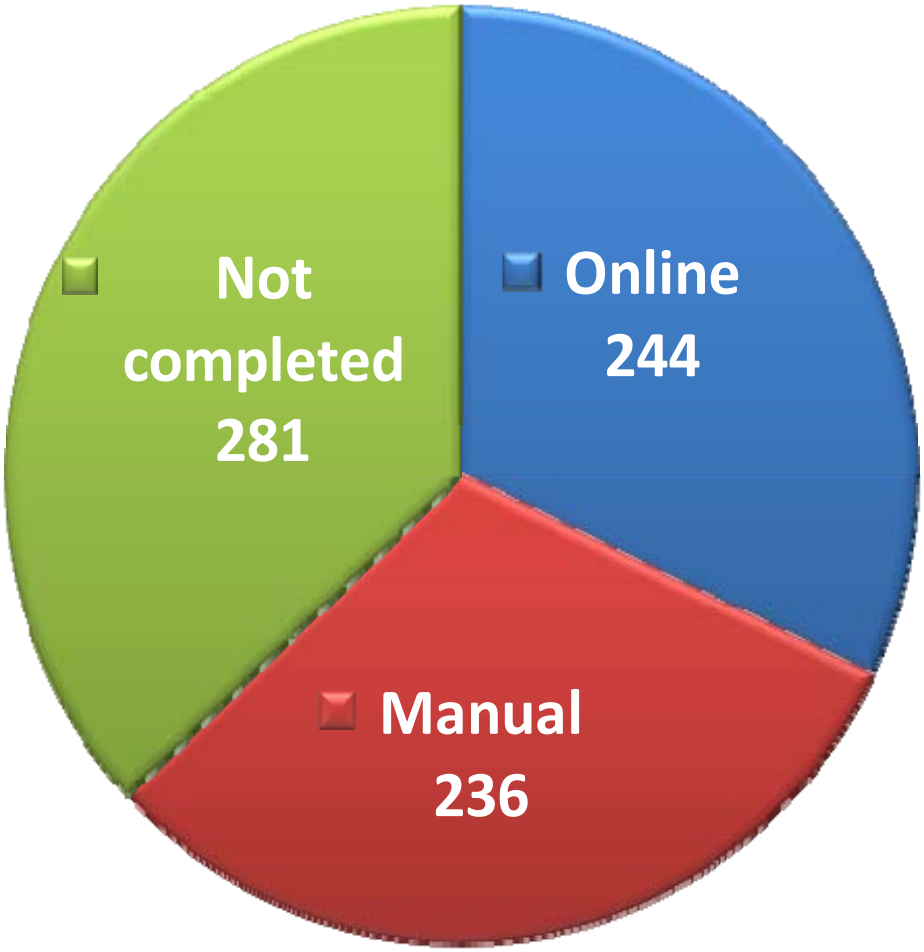
was assigned 390 surveys

OKLAHOMA RURAL WATER ASSOCIATION
ORWA

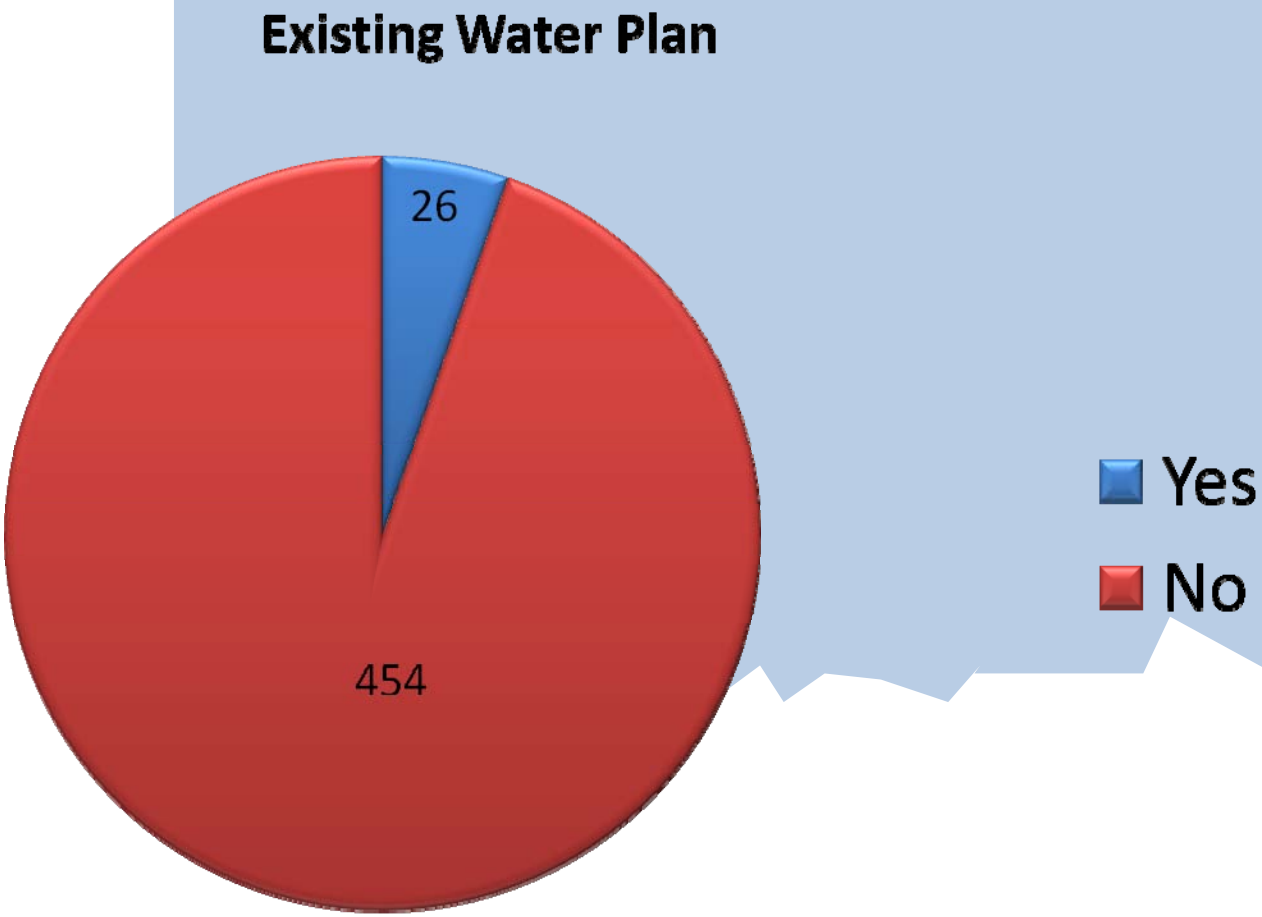
was assigned 371 surveys

- Survey distribution covers over 95% of Oklahoma's population

Provider Survey Responses



Provider Survey Response: Have an Existing Water Supply Plan?



Water Quality Criteria for Hot Spot Screening

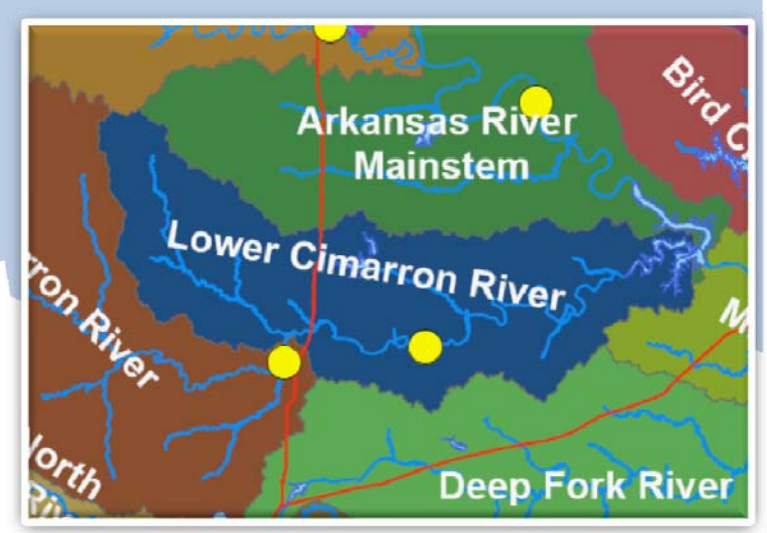
- Additional gap screening: When water is physically available (wet water) but is not suitable for use without expensive additional treatment
- Streams, lakes and groundwater
- Matching of BUMP HUCs with OCWP basins
- Types of beneficial uses impacted by water quality
  - *Municipal and domestic*
  - *Industrial*
  - *Agricultural*
  - *Aquatic*
  - *Recreational (Primary Body Contact)*

Water Quality Criteria for Hot Spot Screening *(continued)*

- Identify water quality parameters that impact the use types (BUMP and other sources)
- Identify data sources and evaluate data and trends in context of water uses
  - *BUMP Streams and Lakes Monitoring Program*
  - *303(d) list of impaired water bodies*
  - *Data from and areas identified by State agencies*
  - *Listed and threatened species*
  - *Water provider surveys and follow-up interviews*
  - *Regional stakeholder meetings*
- Identify existing water quality hot spots even if "wet water" is available (no supply gap)

Next Steps: Basin Supply Fact Sheets

- Synthesis of Supply, Demand, and Solutions
  - *Basin water supply resource summary*
  - *Basin water demand summary (by sector and year)*
  - *Major water supply reservoir characteristics*
  - *Existing and planned inter-basin transfers*
  - *Basin-level supply gaps*
  - *Conceptual basin-level supply solutions*



- Public Water Supplier Summary
  - *Listing of suppliers, projected demands, existing sources, infrastructure needs, & key findings from survey*

Agenda for This Morning

- *Opening Remarks*
- *OCWP Technical Studies Overview*
- *OCWP Programmatic Work Plan*
- *Planning Workshops Supply & Demand Handbook*
- *Provisional Water Demand Projections*

-- Break --

- *Oklahoma's Water Resources*
- *Physical Water Supply Availability*
- *On-going & Upcoming Technical Studies*
- *Water Allocation Modeling*

Water Allocation Modeling

Questions

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OKLAHOMA COMPREHENSIVE WATER PLAN

Technical Studies Update:
Methods, Provisional Results to Date, & Next Steps

Kyle Arthur – OWRB
Bryan Mitchell – CDM
Bill Davis – CDM
John Rehring – CDM
Travis Bogan – CDM
Ben Harding – AMEC

Basic Water Science Seminar
May 15, 2009
Oklahoma City, Oklahoma