Drainage of Coalbed Natural Gas Resources Powder River Basin, Wyoming

Fort Union Formation Coal Stratigraphy
Regional Groundwater Drawdown

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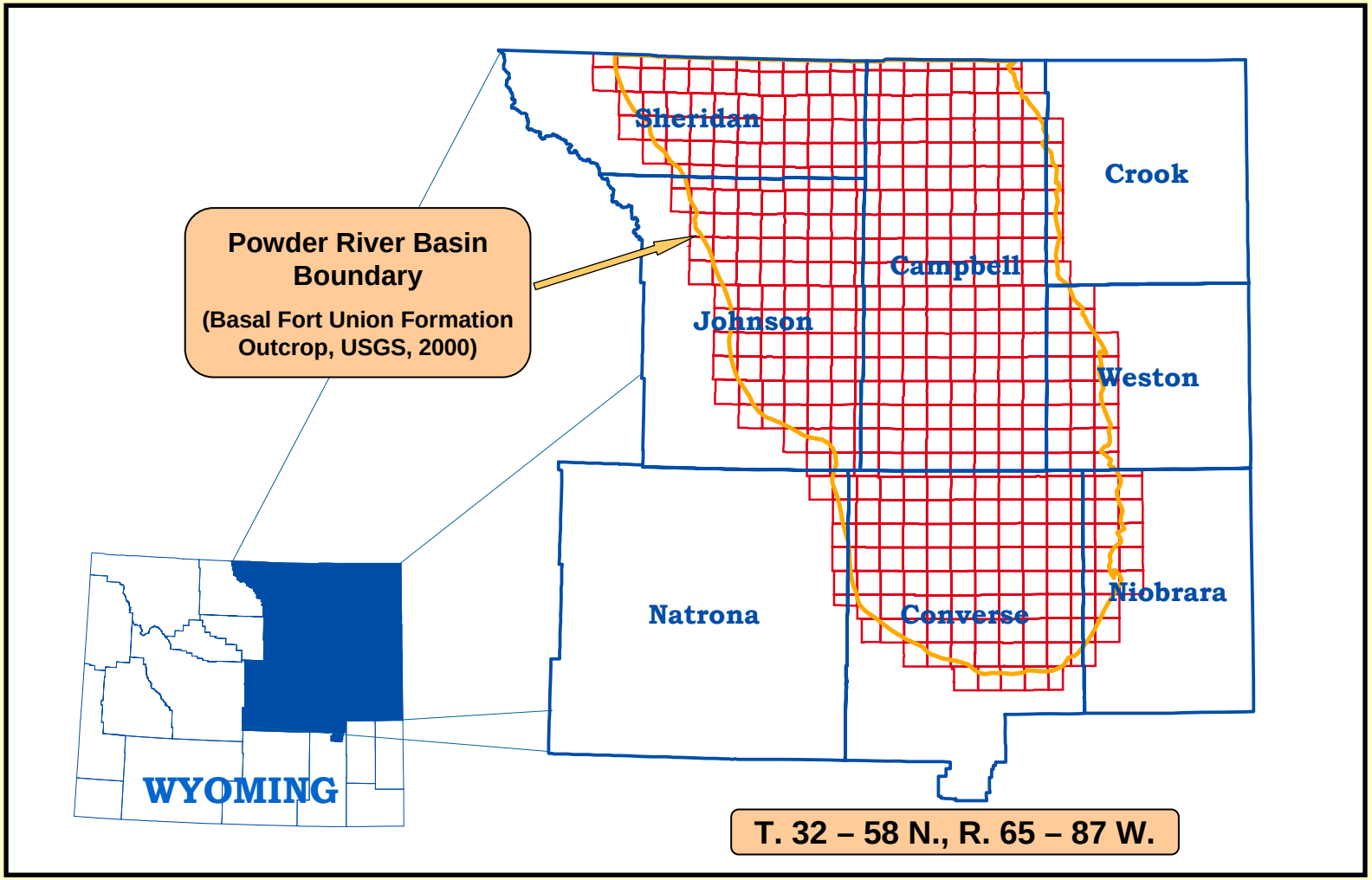
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Reservoir Management Group

Wyoming State Office

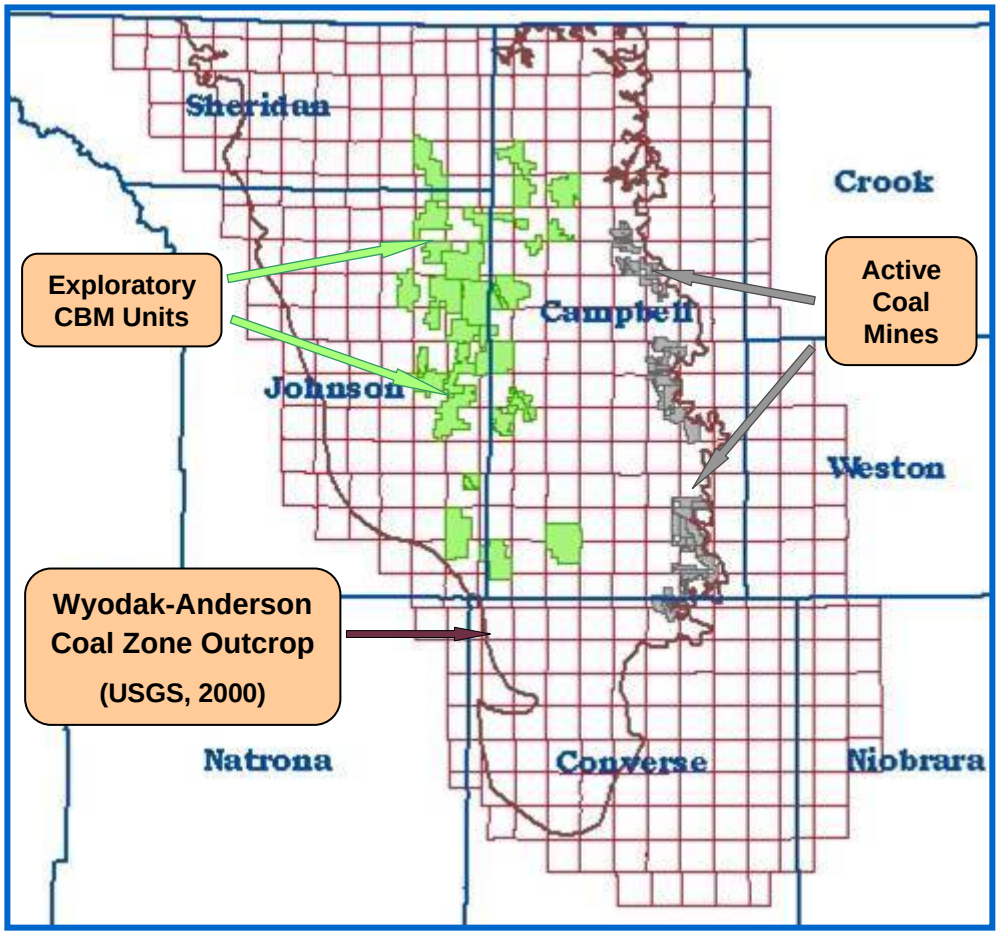
Wyoming Powder River Basin



Projection: UTM Zone 13
North American Datum, 1983

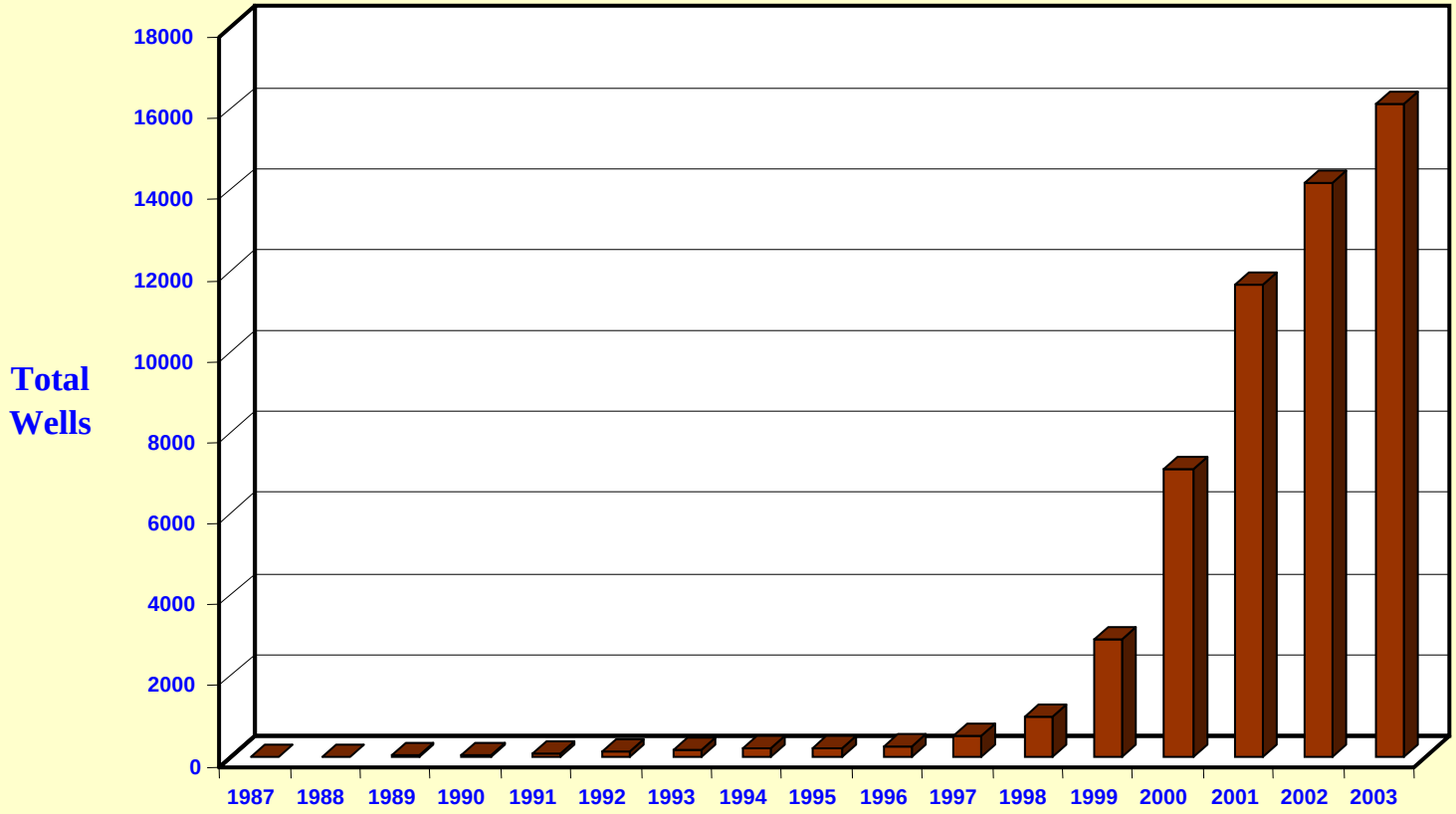
POWDER RIVER BASIN COALBED METHANE DEVELOPMENT

Basin Overview



Projection: Geographic
North American Datum, 1927

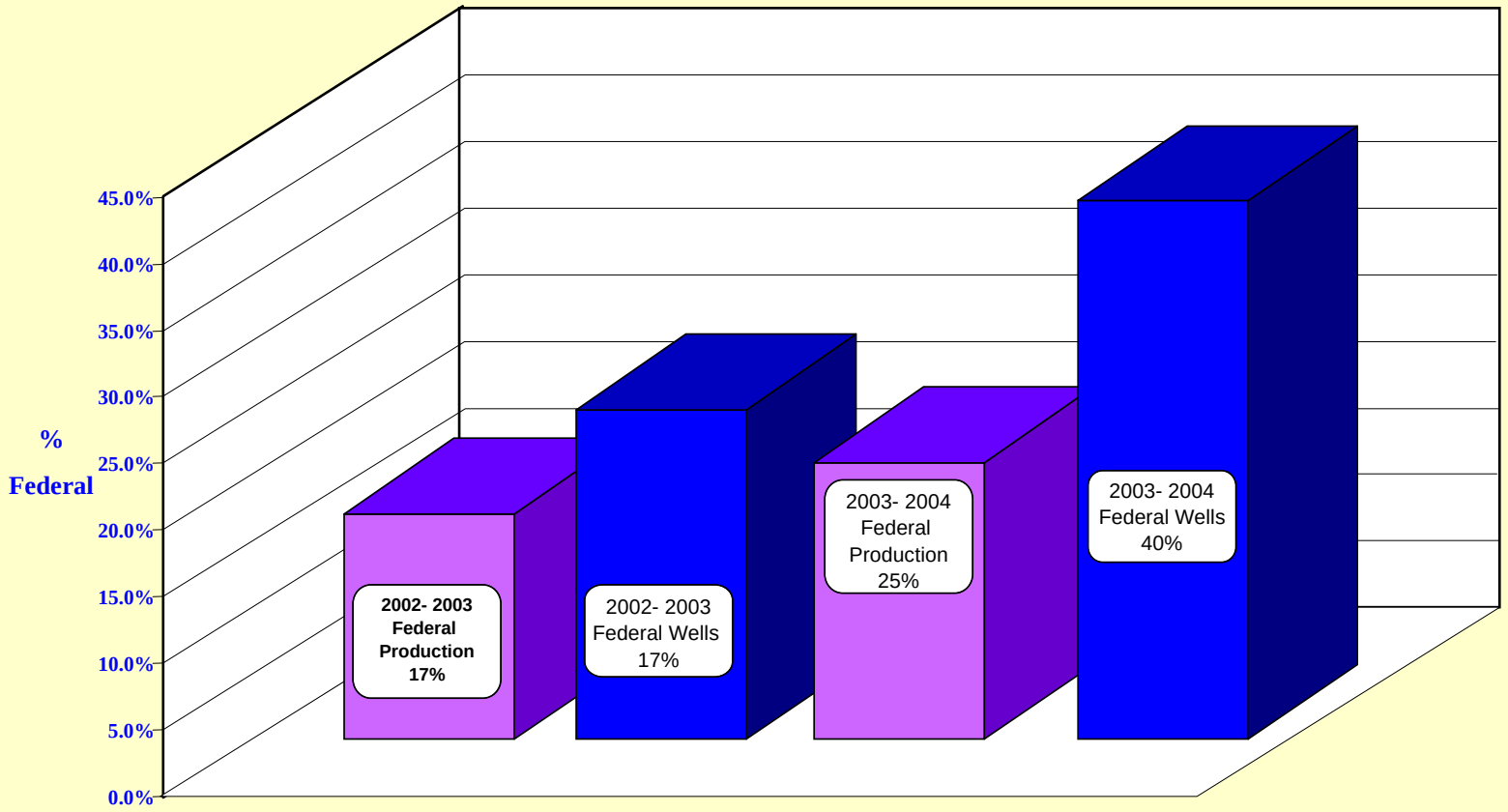
Powder River Basin
Total Coalbed Methane Wells
1987 - 2003
(includes producing and shut-in wells)



Well Data from Wyoming Oil and Gas Conservation Commission, May 2004

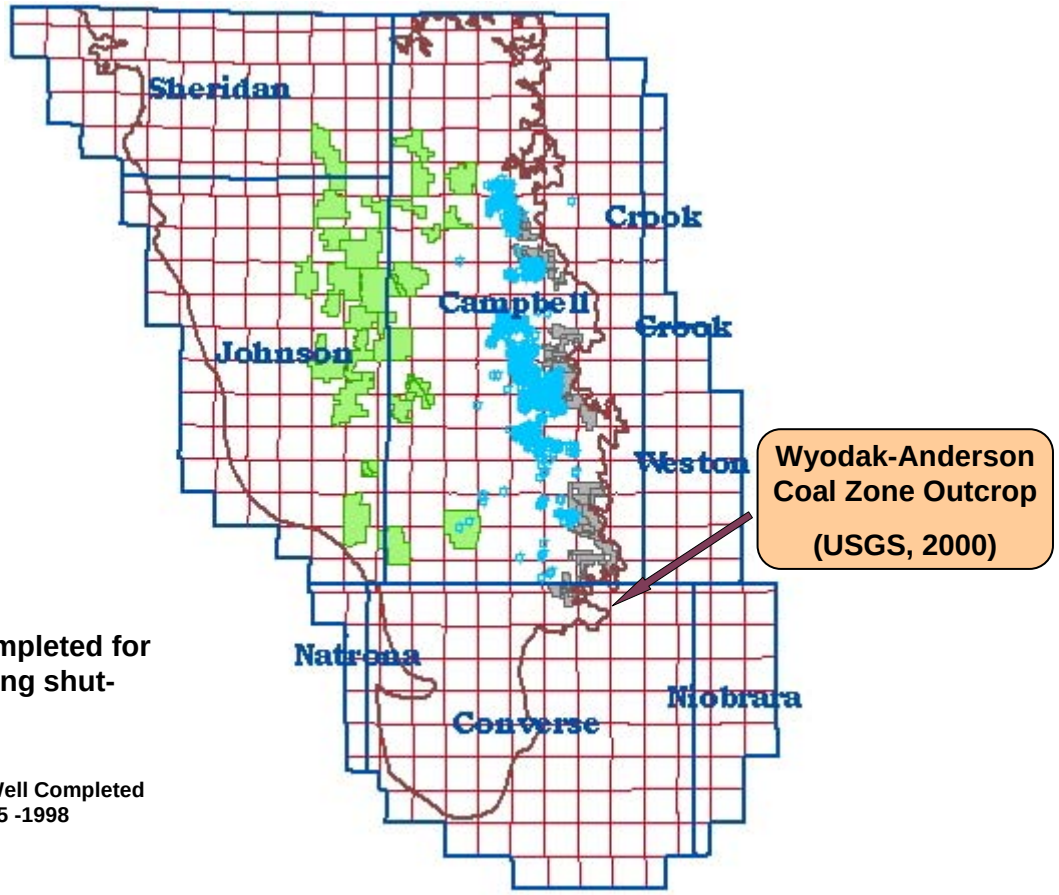
(Note that WOGCC statistics included all Wyoming CBM wells until 1991, but totals outside Powder River Basin are negligible)

Proportion of Federal CBM Wells And Production
July 2003 – June 2004



Well and Production Data from Wyoming Oil and Gas Conservation Commission, May 2004

Coalbed Methane Wells 1995 - 1998



969 Total Wells Completed for Production (including shut-in,non-producing)

* Coalbed Methane Well Completed for Production, 1995 -1998

Well Data from Wyoming Oil and Gas Conservation Commission

Projection: UTM Zone 13
North American Datum, 1983

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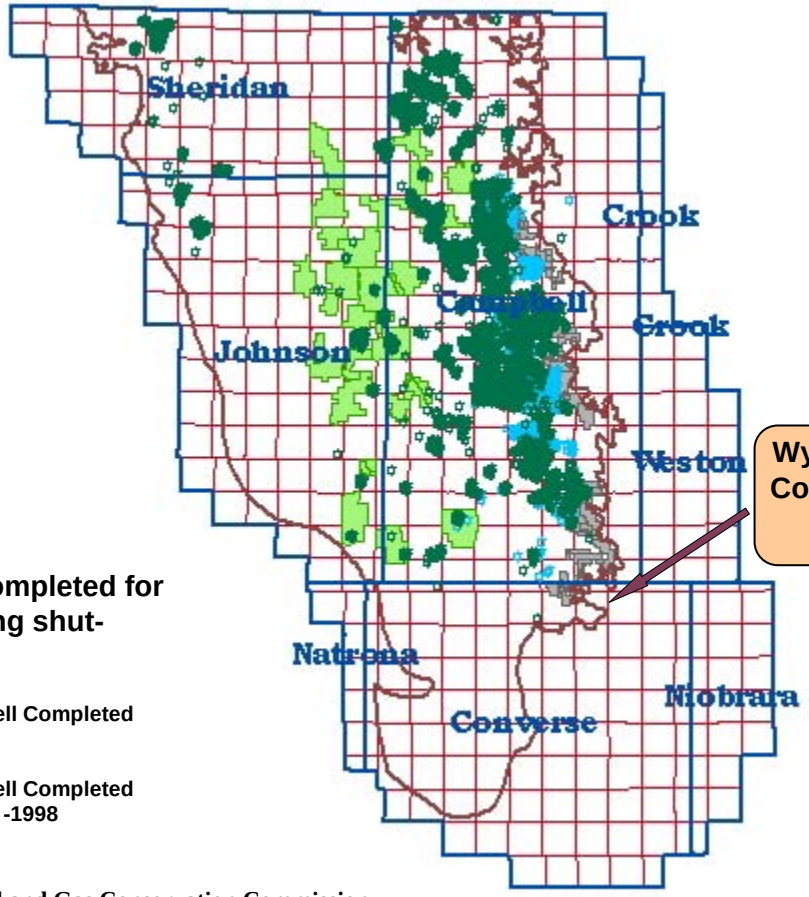
Coalbed Methane Wells 1995 - 1999



Wyodak-Anderson Coal Zone Outcrop

(USGS, 2000)

3,585 Total Wells Completed for Production (including shut-in,non-producing)

- * Coalbed Methane Well Completed for Production, 1999
- * Coalbed Methane Well Completed for Production, 1995 -1998

Well Data from Wyoming Oil and Gas Conservation Commission

Projection: UTM Zone 13
North American Datum, 1983

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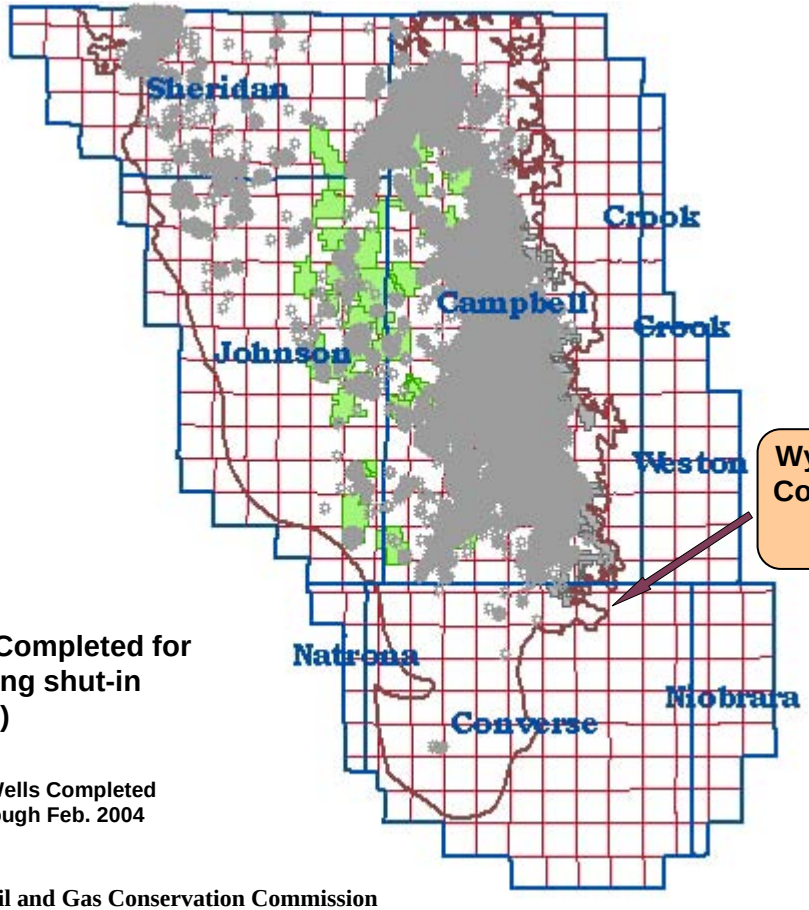
Coalbed Methane Wells Feb. 2004



Wyodak-Anderson Coal Zone Outcrop

(USGS, 2000)

14,838 Total Wells Completed for Production (including shut-in and non-producing)

* Coalbed Methane Wells Completed for Production Through Feb. 2004

Well Data from Wyoming Oil and Gas Conservation Commission

Projection: UTM Zone 13
North American Datum, 1983

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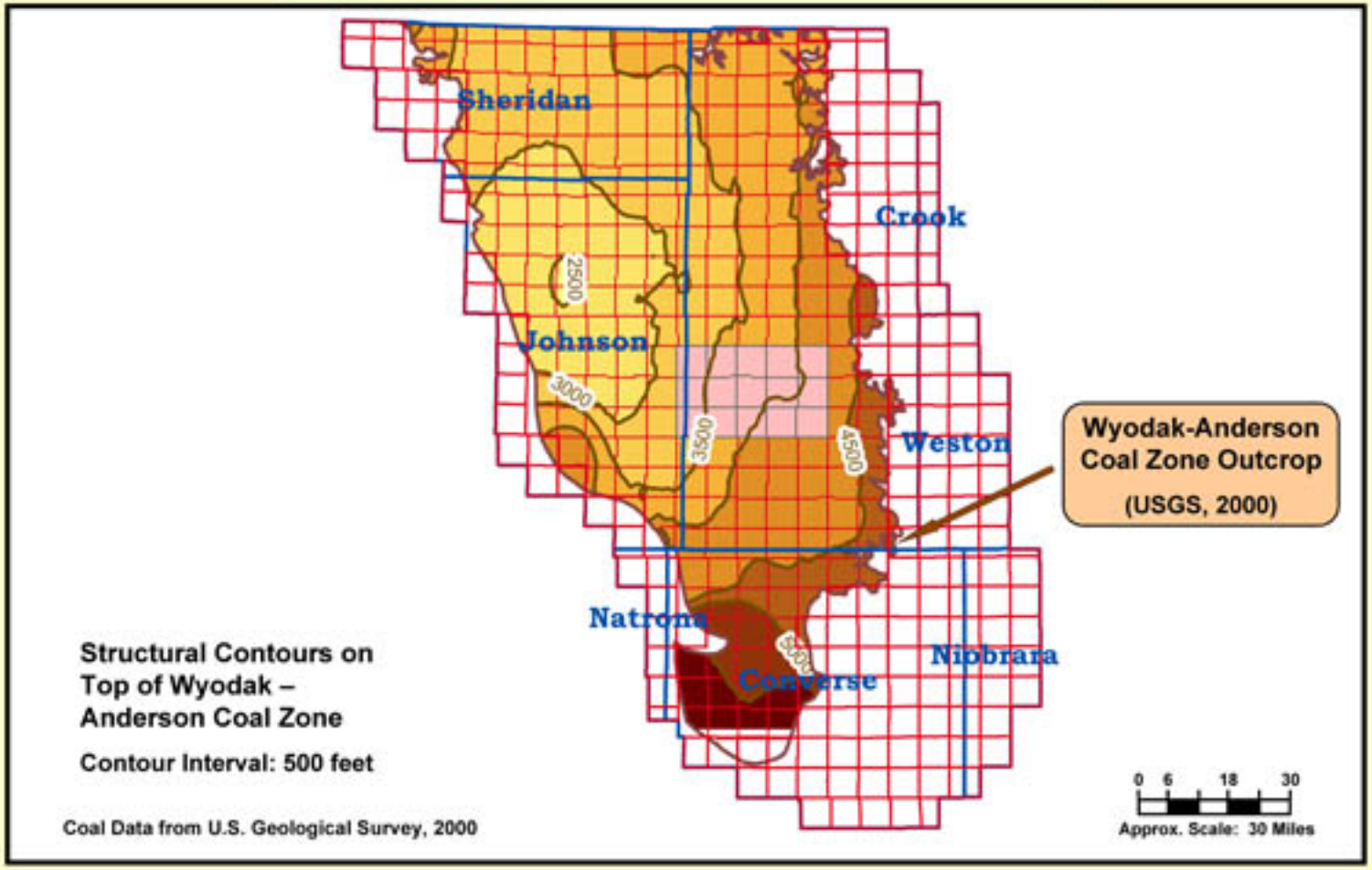
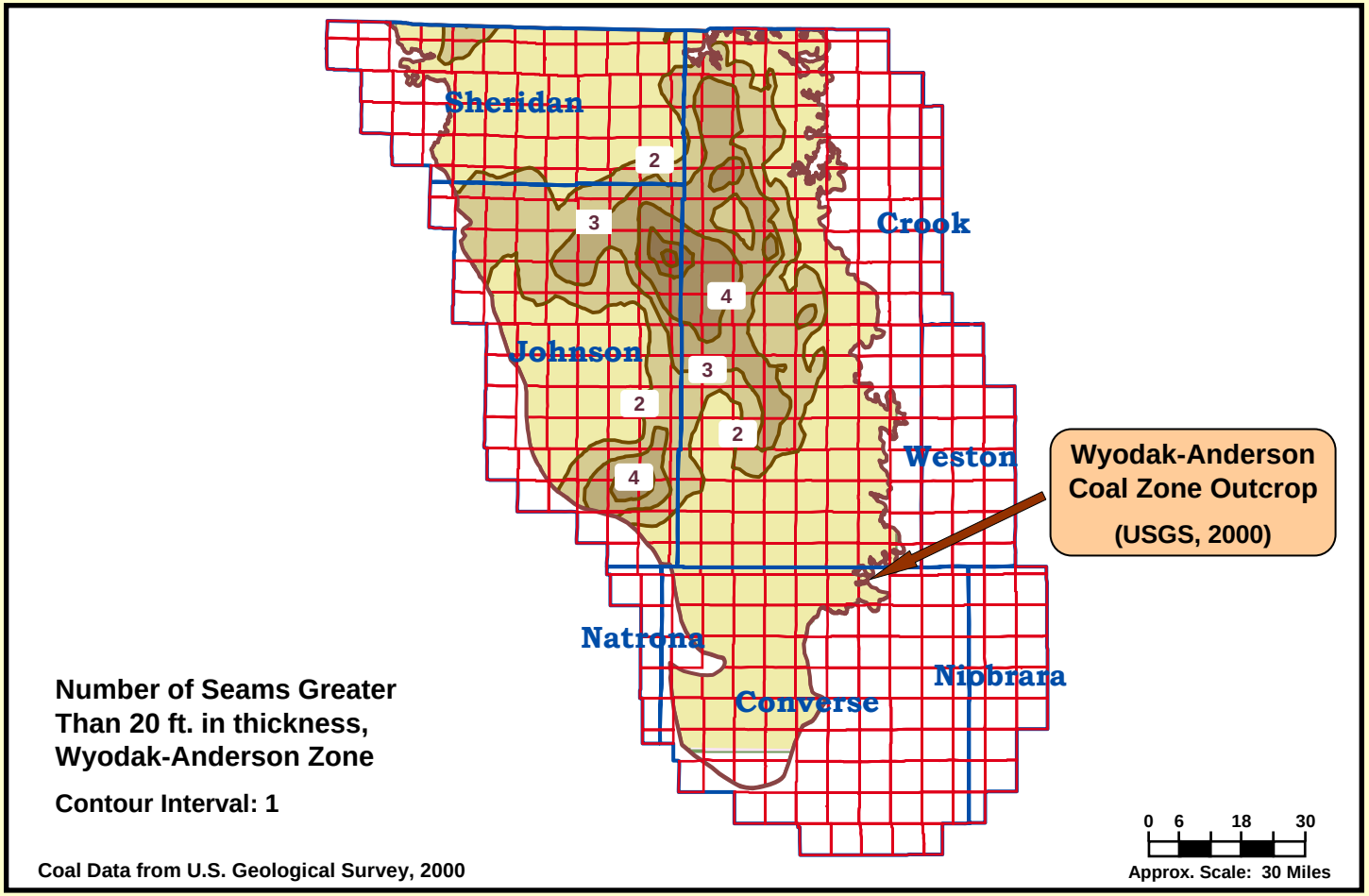
BASIN GEOLOGY, COALBED STRATIGRAPHY AND CBNG RESERVOIR ANALYSIS

Geologic Structure
Wyodak-Anderson Coal Zone



Projection: UTM Zone 13
North American Datum, 1983

Seams Greater Than 20 Feet Thick

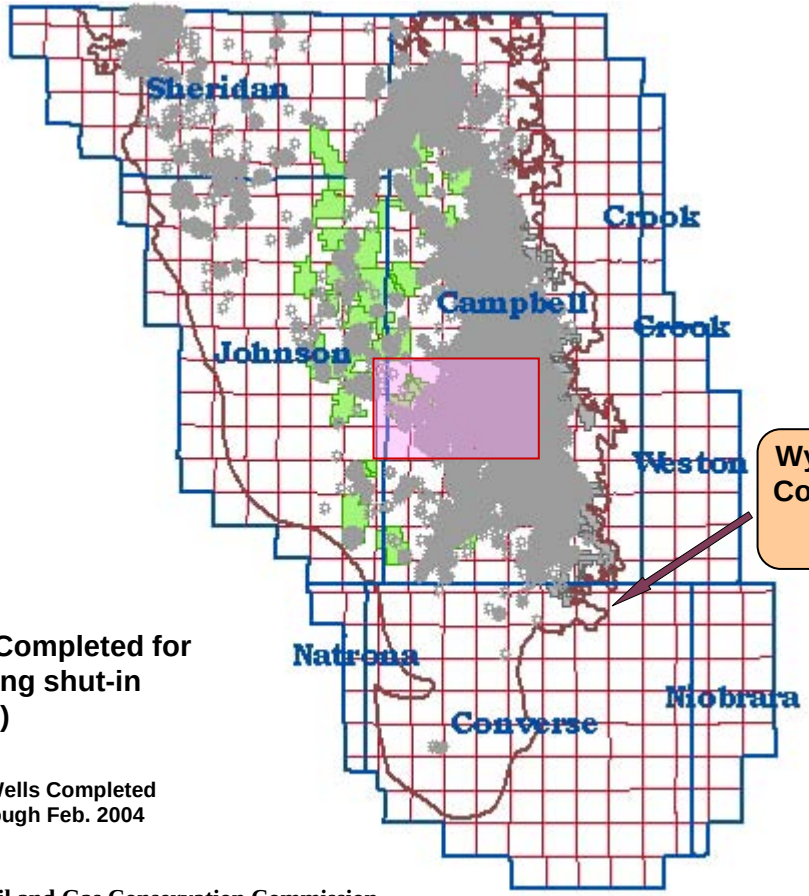


Projection: UTM Zone 13
North American Datum, 1983

Issues related to coalbed complexity

- ✓ Multiple coal seams in production
- ✓ Uncertainty in coal seam identification and correlation
- ✓ Inconsistent seam nomenclature

Coalbed Methane Wells Feb. 2004



Wyodak-Anderson Coal Zone Outcrop

(USGS, 2000)

14,838 Total Wells Completed for Production (including shut-in and non-producing)

* Coalbed Methane Wells Completed for Production Through Feb. 2004

Well Data from Wyoming Oil and Gas Conservation Commission

Projection: UTM Zone 13
North American Datum, 1983

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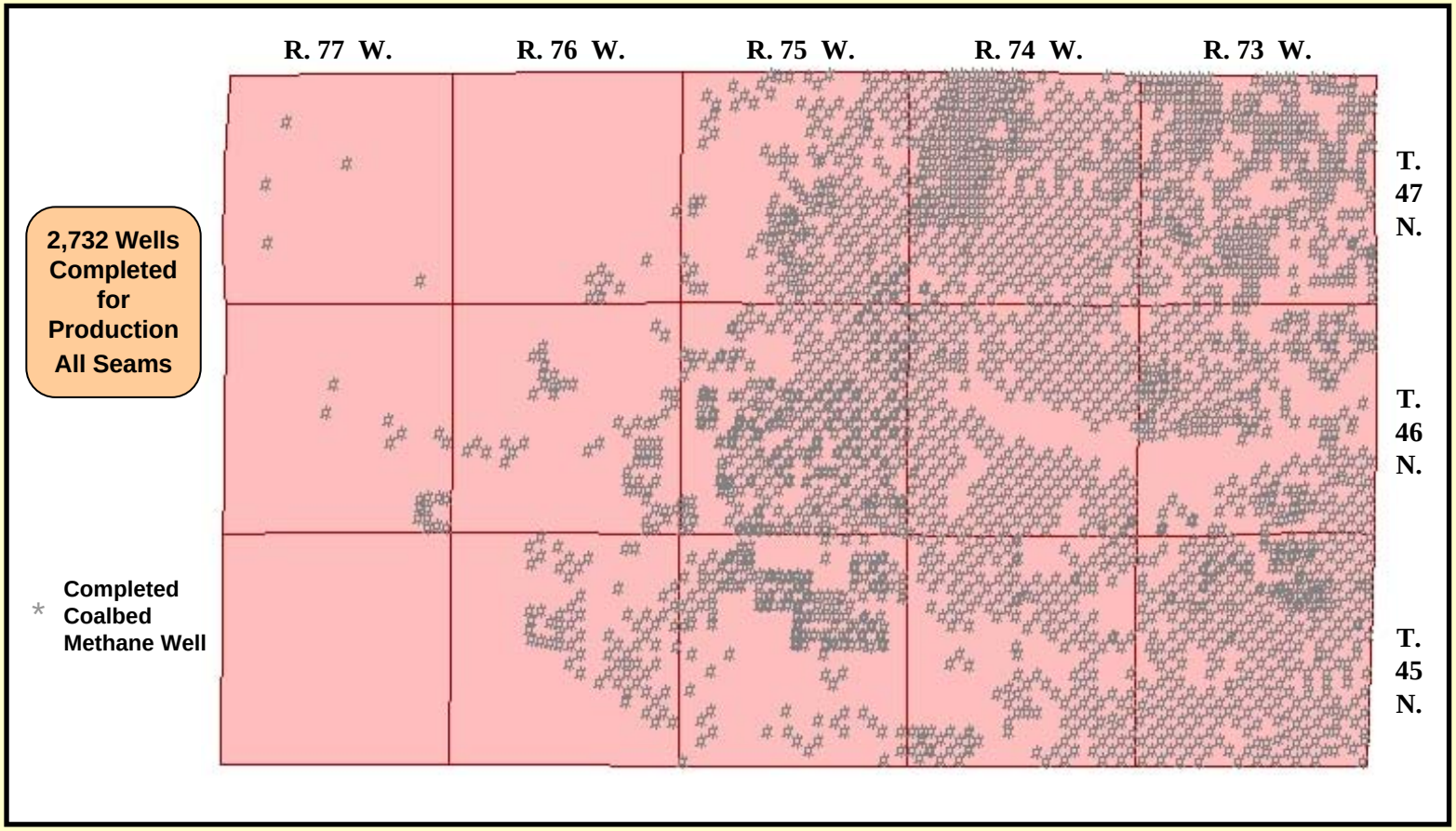
Completed Coalbed Methane Wells
Drainage Study Area



Well Data from Wyoming Oil and Gas Conservation Commission, Feb. 2004

(Note that WOGCC statistics included all Wyoming CBM wells until 1991, but totals outside Powder River Basin are negligible)

Projection: UTM Zone 13
North American Datum, 1983

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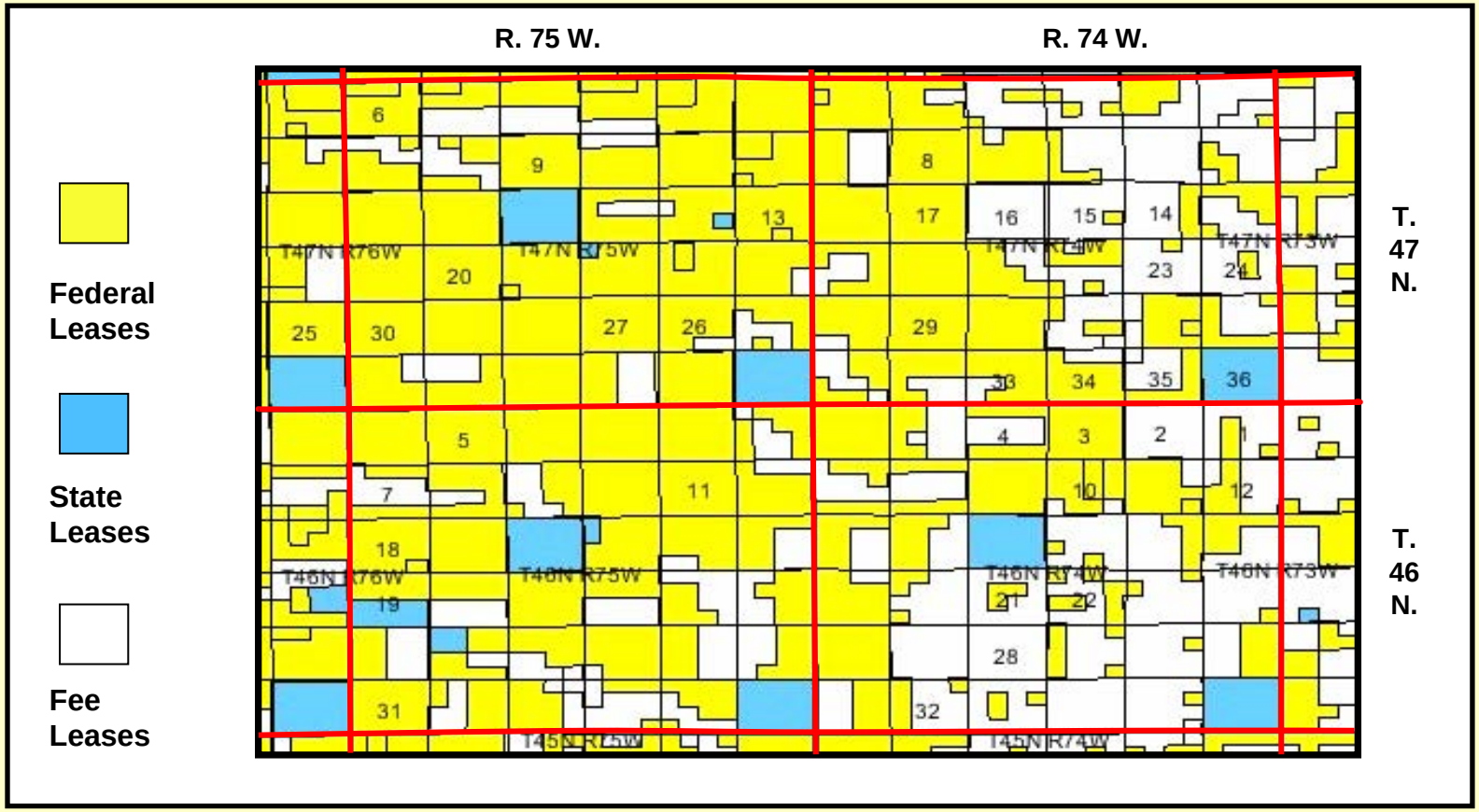
Typical Ownership Pattern
Drainage Study Area

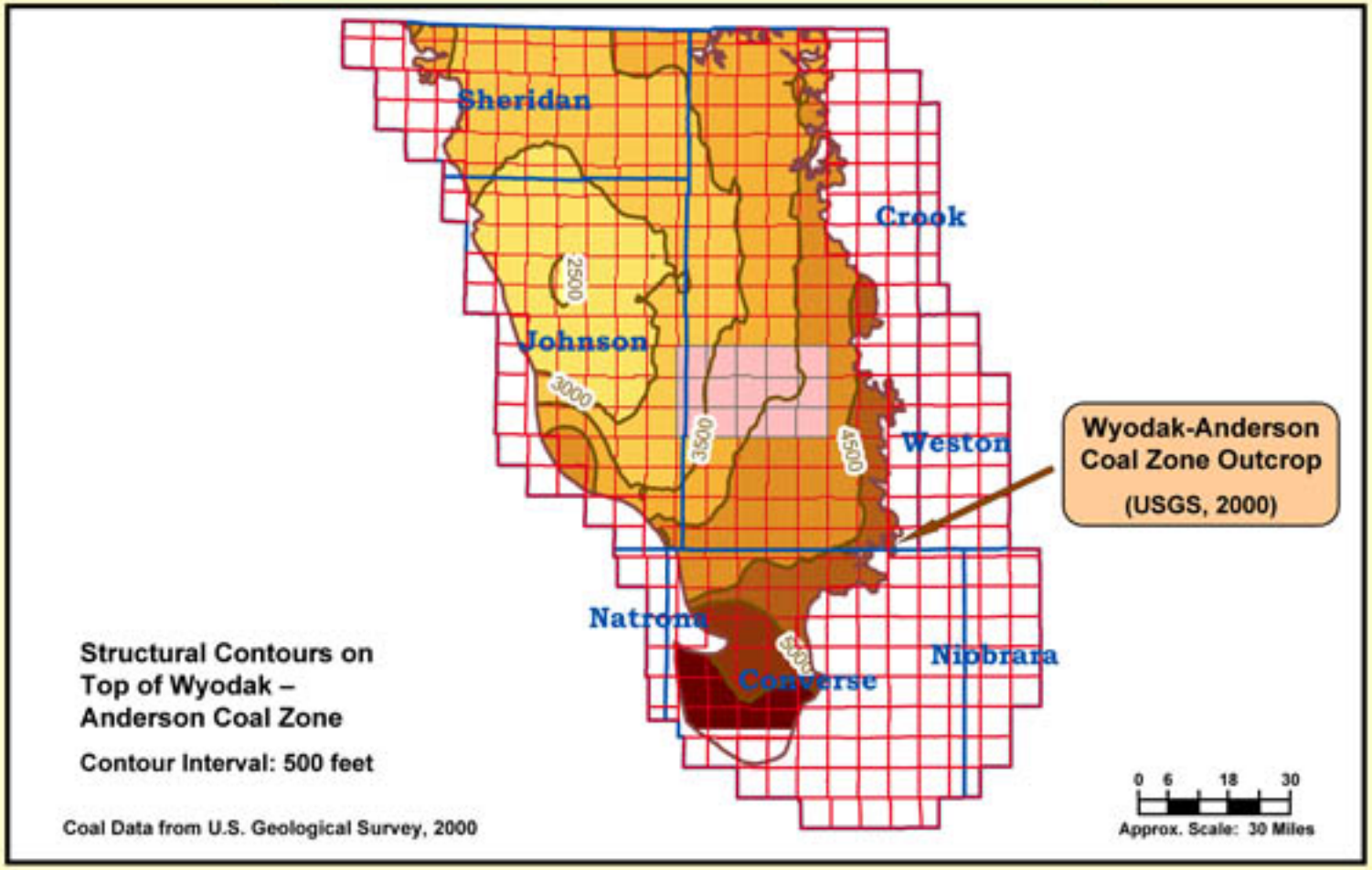


Projection: Geographic

North American Datum, 1927

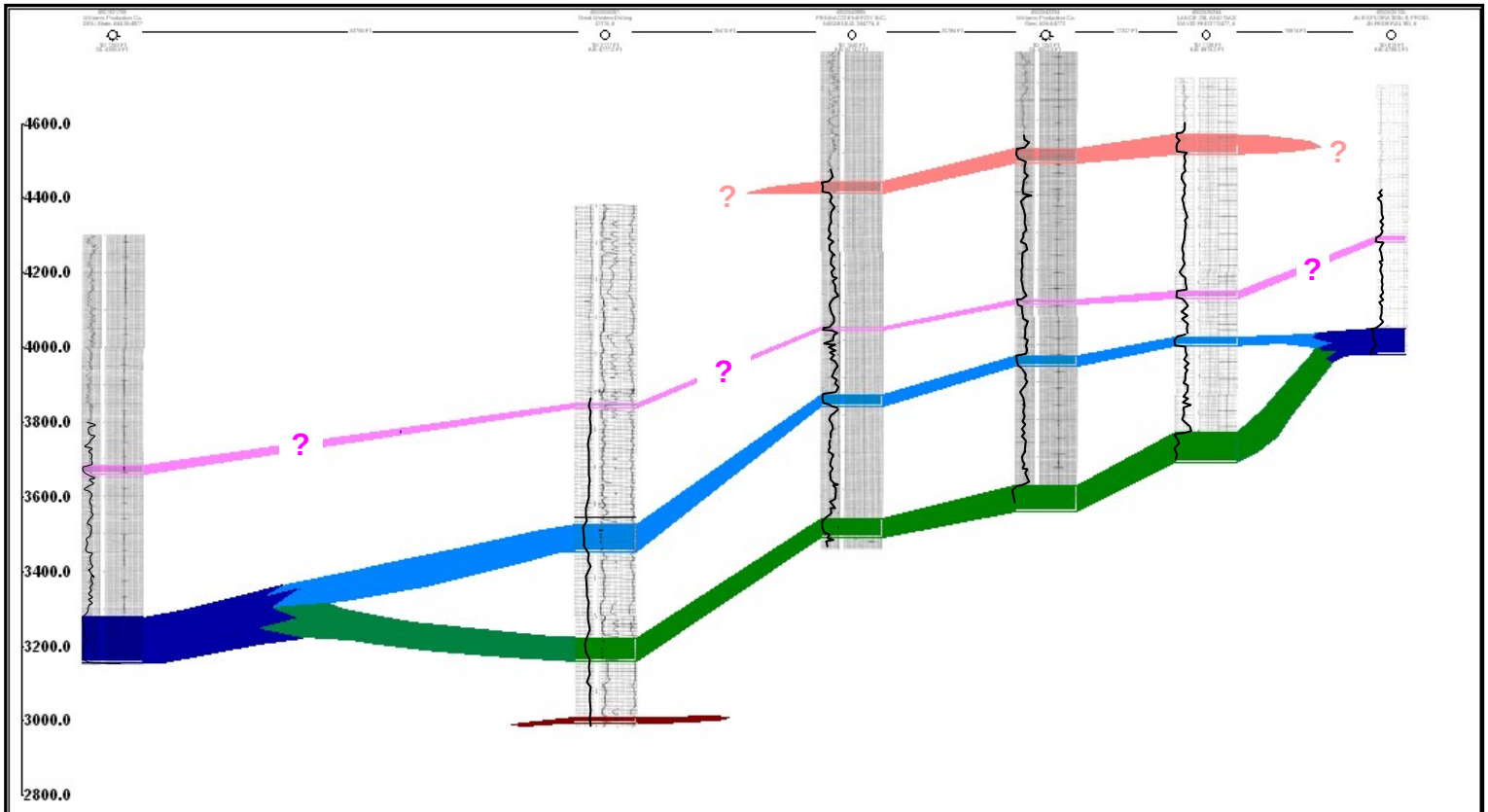
Lease and Land Data from Wyoming Oil and Gas Conservation Commission, May 2004

Geologic Structure
Wyodak-Anderson Coal Zone



Projection: UTM Zone 13
North American Datum, 1983

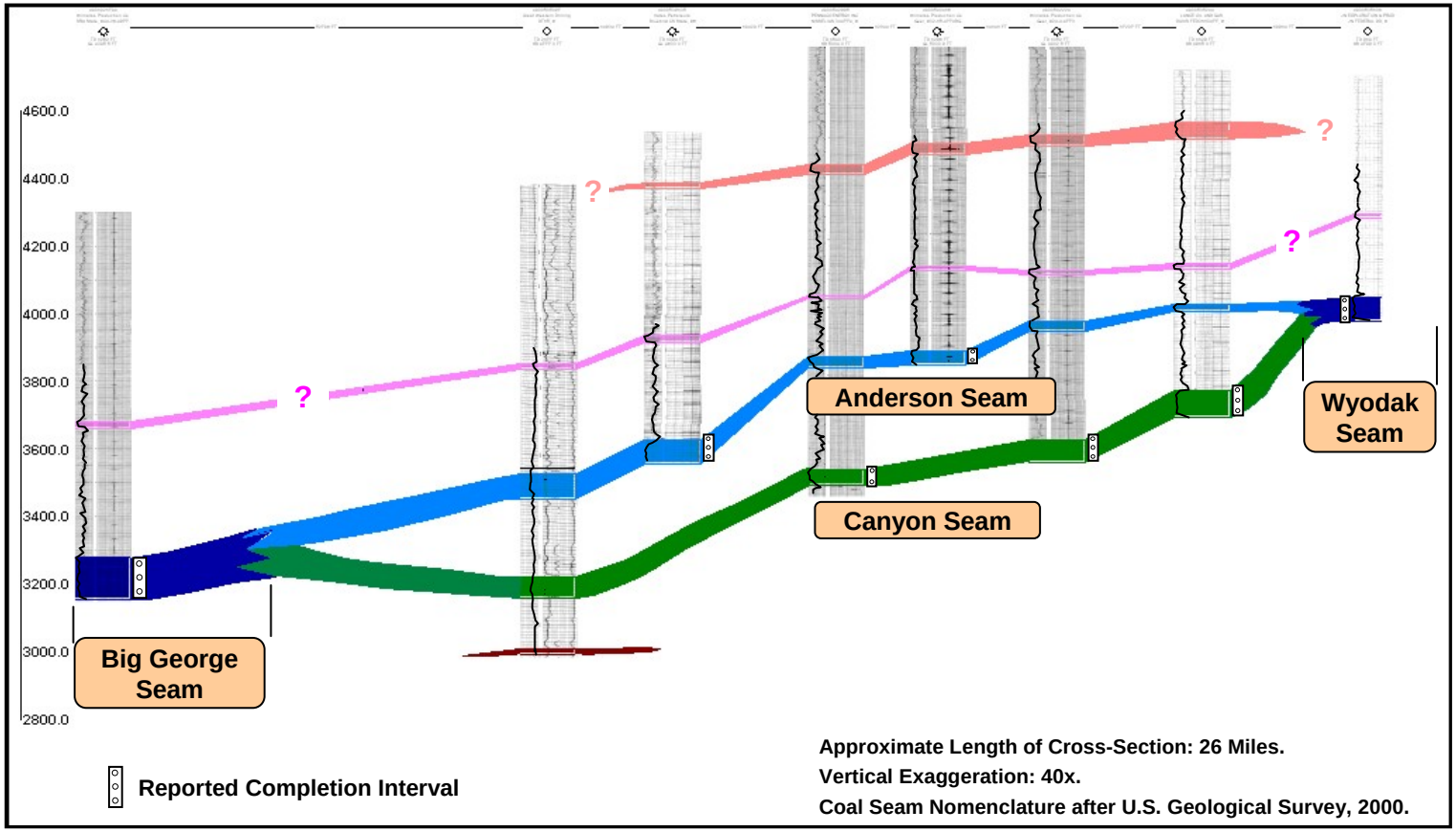
Structural Cross-section/Generalized Stratigraphy
Wyodak - Anderson Coal Zone



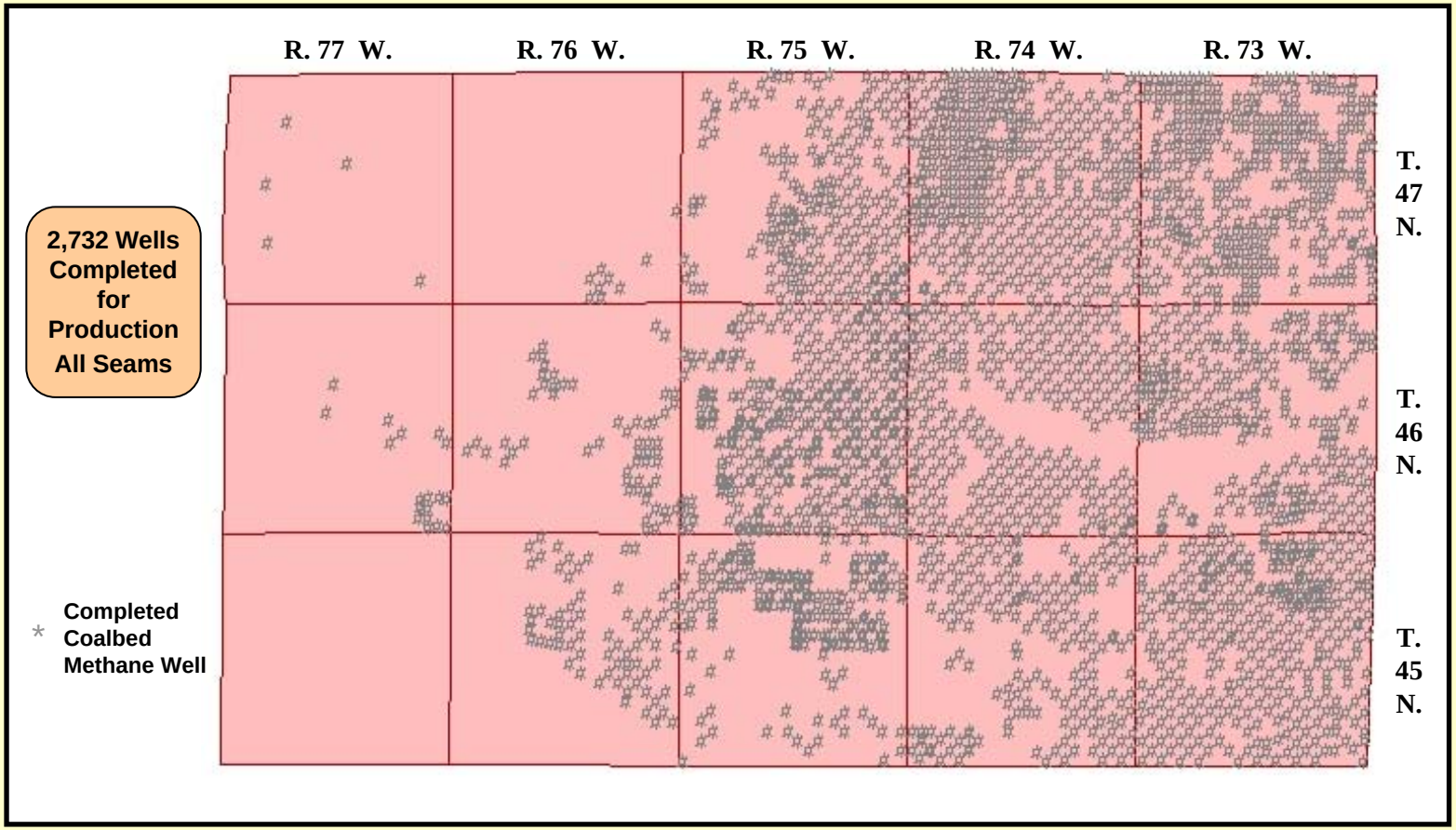
Approximate Length of Cross-Section: 26 Miles.
Vertical Exaggeration: 40x.

Coal Seam Nomenclature after U.S. Geological Survey, 2000.

Structural Cross-section/Productive Intervals
Wyodak - Anderson Coal Zone



Completed Coalbed Methane Wells
Drainage Study Area



Well Data from Wyoming Oil and Gas Conservation Commission, Feb. 2004

(Note that WOGCC statistics included all Wyoming CBM wells until 1991, but totals outside Powder River Basin are negligible)

Projection: UTM Zone 13
North American Datum, 1983

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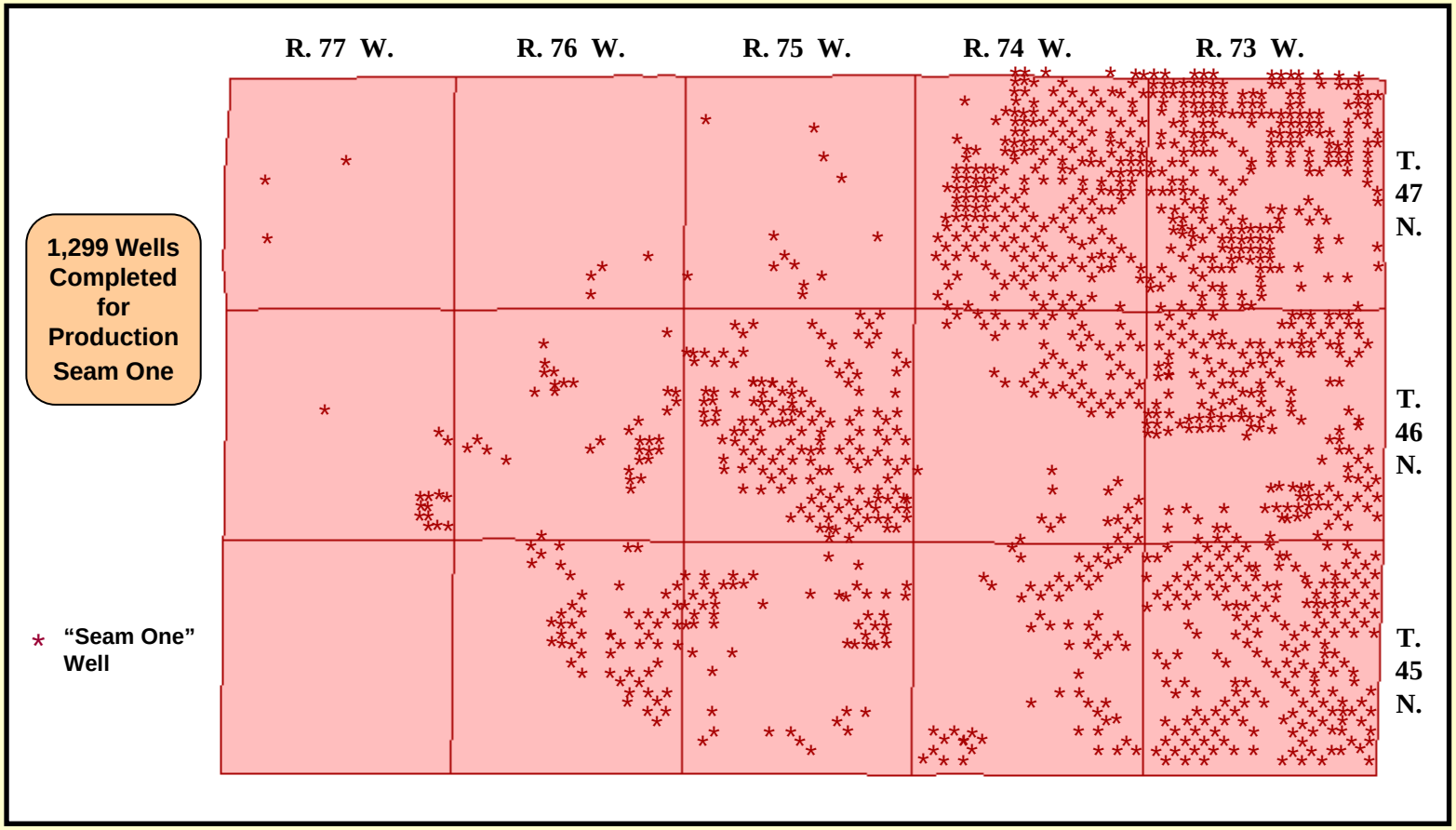
Upper Seam (Seam One) Wells
Drainage Study Area



Well Data from Wyoming Oil and Gas Conservation Commission, Feb. 2004

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Projection: UTM Zone 13
North American Datum, 1983

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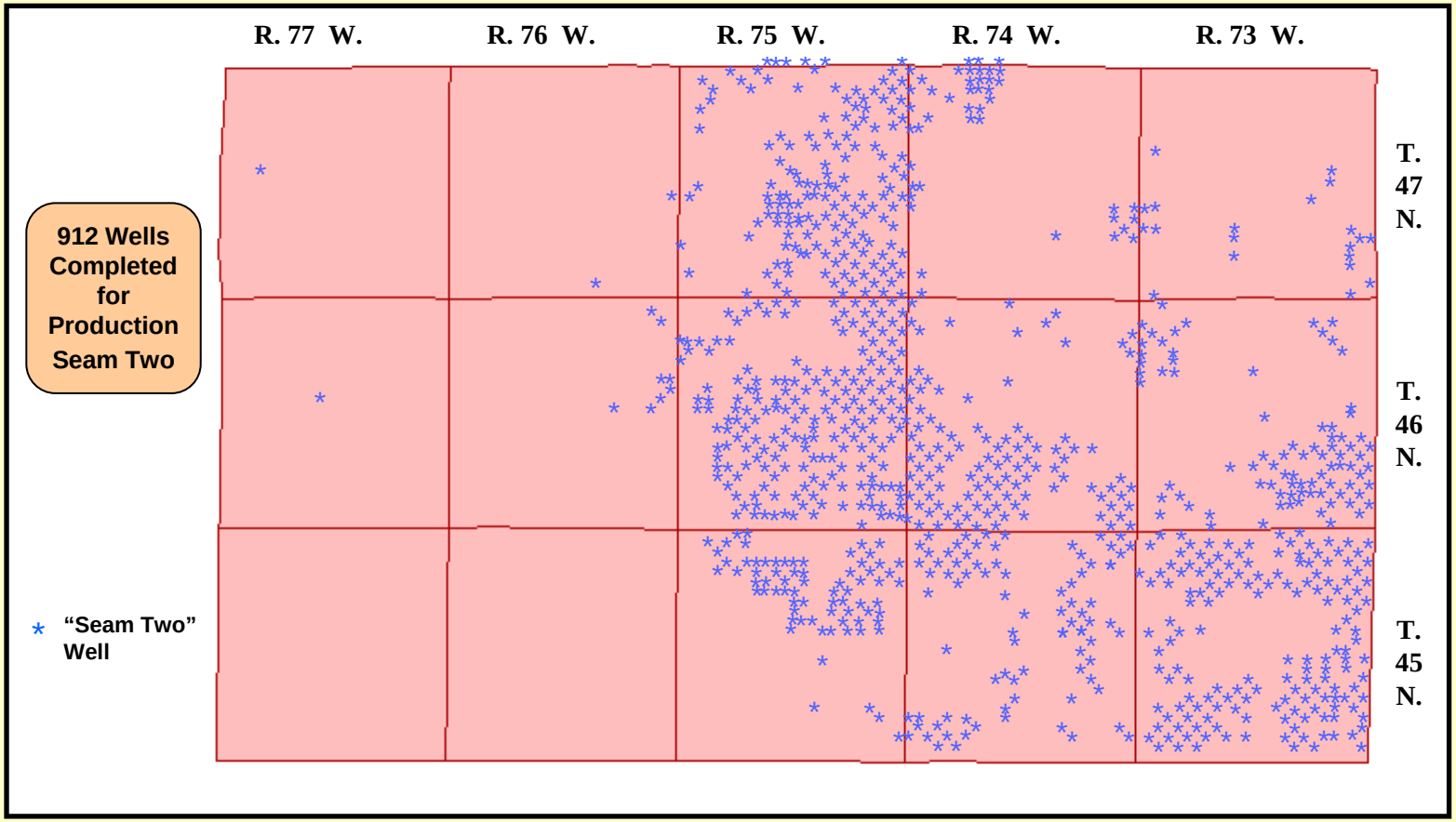
Lower Seam (Seam Two) Wells
Drainage Study Area



Well Data from Wyoming Oil and Gas Conservation Commission, Feb. 2004

(Note that WOGCC statistics included all Wyoming CBM wells until 1991, but totals outside Powder River Basin are negligible)

Projection: UTM Zone 13
North American Datum, 1983

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Inconsistent Nomenclature

- Upper Seam ("Seam One")
  - ✓ 103 "Anderson"
  - ✓ 273 "Big George"
  - ✓ 12 "Canyon"
  - ✓ 375 "Fort Union"
  - ✓ 293 "Wyodak"
  - ✓ 237 Unnamed

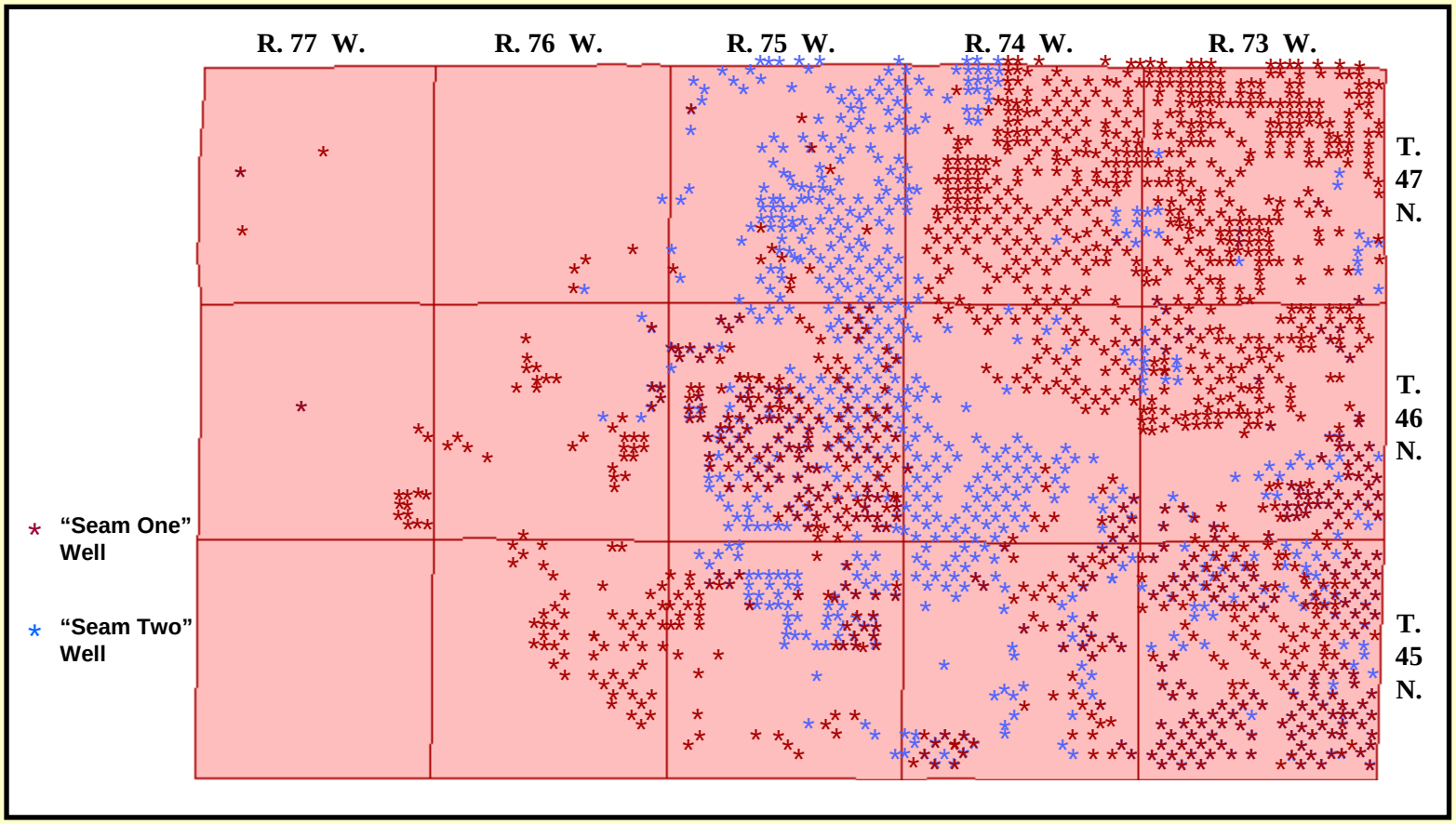
Reservoir name reported in Wyoming Oil and Gas Conservation Commission database

Inconsistent Nomenclature

- Lower Seam ("Seam Two")
  - ✓ 10 "Anderson"
  - ✓ 11 "Big George"
  - ✓ 180 "Canyon"
  - ✓ 106 "Fort Union"
  - ✓ 545 "Wyodak"
  - ✓ 55 Unnamed

Reservoir name reported in Wyoming Oil and Gas Conservation Commission database

Seam One and Two Wells
Drainage Study Area



Well Data from Wyoming Oil and Gas Conservation Commission, Feb. 2004

(Note that WOGCC statistics included all Wyoming CBM wells until 1991, but totals outside Powder River Basin are negligible)

Projection: UTM Zone 13
North American Datum, 1983

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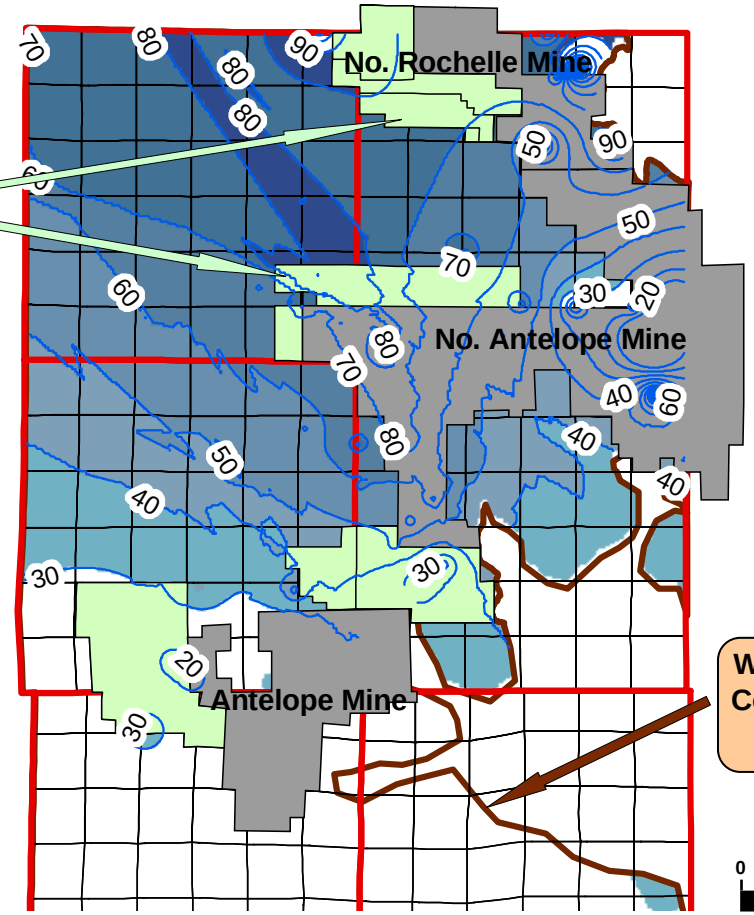
GROUNDWATER DRAWDOWN AND REGIONAL RESERVOIR EFFECTS

Hydrostatic Head Decline
North Antelope Area



Coal lease-by-application parcels

Wyodak-Anderson Coal Zone Outcrop (USGS, 2000)

Hydrostatic Head Calculated From GAGMO Groundwater Monitoring Well Data (2002) and Geologic Structure Mapped From Publicly Available Drill-hole Data

Contour Interval: 10 feet

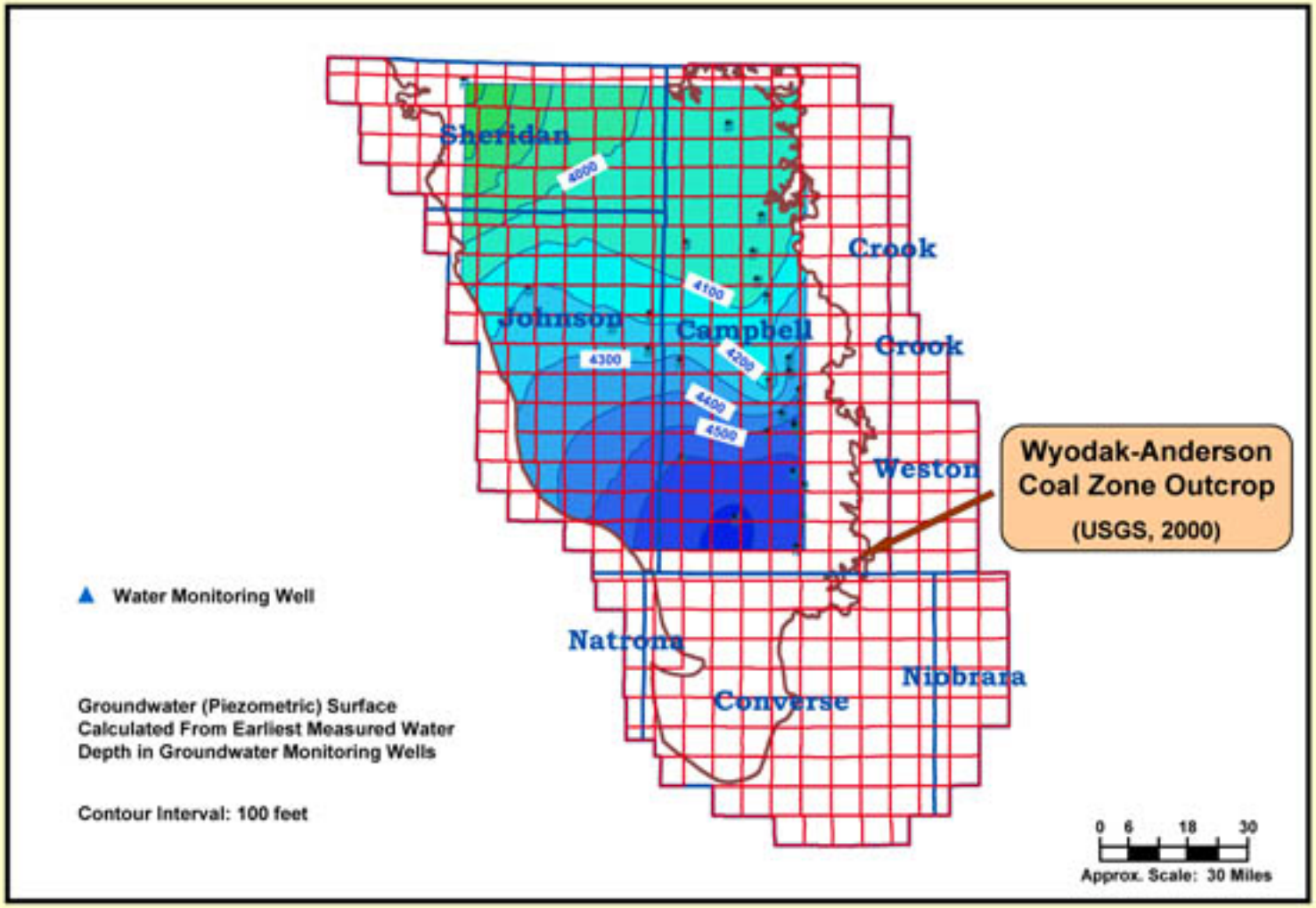
0 5

Approx. Scale: 5 Miles

Projection: UTM Zone 13
North American Datum, 1927

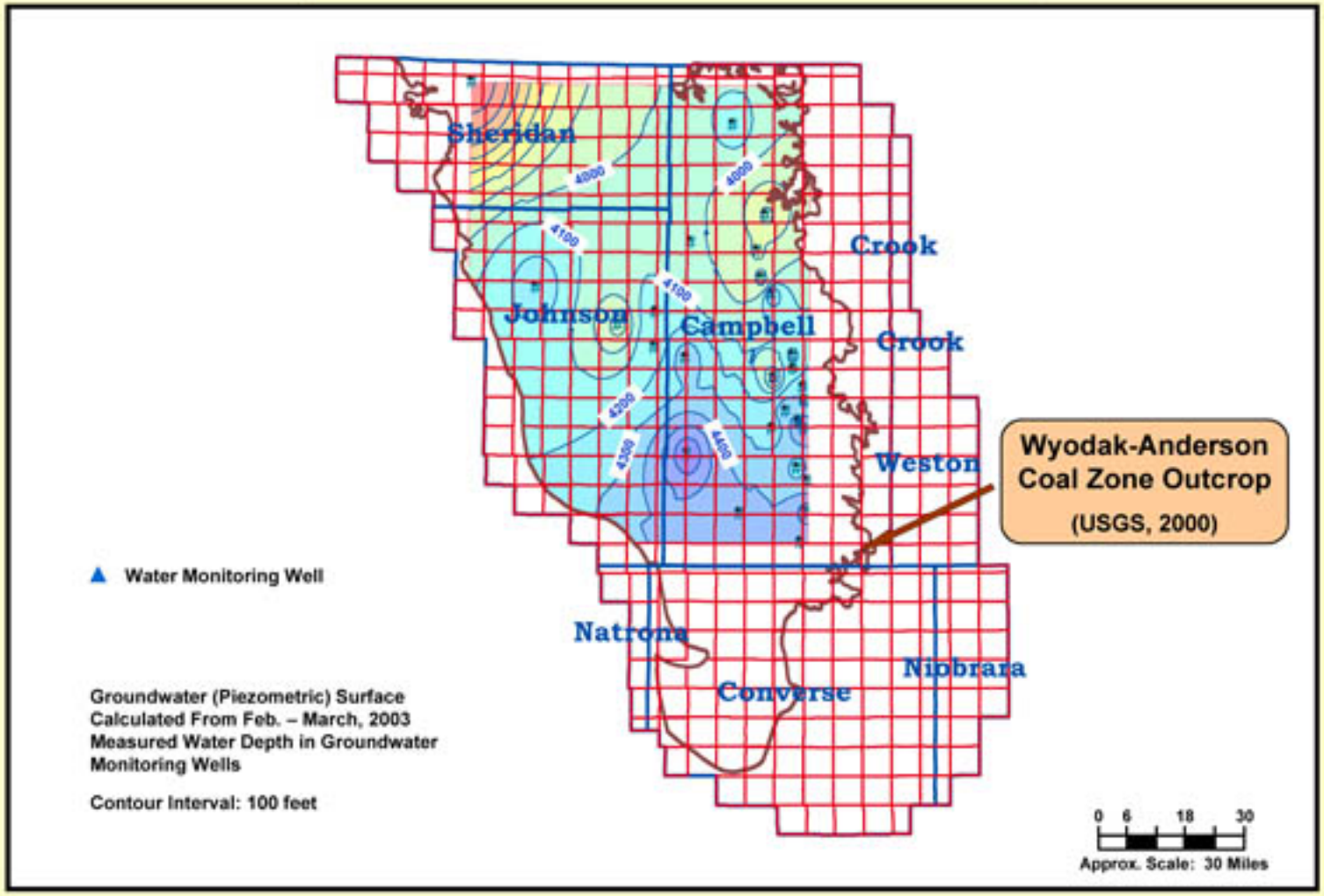
N W E S

"Pre-Development" Groundwater Surface



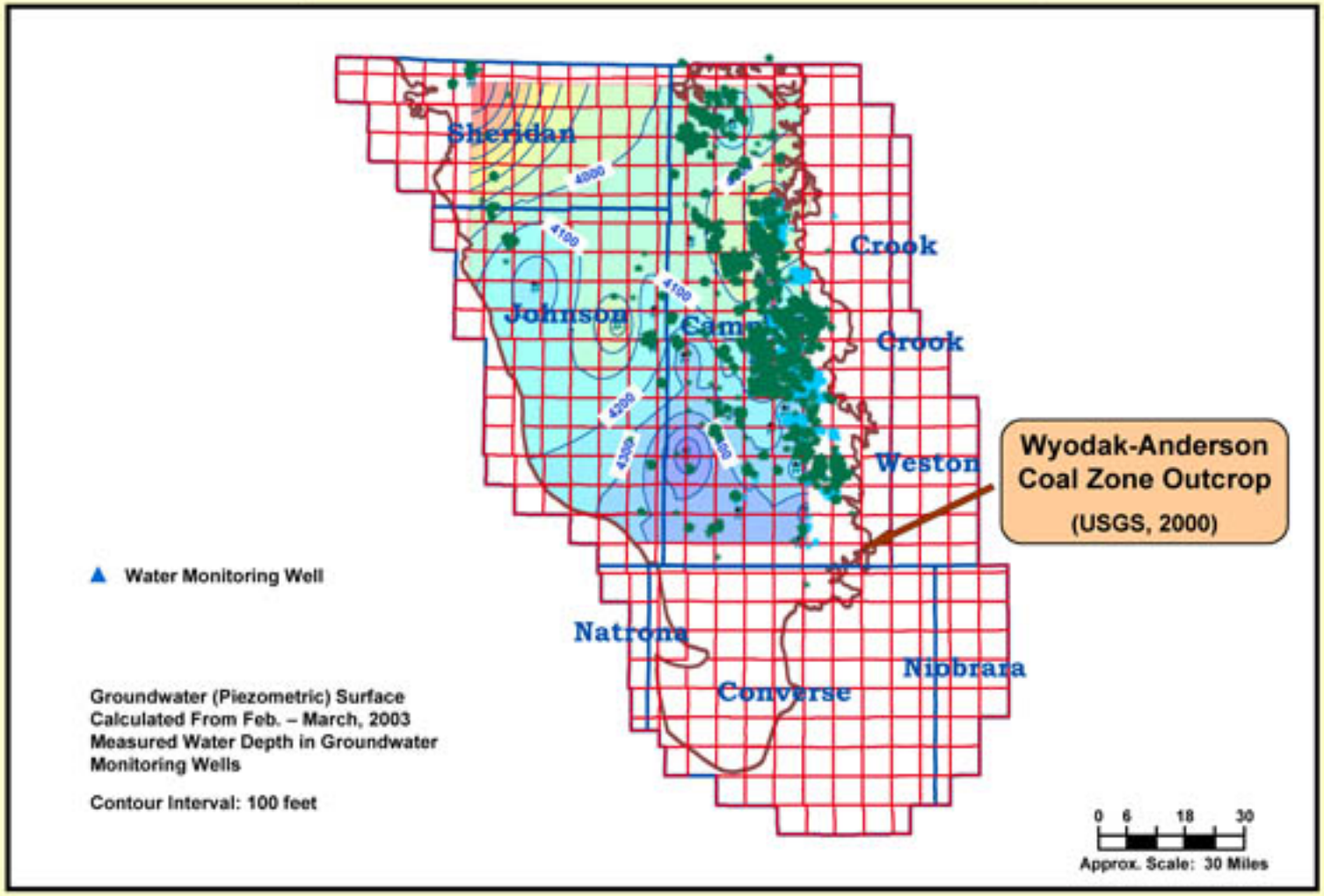
Projection: UTM Zone 13
North American Datum, 1983

2003 Groundwater Surface



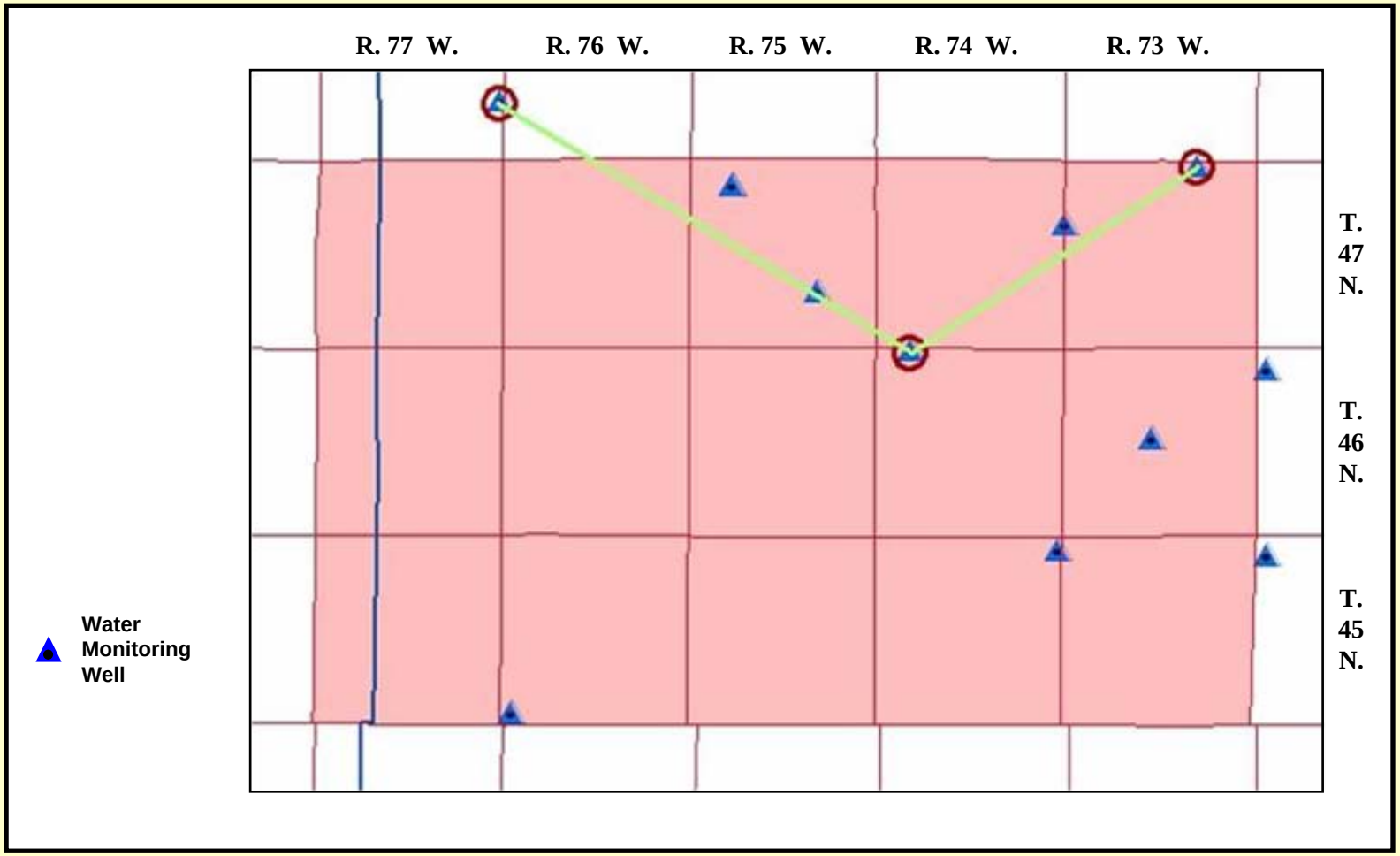
Projection: UTM Zone 13
North American Datum, 1983

2003 Groundwater Surface



Projection: UTM Zone 13
North American Datum, 1983

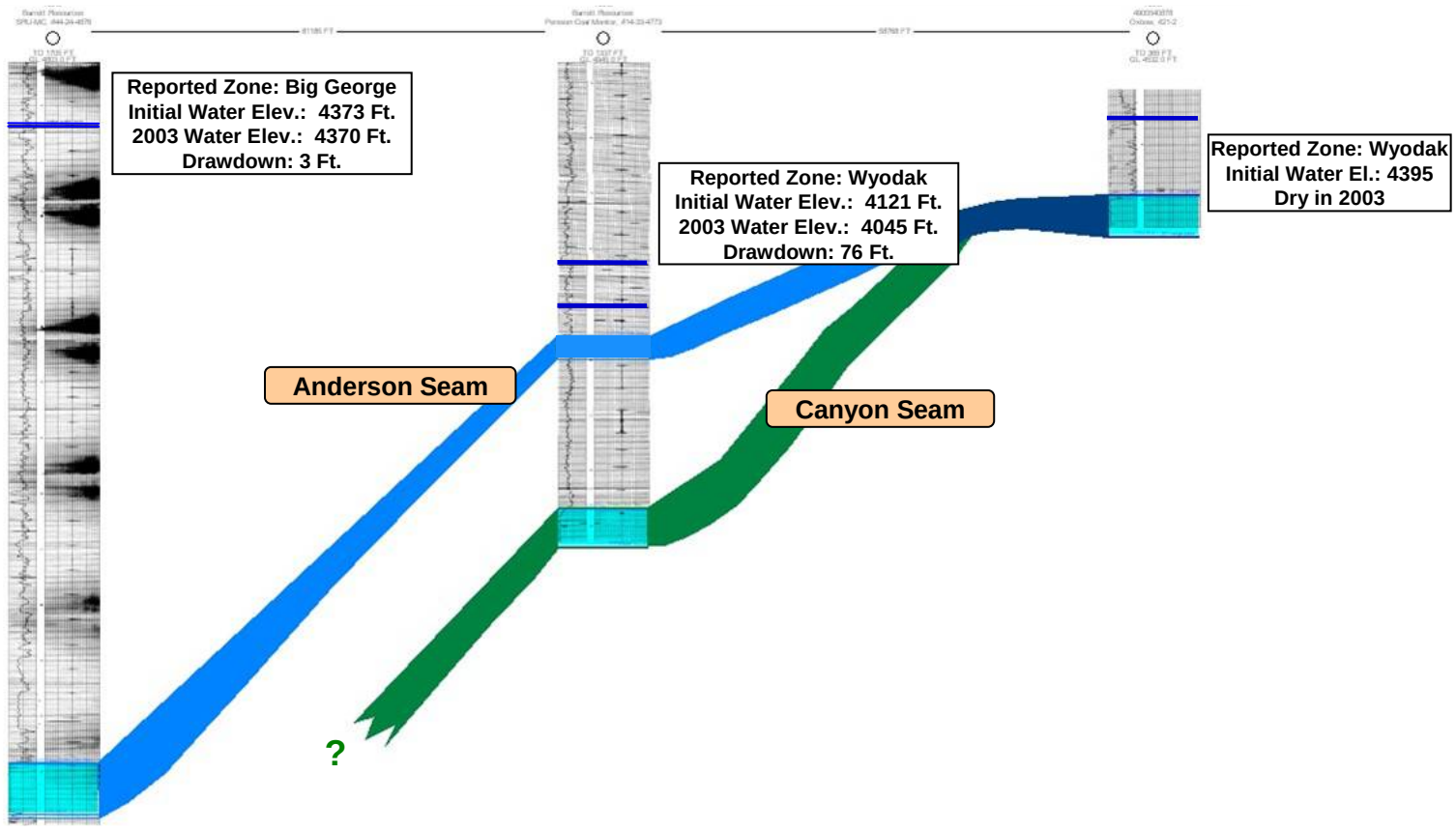
Completed Coalbed Methane Wells
Drainage Study Area



Monitoring Well Data from BLM Monitoring Wells, March. 2003

Projection: UTM Zone 13
North American Datum, 1983

Cross-section – Groundwater Monitoring Wells
Wyodak Anderson Coal Zone

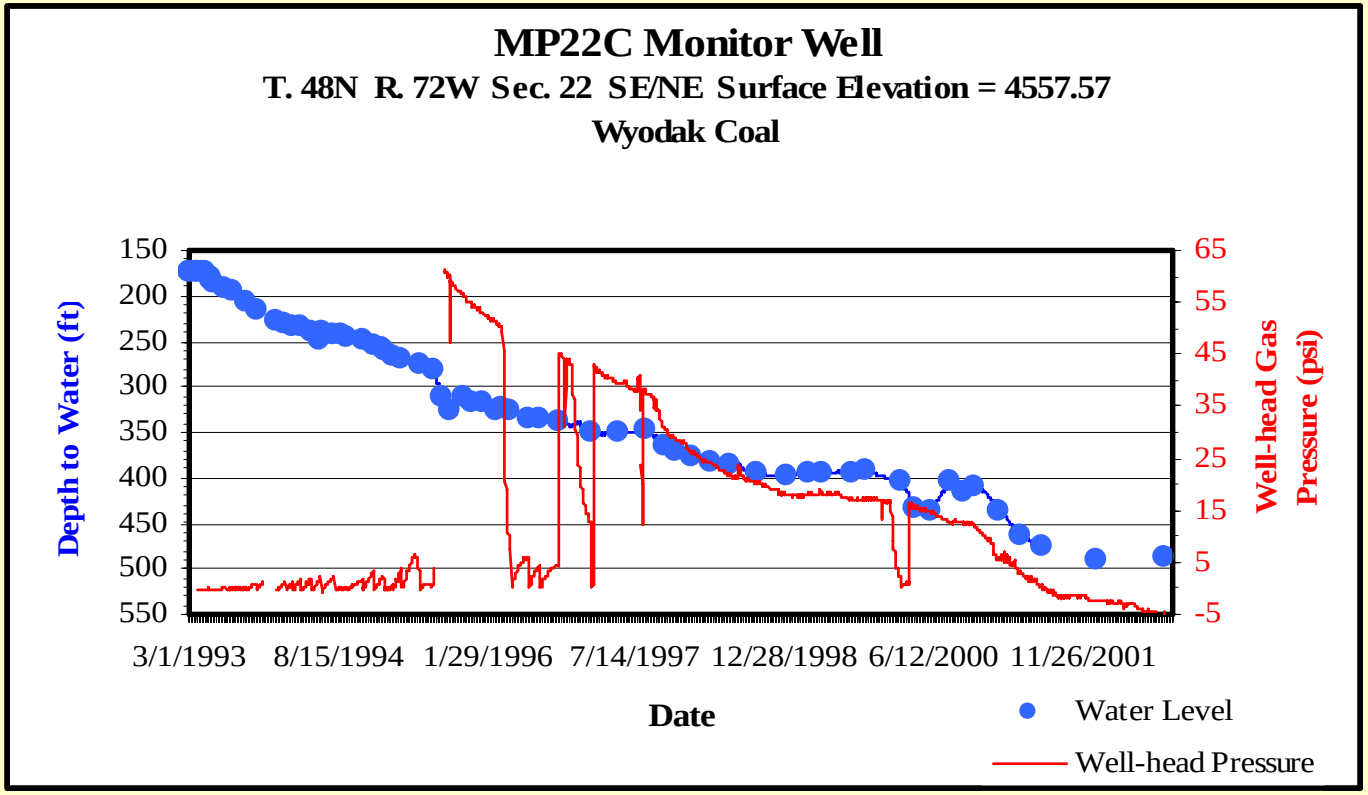


Approximate Length of Cross-Section: 26.5 Miles.

Groundwater data from BLM Water Monitoring Wells, 2003.

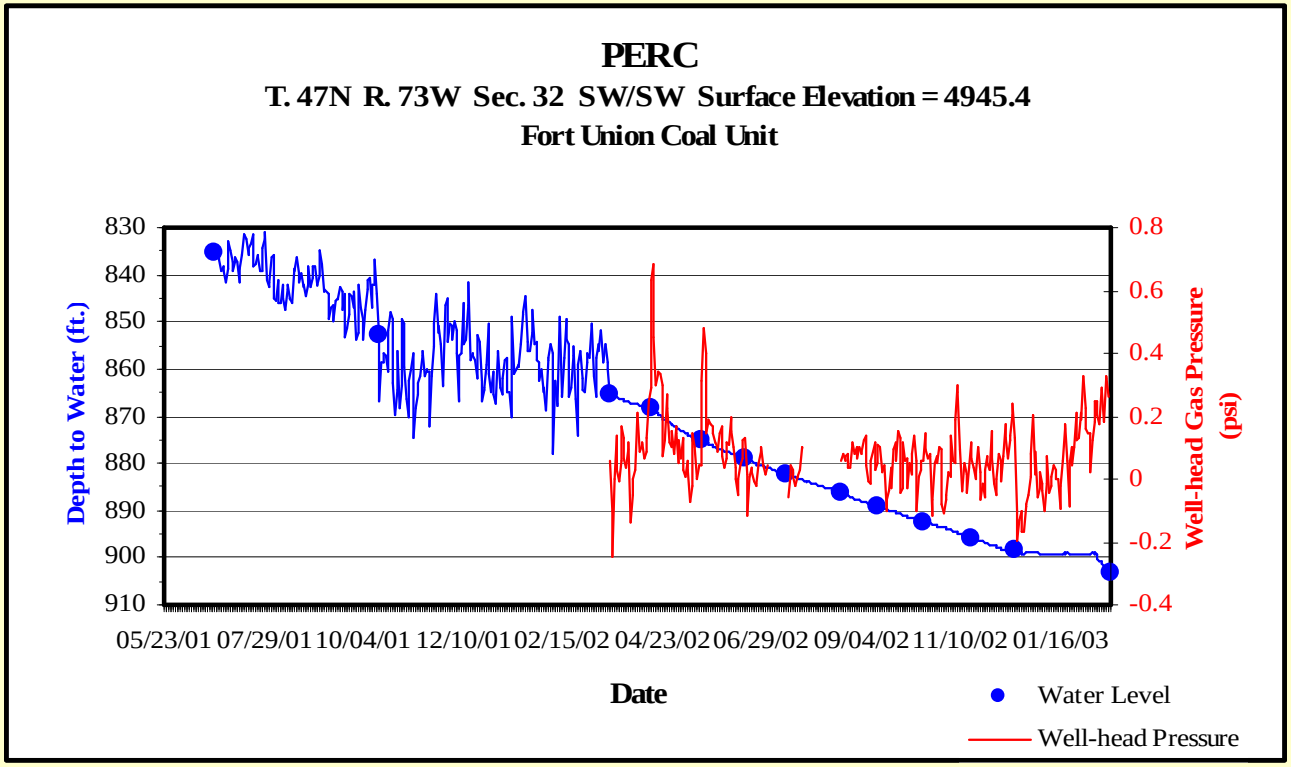
Coal Seam Nomenclature after U.S. Geological Survey, 2000.

Water Level/Gas Pressure
MP22C Monitoring Well



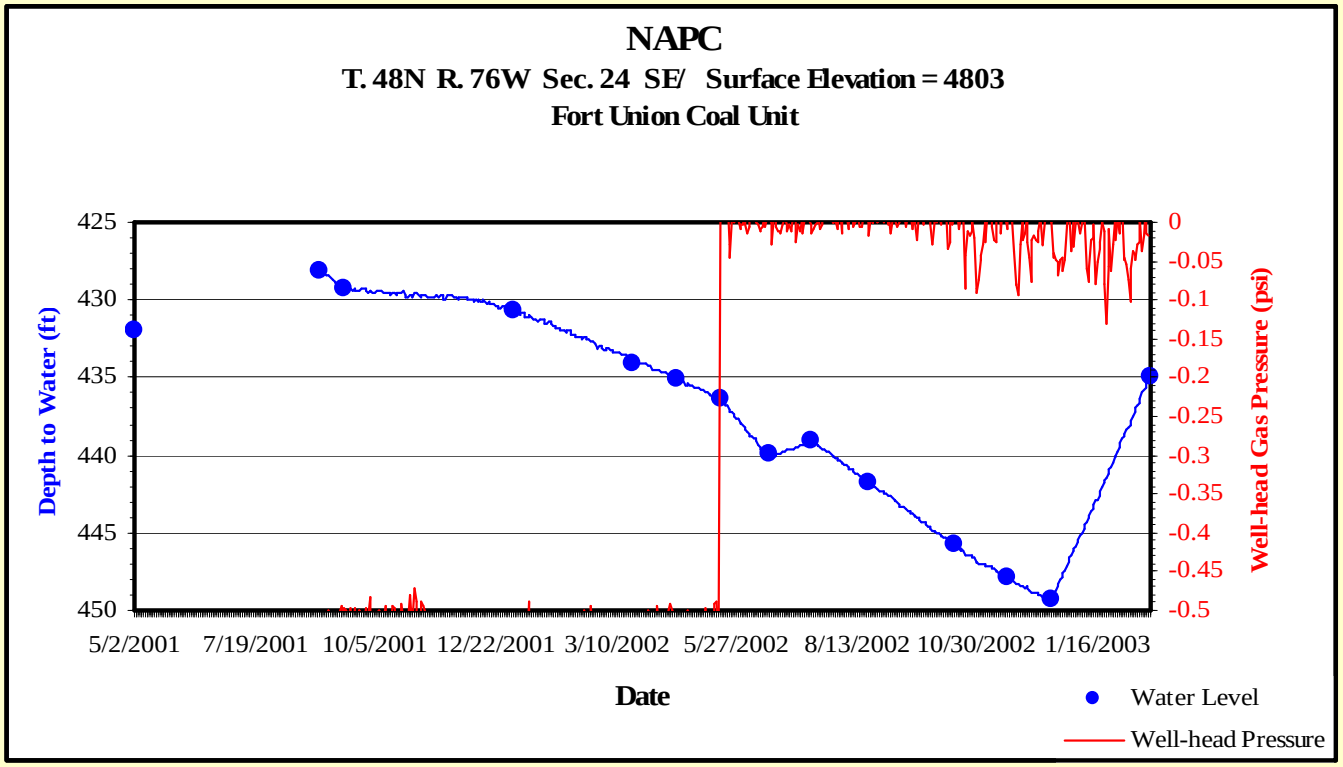
Data from BLM Monitoring Well Database March, 2003

Water Level/Gas Pressure
PERC Monitoring Well



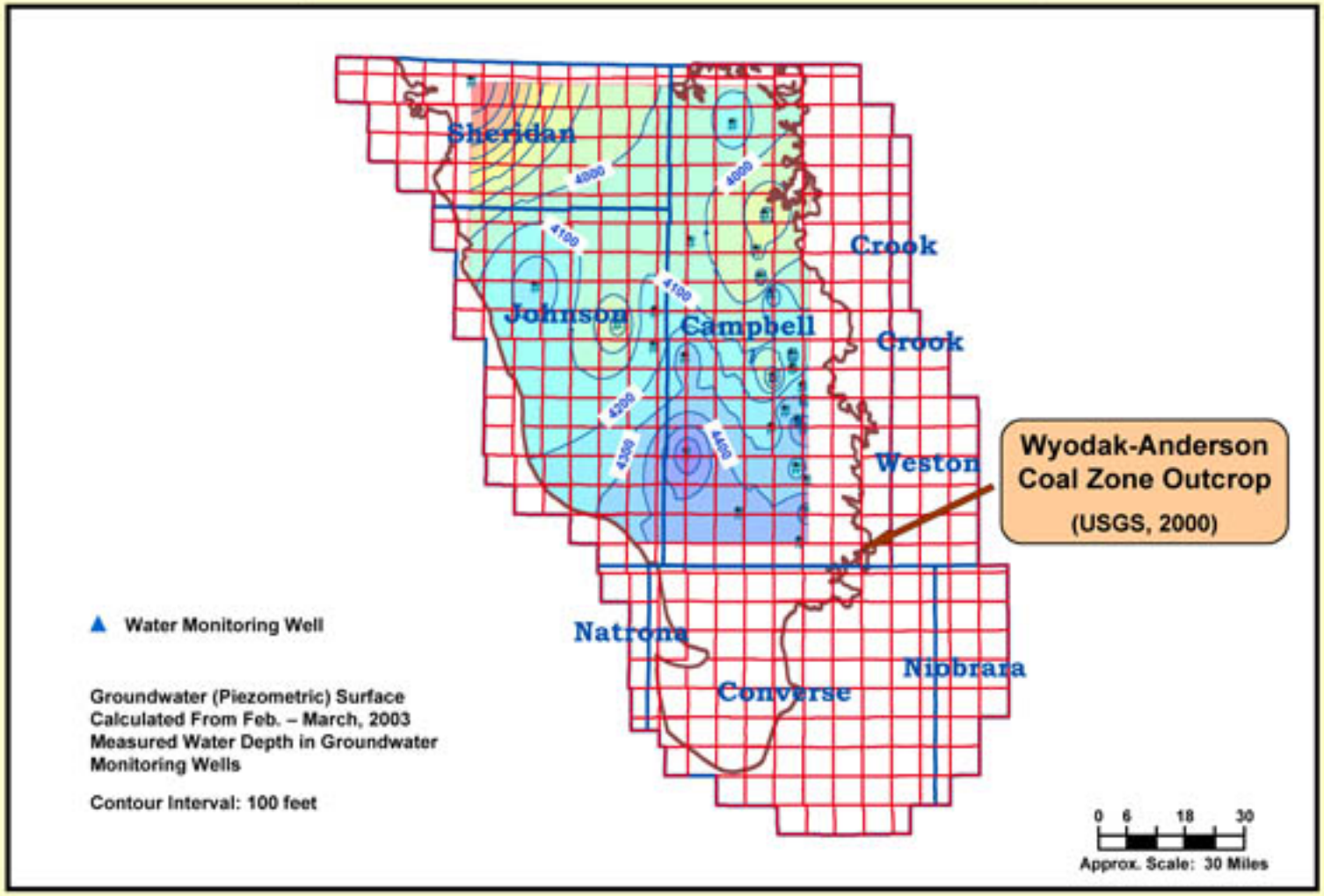
Data from BLM Monitoring Well Database March, 2003

Water Level/Gas Pressure
NAPC Monitoring Well



Data from BLM Monitoring Well Database March, 2003

2003 Groundwater Surface



Projection: UTM Zone 13
North American Datum, 1983

Future Drainage Capabilities

- ✓ Regional drainage review
- ✓ Refined geological/reservoir models
- ✓ Reservoir Simulation

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