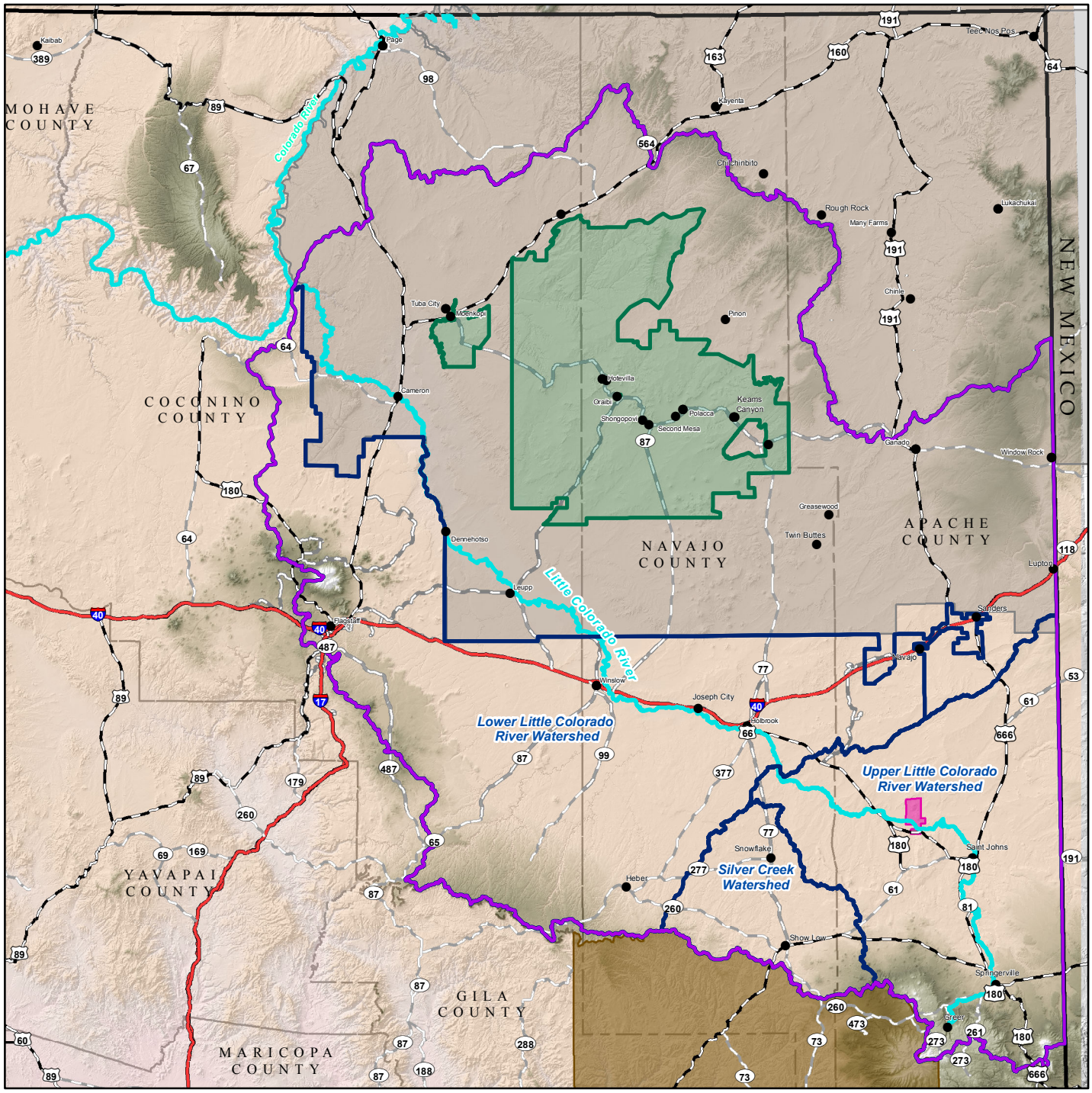
FIGURES



Legend

- LCR Adjudication Area Boundary
- Watershed Boundary
- City/Town
- Major River
- Interstate Highway
- U.S. Route
- State Highway
- Local Roads
- County
- State Boundary

Indian Reservations

- Hopi
- White Mountain Apache
- Navajo
- Zuni

0 25 50
Miles

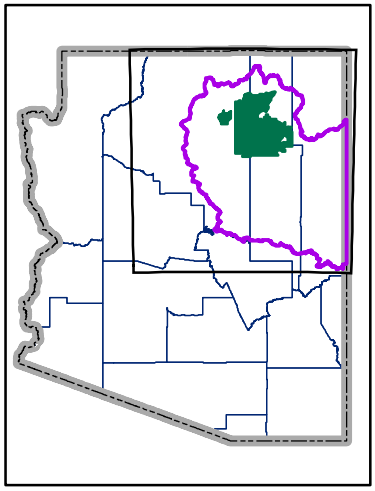
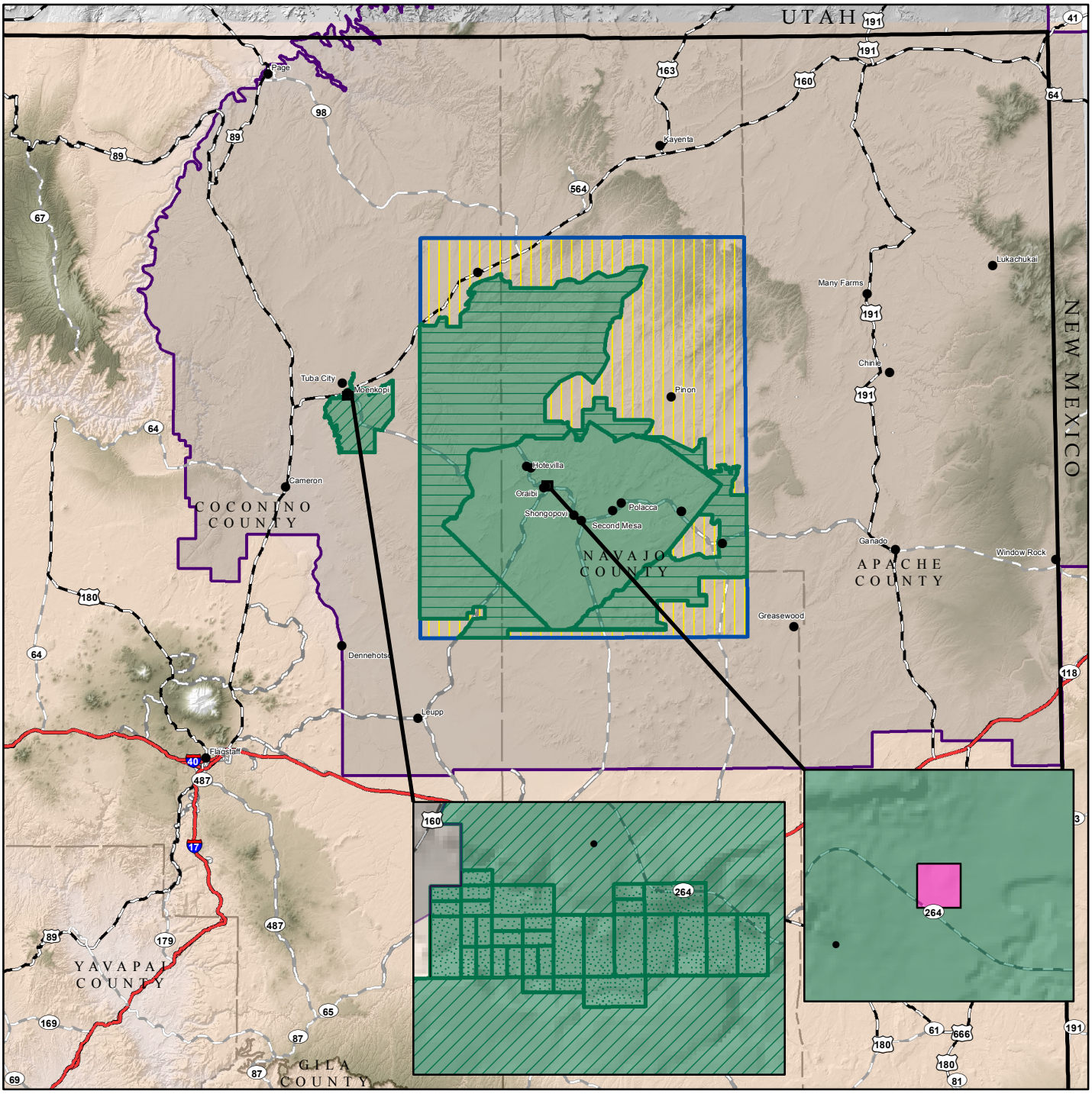


Figure 1-1

Location of the Hopi Indian Reservation Within the LCR Adjudication Area

Final Hopi HSR
December 2015



Legend

- Town
- Interstate Highway
- U.S. Route
- State Highway
- Local Roads
- County
- State Boundary

- Hopi District 6
- Hopi Partitioned Land
- Hopi Moenkopi Area
- Hopi Allotment
- Navajo Lands
- Navajo Partitioned Land
- 1882 Executive Order Reservation Boundary
- 1934 Ad Reservation Boundary
- Inholding

0 20 40
Miles

N

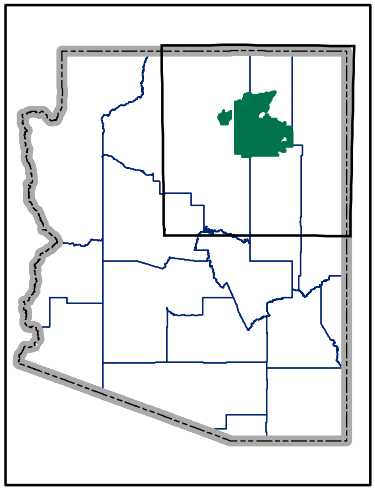
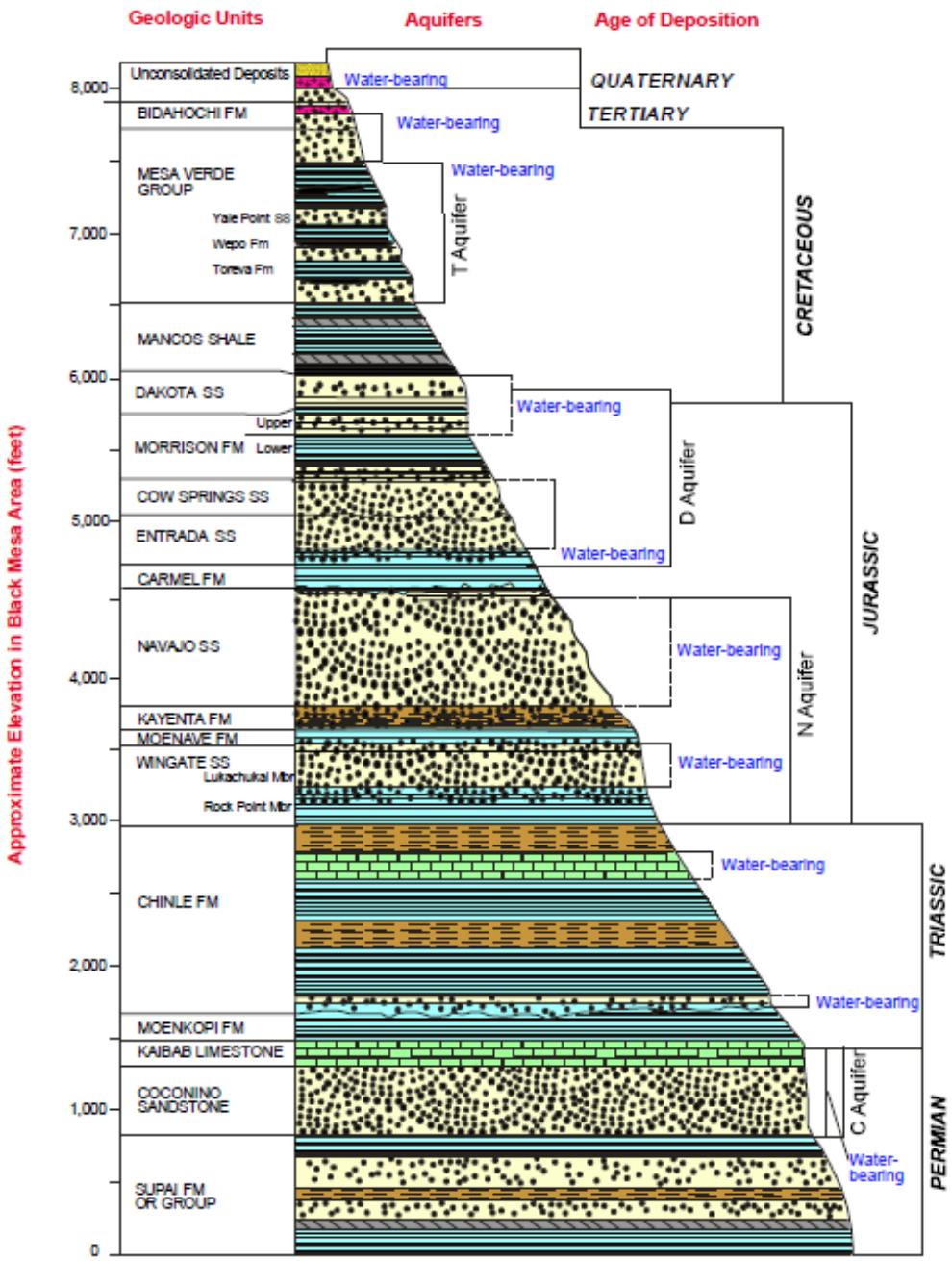


Figure 1-2

Hopi and Navajo Indian Reservations

Final Hopi HSR

December 2015



Rock Types

- Alluvium/Colluvium
- Volcanic Rock
- Coal
- Sandstone
- Siltstone
- Siltstone, Mudstone
- Shale
- Limestone

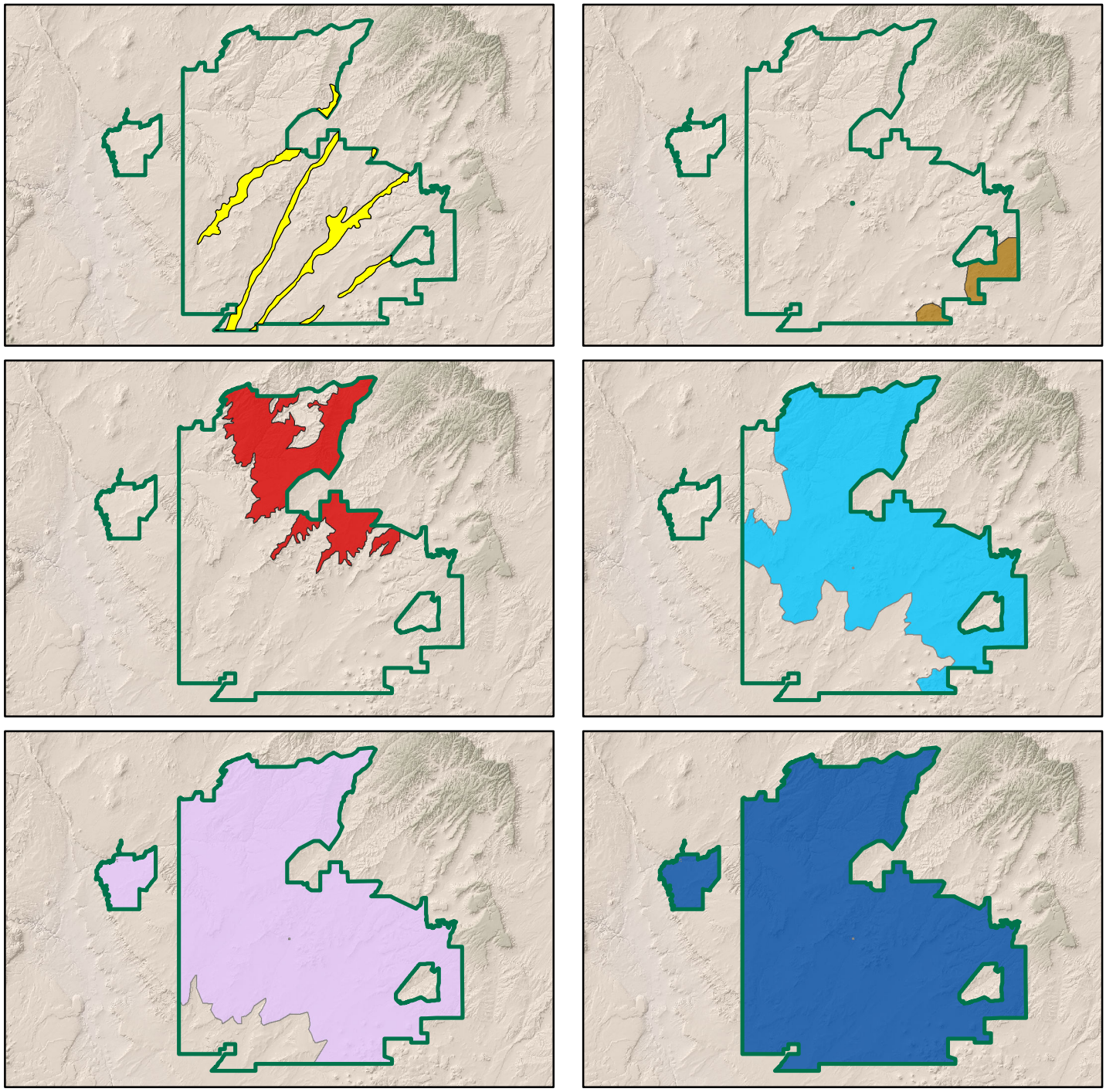
Source: GeoTrans and Waterstone (1999)

Figure 2-1

Important Geologic Units and Aquifers Underlying the Hopi Indian Reservation

Final Hopi HSR

December 2015



Legend

- Alluvial/Colluvial Aquifer
- Bidahochi Aquifer
- T Aquifer
- D Aquifer
- N Aquifer
- C Aquifer
- Hopi Reservation

Sources:

1. ADWR (1989)
2. Hopi (2001)
3. Richards and others (2000)
4. Truini and Longsworth (2003)

N

0 20 40
Miles

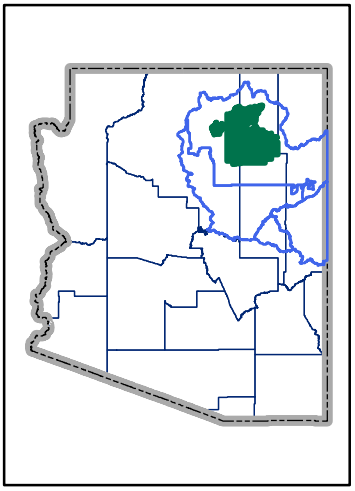
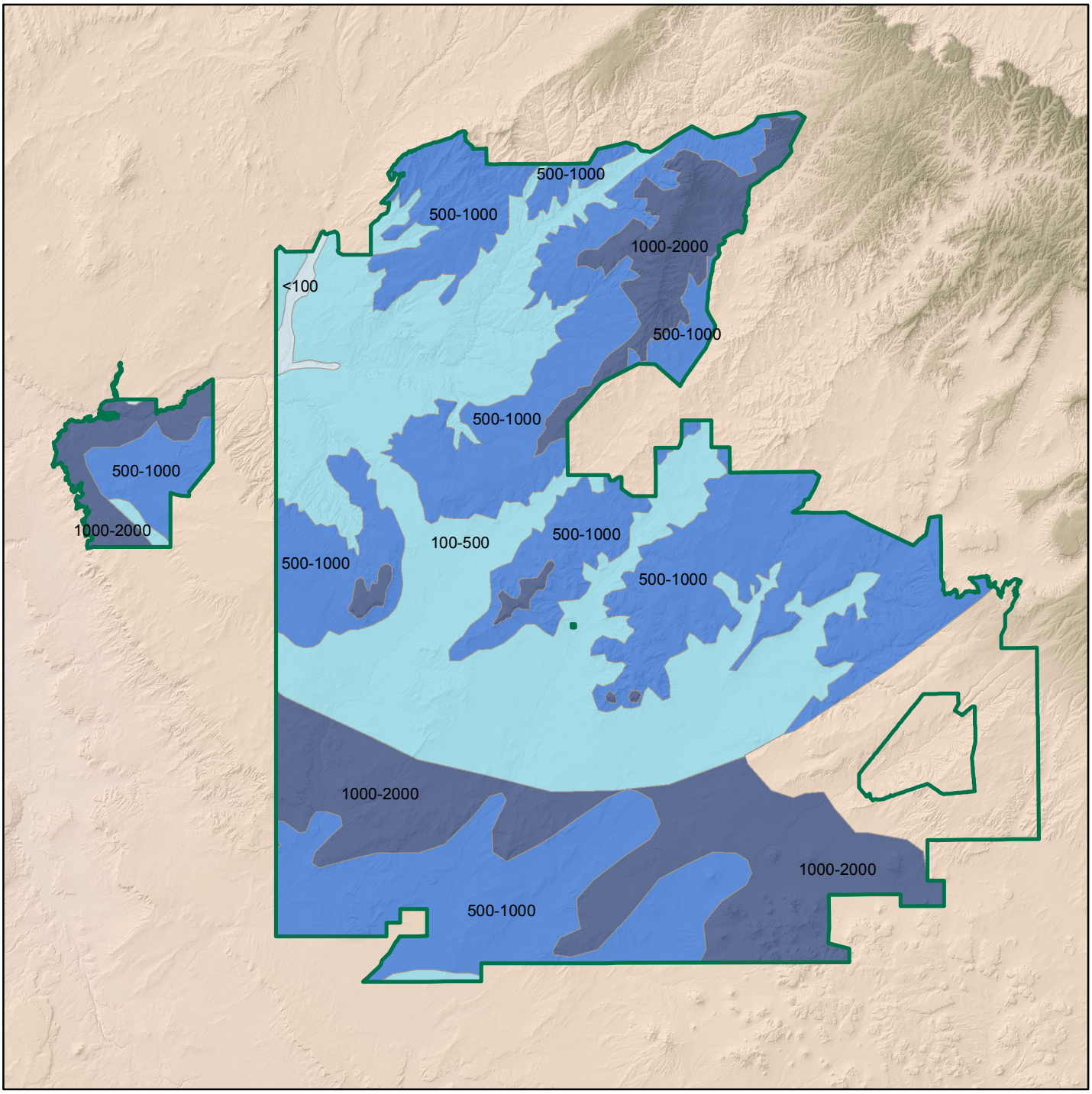


Figure 2-2

Lateral Extent of Aquifers Beneath the Hopi Indian Reservation

Final Hopi HSR

December, 2015



Legend

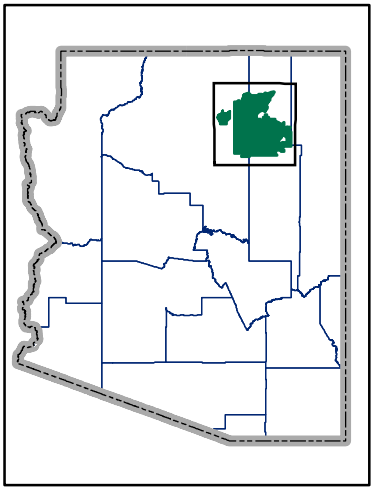
Water Level in Well

- <100 feet
- 100-500 feet
- 500-1,000 feet
- 1,000-2,000 feet
- Hopi Reservation

Source:
McGavock and Edmunds (1974)
Original scale 1:375,000

Notes:
(1) Numbers indicate approximate range of water level, in feet below land surface, after 100 days of continuous pumping at 25 gallons per minute.
(2) Levels reflect the first aquifer encountered that would yield the specified amount.

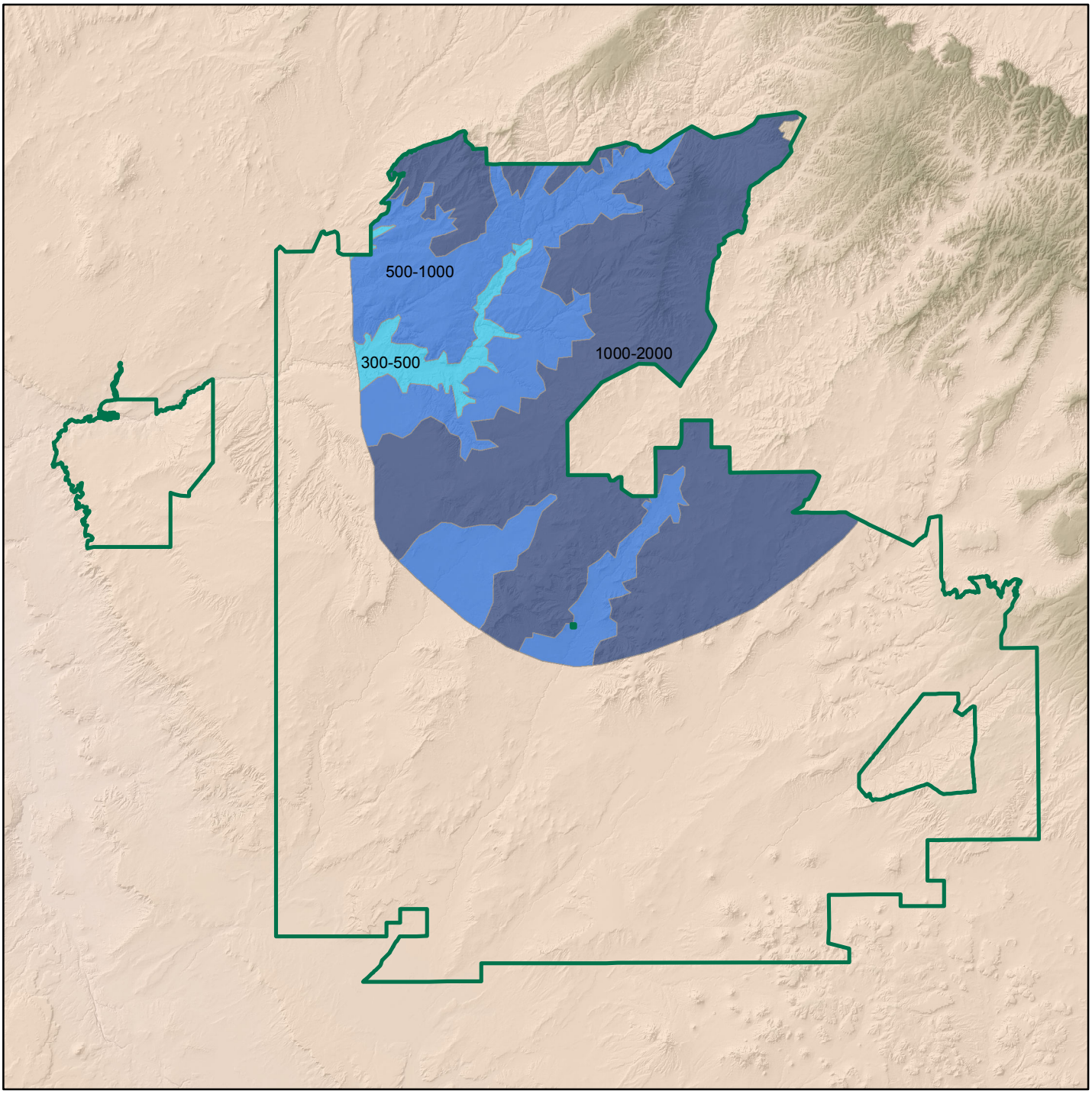
0 9 18
Miles



N

Figure 2-3
Estimated Pumping Water Level in Wells Yielding at Least 25 gpm on the Hopi Indian Reservation

Final Hopi HSR
December 2015



Legend

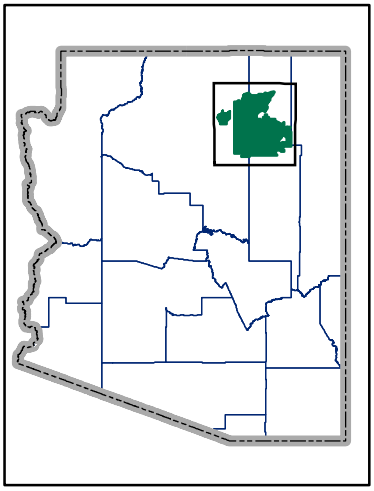
Water Level in Well

- 300-500 feet
- 500-1,000 feet
- 1,000-2,000 feet
- Hopi Reservation

Source:
McGavock and Edmunds (1974)
Original scale 1:375,000

Notes:
(1) Numbers indicate approximate range of water level, in feet below land surface, after 100 days of continuous pumping at 25 gallons per minute.
(2) Levels reflect the first aquifer encountered that would yield the specified amount.

0 9 18
Miles



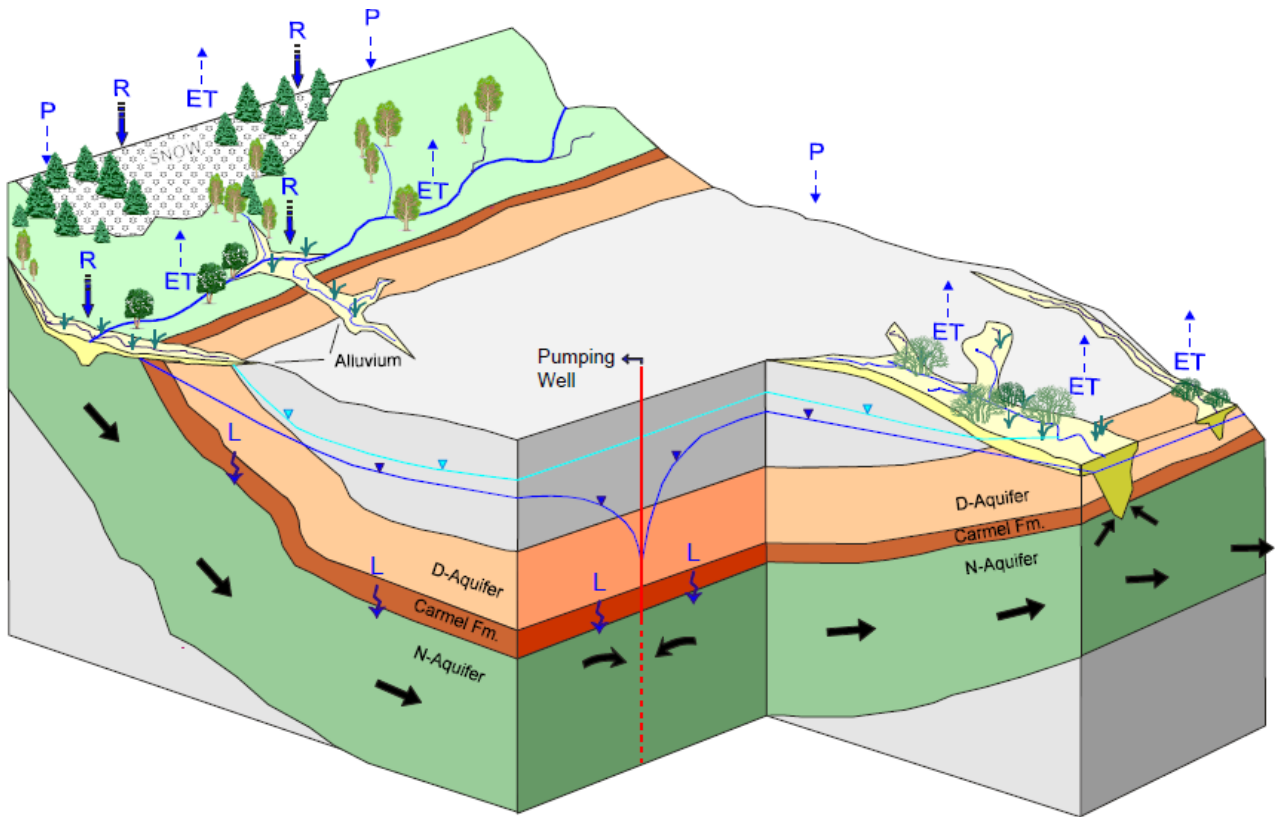
N

Figure 2-4

Estimated Pumping Water Level in Wells Yielding at Least 500 gpm on the Hopi Indian Reservation

Final Hopi HSR

December 2015



Legend

- Stream
- N-Aquifer Potentio-metric Surface
- D-Aquifer Potentio-metric Surface
- ET Evapotranspiration
- P Precipitation
- R Runoff
- L Leakance
- Groundwater Flow Direction

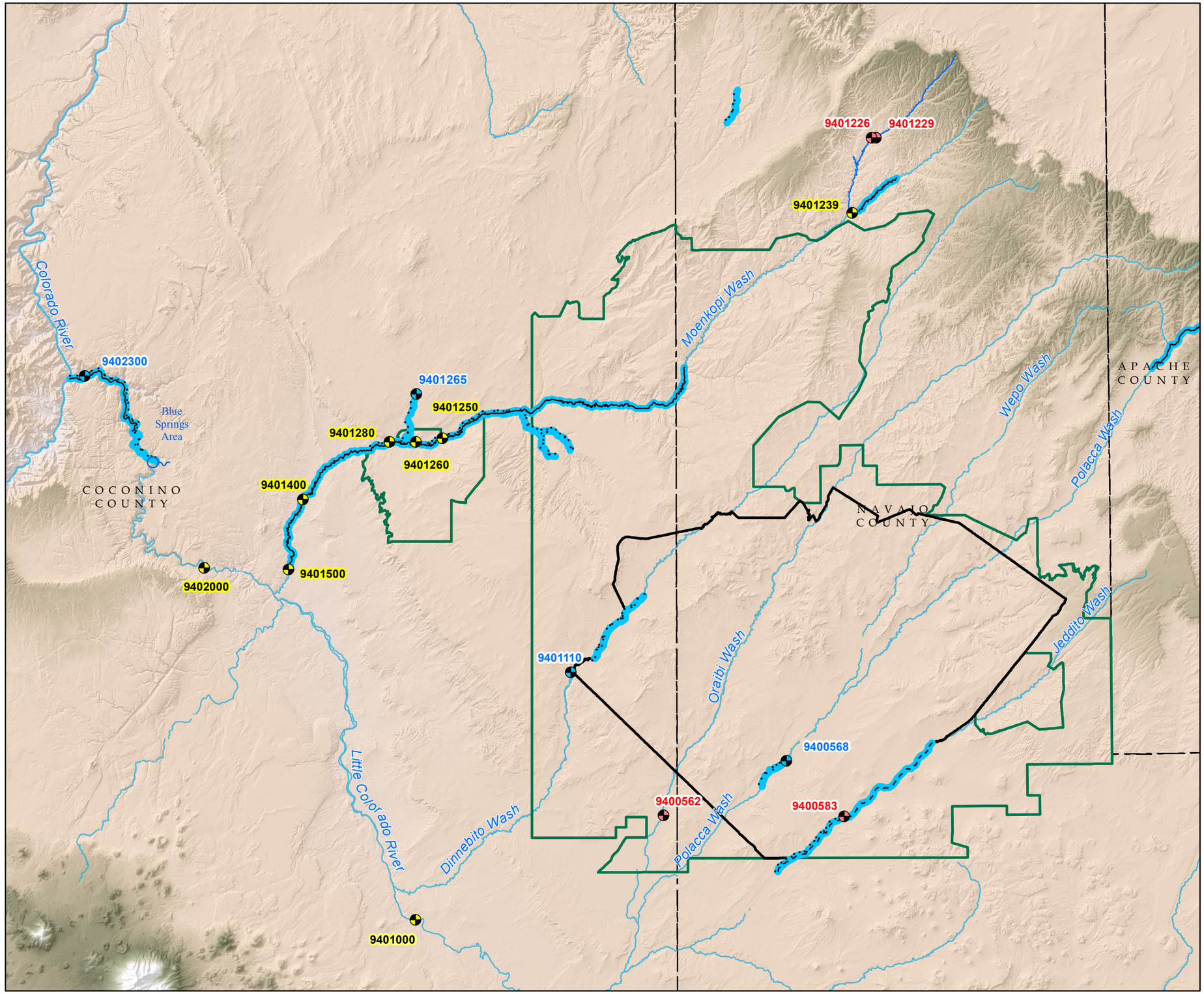
Source: GeoTrans and Waterstone (1999)

Figure 2-5

Conceptual Hydrologic Model for Three Aquifers Beneath the Hopi Indian Reservation

Final Hopi HSR

December 2015



Legend

Recent Streamflow Regime

- Ephemeral
- Intermittent
- Perennial

Historic Perennial Streamflow

- Historic Perennial Reach
- Cooley and Others (1969)
- Hack (1942)
- Gregory (1916)

- Stream
- Hopi Reservation
- Hopi District 6
- County

Source: USGS

0 10 20 Miles

N

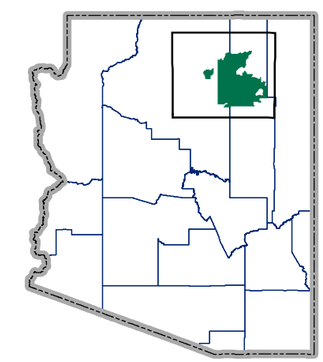
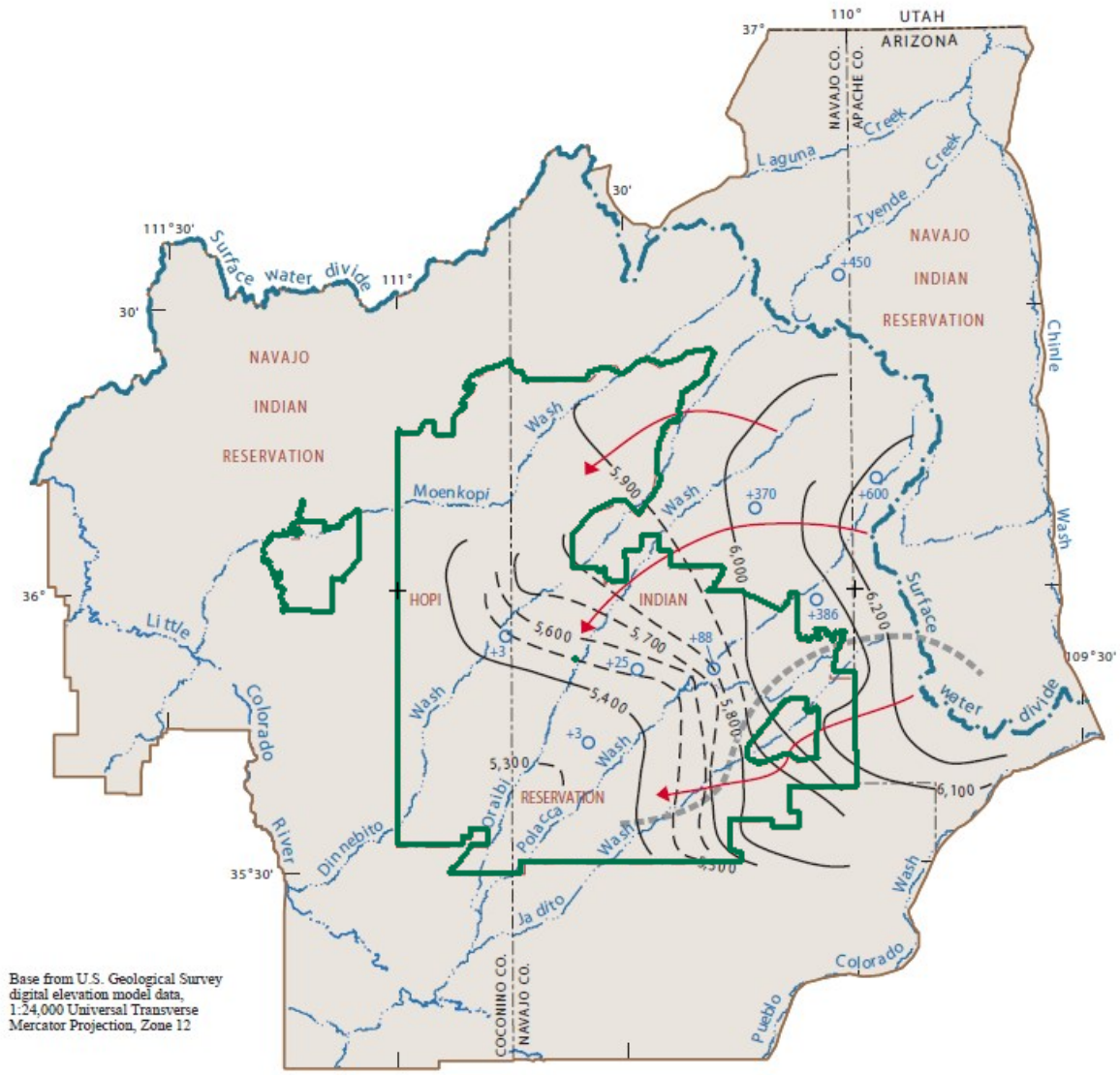


Figure 2-6
Historic Perennial Stream Reaches and Recent Streamflow Regimes in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR
December 2015



Base from U.S. Geological Survey digital elevation model data, 1:24,000 Universal Transverse Mercator Projection, Zone 12

Legend

6,000 — POTENTIOMETRIC CONTOUR—Shows the altitude at which the water level would have stood in a tightly cased well, 1951–61, in feet above mean sea level. Dashed where approximately located. Contour interval 100 feet

APPROXIMATE SOUTHEAST LIMIT OF THE NAVAJO SANDSTONE

+370 DIFFERENCE BETWEEN POTENTIOMETRIC SURFACE OF THE D AQUIFER AND PRESTRESS WATER LEVEL IN THE N AQUIFER—in feet. Data for N aquifer from Thomas (2002).

General Direction of Flow

Hopi Reservation

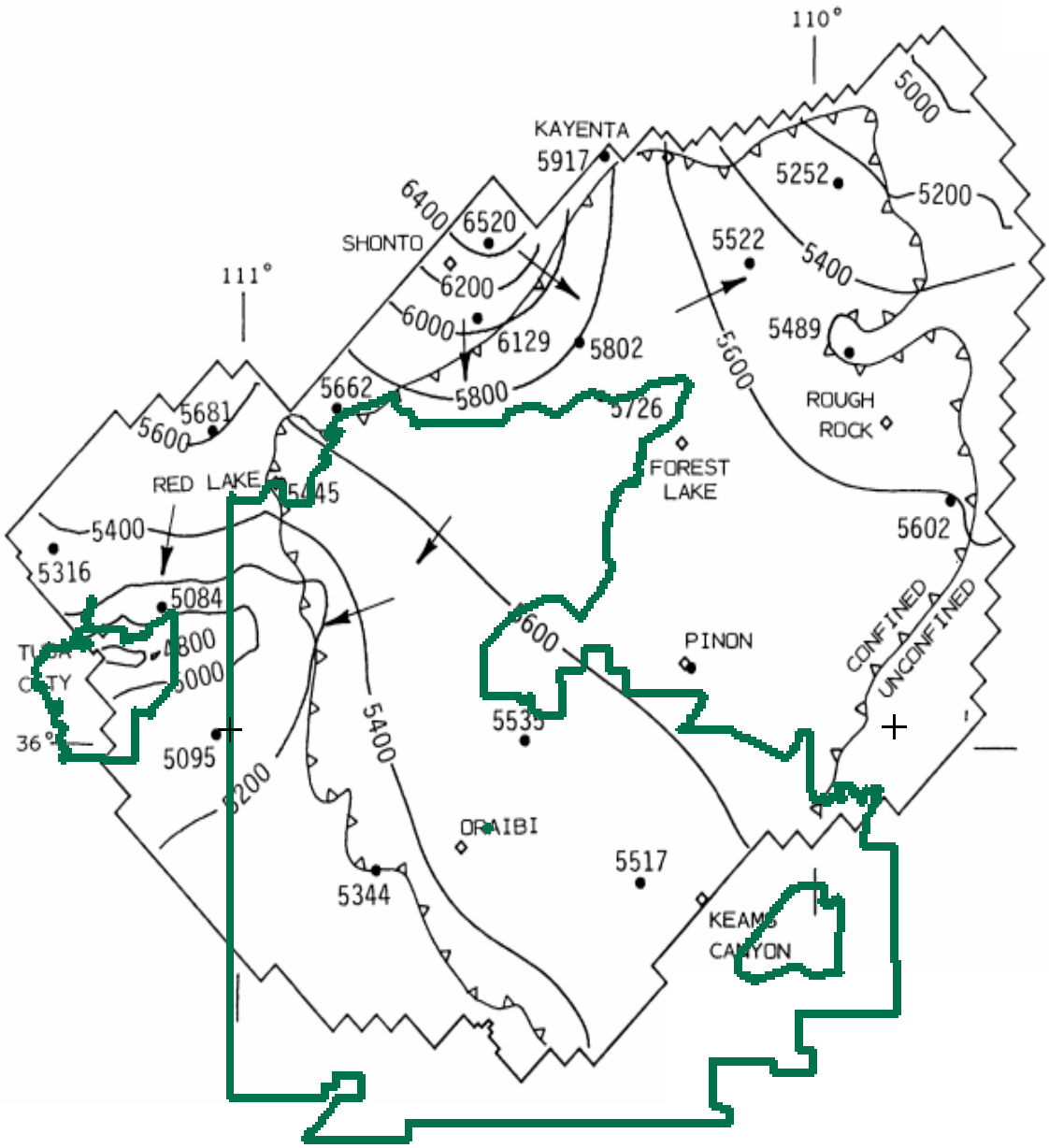
Source: Truini and Longsworth (2003)

Figure 2-7

D Aquifer Water Levels in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015



200 — LINE OF EQUAL SATURATED THICKNESS—Shows approximate generalized saturated thickness. Interval 200 feet

APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS

BOUNDARY OF MATHEMATICAL MODEL

Hopi Reservation

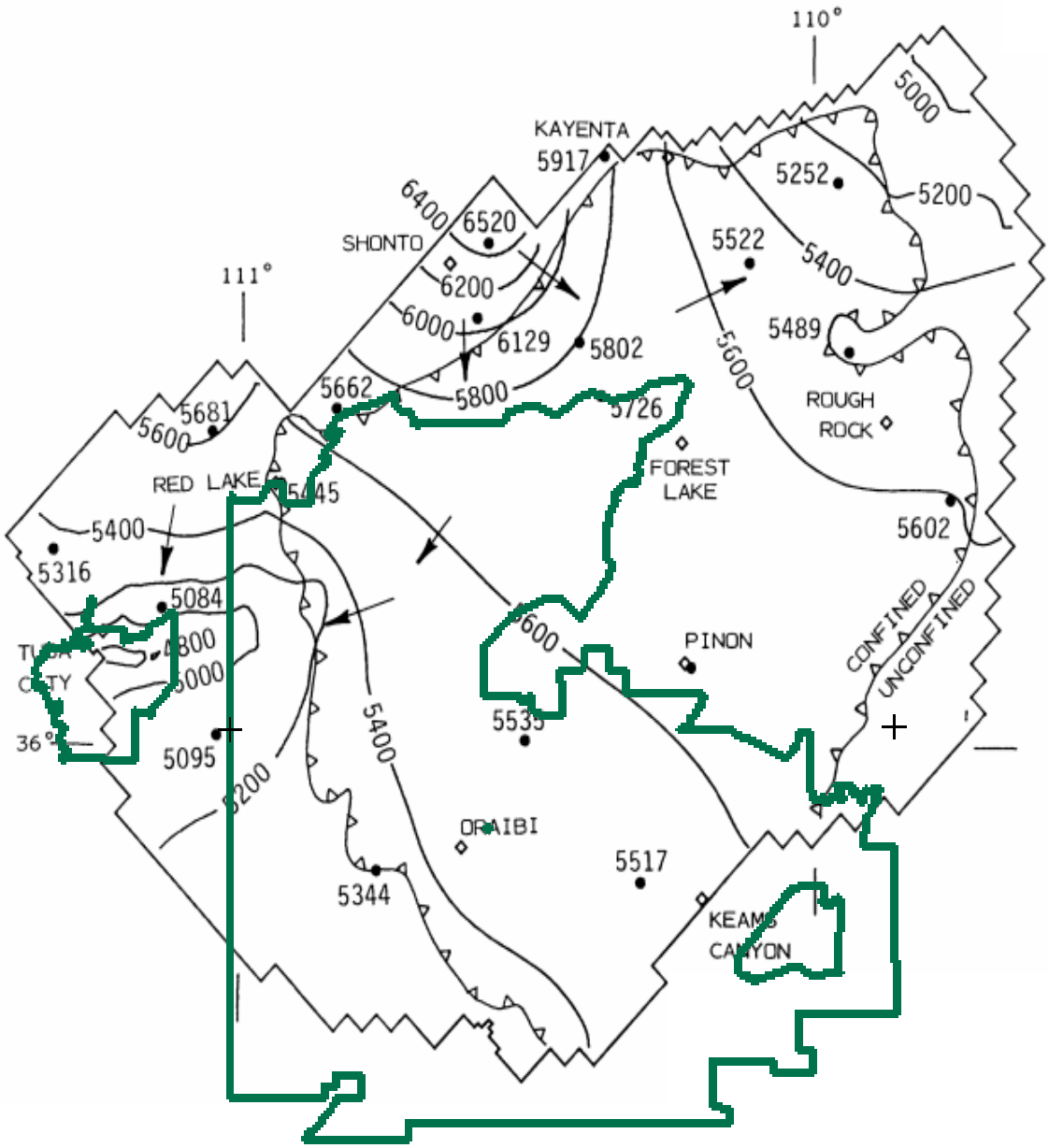
Source: Brown and Eychaner (1988)

Figure 2-8

"Predevelopment" N Aquifer Saturated Thickness in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015



5600 — LINE OF EQUAL SIMULATED WATER-LEVEL ALTITUDE— Contour interval 200 feet. Datum is sea level

APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS

6520 — WELL IN WHICH DEPTH TO WATER WAS MEASURED— Measurement was made before 1965 or during assumed local equilibrium before 1972. Number, 6520, is altitude of water level in feet above sea level

GENERALIZED DIRECTION OF GROUND-WATER MOVEMENT

BOUNDARY OF MATHEMATICAL MODEL

Hopi Reservation

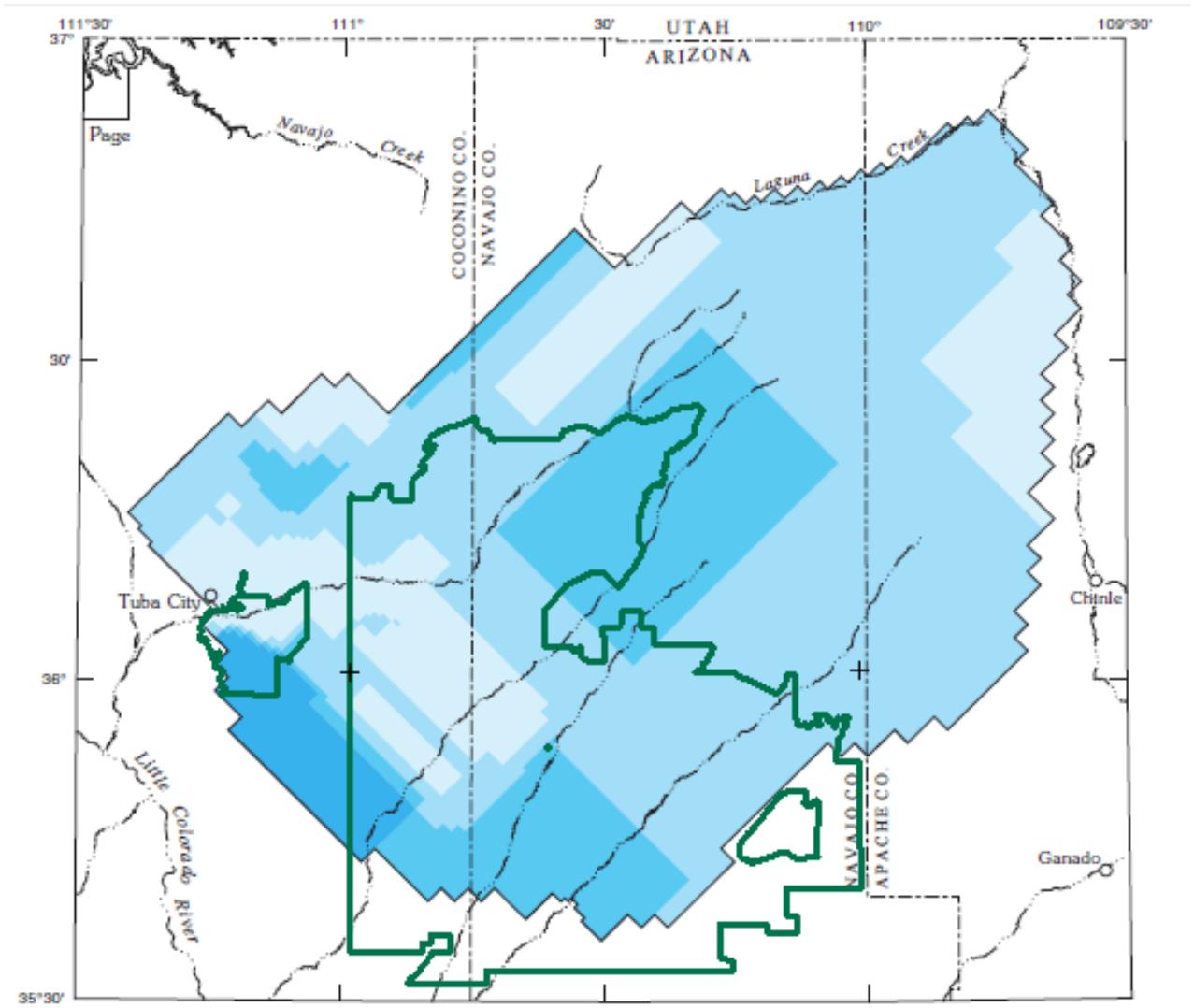
Source: Brown and Eychaner (1988)

Figure 2-9

"Predevelopment" N Aquifer Water Levels and Flow Directions in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015



EXPLANATION

HYDRAULIC CONDUCTIVITY, IN FEET PER DAY:

- 0.1 to 0.4
- 0.4 to 0.8
- 0.8 to 1.2
- 1.2 to 1.8

MODEL BOUNDARY

Hopi Reservation

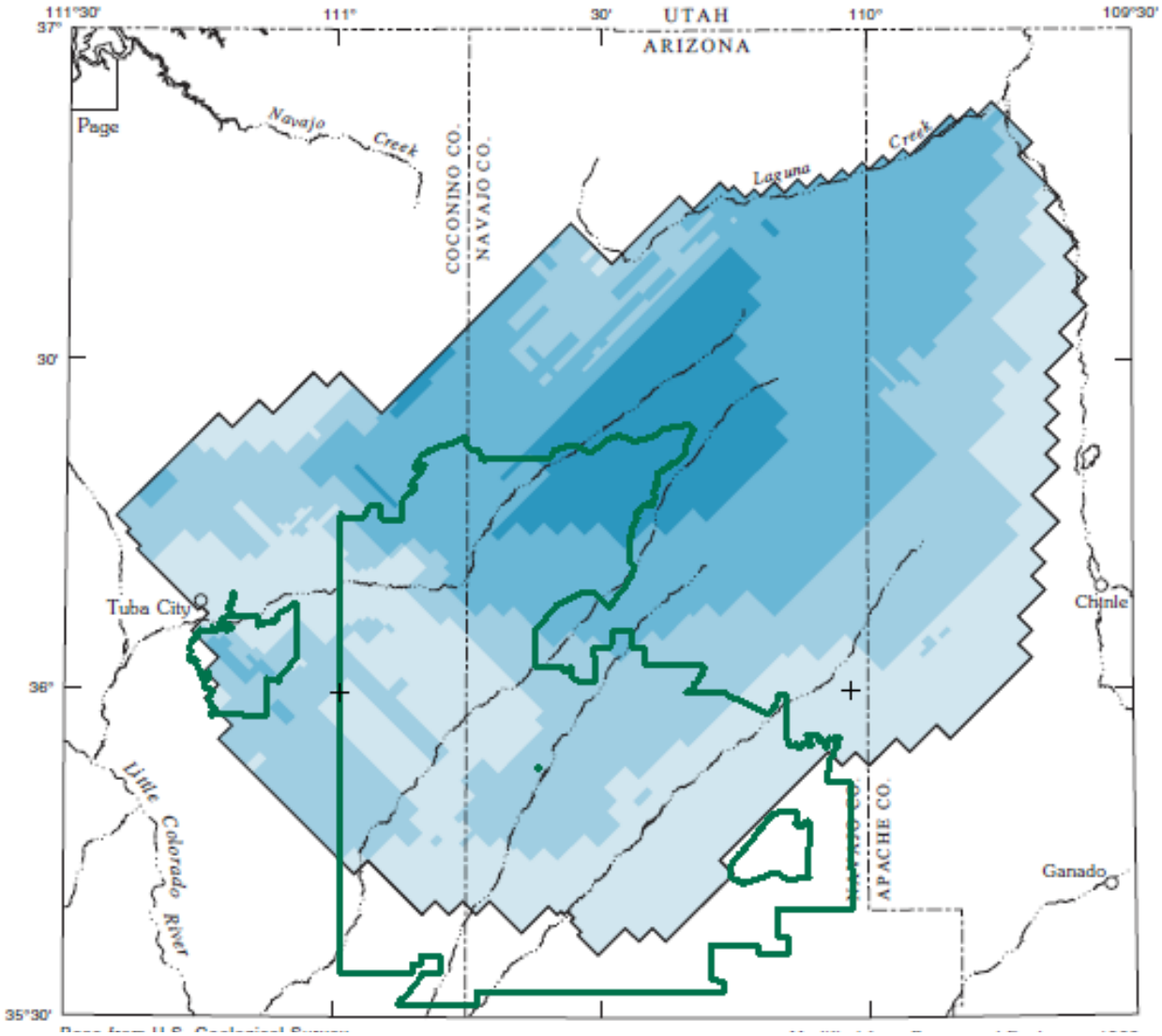
Source: Thomas (2002)

Figure 2-10

USGS Simulation of N Aquifer Hydraulic Conductivity in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015



EXPLANATION

TRANSMISSIVITY, IN FEET SQUARED PER DAY:

20 to 200 | 200 to 400

400 to 700 | 700 to 1,040

MODEL BOUNDARY

Hopi Reservation

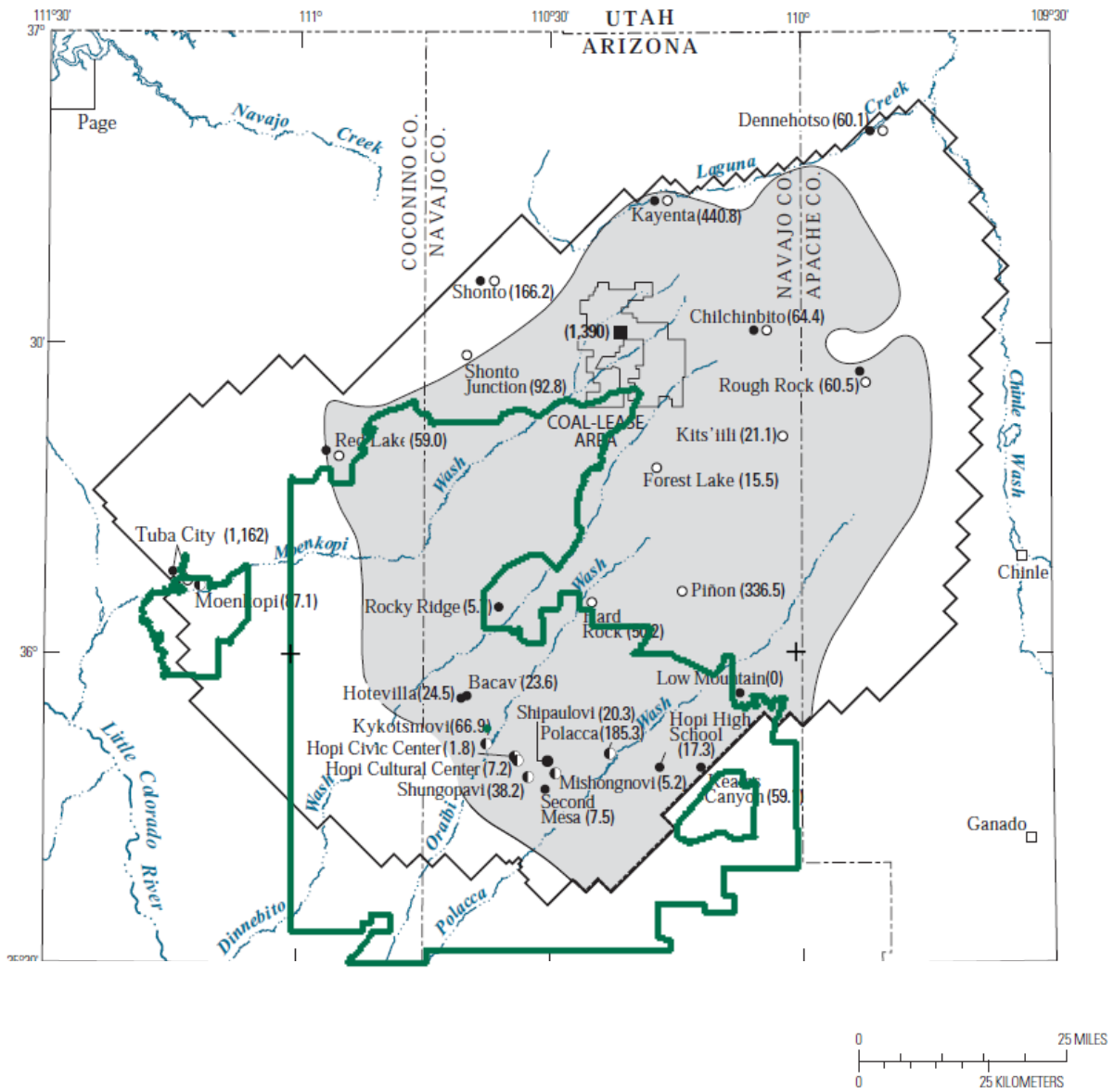
Source: Thomas (2002)

Figure 2-11

USGS Simulation of N Aquifer Transmissivity in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015



CONFINED AND UNCONFINED CONDITIONS IN THE N AQUIFER WITHIN MODEL BOUNDARY

- Confined
- Unconfined
- APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS- From Brown and Eychaner (1988)
- BOUNDARY OF MATHEMATICAL MODEL— From Brown and Eychaner (1988)
- Hopi Reservation

EXPLANATION

WELL-SYSTEM OWNER

- Bureau of Indian Affairs
- Navajo Tribal Utility Authority
- Hopi Tribe
- Peabody Western Coal Company

Piñon (336.5) WITHDRAWALS FROM THE N AQUIFER-Piñon, well-system name; 336.5, total withdrawal in acre-feet for 2011. The total is cumulative at locations served by multiple wells

Source: Macey and Unema (2013)

Figure 2-12

2011 N Aquifer Well Withdrawals in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015

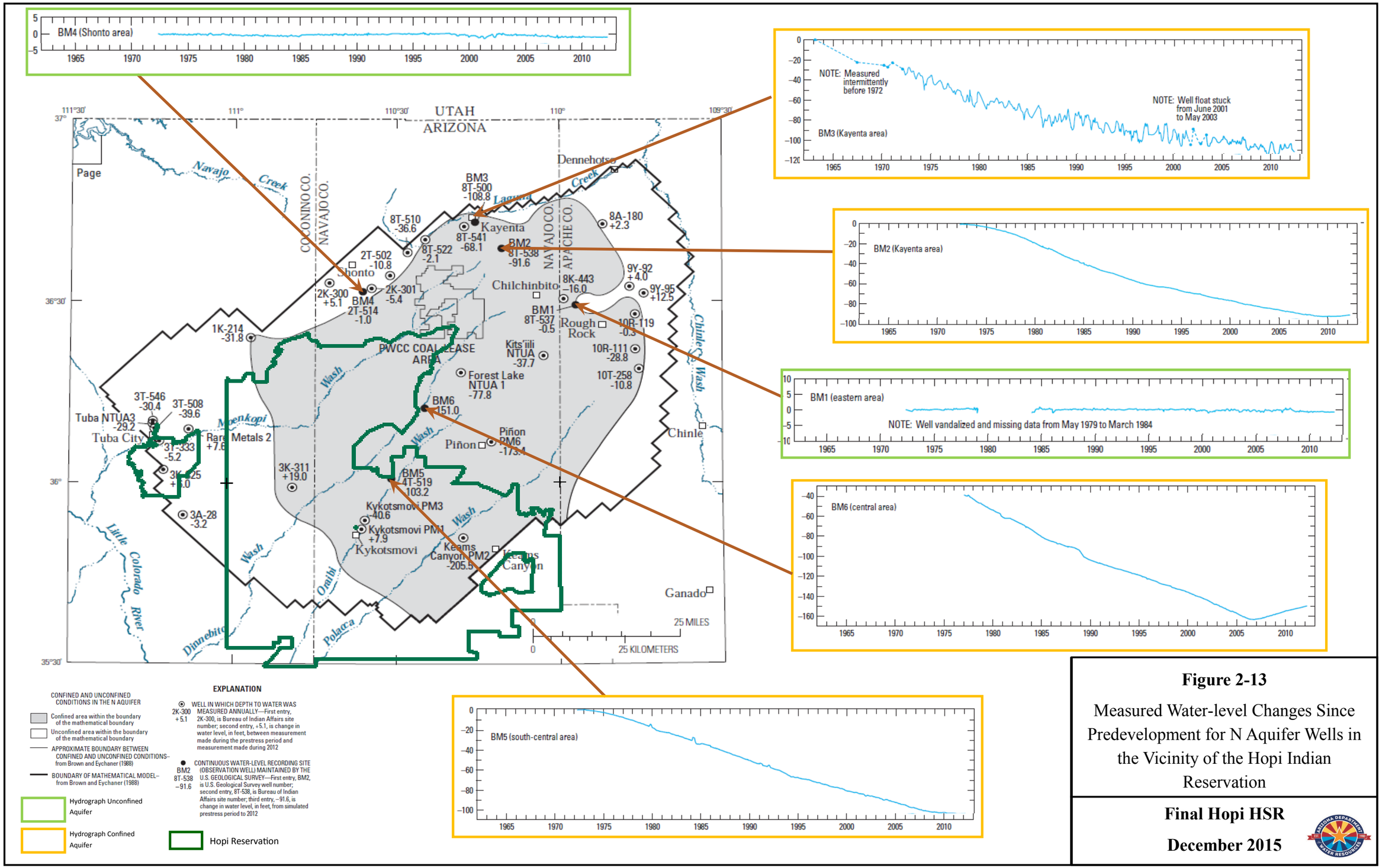
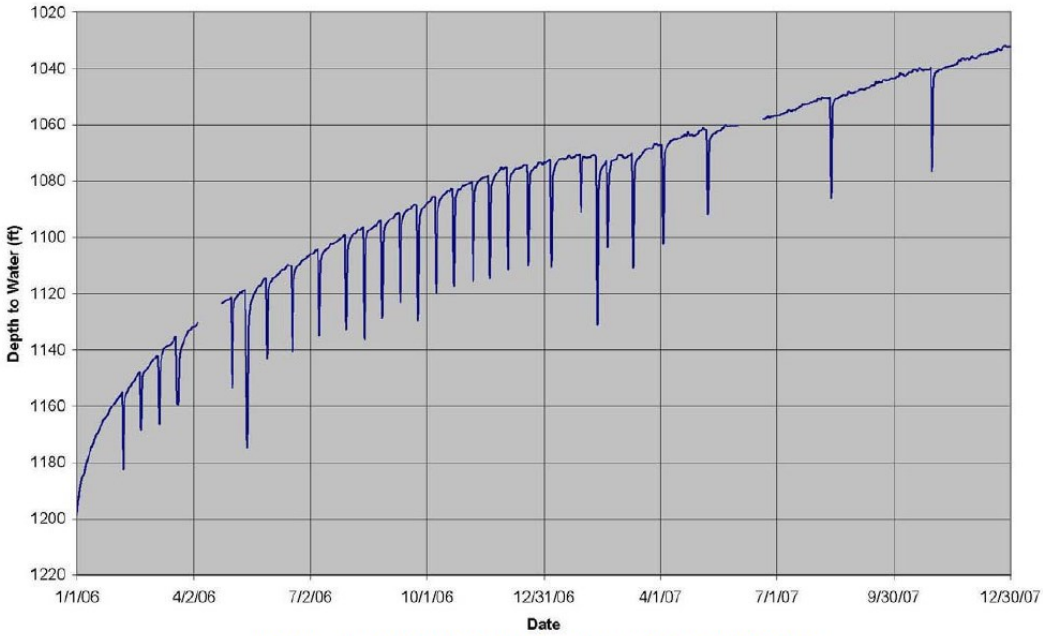


Figure 2-13

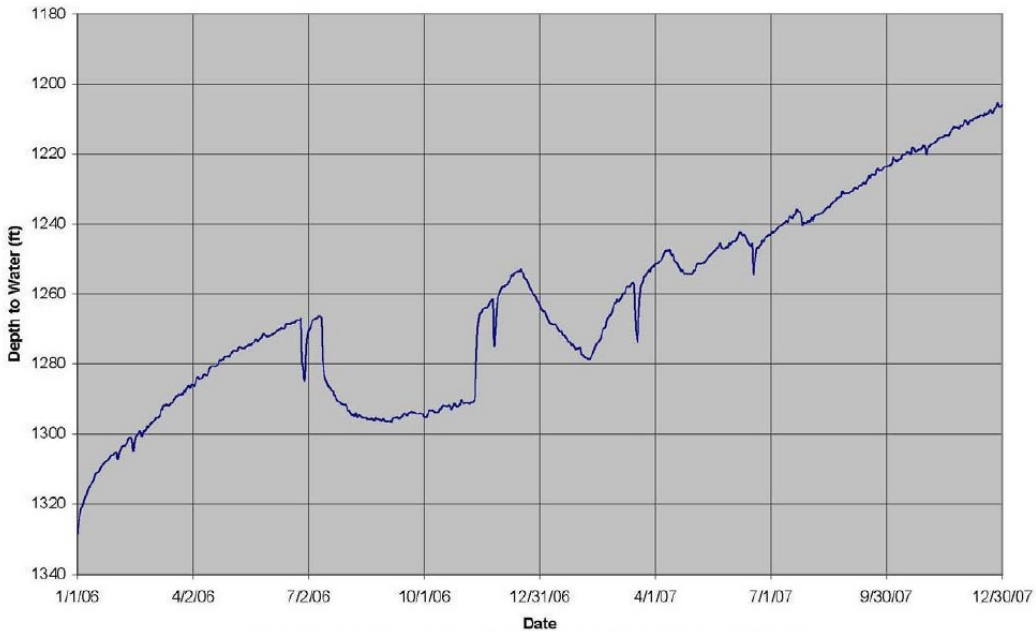
Measured Water-level Changes Since Predevelopment for N Aquifer Wells in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015



Hydrograph for PWCC Observation Well NAVOBS3



Hydrograph for PWCC Observation Well NAVOBS6

Figure 2-14

Water Level Rise Measured in Two PWCC N Aquifer Wells

Source: Cochran (2008)

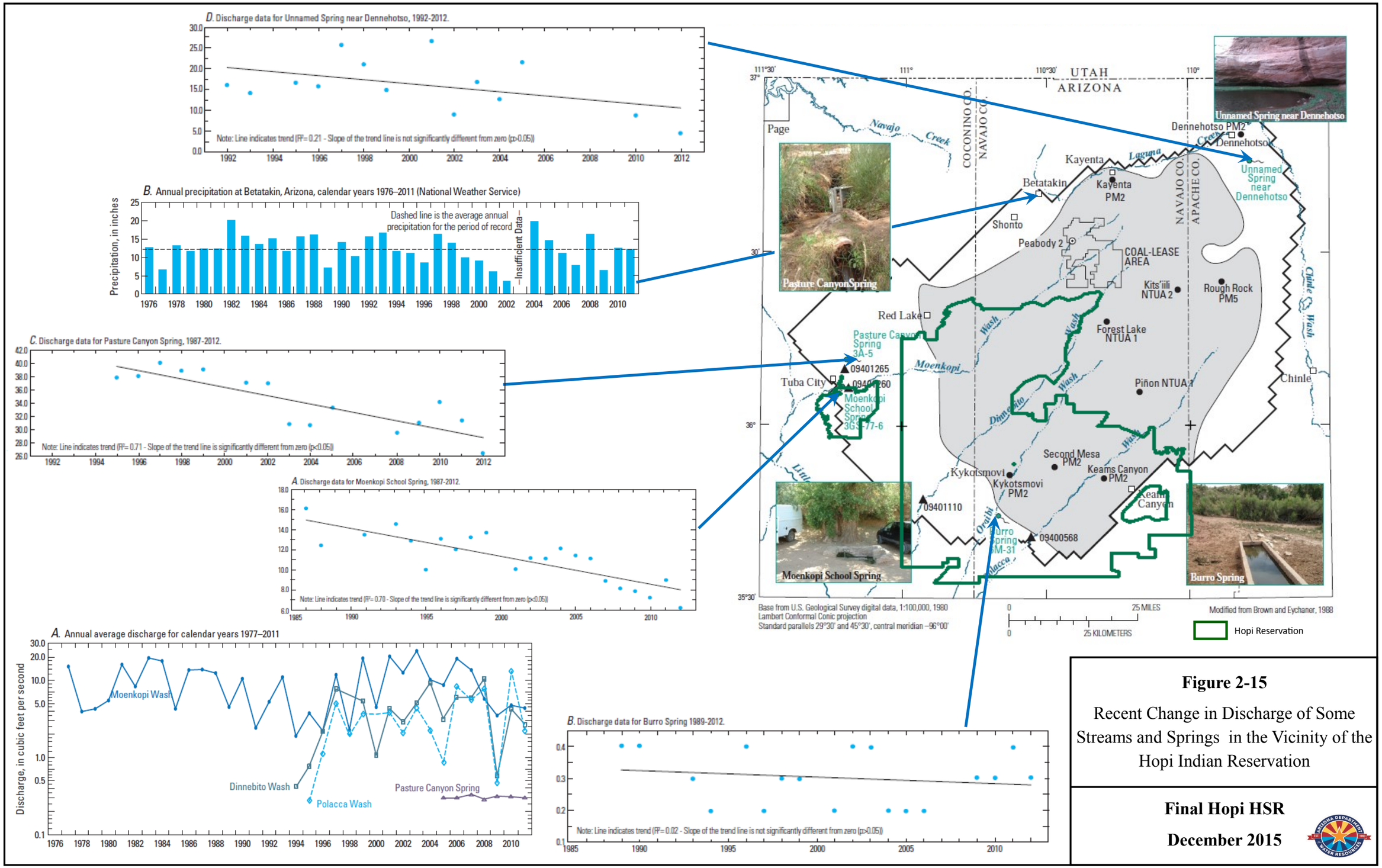


Figure 2-15

Recent Change in Discharge of Some Streams and Springs in the Vicinity of the Hopi Indian Reservation

Final Hopi HSR

December 2015