CLARK, LINCOLN, AND WHITE PINE COUNTIES GROUNDWATER DEVELOPMENT PROJECT EIS

WATER RESOURCES TECHNICAL REVIEW
MEETING 1 – BASELINE DATA
June 23-24, 2005

HYDROLOGY – GROUNDWATER – HYDRAULIC PROPERTIES

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Overview

- Objective
- General Information
- Scope of Work
- Datasets by Source
- General Data Observations
- Electronic Information Organization

Presentation Objective

- Present hydraulic property data compiled in support of SNWA's Groundwater Development Project in Clark, Lincoln, and White Pine Counties.

Definitions

- **Hydraulic properties include permeability and storage parameters of geologic units.**
  - **Permeability parameters quantify the ability of geologic media to transmit fluids.**
  - **Storage parameters provide a measure of the storage capabilities of the geologic media.**

General Uses of Aquifer Properties

- Quantification of the permeability and storage parameters of a flow system is needed for several reasons:
  - It facilitates comparison of water-bearing geologic units.
  - It facilitates the identification of aquifers versus confining units.
  - It is required in flux calculations using simple analytical or complex numerical models of groundwater flow.

Role of Aquifer Properties in the EIS

- Aquifer properties are part of the description of the geologic framework of the groundwater flow system.

- A description of the flow system and its components is:
  - included in the "Affected Environment" section of the EIS.
  - is needed in the prediction of potential impacts of the alternatives on the environment.

Data from Outside Study Area

- Are used to supplement the site-specific data.
- Although measured hydraulic properties are highly dependent on location, averages and ranges are comparable for similar hydrogeologic units.
- Hydrogeologic units are considered similar if they have comparable:
  - Rock types
  - Deposition and alteration histories
  - Structural settings

Permeability Parameter Data Types

- Permeability (k): the fluid- transmitting characteristic of geologic media in quantitative terms
- Hydraulic conductivity (K): the water- transmitting characteristic of geologic media in quantitative terms
- Transmissivity (T): the product of hydraulic conductivity and aquifer thickness
- Specific capacity: Well yield per unit of drawdown

Storage parameter Data Types

- **Storage coefficient (S): the volume of water that an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.**

- **Specific yield: Portion of water in storage in the ground that will drain under the influence of gravity. Retained portion is called specific retention.**

Methods of Measurement by Scale

- **Large-Scale**
  - Constant-rate pumping tests
- **Medium scale**
  - Slug tests
  - Packer tests
  - Step-drawdown tests
  - Drill-stem tests
- **Small-Scale (Core)**
  - Permeameter tests

Constant-Rate Tests

- Used to estimate T and S
- Tests may include single well or multiple wells.
- Consist of two phases: pumping and recovery.

Constant-Rate Tests - Process

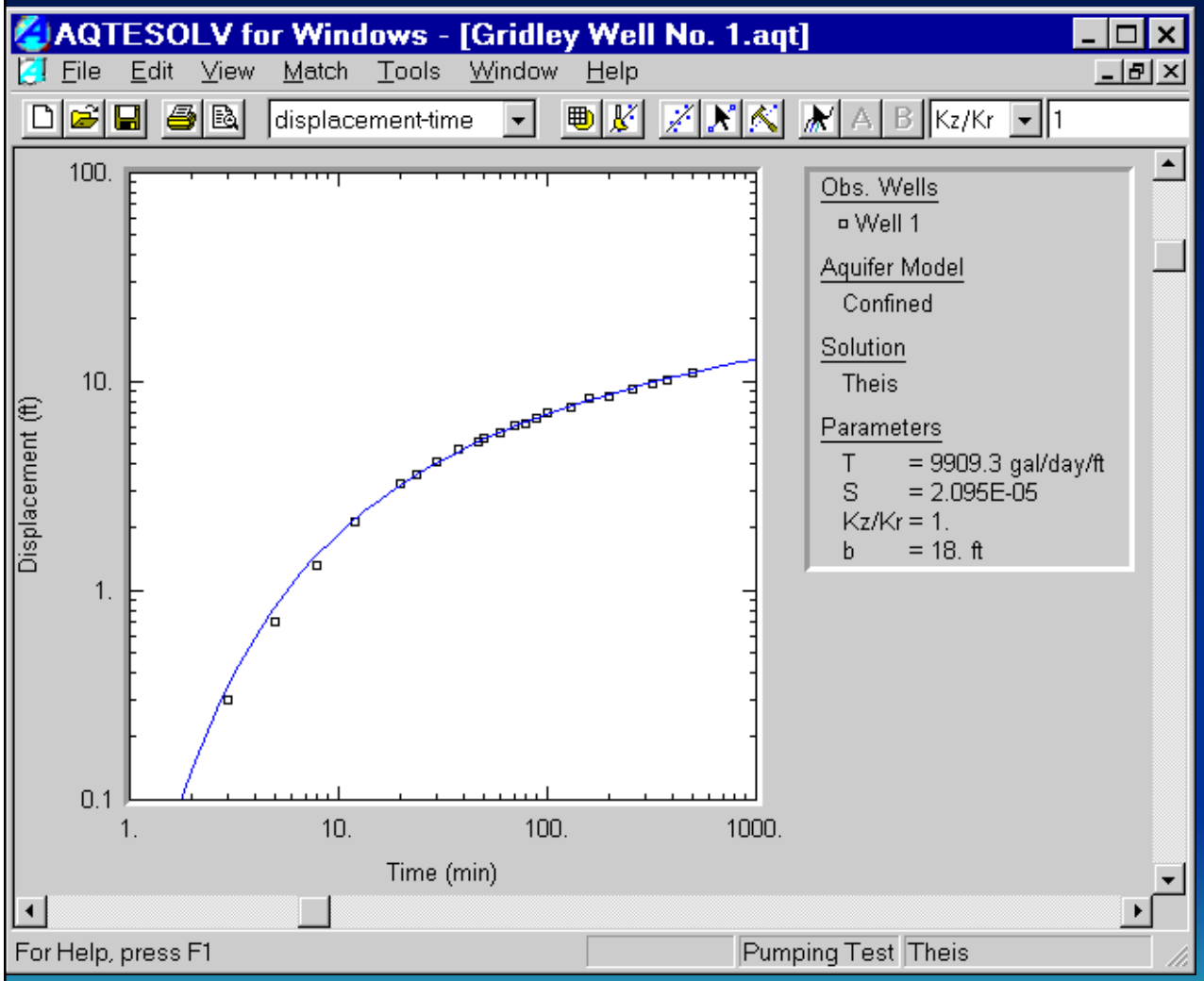
1. The pumping well is pumped at a constant rate for a period ranging from several hours to several days.

2. Changes in water levels in the pumping well and observation wells (if any), located at different distances from the pumped well, are collected throughout the test.

3. Changes in water levels are also collected after the pump is stopped until the well recovers to near pre-pumping conditions.

4. The resulting time-drawdown data records are analyzed to derive estimates of T or K and S if test includes observation wells.

Constant-Rate Tests – Data Analysis



Example of time-drawdown data collected during a constant-rate test.

Source: http://www.aquifertest.com/examples/gridley.htm

- Time-drawdown (or displacement) data are analyzed using one of the existing methods, Theis (1935) for example, to derive estimates of transmissivity (T) and storage coefficient (S).
- Data may be analyzed using different methods depending on aquifer conditions.
- Many methods are available for analyzing constant-rate test data in unconfined, confined, leaky and fractured aquifers.
- These methods have been implemented in software packages such as AQTESOLV.

Constant-Rate Tests
Data Analysis Methods

- Theis (1935)
- Cooper-Jacob (1946)
- Papadopulos-Cooper (1967)
- Theis (1935) residual drawdown
- Hantush (1962)
- Neuman (1974)
- Moench (1993, 1996)
- Streltsova (1974)
- Moench (1997)
- Hantush-Jacob (1955)
- Hantush (1960)
- Moench (1985)
- Neuman-Witherspoon (1969)
- Moench (1984)
- nSIGHTS (Version 2.0)

Slug Tests/Packer Tests

- A slug test is usually conducted as single-well test.
- A packer test is a slug test conducted in an isolated well interval.
- A slug of water is either added or removed from the well or the isolated interval.
- Changes in water-level are collected throughout the test.
- The data record is analyzed to derive estimates of transmissivity or hydraulic conductivity.

More on Packer tests…

Example of a single packer

- A given interval is isolated with a single or double packer(s).
- Changes in pressure are recorded using a transducer.

Source: http://www.archwayengineering.com/products/double_packers.html

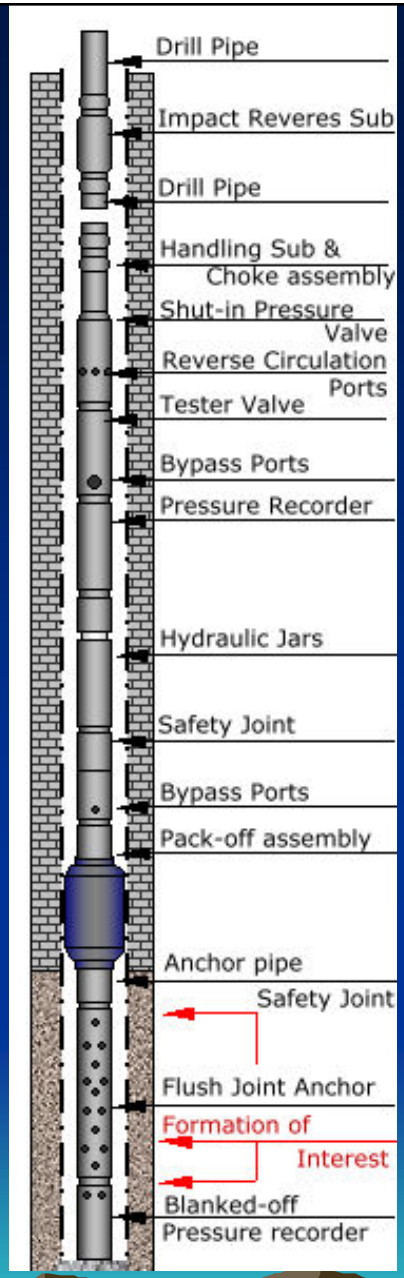
Slug Test Analysis Methods

- Cooper et al. (1967)
- Hvorslev (1951)
- Hyder et al. (1994)
- Bouwer-Rice (1976)

Step-Drawdown Tests

- Conducted prior to constant-rate pumping tests.
- Used to estimate well efficiency and optimal pumping rate.
- Usually conducted as three consecutive short-duration pumping tests
- Provide estimates of well specific capacity which may be used to derive estimate of transmissivity.
- Step-Drawdown test record may be analyzed using the Theis (1935) step test method to derive estimate of transmissivity.

Drill-Stem Tests



Example Drill-Stem Test Assembly

- **Drill-stem tests are conducted to determine the potential of a producing formation.**
- **The DST test tool is placed on the bottom of the drill stem and lowered in the hole.**
- **Weight is applied to the tool to expand a hard rubber sealer (packer).**
- **The tool ports are opened to the formation to start the test.**
- **A transducer records pressure versus time during pressure buildup.**
- **The time-pressure data may be analyzed to derive an estimate of transmissivity.**

Source: http://www.osha.gov/SLTC/etools/oilandgas/well_completion/well_completion.html#Drill%20Stem%20Testing

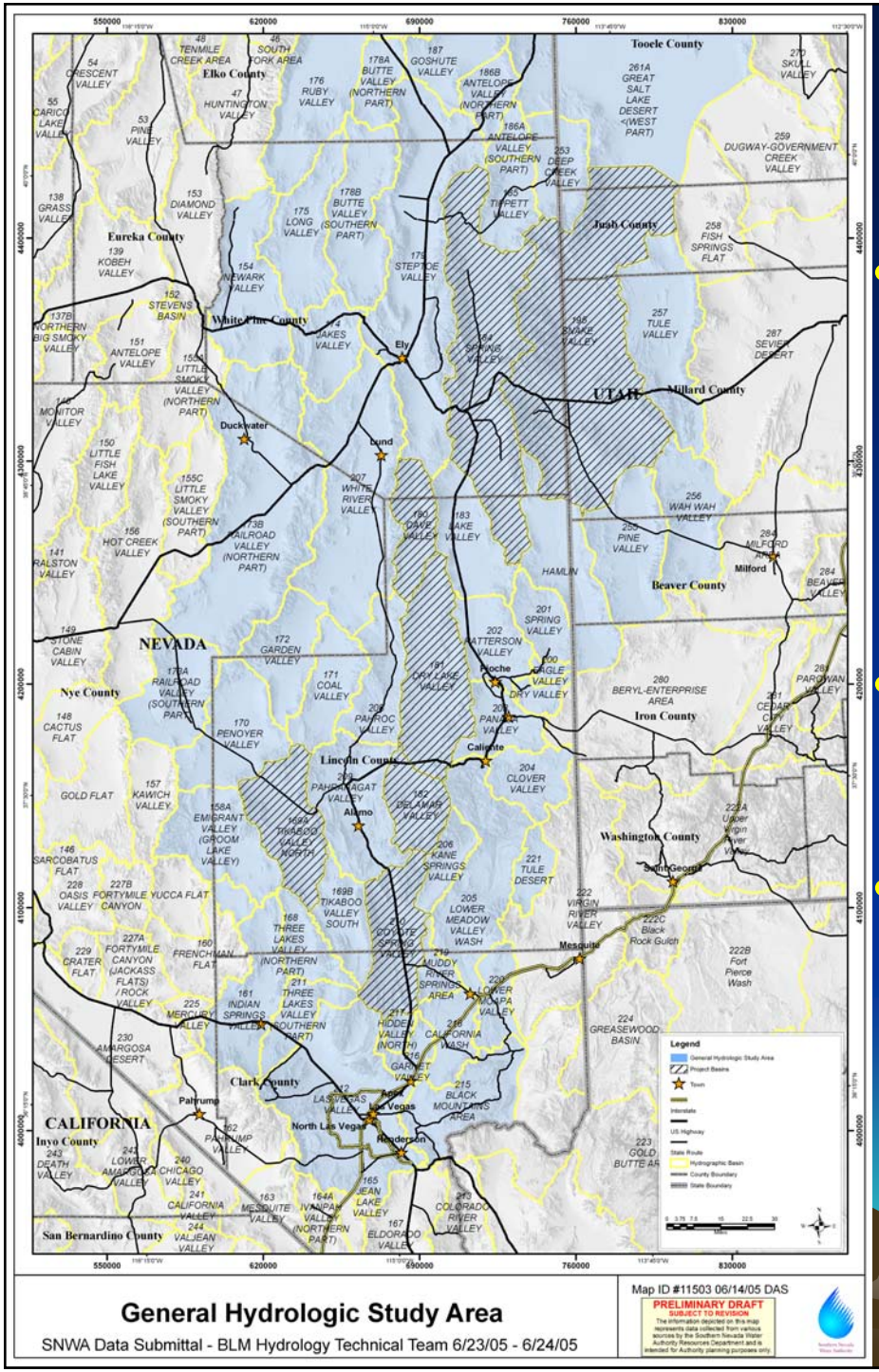
Permeameter Tests

Example of a Liquid Permeameter

Source: http://www.temco.com/tempstuff/liqper.htm

- Conducted on cores in the laboratory.
- A fluid (gas or liquid) is injected into the core at various pressures and the differential pressure and flow rates are recorded.
- This information is then used in a Darcy equation to calculate the permeability of the core sample.

Scope of Data Gathering Effort



- **Investigation Area**
  - *Hydrologic Study Area*
  - Parts of Great Basin neighboring the study area
- **No field data collection**
- **Existing data compilation effort only**
  - Includes analyzed test data only.
  - Does not include raw test data requiring analysis.

Data Sources

- **Site-Specific Data Sources**
  - Include data for locations within the study area.
  - Reports contain original aquifer test data collected for a single study.
- **Regional Data Sources**
  - Include data for regions including or located near the study area. May overlap with study area.
  - Reports contain either original aquifer test data for a single study or data compiled from various reports.

Major Site-Specific Data Sources

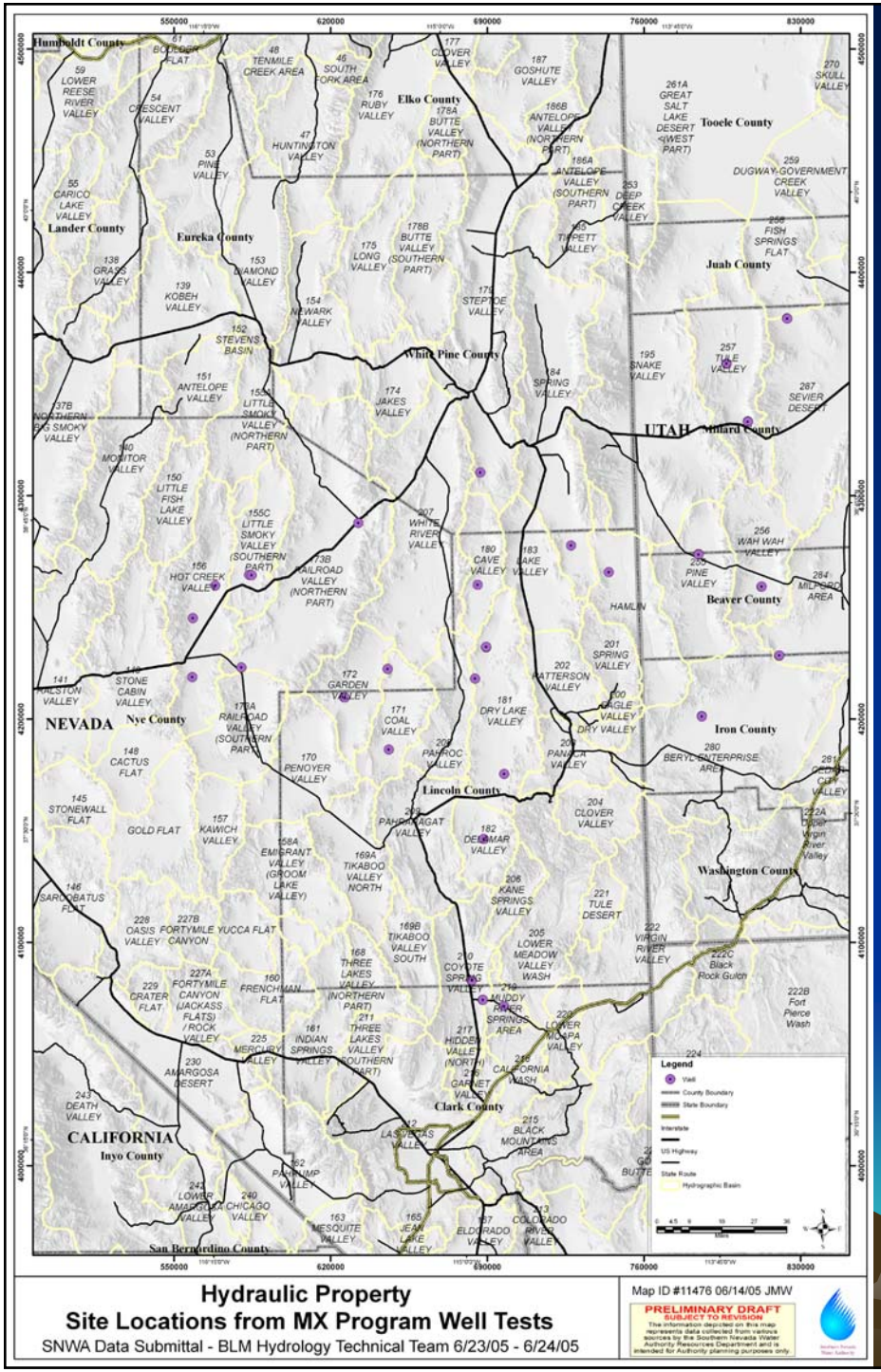
- MX Well tests in Ertec reports (also summarized by Bunch & Harrill, 1984)
- Drillers Logs from Nevada Division of Water Resources (NDWR, 2004)
- Drill-stem tests in McKay and Kepper (1988)
- White Pine Power Project well tests in Leeds, Hill and Jewett (1981b and 1983)

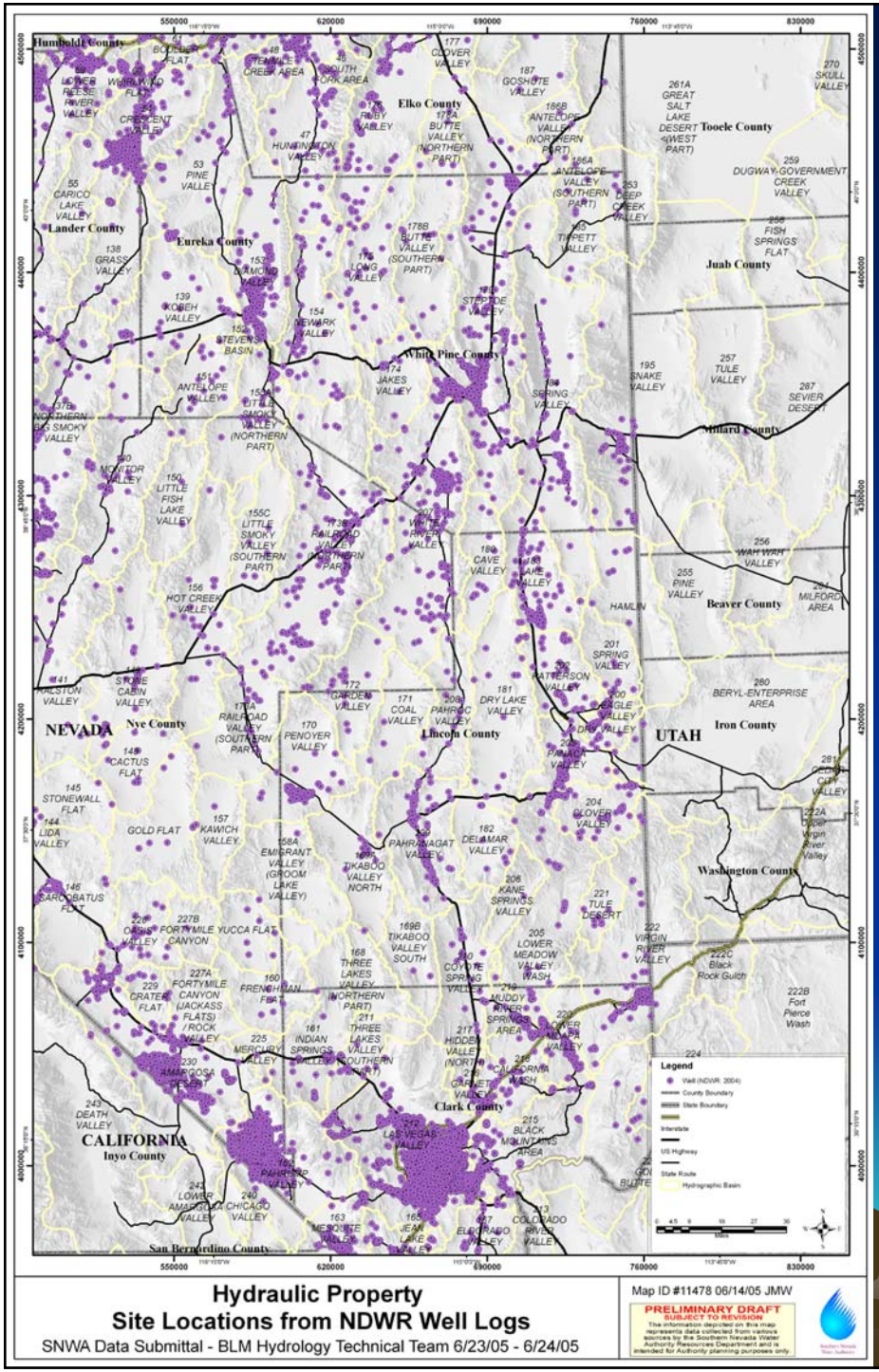
Other Site-Specific Data Sources

- Berger et al. (1988) for Coyote Spring Valley
- Johnson et al. (1998) for Coyote Spring Valley
- Converse (2002) for Coyote Spring Valley
- Converse (1997, 1998a & b) for Three Lakes Valley South
- SRK (2001) for Dry Lake Valley
- Johnson (2002) for Dry Lake Valley
- URS (2001) for Meadow Valley
- Mifflin & Associates (2001) for Moapa Valley

USAF MX Siting Investigation / Water Resources Program - MX Well Tests in Ertec Reports and Bunch & Harrill (1984)

- Area of investigation extends over Nevada and Utah.
- A number of wells were constructed and tested in 1980 and 1981. Project ended in 1981.
- 53 wells were used during the testing. Approximately half of them fall within the map area.
- Most tests (21) were conducted in the valley-fill aquifer. A few tests were conducted in the carbonate aquifer.



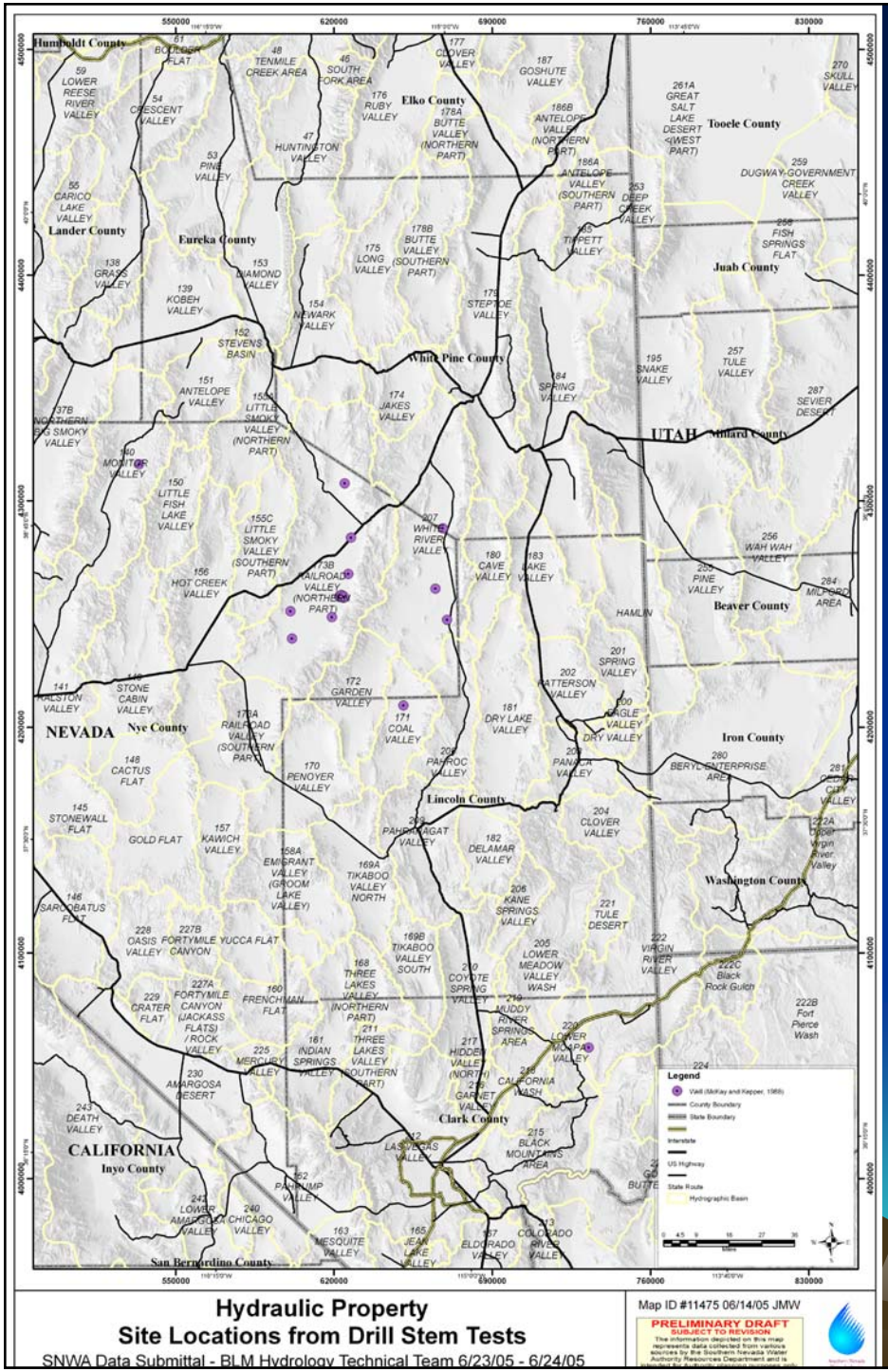


Drillers Logs from Nevada Division of Water Resources (NDWR, 2004)

- The NDWR drillers log database contains more than 85,000 logs for all wells in Nevada.
- The database does not include drillers logs for most domestic wells but includes logs for dry wells.
- In addition to location and well construction, drillers logs contain lithology.
- 964 drillers logs include specific-capacity data.

Drill-Stem Tests for Oil and Gas Wells

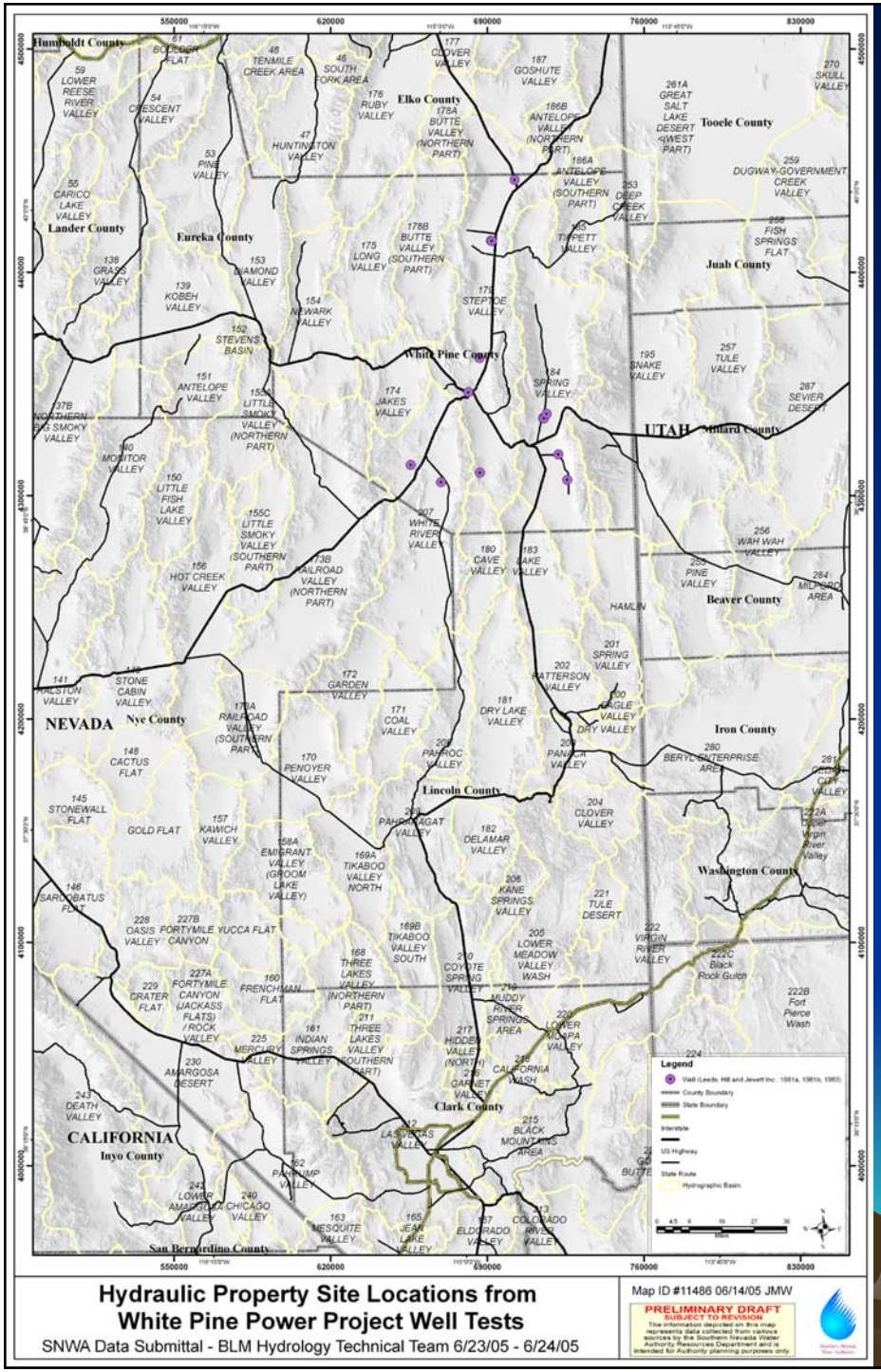
- **McKay and Kepper (1988)**
  - **Most wildcat wells reviewed are in Railroad Valley and White River Valley flow systems.**
  - **100 wildcat oil and gas files (NBMG) were reviewed.**
  - **20 wells had complete DST records for carbonate aquifer.**
  - **Transmissivities were calculated for the 20 wells. Locations are shown on map.**
  - **DST transmissivity values were smaller than those derived from aquifer tests by up to 3 orders of magnitude.**
- **Recent Drill-Stem Tests**
  - **About 50 drill-stem tests (1987- 2003) have been conducted within the study area since the McKay and Kepper (1988) report.**
  - **To this date, these data have not been analyzed.**



White Pine Power Project Well Tests in Leeds, Hill and Jewett (1981b and 1983)

- Study was conducted in three phases. Data were derived from step-drawdown and pump tests.

- Eleven wells were installed and tested in the valley fill and carbonate aquifer in:
  - Spring Valley
  - Steptoe Valley
  - White River Valley

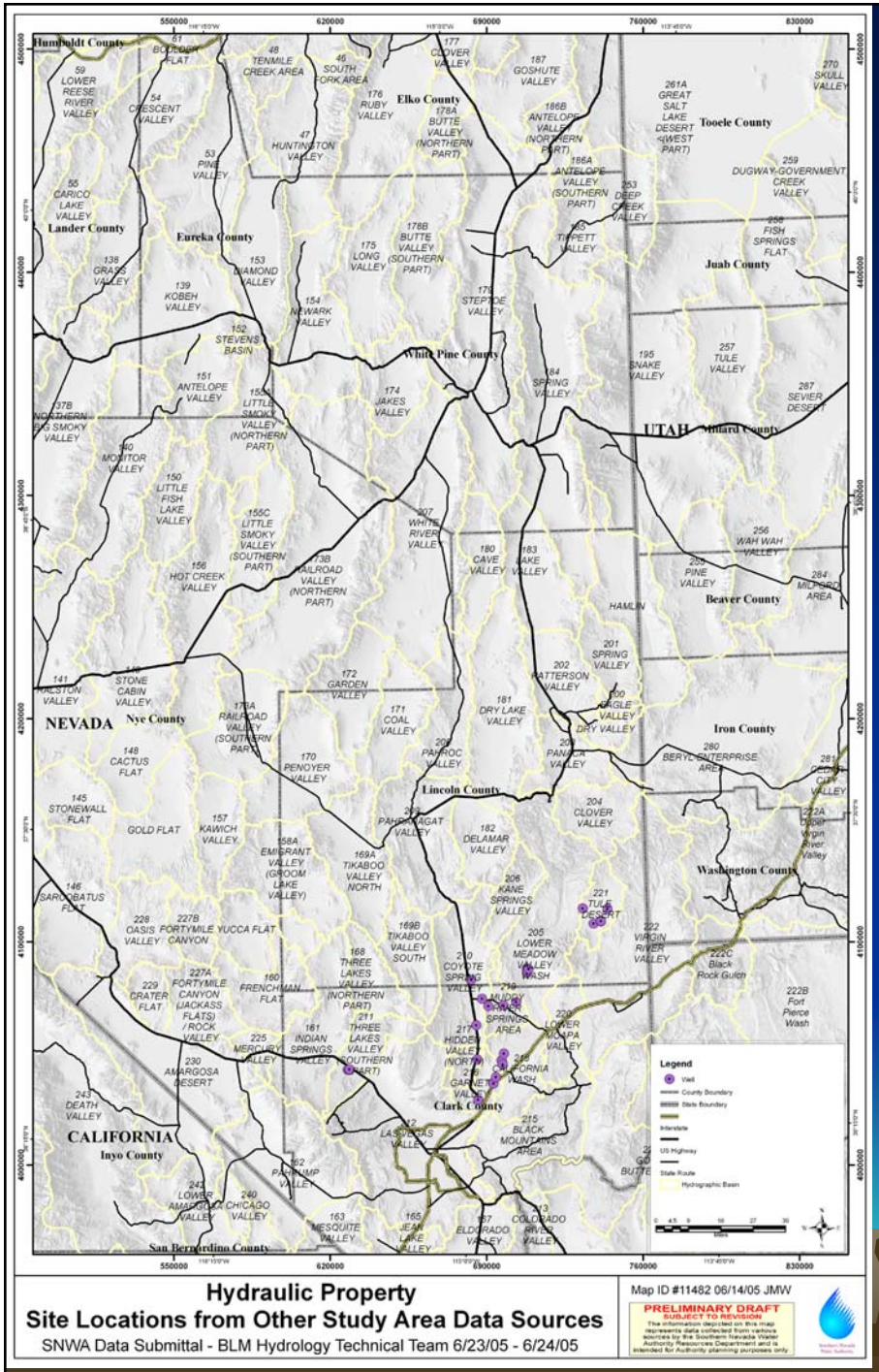


Hydraulic Property Site Locations from White Pine Power Project Well Tests

SNWA Data Submittal - BLM Hydrology Technical Team 6/23/05 - 6/24/05

Map ID #11486 06/14/05 JMW

PRELIMINARY DRAFT
SUBJECT TO REVISION



Other Site-Specific Sources of Data

- Consist of reports on localized hydrological studies.
- Include step-drawdown and constant-rate tests for 18 wells in:
  - Coyote Spring Valley
  - Moapa Valley
  - Lower Meadow Wash Valley
  - Garnet Valley
  - Three Lakes Valley South
- Dataset slug, step-drawdown, and constant-rate pumping tests for valley-fill and carbonate rocks.

Main Regional Data Sources

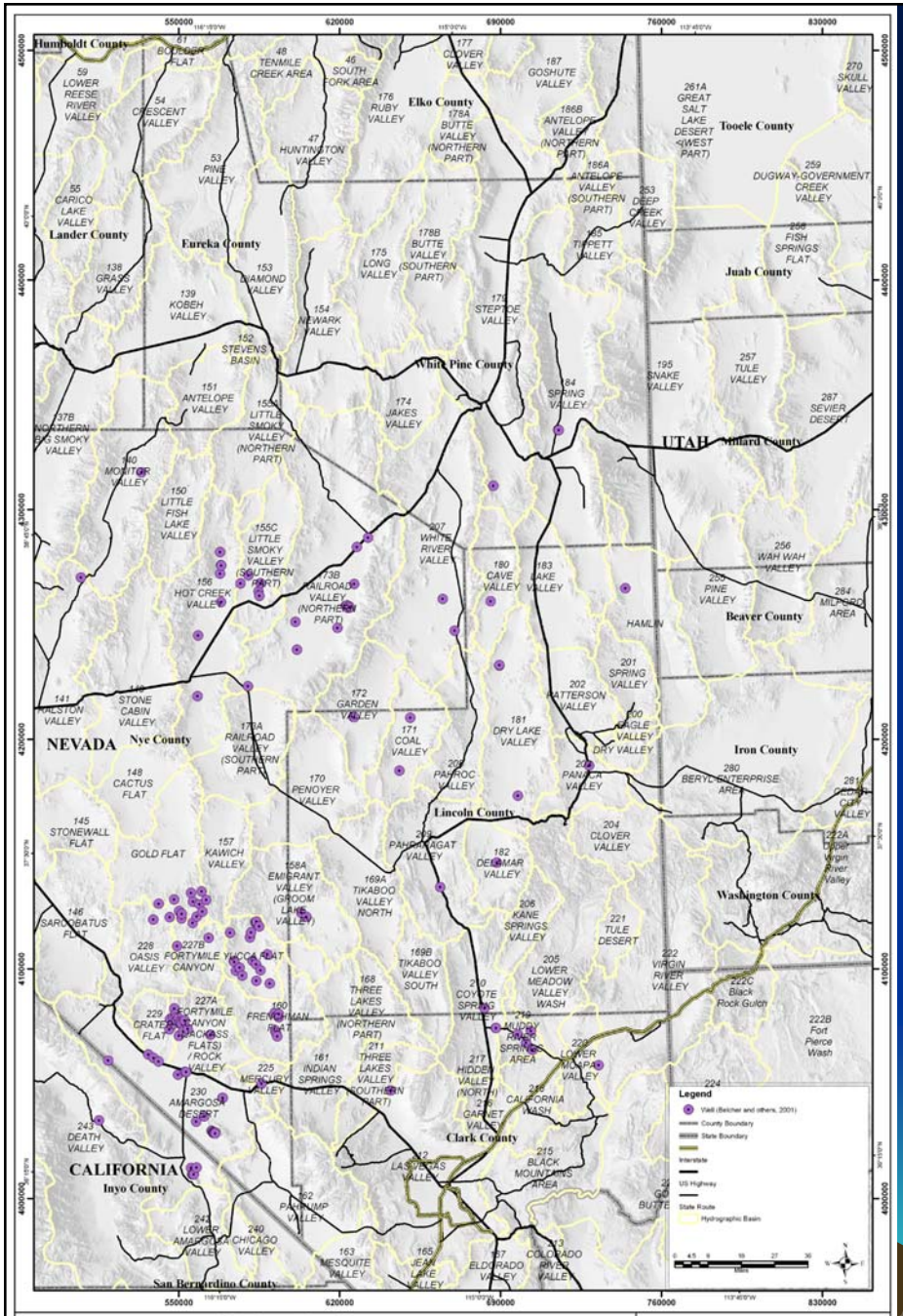
- Death Valley Regional Model data (Belcher et al., 2001)
- Nevada Test Site Regional Model data (IT, 1996)
- Slug test data in report by SNJV (2004c)
- Other Regional Data Sources

Other Regional Data Sources

- IT (2000 a through i)
- SNJV (2004 b & c)
- Nye County Early Warning Drilling Program (Questa Engineering Corp., 1999a, b &c; 2000a & b; 2001; 2002a,b & c; 2003)
- USGS report (Maurer et al., 2004)

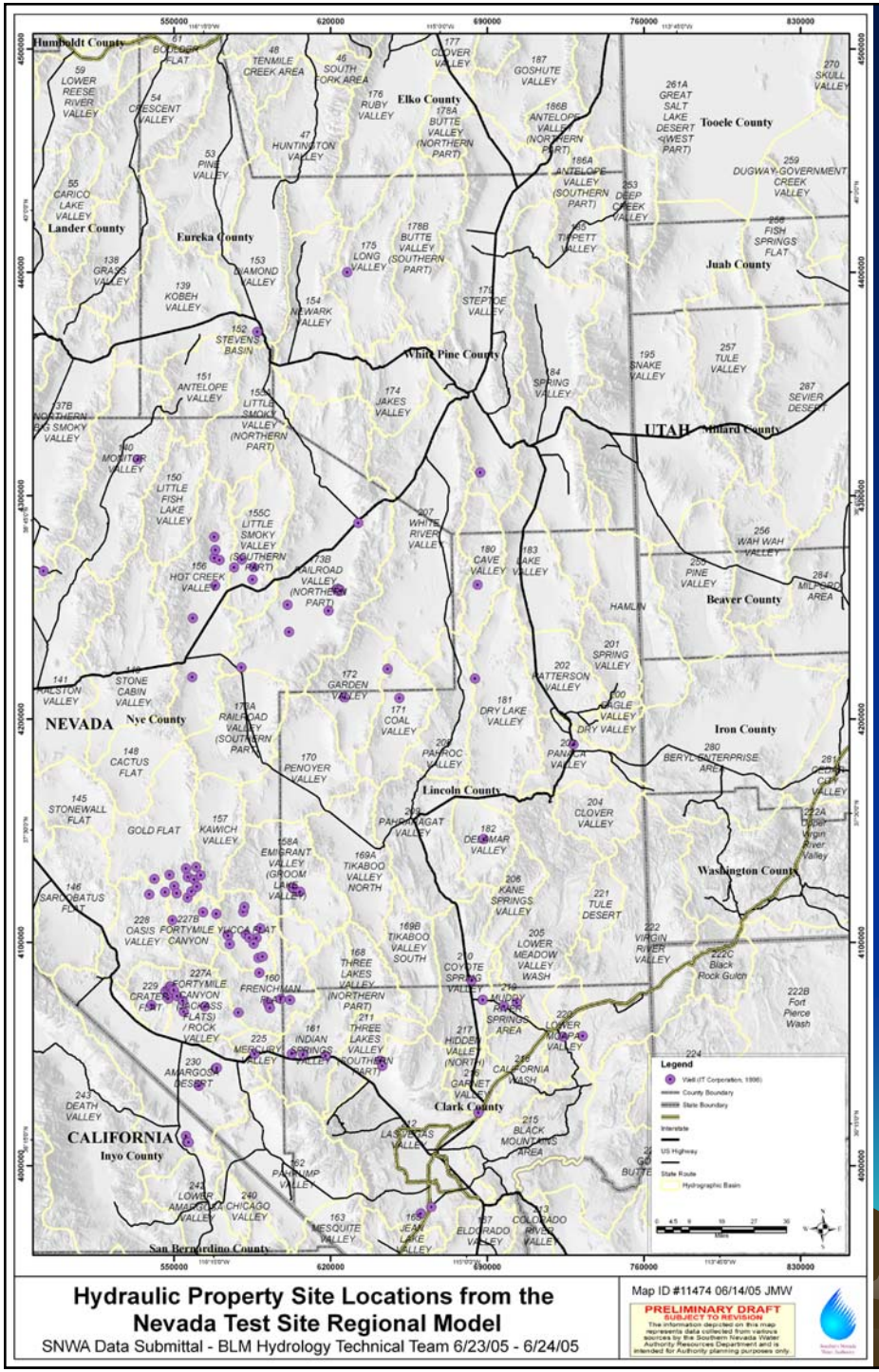
Death Valley Regional Model Data (Belcher et al., 2001)

- Dataset consists of literature data.
- Study was conducted to support development of Death Valley Regional Flow System Model.
- Most data fall within the DVRFS model area (overlaps SNWA's study area).
- The dataset includes only "good quality" data as qualified by the authors of the report.



Nevada Test Site Regional Model Data (IT, 1996)

- Dataset was developed to support an earlier version (1996) of the DVRFS model.
- Dataset may have great overlap with the DVRFS dataset.
- Dataset contains most data available at the time of the study (not just “good quality” data).
- Dataset set includes data quality flags.



Hydraulic Property Site Locations from the Nevada Test Site Regional Model

SNWA Data Submittal - BLM Hydrology Technical Team 6/23/05 - 6/24/05

Map ID #11474 06/14/05 JMW

PRELIMINARY DRAFT
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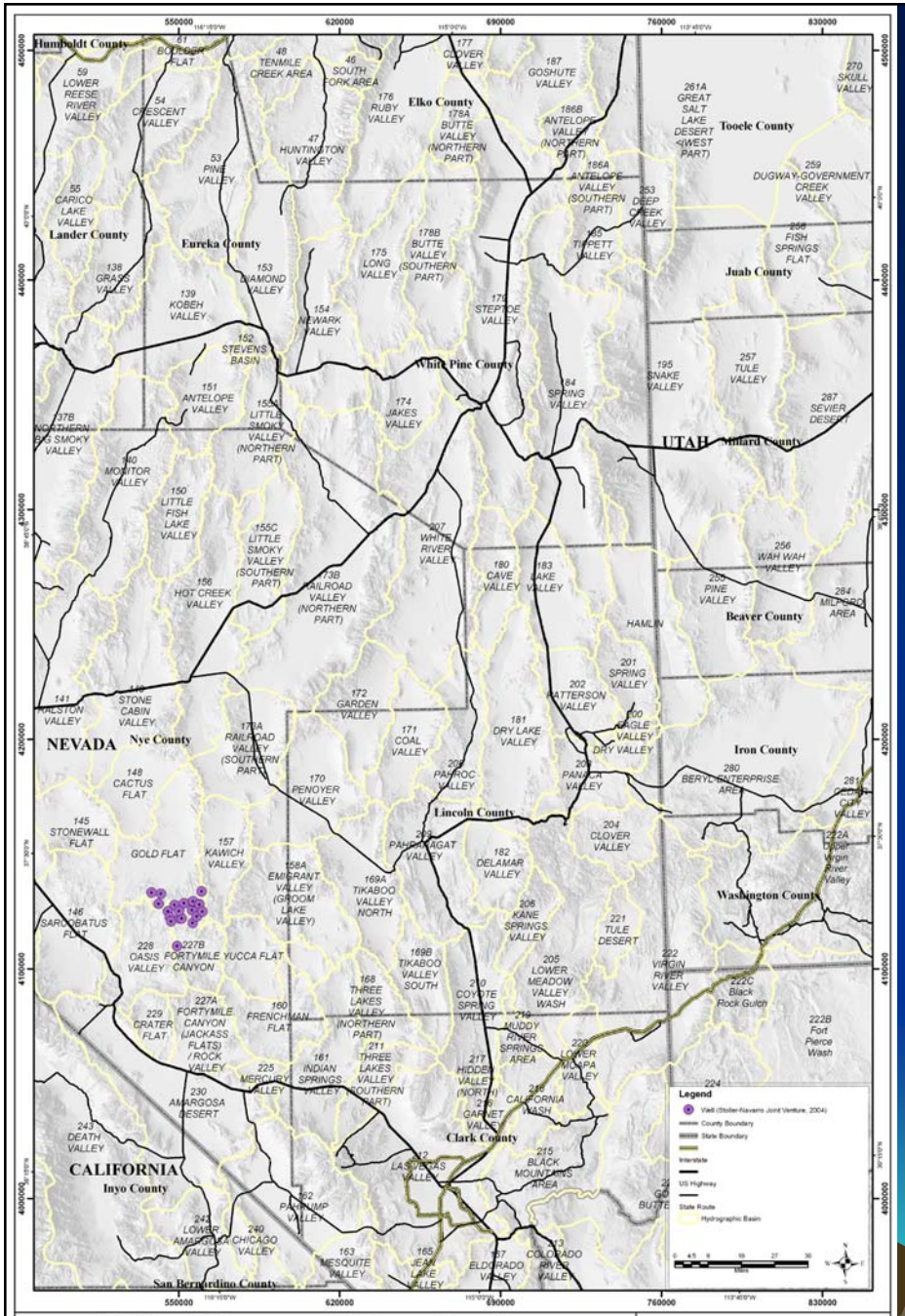
The information depicted on this map represents data collected from various sources by the Southern Nevada Water Authority Resources Department and is intended for Authority planning purposes only.

Slug Test Data in Report by SNJV (2004c)

- Previously collected slug test data were compiled by SNJV.
- Data were analyzed in support of Pahute Mesa environmental restoration studies.
- Tests were conducted in volcanic rocks on the Nevada Test Site.
- Dataset includes 783 records. Multiple tests were conducted at any given well and each test was analyzed using several methods.



Hydraulic Property Site Locations from Slug Tests Perfomed on the Nevada Test Site

SNWA Data Submittal - BLM Hydrology Technical Team 6/23/05 - 6/24/05

Map ID #11484 06/14/05 JMW

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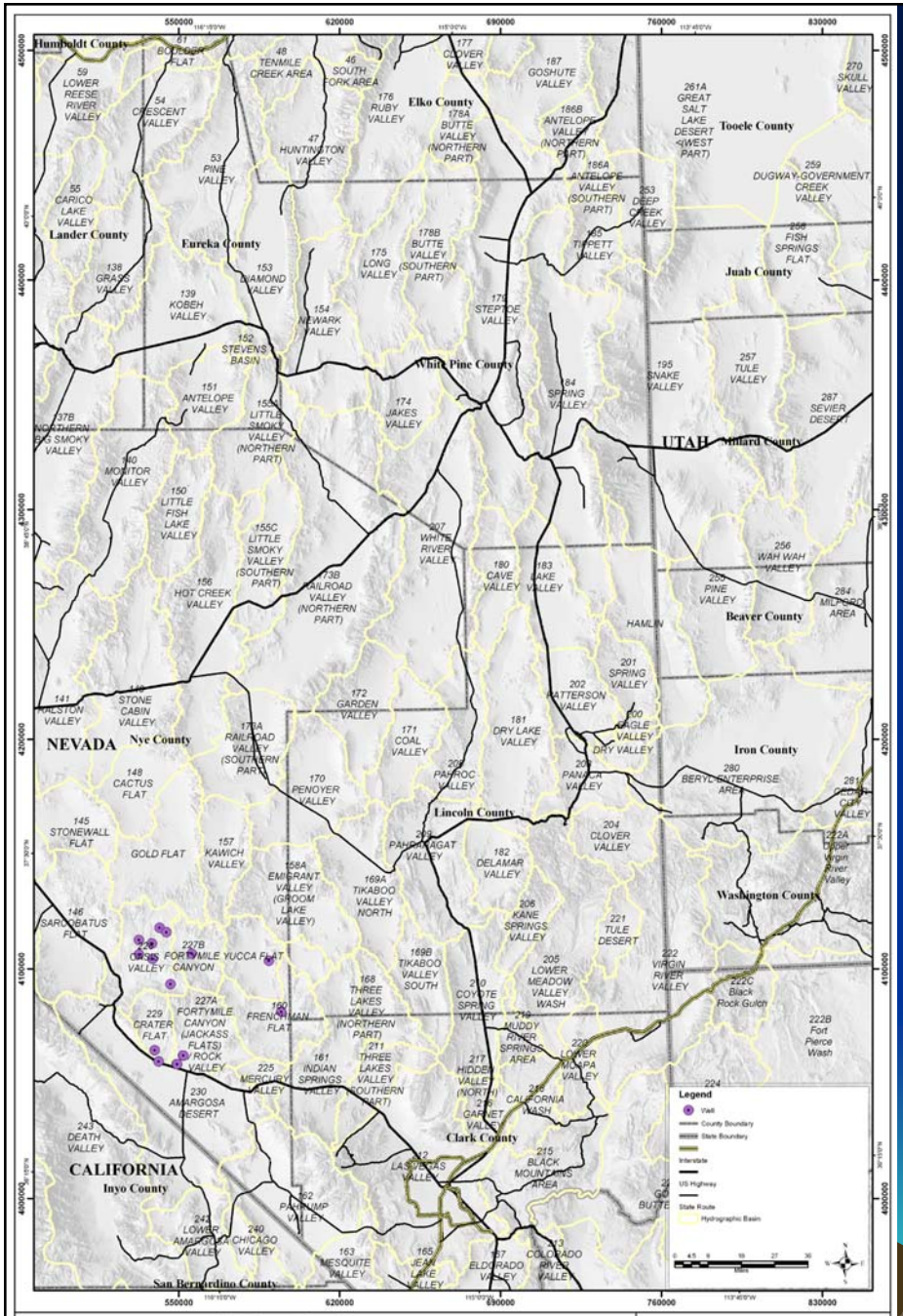
Other Regional Data

- Consist of hydrologic data interpretation reports for wells or well clusters from:
  - DOE Environmental Restoration (ER) reports
  - Nye County Early Warning Drilling Program (EWDP)
  - A USGS report (Maurer et al., 2004)
- DOE/ER and EWDP Locations shown on map.
- USGS report (Maurer et al., 2004) includes literature data for all of Nevada. Locations are not shown on map.



Hydraulic Property
Site Locations from Other Regional Data Sources
SNWA Data Submittal - BLM Hydrology Technical Team 6/23/05 - 6/24/05

Map ID #11481 06/14/05 JMW

PRELIMINARY DRAFT
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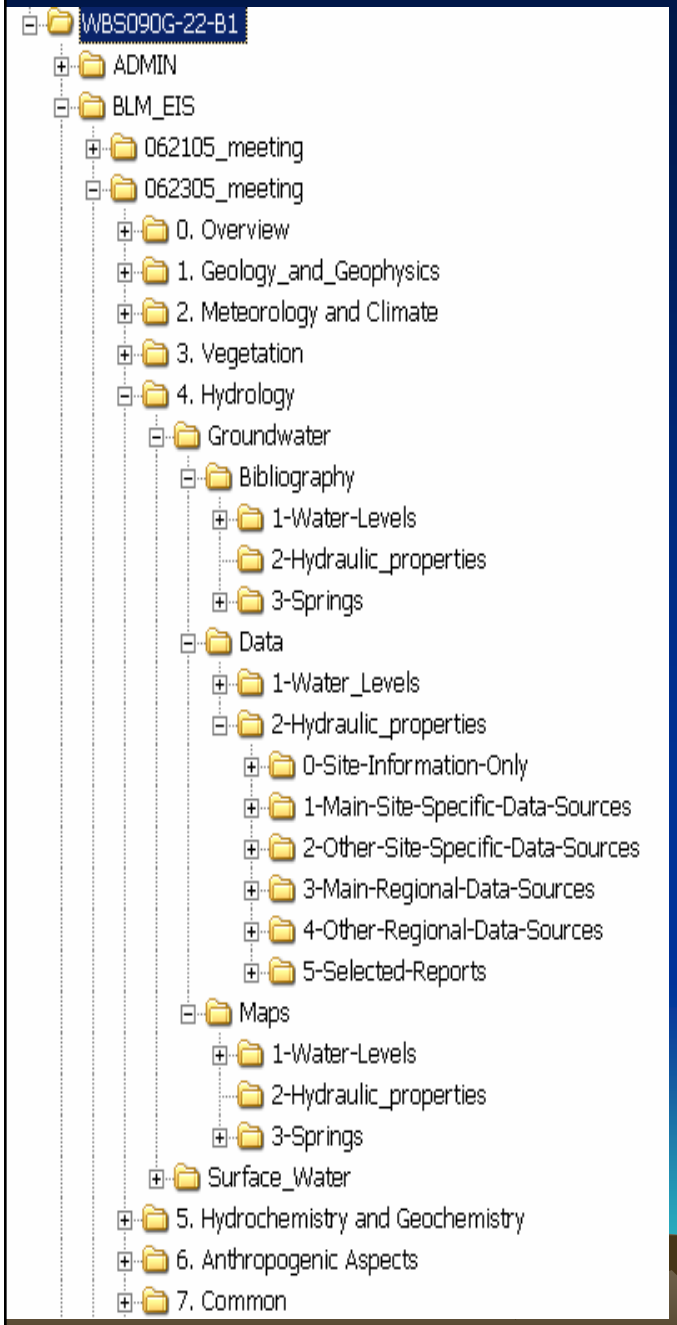
General Data Observations

- Data distribution is clustered around population centers and the Nevada Test Site.
- Most tests are for shallow wells.
- Most tests are single-well tests.
- Most constant-rate tests are short-term pumping tests.



Electronic Information Organization

- All information regarding the hydraulic properties is located in the "Groundwater" subfolder of the "Hydrology" folder. The information is included into four directories:
  - Bibliography\2-Hydraulic_properties: Contains a list of citations of data sources and other related documents
  - Data\2-Hydraulic_Properties: Contains compiled data organized by source as described in this presentation.
  - Maps\2-Hydraulic_Properties: Contains pdf files of the maps included in this presentation.
- A pdf file of this presentation is included under 8. Presentations\4. Hydrology\Groundwater\2-Hydraulic_Properties.