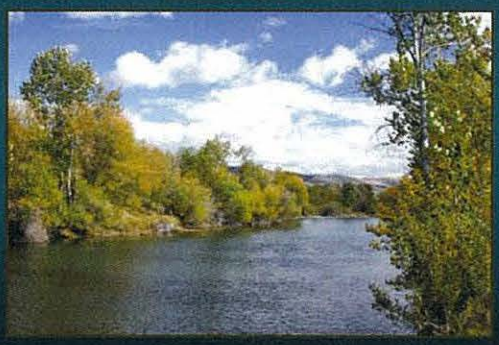
Treasure Valley Water

March 12, 2008

Christian R. Petrich
SPF Water Engineering, LLC
www.spfwater.com

Outline

- Treasure Valley Hydrologic Project
  - Background
  - Hydrologic concepts
  - Aquifer description
  - Findings



Project Description

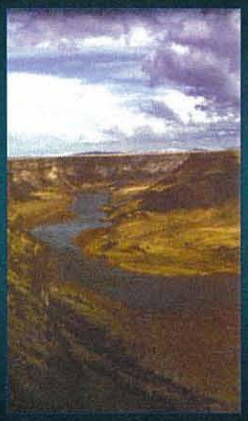
- Purpose: provide information and data for water management
- Components
  - Describe ground water flow characteristics
  - Develop computer model of ground water flow
  - Simulate potential changes in recharge and effects of increased pumping

Cooperative Effort

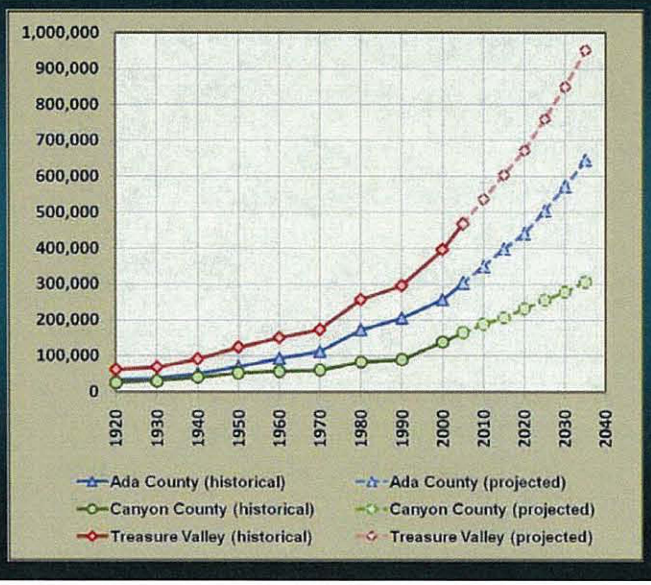
- Policy Committee helped define issues and questions
- Technical Committee provided technical guidance and review

Contributors and Participants

- Idaho State Legislature
- Idaho Department of Water Resources
- U.S. Congress
- Environmental Protection Agency
- United Water Idaho
- University of Idaho
- Idaho Water Resources Research Institute
- Idaho Water Resource Board
- Boise State University
- U.S. Geological Survey
- U.S. Bureau of Reclamation
- Ada and Canyon Counties
- Cities of Boise, Meridian, Nampa, Caldwell, Eagle, and Kuna

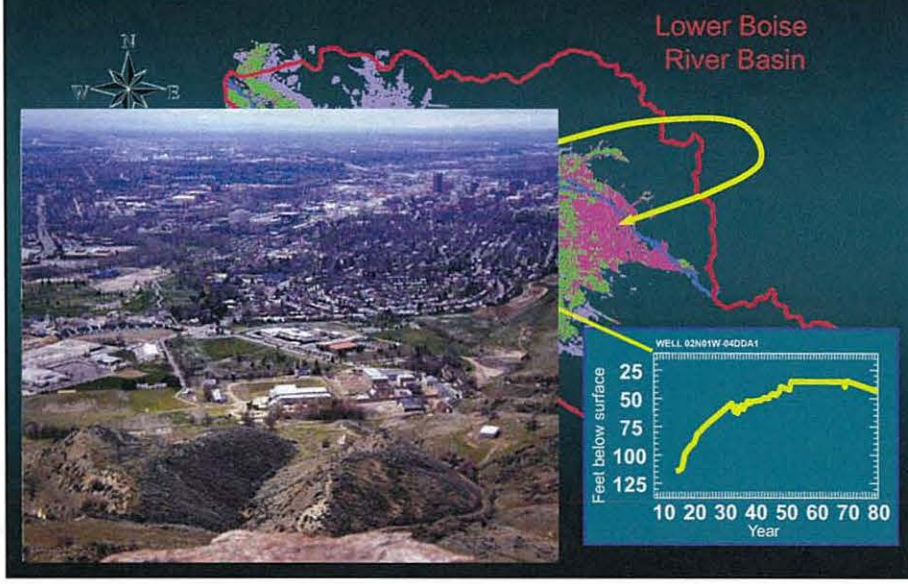


Increasing Population



John Church data (projections have not yet been updated to reflect current economic downturn

Irrigation / Land Use (1937-1994)



Project Questions

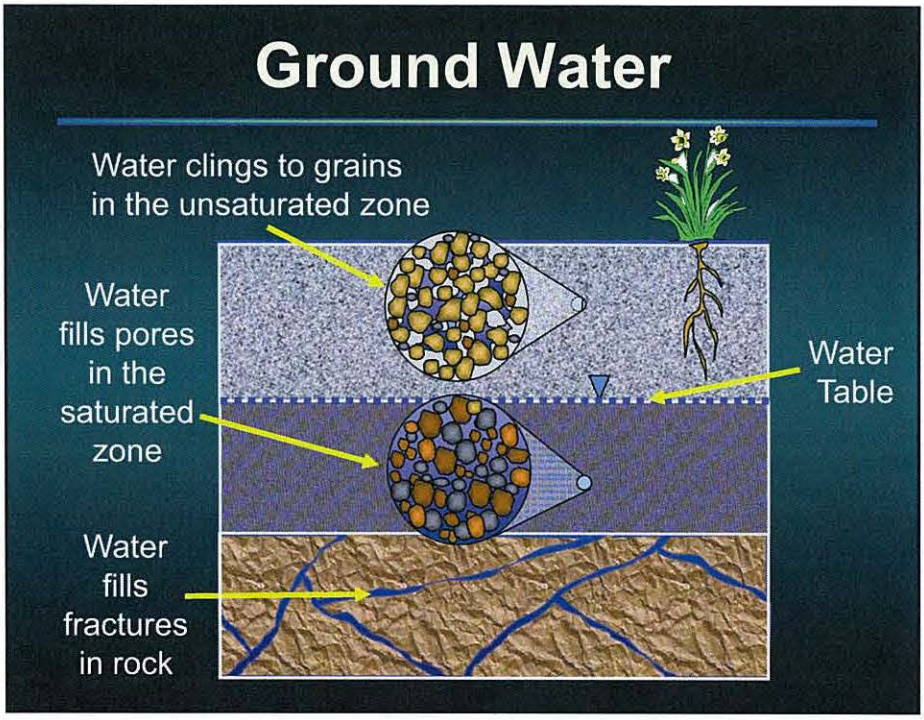
1. Does the Treasure Valley have a ground water shortage?
2. How big is the aquifer? Where are the aquifer boundaries?
3. Where and to what degree are ground water levels declining?
4. What is the carrying capacity of the aquifer?
5. What is the degree of hydraulic connection between Treasure Valley surface and ground water?
6. How are shallow and deep aquifer is connected?

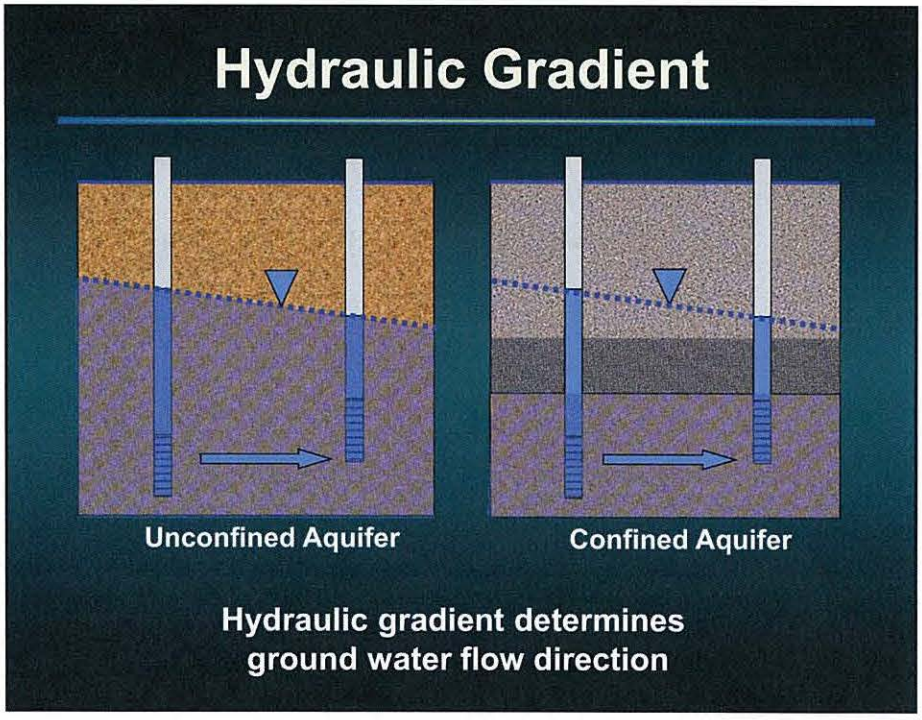
Project Questions

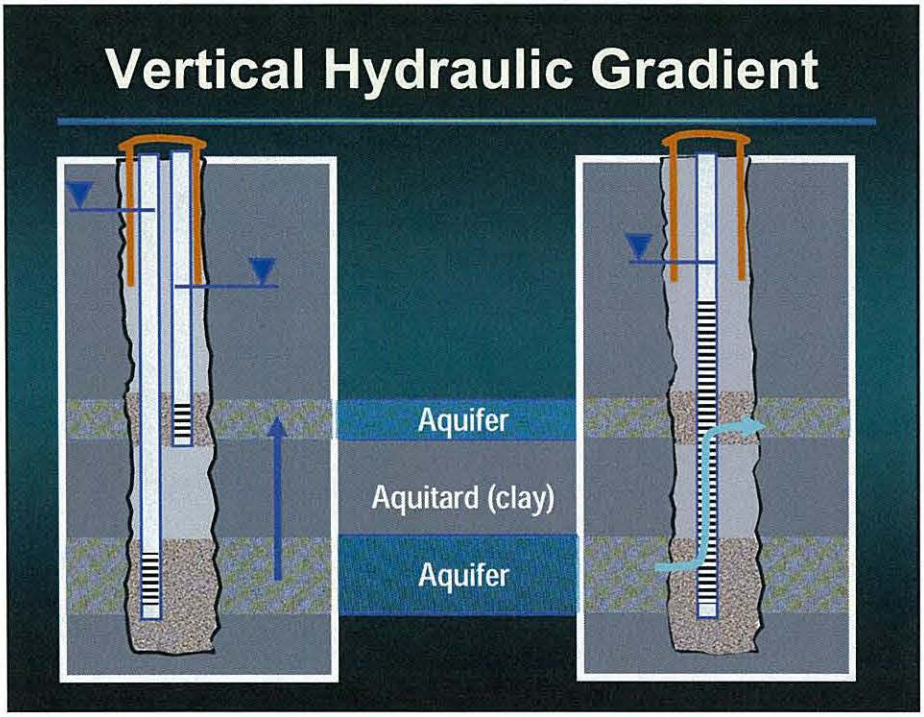
7. How are Treasure Valley aquifers recharged and where does the recharge occur?
8. How has land development impacted Treasure Valley water supplies?
9. How susceptible is the Treasure Valley aquifer system to contamination?
10. Is water conservation necessary to meet future water demands?
11. Can tools or data be developed to assist with land-use planning decisions regarding water resources?

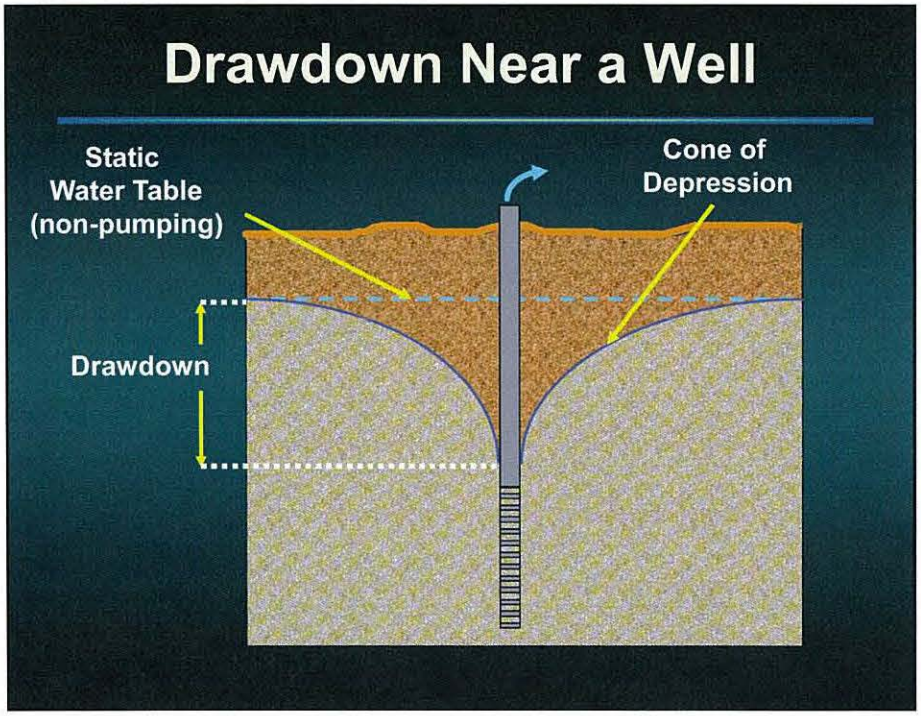
Hydrology Concepts

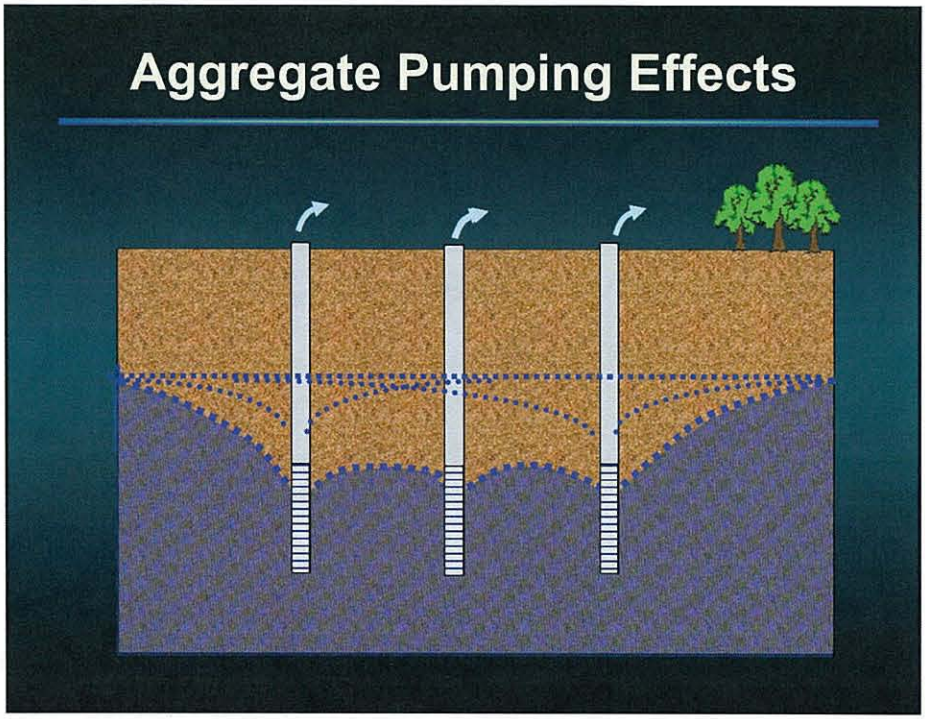
- Presence of ground water
- Hydraulic gradient
- Drawdown near a well
- Ground and surface water interaction
- Ground water flow systems

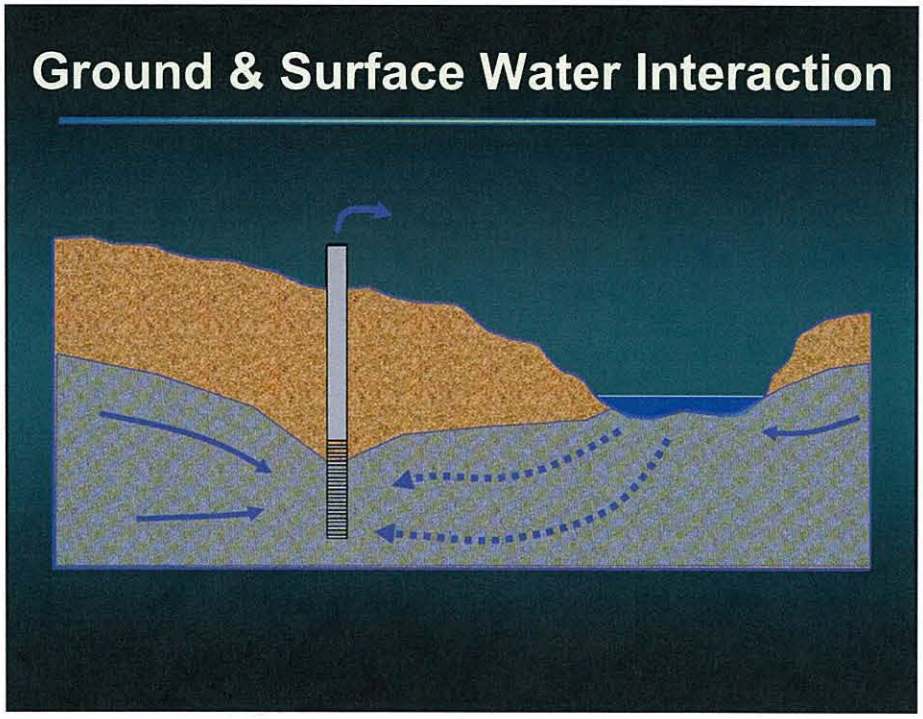

Ground Water
Water clings to grains in the unsaturated zone
Water fills pores in the saturated zone
Water fills fractures in rock
Water Table

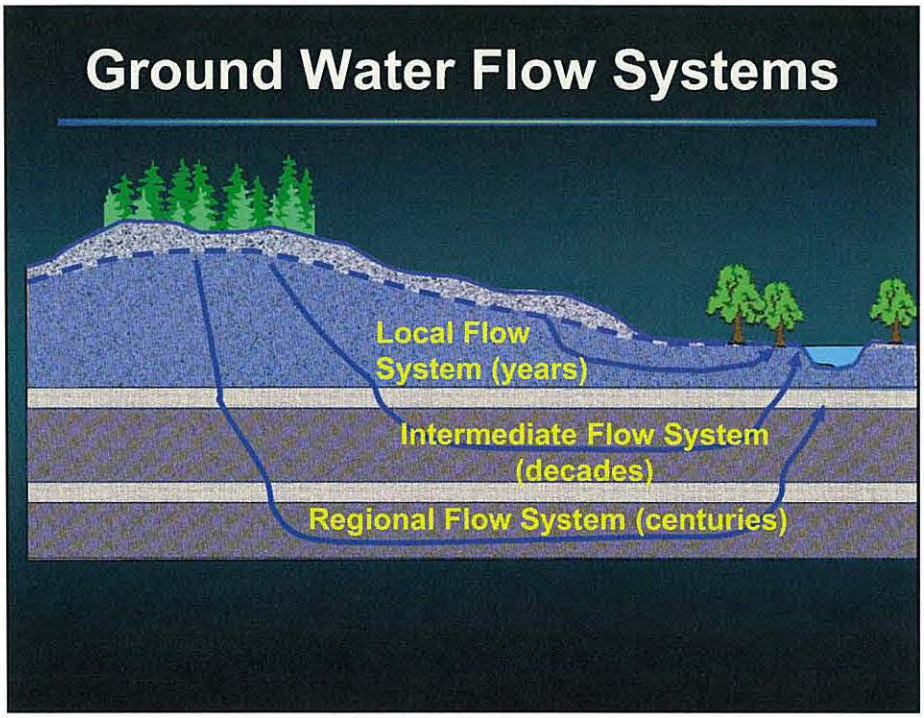

Hydraulic Gradient
Unconfined Aquifer
Confined Aquifer
Hydraulic gradient determines ground water flow direction

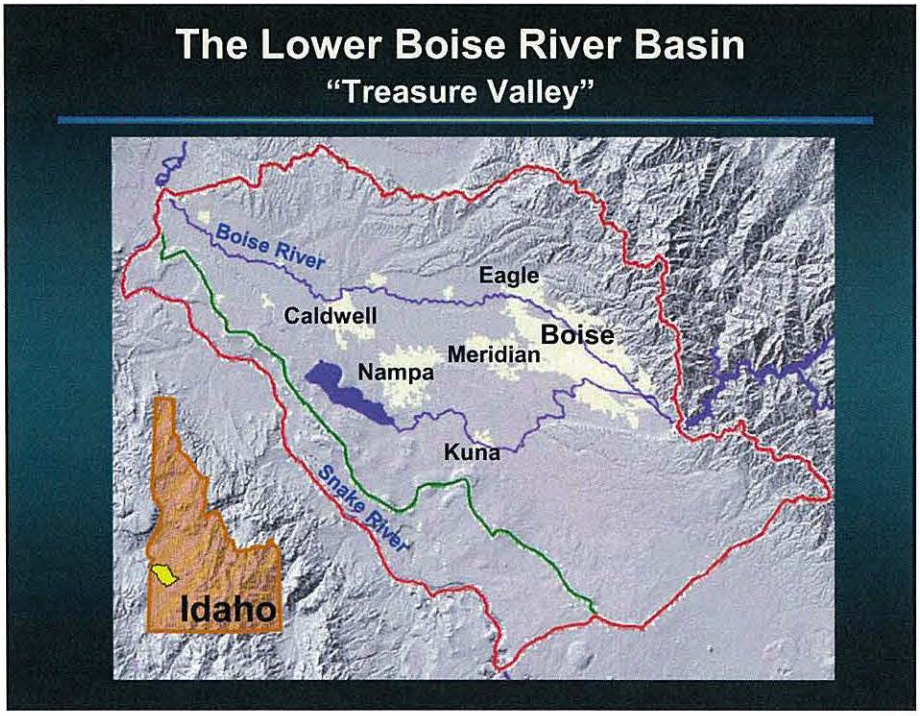

Vertical Hydraulic Gradient
Aquifer
Aquitard (clay)
Aquifer

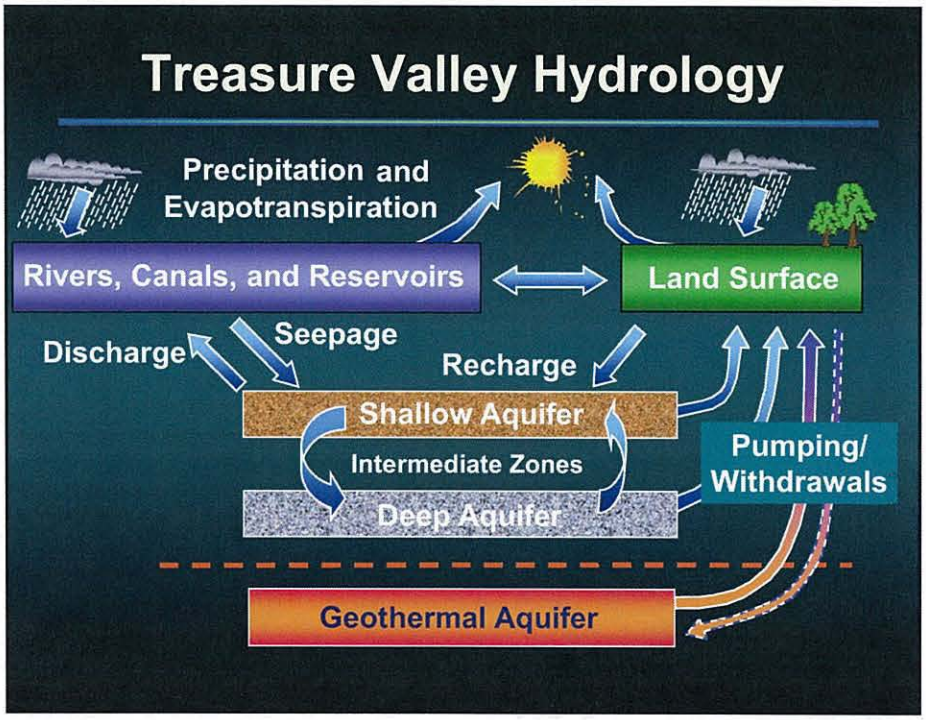

Drawdown Near a Well
Static
Water Table
(non-pumping)
Cone of
Depression
Drawdown

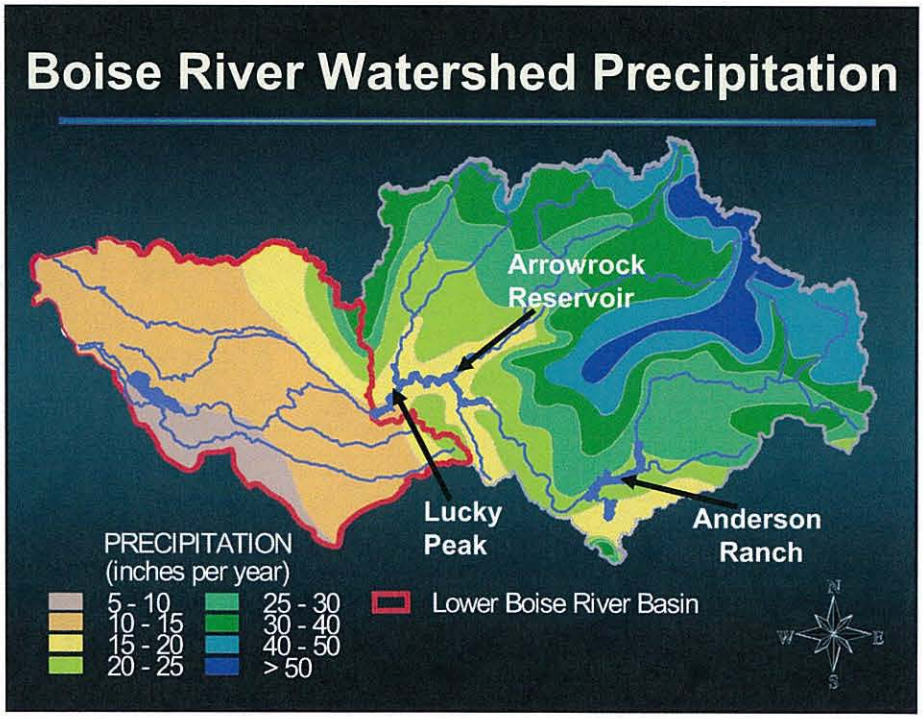

Aggregate Pumping Effects

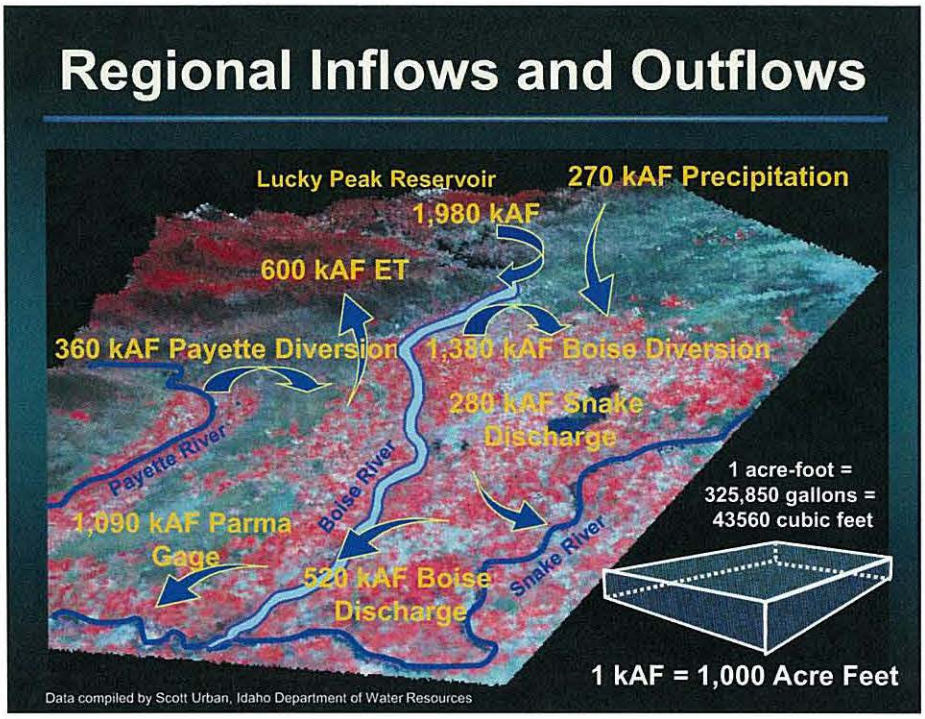

Ground & Surface Water Interaction

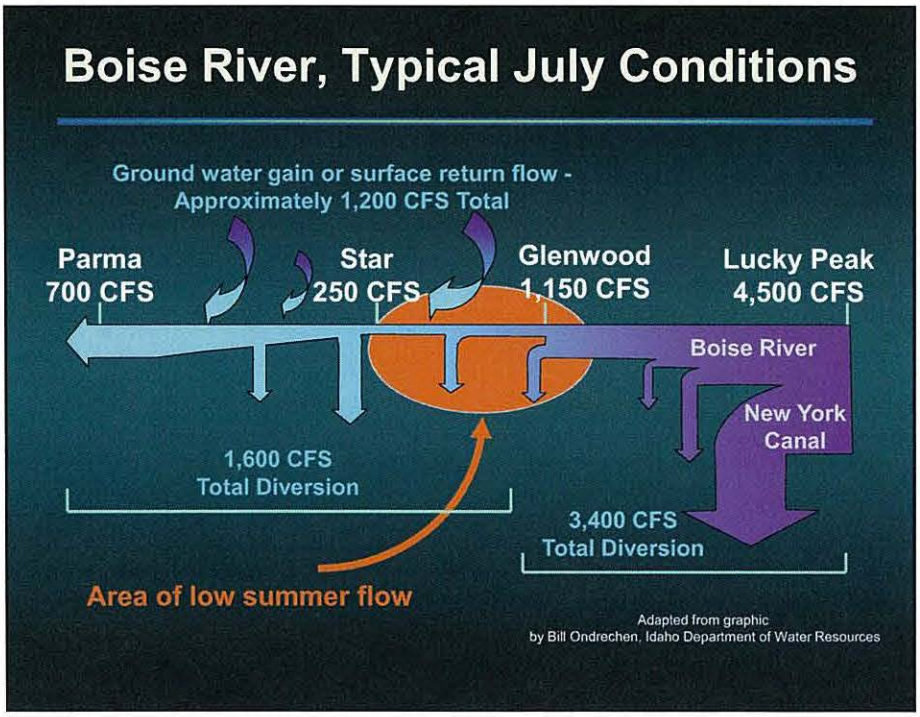

Ground Water Flow Systems
Local Flow System (years)
Intermediate Flow System (decades)
Regional Flow System (centuries)

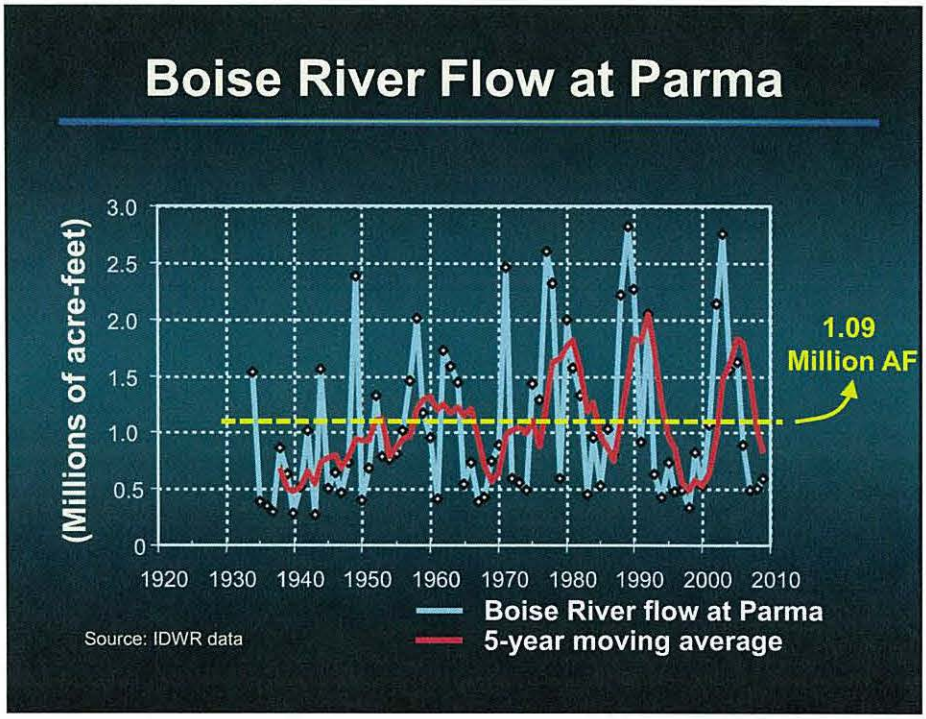

The Lower Boise River Basin
"Treasure Valley"
Boise River
Eagle
Caldwell
Boise
Meridian
Nampa
Kuna
Snake River
Idaho


Treasure Valley Hydrology
Precipitation and Evapotranspiration
Rivers, Canals, and Reservoirs
Land Surface
Seepage
Discharge
Recharge
Shallow Aquifer
Intermediate Zones
Deep Aquifer
Pumping/ Withdrawals
Geothermal Aquifer


Boise River Watershed Precipitation
Arrowrock Reservoir
Lucky Peak
Anderson Ranch
PRECIPITATION (inches per year)
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 40
40 - 50
> 50
Lower Boise River Basin
N
W
E
S

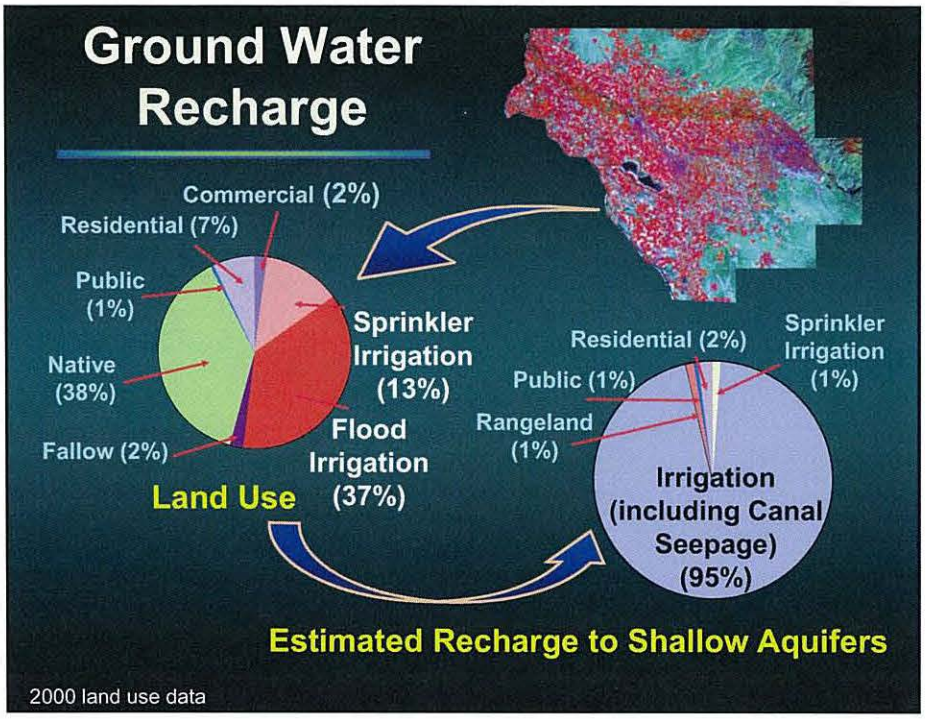

Regional Inflows and Outflows
Lucky Peak Reservoir
270 kAF Precipitation
1,980 kAF
600 kAF ET
360 kAF Payette Diversion
1,380 kAF Boise Diversion
280 kAF Snake Discharge
Payette River
Boise River
1,090 kAF Parma Gage
520 kAF Boise Discharge
Snake River
1 acre-foot = 325,850 gallons = 43560 cubic feet
1 kAF = 1,000 Acre Feet
Data compiled by Scott Urban, Idaho Department of Water Resources

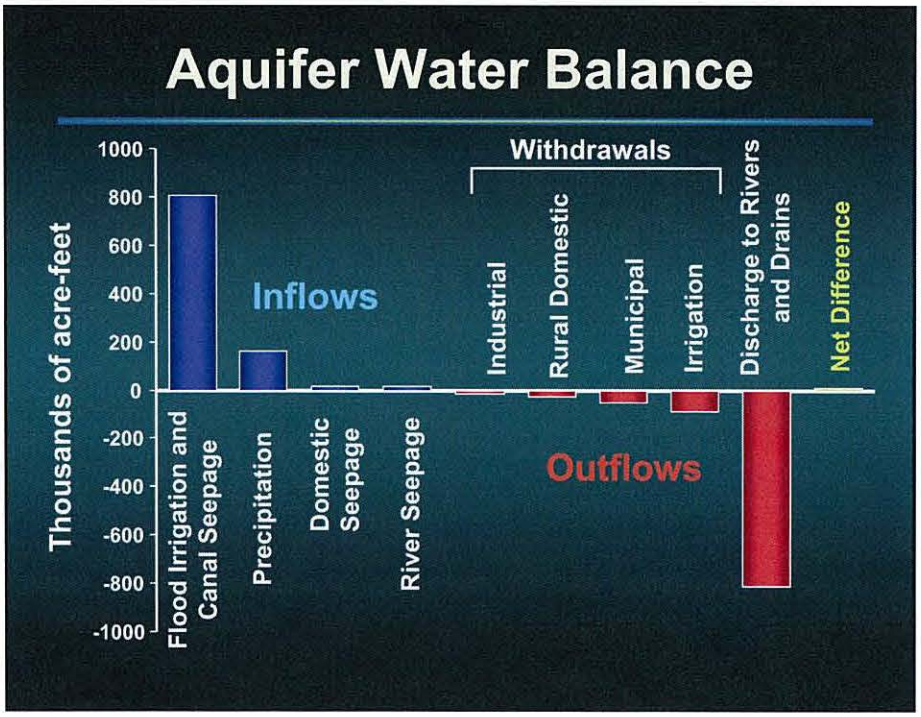

Boise River, Typical July Conditions
Ground water gain or surface return flow - Approximately 1,200 CFS Total
Parma 700 CFS
Star 250 CFS
Glenwood 1,150 CFS
Lucky Peak 4,500 CFS
Boise River
New York Canal
1,600 CFS Total Diversion
3,400 CFS Total Diversion
Area of low summer flow
Adapted from graphic by Bill Ondrechen, Idaho Department of Water Resources



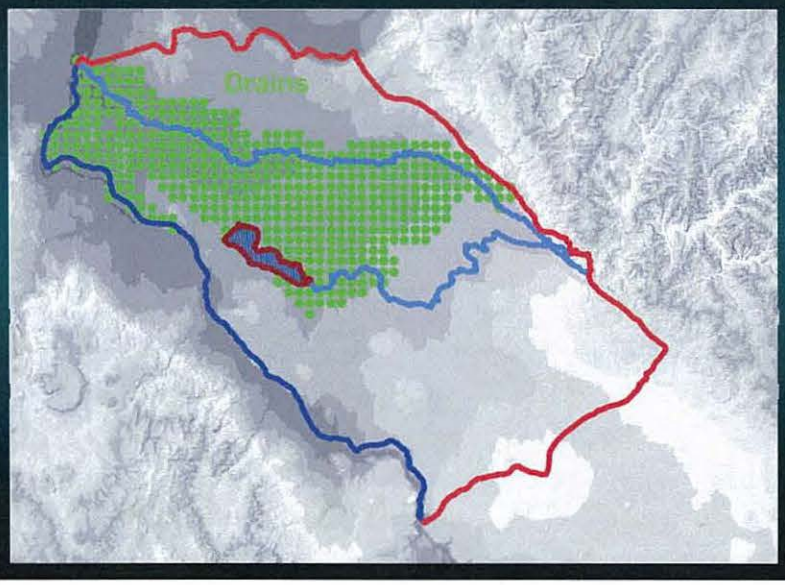
Carrying Capacity

- Carrying capacity is difficult to define
- *If* 1 million acre feet were available for use, how many people might it support?
  - 0.25 acre feet per housing unit (4 million homes)
  - 2.5 people per home (10 million people)
  - Most of this use is *non-consumptive*
  - With reuse …?
- Unrealistic example, presented for discussion purposes only
  - Neglects irrigation
  - Neglects commercial/industrial use


Ground Water Recharge
Commercial (2%)
Residential (7%)
Public (1%)
Native (38%)
Fallow (2%)
Sprinkler Irrigation (13%)
Flood Irrigation (37%)
Land Use
Residential (2%)
Public (1%)
Rangeland (1%)
Sprinkler Irrigation (1%)
Irrigation (including Canal Seepage) (95%)
Estimated Recharge to Shallow Aquifers
2000 land use data


Aquifer Water Balance
Thousands of acre-feet
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
Inflows
Withdrawals
Industrial
Rural Domestic
Municipal
Irrigation
Discharge to Rivers and Drains
Net Difference
Outflows
Flood Irrigation and Canal Seepage
Precipitation
Domestic Seepage
River Seepage

General Location of Drainage System



Drains

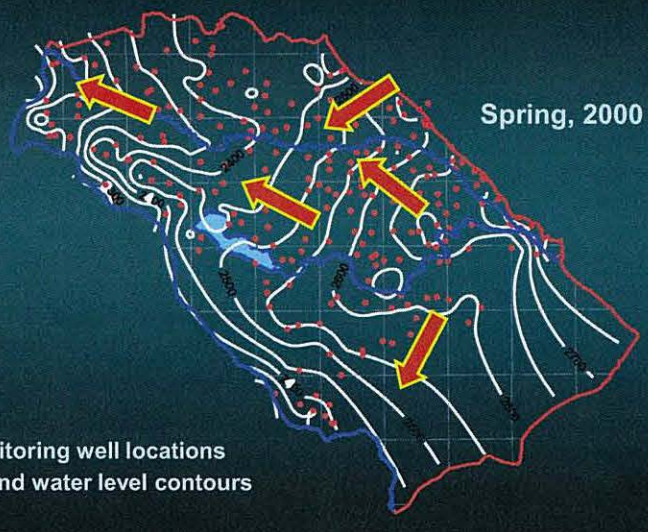
- Constructed to drain ground water from shallow aquifers
- Served to
  - Reduce "water-logged soils"
  - Provided for additional irrigation through re-diversion
- Drains flow year-round

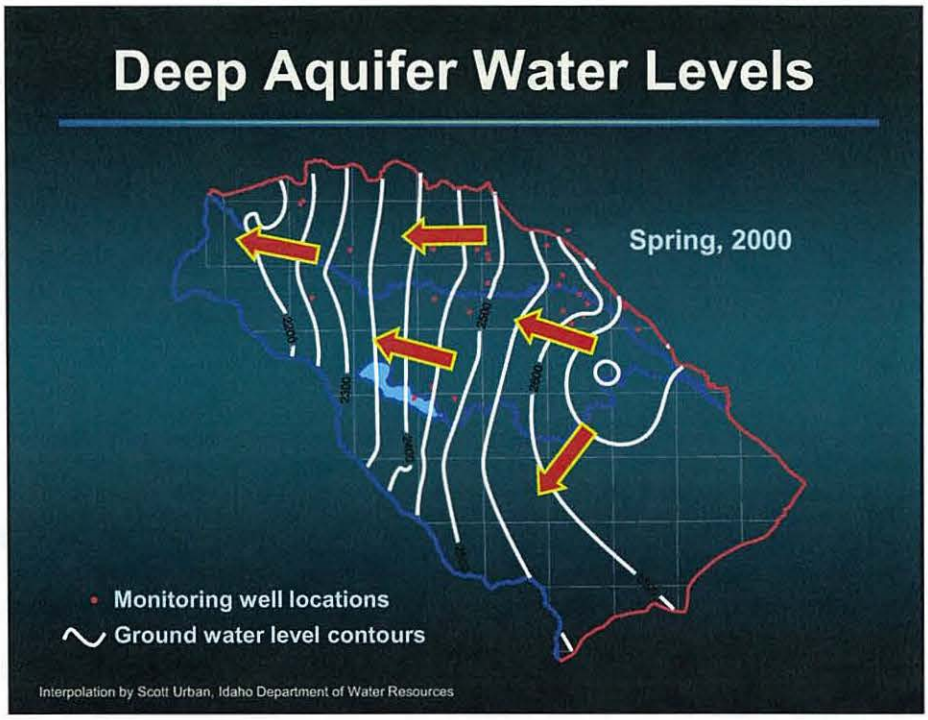

Dredging the Wilson Cr Slough, circa 1914

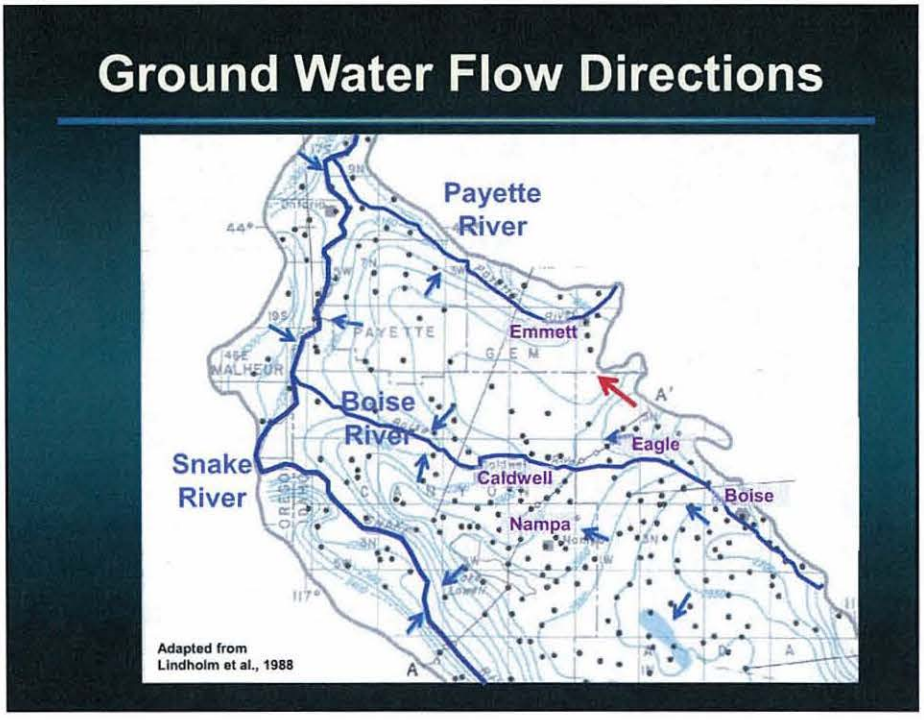
Ground Water Level Measurements

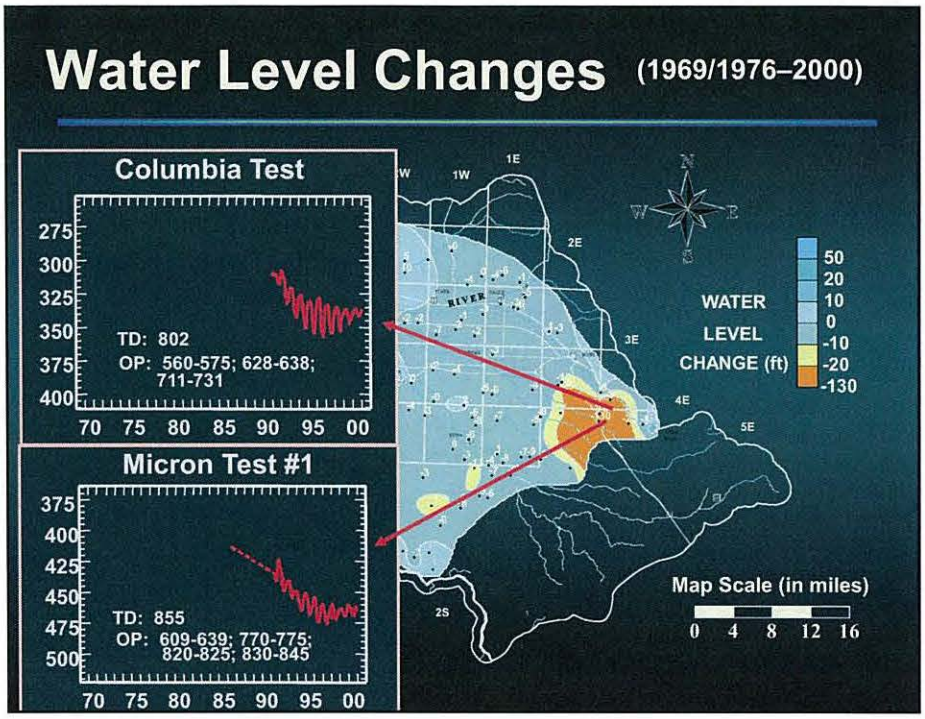
- "Mass" ground water level measurements in approximately 300 wells (spring and fall of 1996, 1998, 2000)
- Monthly measurements in about 70 wells
- Dedicated multi-level monitoring wells

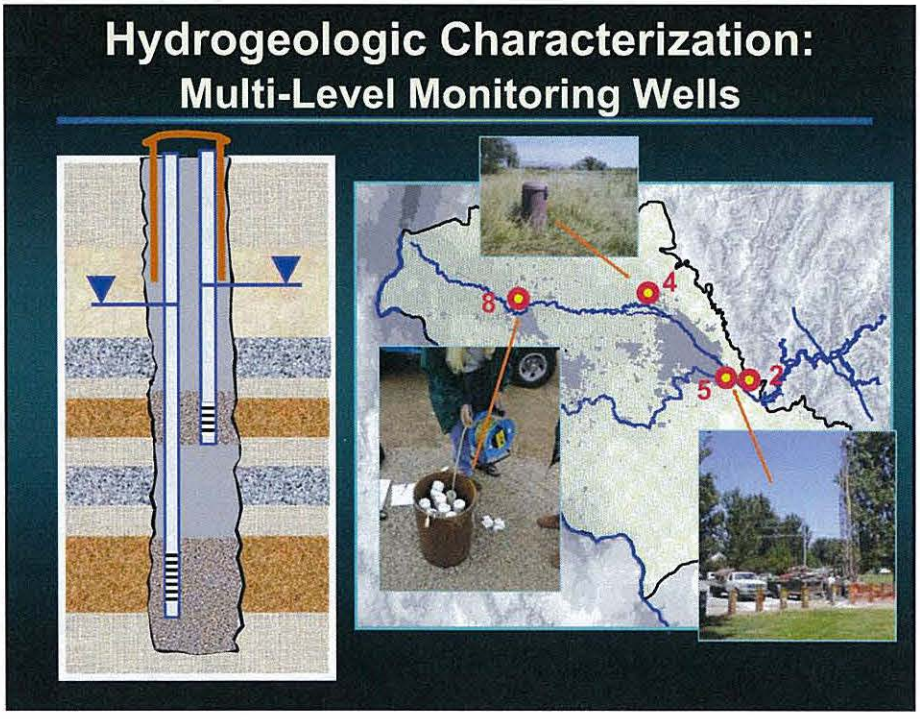
Shallow Aquifer Water Levels

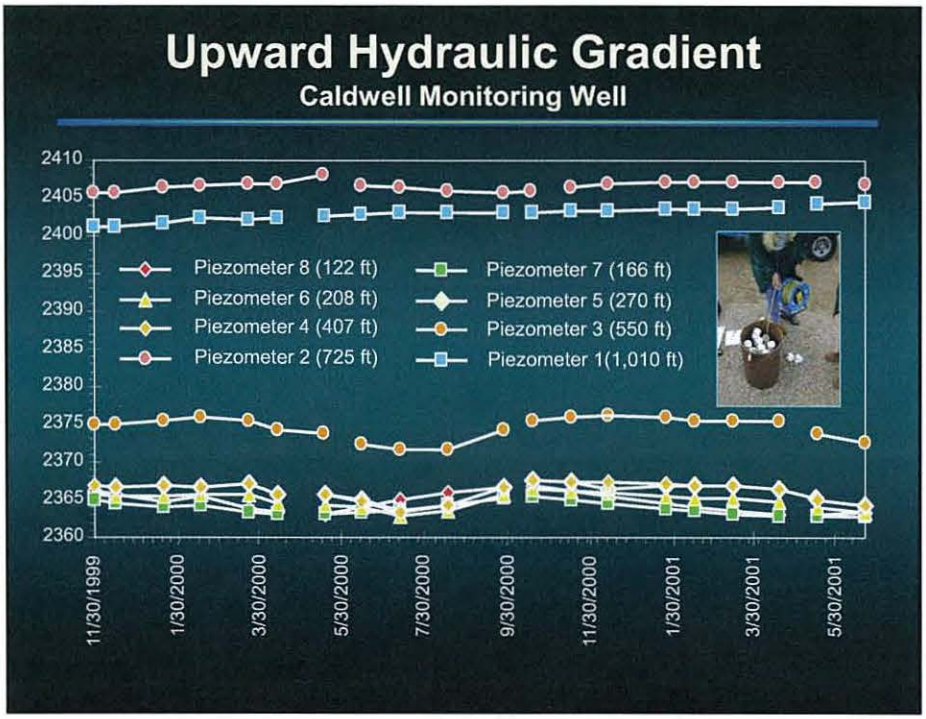


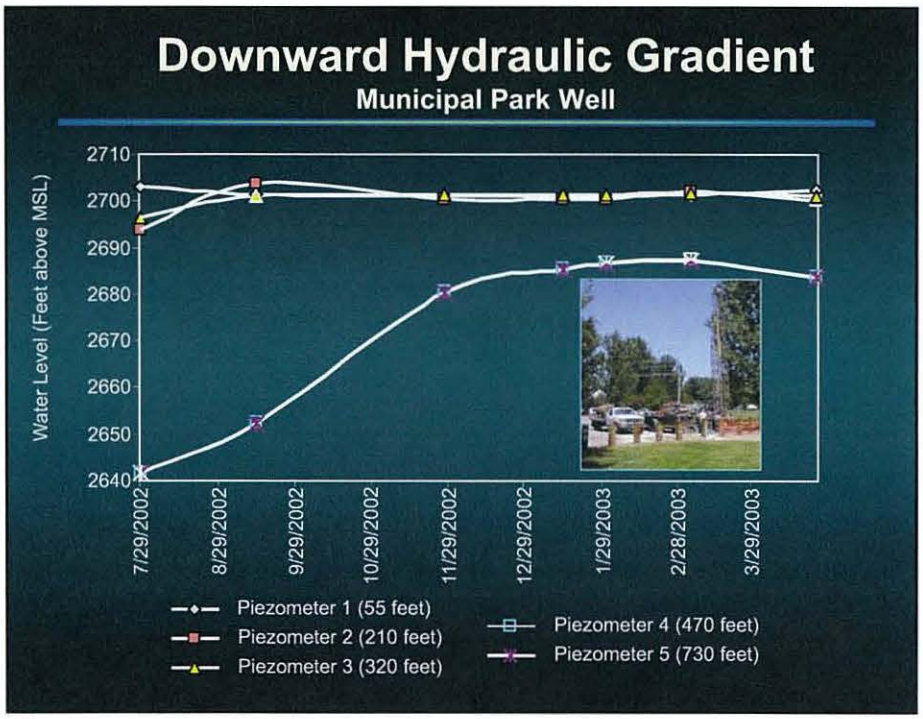

Deep Aquifer Water Levels
Spring, 2000
Monitoring well locations
Ground water level contours
Interpolation by Scott Urban, Idaho Department of Water Resources

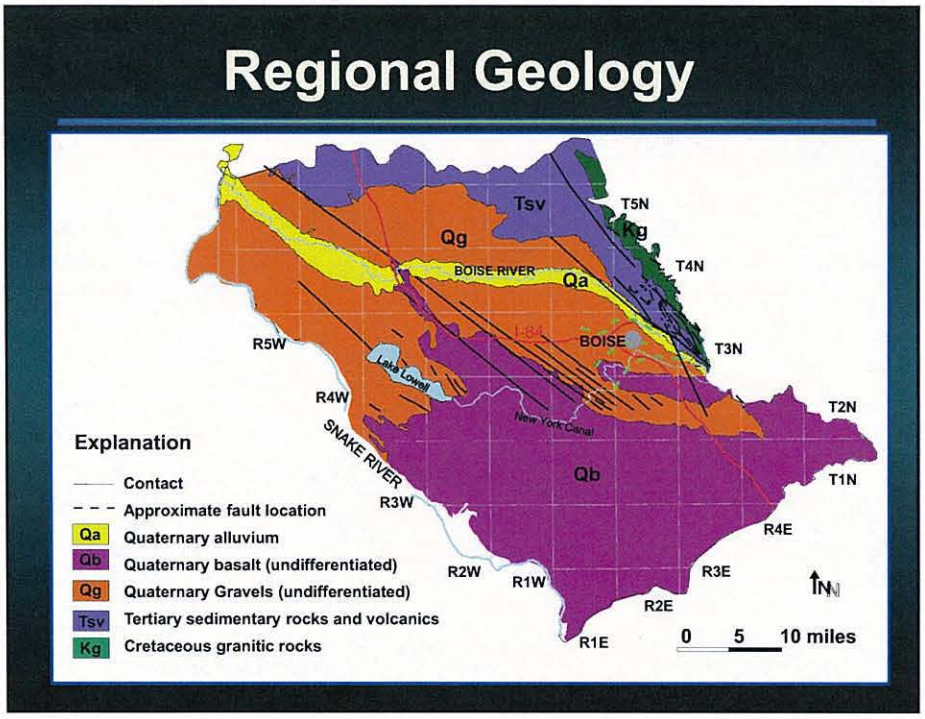

Ground Water Flow Directions
Payette River
Boise River
Snake River
Emmett
Eagle
Caldwell
Boise
Nampa
A
A'
Adapted from Lindholm et al., 1988

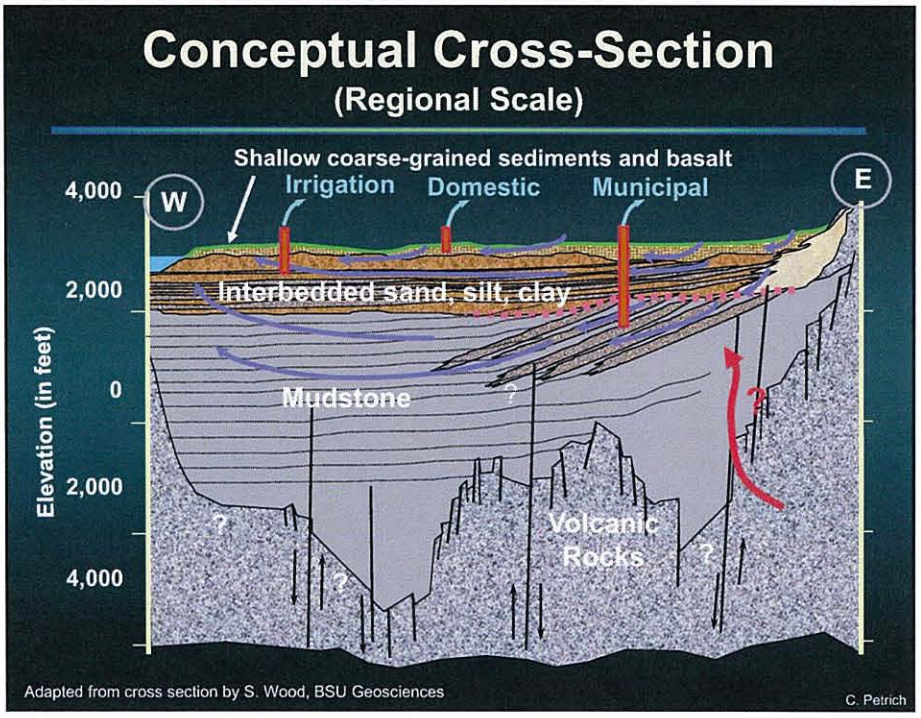

Water Level Changes (1969/1976–2000)
Columbia Test
275
300
325
350
375
400
TD: 802
OP: 560-575; 628-638; 711-731
70 75 80 85 90 95 00
Micron Test #1
375
400
425
450
475
500
TD: 855
OP: 609-639; 770-775; 820-825; 830-845
70 75 80 85 90 95 00
1W
1E
2E
3E
4E
5E
2S
RIVER
N
W
E
S
WATER LEVEL CHANGE (ft)
50
20
10
0
-10
-20
-130
Map Scale (in miles)
0 4 8 12 16

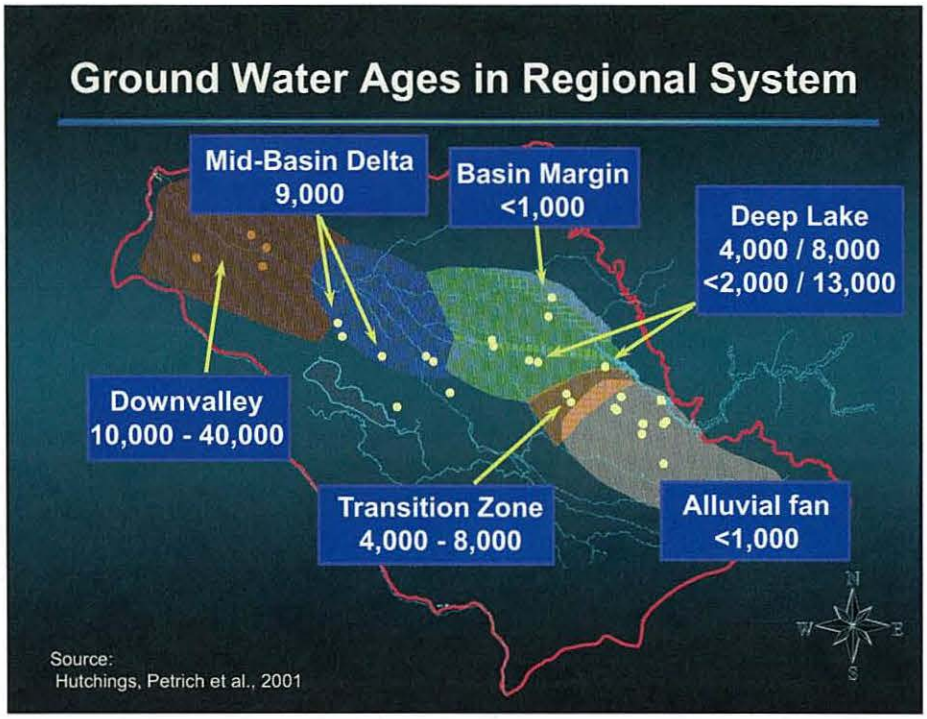

Hydrogeologic Characterization:
Multi-Level Monitoring Wells
8
4
5
2

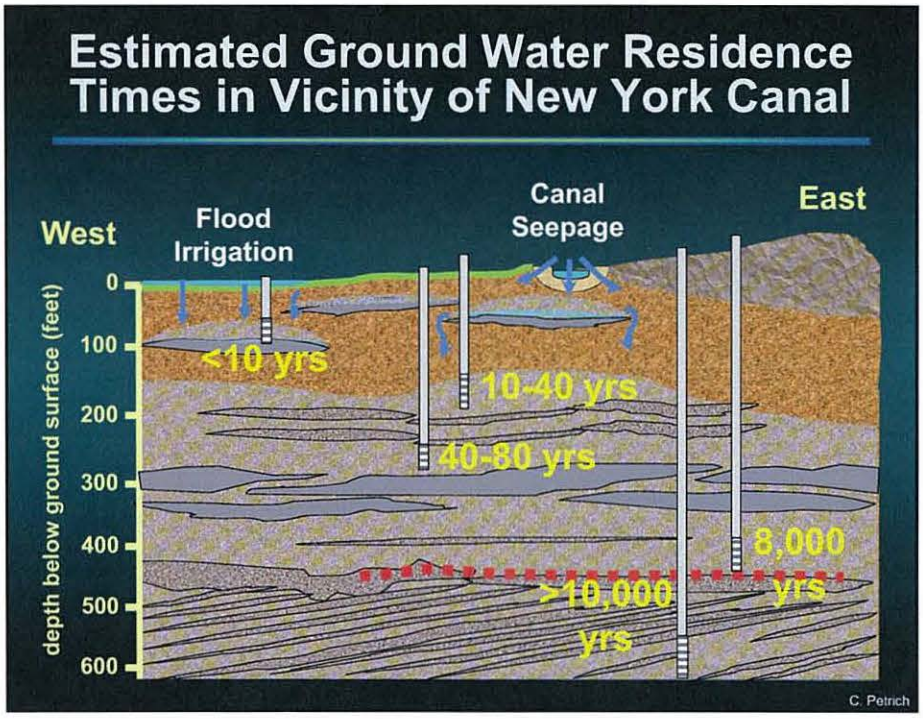

Upward Hydraulic Gradient
Caldwell Monitoring Well
2410
2405
2400
2395
2390
2385
2380
2375
2370
2365
2360
Piezometer 8 (122 ft)
Piezometer 7 (166 ft)
Piezometer 6 (208 ft)
Piezometer 5 (270 ft)
Piezometer 4 (407 ft)
Piezometer 3 (550 ft)
Piezometer 2 (725 ft)
Piezometer 1(1,010 ft)
11/30/1999
1/30/2000
3/30/2000
5/30/2000
7/30/2000
9/30/2000
11/30/2000
1/30/2001
3/30/2001
5/30/2001


Downward Hydraulic Gradient
Municipal Park Well
Water Level (Feet above MSL)
2710
2700
2690
2680
2670
2660
2650
2640
7/29/2002
8/29/2002
9/29/2002
10/29/2002
11/29/2002
12/29/2002
1/29/2003
2/28/2003
3/29/2003
Piezometer 1 (55 feet)
Piezometer 2 (210 feet)
Piezometer 3 (320 feet)
Piezometer 4 (470 feet)
Piezometer 5 (730 feet)

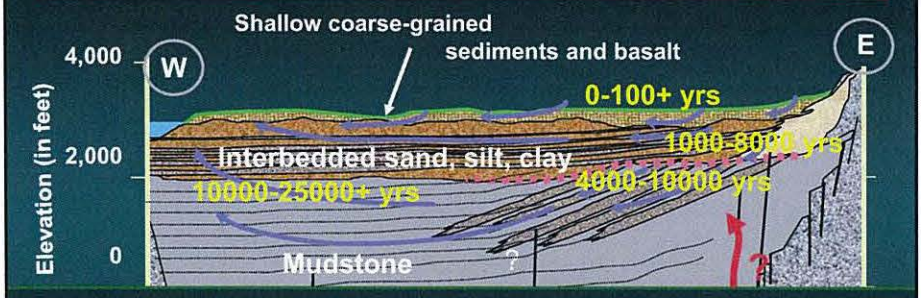

Regional Geology
Tsv
Qg
Kg
Qa
Qb
BOISE RIVER
BOISE
I-84
Lake Lowell
New York Canal
SNAKE RIVER
T5N
T4N
T3N
T2N
T1N
R5W
R4W
R3W
R2W
R1W
R1E
R2E
R3E
R4E
N
0 5 10 miles
Explanation
Contact
Approximate fault location
Qa Quaternary alluvium
Qb Quaternary basalt (undifferentiated)
Qg Quaternary Gravels (undifferentiated)
Tsv Tertiary sedimentary rocks and volcanics
Kg Cretaceous granitic rocks


Conceptual Cross-Section
(Regional Scale)
Shallow coarse-grained sediments and basalt
Irrigation
Domestic
Municipal
W
E
4,000
2,000
0
2,000
4,000
Elevation (in feet)
Interbedded sand, silt, clay
Mudstone
Volcanic Rocks
?
Adapted from cross section by S. Wood, BSU Geosciences
C. Petrich


Ground Water Ages in Regional System
Mid-Basin Delta
9,000
Basin Margin
<1,000
Deep Lake
4,000 / 8,000
<2,000 / 13,000
Downvalley
10,000 - 40,000
Transition Zone
4,000 - 8,000
Alluvial fan
<1,000
N
W
E
S
Source:
Hutchings, Petrich et al., 2001


Estimated Ground Water Residence Times in Vicinity of New York Canal
West
Flood Irrigation
Canal Seepage
East
depth below ground surface (feet)
0
100
200
300
400
500
600
<10 yrs
10-40 yrs
40-80 yrs
>10,000 yrs
8,000 yrs
C. Petrich

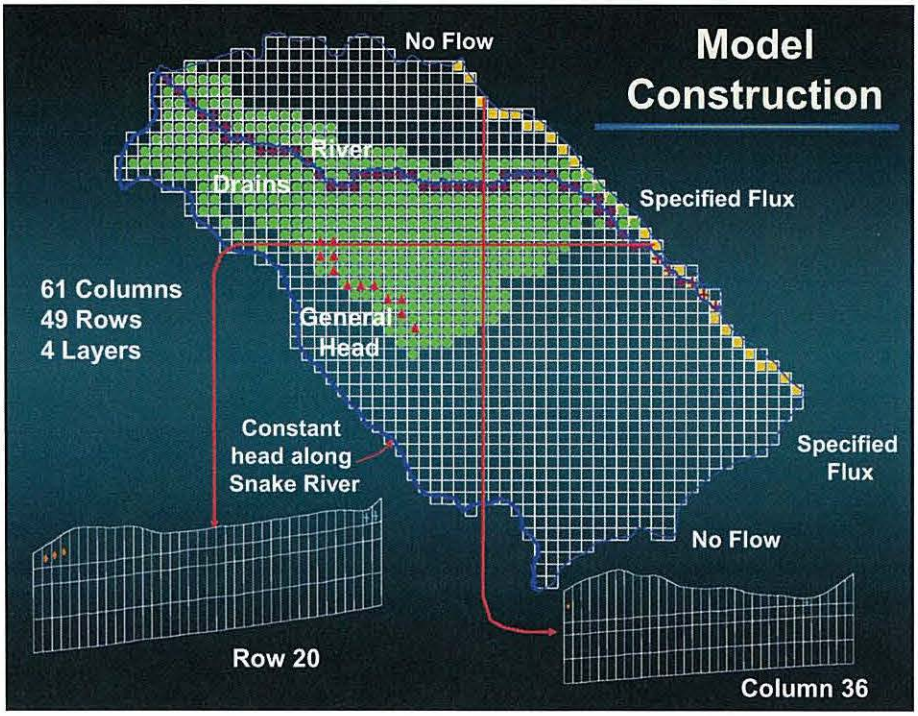
Regional Ground Water Flow System

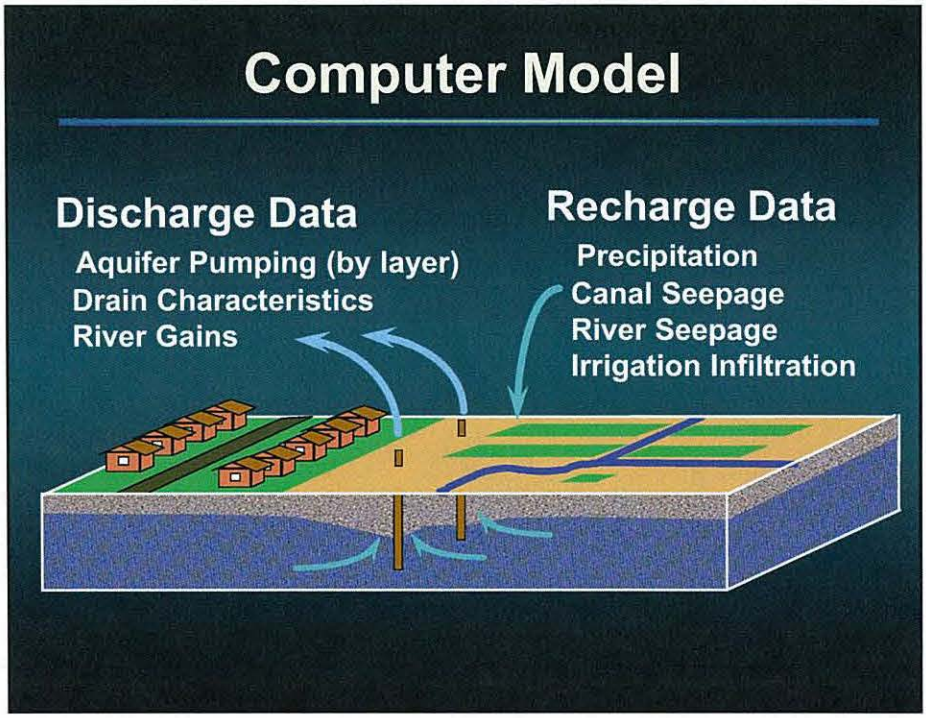


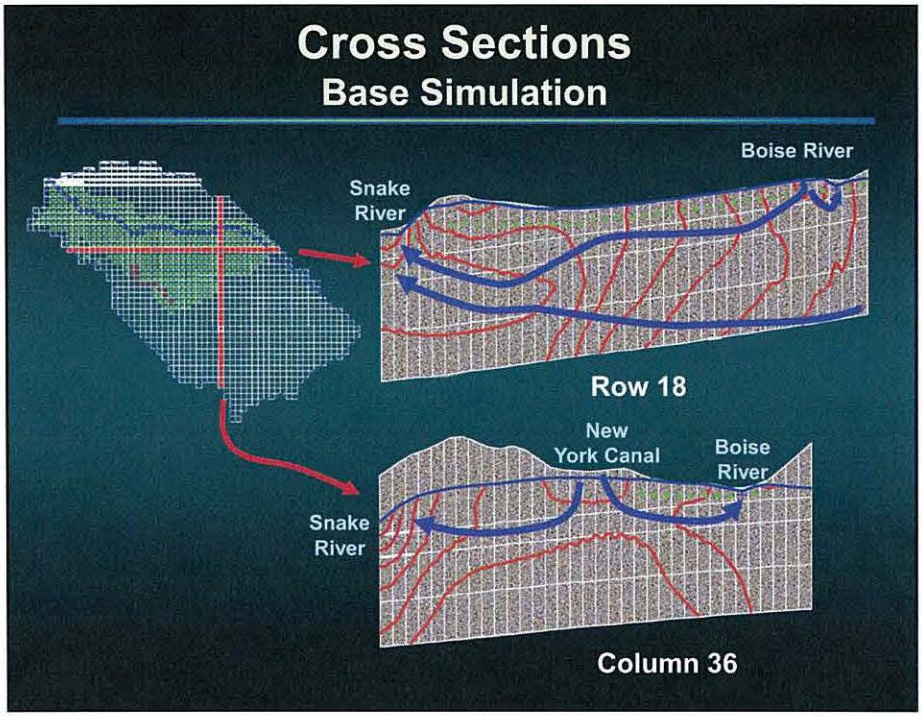
Factors Influencing Flow in Regional System

1. Discharge-limited in some areas (the water can't get out)
2. Recharge can be induced with pumping in some areas
3. Residence times do not necessarily reflect travel times
3. Aquifer properties control the rate of flow from shallow to deep zones, or vice versa

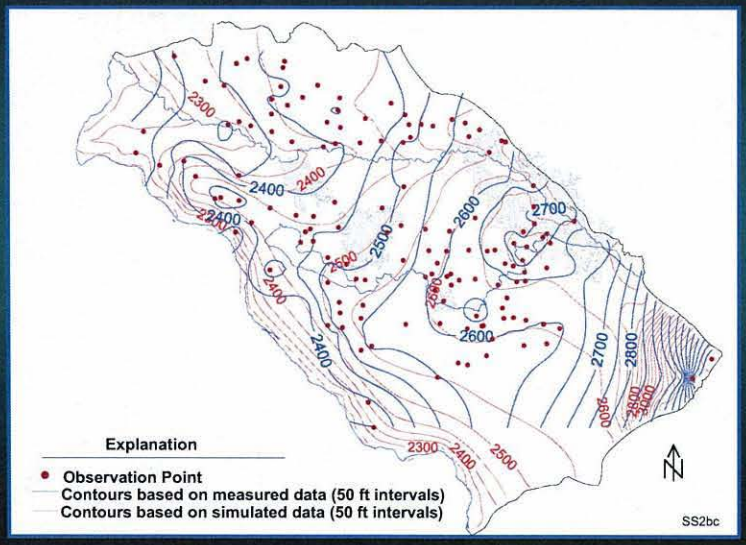
Model Construction




Computer Model
Discharge Data
Aquifer Pumping (by layer)
Drain Characteristics
River Gains
Recharge Data
Precipitation
Canal Seepage
River Seepage
Irrigation Infiltration


Cross Sections
Base Simulation
Boise River
Snake River
Row 18
New York Canal
Boise River
Snake River
Column 36

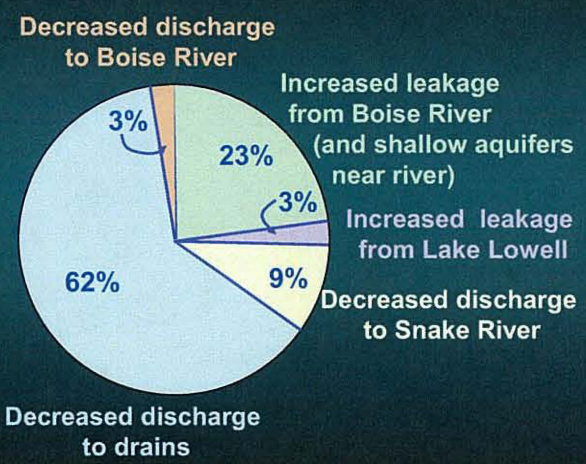
Base Calibration, Layer 1



Increased Pumping Scenario

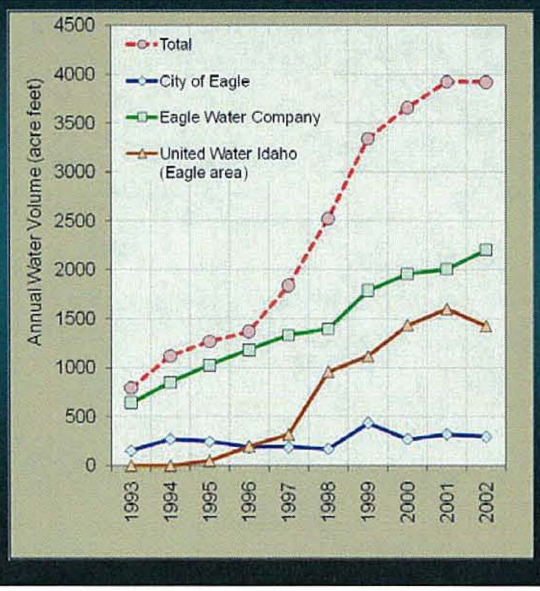
- Aggregate pumping represented by unprocessed water right applications
- Over 450 applications
- Proposed non-supplemental withdrawals approximately 20% of 1996 pumping
- Achieved new water level equilibrium

Sources of Water for Increased Simulated Withdrawals



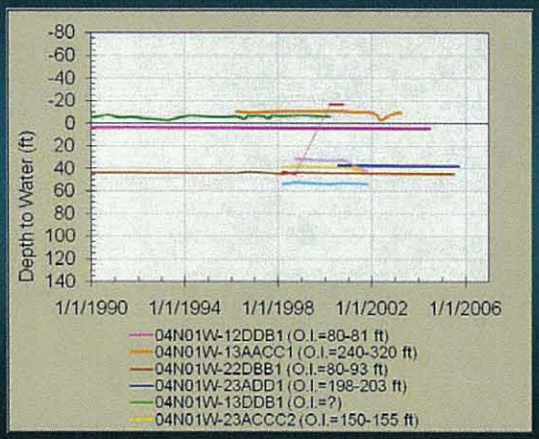
Eagle Vicinity Pumping and Water Levels

- Production in Eagle area quadrupled between 1993 and 2002



Eagle-Area Water Levels

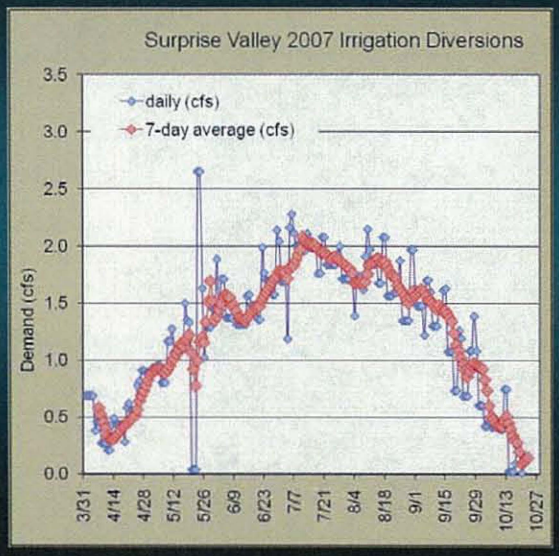
- Eagle-area water levels remained relatively stable



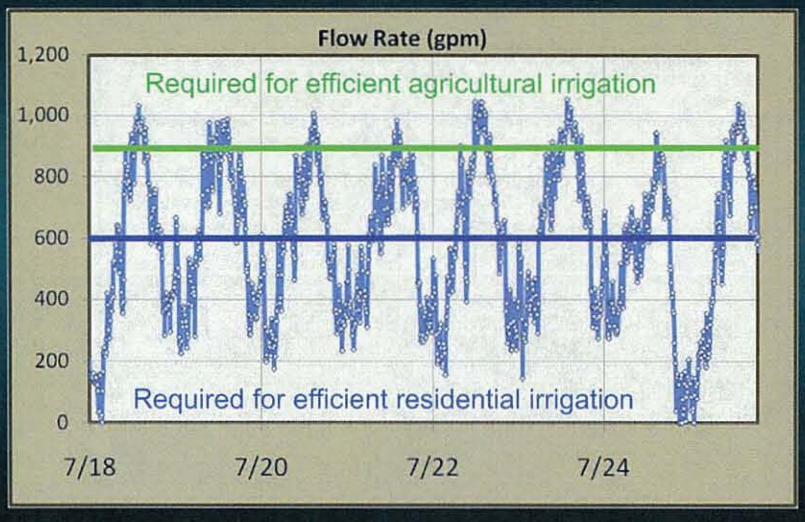
Urbanization of Agricultural Land

Pressurized Irrigation System

- ~ 60% Irrigated
- 4.2 to 4.4 AF/acre for actual irrigated area
- 2.5 to 2.6 AF/acre for gross area



Pressurized Residential Irrigation System



What did we learn?

Water Supply

- Abundant water supply (although not unlimited)
- Treasure Valley does not have a water shortage
- Approximately 2 million acre feet flow into the valley
- Approximately 1 million acre feet flow out of the valley
- Greater flows in some years, less in others

Aquifer Characteristics

- Treasure Valley Aquifer System extends throughout valley
- Aquifer extends several thousand feet deep, although upper 400 to 800 feet are generally most productive
- Shallow and deeper aquifers have varying degrees of hydraulic connection
- Recharge occurs primarily as infiltration from surface channels and irrigated ground

Carrying Capacity

- "Carrying capacity" of aquifer is difficult to define
  - The best way to assess pumping increases is to pump and monitor
  - Can continue to increase pumping (in some areas) until aquifers no longer discharge to drains
  - Ground and surface water is likely ample for very large increase in population
  - In gross numbers, existing water supplies could provide for more people than we currently envision

Ground Water Levels

- Ground water levels are stable in most areas
  - Historic declines have been observed in some local areas
    - » But water levels now stable
    - » Tribute to successful management
  - Modest declines have been observed in other areas, but some drawdown is necessary for water to flow to wells
  - Ground water levels have increased in some areas
  - Some areas will not support large increases in ground water pumping

Future Ground Water Development

- Abundant ground water in western portion of valley
- Areas of more limited water availability
  - Eastern areas
  - Southern areas
  - Portions of foothills
- Increased pumping
  - Possible in many areas
  - Ground water levels will reach new equilibrium
  - Pumping may result in
    - » Increased recharge from river or shallow aquifers
    - » Decreased discharge to surface channels
    - » Or both

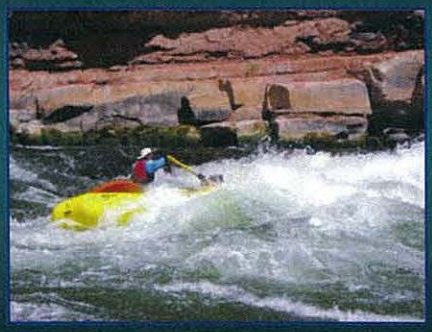
Other "Sources" of Future Water Supply

- Targeted efficiency improvements
- Improved water management
- Changes in existing water use
- Snake River
- Payette River
- Aquifer storage and recovery

Summary

- Adequate supply of water for current and future needs
- Challenge is to
  - Plan now to meet future water demand
    - » Infrastructure
    - » Policy
  - Some opportunities will require regional approach
  - Identify current policies that may inadvertently preclude future water-supply options

Questions



Christian Petrich
SPF Water Engineering, LLC
383-4140

cpetrich@spfwater.com