MONITORING APPROACHES ADAPTED BY SOUTHWEST USA TRIBAL AND MUNICIPAL WATER PROVIDERS TO ADDRESS WATER SUPPLY CHALLENGES ASSOCIATED WITH DROUGHT AND CLIMATE CHANGE

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Sustainable Water Sources

- Conservation and drought preparedness is part of the solution
- Monitoring the availability, quality and short/long term changes of the water supply provides the foundation for sustainable management
  - Water supply master planning
  - CIP prioritization
  - Alternative supplies and contingency plans
  - Asset management, policies, processes

Monitoring of Water Resources Critical to Making long term Water Management Decisions

- In many cases very little data is available
- Drought related impacts such as decreased runoff and increasing groundwater demand has resulted in shortages
- Climate change has also focused purveyors to evaluate
  - Impacts on water supply
    - Earlier runoff
    - Stronger drought sequences
- Investigating and monitoring water quantity and quality has received attention
- Pressure to identify new water sources to support growth has risen
- Information therefore is important for sustainability of water resources

Water Rights Limitations

- Surface waters are fully appropriated in SW
- Potable Groundwater Supplies are declining
- Cost per acre-foot of water is rising
- Municipalities/Tribes are looking to alternative sources
  - Importation of water becoming common solution
  - Recharging groundwater improves long term needs, including enhancement of recharge
  - Re-Use of reclaimed water frees up potable supplies
  - Treatment of contaminated groundwater for potable use getting attention
  - Desalinization

Regulatory Framework

- Many States have programs in place
- Assured Water Supplies, Reuse options available
- Underground Water Storage permits
- Recharge credits - gallon for gallon
- Water Quality Impacts addressed
- Monitoring is basis for permit conditions

Case studies – Adaptive Measures

Recharge

- Spreading basins, ASR, Vadose zone wells
- Reclaimed water
- Surface water
- treated water

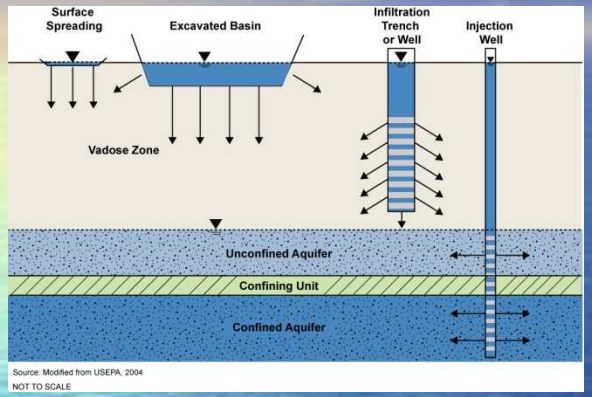
Enhancement of Recharge

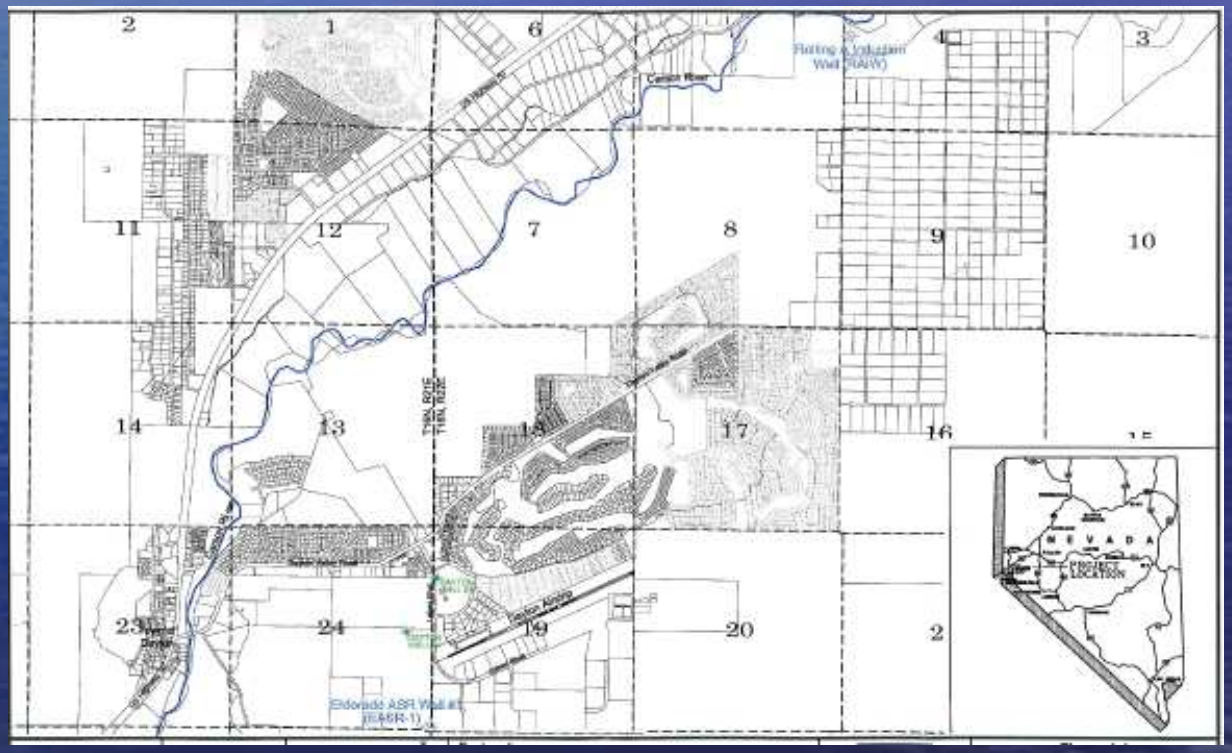
Importation of Surface water

Desalinization-Brackish Water Supplies

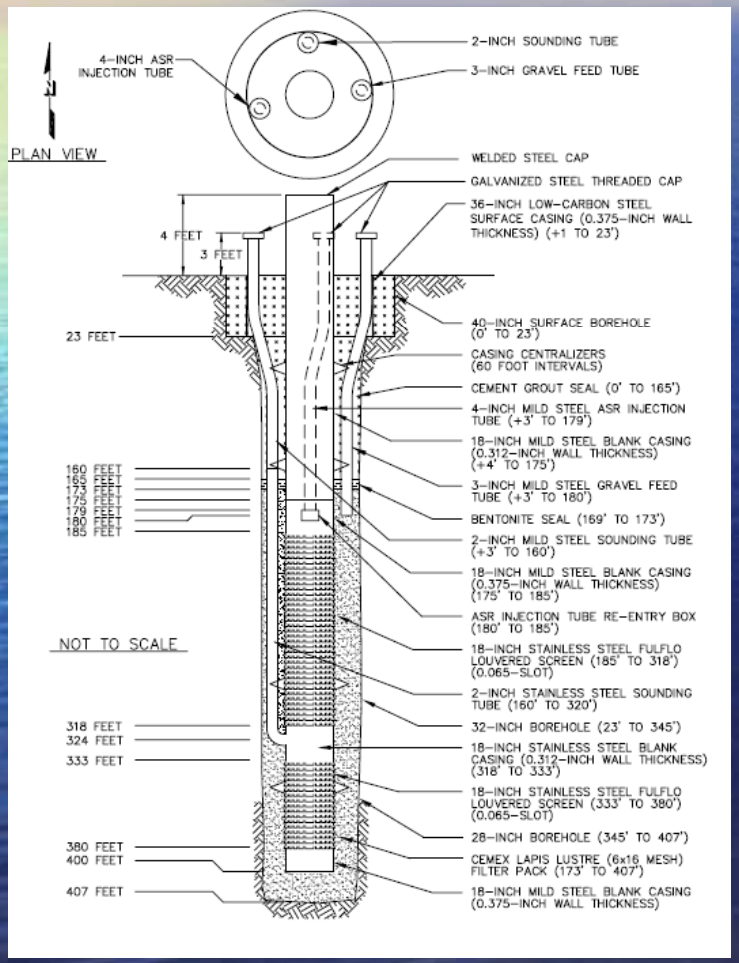
Well-field upgrades and modification

Nevada Site uses Multiple Recharge Scenarios



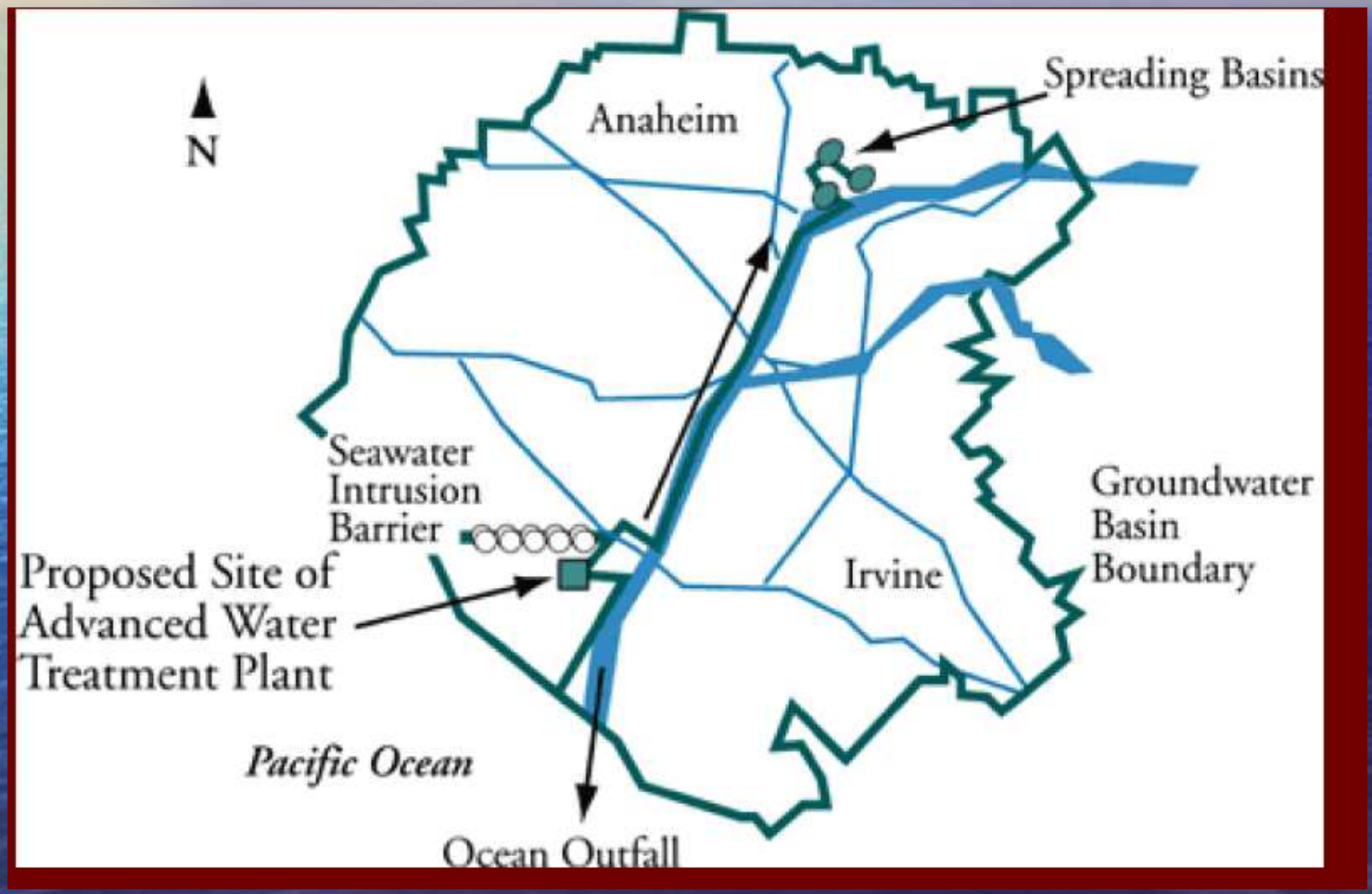


Use of Wells/Spreading Basins to Augment Groundwater Supply during Peak Seasonal Demand



Injection Wells and Monitoring Wells

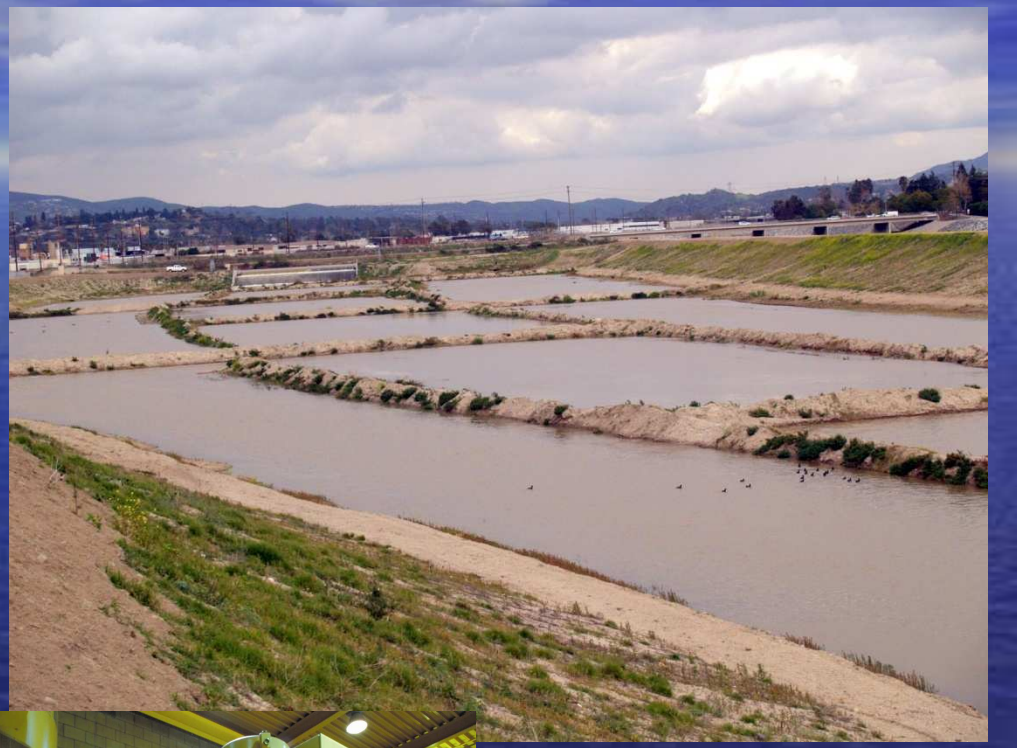
Orange County, CA. Success Story



Spreading Basins and Treatment

- Part of a $486 million groundwater replenishment program

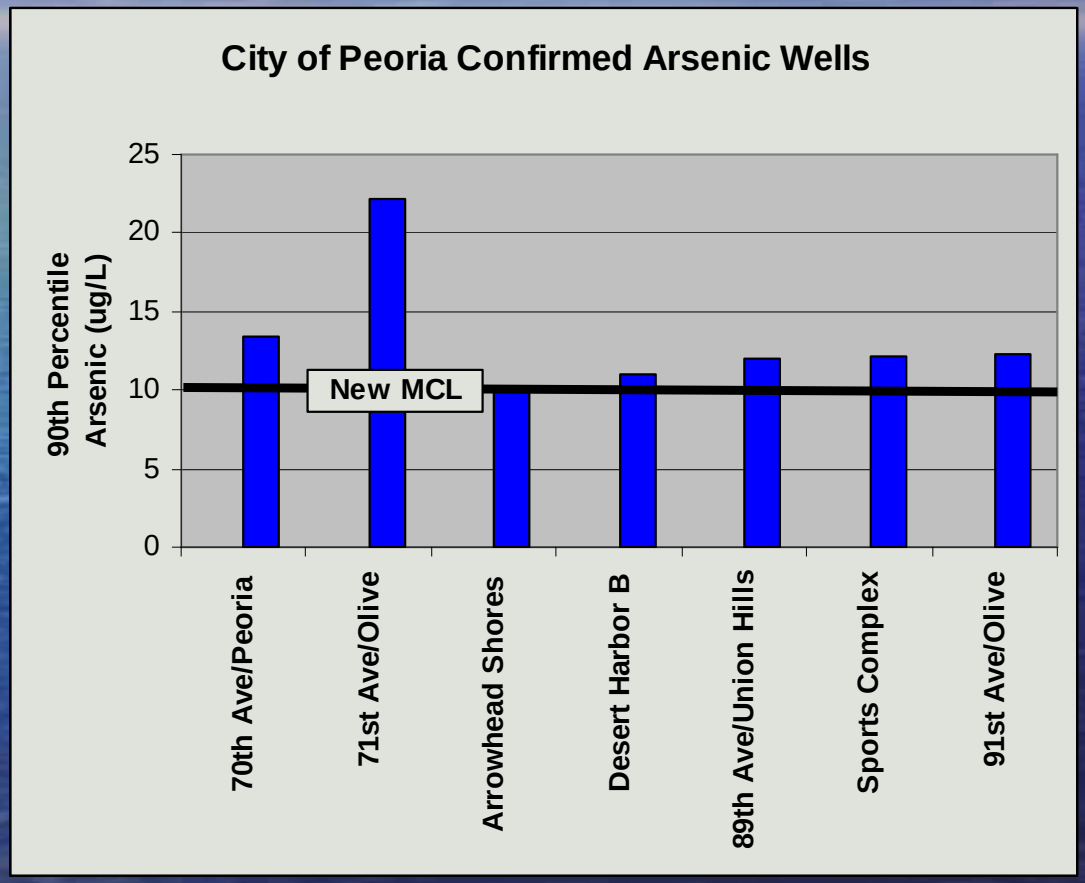
- Treated water piped to recharge basins will help supply water to over 2 million residents



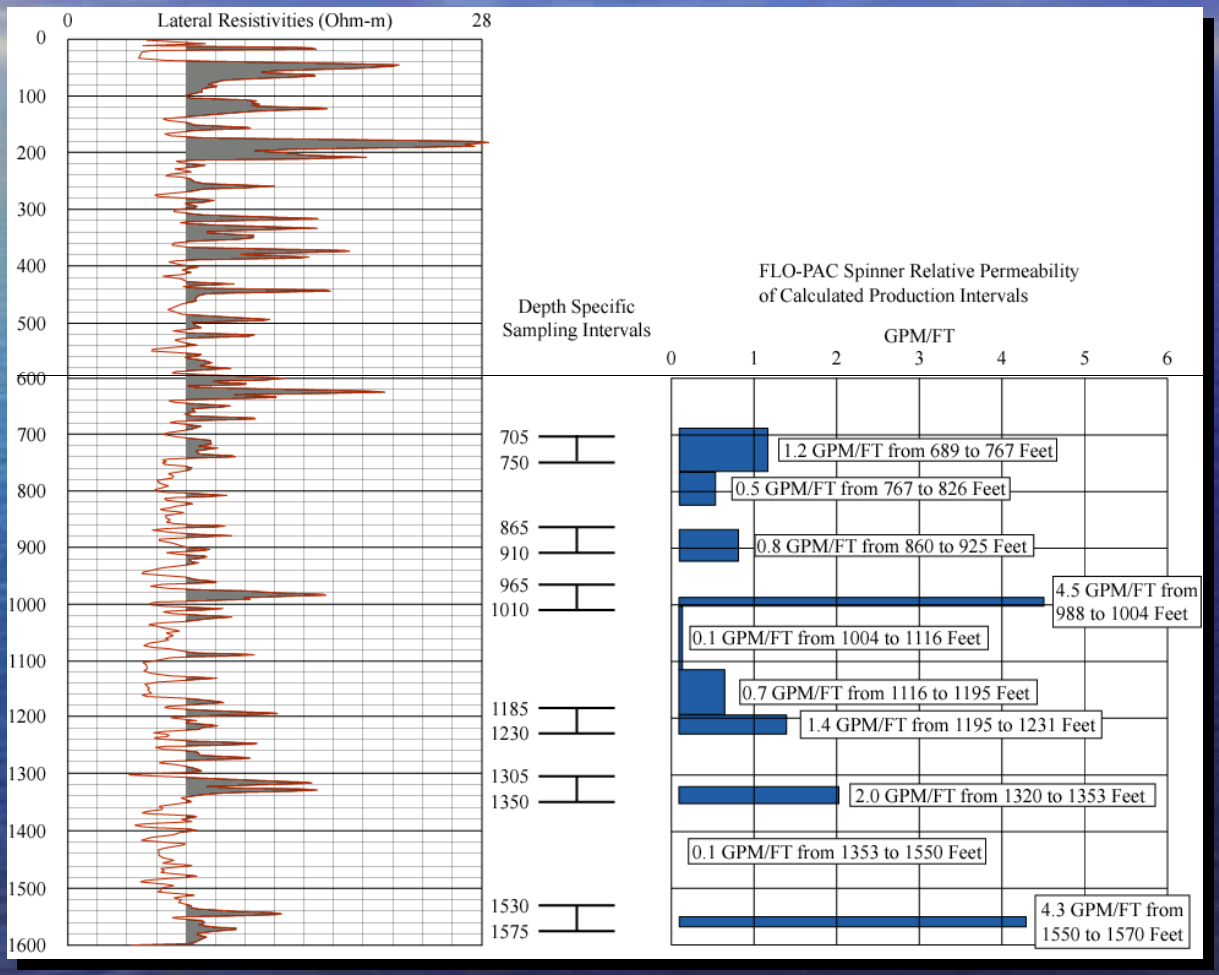
Arizona City Non Treatment Strategies for Arsenic

- Peoria Assessing Non-Treatment Strategies
- Operational and Well Evaluation
  - Operational pumping strategies
  - Modifications of Well Designs – isolate high arsenic zones
- Blending Evaluation
  - Blend water from low arsenic sources to reduce concentrations in high concentration well water

Arsenic Concentrations in 7 of 29 Wells

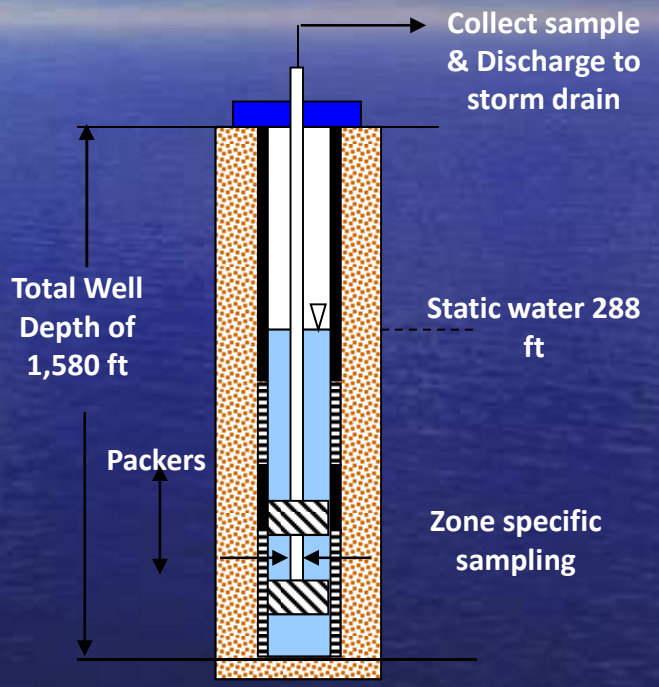


Downhole Testing Results

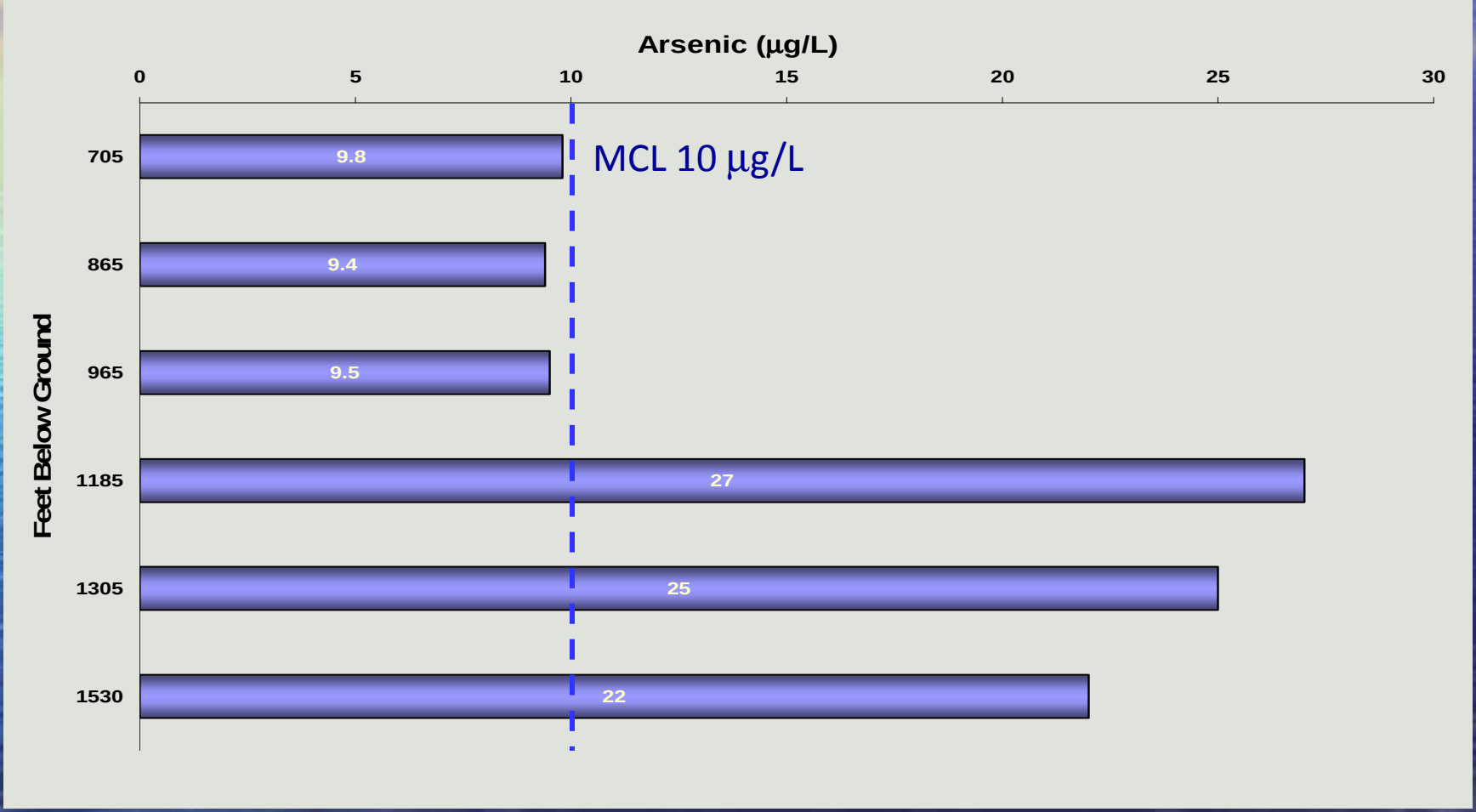


Well Zonal Sampling

- **Depth Specific Sampling**
  - Set and inflate packers at target depth
  - Purge target zone at a low rate >20gpm
  - Measure field parameters, pH, EC, turbidity, temp
  - Collect groundwater samples analyzing for As, TDS, F, nitrate, sulfate



Zonal Sampling Results



Reuse Goal – Reuse 100% of Reclaimed Water

- MBR Facility: 140 acres
- A+ Effluent
- 60 sq. mile Planning Area in Early Stage of Build Out
  - Effluent Distribution Piping System Limits Reuse
- 2.8 mgd - Initially Recharge:
  - 1.8 mgd-to Basins (10-acres)
  - 1.0 mgd-to Vadose Zone Wells
- Ultimate Goal - Reuse all 31 mgd

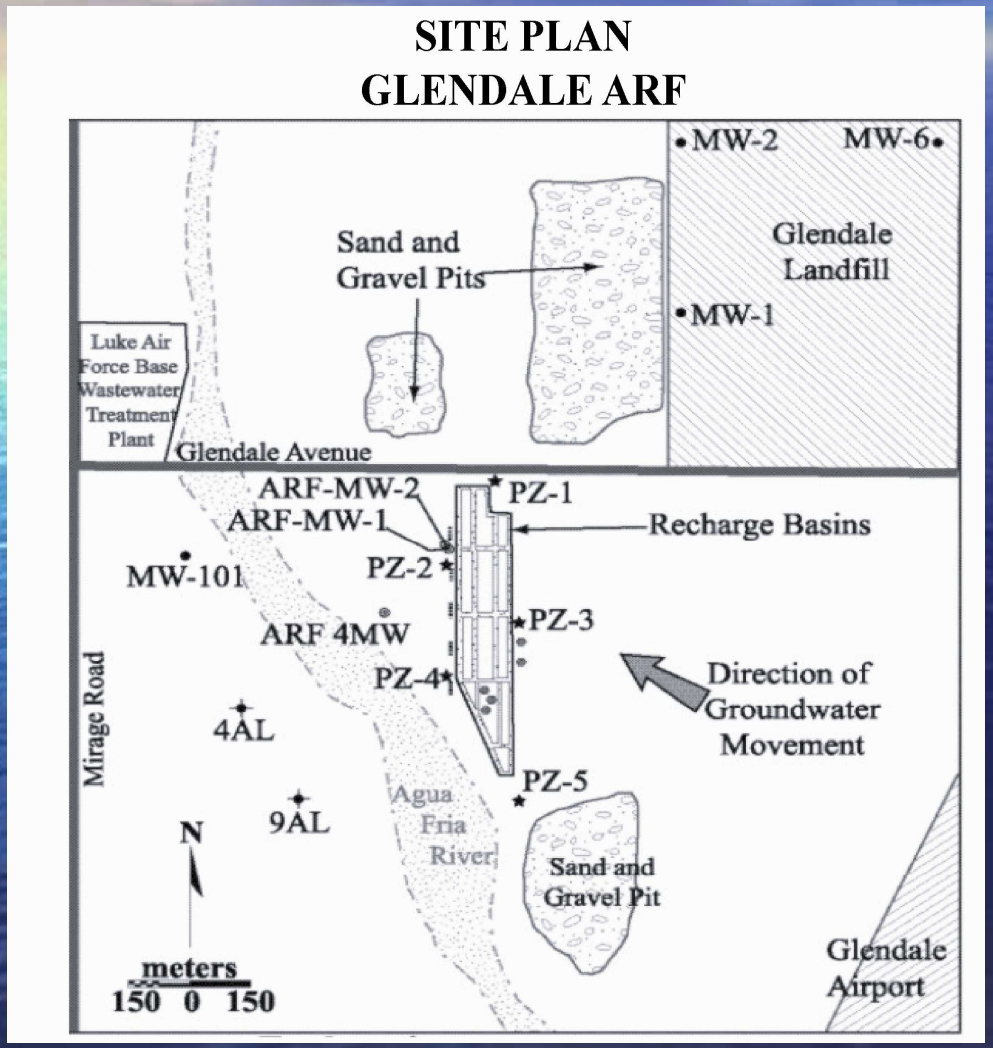
Effluent Reuse Options

- Irrigation - Public Parks, Turf, Planting Strips
- Residential Irrigation
- Residential & Commercial Construction
- MSW Landfill Dust Control

Effluent Reuse Options

Description	**Treated Effluent Usage**
Parks – Overall Site Usage	25 gallons/square foot/year
Turf	37 gallons/square foot/year
Trees – Low Water Usage	1,500 gallons/tree/year
Shrubs – Low Water Usage	630 gallons/shrub/year
Other Low Water Usage - landscaping	10 gallons/square foot/yr.
Residential Construction Water	10,000 gallons/7,500 square foot lot
Commercial Construction Water	100,000 gallons/acre
Dust Control	125,000 gallons/day

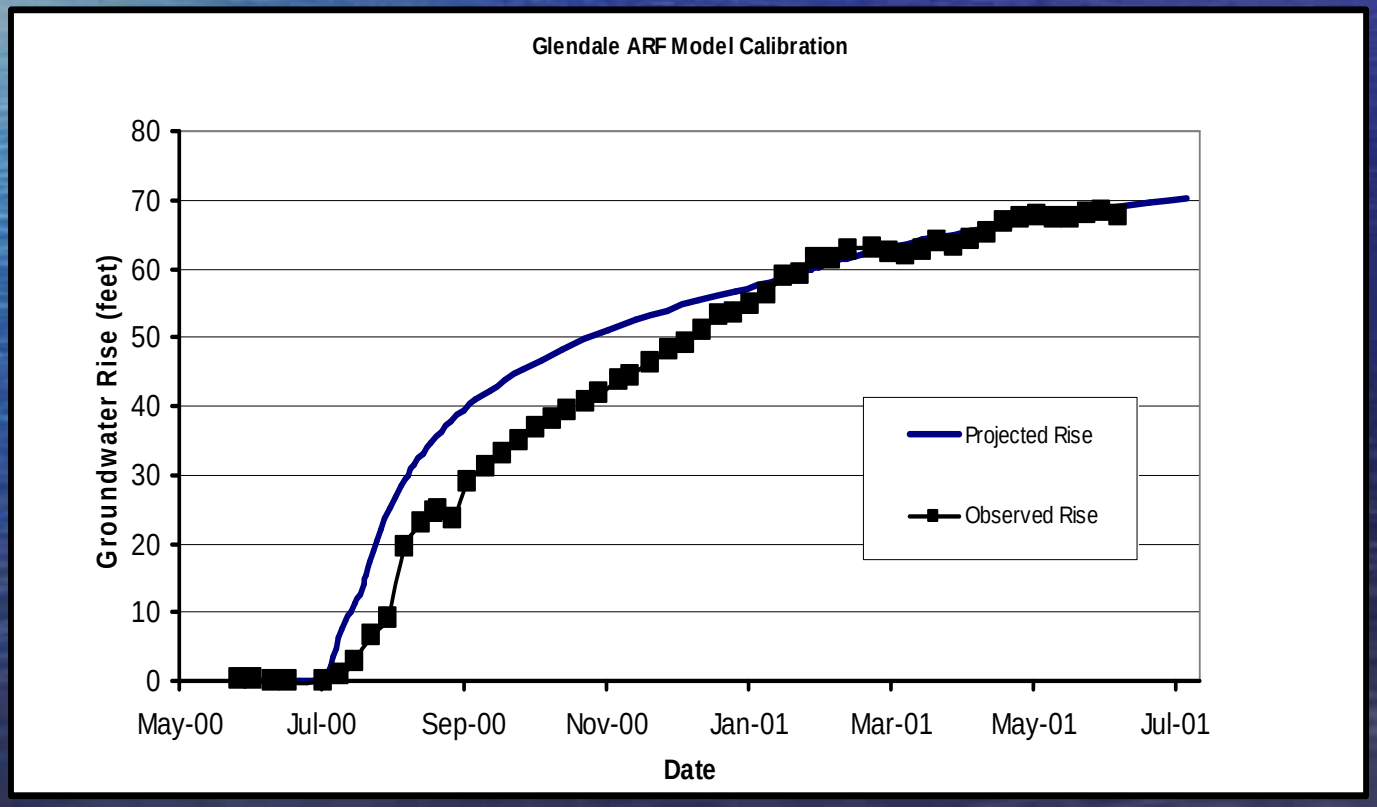
Glendale – Recharge of Reclaimed Water



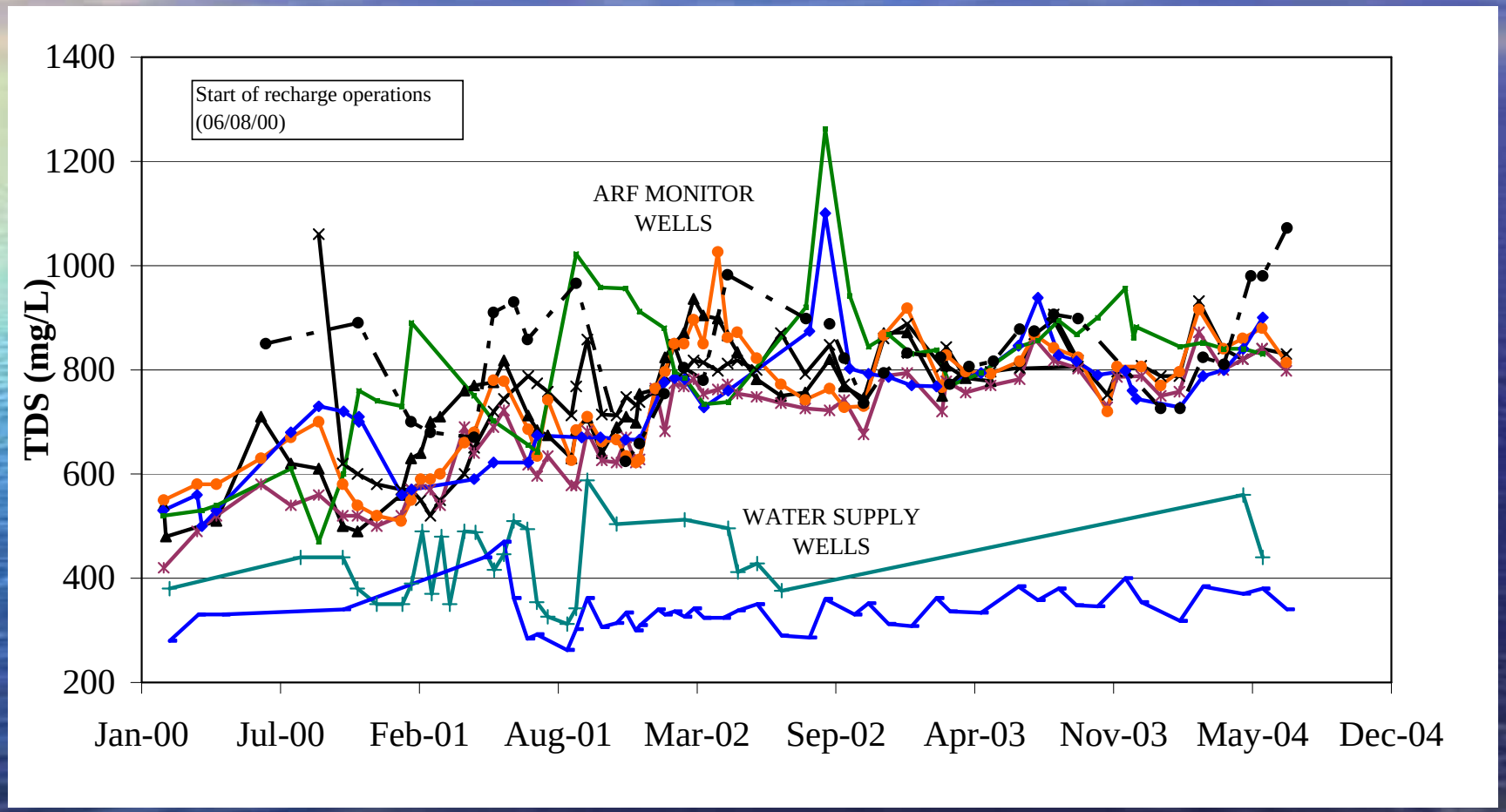
Model Predictions

Groundwater flow model using observed water level data from first 4 years of recharge operations

- Determine the max recharge rates to optimize full recharge capacity
- Minimize impacts to surrounding facilities



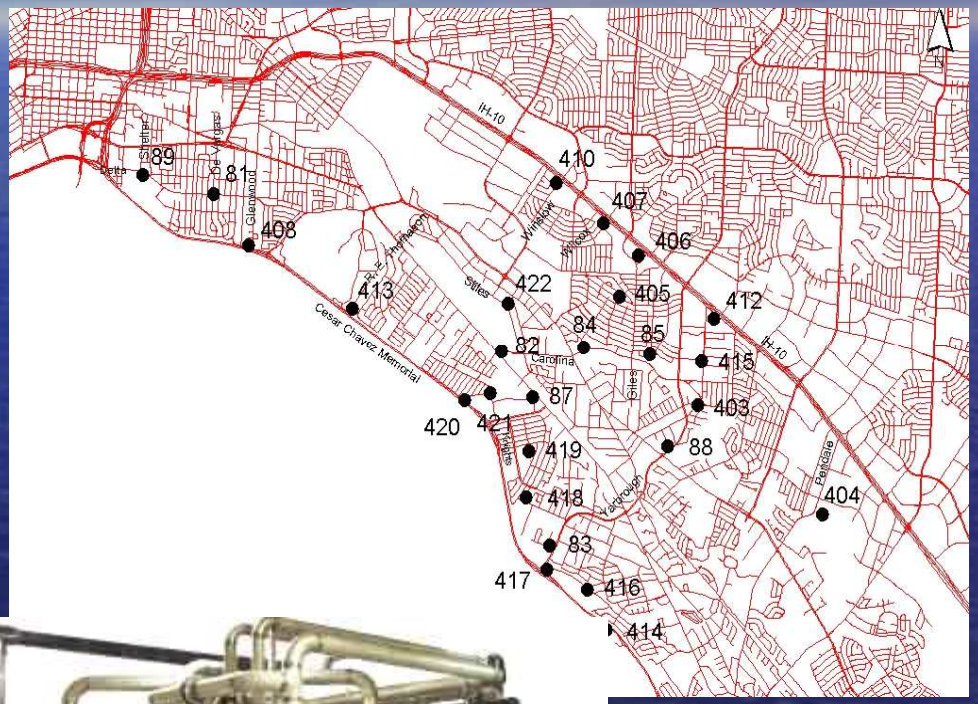
TDS Trends


1400
1200
1000
800
600
400
200
TDS (mg/L)
Start of recharge operations (06/08/00)
ARF MONITOR WELLS
WATER SUPPLY WELLS
Jan-00
Jul-00
Feb-01
Aug-01
Mar-02
Sep-02
Apr-03
Nov-03
May-04
Dec-04

El Paso Water Utilities Brackish Treatment

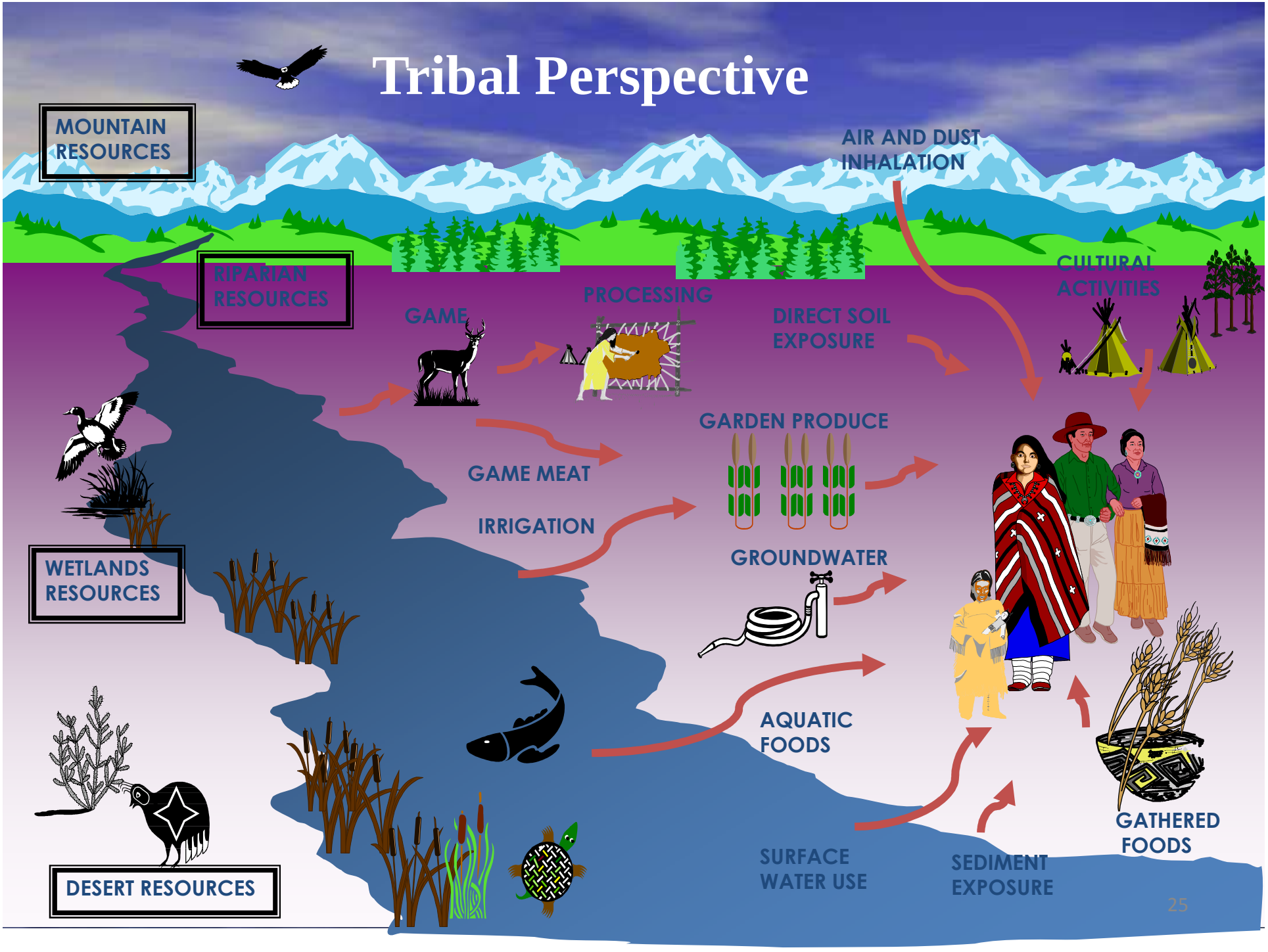
- Arsenic and high TDS groundwater required treatment in some wells

- Wellhead treatment using reverse osmosis has been successful in providing potable water to its customers



Central Arizona Salinity Study

- Brackish groundwater in AZ is a potential source of water
- Long term sustainability is uncertain

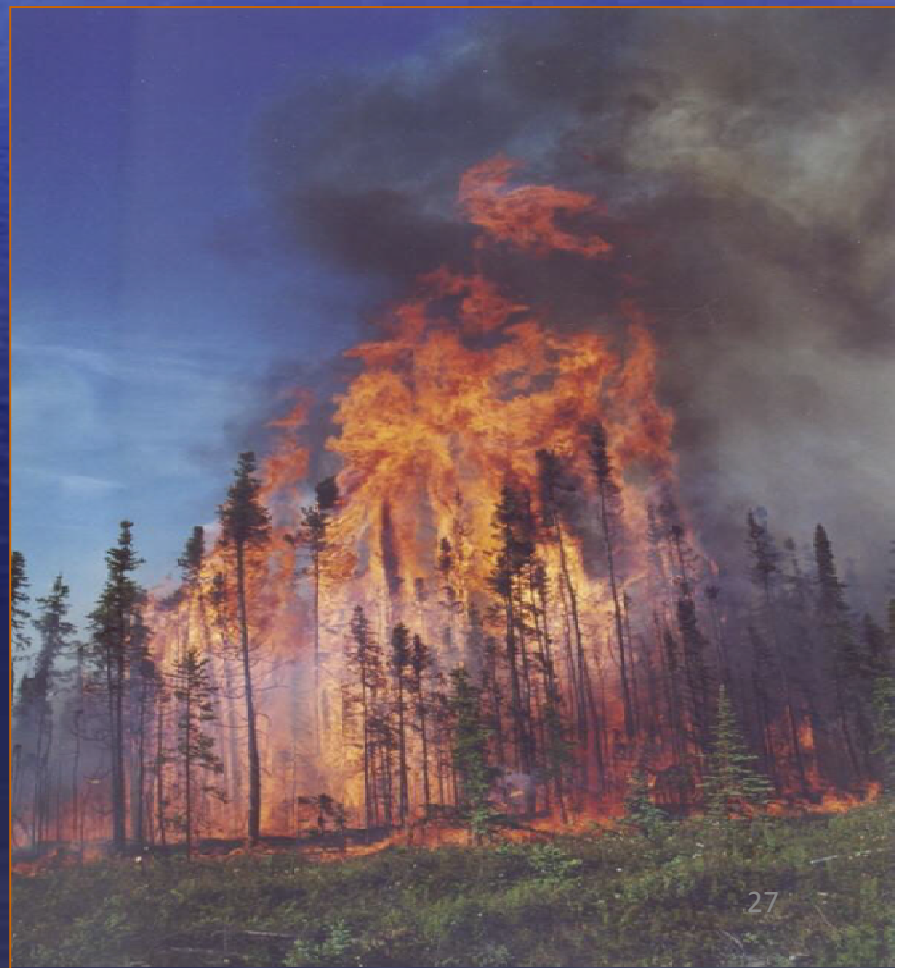

Tribal Perspective
MOUNTAIN RESOURCES
AIR AND DUST INHALATION
RIPARIAN RESOURCES
CULTURAL ACTIVITIES
PROCESSING
GAME
DIRECT SOIL EXPOSURE
GARDEN PRODUCE
GAME MEAT
IRRIGATION
GROUNDWATER
WETLANDS RESOURCES
AQUATIC FOODS
GATHERED FOODS
SURFACE WATER USE
SEDIMENT EXPOSURE
DESERT RESOURCES

Climate Change Impacts

- Impacted Native life-ways
- Raising sheep
- Growing corn
- Plants needed for ceremonies
- Loss of Native plants
  - Medicines
  - Healthy rangeland
  - Increase in Insects
  - Lodgepole pine, Cottonwoods

Climate Change Impacts

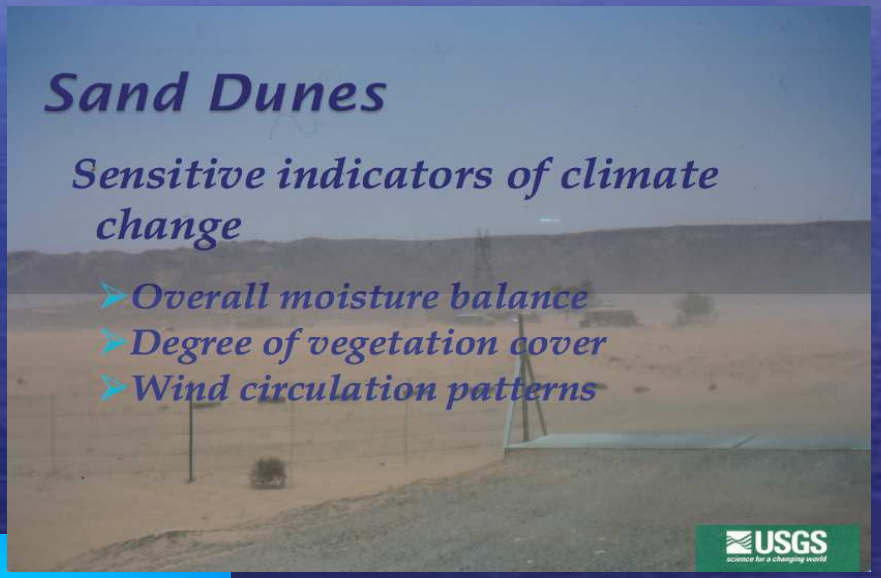
- Impacted quality of life
- Water quality and quantity
- Respiratory and other health effects of sand and dust



Navajo Country
Kayenta AZ

- Sept 2003

- Sept 2004



Tribal Monitoring Data

Extremes are what we feel

•Understanding variability will help us understand impacts

•Tribal lands need their own data – our local climates are important and have been impacted by land use and climate change

Land use and climate change effects are linked

GLOBAL WARMING/CLIMATE CHANGE
Hualapai Tribe

I. Reduced Water Availability

Reduced Precipitation/Increasing Temperatures
Impacts to water rights
Less water available for tribal water rights
Increased costs of operations
Increased costs of water lines, storage tanks, new wells
Increased costs of water hauling

II. Mitigation Actions being undertaken by the Hualapai Tribe
Construction of water catchment
Removal of non-native tamaris
Development of fish-rearing facility
Installation of new wells and pipelines
Watershed Management Planning
Erosion

Mitigation Actions being undertaken by the Hualapai Tribe

Construction of water catchments

ADAPTIVE MEASURES AND MANAGMENT

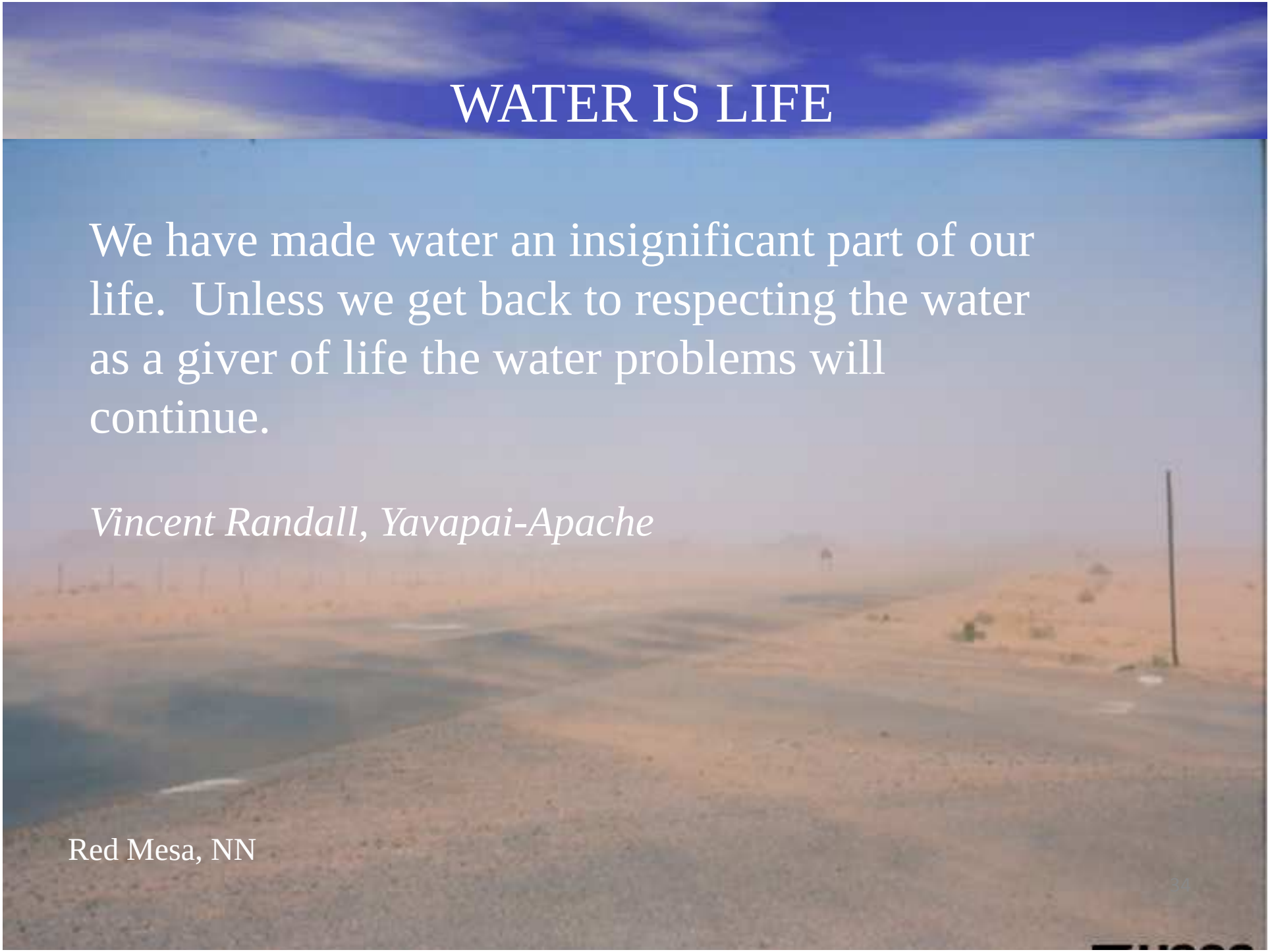
New well and pipeline

Mud Tank well

WATER IS LIFE

We have made water an insignificant part of our life. Unless we get back to respecting the water as a giver of life the water problems will continue.

Vincent Randall, Yavapai-Apache



Red Mesa, NN