CONCERNS

- THE RELATIONSHIP OF YUCCA MOUNTAIN TO THE REGIONAL FLOW SYSTEM

- POSSIBLE CONTAMINATION OF THE DOWNGRADIENT FLOW SYSTEM

- IMPACTS ON FUTURE WATER SUPPLY DEVELOPMENT
REQUIRED ANALYSIS

• DETERMINE THE PROBABLE FLUID FLOW PATHS TO THE ASSESSIBLE ENVIRONMENT
  THIS REQUIRES A THOROUGH UNDERSTANDING OF THE SATURATED ZONE FLOW SYSTEM AT REGIONAL, SUB-REGIONAL AND SITE SCALES

• EVALUATE CONSEQUENCES OF PRE AND POST CLOSURE SYSTEM DYNAMICS
  INCREASED REGIONAL WATER USE – IRRIGATION
  MINERAL
  URBAN
  CLIMATIC CHANGE EFFECTS – WATER LEVELS
  DISCHARGE LOCATIONS

STRUCTURAL CHANGES – FAULTING
REGIONAL FLOW SYSTEM

- CURRENT UNDERSTANDING ORIGINALLY BASED ON WORK BY WINOGRAD AND THORDARSON (1975)

- UPDATED, REVISED, AND MODELED BY WADDELL (1982)


- ADDITIONAL WORK BY DRI AND USGS RELATED TO THE REGIONAL CARBONATE AQUIFER
Generalized geology.
Mean annual precipitation
Figure 3-10. Regional ground-water flow paths. Modified from Waddell et al. (1984).
Figure 3-2. Hydrogeologic study area, showing three ground-water subbasins. Modified from Rush (1970), Blankennagel and Weir (1973), Winograd and Thordarson (1975), Dudley and Larsen (1976), Waddell (1982), and Waddell et al. (1984).
Figure 3-43. Location of regional and subregional modeled areas, with generalized ground-water flow directions. Modified from Czarnecki and Waddell (1984)
EXPLANATION

CONTOUR SHOWING ALTITUDE OF MEASURED HYDRAULIC HEAD - Contour interval 80 meters. Datum is sea level

APPROXIMATE LOCATION OF HYDRAULIC HEAD MEASUREMENT SITE

Measured hydraulic head and location of measurement sites.
Model boundary fluxes, constant-head nodes, and transmissivity zones.
A Refined Accurate Regional/Sub-regional Model Which Will Define the Present System And Which Can Be Used to Evaluate Possible Futures Is Required

- A More extensive Data Base Is Needed To Define the Saturated Zone Flow Regime
  - Fracture Flow Importance
  - Barriers/Conduits
  - Interaction with Regional Carbonate System (i.e., Vertical Flow Components)

- Evaluate the Impact of Perturbations To the Existing Flow System
  - Climate
  - Increased Use
  - Structural Changes
CLIMATE CHANGE
(INCREASED RECHARGE)

RISE IN WATER TABLE
SHORTENED FLOW PATHS

IF ONE LOOKS AT GWTT UNDER THIS OR SIMILAR CONDITIONS TOGETHER WITH INCREASED SITE FLUX – GWTT COULD BE VERY SHORT.
INCREASED REGIONAL WATER USE

- EFFECTS OF INCREASED IRRIGATION (AMARGOSA DESERT)

- EFFECTS OF INCREASED MINING OPERATIONS SUCH AS SAGA MINERALS; BOND GOLD

- EFFECTS OF INCREASED URBAN WATER USE – i.e., DEVELOPMENT OF THE REGIONAL CARBONATE AQUIFER FOR THE LAS VEGAS AREA
STRUCTURAL CHANGES

- REGIONAL CHANGES IN POTENTIAL AND DISCHARGE LOCATIONS
- SITE CHANGES IN POTENTIAL
- NEW BARRIERS OR CONDUITS
RECOMMENDATIONS

CONCENTRATED EFFORT TO REFINE REGIONAL/SUB-REGIONAL AND SITE FLOW MODELS

- REGIONAL SYSTEM BOUNDARIES NEED BETTER DEFINITION – LITTLE REFINEMENT HAS BEEN MADE SINCE ORIGINAL WORK IN THE EARLY 70'S

- DEFINITION OF RECHARGE AREAS QUESTIONS WILL REMAIN RELATED TO UNDERFLOW FROM THE NORTH AND THE IMPORTANCE OF WASH SYSTEM RECHARGE TO THE REGIONAL AND SUB-REGIONAL SYSTEMS (e.g., AMARGOSA RIVER)

- STUDIES TO DEFINE THE MECHANISMS FOR AND IMPORTANCE OF AREAS WITH STEEP GRADIENTS – NEAR DEATH VALLEY, EAST OF MERCURY, NORTH OF YUCCA FLAT

- NEED TO BETTER UNDERSTAND THE SOURCE AND CONTROLS ON DISCHARGE FOR THE SPRINGS NEAR FURNACE CREEK RANCH
• NEED TO DEFINE THE INFLUENCE OF ANISOTROPY ON LOCAL FLOW PATHS

• TESTING SHOULD BE EXPANDED BEYOND THE SITE TO THE SUBREGIONAL SYSTEM

• IMPORTANCE OF VERTICAL GRADIENTS NEEDS ADDITIONAL STUDY – SHOULD DEVELOP ADEQUATE DATA FOR A 3-D MODEL TO ANSWER QUESTIONS CONCERNING THE CARBONATE AQUIFER AND DISCHARGE TO DEATH VALLEY

• THOROUGH EVALUATION OF POSSIBLE FUTURE CONDITIONS NEEDS TO BE UNDERTAKEN ONCE ADEQUATE REVISED MODELS ARE AVAILABLE
EXAMPLE OF FUTURE CONDITIONS

CZARNECKI (1985)

CHANGE:
\[ \Delta \text{PRECIP} = 100\% \]
\[ \Delta \text{RECHARGE} = 15 \text{ TIMES} \]

RESULTS:
\[ \Delta \text{WT} = 130 \text{ M RISE} \]
FLOW PATH SHORTENED BY 2/3

IF A SCENARIO SUCH AS THIS WERE TO OCCUR: 1) THE UNSATURATED ZONE WOULD BE REDUCED TO 20 M IN THE TOPOPAH SPRING UNIT (DISTURBED ZONE TO WATER TABLE); AND 2) SATURATED ZONE FLOW PATH WOULD BE \( \approx 14 \text{ KM} \) TO NEW DISCHARGE POINTS

TRAVEL TIME COULD BE <1,000 YEARS
REFERENCES


EDUCATION

B.S.C.E. (1965) University of Nevada, Reno
M.S.C.E. (1968) University of Nevada, Reno
Additional graduate work in hydrology (1968-1972)

EXPERIENCE

1976 – Present
Senior Research Engineer, Water Resources Center, Desert Research Institute, University of Nevada System, Reno. Research in water resources evaluation, hydrologic modeling, and environmental assessment.


Co-Investigator, "Environmental Assessment Hi-Shear Technology Corp. – Moapa Indian Reservation," Hi-Shear Technology Corp., 1985.


Department of Civil Engineering, University of Nevada, Reno. Engineering Hydrology – CE 364–564; Advanced Hydrology 1–CE 718.


1974–1976

Acting Deputy Director, Water Resources Center. Responsible for information dissemination program and Center day to day operations. Procurement of grant and contract funds through various agencies, including state, local and Federal governments. Center operating authority during frequent absence of Director. Research on water resources systems engineering and hydrological modeling.

Lecturer, Department of Civil Engineering, University of Nevada, Reno.


1964-1956  Engineering Aid, Eagle-P'icher Company, Clark Station, Nevada.

MEMBERSHIPS

Registered Professional Engineer, Nevada

American Society of Civil Engineers
RESEARCH REPORTS, PAPER AND PUBLICATIONS


Resources Research, Desert Research Institute, University of Nevada System, Reno, January 1972.


Desert Research Institute, “Environmental Assessment Hi-Shear Technology Corporation Development, Moapa Indian Reservation, Clark County, Nevada,” prepared major portions of report – submitted to Bureau of Indian Affairs, December 1985.


CONSULTING ACTIVITIES


While employed by IECO 1973-74

a. Eyser Engineering, Madrid, Spain, Rio Rubi Flood Studies (Design Flood).

b. Seattle City Light, Seattle, Washington, PMF for Boundary Dam (Safety of Dams).

c. Electrobras, Rio de Janeiro, Brazil, Basic hydrologic and reservoir operation studies – Itaipu Dam.

