Oil Shale, Salinity and the Lower Basin States

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Background

• COLORADO RIVER AND TRIBUTARIES PROVIDES U.S.
  – MUNICIPAL & INDUSTRIAL WATER TO ~33 MILLION PEOPLE
  – IRRIGATION TO NEARLY 4 MILLION ACRES OF LAND
• THE RIVER ALSO SERVES MEXICO
  – ~3 MILLION PEOPLE
  – 500,000 ACRES IN MEXICO
• EFFECT OF SALINITY A MAJOR CONCERN IN U. S. AND MEXICO (USBR, 2005).
  – SALINITY DAMAGES IN THE UNITED STATES ARE PRESENTLY ABOUT $700 MILLION A YEAR.
Background

• THE COLORADO RIVER SALINITY CONTROL FORUM REPORTED
  – BY 2025 A TARGET OF 1.8 MILLION TONS PER YEAR OF SALT WILL NEED TO BE DIVERTED FROM ENTERING THE COLORADO RIVER TO MEET LOWER BASIN WATER STANDARDS (BELOW LEES FERRY, ARIZONA)
  – COLORADO RIVER BASIN SALINITY PROJECT HAS CONTROLLED OVER 1,072,000 TONS OF SALT PER YEAR
  – REQUIRES FUNDING AND IMPLEMENTING NEW MEASURES THAT REMOVE ADDITIONAL 728,000 TONS
  – SALINITY CONTROL ACT AUTHORIZES SECRETARIES OF THE US DEPARTMENT OF INTERIOR AND AGRICULTURE TO ENHANCE AND PROTECT QUALITY OF WATER AVAILABLE IN COLORADO RIVER FOR USE IN THE UNITED STATES AND MEXICO.
AT HOOVER DAM, THE RIVER DELIVERS A STAGGERING 9 MILLION TONS OF DISSOLVED SALTS PER YEAR (rubicon.water.ca.gov/v2/CRR.html)
Salt Increase Downstream

- TOTAL DISSOLVED SOLIDS (TDS) IN MOUNTAINOUS HEADWATERS OF COLORADO ~50mg/L
- AT IMPERIAL DAM, ARIZONA, AVERAGE TDS 850mg/L (USGS 2000).
- 1.7 TIMES EPA’S SECONDARY DRINKING WATER STANDARD OF 500 mg/L
20,000 ADDITIONAL GAS WELLS WILL BE DRILLED ALONGSIDE THE OIL SHALE LEASE SITES IN THE WHITE RIVER BUREAU OF LAND MANAGEMENT (BLM) DISTRICT.

SALT ENTERS THE COLORADO RIVER FROM SURFACE RUNOFF, SPRINGS, WELLS ETC; FROM BLM ADMINISTERED LANDS – ±700,000 TONS PER YEAR.
BASIN WIDE FRACTURING WOULD FORCE A LONG TERM FLOW OF BRINE FROM THE MORE SALINE ZONES INTO THE BASINS SURFACE WATER.

THE DEEPER AQUIFERS CONTAIN VERY SALINE WATERS WITH TOTAL DISSOLVED SOLIDS VALUES OF GREATER THAN 10,000mg/L.
Oil Shale Development May Increase Surface Water Salt Concentrations

- **RE-INTRODUCTION OF GROUNDWATER TO SPENT SHALE**
  - A model which simulated the flooding of in-situ mine works predicted total dissolved solids (TDS) would increase by over 1,000 to 1,900 mg/L across a 30 square mile area with concentration increases most pronounced in the most conductive zones (Robson and Saulnier, 1980).

- **LARGE SCALE DEWATERING**
  - Predicted to increase surface water salinity by reducing dilution of saline groundwater.

- **REDUCTION IN STREAMFLOWS**
  - Have caused total dissolved soilids to increase by 300 mg/L in Piceance Creek (Robson and Saulnier, 1980).

- **LEACHING OF SPENT SHALE**.
  - Soluble salts can approach 1% in spent shale (Freerer et al., 1986), and even greater than in raw shale oil shale (USDOE, 2006).
A ONE MILLION BARREL PER DAY OPERATION MAY INCREASE SALINITY IN THE LOWER COLORADO RIVER BASIN BY 2.4%, CAUSING AN ESTIMATED $25 MILLION IN DAMAGES EACH YEAR.

(COLORADO SALINITY CONTROL PROGRAM 2005)
IN ADDITION TO SALINITY, GROUNDWATER CONTAMINATION CAN RESULT FROM DISSOLUTION OF TRACE ELEMENTS LIBERATED BY THE RETORT (ARSENIC, BORON, FLUORIDE, SELENIUM). IF MINING-SURFACE RETORT TECHNOLOGIES ARE EMPLOYED, EVERY DISPOSAL OPTION WOULD LEAVE A STAGGERING AMOUNT OF SPENT SHALE EXPOSED TO WATER FLOW.

OVER ONE TON OF SPENT SHALE PER BARREL OF OIL OR 1 BILLION TONS EACH YEAR FOR A 3 MILLION BARREL PER DAY INDUSTRY (USDOE, 2006).
• PROVIDES GUIDANCE ON RANGE OF POSSIBLE TOTAL DISSOLVED SOILIDS INCREASES IN RIVERS AND STREAM FOLLOWING LARGE SCALE IN SITU RETORT IN THE PICEANCE BASIN (PERSOFF AND FOX, 1981)

- 700 - 42,000 mg/L IN PICEANCE CREEK AT GREEN RIVER
- 20 – 1270 mg/L IN THE WHITE RIVER, UTAH
- 3 – 150 mg/L IN THE GREEN RIVER, UTAH
- 1 – 50 mg/L IN THE COLORADO RIVER, ARIZONA.
Conclusions

• MAJOR POTENTIAL NONPOINT SOURCES ARE LEACHATES FROM ABOVEGROUND STORAGE OR STORAGE OF SPENT OR RAW SHALE AND FROM IN SITU OPERATIONS THAT HAVE CEASED.

• 1922 COMPACT OBLIGATES UPPER BASIN STATES TO DELIVER POTABLE WATER THAT CAN BE REASONABLY APPLIED TO DOMESTIC AND AGRICULTURAL USES.

• STRATEGIES TO CONTROL SALINITY FROM LEACHING AT A COMMERCIAL SCALE HAVE YET TO BE PROVEN AND THUS LONG TERM MONITORING WILL BE REQUIRED TO ASSURE THAT CONTAMINANTS ARE NOT RELEASED DURING AND AFTER IN SITU DEVELOPMENT (USDOE, 2006)
References

BARTIS, J.T., et al. (2005) OIL SHALE DEVELOPMENT IN THE UNITED STATES: PROSPECTS AND POLICY ISSUES. RAND CORPORATION. SANTA MONICA. CALIFORNIA.


