Water Research - Desalinization and Aquifer Mapping Opportunities

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Legislative Finance Committee

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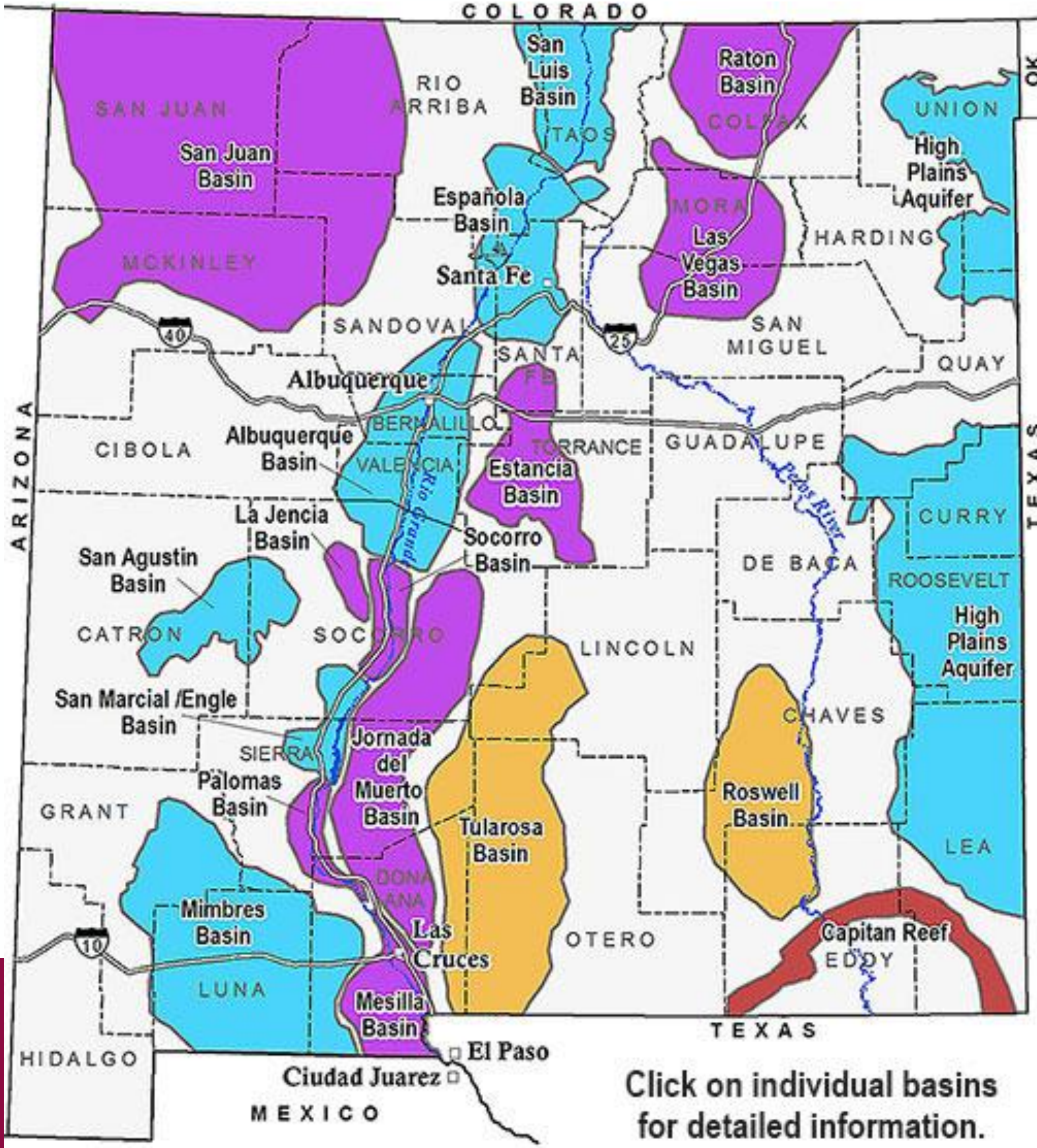
Brackish Groundwater Is a Valuable Alternative Water Resource



Brackish Water Aquifers in New Mexico

Blue: TDS <1,000 mg/L (potable)

Purple: TDS 1,000–3,000 mg/L (slightly brackish)

Orange: TDS 3,000–10,000 mg/L (brackish)

Red: TDS>10,000 mg/L (saline or brine).

Source: New Mexico Bureau of Geology and Mineral Resources. Dr. Lewis Land and Stacy Timmons

Challenges and Opportunities of Developing Brackish Water Desalination

- Water quantity and quality
- Costs versus benefits to economic development, industry, agriculture, communities, and the environment
- Concentrate and waste management

Aquifer Characterization and Mapping

High Recovery Desalination and Brine Valorization

Techno-Economic-Social-Environmental Assessment

Characterization of New Mexico Brackish Groundwater and Desalination for Fit-For-Purpose Applications

Under NMED - NMSU Partnership
2024 - 2025

Runwei Li, Lin Wang, Yun Ma, Wanqin Yu, William Bahureksa, Simeon Schum, Yanyan Zhang, Huiyao Wang, Zachary Stoll, Tanner Schaub, and Pei Xu

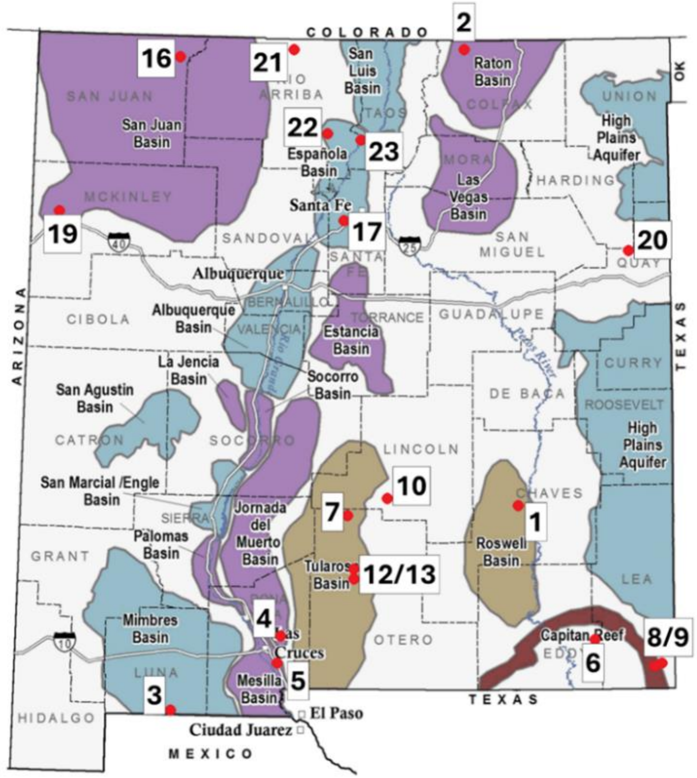
Brackish Water Characterization Overview

Historical Records

Office of the State Engineer
Interstate Stream Commission

Literature review based on brackish water quality-related records from the New Mexico Office of the State Engineer (OSE) Library and USGS database

Current Characterization



19 sampling sites identified with support from the New Mexico Environment Department (NMED), New Mexico Bureau of Geology & Mineral Resources, NM Water Facilities, and private well owners.

Multi-tiered approach (~300 analytes) for brackish water characterization

Tier 1
Field tests: Temperature, Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), Oxidation Reduction Potential (ORP), Turbidity
Other bulk tests: Ammonia, Alkalinity, Total suspended solids (TSS), Total Dissolved solids (TDS), Hardness (total and dissolved), Total and Dissolved Organic Carbon (TOC and DOC), UV-Vis full wavelength scan, Fluorescence Excitation-Emission Matrix (FEEM)
Tier 2
Metal elements (24): Aluminum, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silicon, Sodium, Strontium, Titanium, Vanadium, and Zinc
Anions (7): Bromide, Chloride, Fluoride, Sulfate, Nitrate, Nitrite, Phosphate
Radionuclides (5): Radium 226, Radium 228, Uranium (total), Gross Alpha/Beta
Tier 3
Volatile organic compounds (94) and semi-volatile organic compounds (120)
Per- and Polyfluoroalkyl Substance (25)
Non-Targeted Mass Spectrometry Analysis

Highlights of Groundwater Quality

Analyte	Range	Average	Median	Standard Deviation
Conductance (mS/cm)	0.18 – 46.1	7.18	1.90	13.3
Turbidity (NTU)	0.14 – 19.2	2.83	0.70	5.12
TDS (mg/L)	**767 – 55,100**	**8003**	**2167**	**12,979**
Total Hardness (mg/L as $CaCO_3$)	101 – 3,504	1204	1079	911
Dissolved Hardness (mg/L as $CaCO_3$)	93 – 3,460	1195	1026	921
Total Alkalinity (mg/L as $CaCO_3$)	76 - 441	246	250	115
TOC (mg/L)	**0.18 – 18.05**	**5.14**	**2.86**	**5.33**

- The measured concentrations of VOCs (94) and SVOCs (120) remain at a relatively low level (i.e., less than 10 ppb) and below the EPA's Maximum Contaminant Levels (MCLs) for primary drinking water if available

Highlights of Groundwater Quality

Analyte	Range	Average	Median	USEPA Drinking Water MCL	Exceeded in [1] Basin/County	Frequency of Detection
Uranium (μg U/L)	BDL - 56	0.018	0.013	30	only in Tularosa/Otero	37%
Gross α (pCi/L)	0.46 - 436	47.0	7.92	15	Capitan/Eddy, Tularosa/Otero High_Plains_Quay	89%
Gross β (pCi/L)	1.09 - 371	34.1	8.72	50		100%
Ra-226 (pCi/L)	BDL - 57.1	4.90	0.12	5*	Capitan/Eddy, Tularosa/Otero	89%
Ra-228 (pCi/L)	BDL - 14.2	2.43	0.71	5*		74%

Note: 1. Groundwater samples from other regions remained well below the USEPA MCLs (Maximum Contaminant Levels); BDL stands for below detection limit; "*" indicates Ra-226/Ra-228 combined regulation.

Highlights of Groundwater Quality - PFAS

Target Analyte	Frequency of Detection	Range	Average	Median	USEPA Drinking Water MCL
PFBA (ppt)	94%	BDL – 43.4	11.6	8.76	-
PFPeA (ppt)	73%	BDL – 50.9	8.58	2.91	-
4:2FTS (ppt)	-	BDL	-	-	-
PFHxA (ppt)	53%	BDL – 36.4	5.74	1.55	-
PFBS (ppt)	44%	BDL – 21.3	5.46	3.13	-
GenX (ppt)	**47%**	**BDL – 42.6**	**7.15**	**2.14**	**10**
PFHpA (ppt)	56%	BDL – 11.5	2.82	1.45	-
6:2FTS (ppt)	3%	BQL	-	-	-
PFPeS (ppt)	26%	BDL – 2.60	1.69	1.59	-
PFHxS (ppt)	44%	BDL – 7.35	2.59	2.26	10
PFOA (ppt)	**70%**	**BDL – 135**	**14.0**	**1.30**	**4.0**
PFNA (ppt)	44%	BDL – 0.88	0.66	0.65	10
PFHpS (ppt)	12%	BDL – 2.95	1.39	1.04	-
PFOS (ppt)	6%	BQL	-	-	4.0
8:2FTS (ppt)	56%	BDL – 17.4	4.27	3.36	-
PFDA (ppt)	15%	BDL – 5.80	1.90	0.71	-
NMeFOSA (ppt)	3%	BQL	-	-	-
NEtFOSAA (ppt)	-	BDL	-	-	-
PFUnA (ppt)	7%	BQL	-	-	-
PFNS (ppt)	6%	BDL – 1.81	-	-	-
PFDoA (ppt)	3%	BDL – 0.16	-	-	-
PFDS (ppt)	12%	BDL – 44.0	17.1	11.2	-
PFTrDA (ppt)	3%	BQL	-	-	-
PFOSA (ppt)	9%	BQL	-	-	-
PFTeDA (ppt)	-	BDL	-	-	-

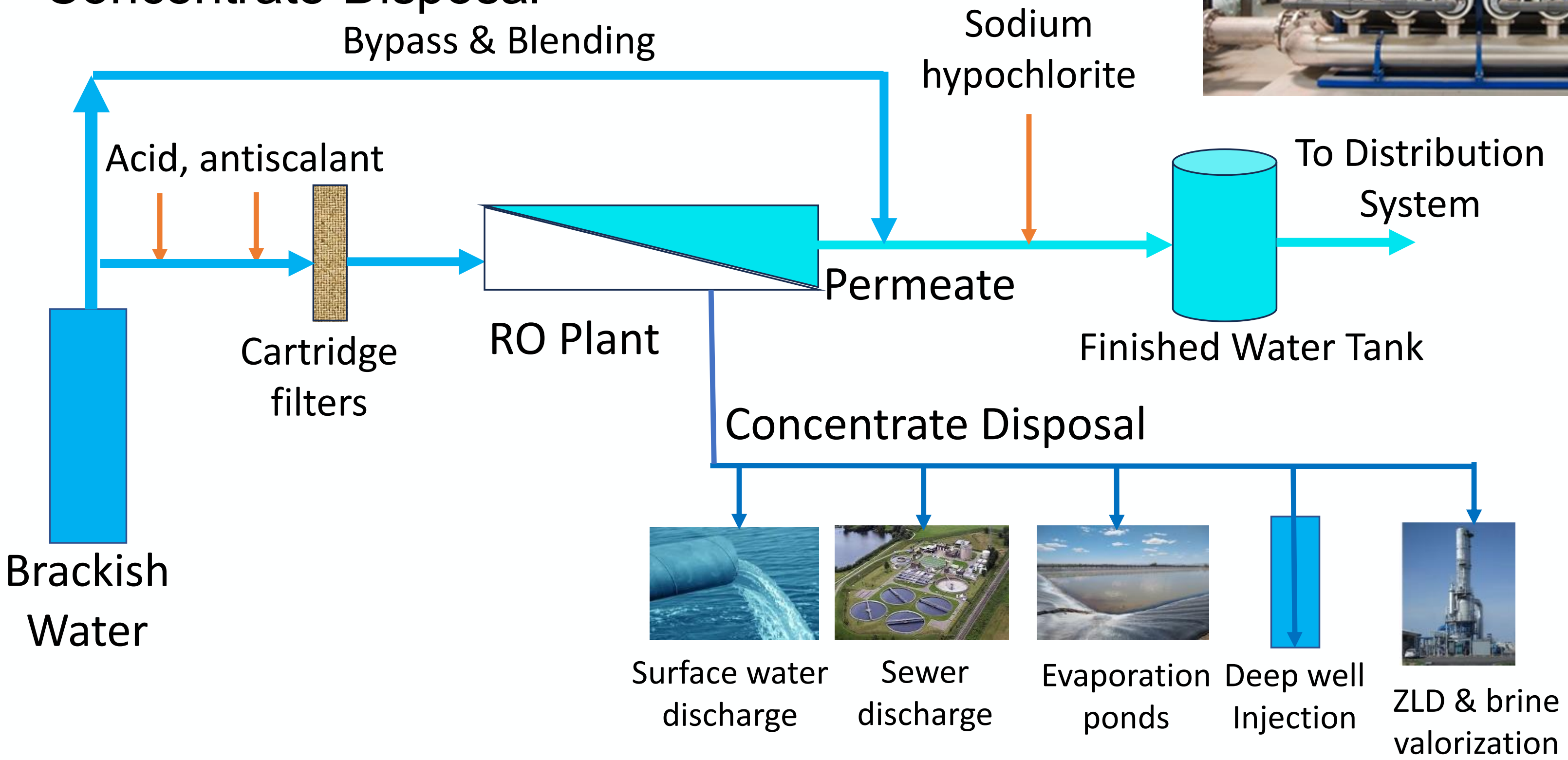
Note: 1. BDL stands for below detection limit; BQL stands for below quantification limit; "-" stands for not applicable. 2. Statistics were not computed when the detection rate ≤ 10%.

Summary of Groundwater Characterization

- Certain metals (e.g., Al, As, Cr, Fe, Mn, Pb, Se) were detected above the drinking water standards.
- Among all detected PFAS analytes, PFOA might have the largest concerns, detected in 70% of the samples. Total PFAS (all quantified PFAS summed together) concentrations were the highest in the Jornada del Muerto and Tularosa groundwater samples, which lie close to Las Cruces and the White Sands Missile Range, respectively.
- Groundwater quality is highly variable and desalination is required to remove salts, metals, organics, PFAS, and radionuclides.

Conventional Brackish Water Desalination

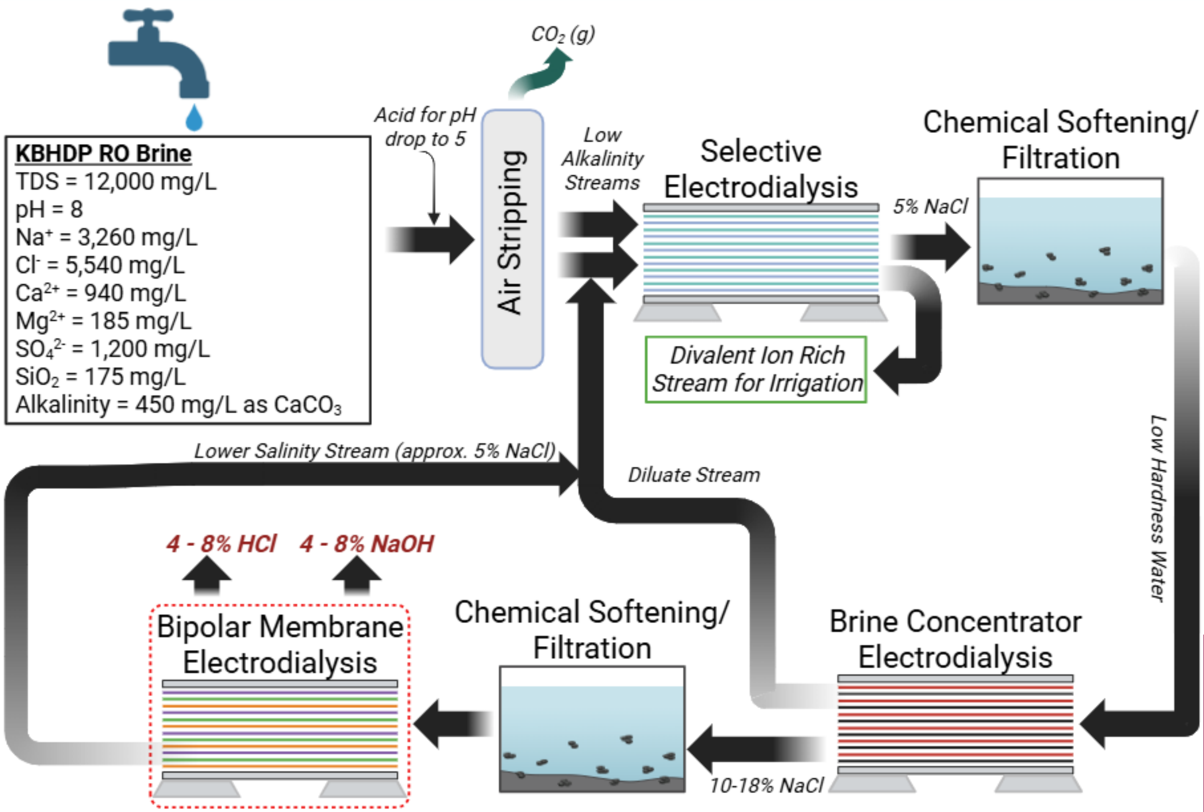
- Pretreatment
- Brackish Water Reverse Osmosis (BWRO) Water Recovery 70-83%
- Concentrate Disposal



High Water Recovery Desalination and Brine Valorization

- Increase efficiency to improve water recovery
- Reduce brine volumes, and thus costs
- Produce valuable minerals for reuse or sale

NMSU's Pilot System Treating KBHDP RO Brine for Near-Zero Liquid Discharge System, and Generating Water for Irrigation, Acids and Caustic Solutions, and Minerals for Cement Manufacturing



Summary of Water Research and Desalination

- Brackish groundwater desalination is a mature process
  - Readily implementable in New Mexico to augment water supplies
  - RO concentrate disposal is a great barrier
- On-going research at NMSU is focused on:
  - Characterization of brackish water quality, including emerging contaminants such as PFAS compounds
  - Development of innovative technologies to further polish water quality, improve water recovery, and valorize brine with marketable products

Support of Strategic Water Supply

NMSU Brackish Water Research and Support Hub

Project Management: Comms, Data Storage & Access, Reporting, PR

Resources & Synergy
- WRRI
- NMSU AI Council
- Research Computing Advisory Council
- STEM Education Network
- Cooperative Extension
- Ag Experiment Station
- Information Technology
- NMPWWRC

RESEARCH CORES PROGRAM

Project Steering Group: NMSU + NMED + NM Tech + NM OSE

Technical Working Group: NMSU Faculty + Research Cores Program + OSI

POC: Dr. Tanner Schaub
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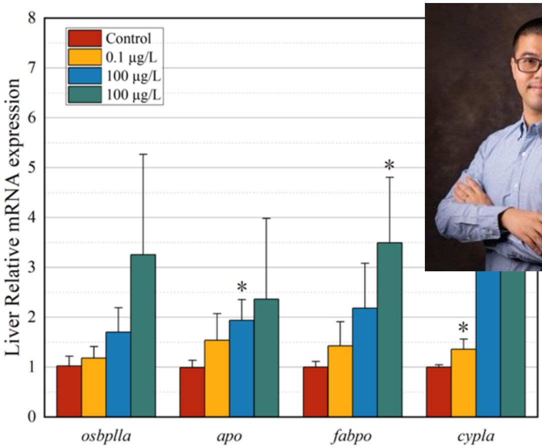
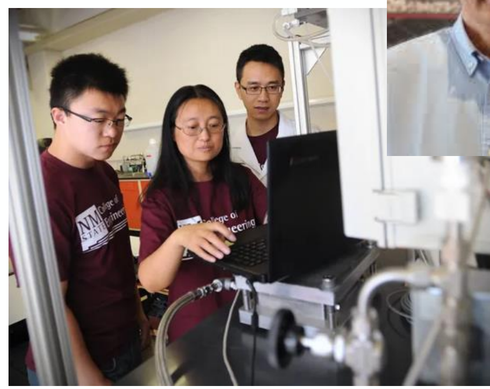
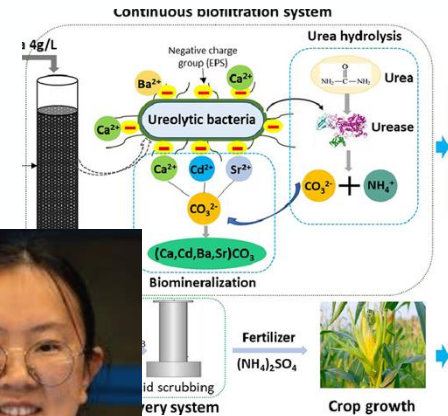
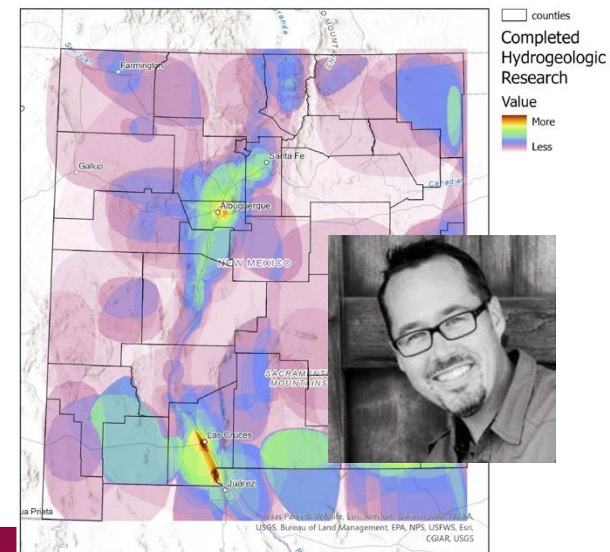
Support of Strategic Water Supply

NMSU Core Team – People & Labs









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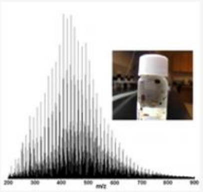
Support of Strategic Water Supply

Infrastructure

RESEARCH CORES PROGRAM



Chemical Analysis & Inst. Lab (CAIL)

Microscopic Imaging Core Suite (MICS)

High-Intensity X-Ray Diffractometer (XRD)

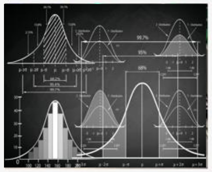
Discovery HPC Cluster

Lab Animal Vivarium

RESEARCH COMPUTING

Research Computing & Data Science

STEM+ Education Research Institute (SERI)



Data Science Consulting Center

Partnerships

NMSU – National Lab Partnerships

NMSU – Industry Partnerships

NM Space Grant Consortium & WRRI

NMSU AI Council & Research Computing Advisory Council

NMSU Cooperative Extension Service

NMSU Genesis Water Lab

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