

Hydrogeology of the Proposed Tule Springs Fossil Beds National Monument, Clark County Nevada

AquaPetrus LLC

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Acknowledgments

- Jill DeStefano, President and Founder of Protectors of Tule Springs
- Dr. Steve Rowland, Paleontologist, UNLV
- Dr. Josh Bonde, Paleontologist, UNLV
- Jonathan Carter, BC Geophysics
- Jim O'Donnell, BC Geophysics, HH Seismic
- Kale McLin, KLM Geoscience
- All of POTS members
- Previous mappers of the area, most notably John Bell and Alan Ramelli of the Nevada Bureau of Mines and Geology (NBMG) and Ric Page of the USGS

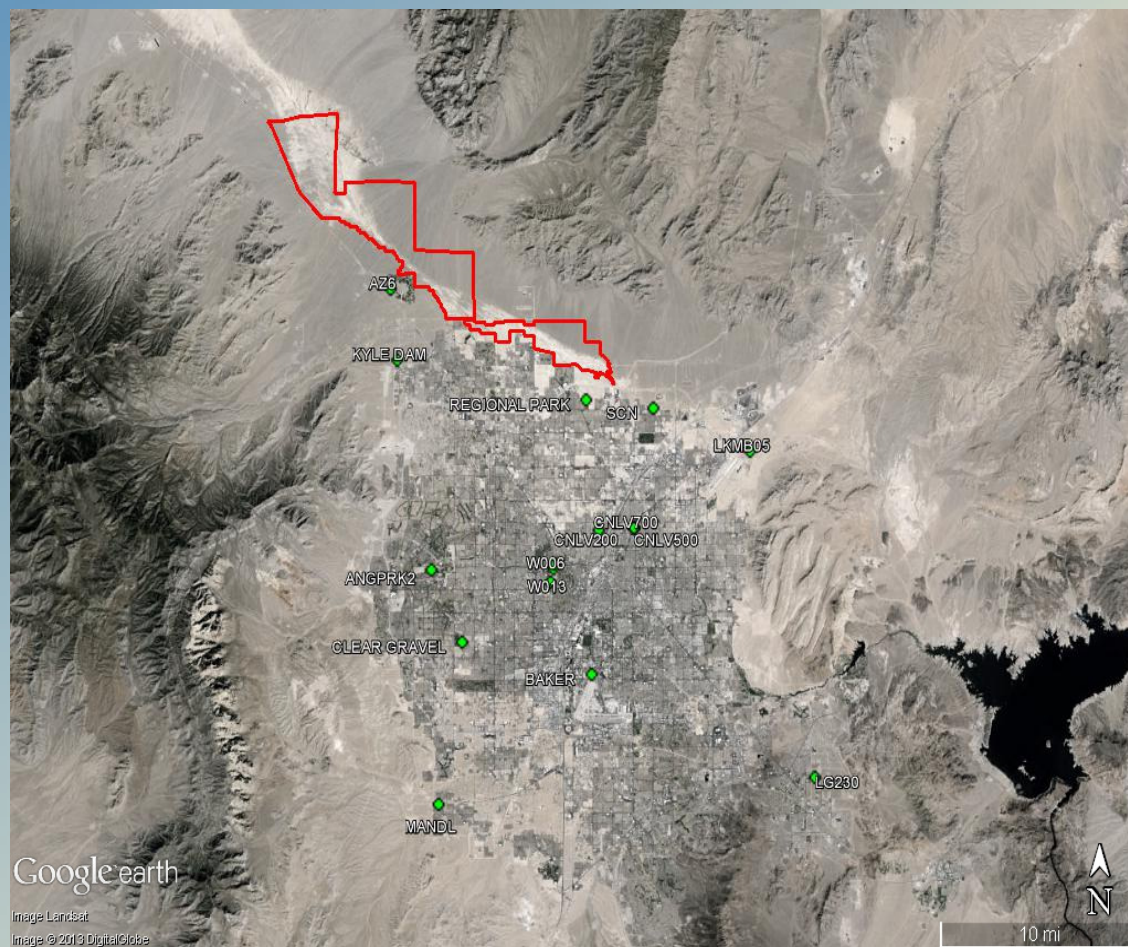
Background

- This presentation is a discussion about some of the most recent data and hypothesis testing to develop better methods of characterizing the distribution of the sediments in the basin-fill of Las Vegas Valley, and by extension, valleys with similar depositional settings.
 - **Especially it's implications for groundwater flow**
- This has been an ongoing interest of mine for the last couple of decades, beginning with my (1996) MS thesis.
- Las Vegas Valley water well database comprises a huge volume (about 15,000 well logs) of low quality data, with locally, very good data.

Key Points

- Description And Status Of Proposed National Monument In The Northern Part of Las Vegas Valley.
- The Area Is An Approximate 20 Mile Reach Of Upper Las Vegas Wash.
- The Dominate Lithological (Geological) Unit In The Area Is the Pleistocene Las Vegas Formation.
- This Section of Las Vegas Wash Is Ephemeral And Only Flows As A Result Of Large Storm Events.
- The Idea That The Stream Was Once Perennial Has Been Proposed At Least Twice, However the Associated Idea Of A Pleistocene “Lake Las Vegas” Has Been Disproven.

Location of Proposed Monument in Las Vegas Valley



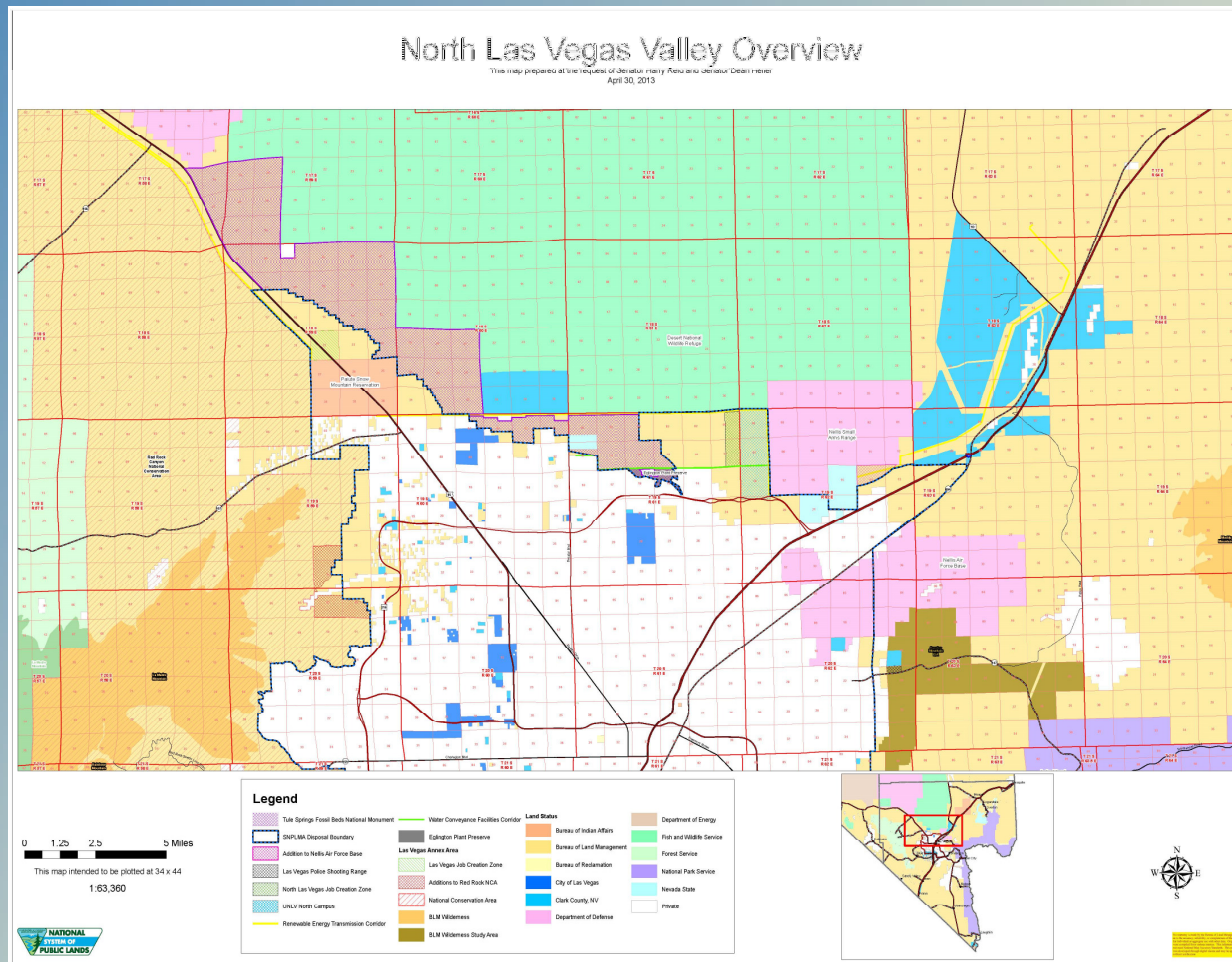
Proposed Tule Springs Fossil Beds National Monument (TSFBNM)

- April 2013, introduced in the US House and Senate (S. 974, H.R. 2015)
- Currently proposed area is 22,600 acres
- Primarily proposed to protect the Pleistocene Megafauna, but also archeological resources and endangered plant species
- Northernmost part of the metropolitan area
- The Desert National Wildlife Refuge forms the northern border
- Located in North Las Vegas and Las Vegas
- Supporting resolutions by CNLV, CLV, CC, NV legislature (2013 session), Gov. Sandoval and all 6 congressional representatives

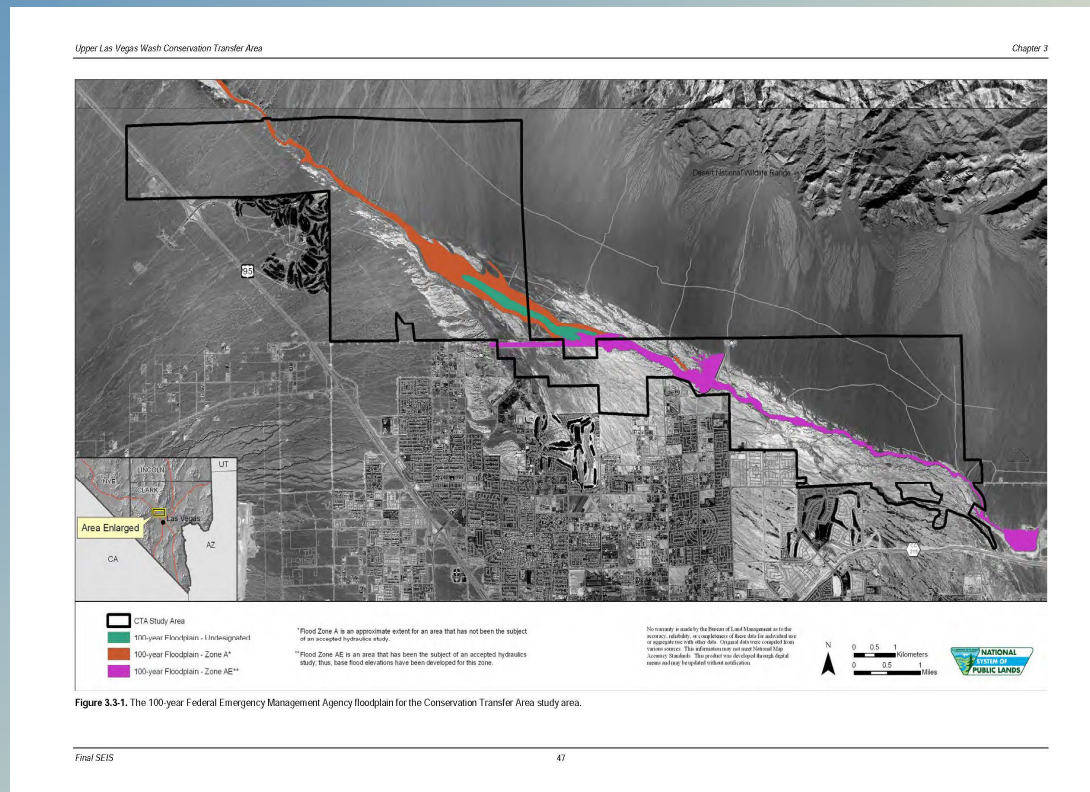
Detail of Location In Northern Las Vegas Valley



April 2013 Legislative Map With Land Status



BLM Flood Hazard Maps (From 2011 BLM EIS)



<https://www.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage¤tPageId=39654>

BLM Fossil Localities (From 2011 BLM EIS)



Hazards Potentially Minimized

- Flood Hazard
 - Defined in the 2011 EIS (however, CLV, NLV and CCFCFCD have different maps)
 - August 25 - 28, 2013 flooding
 - Two (three) large detention basins in place
- Poor Soil Conditions
 - Seismic hazard defined by average velocity of the uppermost 100 feet
 - Subsidence potential
 - At least one of the endangered species thrives in gypsiferous soils
- Illegal Collection Of Vertebrate Fossils
- Illegal Collection Of Archeological Resources
- Harm To Endangered Plant Species

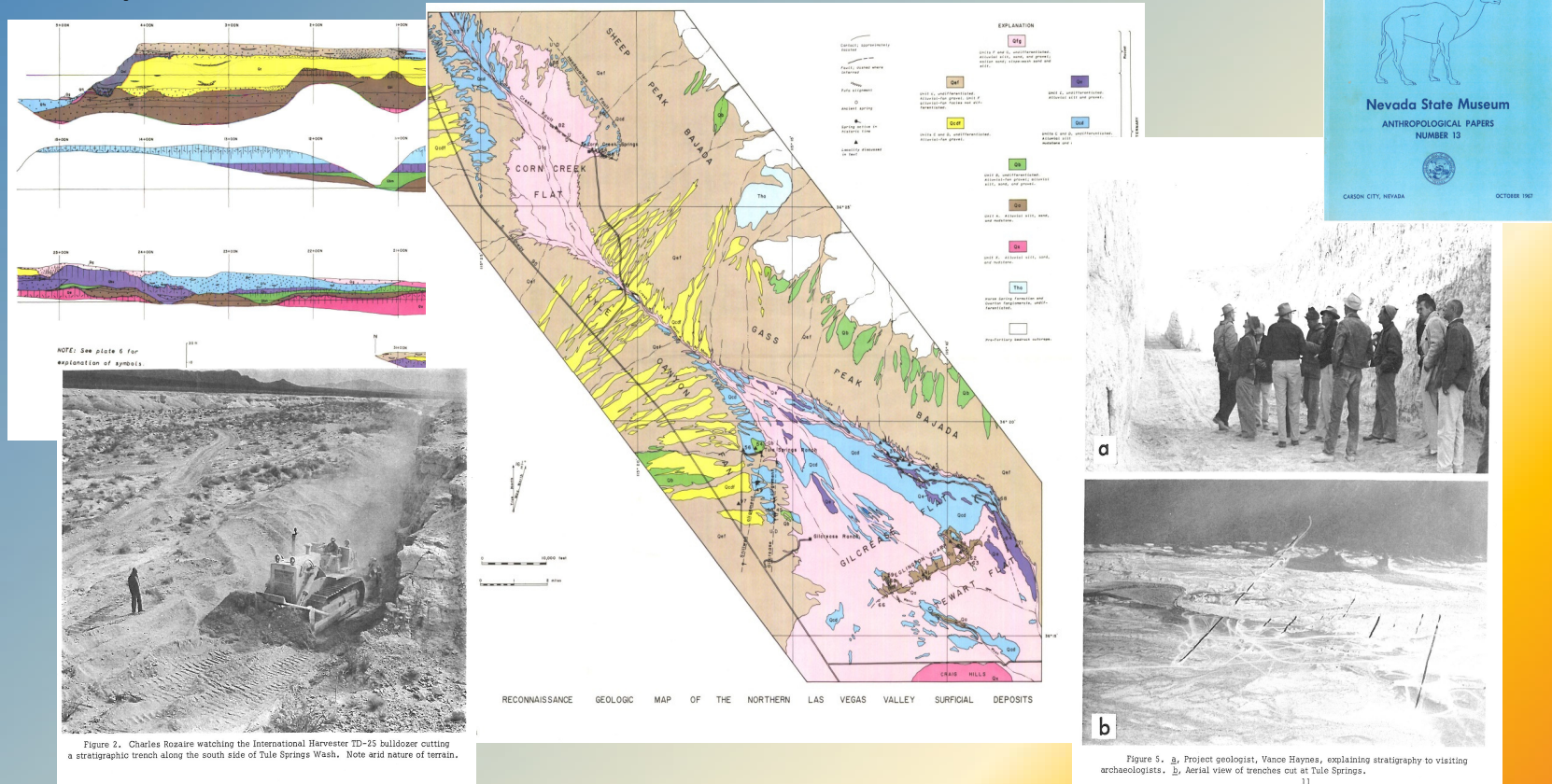
Additional Characteristics

- Currently BLM Administered (without special designation)
- Adjacent To Snow Mountain Piute Reservation (hence detailed discussions with the tribe)
- Adjacent To The Desert National Wildlife Refuge / Nellis Range (hence detailed discussions with the US Air Force)
- Current Preservation Efforts Began In 2006 (formation of POTS)
- **Reasons For Support Varies By Individual**
- Existing Utility Infrastructure (most notably a high capacity Electrical Line, a major Natural Gas pipeline and two large Flood Control detention basins and associated dikes, and two of NLV's large capacity Reservoirs, and a large Shooting Range)

Fossil Assemblages

- The fossil assemblage in the Las Vegas Formation includes mollusks, amphibians, birds and small and large mammals
- The large mammals include:
 - Ground sloth (*Nothrotheriops shastensis*)
 - North American lion (*Panthera atrox*)
 - Camel (*Camelops* sp.)
 - Horse (*Equus* sp.)
 - Bison (*Bison* sp.)
 - Mammoth (*Mammuthus columbi*)
 - Additional Species
- Due to abundance, and apparent lack of preservation bias, paleoecological studies are possible

Nevada State Museum Anthropological Papers Number 13 (Wormington and Ellis, 1967) (aka Haynes, 1967)



Scientific Questions for Proposed Monument

- Education About Geologic And Hydrologic Processes In An Urban Area
- Distribution of Las Vegas Formation (LVF) And Geologic Units Named And Described In Donovan, 1996
 - Specifically the relationship with the Tule Springs alloformation (TSA).
 - Donovan, 1996 was referenced and the possible conflicts in interpretation / Geologic nomenclature was specifically mentioned in 2011 BLM EIS.
- Differences Between LVF and TSA Are Due To Multiple Factors.
 - The differences will not be fully described in this presentation but the most obvious is that the difference between surficial mapping and sub-surficial mapping
 - **Another factor is the use of allostratigraphic units by Donovan, 1996; now commonly used worldwide, and strongly recommended to solve stratigraphic questions in similar settings**

Las Vegas Formation (Historical)

- Distinctive (mappable) light colored fine grained badlands deposits in the central axis of Las Vegas Valley
- Named by Longwell et al (1965) (NBMG Bulletin 62)
 - Type section in the NE corner of a legal Township
- Mapped in detail by C. V. Haynes in the Corn Creek and Tule Springs areas (Haynes, 1967)
 - Divided into 7 units (functional formal beds) (A-E), plus local detail at locations of interest (fossil and archeological sites)
 - The work was performed in 1962 –'63 and included W. Libby (Carbon 14 method) and hence many sites were dated using the brand new, Noble Prize winning C14 method.
 - Although somewhat improved, the maximum age for C14 is still about is 40,000 years bp

Las Vegas Formation (Key Points) 1

- Maximum Thickness Is 30 meters (~ 100 ft)
- The most fossiliferous units are B, D and E
 - Correspond to wet / glacial periods determined by either global or local (outcrop scale) correlation
 - Unit D is the most aerially extensive
- Maximum Inferred Age Is ~ 250,000 yr bp (c.f. Ramelli et al, 2012 and Page et al, 2005), by thermoluminescence
- **All of the LVF is late Pleistocene**

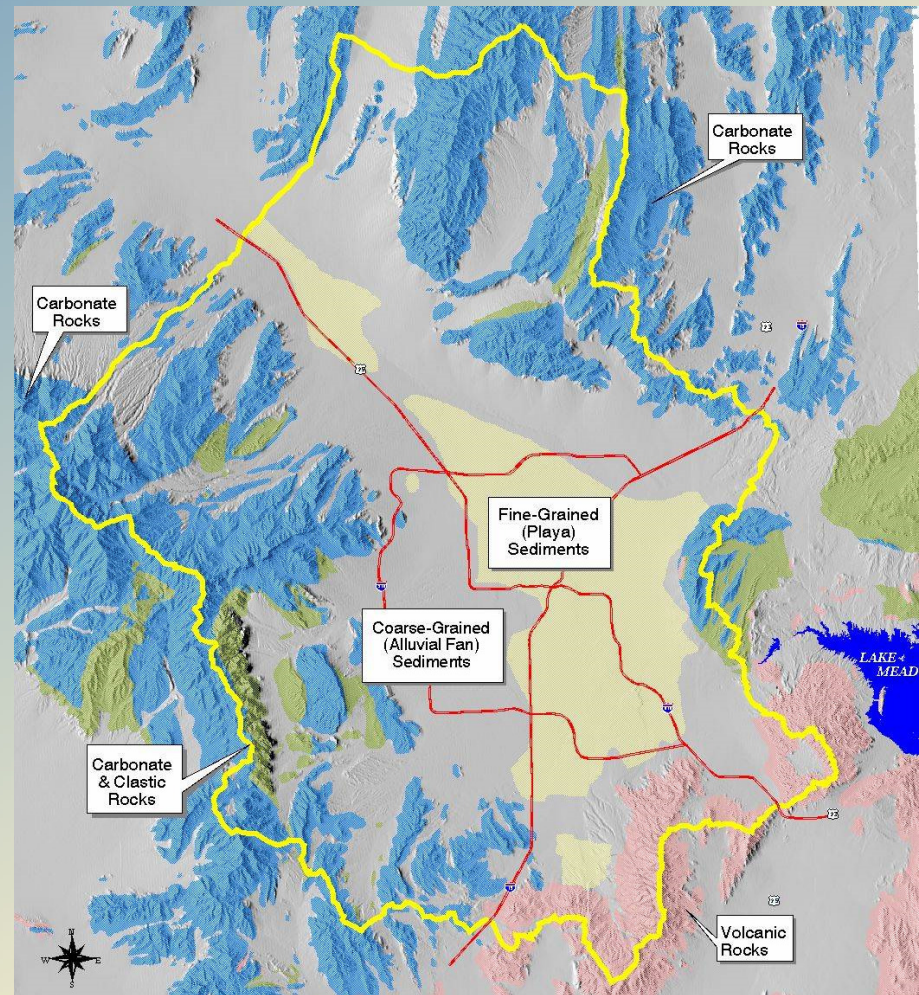
Las Vegas Formation (Key Points) 2

- The uppermost units (D & E) are well dated by multiple techniques and correspond to Marine Oxygen Isotope (MIS) Stage 2 (Wisconsin) and Younger Dryas, respectively
- Unit B likely corresponds to MIS Stage 6 (130,000 to 190,000 yr bp)
- Thickness and age of Unit A (basal and poorly exposed unit) remains poorly defined
- **Most of the underlying Pleistocene sediments, and all of the probable Pliocene units in the basin-fill are unnamed, except by Donovan 1996, and constitute about 1-2 thousand ft section of sediment**

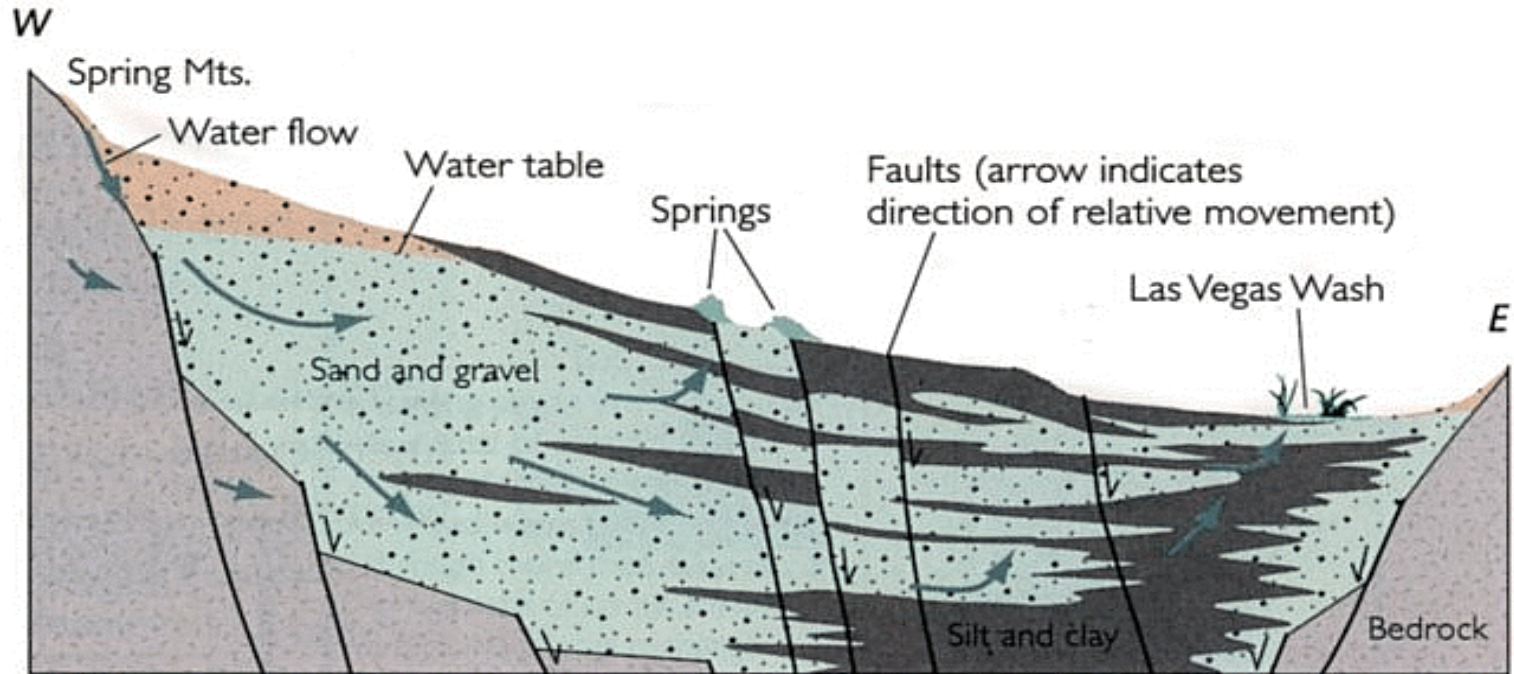
Political Boundaries in Las Vegas Valley



General Distribution of Rock / Soil Types

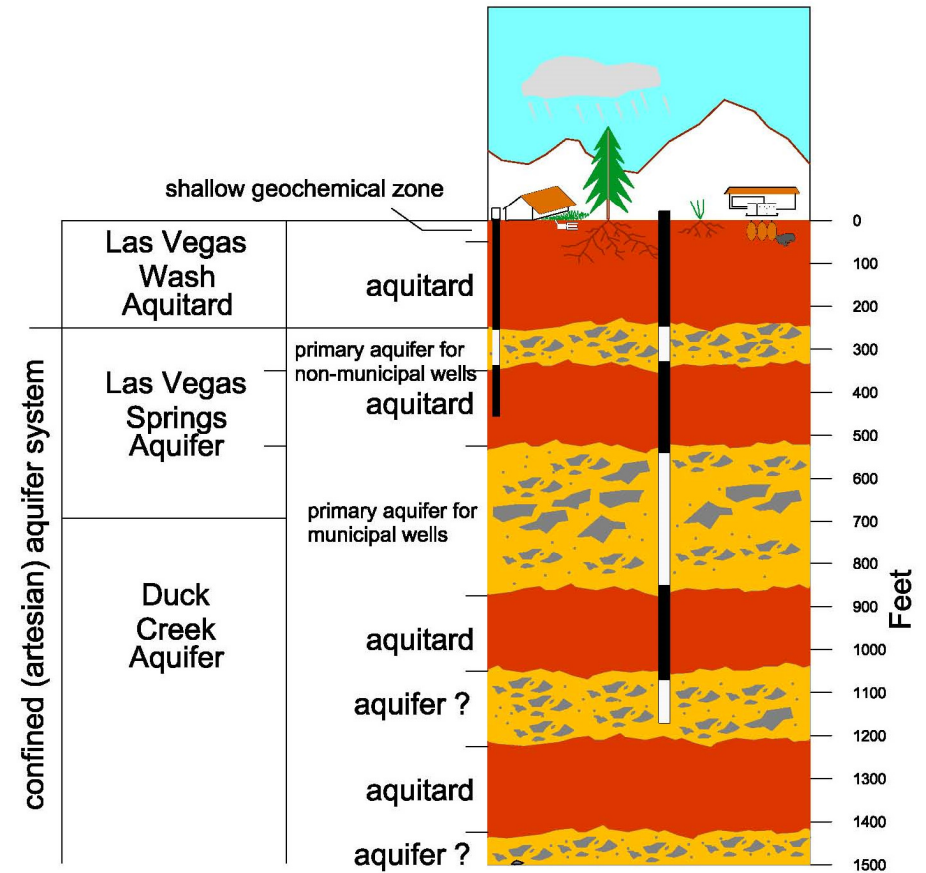


Very Generalized Cross Section of Las Vegas Valley (coarse grained sediments are over emphasized)

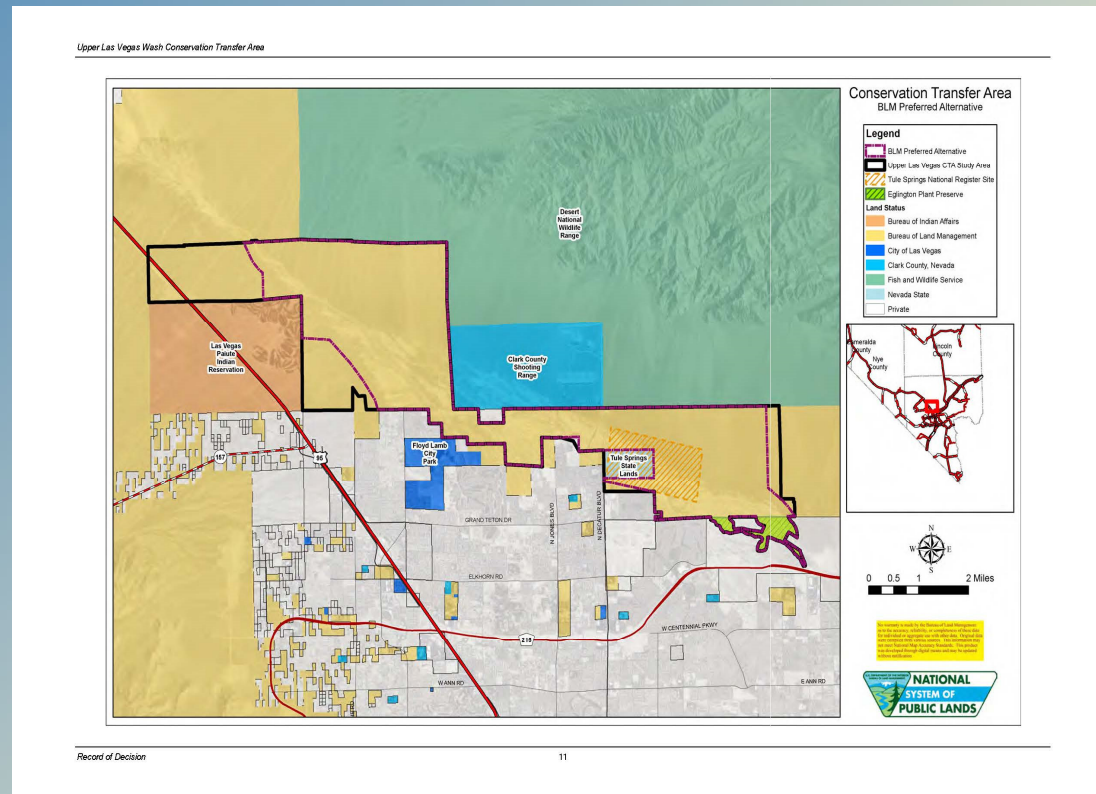


Hydro Stratigraphic Diagram

Very simplified diagram of the ground-water system in the central part of Las Vegas Valley



2011 BLM EIS Map of the Proposed Monument 1



<https://www.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage¤tPageId=39654>

2011 BLM EIS Map of the Proposed Monument 2



Figure 1.1-2. Upper Las Vegas Wash Conservation Transfer Area study area boundary.

Archaeological conclusions from the 1962-'63 excavation

“There is no evidence for the presence of humans earlier than 13,000 years ago. The previously announced date in excess of 23,800 years was derived from a mixed sample taken from deposits of different age and is meaningless; the previously announced date in excess of 28,000 years gives the age of carbonized wood, but it does not prove the use of fire, nor does it serve to date the scraper found in the locality from which the sample was taken.”

---- Richard Shutler, 1967

Current Water levels Near The Proposed Monument Area are about 300 to 100 ft below land surface)

- Based on the paleoecological data of the LVF, Upper Las Vegas Wash was a live stream (perennial) in Unit E, D, and B time
- Unit E is Younger Dryas (~ 10,000 yr bp)
- Unit D is MIS 2 (or Wisconsin) (~ 15,000 to ~30,000 yr bp)
- Unit B is MIS 6 (~ 130,000 to ~ 190,000 yr bp)

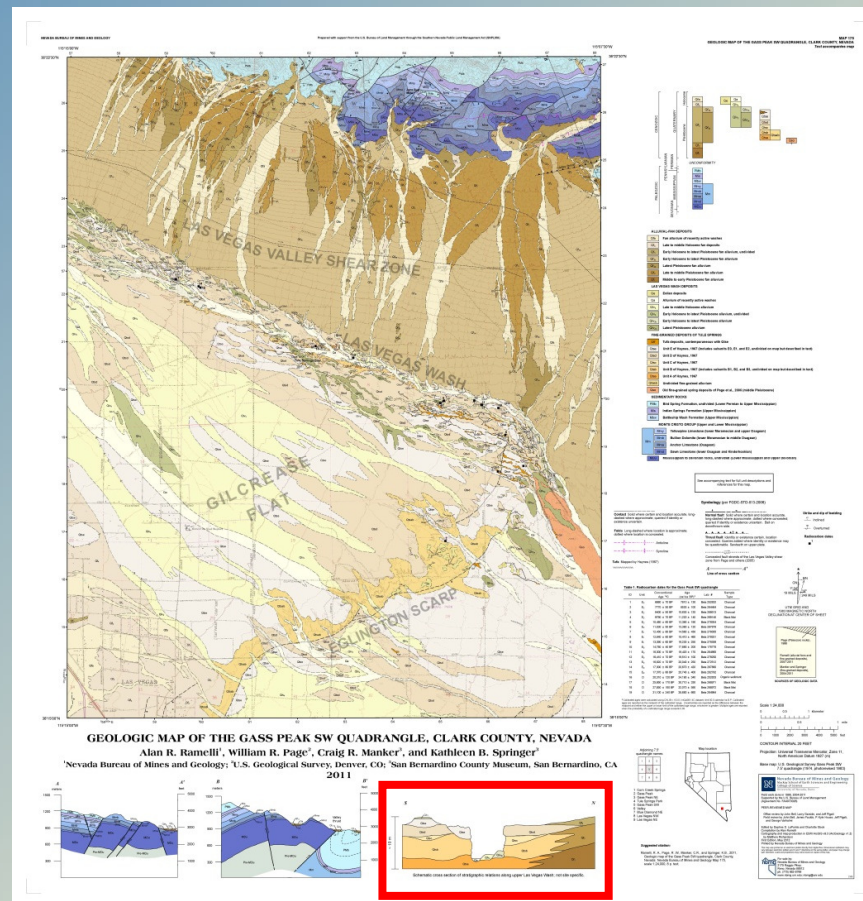
21st Century Reports

- 2011 BLM EIS of Proposed Monument Area
- 2005 Las Vegas 30 by 60 Minute (100K) Geologic Map of the USGS
- 2005 – 2014 Several 7.5 Minute Geologic Maps by Nevada Bureau of Mines and Geology (NBMG)

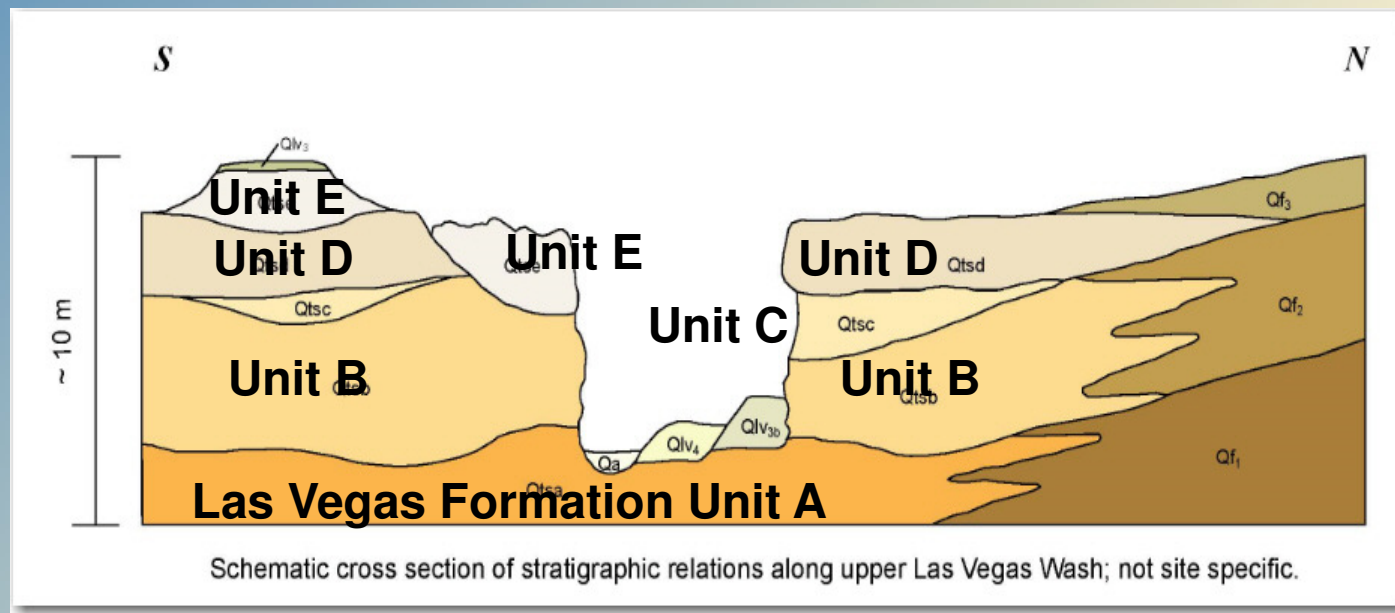
Trench K in October 2014



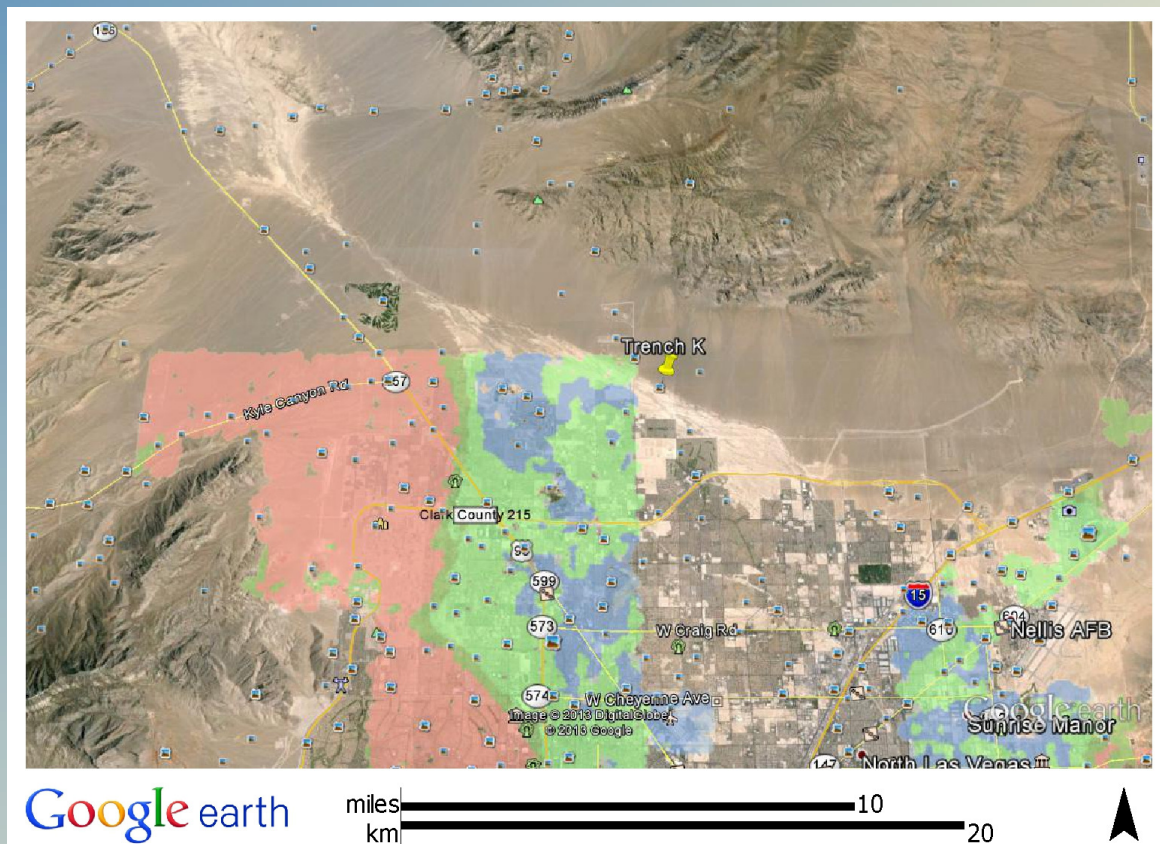
Ramelli et al., 2012, Geologic Map Gass Peak SW Quadrangle, NBMG



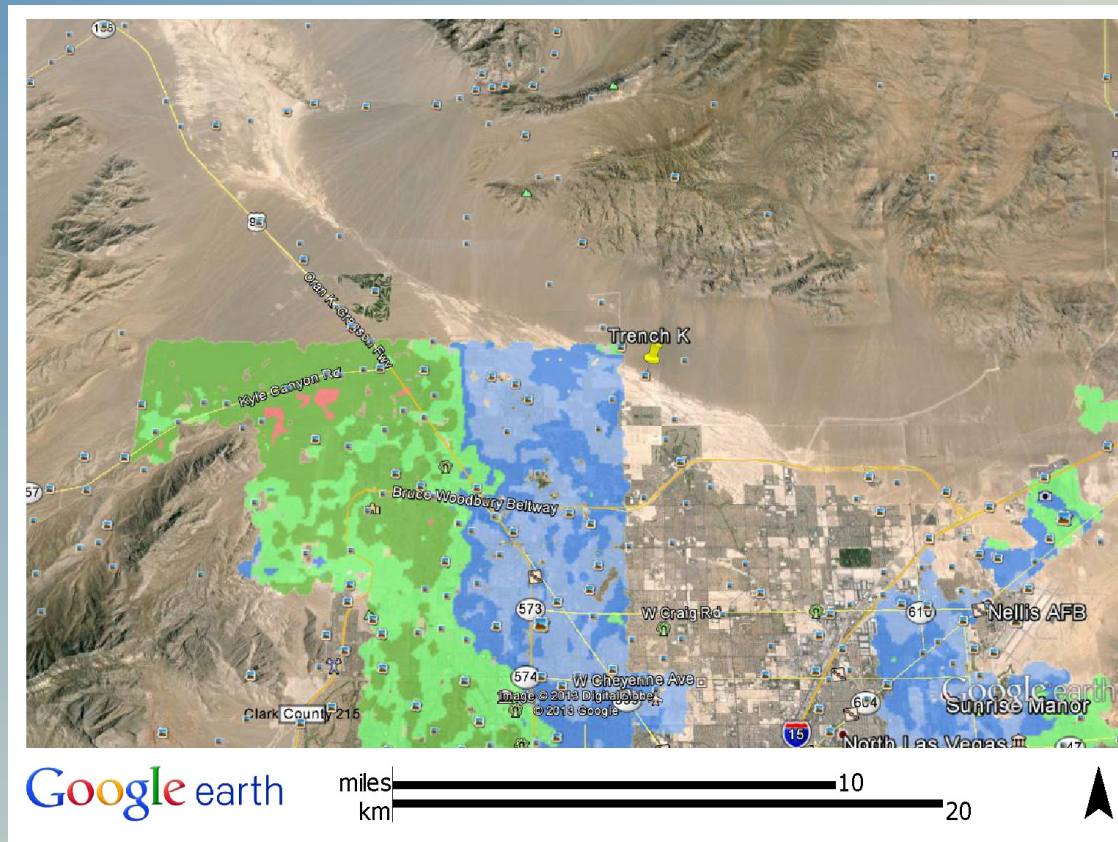
Detail, Ramelli et al., 2012, Geologic Map Gass Peak SW Quadrangle, Nevada Bureau of Mines and Geology



Clark County Seismic Velocity (ReMi) Data – 10,700, 600 ft cabled lines (collected and processed by Optim) 2008 - 2011



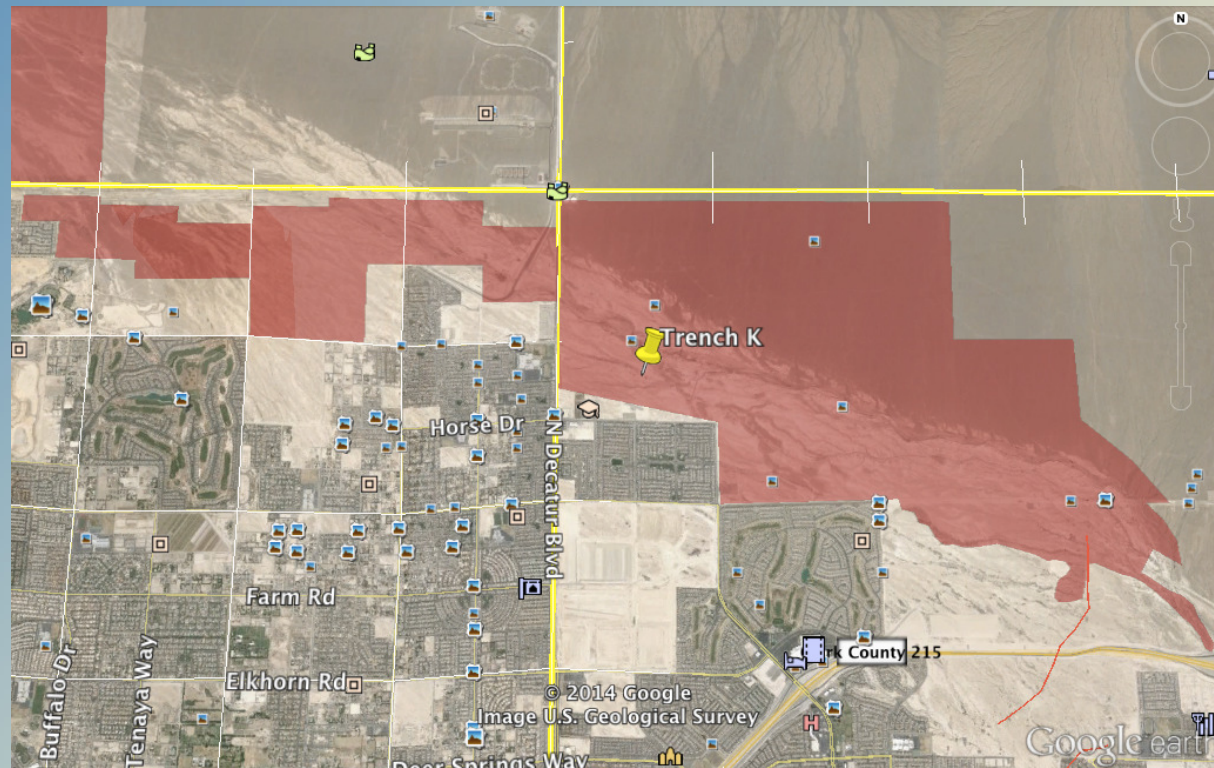
Same Velocity Categories In the Uppermost 20 ft



Las Vegas Formation Outcrop



Detail of Eastern Part of Proposed Monument



Well log from NLV / UNLV Experiment Station

1. OWNER City of North Las Vegas AL
MAILING ADDRESS P.O. Box 4086 I
N. Las Vegas, NV 89036

2. LOCATION NW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 7 T. 20 R. 15
PERMIT NO. 58461T Issued by Water Resources Parcel No.

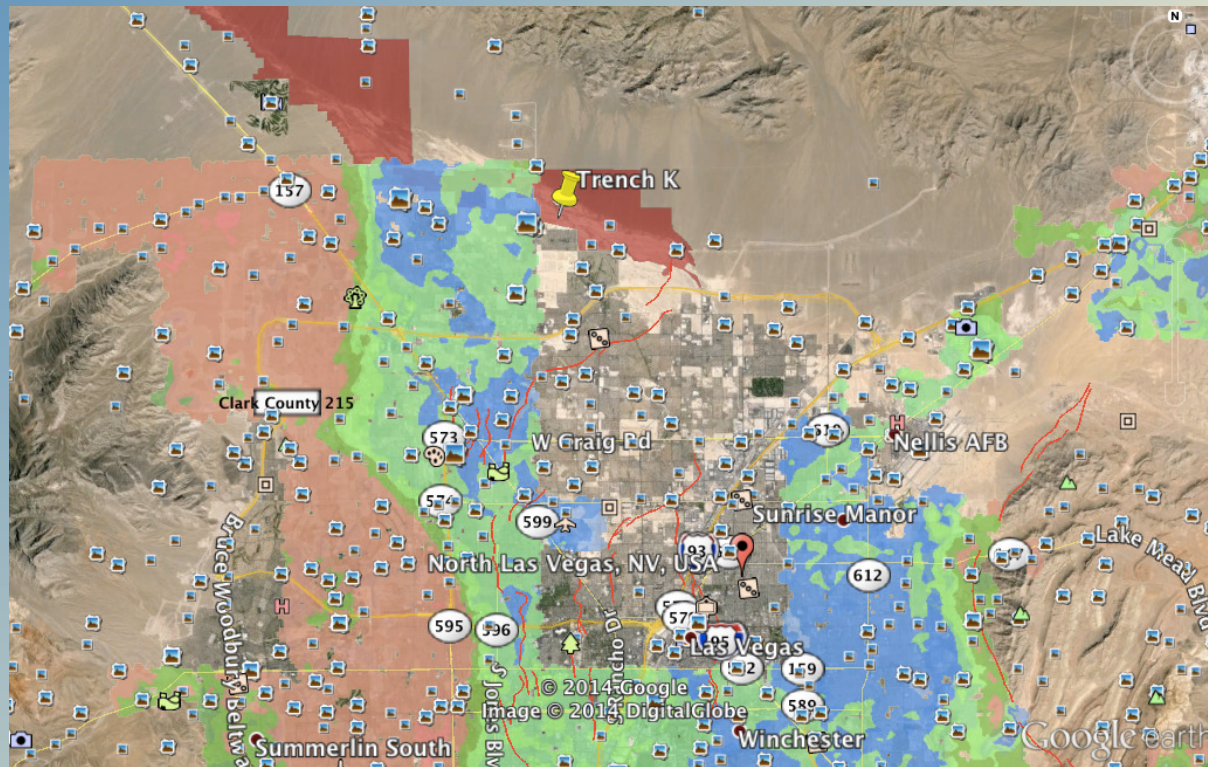
3. WORK PERFORMED
☒ New Well ☐ Replace ☐ Recondition
☐ Deepen ☐ Abandon ☐ Other

4. ☐ Domestic
☒ Municipal/Industrial

6. LITHOLOGIC LOG

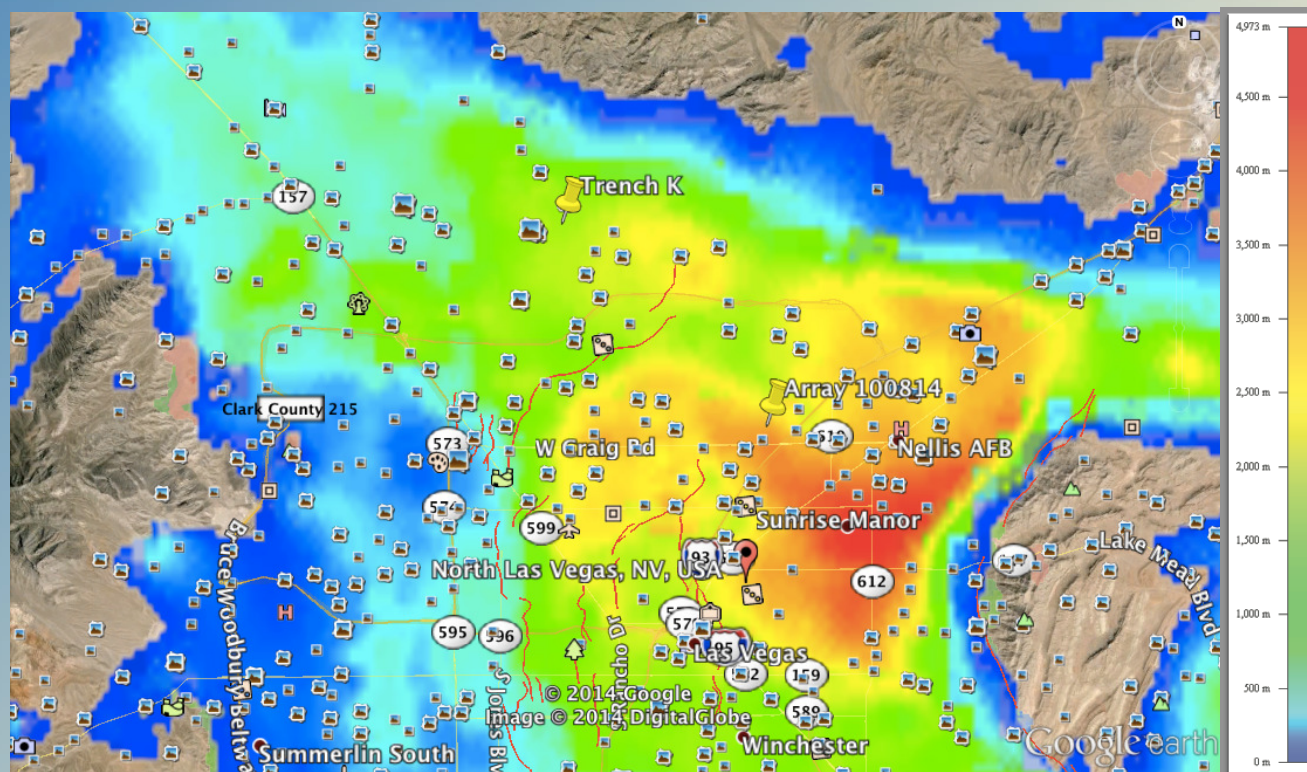
Material	Water Strain	From	To	Thick-ness
White clay		0	100	100
Gravel stringers & clay		100	140	40
Brown clay		140	200	60
Gravel & brown clay		200	280	80
Gravel		280	300	20
Br. clay & gravel mixed		300	340	40
Brown clay		340	360	20
Fractured gravel		360	380	20
Brown sandy clay		380	440	60
Stringers of grav. & clay		440	480	40
Clay		480	500	20
Clay & gravel		500	520	20

Proposed Monument and Clark County Seismic Velocity Data



Overall Geometry of the Basin

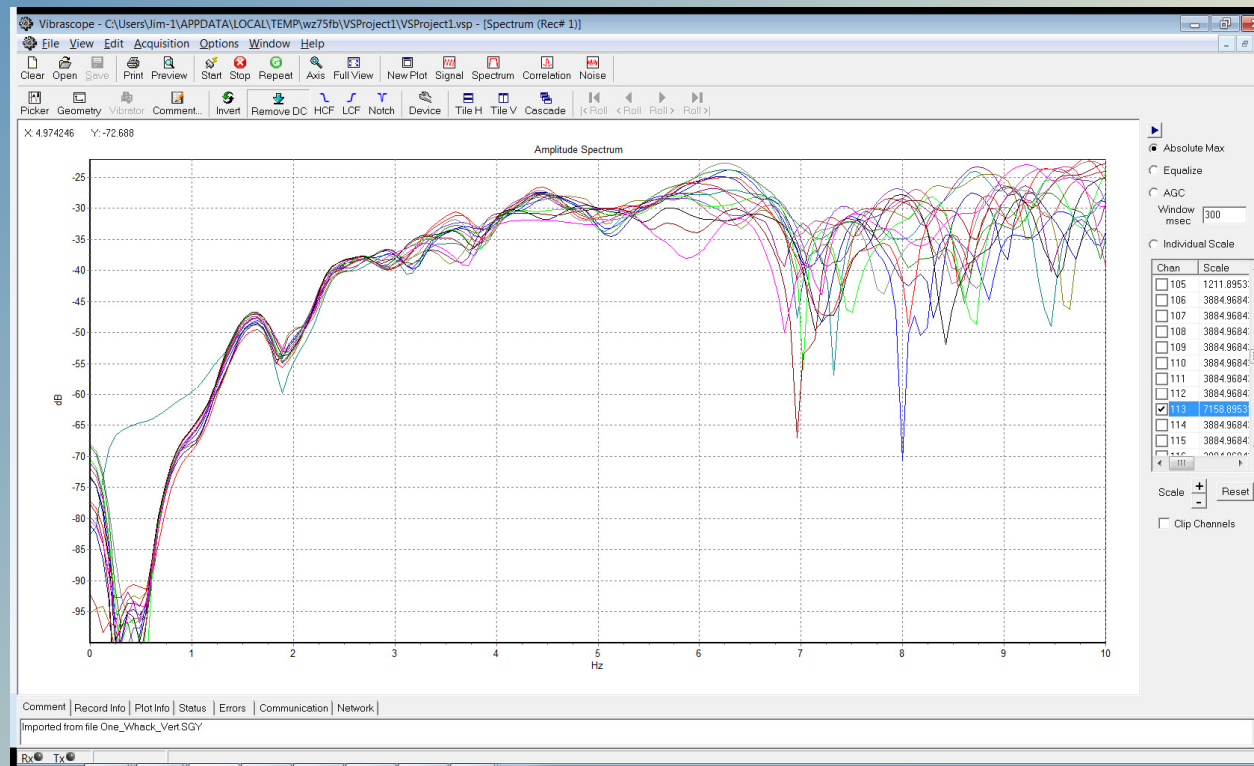
USGS Gravity Interpretations (Langenheim et al. 1999)



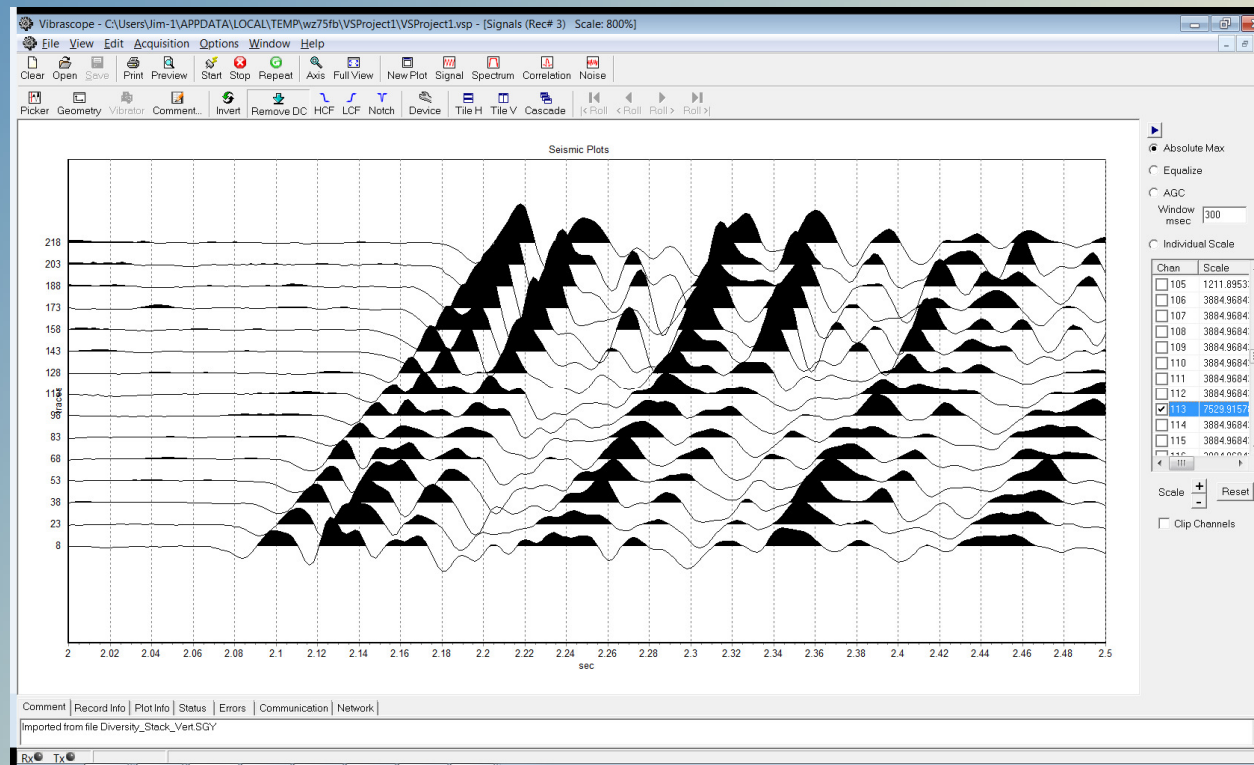
Recently Collected (10/08/14) Cable-Less, Low Frequency (2 Hertz), 700 ft Cube of ReMi Data

- 15 Columns, 15 Rows, 50 ft Spacing
- Primarily, a test of method, for other areas in Nevada, with less well log control data
- Use in Las Vegas Valley was due to location of key equipment, and the availability of well log data
- Used a combination of passive and active controlled energy sources

Selected Raw ReMi (Seismic Velocity) Data from 10/08/14



Partially Processed Selected Data



No Conclusions yet

Flooding !



Altitude At Selected Locations Along Las Vegas Wash

- Corn Creek 2920 famsl
- Tule Springs / Floyd Lamb CLV Park 2470 famsl
- NLV Detention Basin 2050 famsl
- **Upper Las Vegas Wash falls ~ 900 ft in 17 miles**

LV Sun (August 25, 2013) Flooding

Flooding shuts U.S. 95 at Horse Drive; 2 people rescued from car in Kyle Canyon



STEVE MARCUS

Vehicles turn around as storm runoff floods Grand Teton Drive near Grand Canyon Drive on Sunday, Aug. 25, 2013.

<http://www.lasvegassun.com/news/2013/aug/25/part-valley-under-flood-advisory-interstate-40-clo/>

LV Review Journal (Oct 3, 2013) Fossils

Southern Nevada leaders make pitch for Tule Springs National Monument



Eric Scott, curator of paleontology at the San Bernardino Museum in southern California, points towards the fossilized tusk of a Columbia Mammoth believed to be 16,000 years old, on Thursday, Dec. 2, 2010, as he talks about the dig site at Tule Springs in the Upper Las Vegas Wash. Scott hosted local officials on a tour of the site in order to show the value of the fossil grounds. (File, JUSTIN YURKANIN/LAS VEGAS REVIEW-JOURNAL)

<http://www.reviewjournal.com/news/government/southern-nevada-leaders-make-pitch-tule-springs-national-monument>



Protectors of Tule Springs Website



<http://tulespringslv.com/>

Las Vegas Ice Age Park Foundation Website



<http://www.iceagepark.org/>

Summary

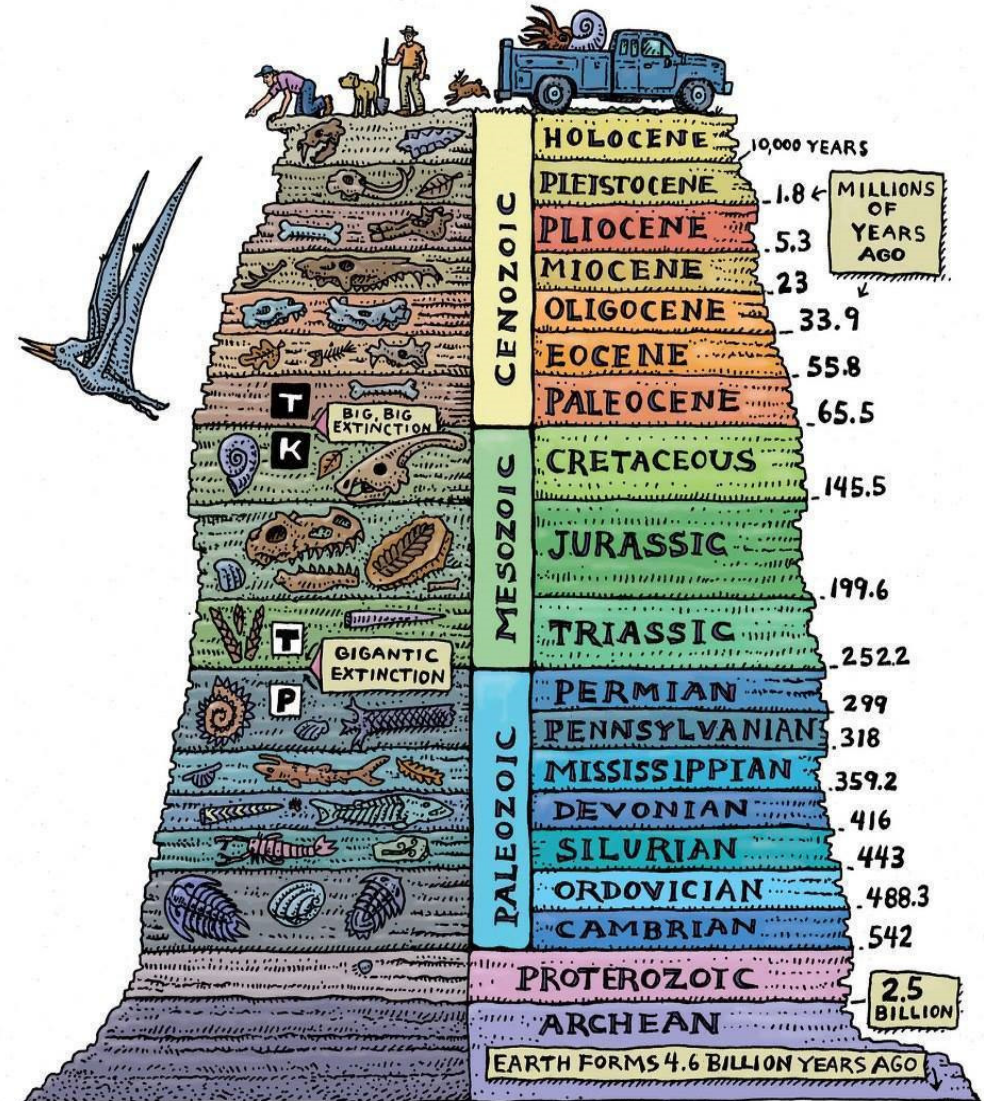
- Proposed National Monument of over 22,000 acres
- Located between the northern edge of urban development and the Desert National Wildlife Refuge, along Upper Las Vegas Wash
- Flooding and poor soils make the area less desirable for development
- Original interest in the site was Archeological
- Current investigations focus on Paleontological resources and Paleo-ecological investigations
- Passive / minimal impact Geophysical data and analysis of existing nearby well logs can provide interpretations of the local Geology
- This area may be key in understanding the Geology of the basin as a whole
- The area can provide excellent education experiences to locals and visitors

Thank You

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