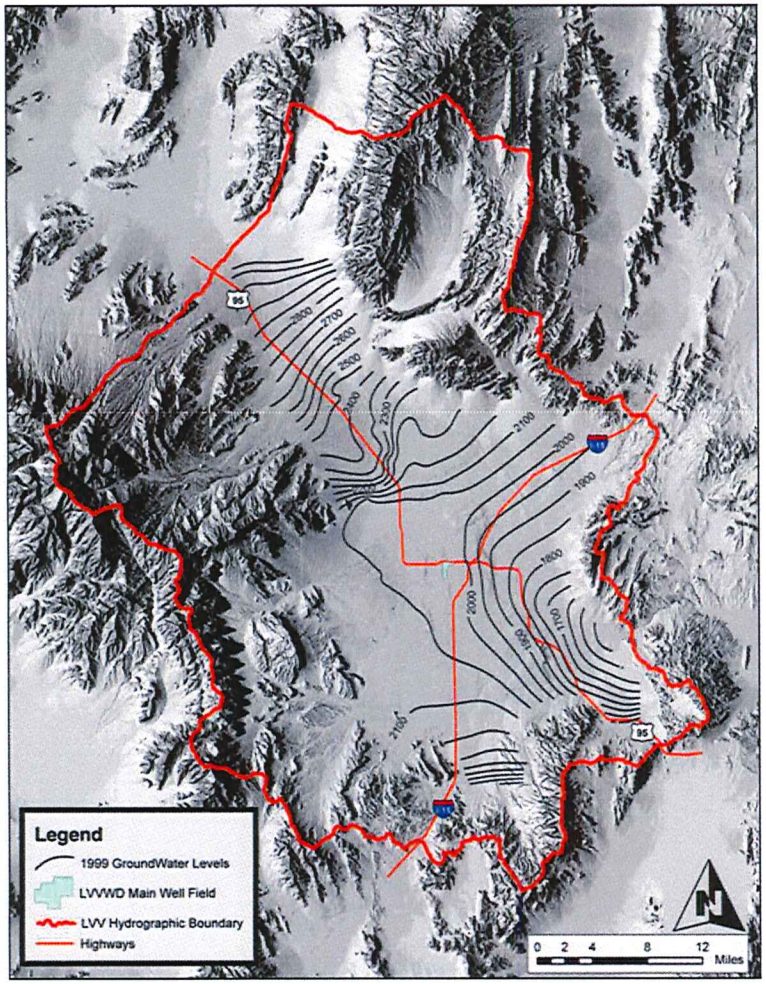
Preliminary Findings

- Continuous lithologic boundaries to vertical groundwater flow unlikely
- Deeper site groundwater (i.e., 60 to 65 ft) is in transition zone from poor-to-better quality groundwater
- Deeper site groundwater historically used for domestic and irrigation supply

Regional Hydrologic Setting

- Very low rainfall of 3 to 4 inches per year
- Recharge from Spring Mountain runoff on upper portion of alluvial fans
- Las Vegas Valley Main Well Field located north of the site
- Imported Lake Mead water recharged in 1990s near MWD
- Groundwater discharges to Las Vegas Wash
- LV Wash flows out of basin

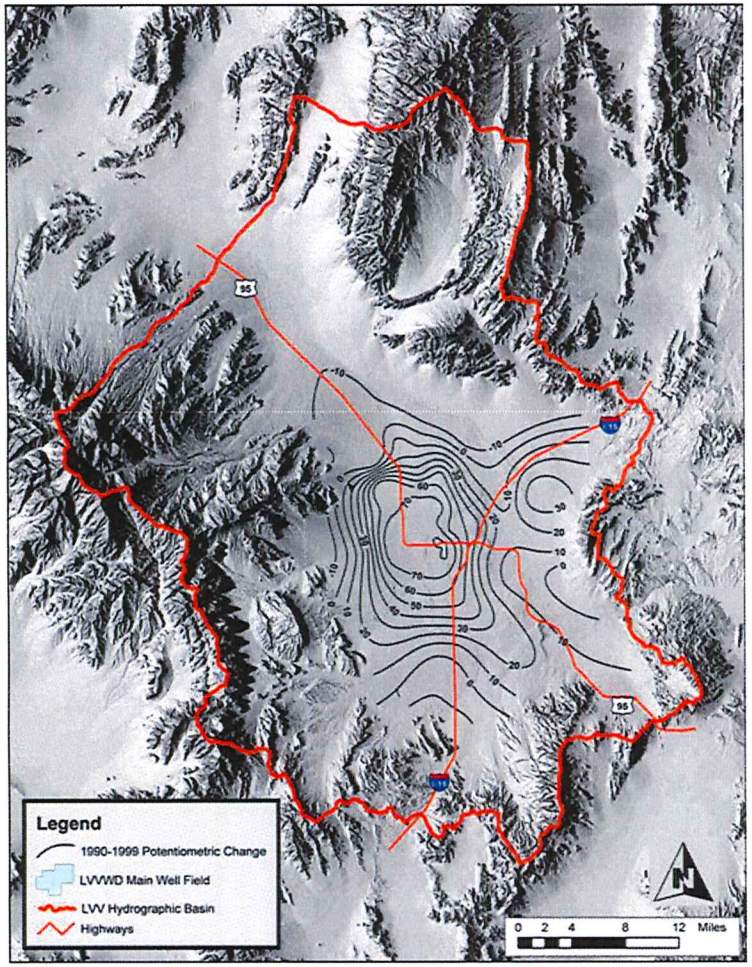
Map of Groundwater Elevations in Deeper Aquifers



- Site is located near 2,000 ft contour line on the 1999 map
- GW elevations at the site ranged from 2,010 to 2,050 ft above msl, during Fourth Quarter 2012 monitoring event

NDEP 00367

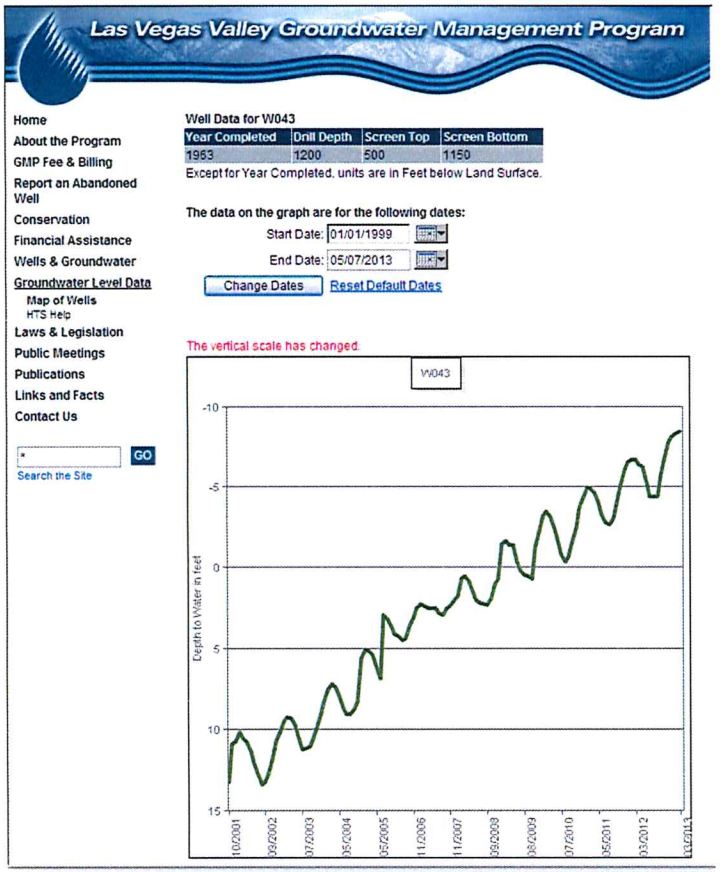
Map of Potentiometric Surface Elevation Changes 1990 to 1999

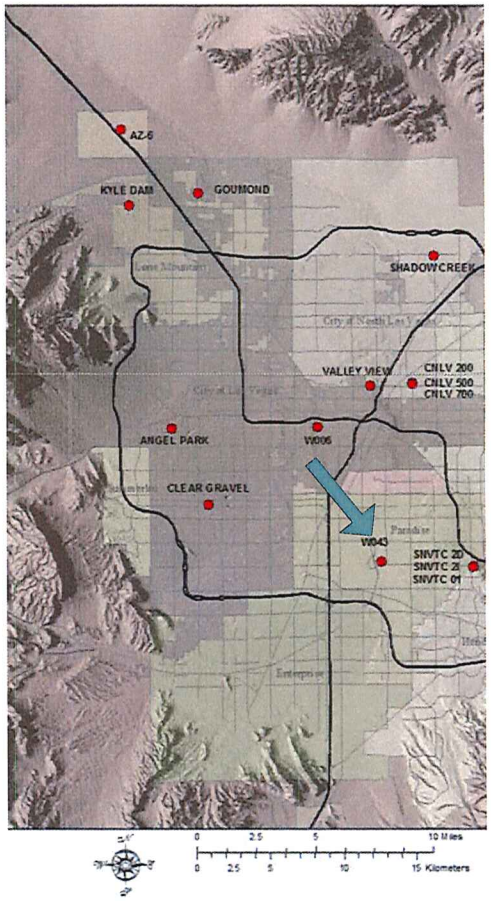


- Water imported to the basin
- Injected near the Main Well Field
- Approximate 30-foot increase from 1991 to 1999 in Primary Producing Aquifers beneath the Rental Car Sites

NDEP 00368

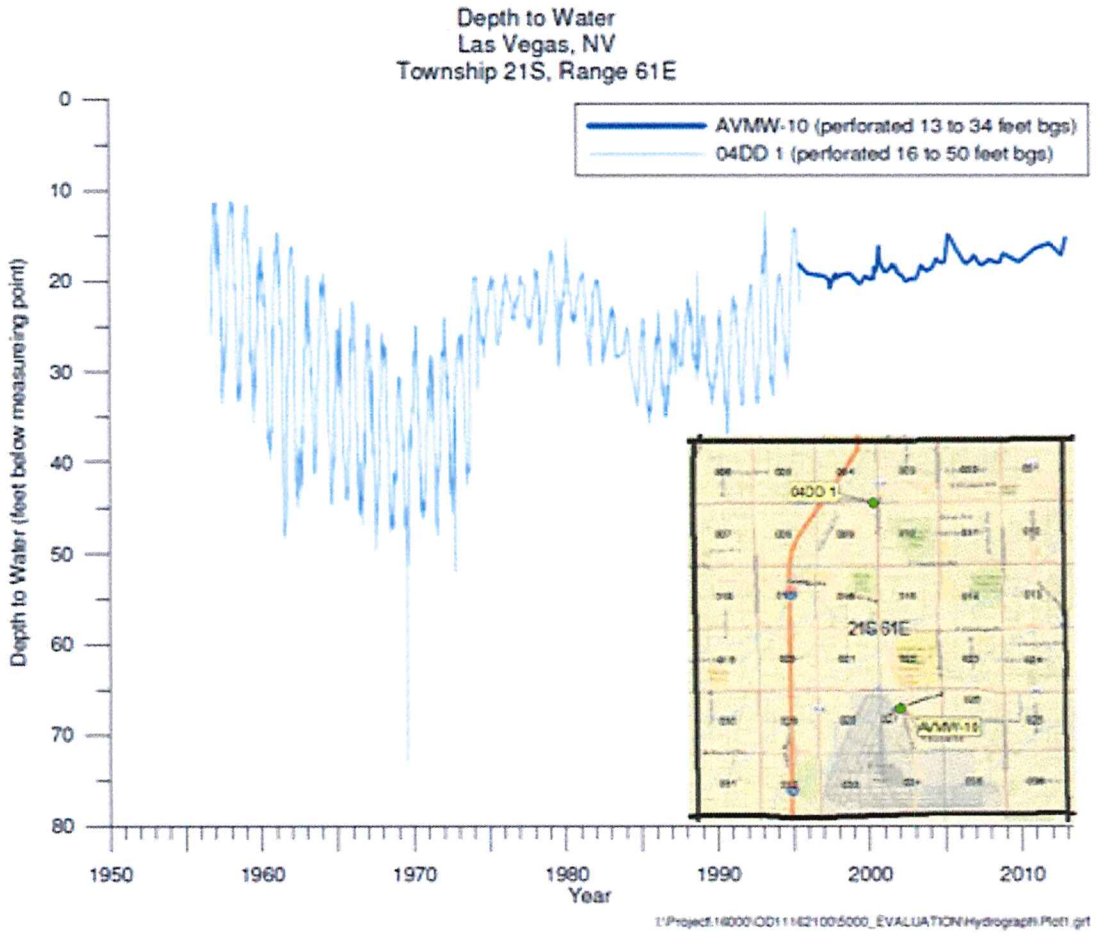
Well Data for Deeper Well W043





NDEP 00369

Shallow Groundwater Hydrograph
McCarran Airport Area - North



- North of the site water level increased about 10 ft from 1991 through 1995
- Water levels at the site have increased by 3 to 4 ft from 1995 to 2012
- 2005 event is visible in the hydrograph

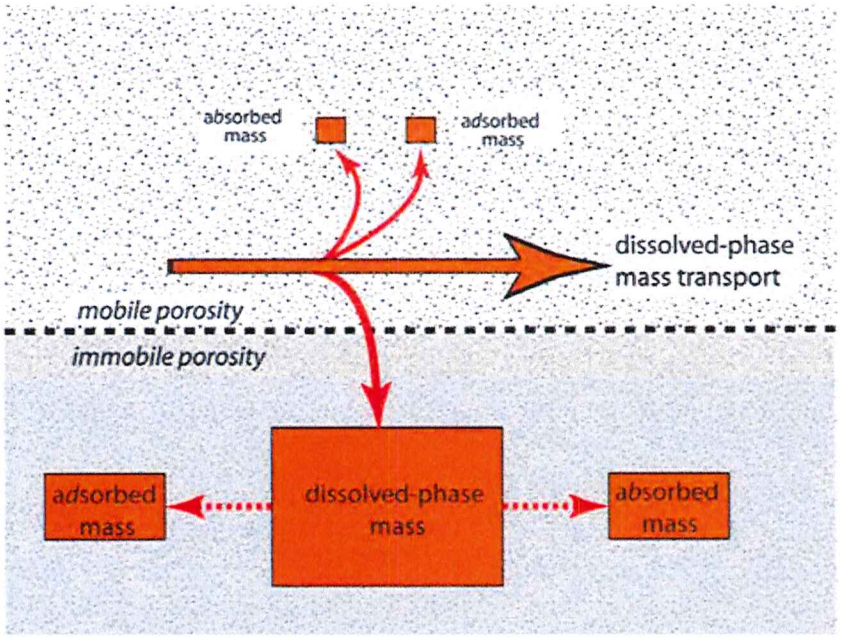
NDEP 00370

Site Characterization: Key Findings

- Narrow, straight plume
- Highest MTBE concentrations are 10 to 15 ft beneath the water table
- Heterogeneous mixture of silts, clays, sands, and gravels

Hypotheses for MTBE Fate & Transport Initial Phase Following Releases

Multi-Domain Transport and Storage

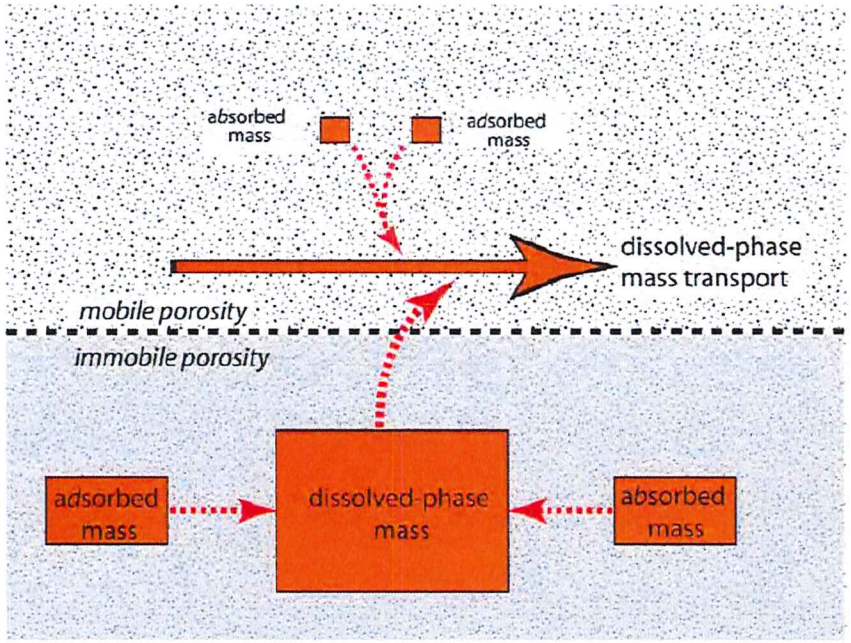


- Migration via sandier units
- Storage in siltier units

NDEP 00372

Hypotheses for MTBE Fate & Transport
Later Phase, Following Source Removal

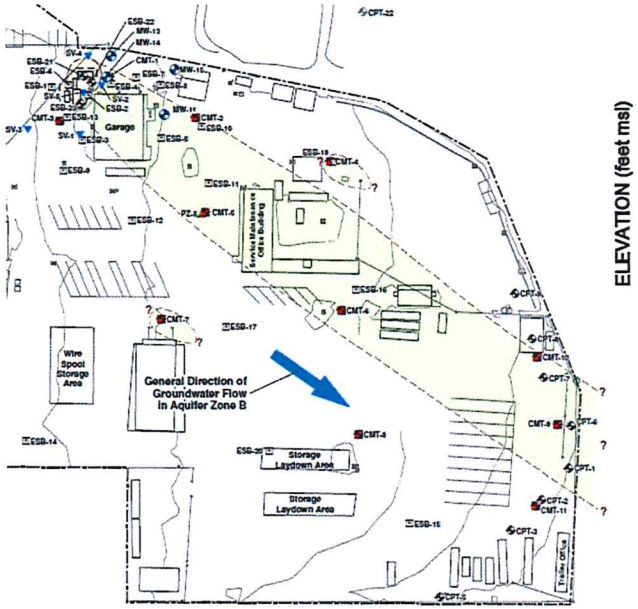
Multi-Domain Transport and Storage

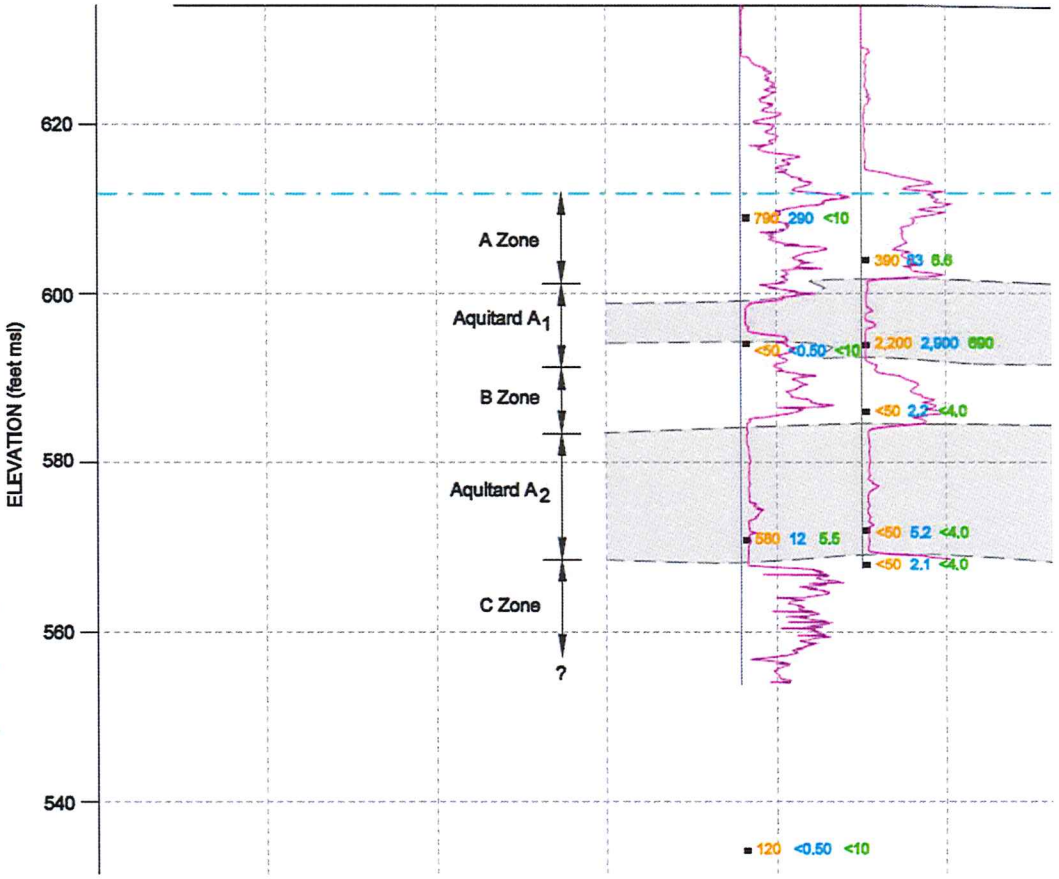


- Residual mass mostly dissolved and within fine-grained units
- Back-diffusion from silts may continue for an extended time period
- Degradation to TBA…?

NDEP 00373

Example Site: Remediation Determined Unnecessary Following Characterization





NDEP 00374

Assumptions in CSM Developed To-Date

- Source area cleanup and downgradient natural attenuation will be sufficient remedies.
- MTBE & TBA will not migrate past Maryland Parkway (>200 ug/L)
- MTBE & TBA will not migrate vertically to the primary producing aquifers (>200 ug/L)
- More…?

Next Steps

- Verify assumptions in current CSM (i.e., know and predict the extent of MTBE and TBA in groundwater)
- Determine needed degree of source remediation
- Other…?

Potential Future Efforts

- Develop cross-sections and delineate three-dimensional extent of MTBE and TBA.
- Identify data gaps.
  - Evaluate the hydraulic gradients and assess groundwater flow between shallow and deeper groundwater (including via conduits).
  - In the locations where elevated MTBE/TBA are detected, is the lithology high- or low-K?
- Optimize remedial efforts.
  - Estimate hydraulic conductivities for finer-grained and coarser units.
  - Is active cleanup of MTBE sequestered in low-K units needed?

References and Bibliography

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- Plume, R.W., 1989, Ground-water conditions in Las Vegas Valley, Clark County, Nevada—Part I, Hydrogeologic framework: U.S. Geological Survey Water-Supply Paper 2320–A, 15 p.
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- Zikmund, 1996, Extent and Potential Use of the Shallow Aquifer and Wash Flow in Las Vegas Valley, Nevada: Southern Nevada Water Authority.

Preliminary Conceptual Site Model

Prepared for the February 4, 2014 Former Rental Car Facilities Meeting

CSM Efforts Since May 2013 Meeting

- Reviewed and integrated surficial geology
- Inclusion of new geologic and water quality data
- Review of completeness and accuracy of data posted on section
- Review of interpreted geology
- Evaluation of sediment trends vs. depth from NDWR well databases and logs
- Plotted concentration trends over time and over distance

Outline of Presentation

- Regional Geology
- Site Geology
- Hydrostratigraphy
- Regional Hydrology
- Regional Groundwater Flow and Gradients
- Results of Additional Analysis and Data Collection

Las Vegas Valley Basin

NDEP 00381

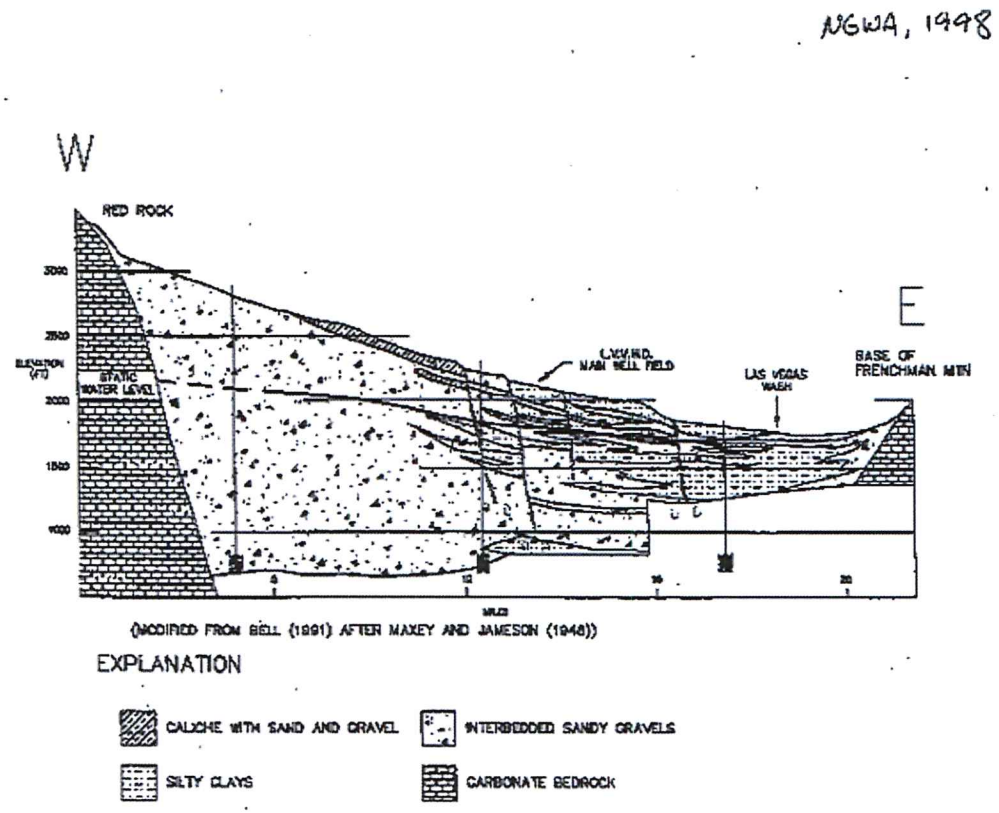
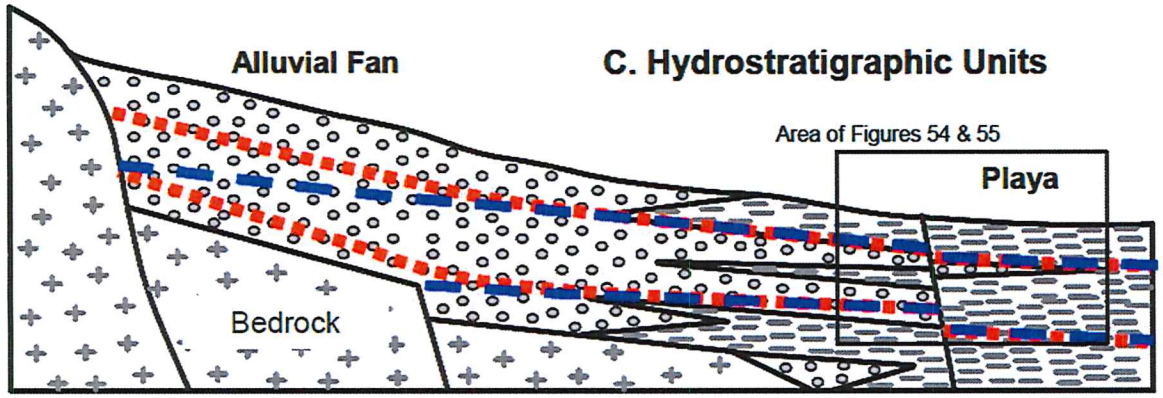
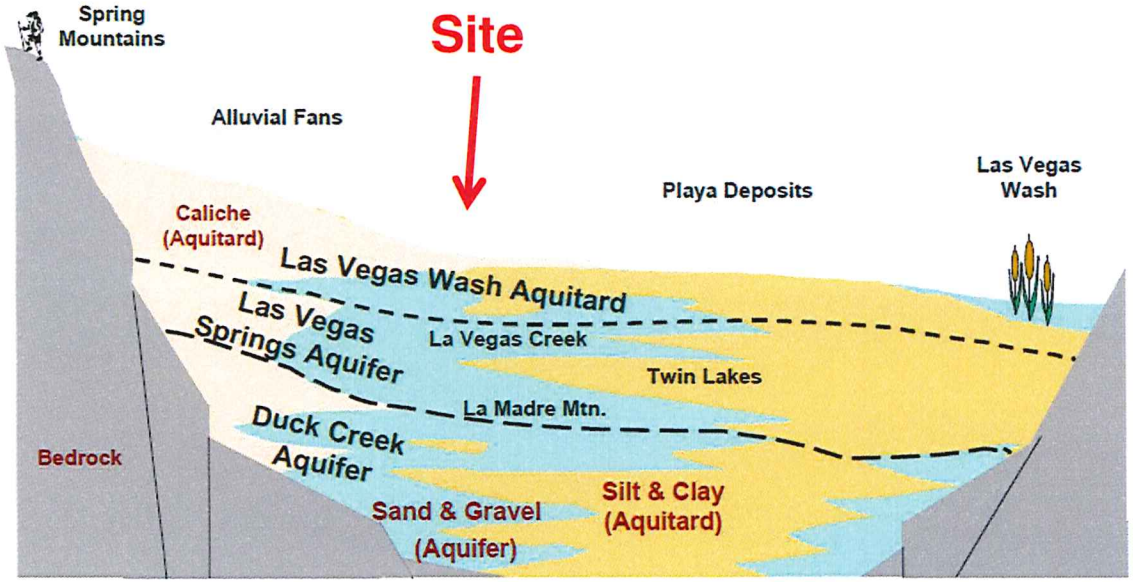


Figure 1-7. -- Generalized Geologic Cross Section of the Las Vegas Valley.

- > 1,500 ft of unconsolidated sediments
- Alluvial fan deposits (coarser) interfingered with playa deposits (finer)
- Water table intersects surface at the Las Vegas Wash

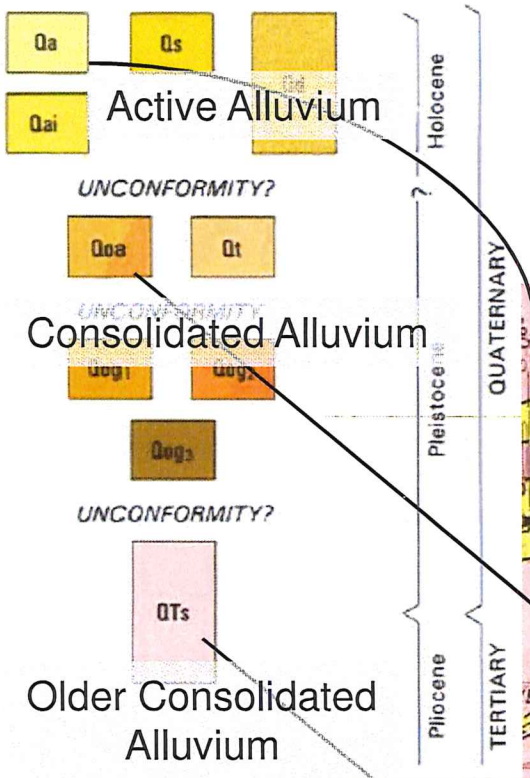
Major Stratigraphic Units (Leising, 2004)



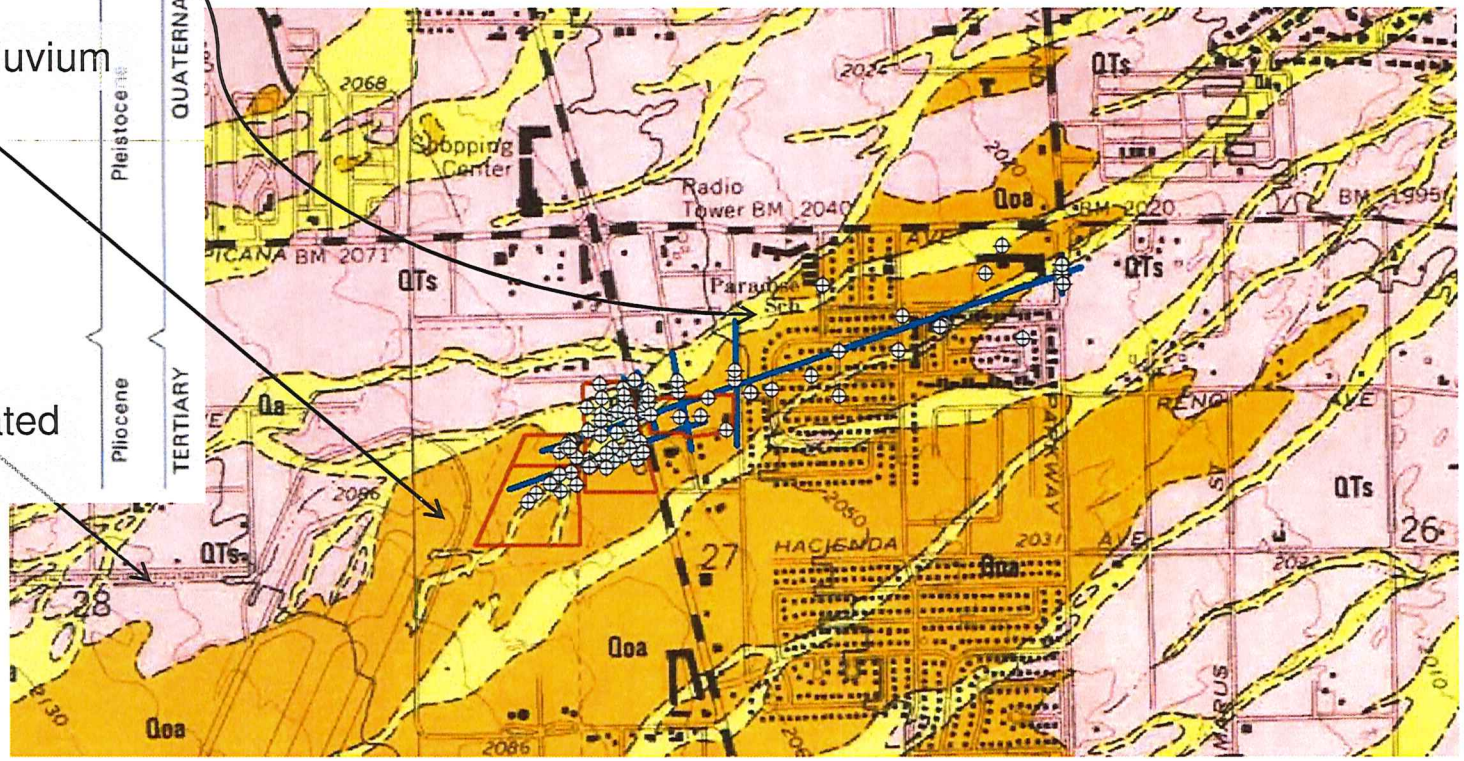


- No distinct lithologic boundaries
- Hydrostratigraphic definitions include:
  - Age of sediments
  - Water quality (TDS)
- Site located near transition from alluvial fan to playa deposits

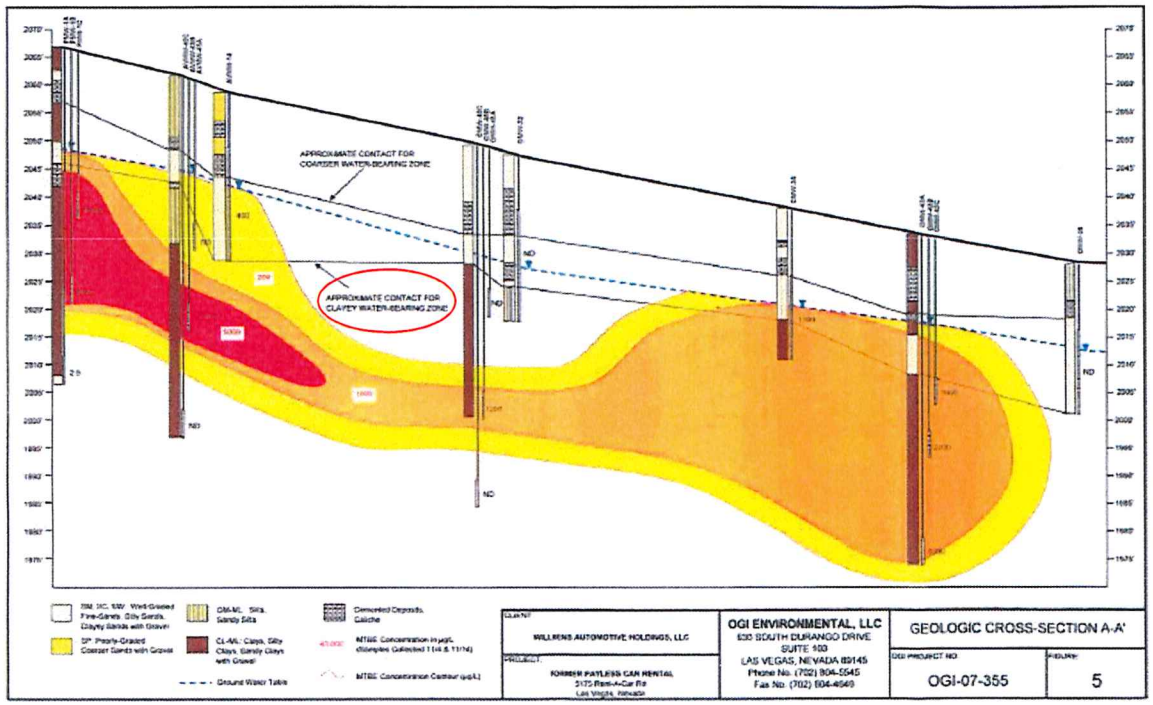
Surficial Geology



- Recent depositional environment is with active washes on an alluvial fan
- Channel widths are usually 200 feet or less (perpendicular to flow)



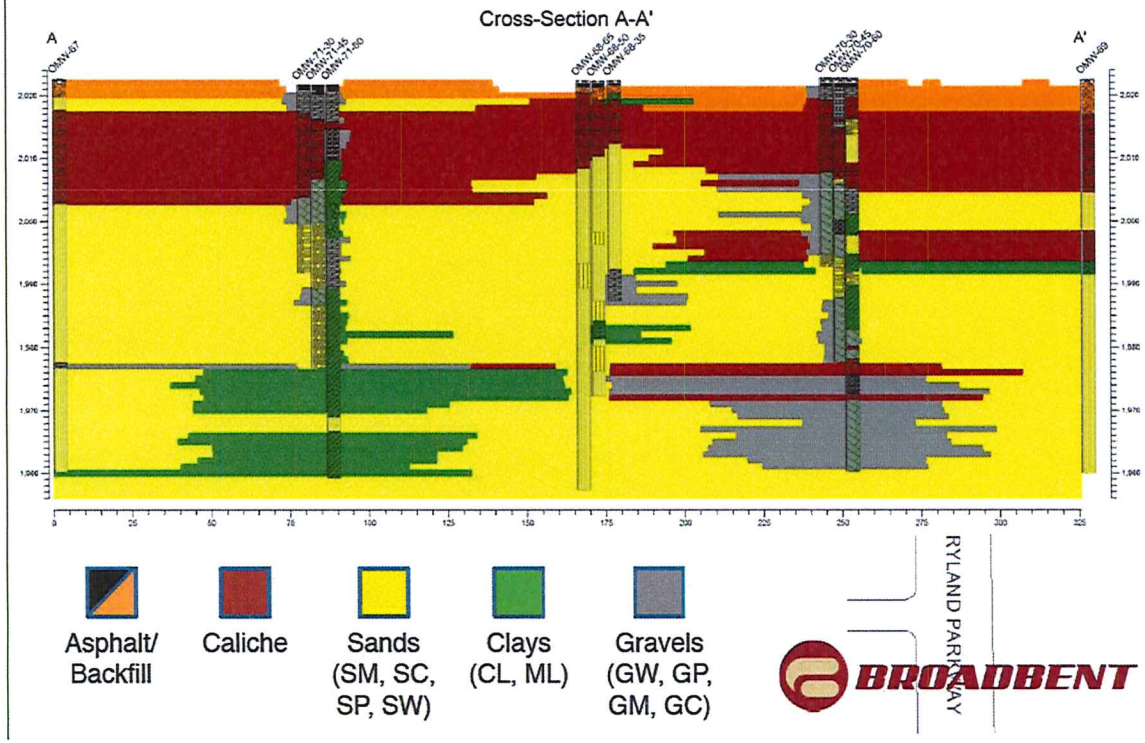
Site Geology & Hydrostratigraphy (1 of 3)



- OGI (2009) interpreted finer unit starting at about 30ft bgs
- Note, "Clayey water bearing zone," is highly conductive

Site Geology & Hydrostratigraphy (2 of 3)

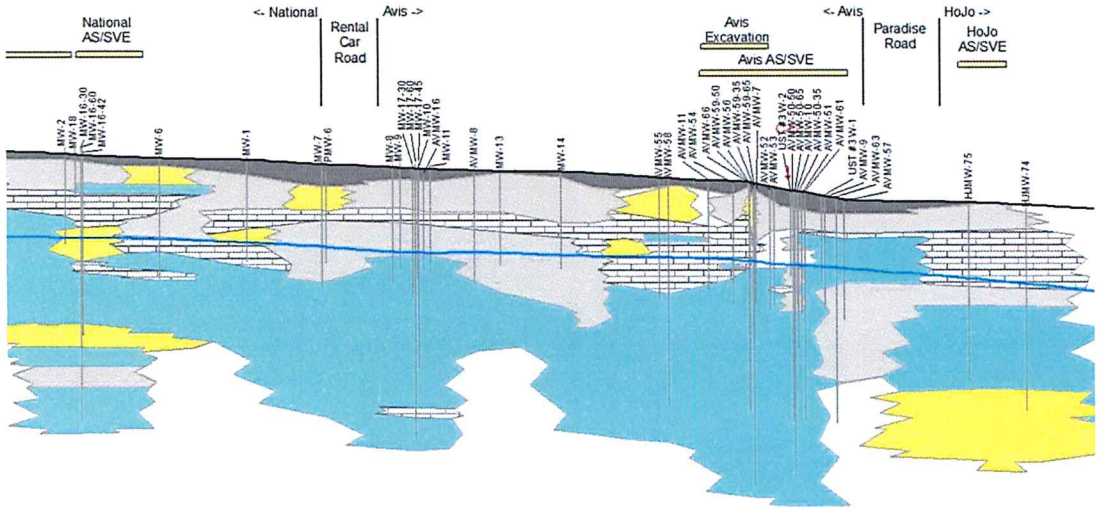
Far Downgradient Investigation



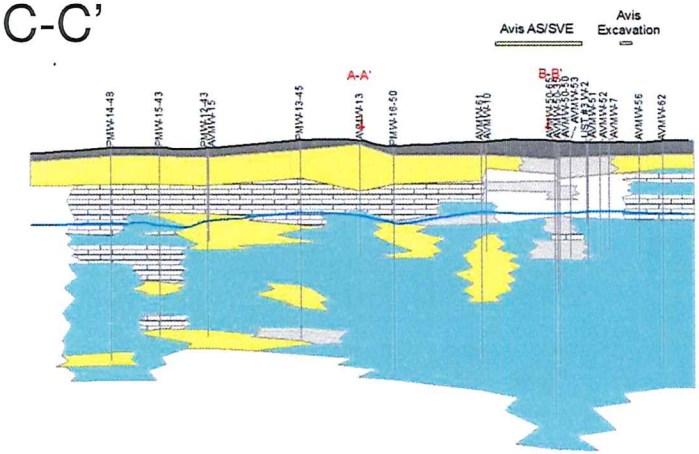
- Many boring logs show silts and clays (some reddish brown) at about 30 ft
- Caliche is common but not at predictable depths
- Not all borings greater than 30 ft deep terminate in silt or clay

Site Geology & Hydrostratigraphy (3 of 3)

Section B-B'



Section C-C'



- "Shallow" Geology – upper 30 feet is predominantly coarser material (Silty Sand).
- "Deeper" Geology – below 30 feet is predominantly fine grained with lenses of coarser material

OGI Slug Test Results (2009)

Table 6. Summary of Hydraulic Testing Results.

Well	Screened Interval (ft bgs)	Test Phase	Hydraulic conductivity (cm/sec)	Hydraulic conductivity (ft/d)	Comments
PMW-1a	55-60	Slug in	1.11E-04	0.31	Excellent curve match
PMW-1a	55-60	Slug out	9.51E-05	0.27	Excellent curve match
PMW-1b	45-50	Slug in	2.54E-04	0.72	Excellent curve match
PMW-1b	45-50	Slug out	2.61E-04	0.74	Excellent curve match
PMW-1c	25-30	Slug in	2.34E-04	0.66	Fair curve match
PMW-1c	25-30	Slug out	2.00E-04	0.57	Good curve match
OMW-43a	55-60	Slug in	9.58E-04	2.71	Excellent curve match
OMW-43a	55-60	Slug out	1.02E-03	2.90	Excellent curve match
OMW-43b	45-50	Slug in	2.93E-03	8.30	Excellent curve match
OMW-43b	45-50	Slug out	2.76E-03	7.83	Excellent curve match
OMW-43c	25-30	Slug in	No solution	No solution	Poor curve match[1]
OMW-43c	25-30	Slug out	1.33E-02	37.78	Poor curve match[1]

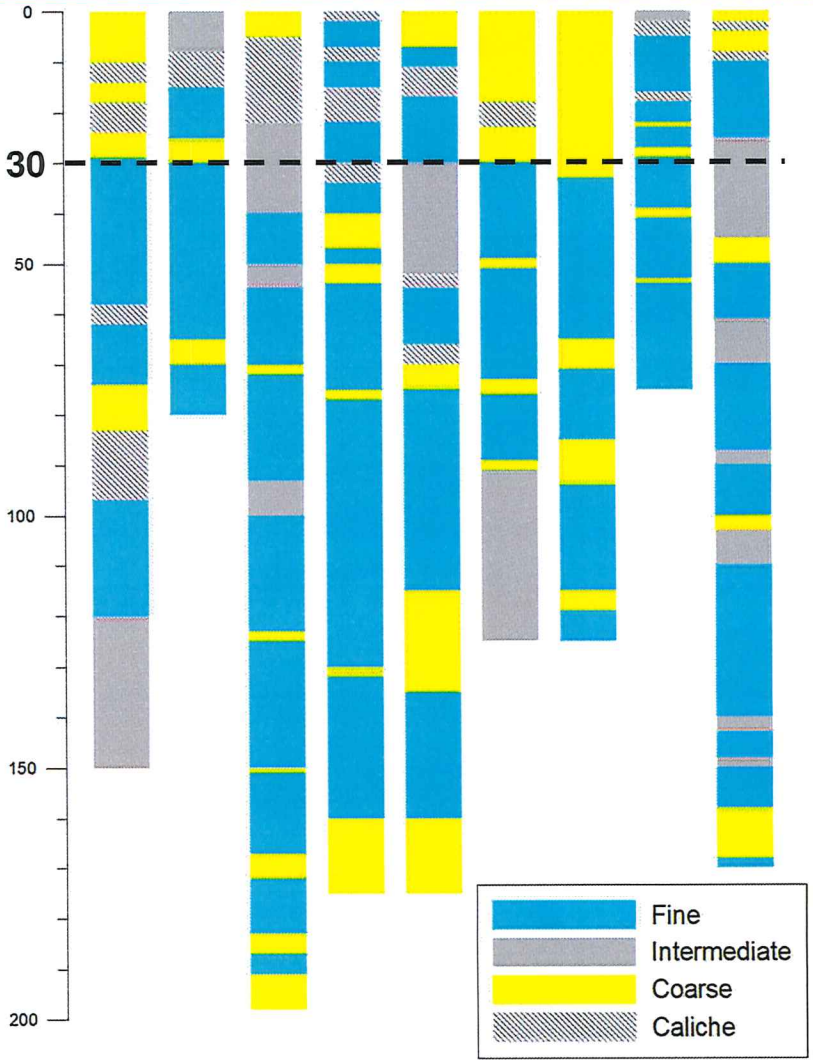
Notes:
(1) The water level recovery rate for well OMW-43A was too rapid to allow sufficient data to be collected for a reliable estimate of hydraulic conductivity. Data indicate a very high conductivity.

Comparison of Slug Test Results

- K in the two clusters ranges from approximately 10^{-3} to 10^{-5} cm/s
- The highest K was measured in shallow wells in the offsite cluster well
- The lowest K was measured in the deepest screened wells, in both the on-site and off-site cluster wells
- The observed lithology corresponds to the slug test data:
  - The deeper aquifer has fine grained clays and lower K values.
  - The shallower wells are set in fine-grained sand and silty sand and have higher K values.
- Upper HSU: range of hydraulic conductivity (K) estimates is higher.
- Lower HSU: range of K estimates is lower.

Analysis of Deeper Geologic Site Data

- Nine drillers logs with sufficient detail for review
- Observations:
  - increased frequency of fine grained sediments below 30 ft bgs
  - No laterally continuous clay units



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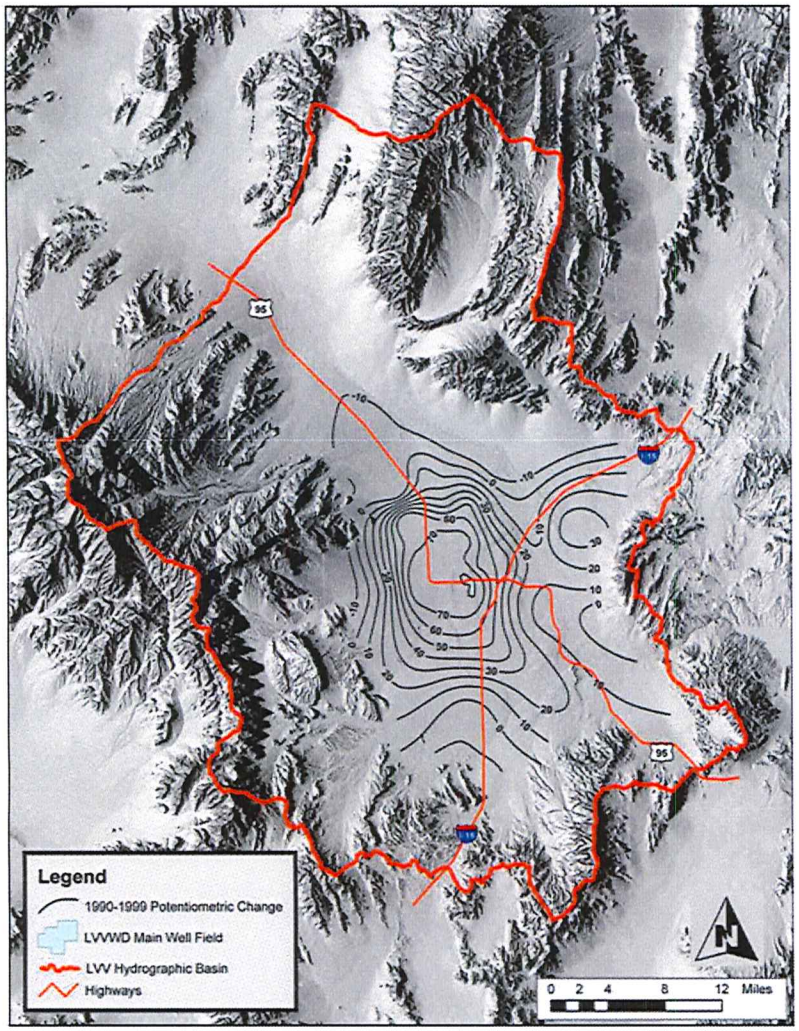
Map of Potentiometric Surface Elevation Changes 1990 to 1999



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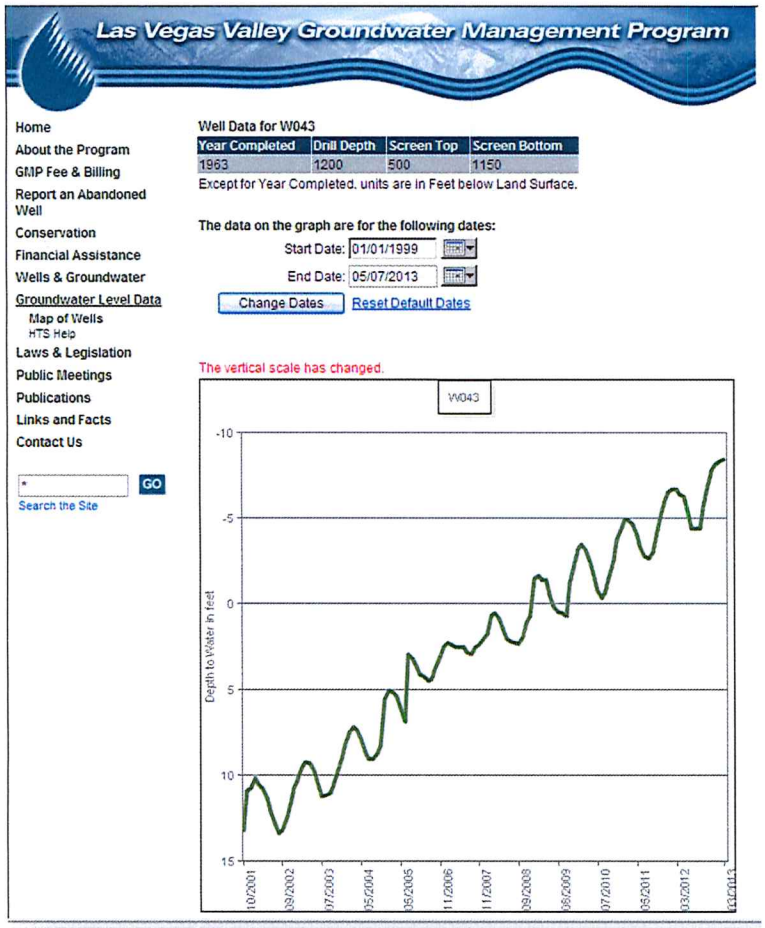
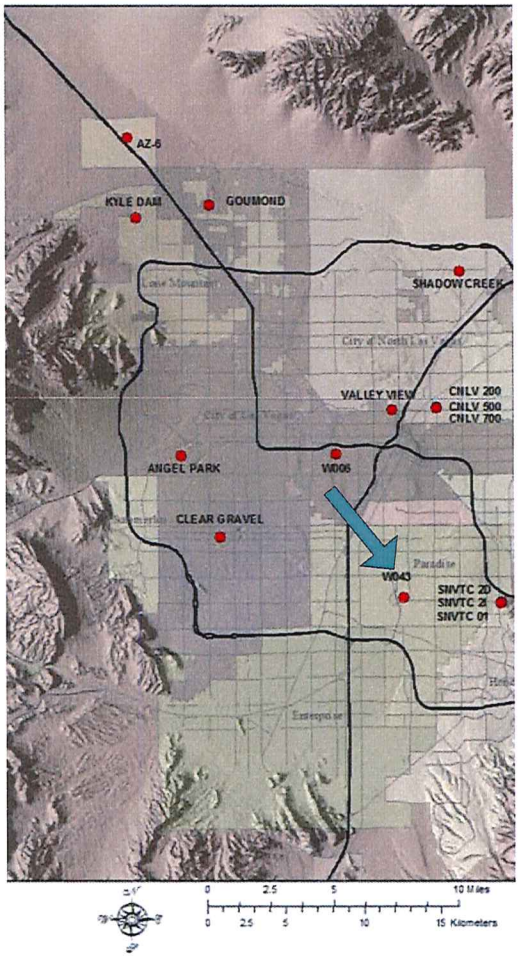
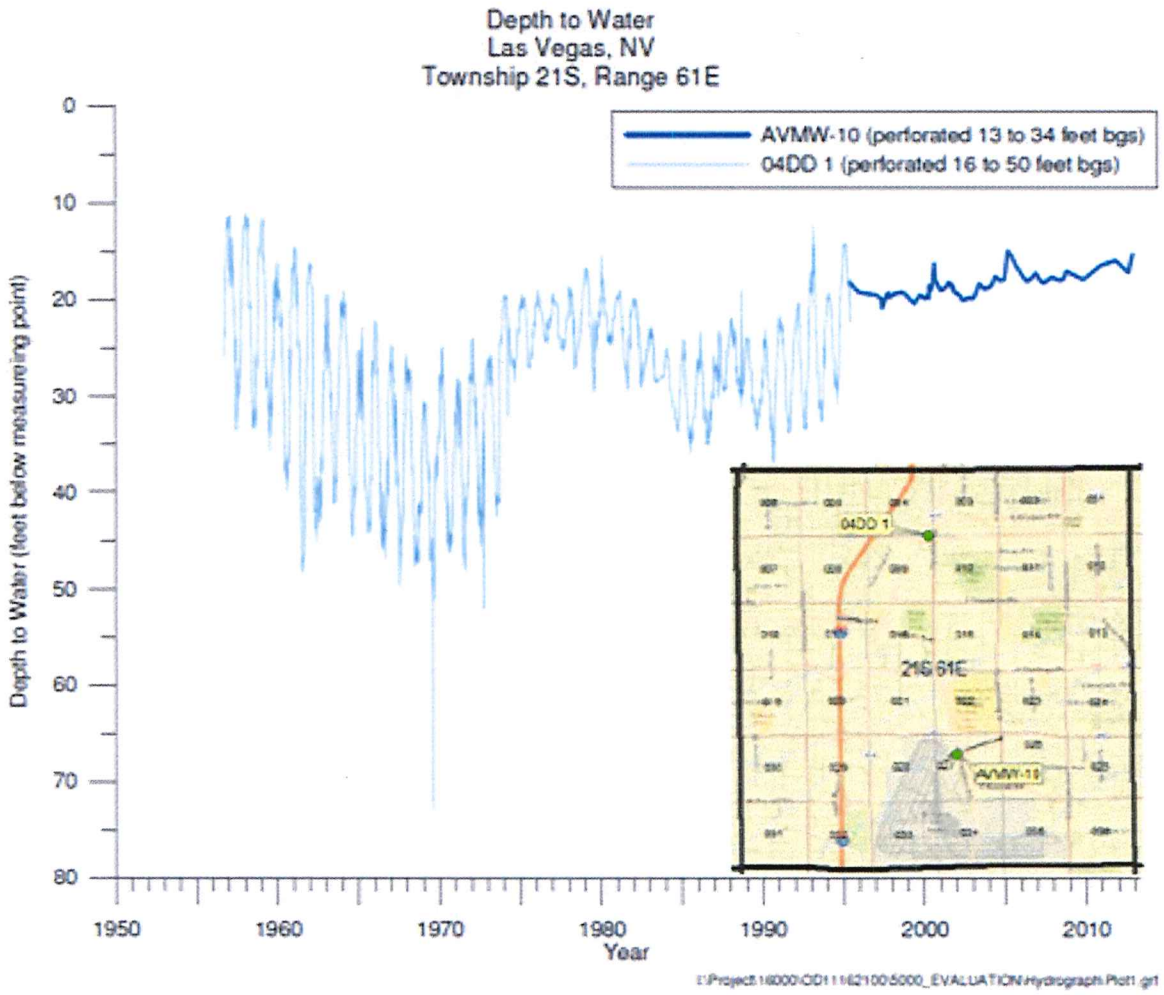
- Injected near the Main Well Field
- Approximate 30-foot increase from 1991 to 1999 in Primary Producing Aquifers beneath the Rental Car Sites

Well Data for Deeper Well W043



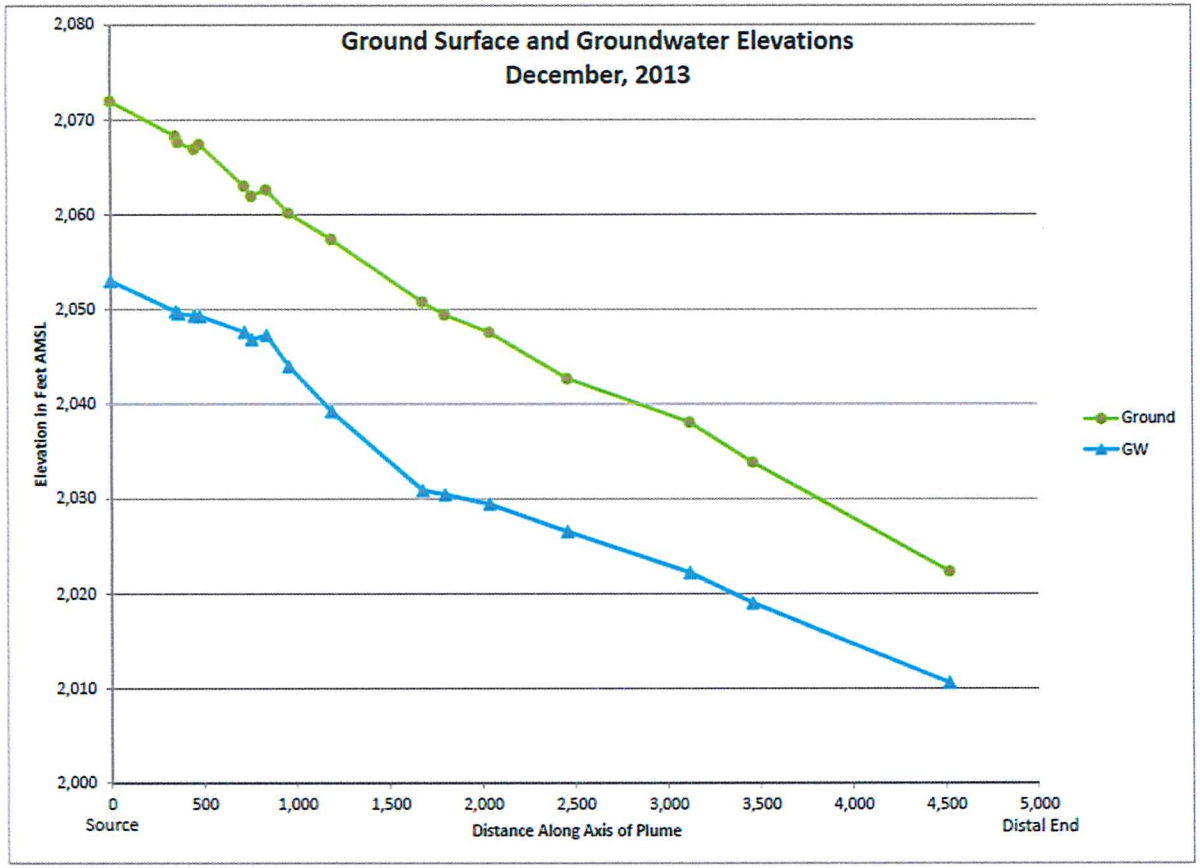


Shallow Groundwater Hydrograph
McCarran Airport Area - North



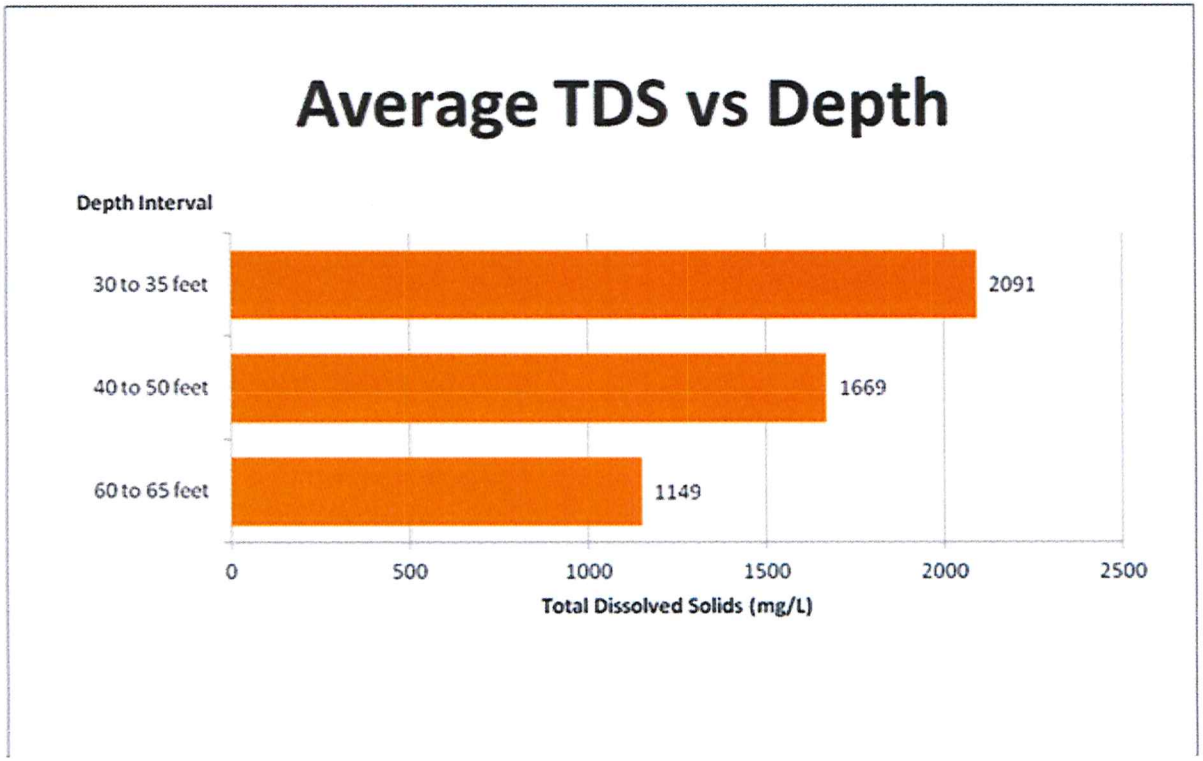
- North of the site water level increased about 10 ft from 1991 through 1995
- Water levels at the site have increased by 3 to 4 ft from 1995 to 2012
- 2005 event is visible in the hydrograph

Groundwater Gradient



- Depth to water table decreases downgradient
- Steepened water table downgradient of source areas

Site "Hydro-Chemi-Stratigraphy"

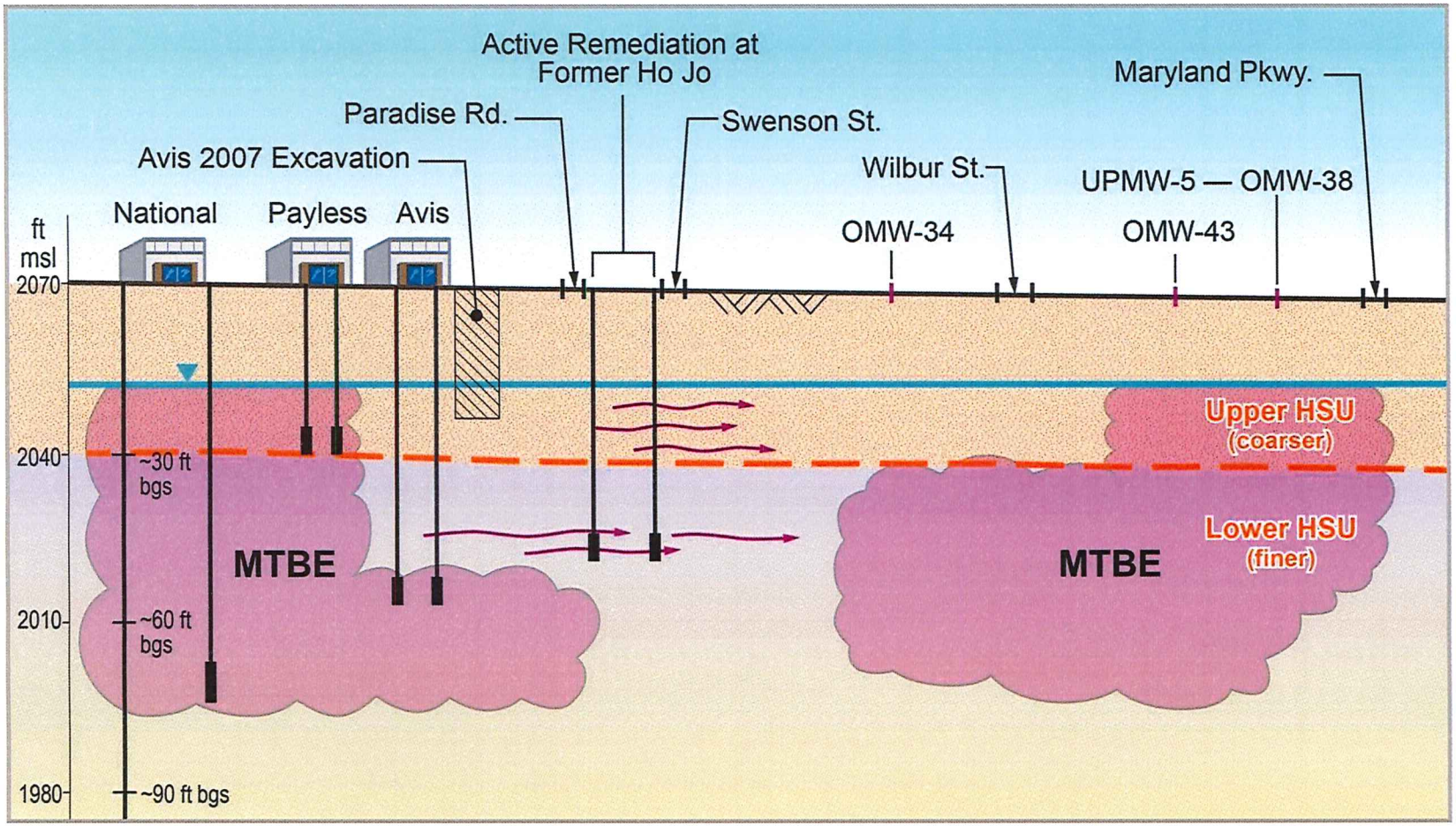


- Water quality improves with depth
- Two of the eleven deeper samples < 500 mg/L TDS
- Producing aquifer TDS in this area is between 400 and 800 mg/L

Summary of Findings

- Continuous lithologic boundaries to vertical groundwater flow unlikely
- Deeper site groundwater (i.e., 60 to 65 ft) is in transition zone from poor-to-better quality groundwater
- Deeper site groundwater historically used for domestic and irrigation supply

Conceptual Site Model



Potential Mechanisms For Vertical Distribution of MTBE

- Vertical Flow
- Conduits
- Historically lower water table

Normal Faults Perpendicular to GW Flow

NDEP 00399

NGWA, 1998

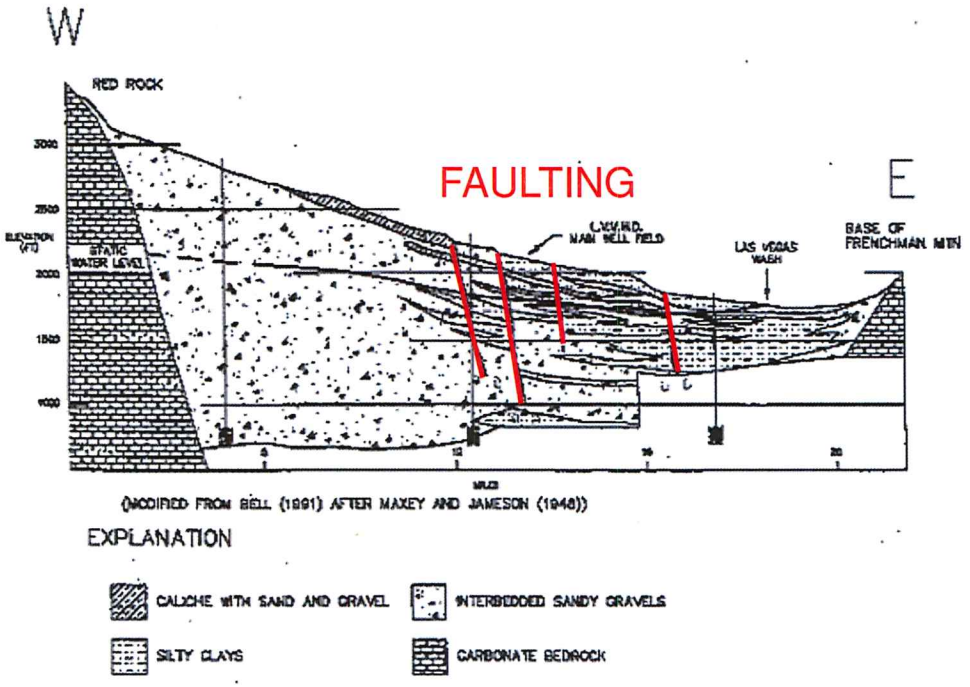
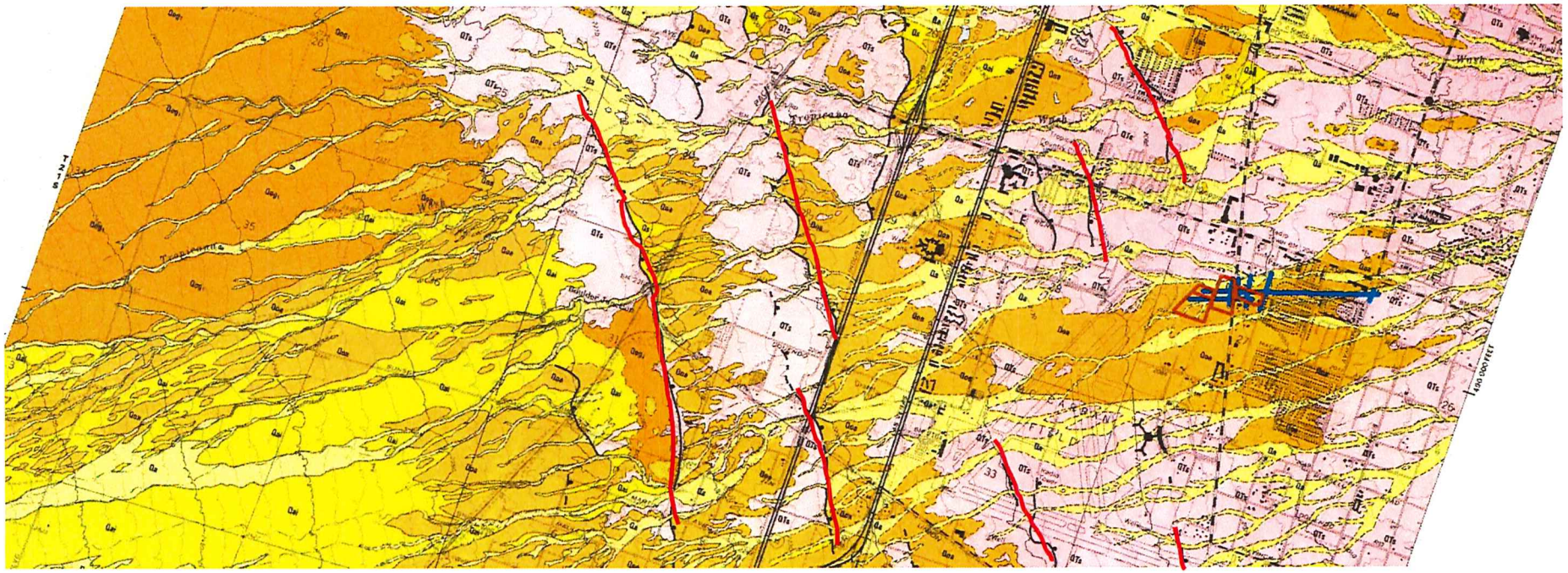


Figure 1-7. -- Generalized Geologic Cross Section of the Las Vegas Valley.

Projection of Regional Fault Traces



Las Vegas Valley Basin

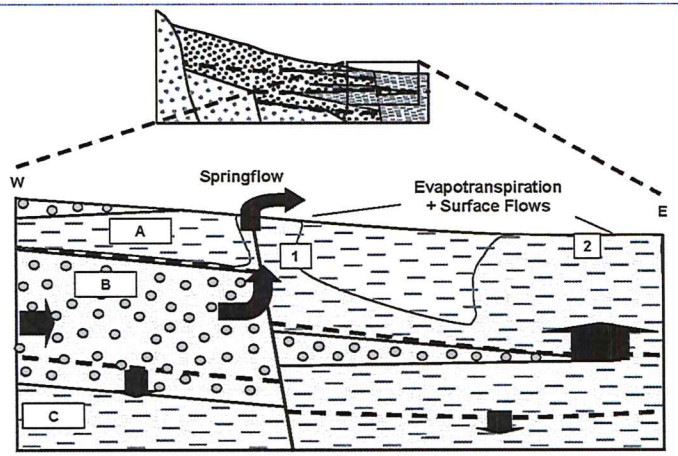


Figure 54. Schematic Cross-Section of the Shallow Groundwater System in Pre-Development Times.

Pre-development groundwater input to the near surface occurred (1) along faults and (2) from the Las Vegas Springs Aquifer (Unit B) through the Las Vegas Wash Aquitard (Unit A). Arrows indicate flow direction and approximate relative magnitudes. Hatchures indicate saturation. The Duck Creek Aquifer (Unit C) may also have received water from the Las Vegas Springs Aquifer.

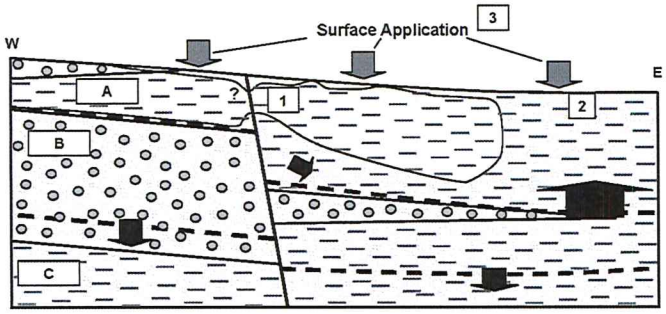
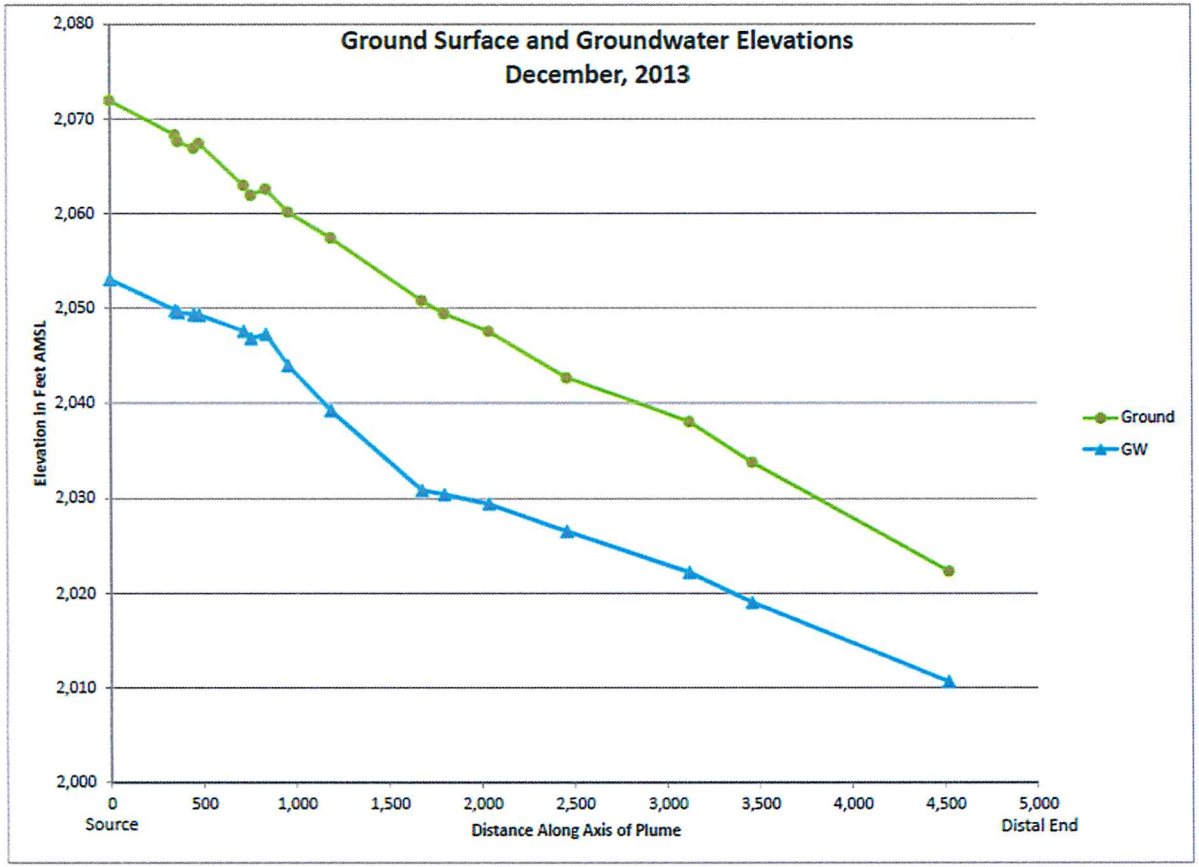


Figure 55. Schematic Cross-Section of the Present Shallow Groundwater System.

The present shallow system originates from (3) surface application and (2) continued slow upward migration of groundwater through the Las Vegas Wash Aquitard in the eastern portion of the Valley. Note that upward movement along the fault at (1) has ceased due to reduced heads in the Las Vegas Springs Aquifer, and that shallow groundwater may not be continuous from place to place.

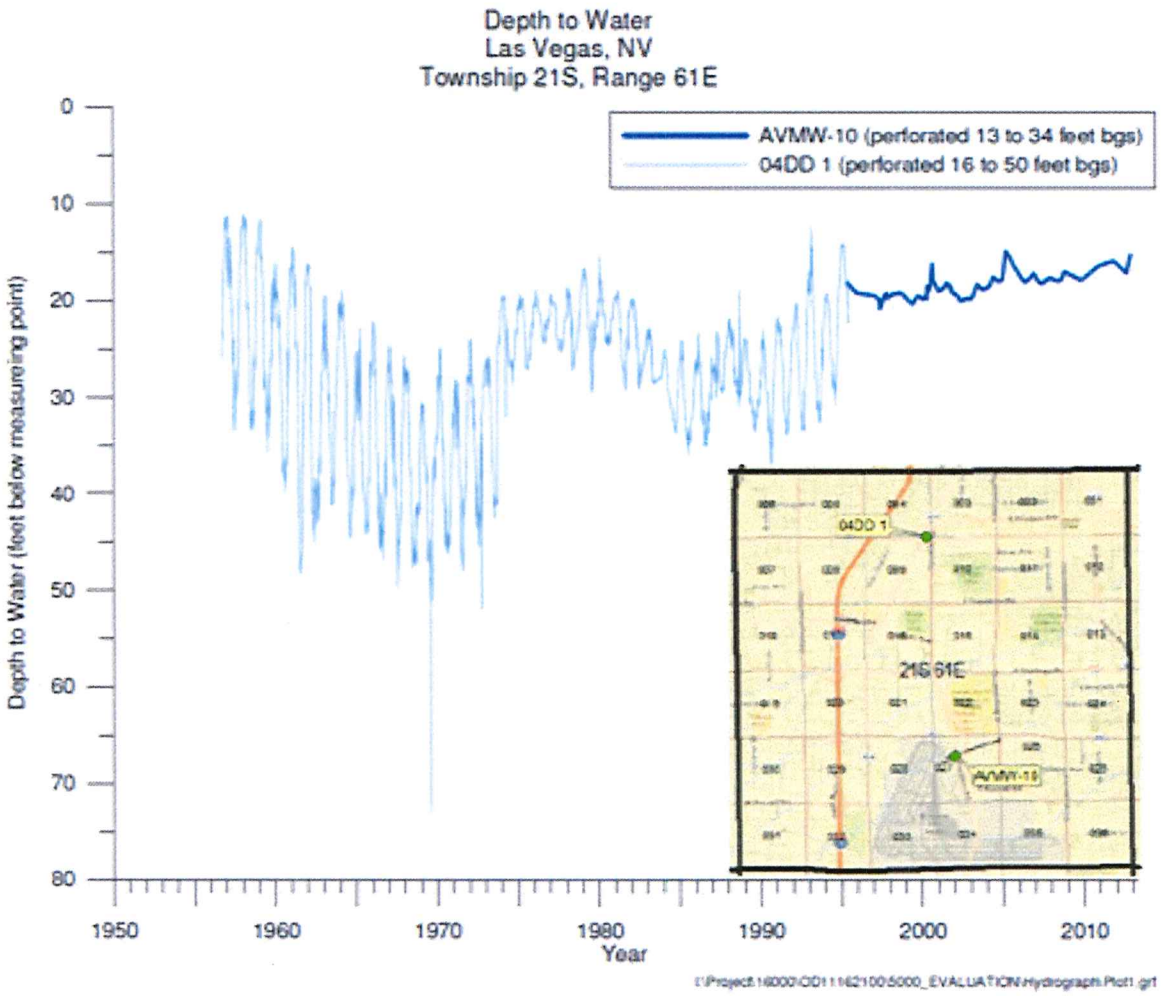
- Historically shallow groundwater was fed by
  - upward flow along faults,
  - upward vertical flow,
  - surface water recharge
- By 1990
  - Over pumping in deeper aquifers had reduced upward flow along faults
  - Surface application of water is more significant
- By 1999 artificial recharge had helped water levels recover
  - Has flow along faults resumed?
  - Has upward vertical flow increased?

Groundwater Gradient Profile



- Steepened water table downgradient of source areas
- Impediment to horizontal flow?
- Upward flow below source areas?

Shallow Groundwater Hydrograph
McCarran Airport Area - North



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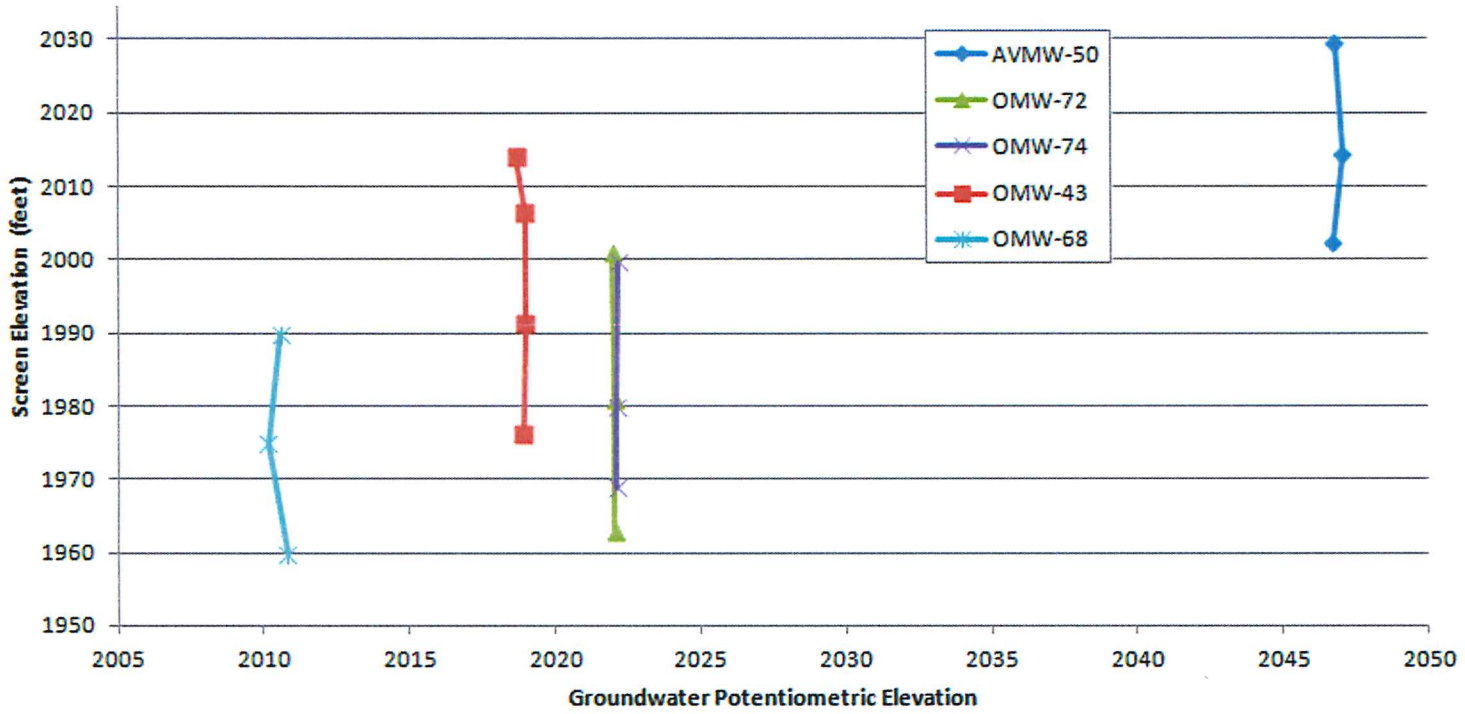
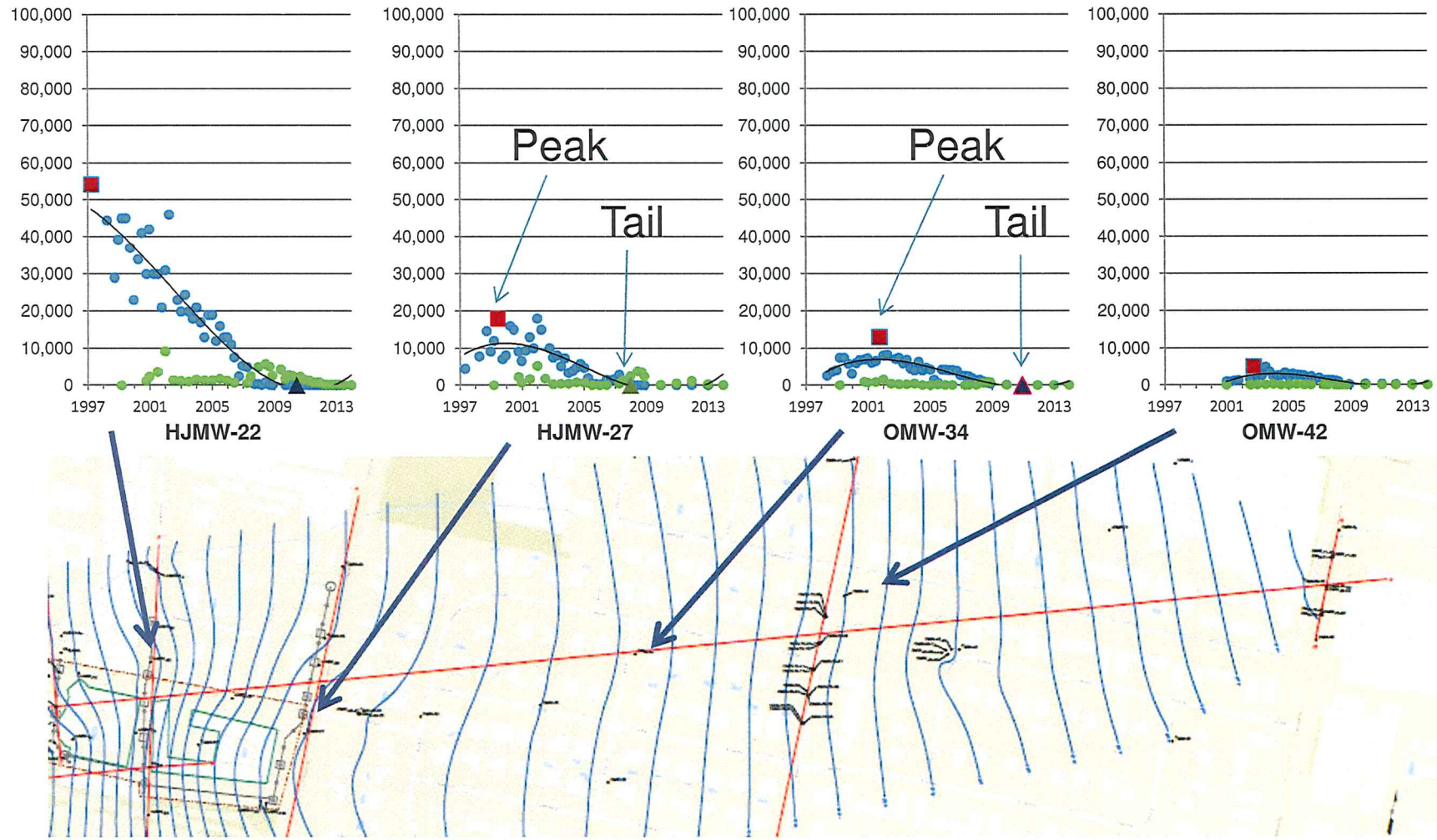
Groundwater Levels in Multi-Depth Wells

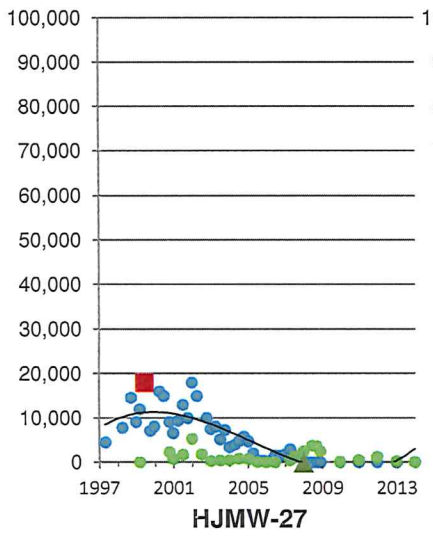


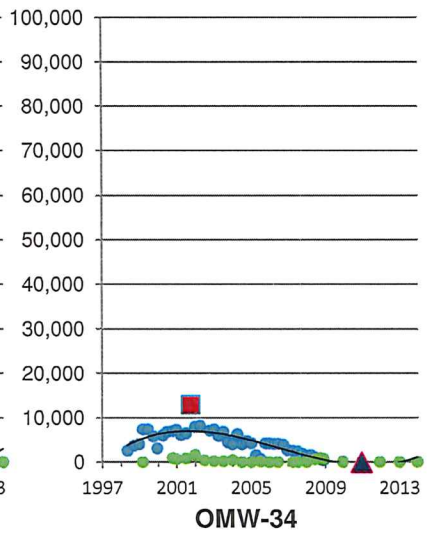
Concentration Trends with Distance and Time

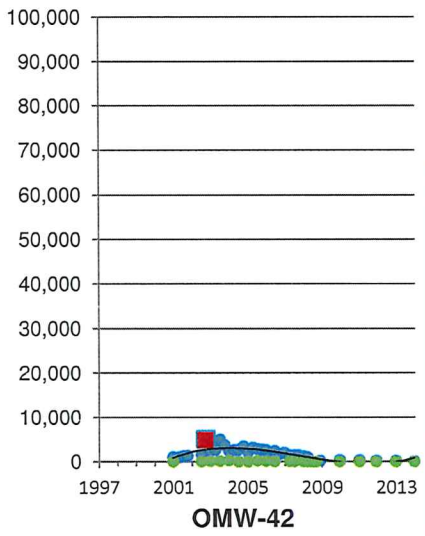
Upper HSU: Palo Verde to Wilbur



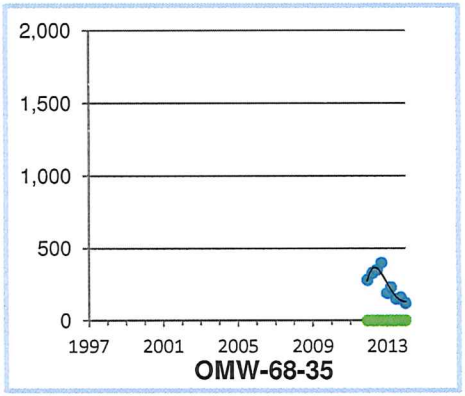
Upper HSU: Swenson to Maryland

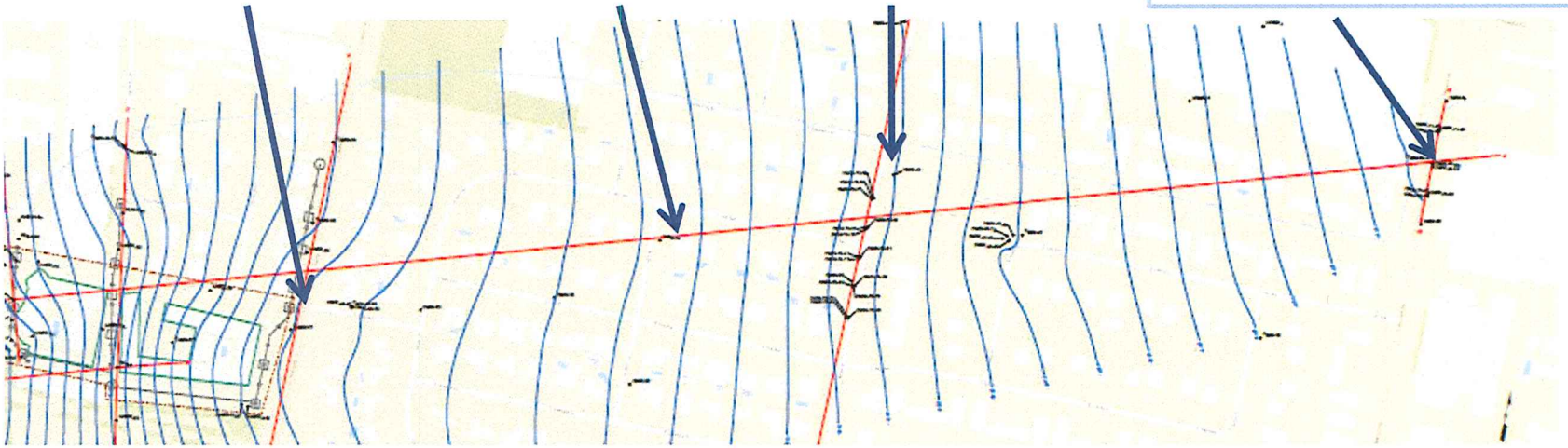




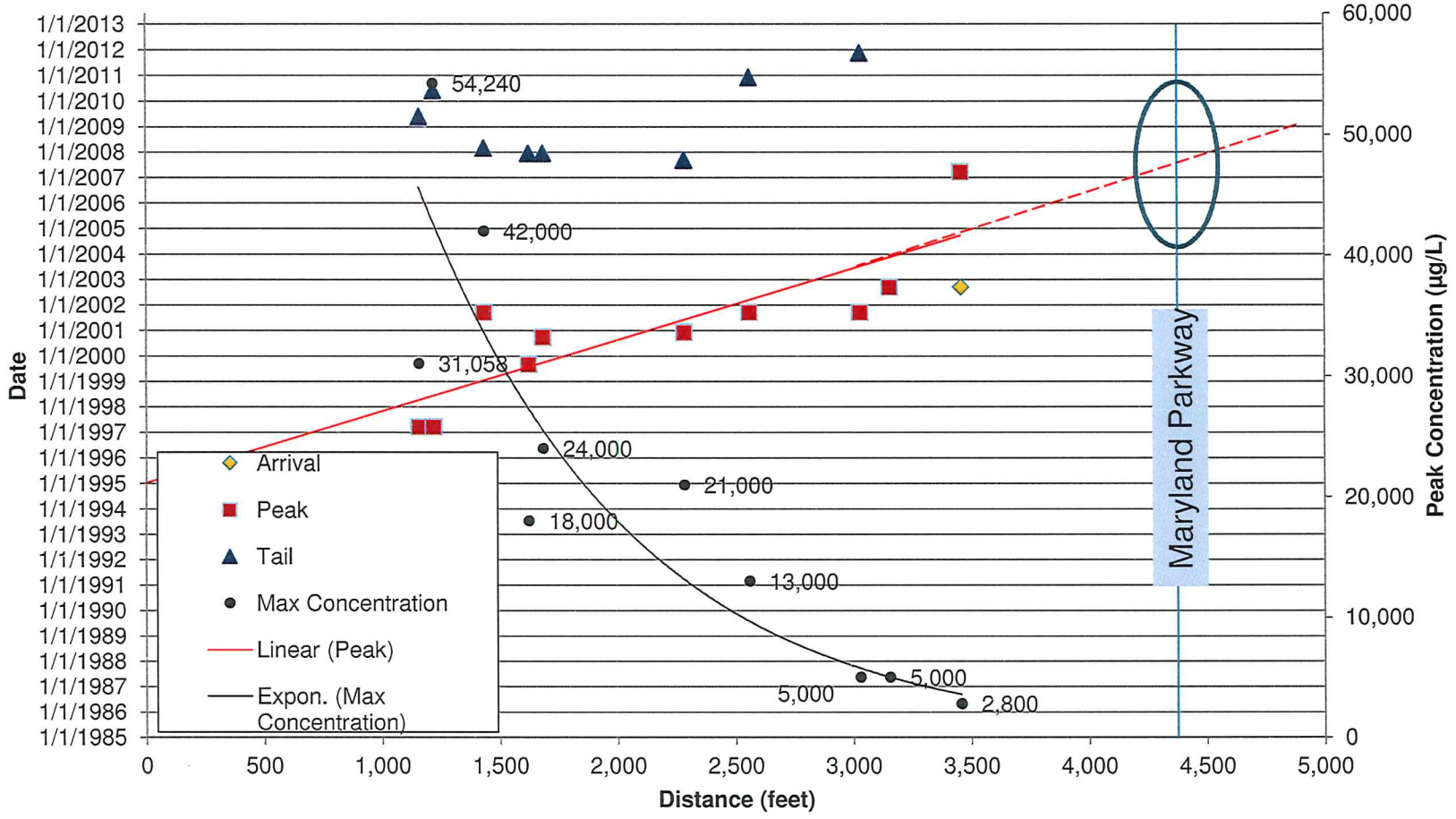


Did the peak already go by ?





Upper HSU: MTBE Arrival Times and Concentration-Distance Curve



Lower HSU: MTBE Trends

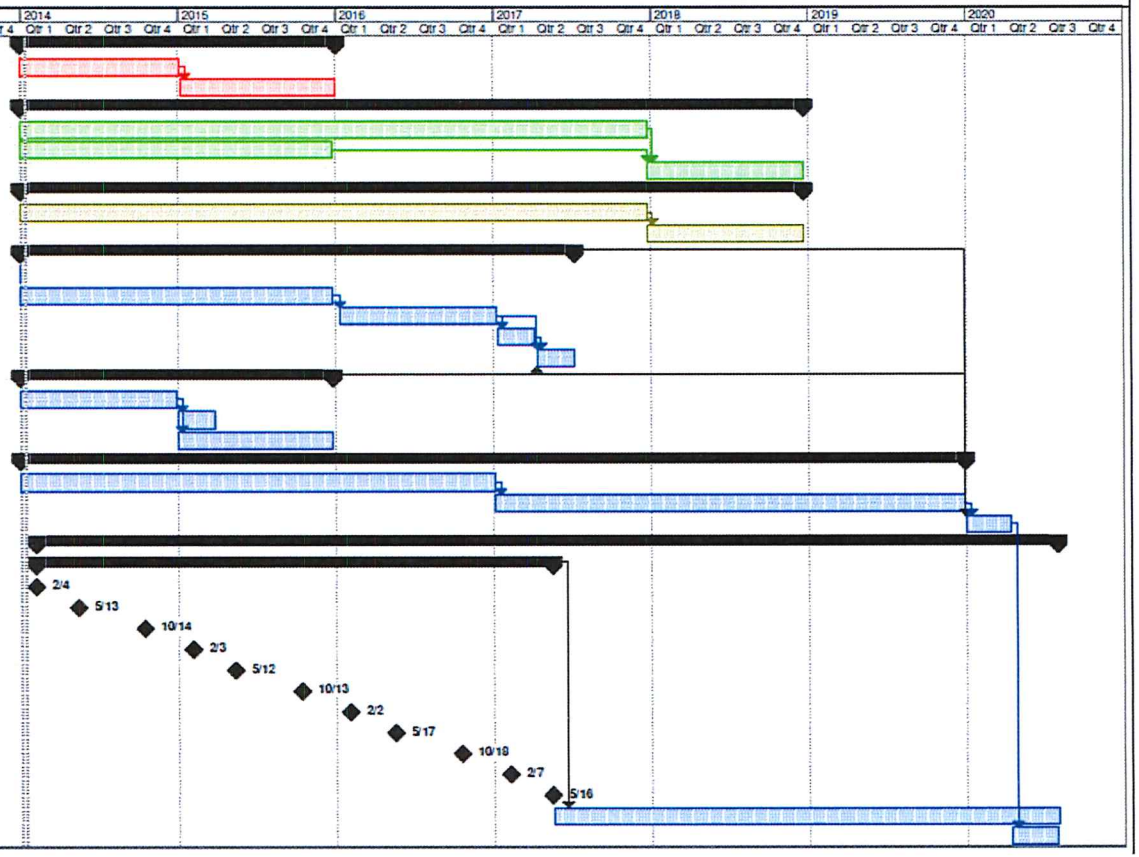
- TBA is detected
- Rate of migration appears slower

Project Lifecycle Schedule Forecast

NDEP 00410

DRAFT

ID	Task Name	Start	Finish
1	**Avis Source Area**	**Mon 12/30/13**	**Fri 1/1/16**
2	Pulse Ox System Operation-Avis	Mon 12/30/13	Fri 1/2/15
3	Post Remedial GWM-Avis	Mon 1/5/15	Fri 1/1/16
4	**Payless Source Area**	**Mon 12/30/13**	**Fri 12/21/18**
5	AS/SVE System Operation-Payless	Mon 12/30/13	Fri 12/22/17
6	Pulse Ox System Operation-Payless	Mon 12/30/13	Fri 12/25/15
7	Post Remedial GWM-Payless	Mon 12/25/17	Fri 12/21/18
8	**National Source Area Remediation**	**Mon 12/30/13**	**Fri 12/21/18**
9	AS/SVE Operation-National	Mon 12/30/13	Fri 12/22/17
10	Post Remedial GWM-National	Mon 12/25/17	Fri 12/21/18
11	**Ho Jo AS/SVE System**	**Mon 12/30/13**	**Fri 7/7/17**
12	Ho Jo System Rehab-Ho Jo	Mon 12/30/13	Mon 12/30/13
13	System O&M-Ho Jo	Mon 12/30/13	Fri 12/25/15
14	Post Remedial GWM-HoJo	Mon 1/11/16	Fri 1/6/17
15	Post-Remed Verif Sampling & Risk Assmt	Mon 1/9/17	Fri 4/7/17
16	No Active Remediation Request	Tue 4/11/17	Fri 7/7/17
17	**CSM Development**	**Mon 12/30/13**	**Fri 12/25/15**
18	Offsite Plume Delineation	Mon 12/30/13	Fri 12/26/14
19	Update cross-sections and isocon maps	Mon 12/29/14	Fri 3/27/15
20	Assess offsite plume stability	Mon 12/29/14	Fri 12/25/15
21	**Offsite Groundwater Monitoring**	**Mon 12/30/13**	**Mon 12/30/19**
22	Quarterly GWM-Offsite	Mon 12/30/13	Mon 1/2/17
23	Annual GWM-Offsite	Tue 1/3/17	Mon 12/30/19
24	Closure Request	Tue 12/31/19	Mon 4/13/20
25	**Project Management**	**Tue 2/4/14**	**Fri 7/31/20**
26	**Triannual Meetings**	**Tue 2/4/14**	**Tue 5/16/17**
27	Feb 2014 Meeting	Tue 2/4/14	Tue 2/4/14
28	May 2014 Meeting	Tue 5/13/14	Tue 5/13/14
29	Oct 2014 Meeting	Tue 10/14/14	Tue 10/14/14
30	Feb 2015 Meeting	Tue 2/3/15	Tue 2/3/15
31	May 2015 Meeting	Tue 5/12/15	Tue 5/12/15
32	Oct 2015 Meeting	Tue 10/13/15	Tue 10/13/15
33	Feb 2016 Meeting	Tue 2/2/16	Tue 2/2/16
34	May 2016 Meeting	Tue 5/17/16	Tue 5/17/16
35	Oct 2016 Meeting	Tue 10/18/16	Tue 10/18/16
36	Feb 2017 Meeting	Tue 2/7/17	Tue 2/7/17
37	May 2017 Meeting	Tue 5/16/17	Tue 5/16/17
38	Oversight During LTM	Wed 5/17/17	Fri 7/31/20
39	Remedial Sys and MW Removals	Tue 4/14/20	Mon 7/27/20



End of Presentation

APPENDIX C

GROUNDWATER ELEVATION CONTOURS AND PLOTTED MTBE AND TBA CONCENTRATIONS IN MONITORING WELLS

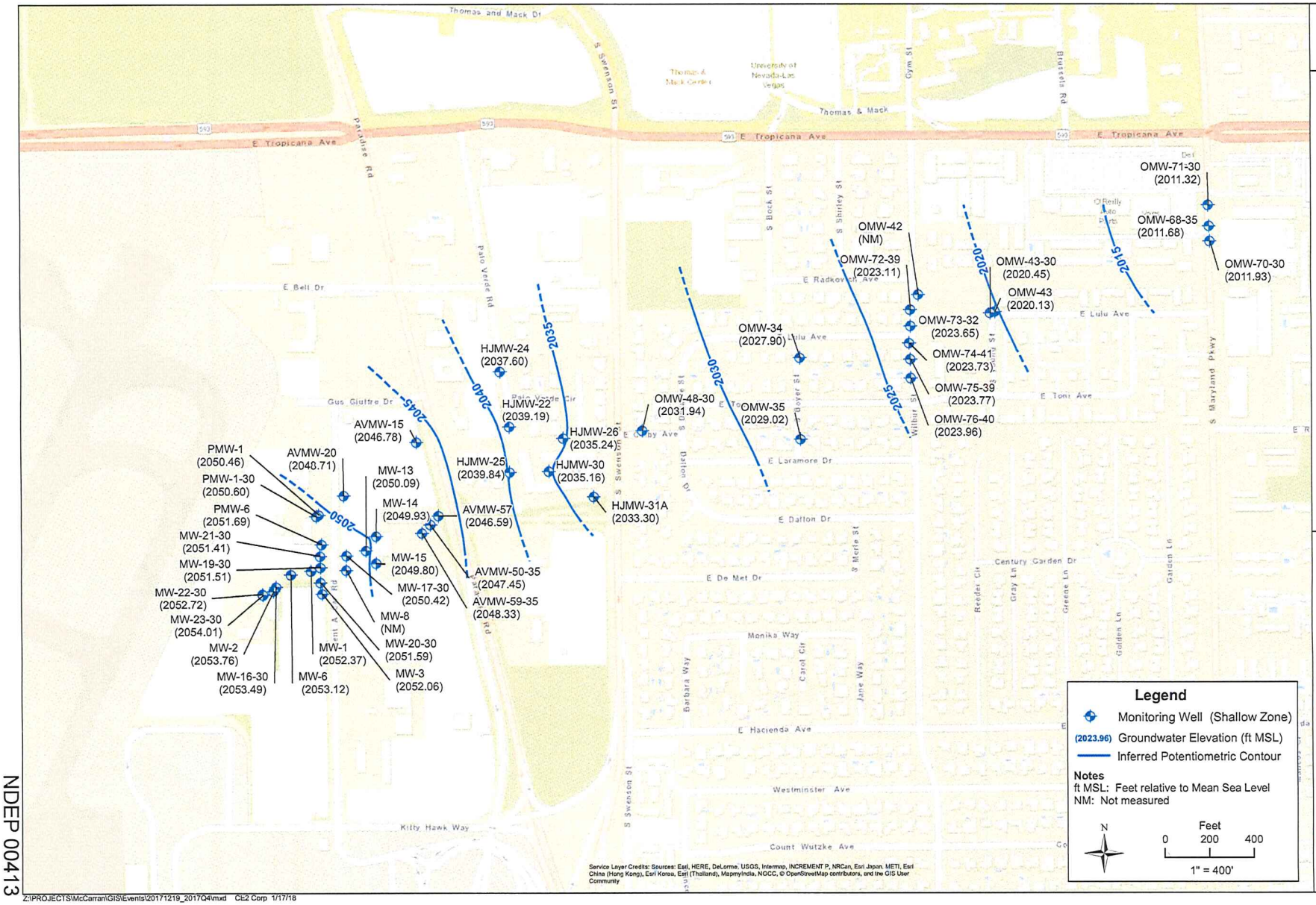


FIGURE 1

Former Car Rental Facilities
McCarran International Airport
Las Vegas, Nevada

Groundwater Potentiometric Surface Elevation Contour Map for the Shallow Zone, Fourth Quarter 2017

OGI ENVIRONMENTAL, LLC

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NDEP 00413

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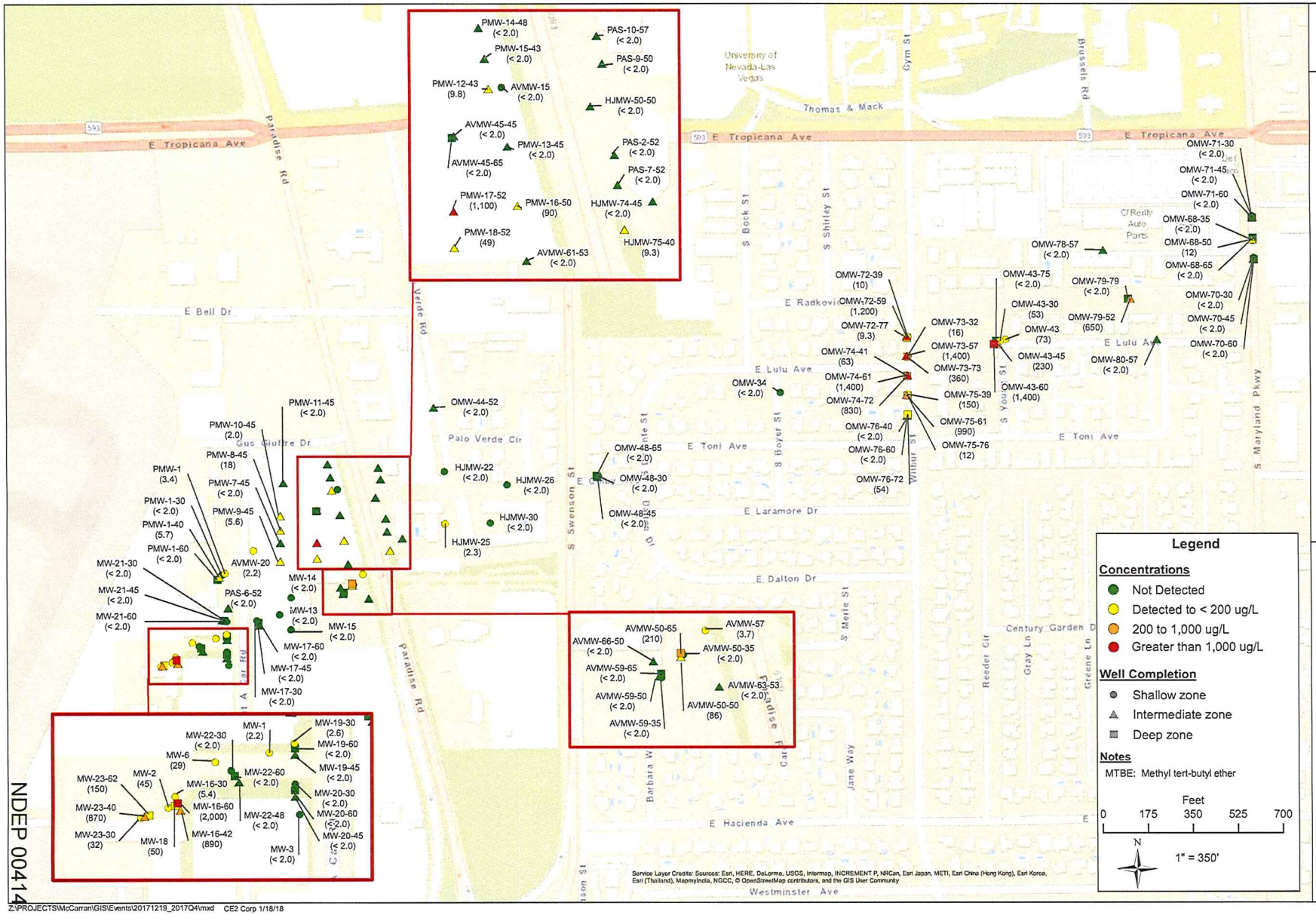

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FIGURE 2

Former Car Rental Facilities
McCarran International Airport
Las Vegas, Nevada

MTBE Distribution in Groundwater
Fourth Quarter 2017

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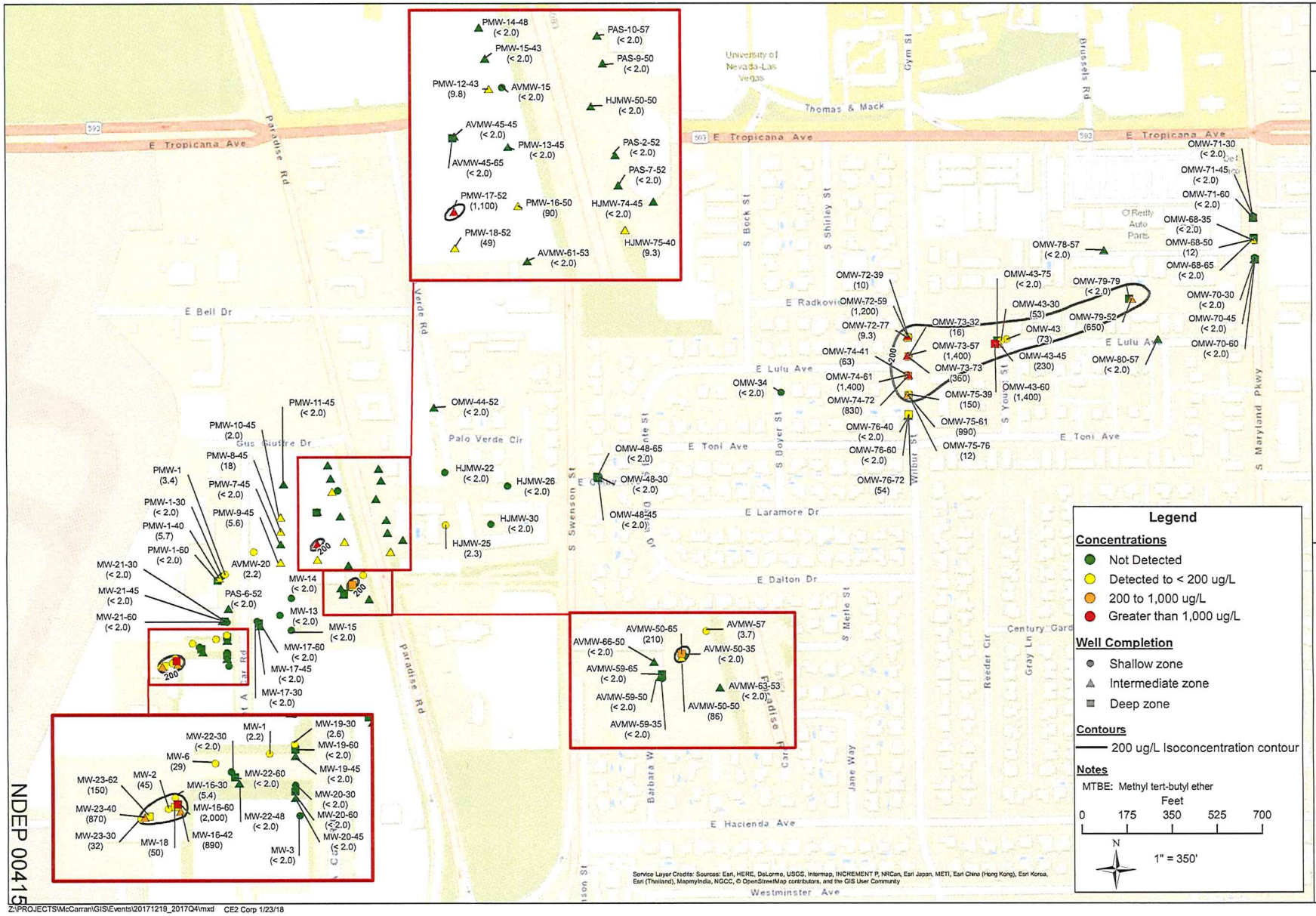

NDEP 00415

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FIGURE 3

Former Car Rental Facilities
McCarran International Airport
Las Vegas, Nevada

MTBE Isoconcentration Map for the Fourth Quarter 2017

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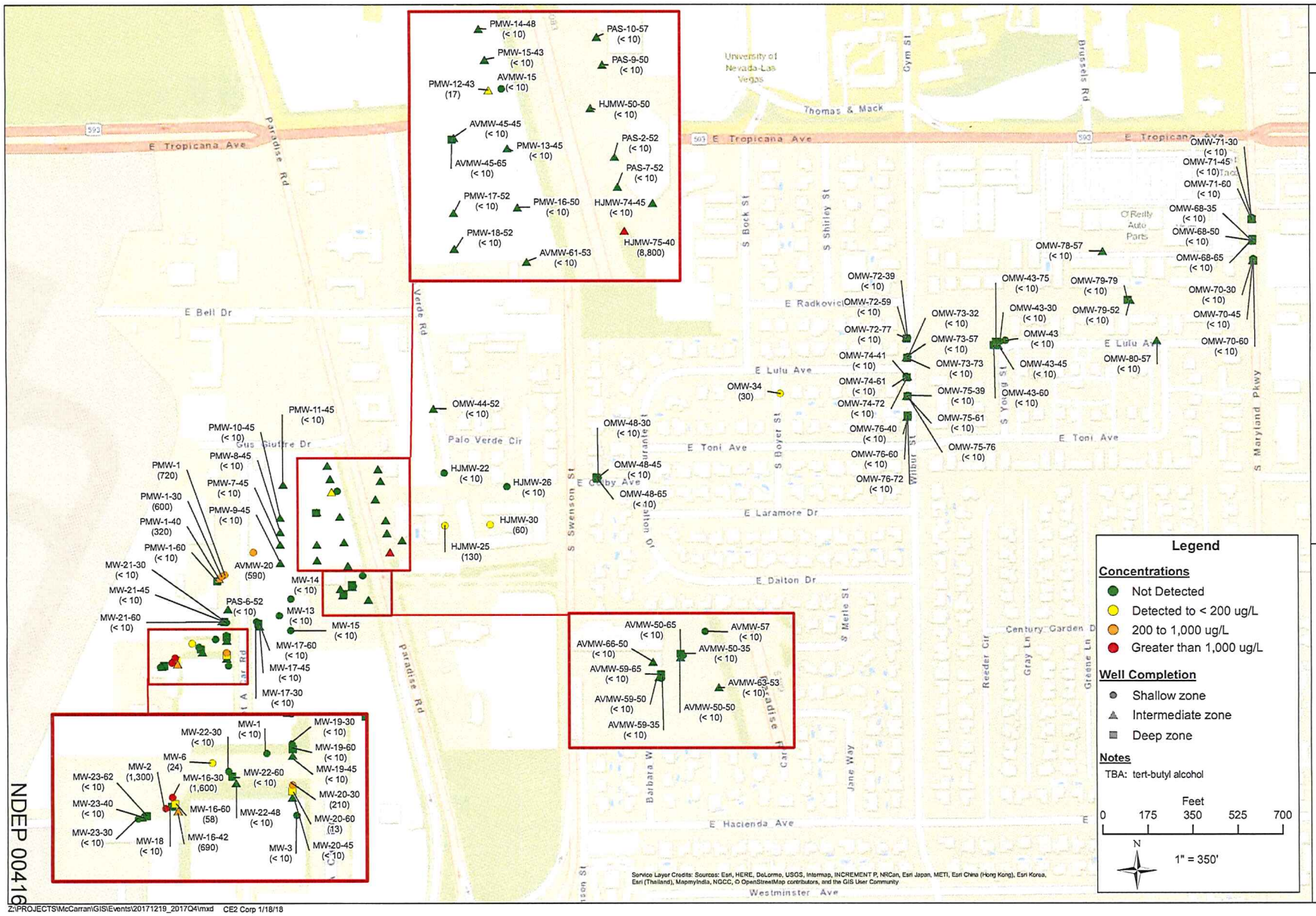

NDEP 00416

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FIGURE 4

Former Car Rental Facilities
McCarran International Airport
Las Vegas, Nevada

TBA Distribution in Groundwater
Fourth Quarter 2017

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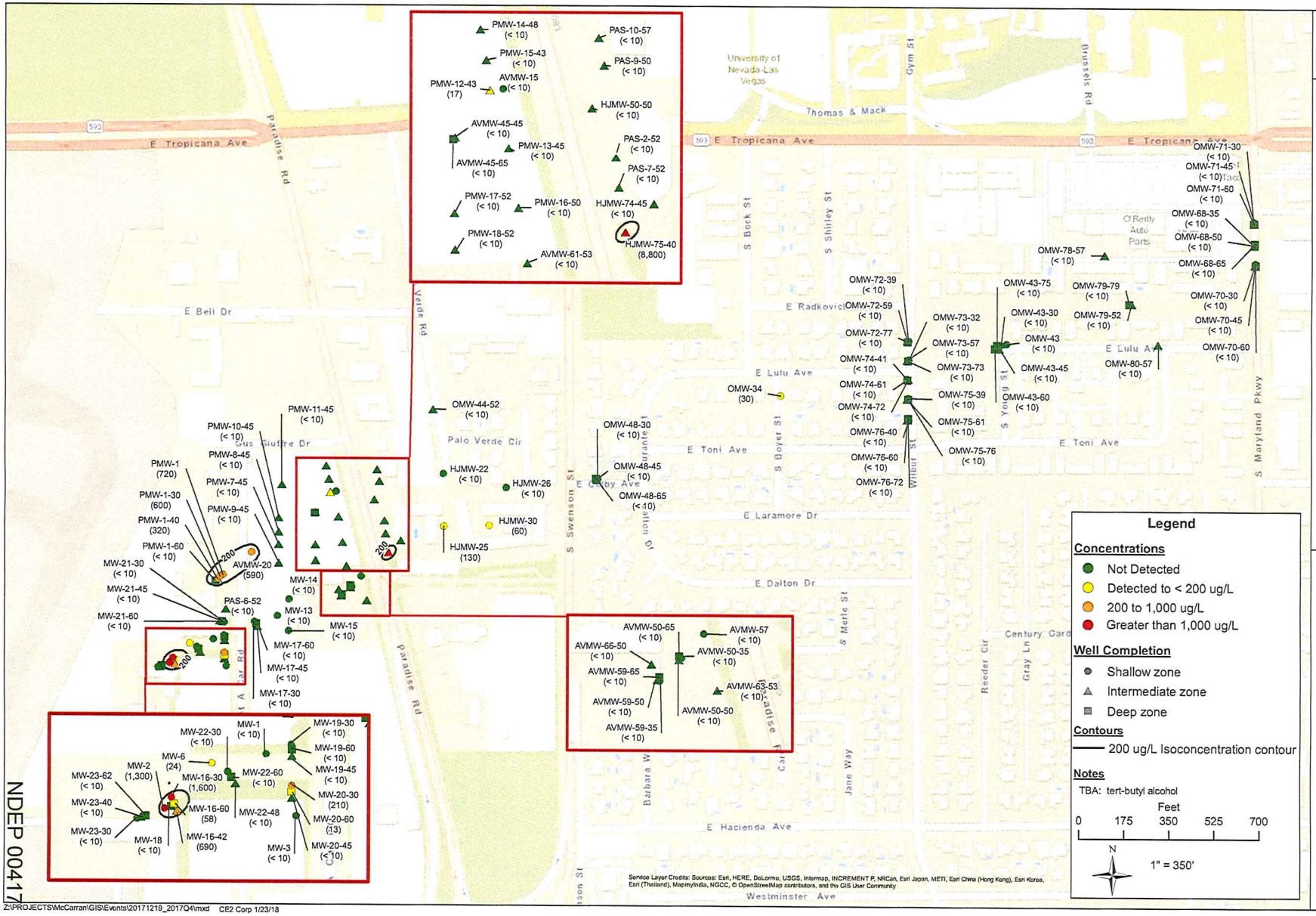

FIGURE 5

Former Car Rental Facilities
McCarran International Airport
Las Vegas, Nevada

TBA Isoconcentration Map for the Fourth Quarter 2017

OGI ENVIRONMENTAL, LLC

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