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science for a changing world

USGS Groundwater monitoring in Mark Twain and VC Highlands, Storey County, Nevada

By Kip K. Allander (kalland@usgs.gov) & David W. Smith (dwsmith@usgs.gov)

Storey County Commissioners meeting,

August 2, 2016

Nevada Water Science Center
U.S. Department of the Interior
U.S. Geological Survey

Outline

- What is groundwater and aquifers?
- Overview of USGS Middle Carson River Monitoring
  - Project with Carson Water Subconservancy District
  - Mark Twain Estates Groundwater
- Virginia City Highlands Groundwater Conditions
  - Water-level declines

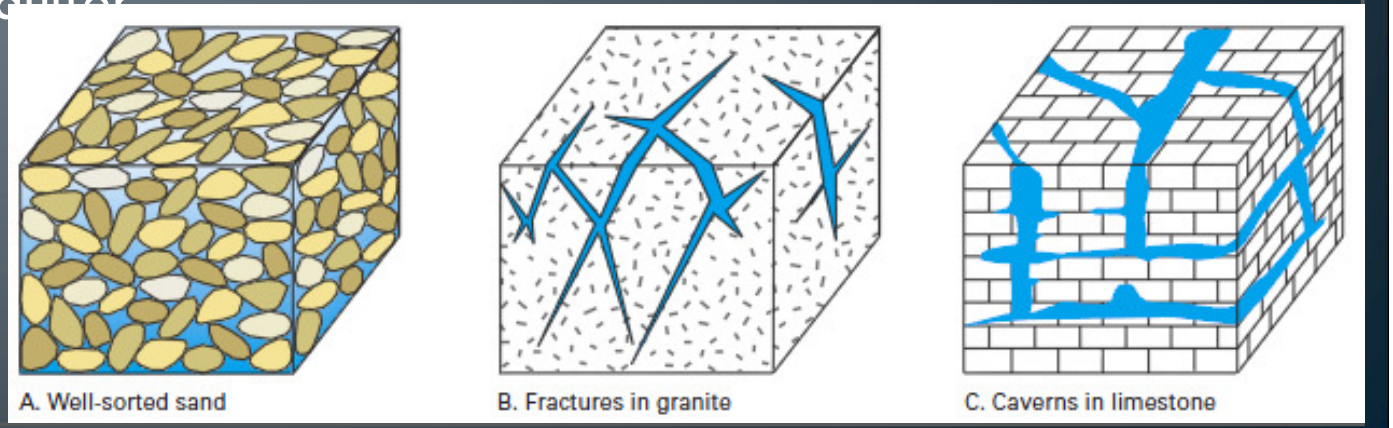
USGS

What is groundwater?

- Liquid water in the subsurface.
- Water occupies spaces between sand, silt, and gravel in fill; or fractures and cavities in rocks.
- Water movement through and storage within the subsurface is governed by aquifer properties.

Permeability is ability of water to move through material.

Storage is amount of water stored in a given volume of aquifer.

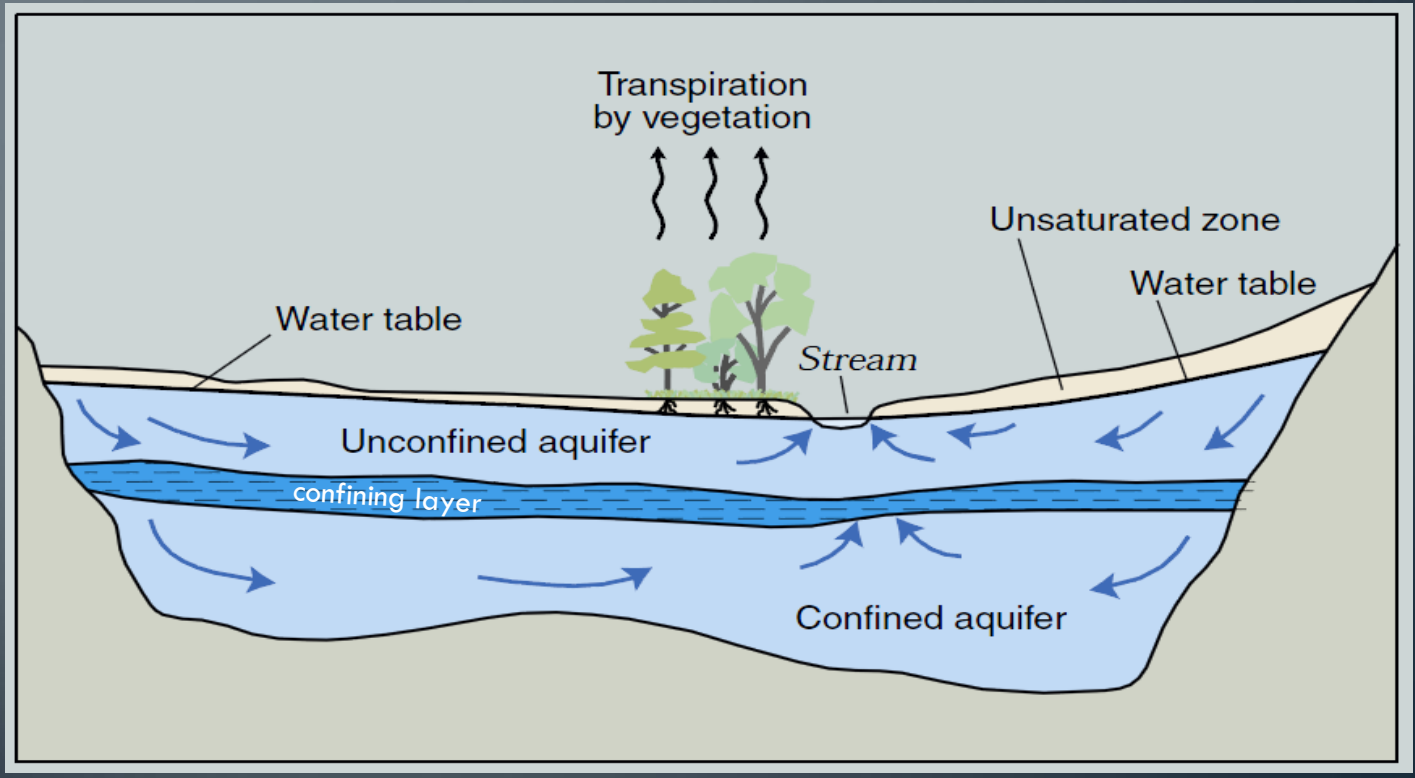


USGS

What is groundwater?

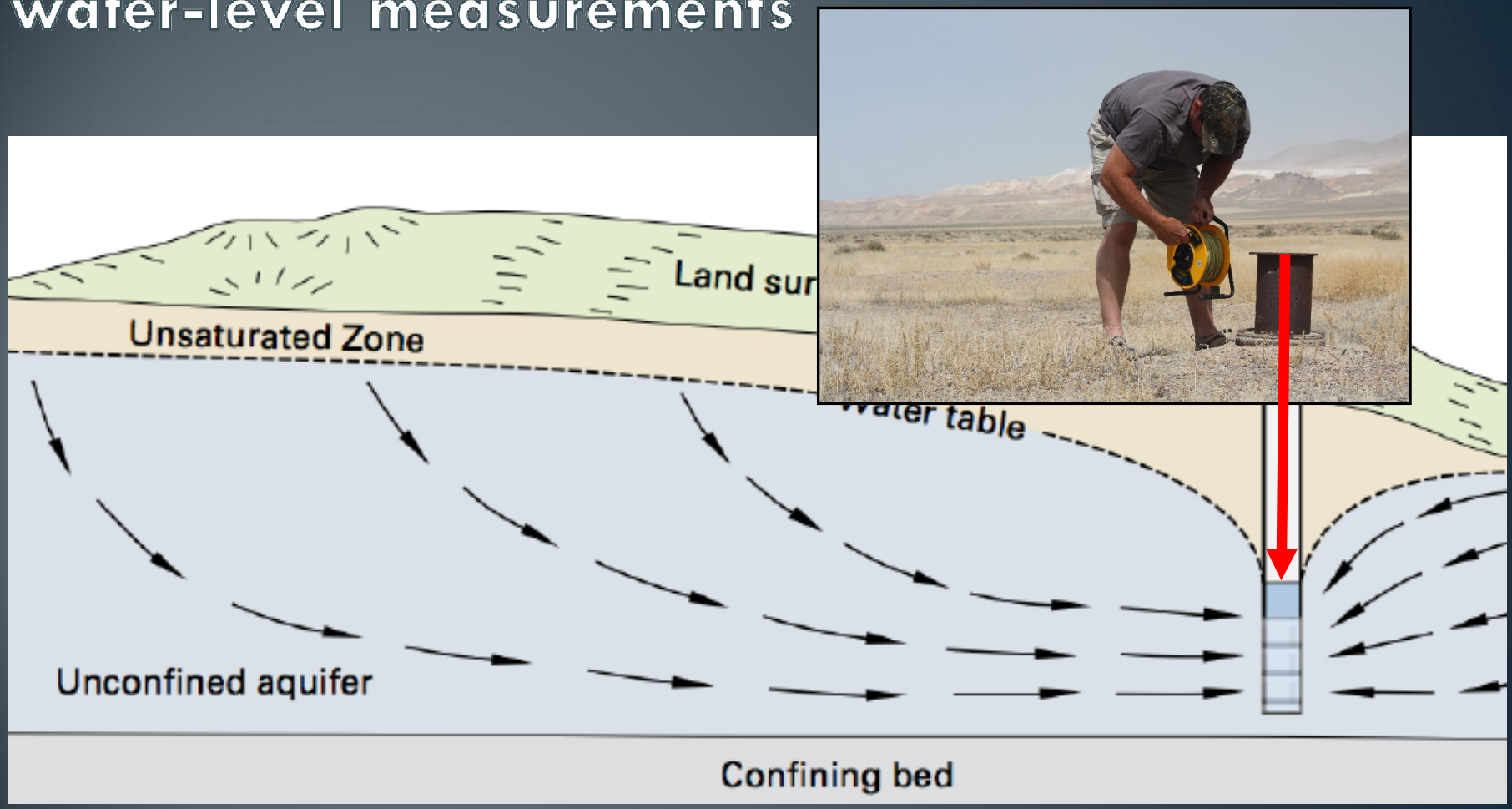
- Groundwater flows from areas of recharge to areas of discharge.

Aquifers exist where groundwater can be developed to provide adequate supply to wells.

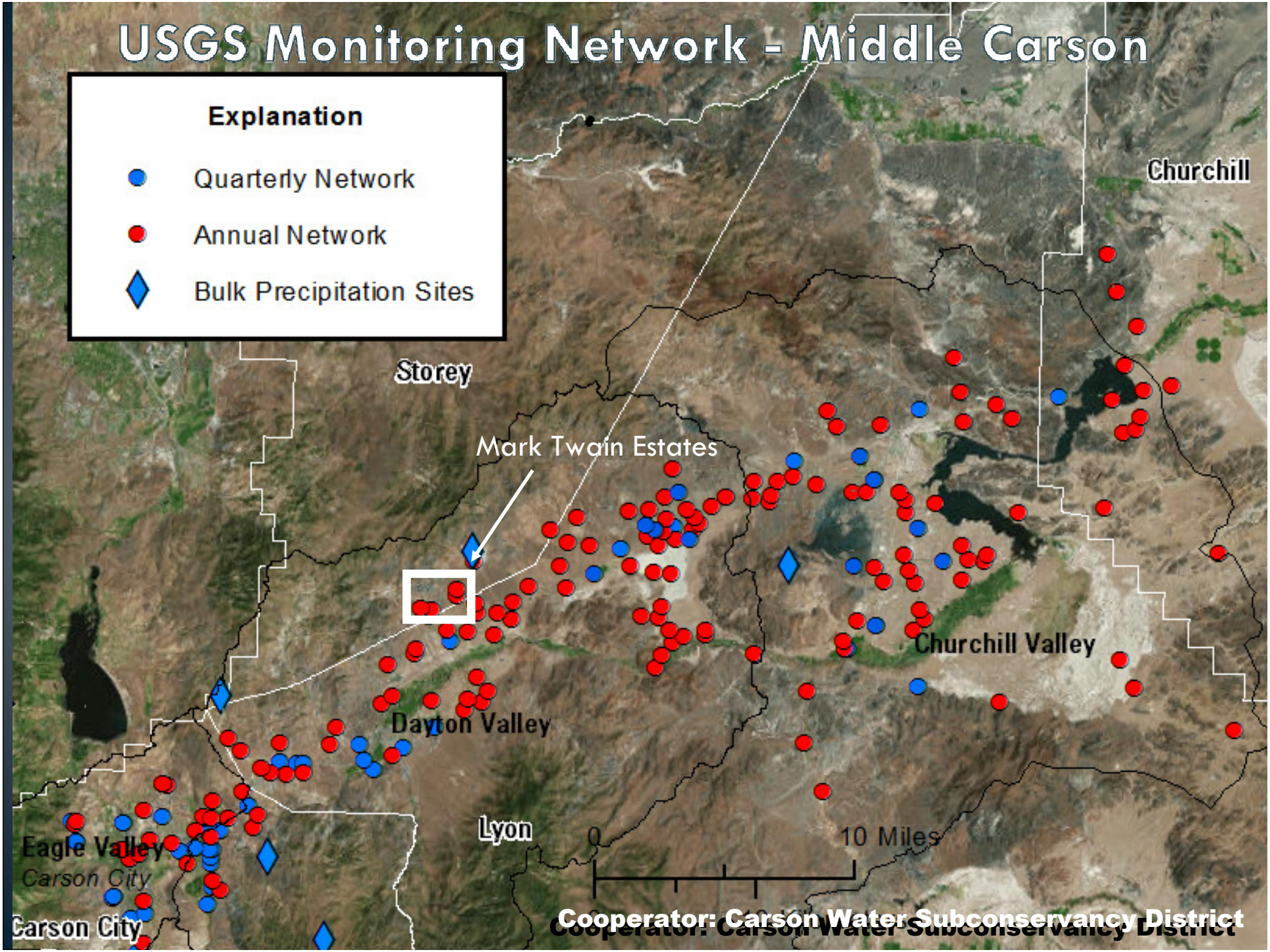


USGS

Change in groundwater levels are observed with water-level measurements



USGS


USGS Monitoring Network - Middle Carson
Explanation
Quarterly Network
Annual Network
Bulk Precipitation Sites
Churchill
Storey
Mark Twain Estates
Churchill Valley
Dayton Valley
Lyon
Eagle Valley
Carson City
Carson City
0
10 Miles
Cooperator: Carson Water Subconservancy District

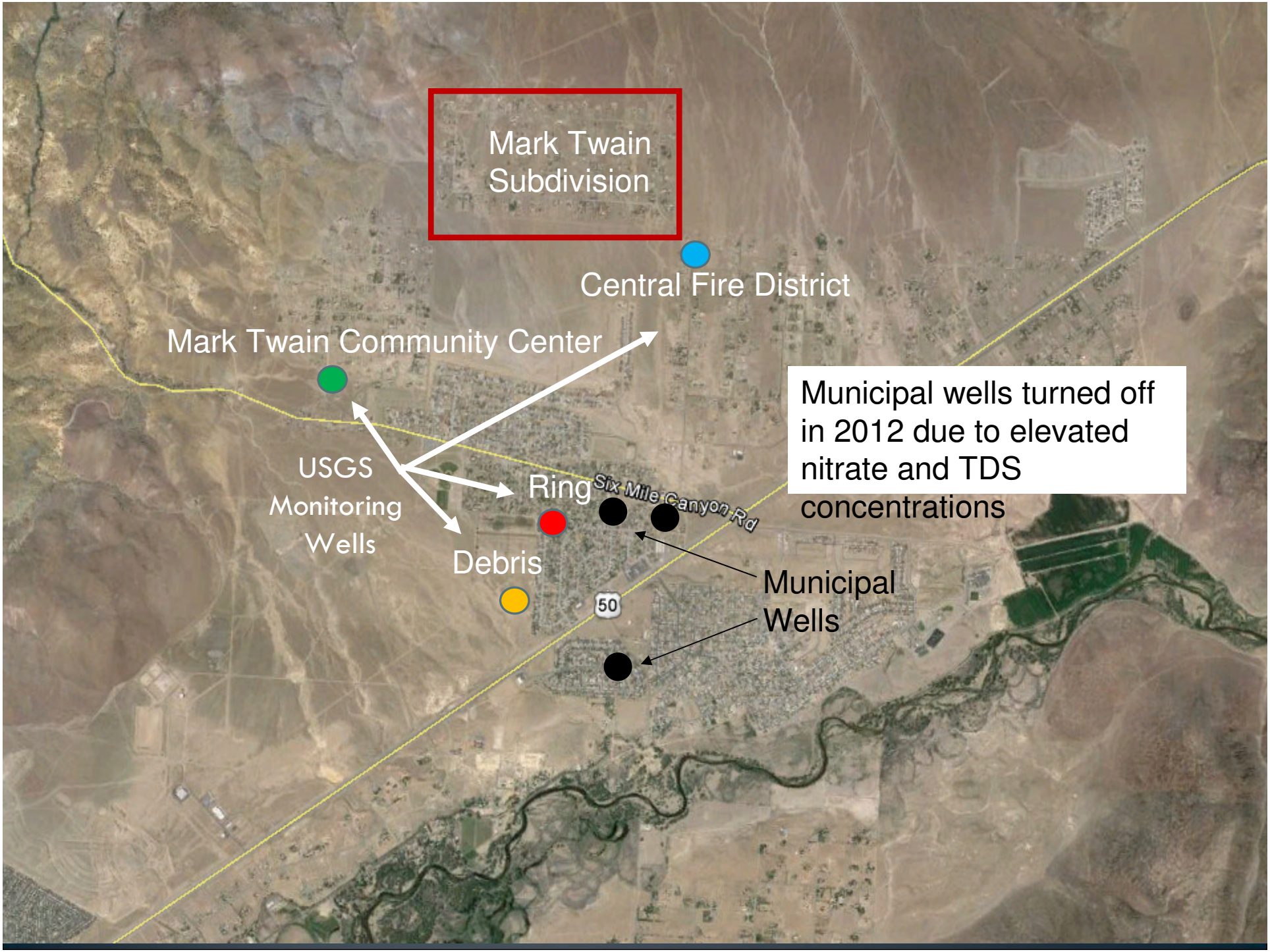
Mark Twain Estates Subdivision

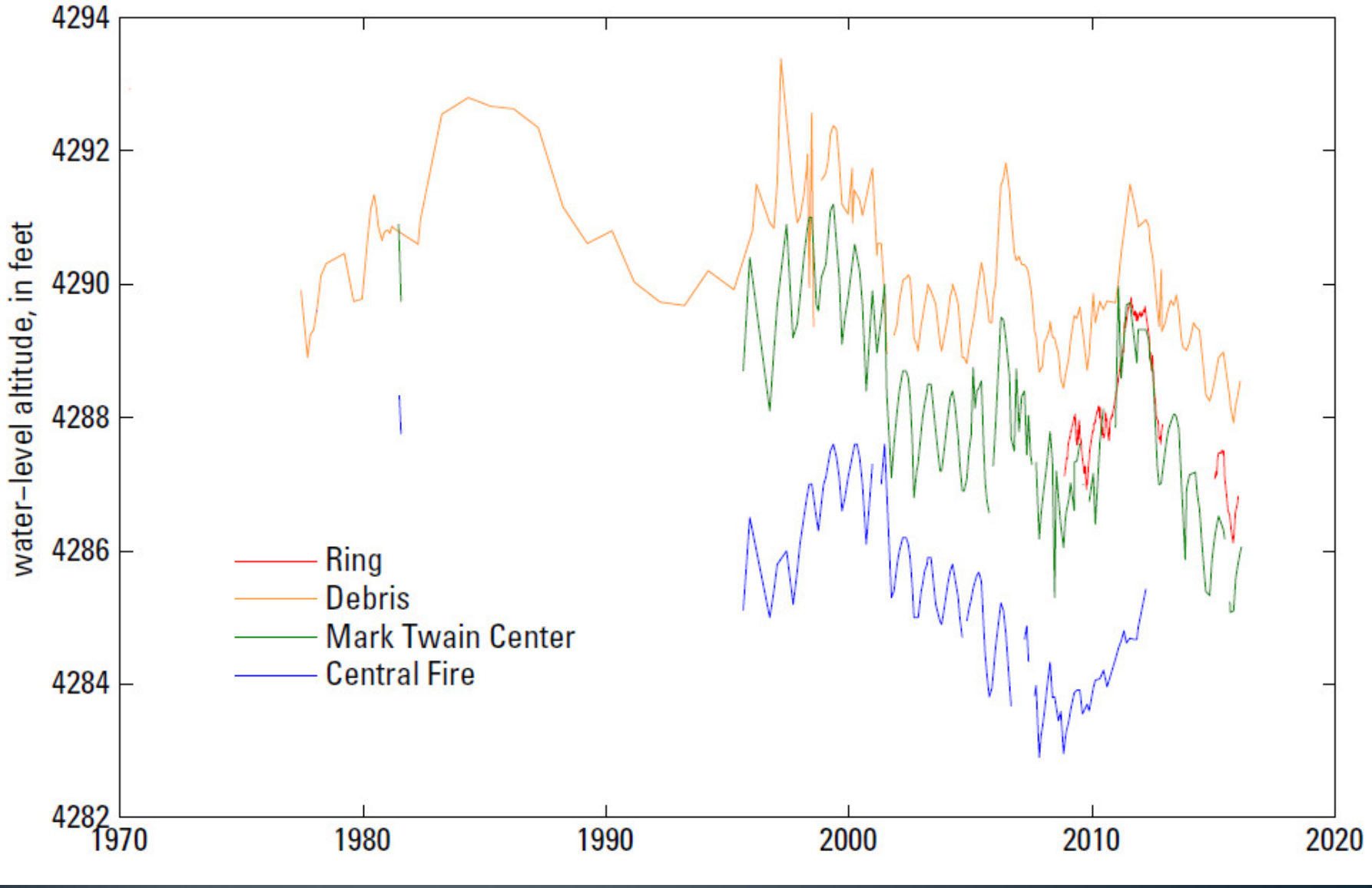
- "Water Woes of Mark Twain Estates"
  - Article in the Virginia City News 11/20/2015
  - 5 domestic wells reported to have gone dry
  - Potential Impact of lift stations from Dayton?
  - Rumors of municipal well pumping cause 20ft of drawdown in the area.

June, 1990

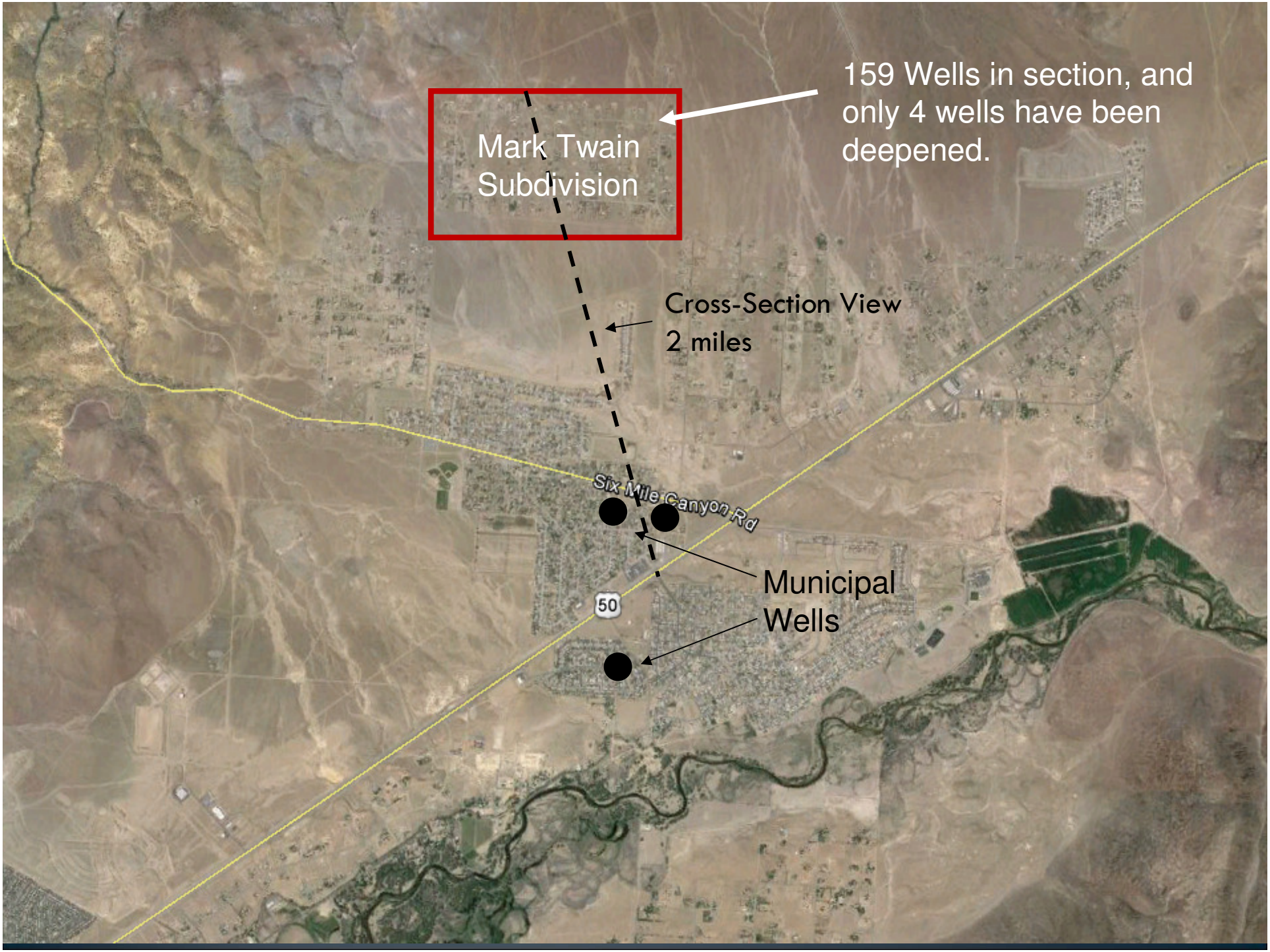
June, 2015

USGS


Mark Twain Subdivision
Central Fire District
Mark Twain Community Center
USGS Monitoring Wells
Ring
Six Mile Canyon Rd
Debris
50
Municipal Wells
Municipal wells turned off in 2012 due to elevated nitrate and TDS concentrations

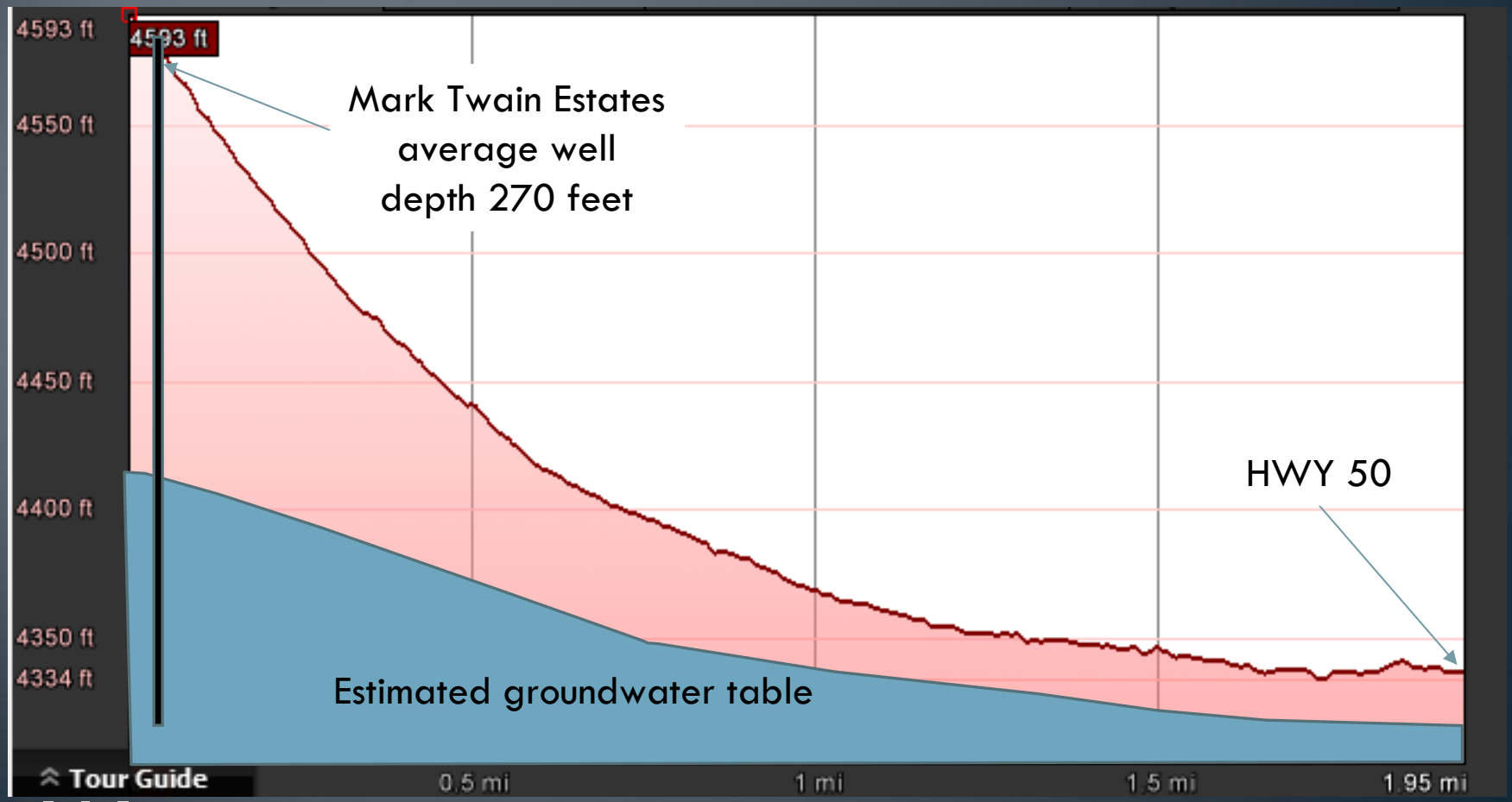

4294
4292
4290
4288
4286
4284
4282
water–level altitude, in feet
1970
1980
1990
2000
2010
2020
Ring
Debris
Mark Twain Center
Central Fire

USGS

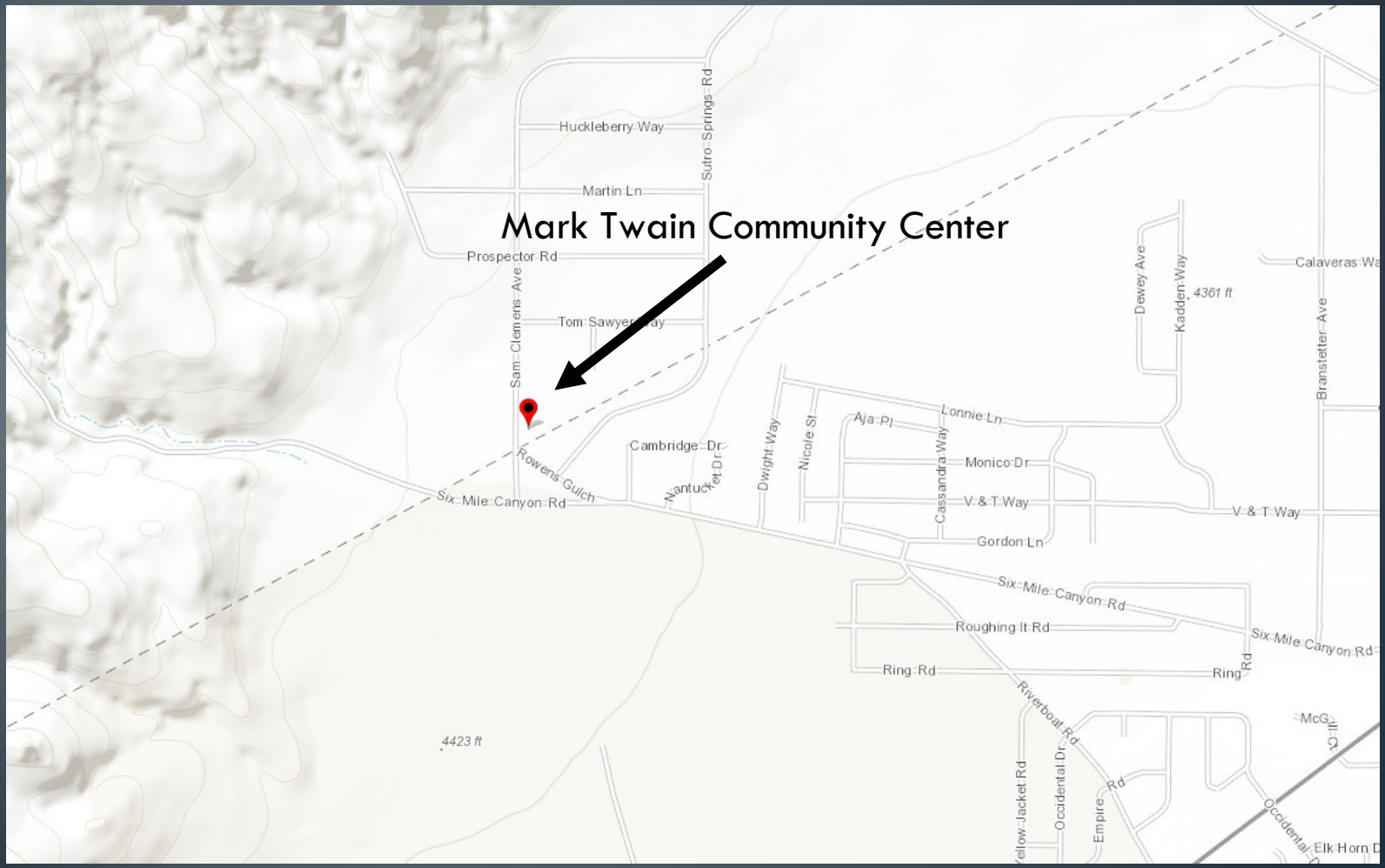

159 Wells in section, and only 4 wells have been deepened.
Mark Twain Subdivision
Cross-Section View
2 miles
Six Mile Canyon Rd
50
Municipal Wells

Elevation Change Mark Twain to HWY 50

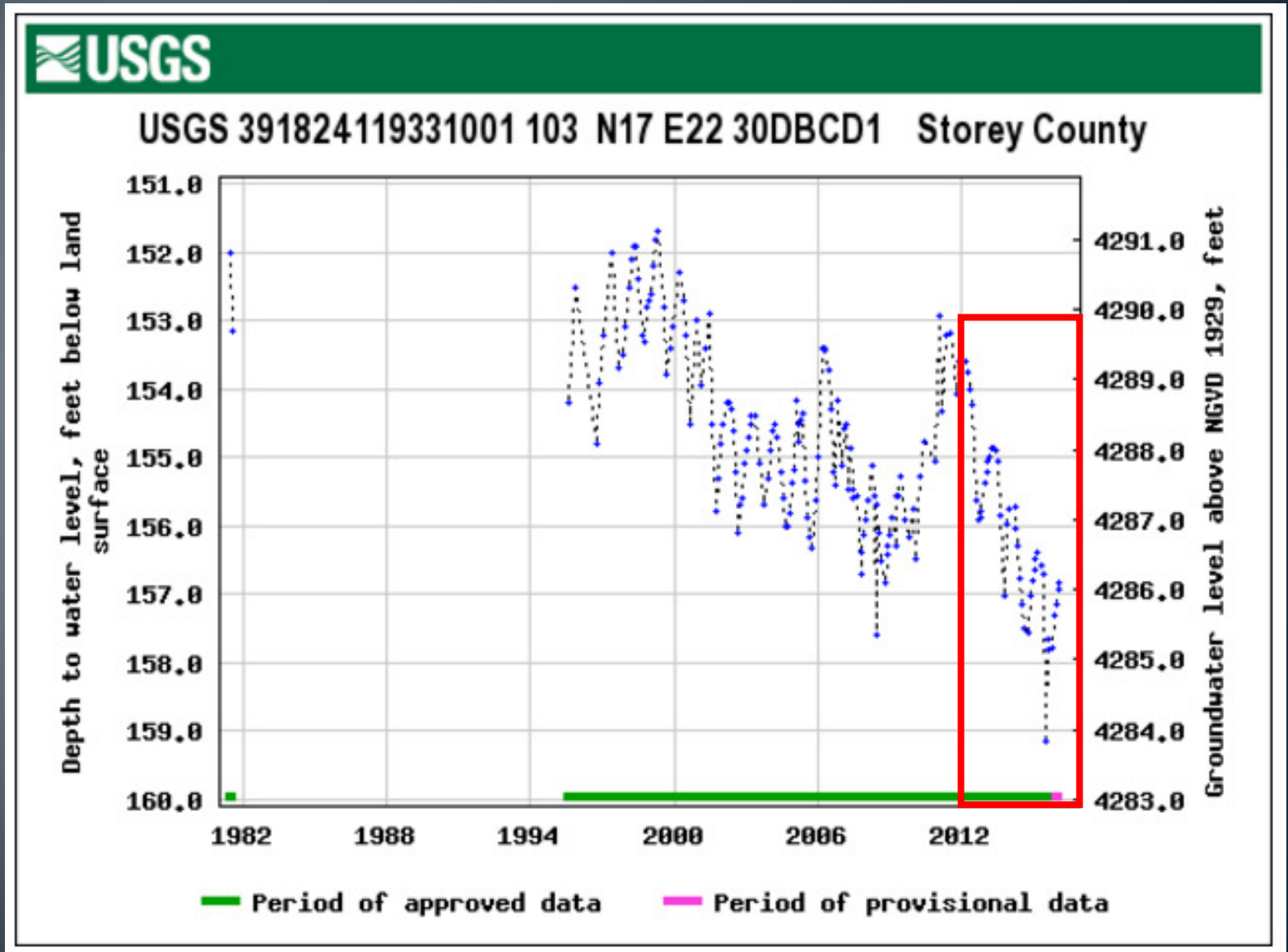
- Elevation difference of 280 ft
- 180 ft to water in Mark Twain Estates



GW Monitoring near Mark Twain Estates

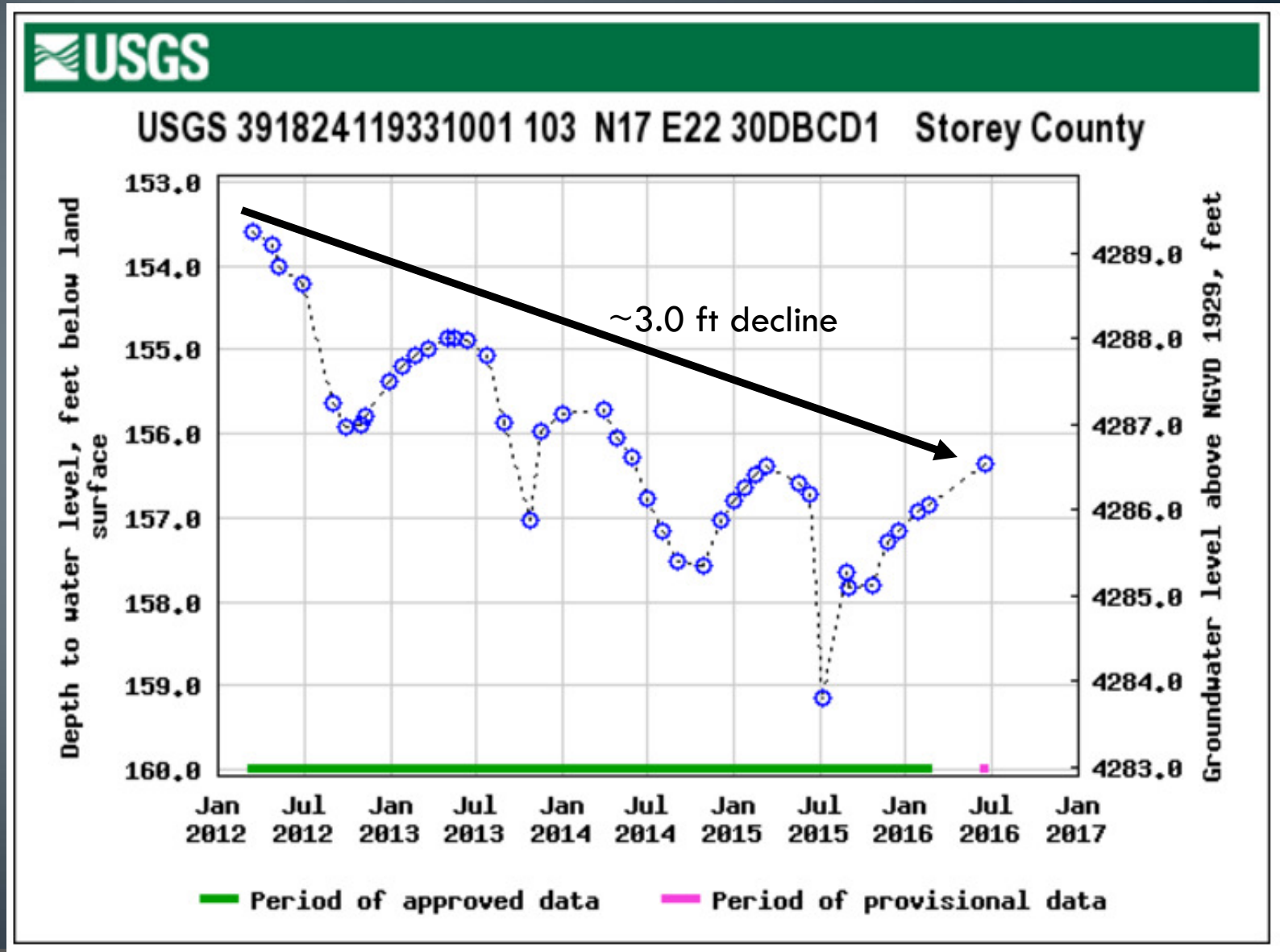


Drought Impacts 2012-2016



USGS

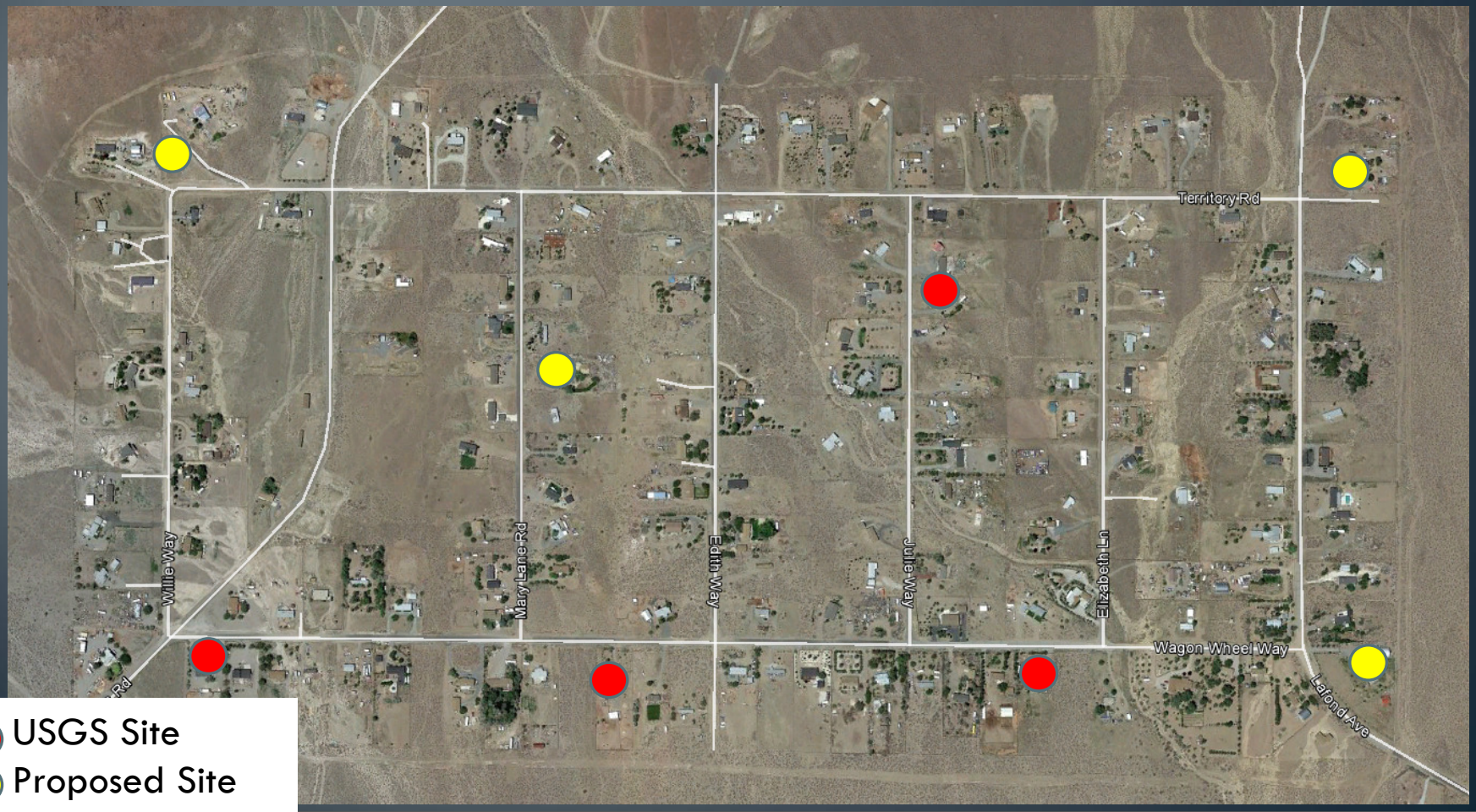
Drought Impacts 2012-2016



USGS

Revised Monitoring Plan for Mark Twain

- Target 7-8 domestic wells for monthly monitoring
- Deploy 1 continuous pressure transducer (potentially need more)

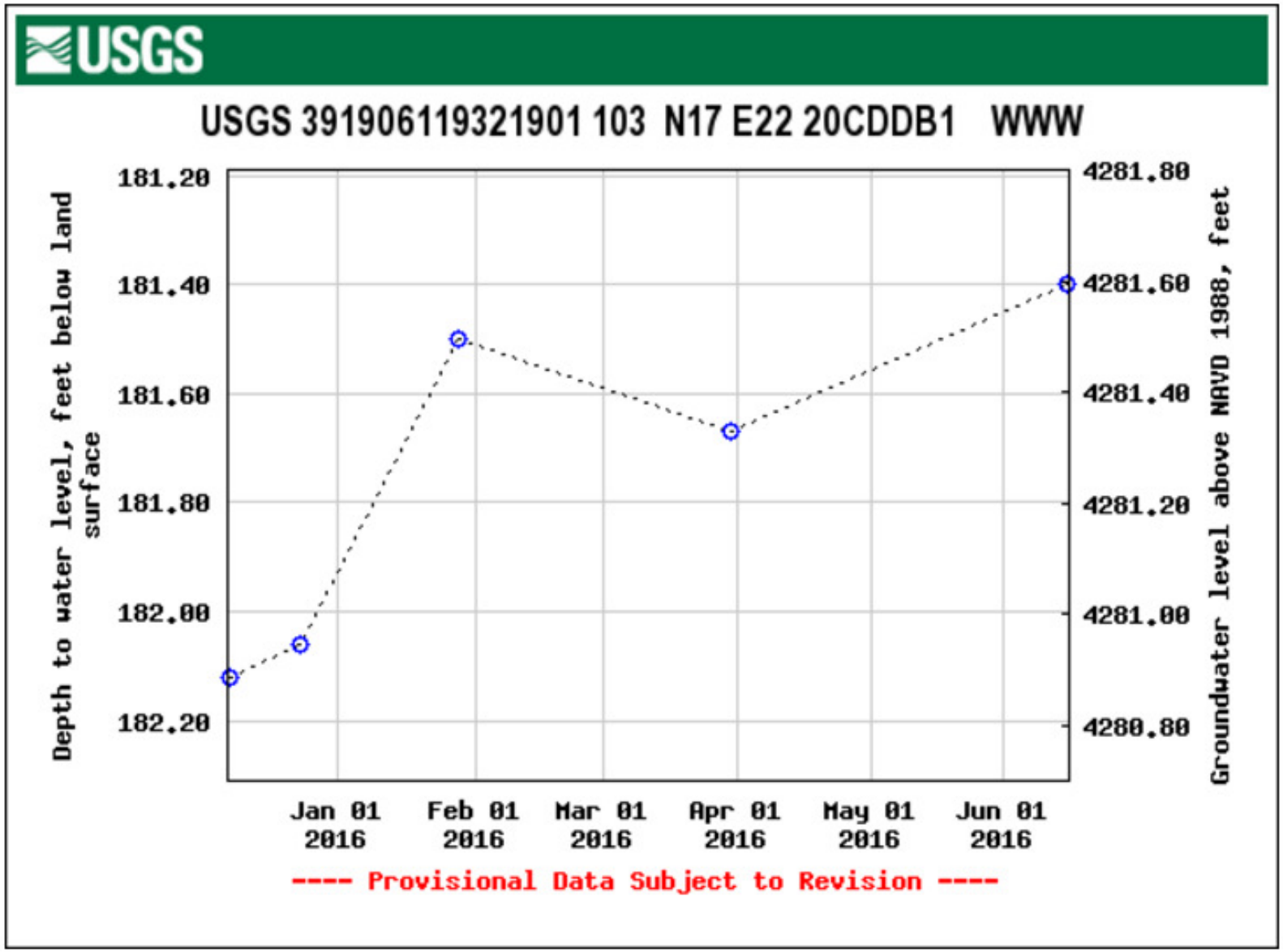


Revised Monitoring Plan for Mark Twain

- Data from current monitoring well

USGS

Mark Twain Water-level Monitoring



USGS

Mark Twain Subdivision Monitoring

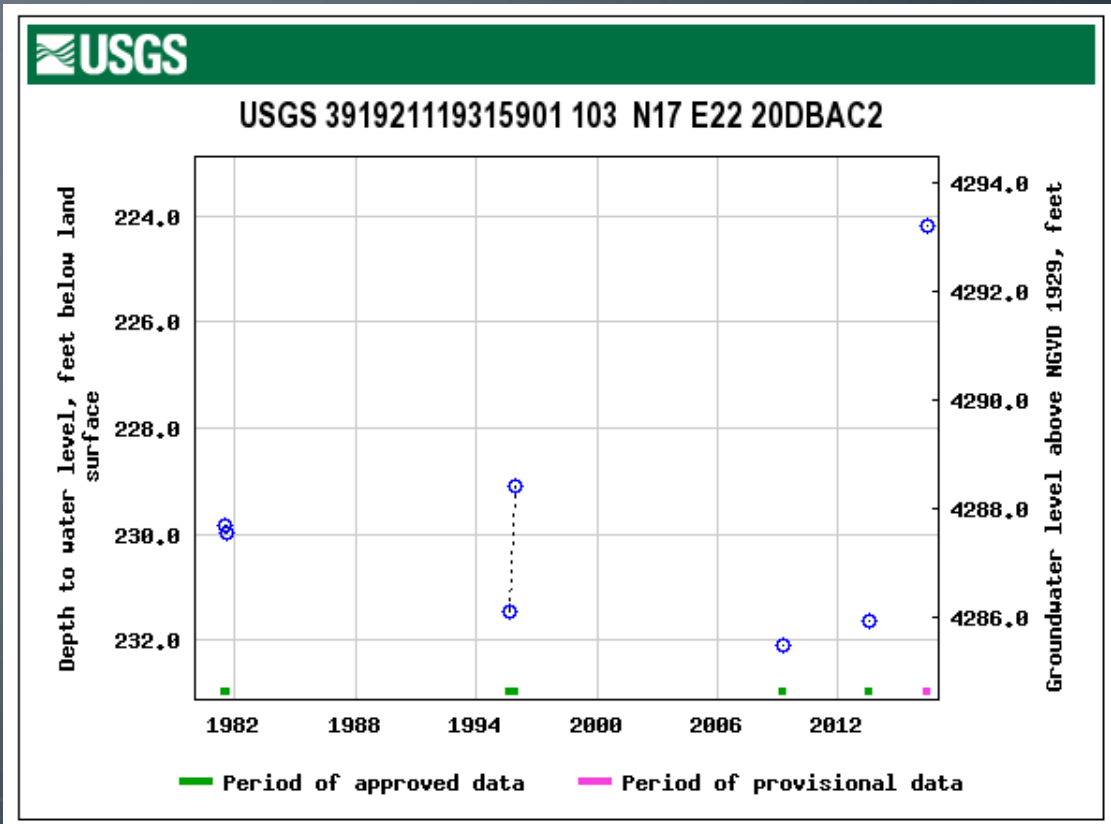
- Target 7-8 domestic wells for monthly monitoring
- Deploy 1 continuous pressure transducer (potentially need more)

Separate Aquifers?

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thick-ness
DIRT / ROCK		0	62	62
LAVA ROCK		62	100	38
STREAKY CLAY-LAVA ROCK		100	108	8
FRACTURED BLACK ROCK		108	205	97
BROWN CLAY-LAVA	X	205	235	30
LAVA ROCK		235	295	60
LAVA ROCK GRAVEL	X	295	325	30

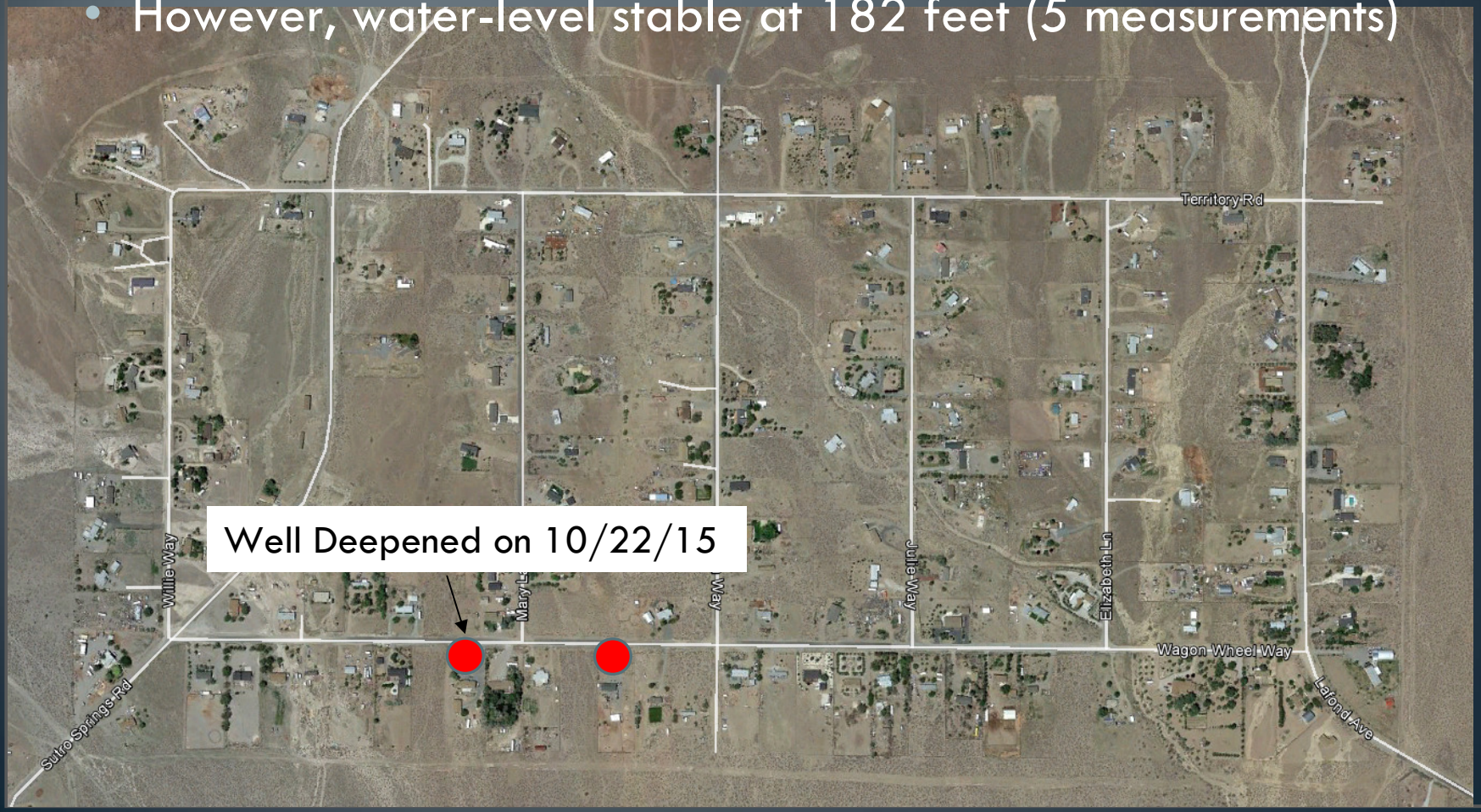
- Total well depth 325 feet
- Separated by brown clay layer at 205-235 ft below land surface
- Water-level has declined only 2 ft since 1982
- Several feet of recovery observed with most recent measurement



USGS

Mark Twain Subdivision Monitoring

- Nevada Division of Water Resources Well Database used to identify wells that have been deepened or re-drilled
- Location of well deepened in 2015
- However, water-level stable at 182 feet (5 measurements)



Results Mark Twain Monitoring

- Well logs indicate potentially multiple aquifers in the area
  - Clay layers between 120-225 ft bls of varying thickness
  - Deep wells completed in fractured Andesite layer >200 ft bls
- Are water-level fluctuations and dry wells isolated to one aquifer and in one area?
- Locally heavy domestic use could potentially result in water level declines in nearby domestic wells. (Isolated area)

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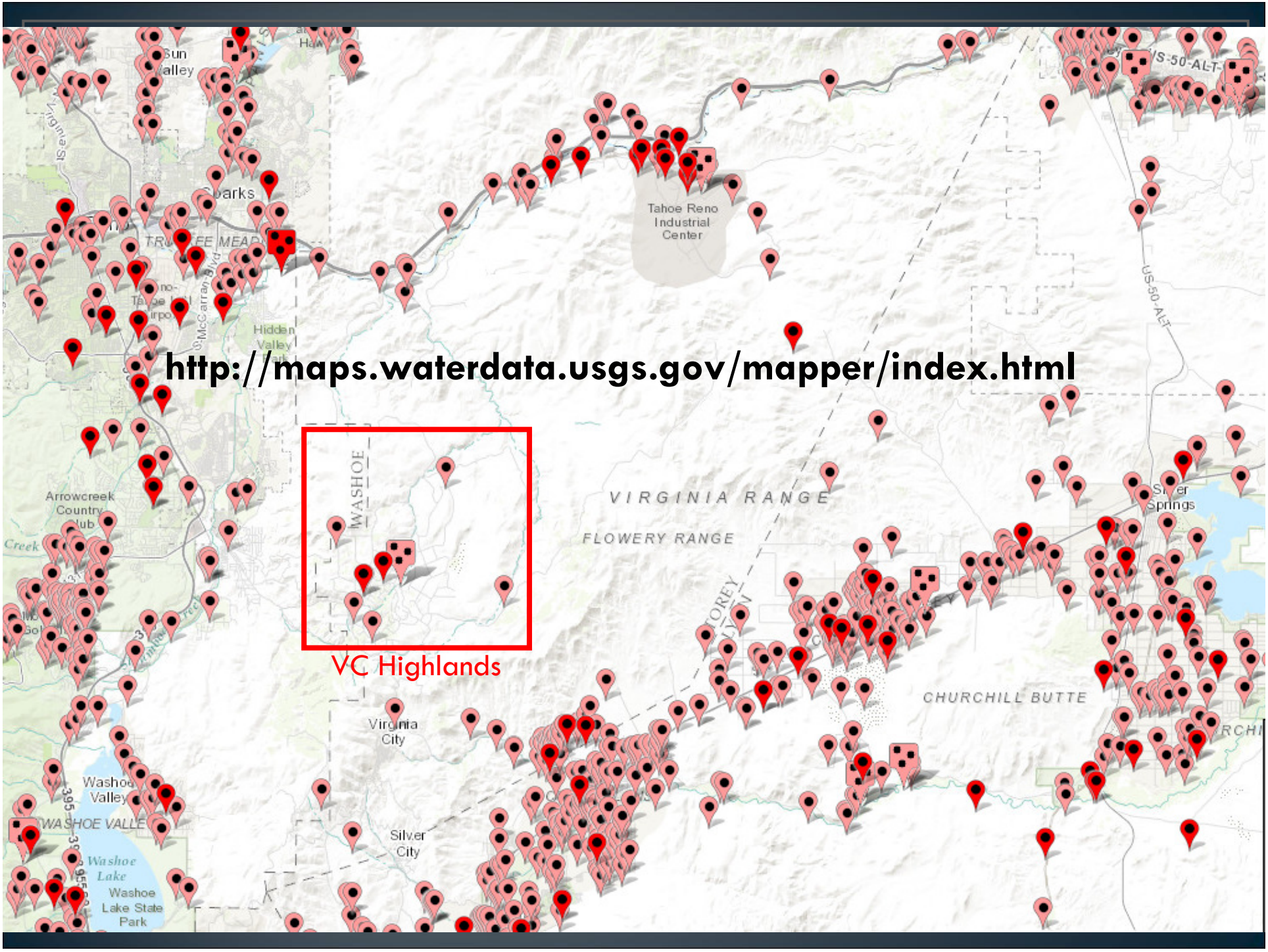
Water-level conditions in VC Highlands

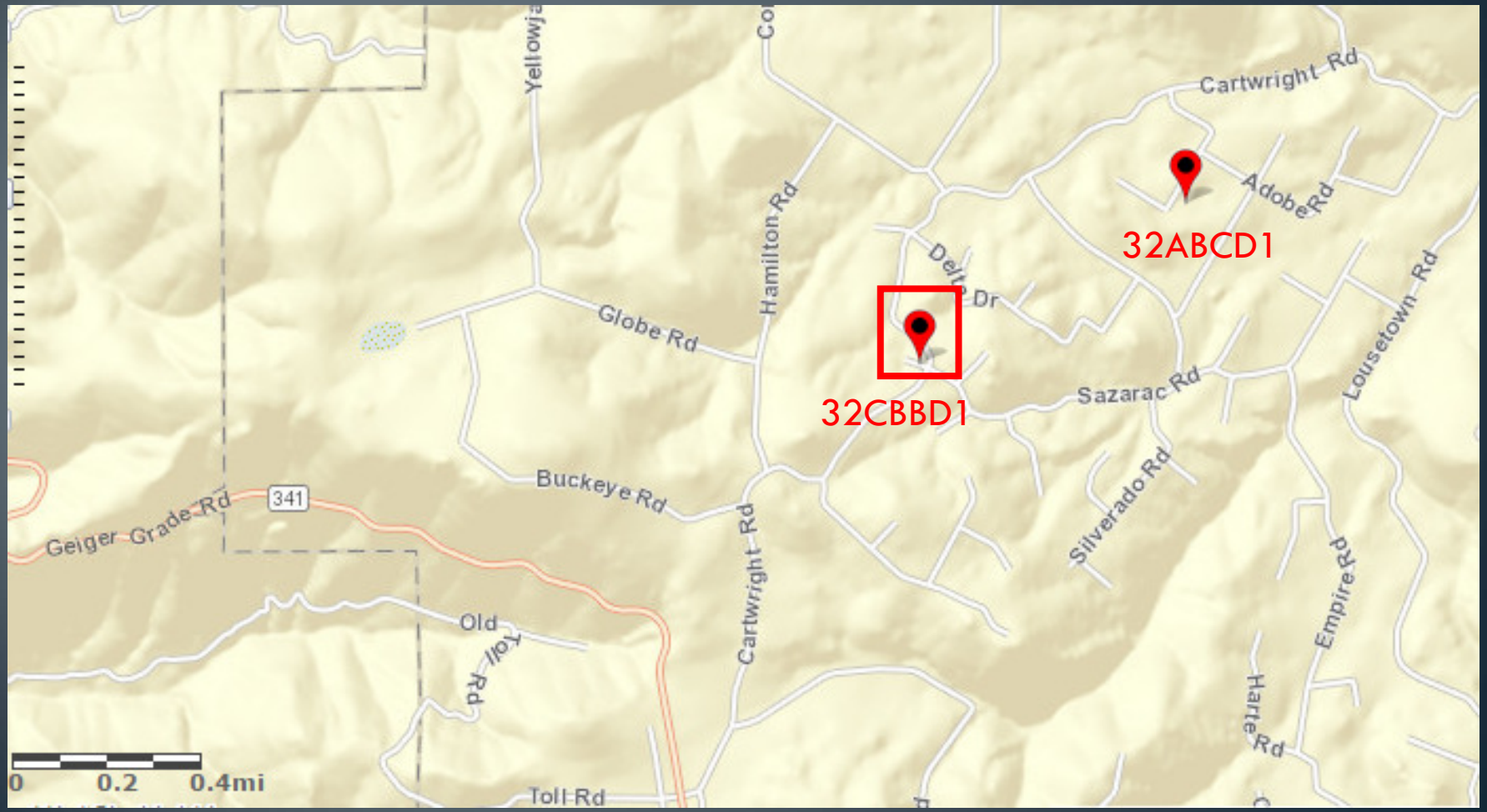
- USGS currently monitors two wells in the VC Highlands
  - Annual frequency for Nevada Division of Water-Resources

- Water-level declines noticed during a recent review of data.

USGS

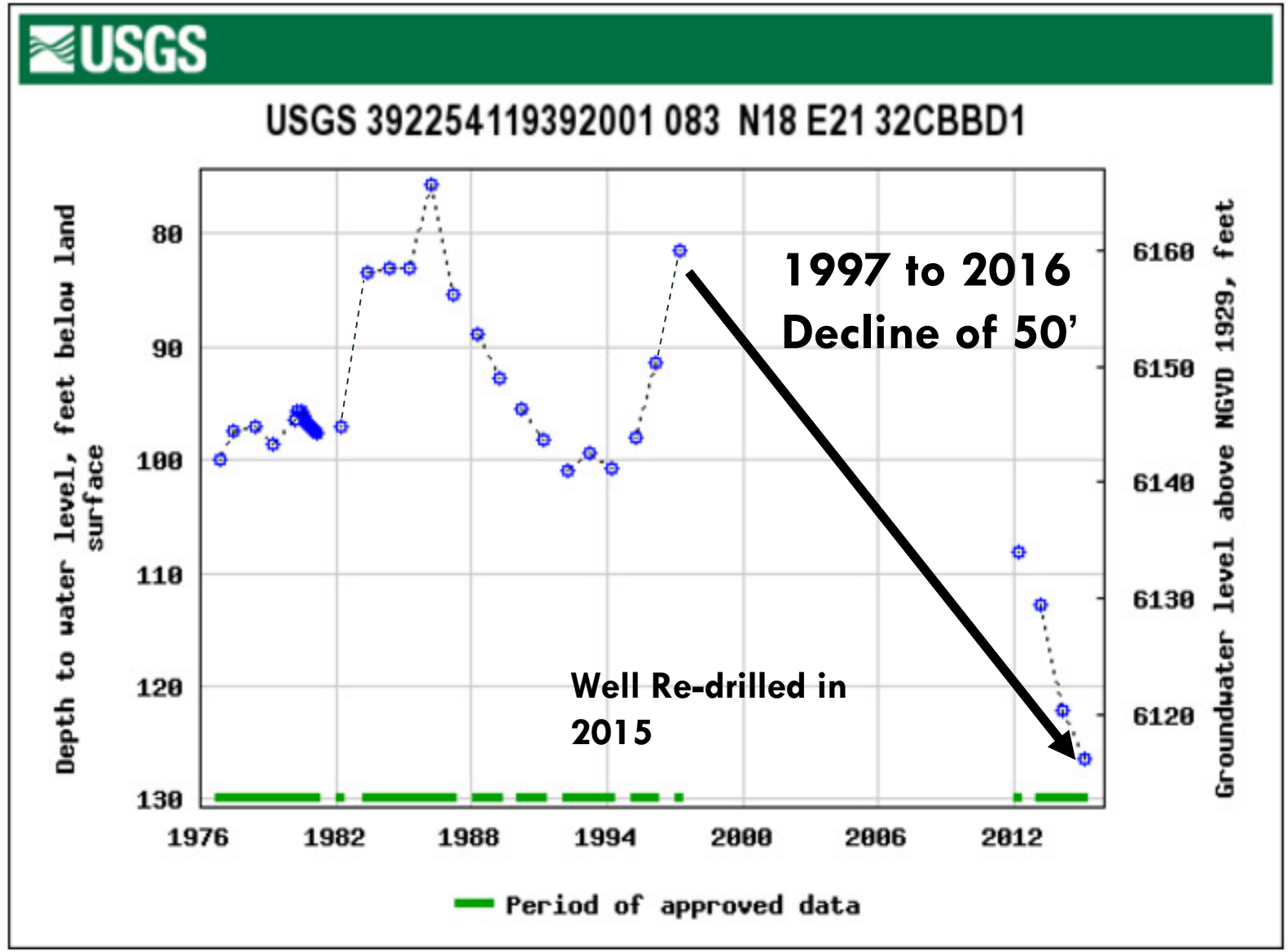

http://maps.waterdata.usgs.gov/mapper/index.html
VC Highlands
VIRGINIA RANGE
FLOWERY RANGE
CHURCHILL BUTTE
WASHOE
Tahoe Reno Industrial Center
Arrowcreek Country Club
Hidden Valley
Virginia City
Silver City
Washoe Valley
WASHOE VALLEY
Washoe Lake
Washoe Lake State Park
Silver Springs
US-50-ALT
McCarran Blvd

USGS Monitoring Wells in VC Highlands



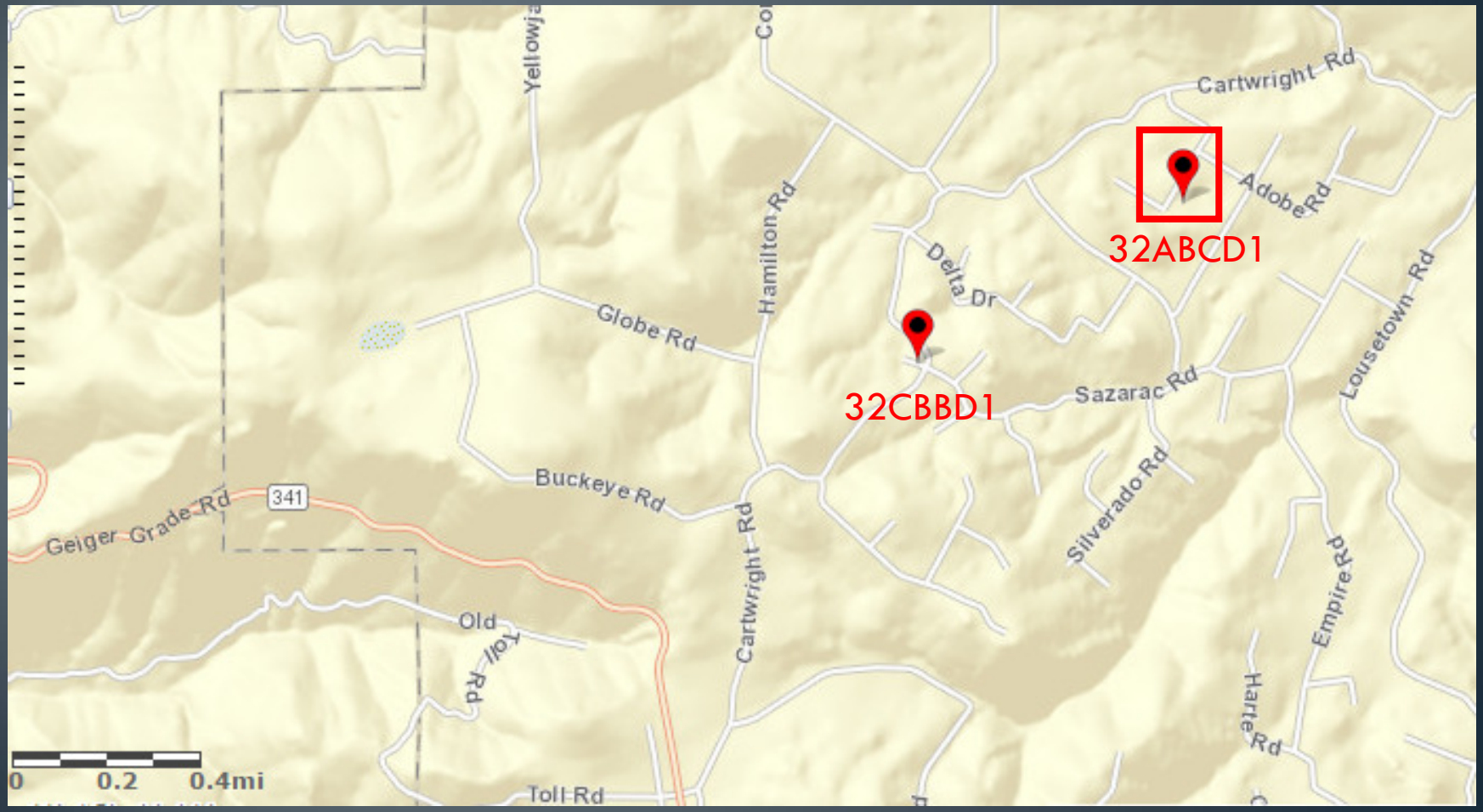
USGS

USGS Annual Well Locations



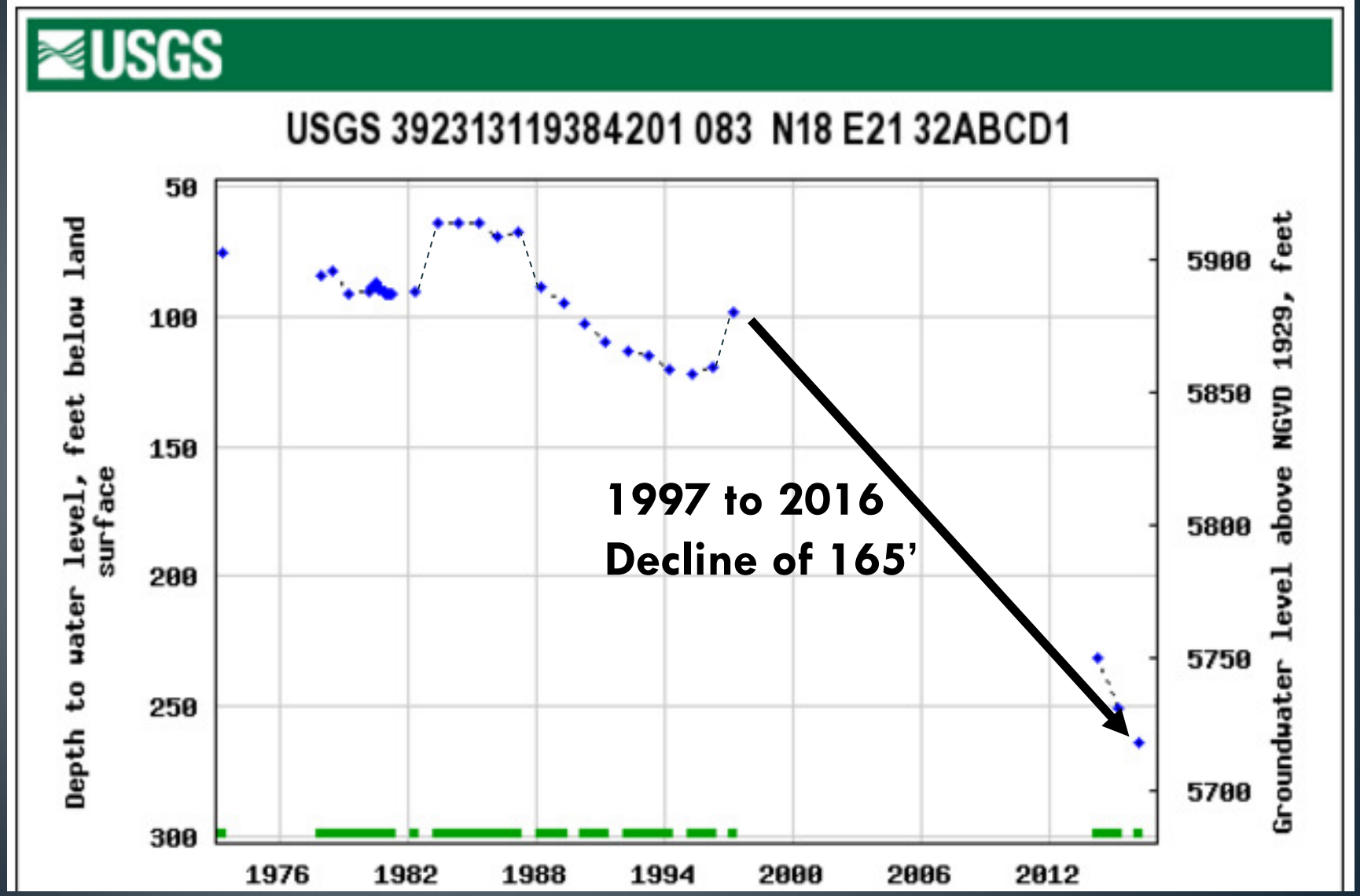
USGS

USGS Monitoring Wells in VC Highlands



USGS

USGS Annual Well Locations

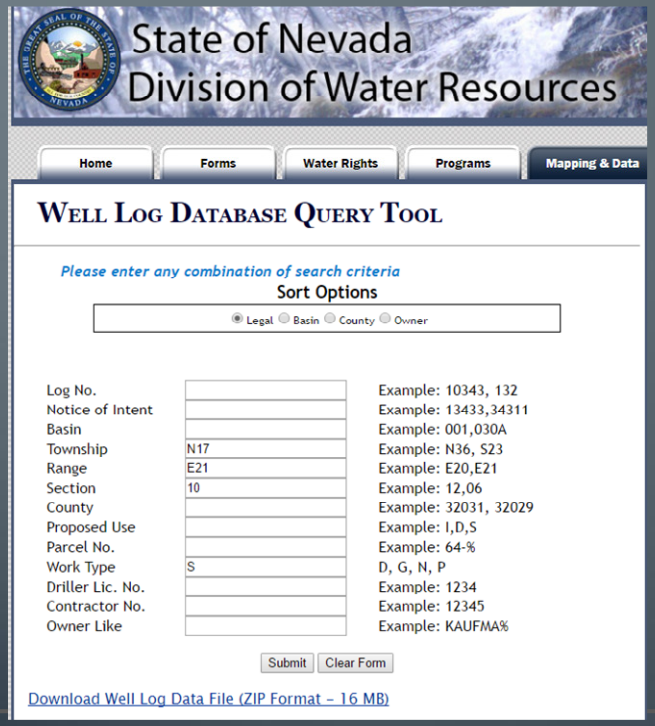


USGS

Are wells being re-drilled in areas of water-level decline?

Nevada Division of Water Resources Well Database, Virginia City Highlands

- State Database **http://water.nv.gov/data/welllog/**
  - **Store well logs, type of well (replacement/deepened)**
  - **Data from 1960 - Current Year**
  - **Wells filed by township/range/section**



State of Nevada
Division of Water Resources

Home | Forms | Water Rights | Programs | Mapping & Data

WELL LOG DATABASE QUERY TOOL

Please enter any combination of search criteria

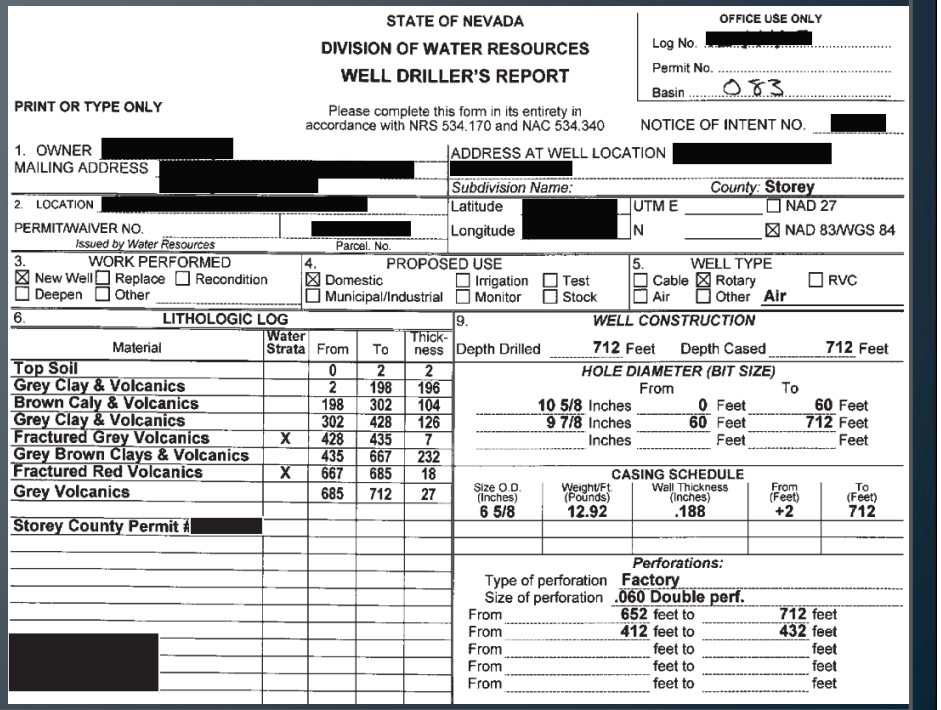
Sort Options

(•) Legal ( ) Basin ( ) County ( ) Owner

Log No.		Example: 10343, 132
Notice of Intent		Example: 13433,34311
Basin		Example: 001,030A
Township	N17	Example: N36, S23
Range	E21	Example: E20,E21
Section	10	Example: 12,06
County		Example: 32031, 32029
Proposed Use		Example: I,D,S
Parcel No.		Example: 64-%
Work Type	S	D, G, N, P
Driller Lic. No.		Example: 1234
Contractor No.		Example: 12345
Owner Like		Example: KAUFMA%

Submit | Clear Form

Download Well Log Data File (ZIP Format - 16 MB)



STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

OFFICE USE ONLY
Log No. [redacted]
Permit No.
Basin 063

PRINT OR TYPE ONLY

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

NOTICE OF INTENT NO. [redacted]

1. OWNER [redacted]
MAILING ADDRESS [redacted]

ADDRESS AT WELL LOCATION [redacted]

Subdivision Name: County: Storey

2. LOCATION [redacted]
PERMIT/WAIVER NO. [redacted]
Issued by Water Resources Parcel. No.

Latitude [redacted] UTM E ☐ NAD 27
Longitude [redacted] N ☒ NAD 83/WGS 84

3. WORK PERFORMED: ☒ New Well ☐ Replace ☐ Recondition ☐ Deepen ☐ Other
4. PROPOSED USE: ☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal/Industrial ☐ Monitor ☐ Stock
5. WELL TYPE: ☐ Cable ☒ Rotary ☐ RVC ☐ Air ☐ Other Air

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Top Soil		0	2	2
Grey Clay & Volcanics		2	198	196
Brown Caly & Volcanics		198	302	104
Grey Clay & Volcanics		302	428	126
Fractured Grey Volcanics	X	428	435	7
Grey Brown Clays & Volcanics		435	667	232
Fractured Red Volcanics	X	667	685	18
Grey Volcanics		685	712	27
Storey County Permit # [redacted]				

9. WELL CONSTRUCTION
Depth Drilled 712 Feet Depth Cased 712 Feet

HOLE DIAMETER (BIT SIZE)

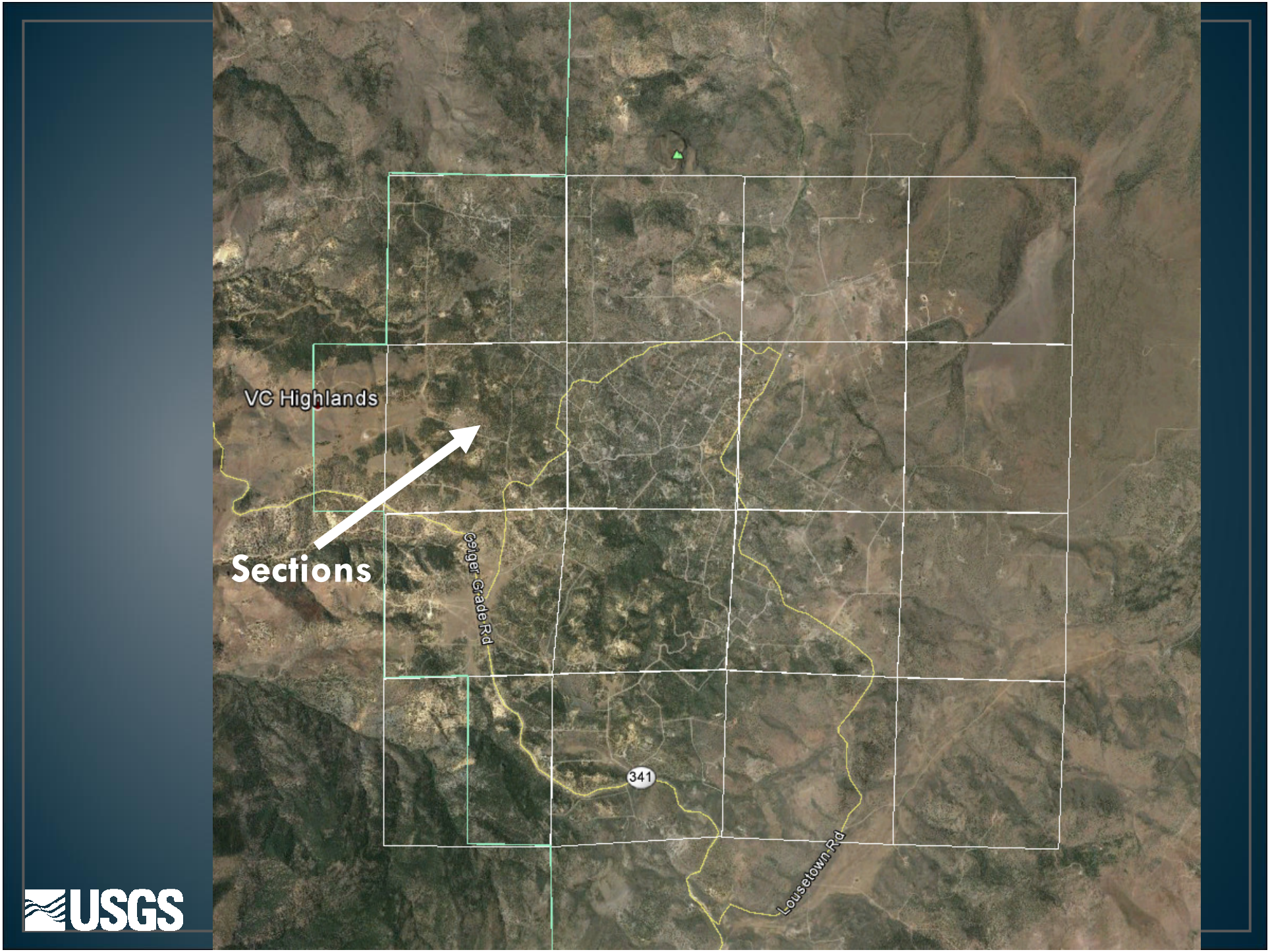
	From	To
10 5/8 Inches	0 Feet	60 Feet
9 7/8 Inches	60 Feet	712 Feet
Inches	Feet	Feet

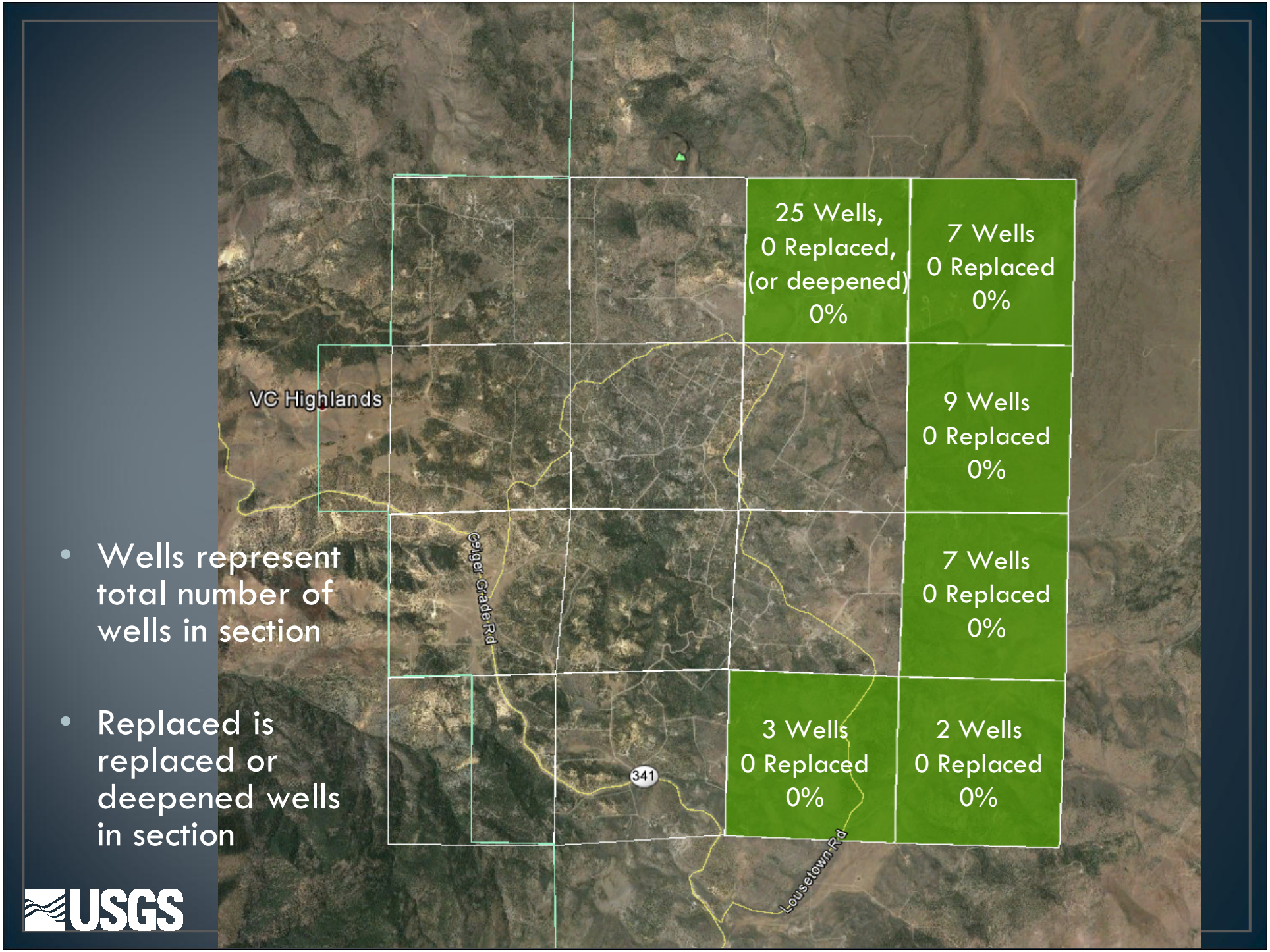
CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
6 5/8	12.92	.188	+2	712

Perforations:
Type of perforation Factory
Size of perforation .060 Double perf.
From 652 feet to 712 feet
From 412 feet to 432 feet
From feet to feet
From feet to feet
From feet to feet

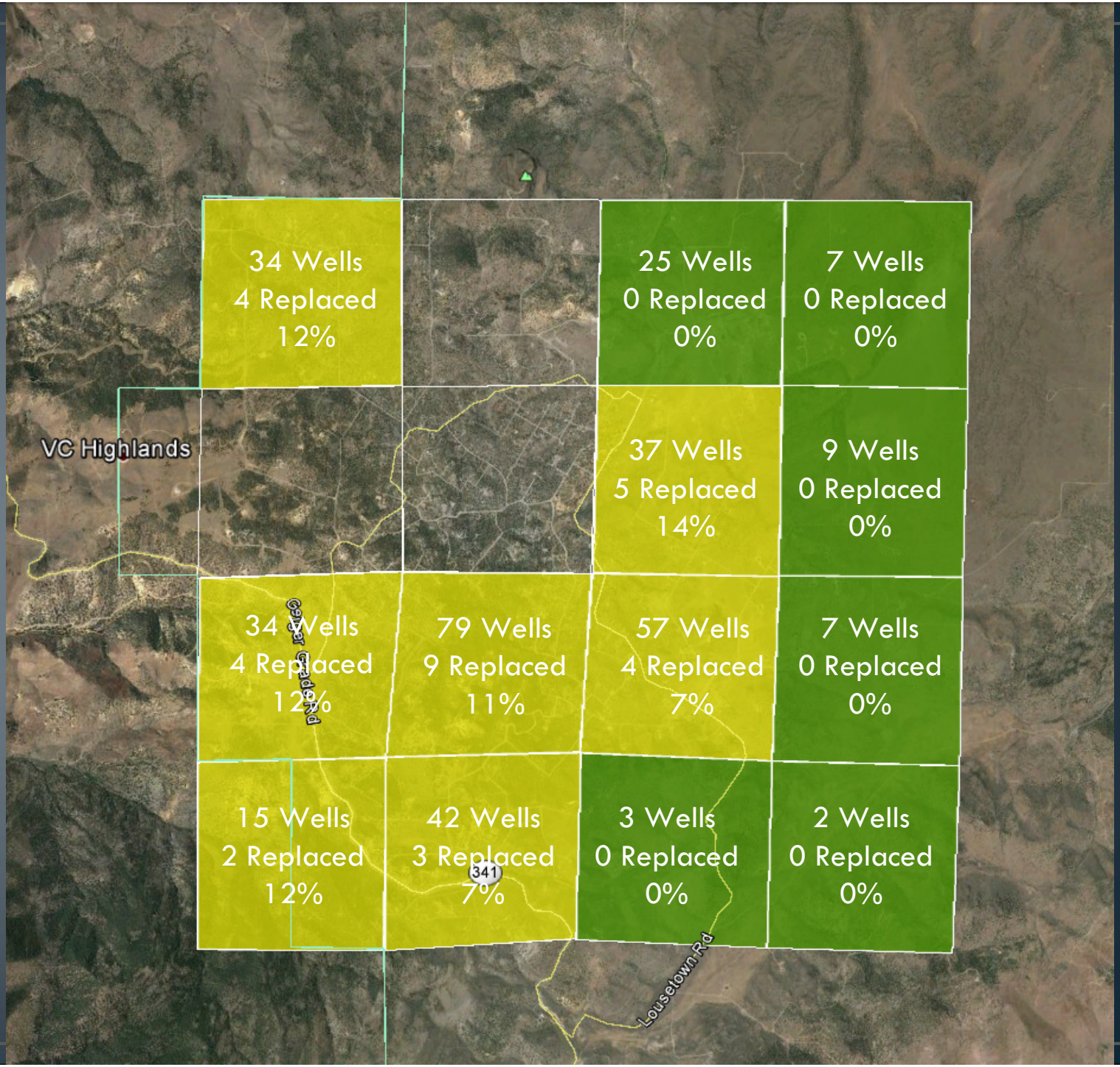
USGS

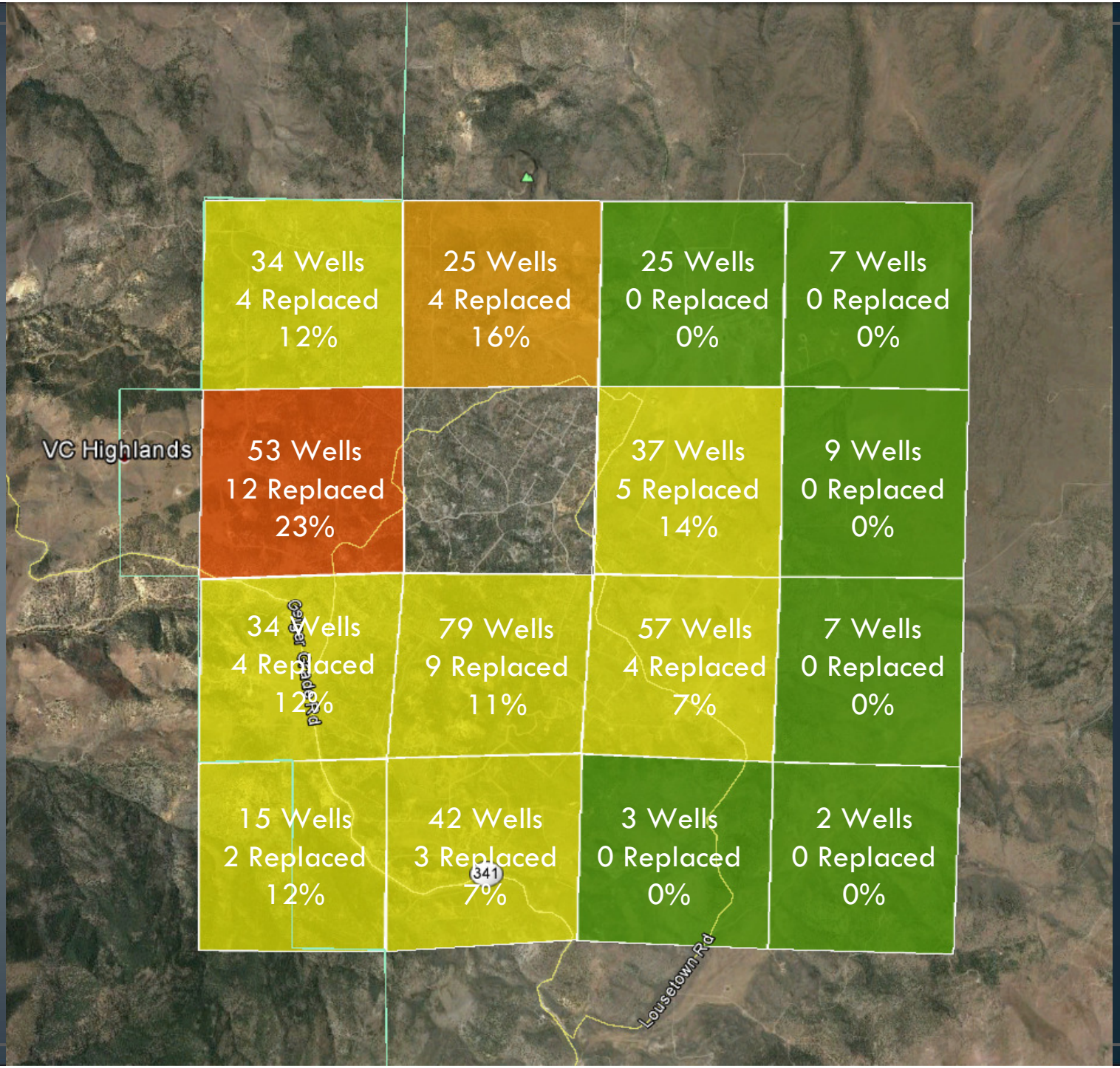

VC Highlands
Sections
Geiger Grade Rd
341
Louisetown Rd



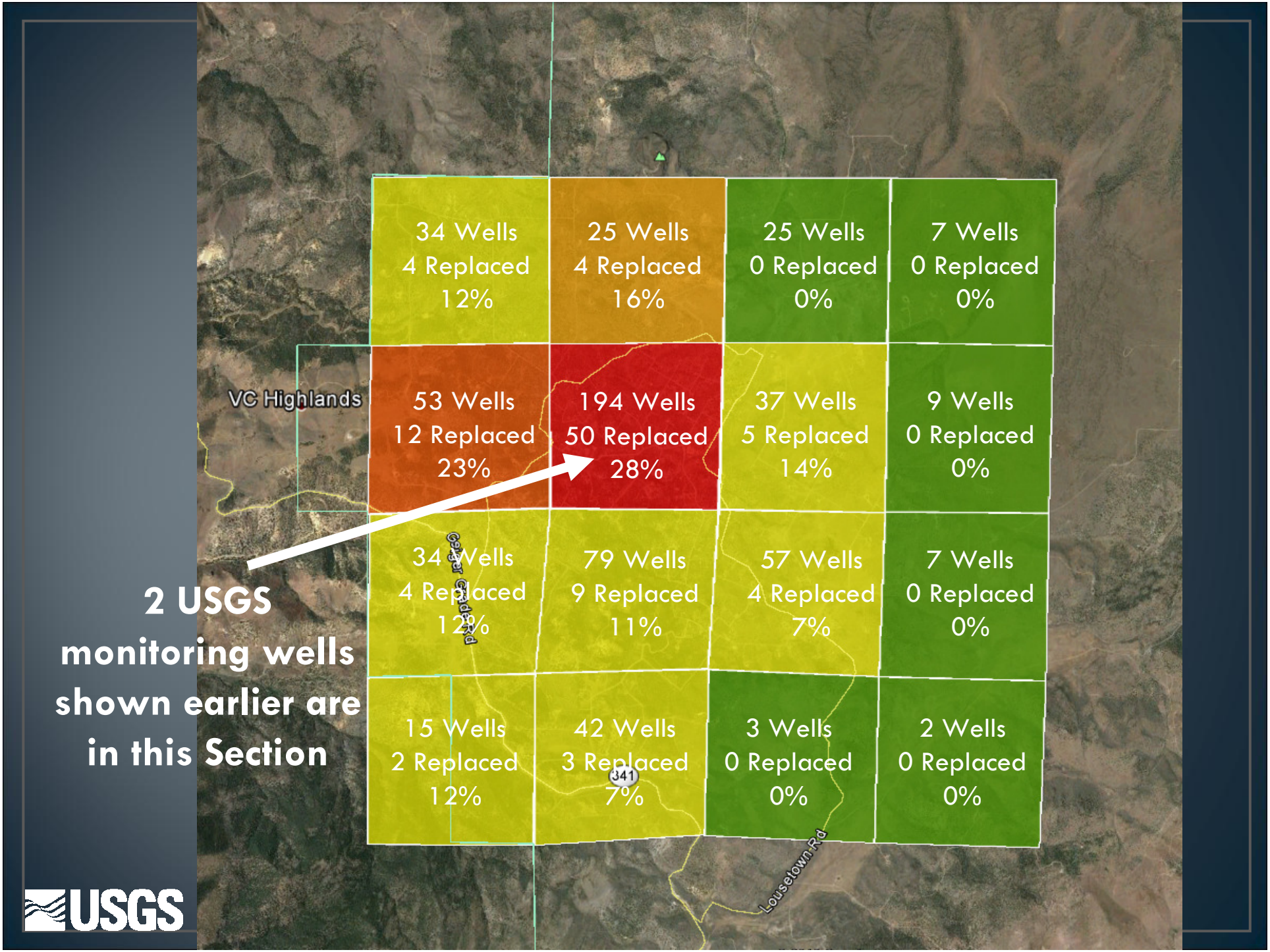
- Wells represent total number of wells in section
- Replaced is replaced or deepened wells in section

USGS


34 Wells
4 Replaced
12%
25 Wells
0 Replaced
0%
7 Wells
0 Replaced
0%
VC Highlands
37 Wells
5 Replaced
14%
9 Wells
0 Replaced
0%
34 Wells
4 Replaced
12%
79 Wells
9 Replaced
11%
57 Wells
4 Replaced
7%
7 Wells
0 Replaced
0%
15 Wells
2 Replaced
12%
42 Wells
3 Replaced
7%
3 Wells
0 Replaced
0%
2 Wells
0 Replaced
0%
341
Louisetown Rd


34 Wells
4 Replaced
12%
25 Wells
4 Replaced
16%
25 Wells
0 Replaced
0%
7 Wells
0 Replaced
0%
VC Highlands
53 Wells
12 Replaced
23%
37 Wells
5 Replaced
14%
9 Wells
0 Replaced
0%
34 Wells
4 Replaced
12%
79 Wells
9 Replaced
11%
57 Wells
4 Replaced
7%
7 Wells
0 Replaced
0%
15 Wells
2 Replaced
12%
42 Wells
3 Replaced
7%
3 Wells
0 Replaced
0%
2 Wells
0 Replaced
0%
Cedar Gap Rd
341
Lousetown Rd

USGS


34 Wells
4 Replaced
12%
25 Wells
4 Replaced
16%
25 Wells
0 Replaced
0%
7 Wells
0 Replaced
0%
VC Highlands
53 Wells
12 Replaced
23%
194 Wells
50 Replaced
28%
37 Wells
5 Replaced
14%
9 Wells
0 Replaced
0%
34 Wells
4 Replaced
12%
79 Wells
9 Replaced
11%
57 Wells
4 Replaced
7%
7 Wells
0 Replaced
0%
15 Wells
2 Replaced
12%
42 Wells
3 Replaced
7%
3 Wells
0 Replaced
0%
2 Wells
0 Replaced
0%
Cedar Gap Rd
341
Louselown Rd
2 USGS monitoring wells shown earlier are in this Section
USGS

USGS
science for a changing world

STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

OFFICE USE ONLY
Log No. [redacted]
Permit No.
Basin 083

PRINT OR TYPE ONLY

NOTICE OF INTENT NO. [redacted]

1. OWNER [redacted]
MAILING ADDRESS [redacted]

ADDRESS AT WELL LOCATION [redacted]
Subdivision Name: County: Storey

2. LOCATION [redacted]
PERMIT/WAIVER NO. [redacted]
Issued by Water Resources Parcel. No.

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☐ Deepen ☐ Other

4. PROPOSED USE
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☐ Air ☐ Other Air

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Grey Volcanics		685	712	27
Storey County Permit # [redacted]				

Fractured Volcanic Aquifers

[redacted]

9. WELL CONSTRUCTION

Depth Drilled 712 Feet Depth Cased 712 Feet

HOLE DIAMETER (BIT SIZE)

		From		To	
10 5/8	Inches	0	Feet	60	Feet
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	Inches		Feet		Feet

CASING SCHEDULE

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Perforations:

Type of perforation Factory
Size of perforation .060 Double perf.

From 652 feet to 712 feet
From 412 feet to 432 feet
From feet to feet
From feet to feet

Conclusions: State Well Log Database

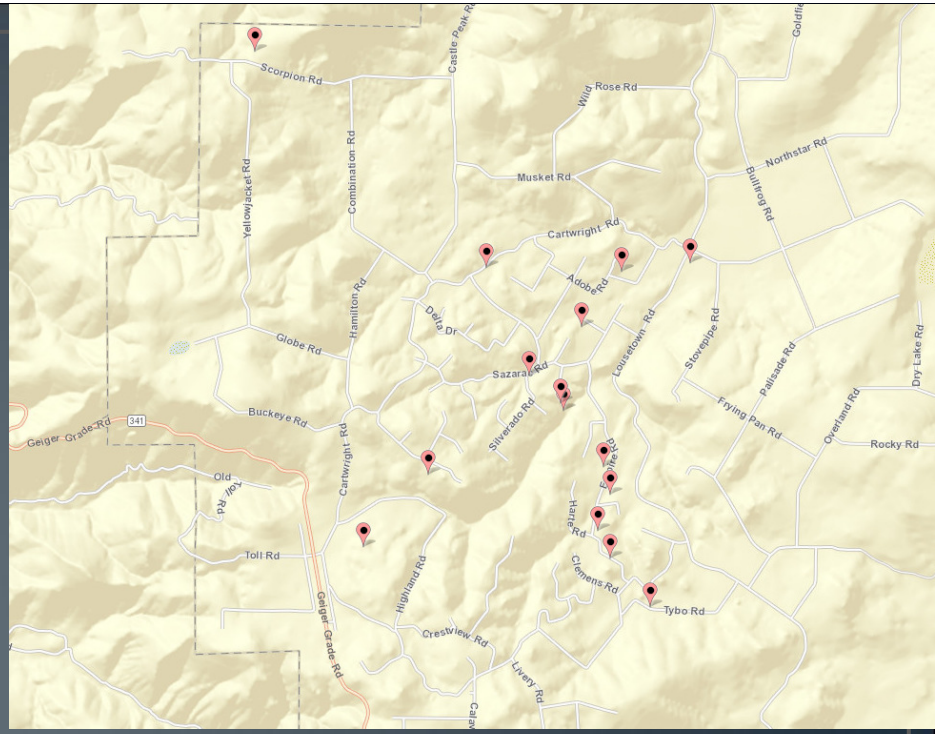
- Groundwater Wells in VC Highlands – ~623
- Wells either deepened or replaced – ~103 or ~16%
- Limited Groundwater Level Measurements
  - 1997 used as reference date

	Number of Wells	Mean Depth (ft)	Redrilled Wells
Before 1997	311	225	16
After 1997	312	*375	87

*assuming $50-100 per/ft drillers fee, represents an estimated cost of $7.5k-15k to homeowner

USGS

USGS Water Quality



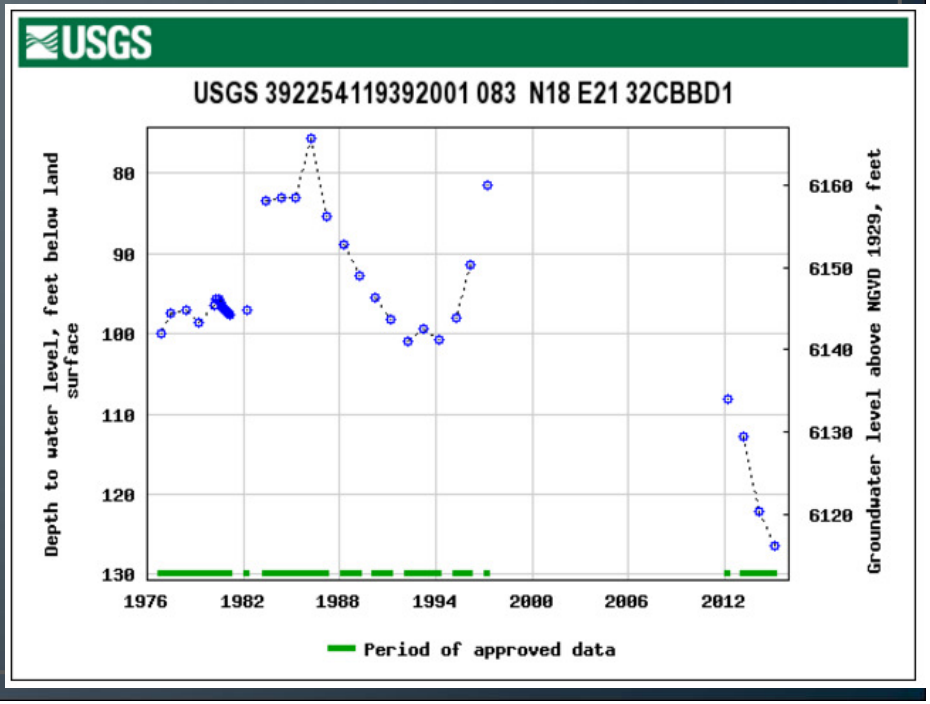
- Water-Quality sampling between 1972-1975
  - 21 wells were sampled for limited analysis
- Arsenic average 2.8 ppb (EPA MCL is 10 ppb)
- Nitrate average 0.11ppm (EPA MCL is 10 ppm)
- Chloride average 9.0 ppm (EPA recommends <250 ppm)
- Total Dissolved Solids (TDS) 867ppm (EPA recommends <1000 ppm)
- <u>High levels of Iron associated with shallow wells >0.3 ppm</u>

USGS

Summary

- Preliminary findings in the Mark Twain area
  - Water levels appear to be stable (early in monitoring period though)
  - Evidence of substantial water level declines not observed
  - Localized water level declines could be present

- VC Highlands
  - Water-level decline is real and causing deepening and re-drilling of wells
  - Extent of declines is not well characterized
  - Historical water quality is available as a baseline reference for characterizing future change



USGS

Where do we go from here?

- Current data is limited; difficult to fully understand the problem
- Additional monitoring to identify water-level trends
  - Identify conditions of groundwater recharge and depletion from pumping
- Identify and characterize aquifers
  - What is the extent of declines in VC Highlands?
- Is water-quality changing?
  - With declining water levels?
  - With time?
  - Some historical measurements are available for comparison

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