Growth or Stagnation?

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Water plays a critical role in the economic development of deserts, like Iron County. Often **The Law of Unintended Consequences of Independent Decisions** plays a big role in planning futures, including futures tied to water availability. It is time to evaluate the consequences of choices impacting water in Iron County. As professional geoscientists, each of us with over 45 years of professional experience, living in Cedar City, we want to help enable a scientific based discussion on Iron County's water future.

CROSSROAD

Iron County is at a crossroad. The Beryl/Enterprise Area recently began a 100 year groundwater management plan. The Beryl Enterprise Groundwater Management Plan was adopted in 2012, and requires 3,250 acre-feet of water rights be retired in 2030 and 2050, and the same amount every 10 years after that until the available water rights are in line with the average recharge. A report in 2000 states there has been ground water levels declines of at least 40 feet over 100 square miles in Beryl Valley. The Utah State Engineer recently took the first steps to implement a similar groundwater management plan for Cedar Valley. Other places have been at similar crossroads in the past. Los Angeles, Phoenix, St. George, and other desert areas in the west have planned for new water, and there has been significant economic growth directly following development of guaranteed supplies of water. However, the Implementation of a Beryl/Enterprise Area type of groundwater management plan does not promote growth. Lack of water, or even limited water availability, ultimately leads to stagnation and the creation of ghost towns like Frisco (Beaver County), Iron Town (Iron County), and Silver Reef (Washington County).

Cedar Valley is the economic heart of Iron County. About 33,500 acre-feet of water goes into the aquifer in an average year from precipitation and runoff, and about 42,700 acre-feet are removed each year. A report states the Cedar Valley Aquifer is overproduced by 9,100 acre feet per year (i.e. 3 billion gallons more water is produced than is restored to the aquifer, where an acre-foot of water is about 325,851 gallons). Overproduction of the Cedar Valley Aquifer was first published by the State Engineer in 1966. There are places in Cedar Valley where the water table has dropped as much as 131 feet since 1939 in one report, and because of overdrafting, or taking out more each year than is being recharged, the water table has dropped in some areas of the valley by as much as 114 feet between 1939 and 2009, according to a Utah Geological Survey study. This drop has resulted in surface settlement and the development of fissures in the Enoch and Quichapa Lake areas. Most of the natural springs once fed by shallow aquifers in the area dried up in the 1940's. In addition, water rights in the Cedar Valley Aquifer have been over allocated 25 to 33 percent for more than 40 years. These facts add up to the need for the Utah State Engineer to implement a groundwater management plan.

The CICWCD has a plan, 7-10 years away, to pump 15,000 acre-feet of water – nearly 5 billion gallons – per year from Pine Valley in the West Desert to Cedar City. This involves building a 50 mile, $150 million pipeline, and would sustain growth for another 25-50 years. Figure 1 is a map provided to the CICWCD in 2006, the year the CICWCD filed for water in Pine Valley (15,000 acre-feet), Wah Wah Valley (12,000 acre-feet), and Hamblin Valley (10,000 acre-feet). This mostly horizontal pipeline is a much better option than the $450 million Lake Powell project, which the CICWCD opted out of in 2012. The CICWCD secured water rights in Pine Valley and Wah Wah Valley in 2014, which rights are still undergoing judicial review. Since 2006, the CICWCD has spent just less than $1 million on the West Desert water, between legal fees, aquifer studies, engineering, and other expenses.

Agriculture is the largest water user in Iron County. There were approximately 532,464 acres (about 25 percent of the county's land), were farmland in 2012.

According to a report by the Utah Foundation published in September 2014, Iron County is expected to see a population increase of 129 percent between 2010 and 2050. The population is projected to jump from 46,163 to about 105,797. Though agricultural to residential conversion will likely result in less water consumption, it will not make too much difference in the overall picture.

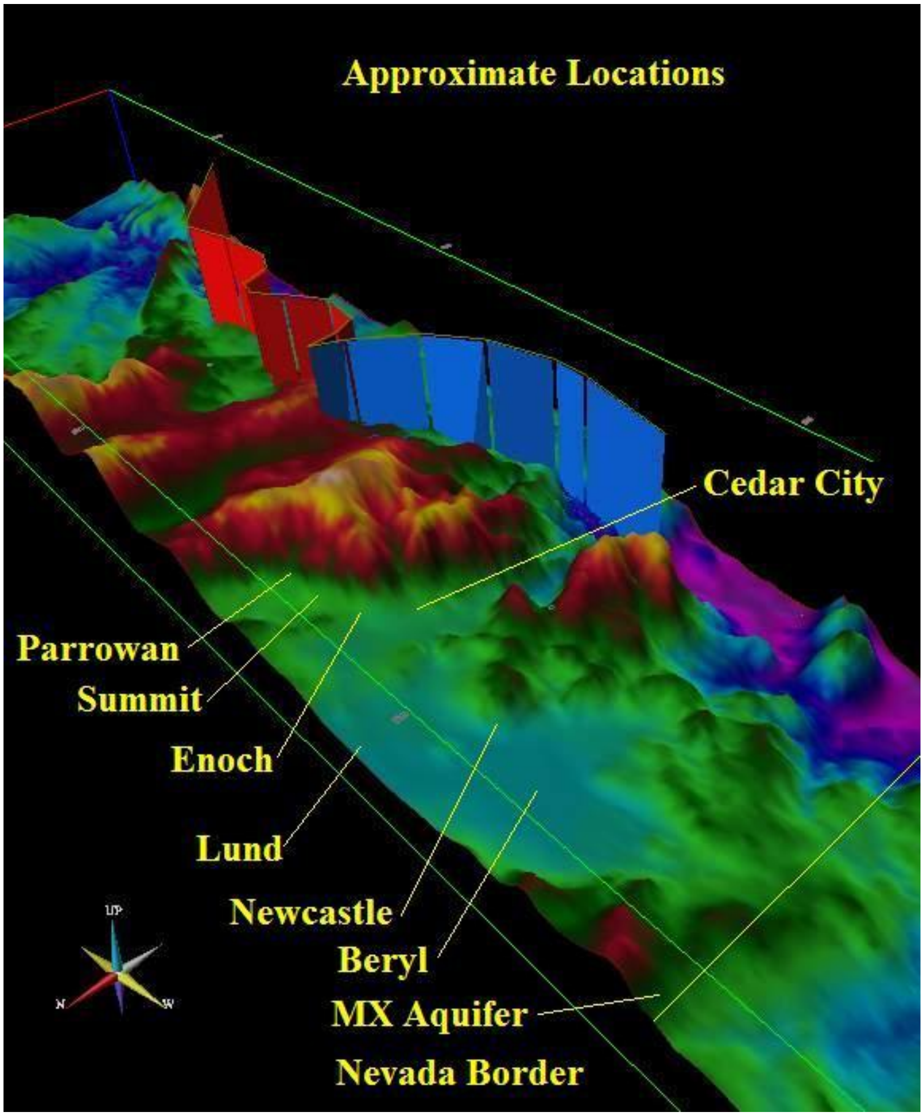


Figure 1. Figure from a movie created for the CICWCD in 2006 by Roice Nelson to discourage the Lake Powell Pipeline and to encourage a pipeline to the West Desert.

SCIENTIFIC FACTS

There is a difference between the Cedar Valley Aquifer and the Cedar Valley Drainage Basin. Water from Cedar Valley is available from anyplace in the Cedar Valley Drainage Basin. There are consolidated rocks on either side of the Cedar Valley Aquifer, within the Cedar Valley Drainage Basin, which hold tremendous volumes of untapped and basically untested water. Water in the Cedar Valley Aquifer is isolated from these "basement" aquifers.

The water in the Cedar Valley Aquifer is old. The age of the water has been dated back to Lake Bonneville or to earlier glaciation. In other words, much of the water which is being overproduced is over 17,500 years old. The Cedar Valley aquifer consists of interbedded layers (Figures 3-4) of clay, silt, sand, gravel, cobbles, and boulders, as shown respectively on Figure 4-9. These aquifers in these layers are isolated from deeper formations, largely by layers of clay. This deeper water is not significantly replenished by annual precipitation and runoff from the surrounding mountains, which is why the water in the Cedar Aquifer dates back to Lake Bonneville and before. This is the water which is being overproduced faster than precipitation and runoff replenishes the water. This is also where the over allocation of water rights occurs. This is because the best farm land sits above the Cedar Valley Aquifer.

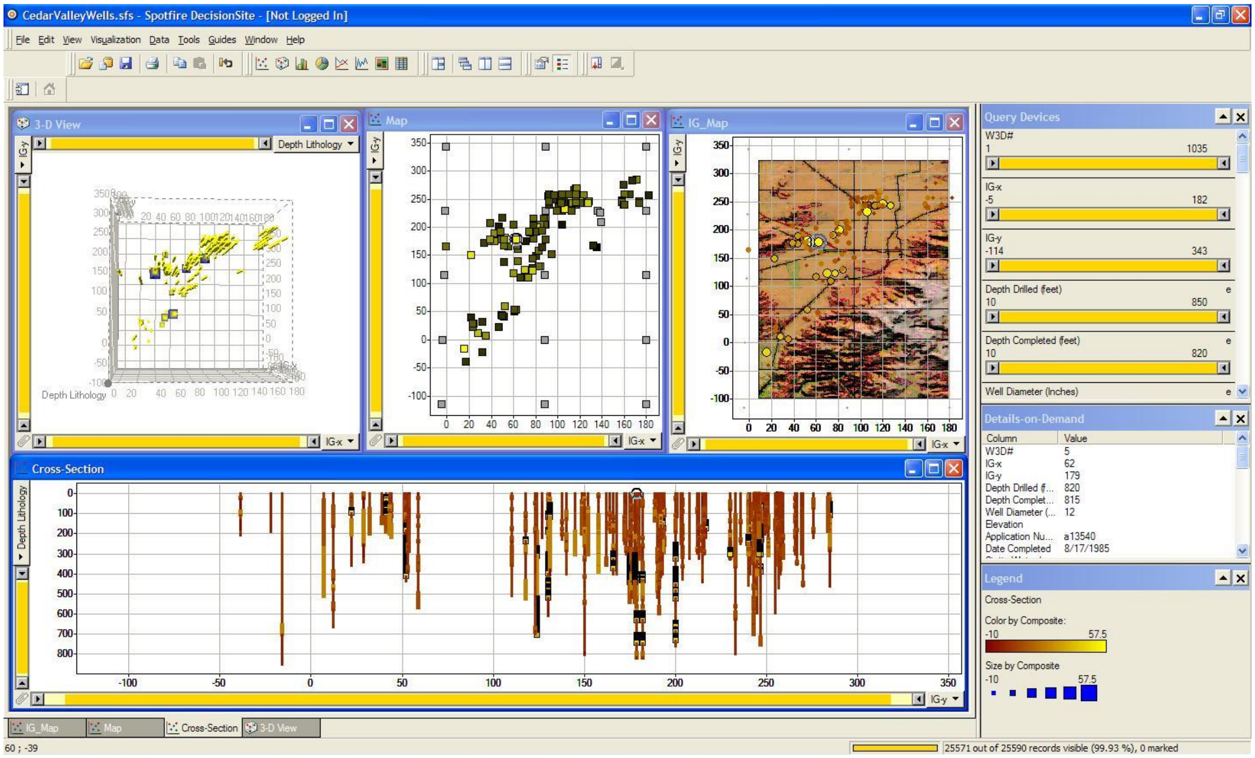


Figure 2. North-to-South cross-section showing wells in the Cedar Valley Aquifer.

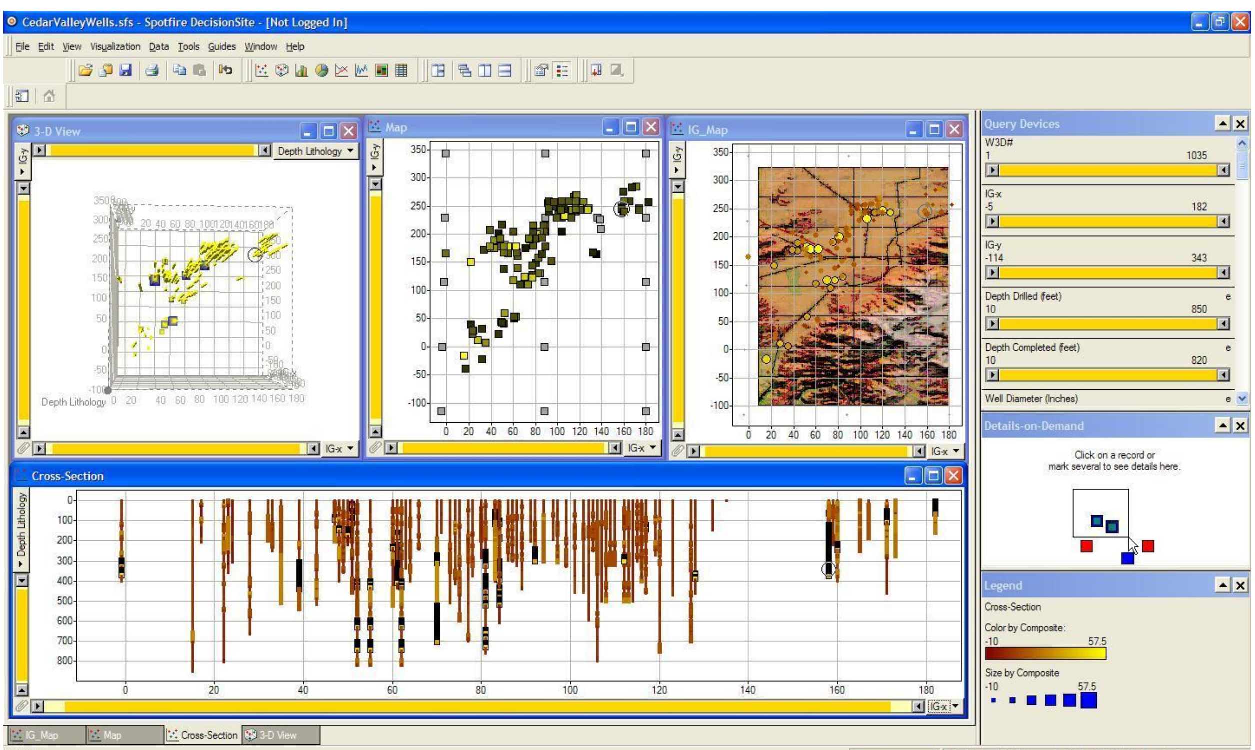


Figure 3. West-to-East cross-section showing wells in the Cedar Valley Aquifer.

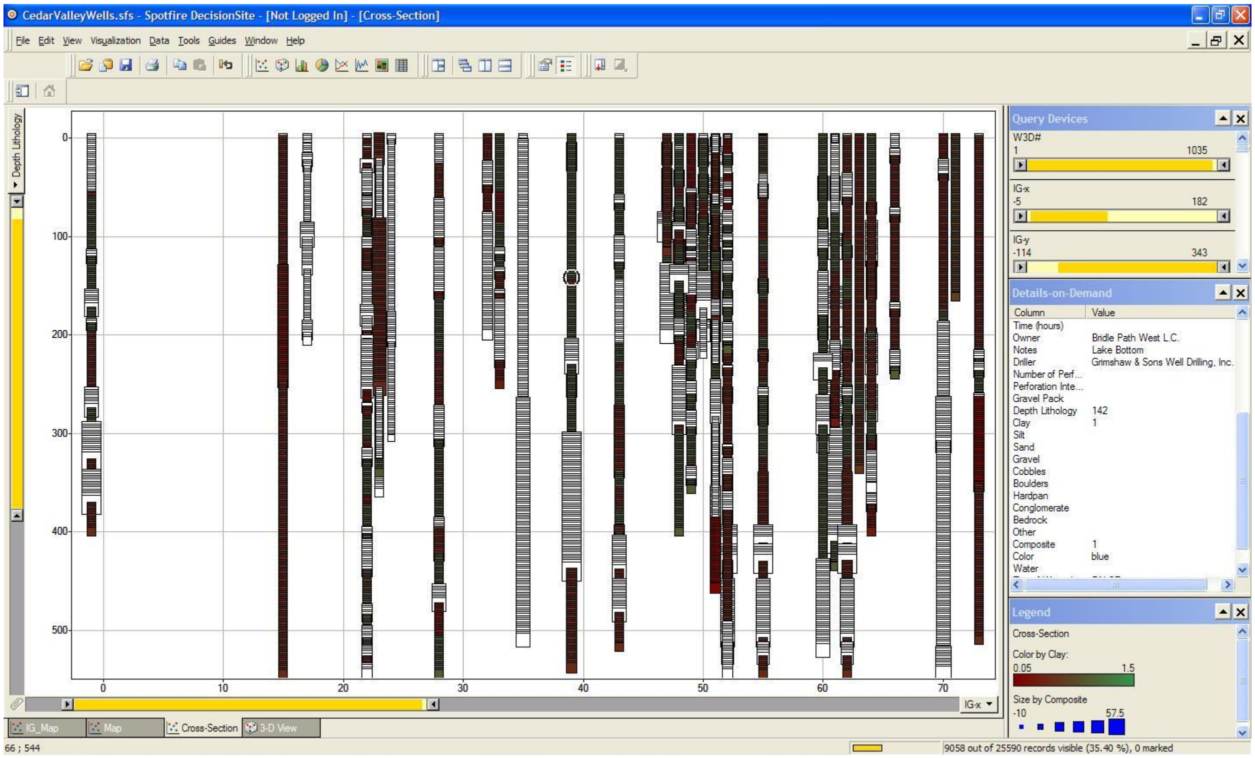


Figure 4. Clay on the west end of the West-to-East cross-section through the Cedar Valley Aquifer.

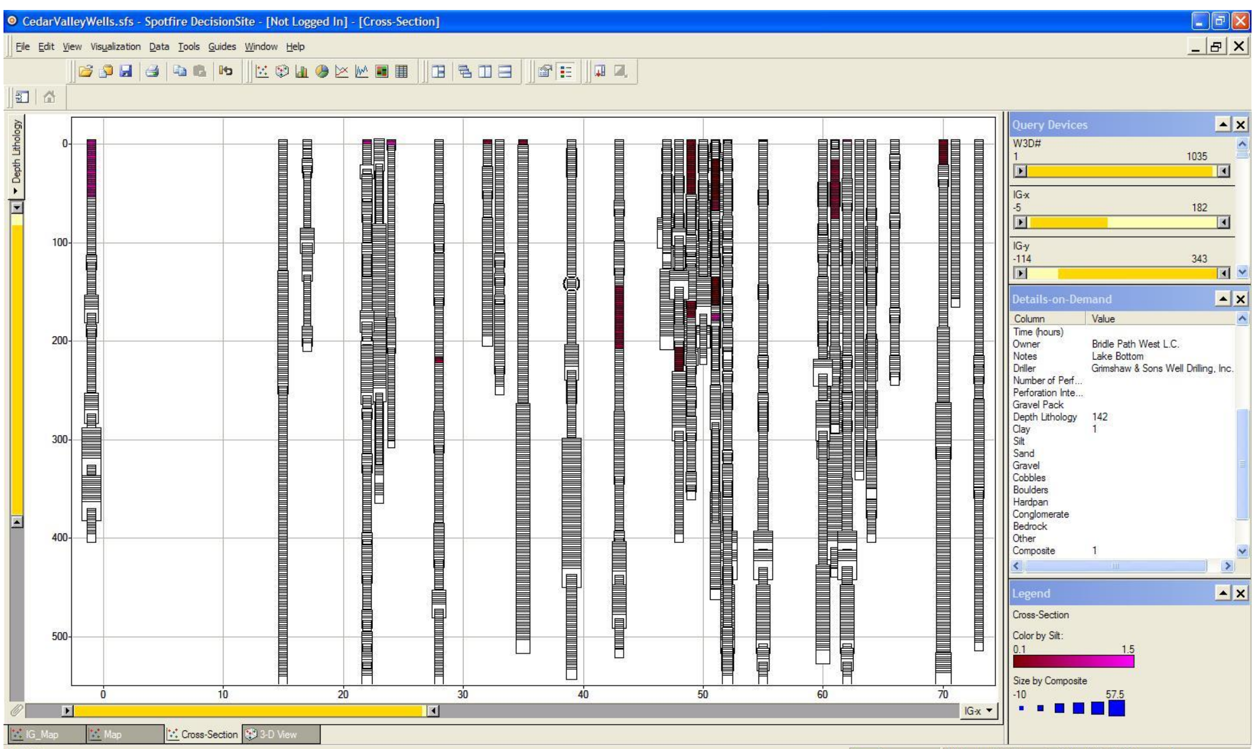


Figure 5. Silt on the west end of the West-to-East cross-section through the Cedar Valley Aquifer.

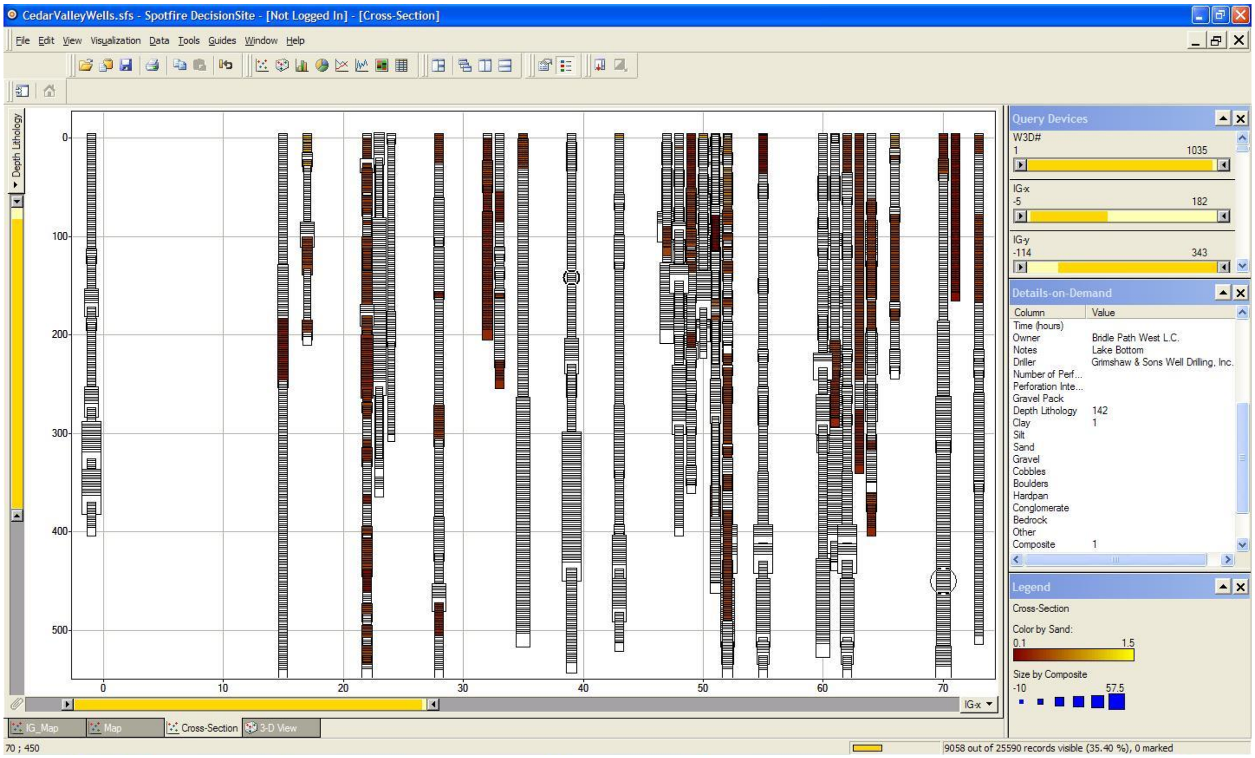


Figure 6. Sand on the west end of the West-to-East cross-section through the Cedar Valley Aquifer.

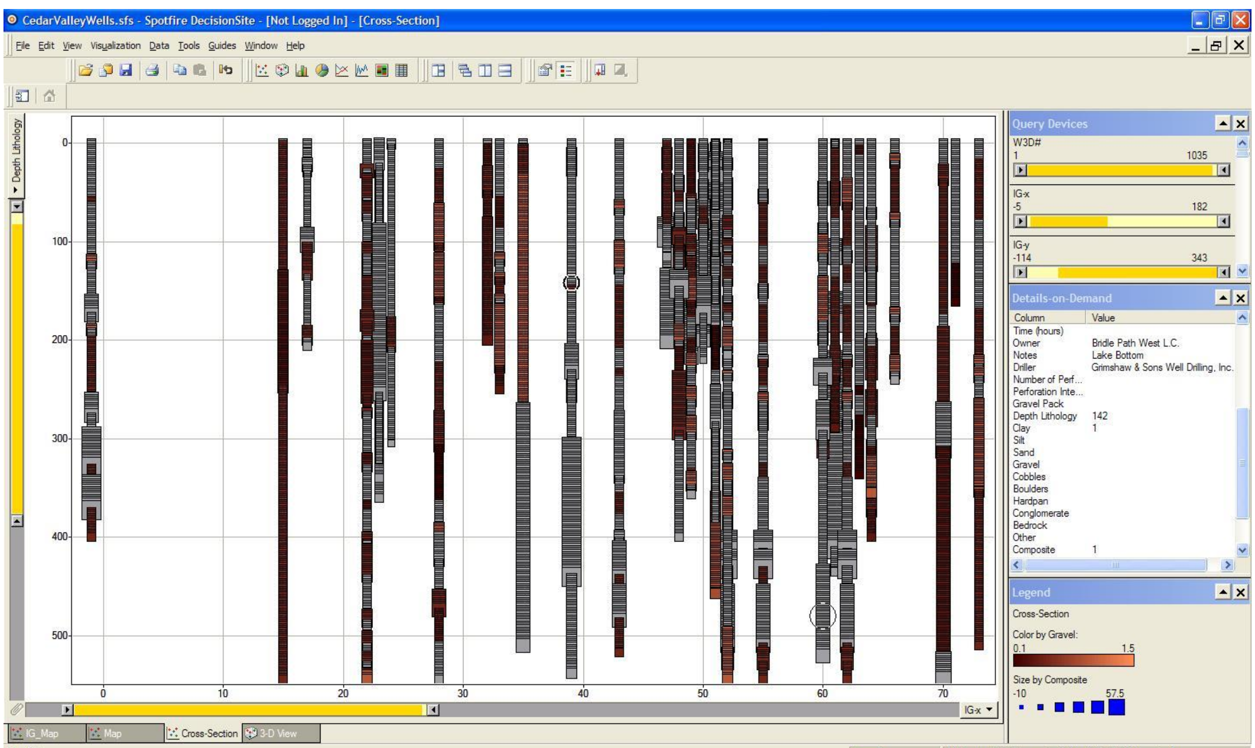


Figure 7. Gravel on the west end of the West-to-East cross-section through the Cedar Valley Aquifer.

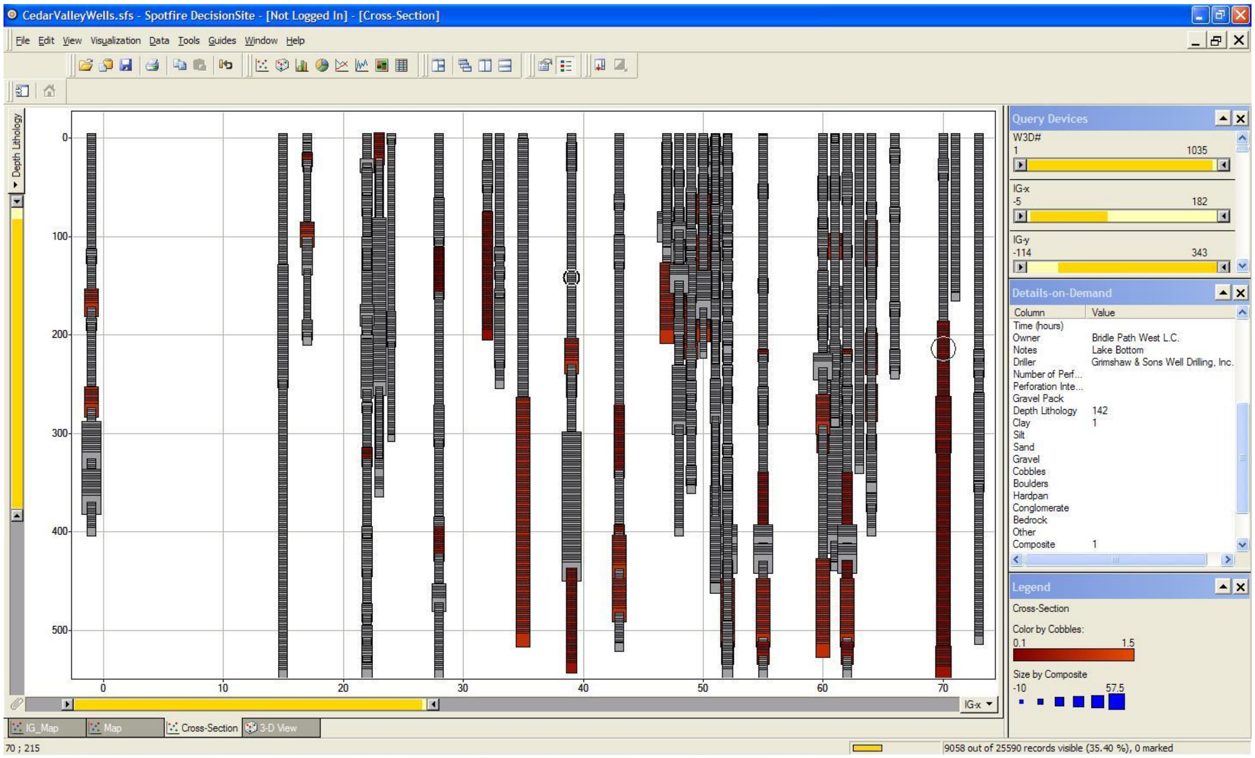


Figure 8. Cobbles on the west end of the West-to-East cross-section through the Cedar Valley Aquifer.

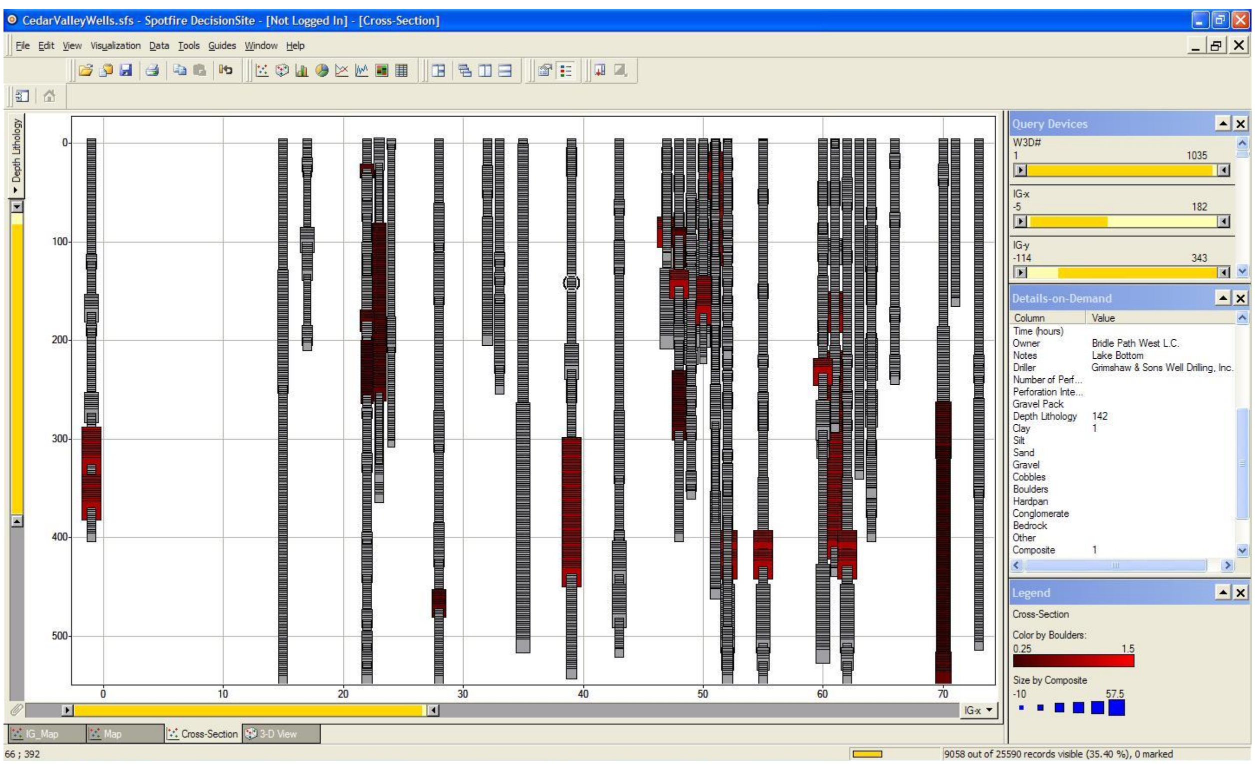
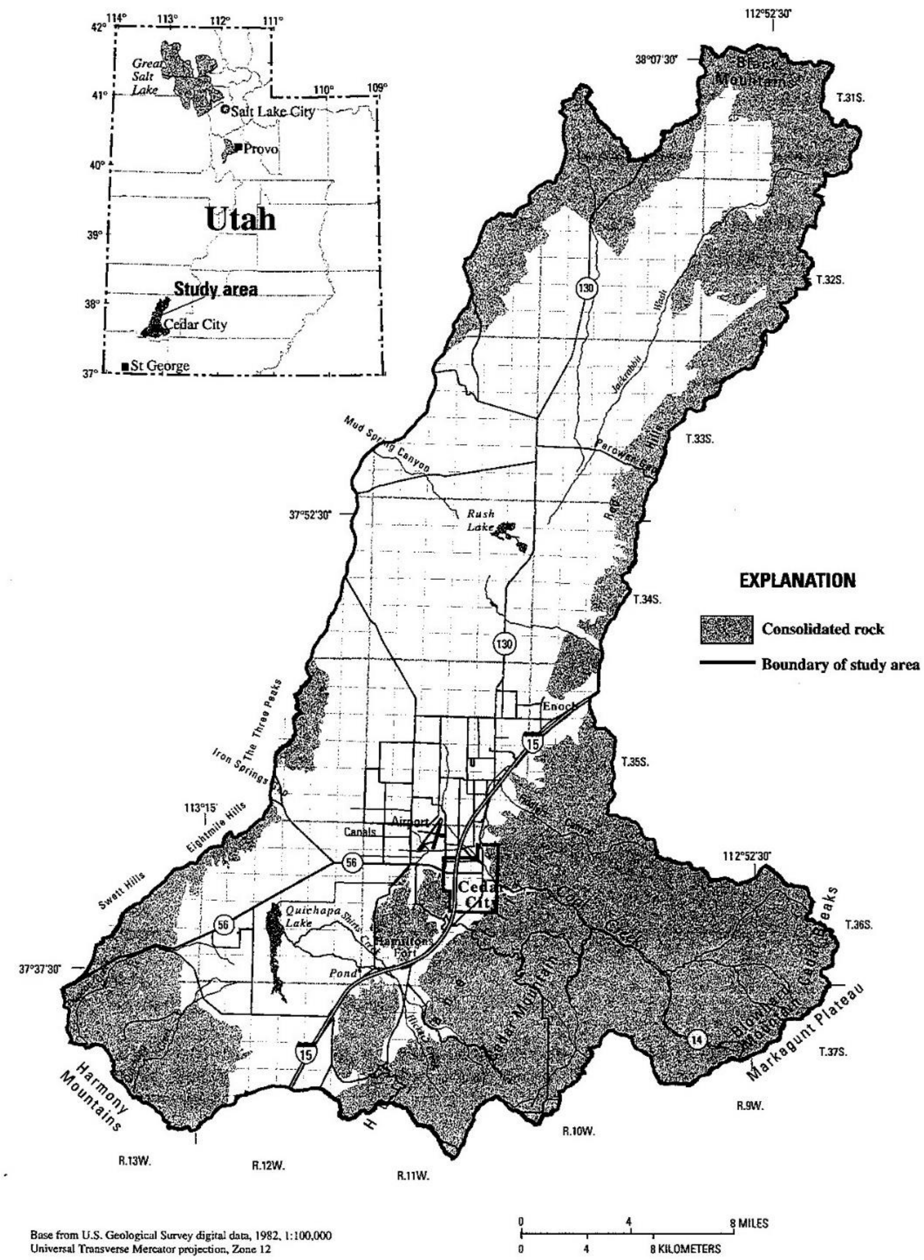


Figure 9. Boulders on the west end of the West-to-East cross-section through the Cedar Valley Aquifer.

However, the Cedar Valley Aquifer is a somewhat isolated basin fill aquifer. The extent of this series of interbedded sand aquifers and clays a sits within the Cedar Valley Drainage Area, as defined on Figure 10.



Location of Cedar Valley study area, Iron County, Utah.

Figure 10. The Cedar Valley Drainage Basin encompasses the Cedar Valley Aquifer (white areas of map), and includes outcropped "basement" rocks both to the east and to the west (black areas of map).

The water which is contained in layers of rocks ranging in age from ancient Pre-Cambrian to more recent Paleocene, drains out of the southern Great Basin along stratigraphic layers (Figure 11) and through large transform faults which can be interpreted on detailed topography maps (Figure 12).

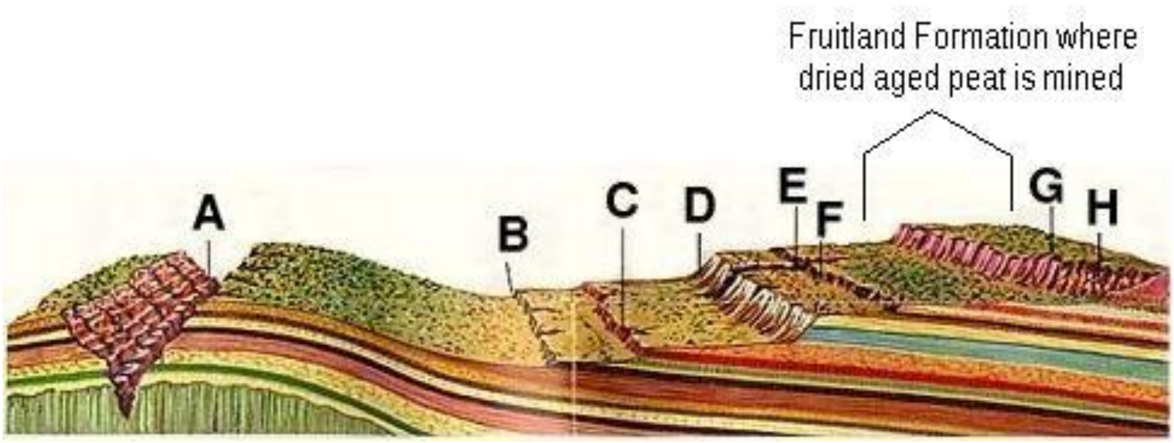


Figure 11. Stratigraphic Layers from the Paleocene (Bryce Canyon) to the Pre-Cambrian known as Grand Staircase layer cake geology, specifically: (A) the Grand Canyon, (B) the Chocolate Cliffs, (C) the Vermilion Cliffs, (D) the White Cliffs, (E) Zion Canyon, (F) the Gray Cliffs, (G) the Pink Cliffs, and (H) Bryce Canyon.

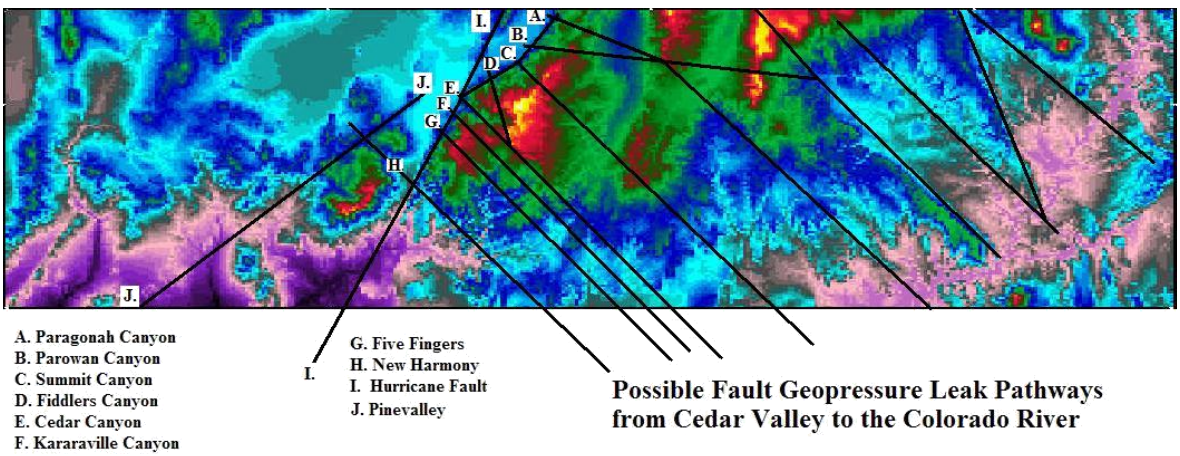


Figure 12. Interpretation of large faults which connect the Southern Great Basin, where the Cedar Valley Drainage Basin sits, to the Grand Canyon.

The key point of Figures 11 and 12 is the area under and surrounding the Cedar Valley Aquifer is not isolated. The area is hydrologically connected the Grand Canyon and beyond. This connection is highlighted by the fact the Southern Great Basin has lower than normal hydrostatic pressure as shown on Figure 13. When water is connected in the subsurface, the pressure builds up the deeper a well penetrates. This pressure is called hydrostatic pressure. If a water tank on top of Cedar Mountain and a water tank on top of Leigh Hill are connected to the same location, there will be much more hydrostatic pressure from the pipe coming from Cedar Mountain. The same thing happens in the subsurface. Lower than normal hydrostatic pressure in the southern great basin is why there are no oil and gas wells.

This hydrologic bypass of the isolated Cedar Valley Aquifer provides a key to understanding new water exploration opportunities in the Cedar Valley Drainage Basin. There are two untapped “basement” aquifers in the Cedar Valley Drainage Basin. The aquifer on the east is the 20-40% porosity Cretaceous rocks shown in the outcrop photo in Figure 14. The extent of this aquifer is shown in Figure 15. It continues outside of the Cedar Valley Drainage Basin to the Parowan Valley Drainage Basin where a very successful water well was drilled at Brian Head in 2015. The aquifer on the west is the Fractured Quartz Monzonite rocks. The extent of this aquifer is shown in Figure 16. It is largely outside of the Cedar Valley Drainage Basin, and the best test to date is south of New Harmony. This aquifer potentially could provide water to recharge the Enterprise/Beryl Area. This potential of this untapped aquifer is also highlighted by the water in the Blowout Pit at Iron Mountain.

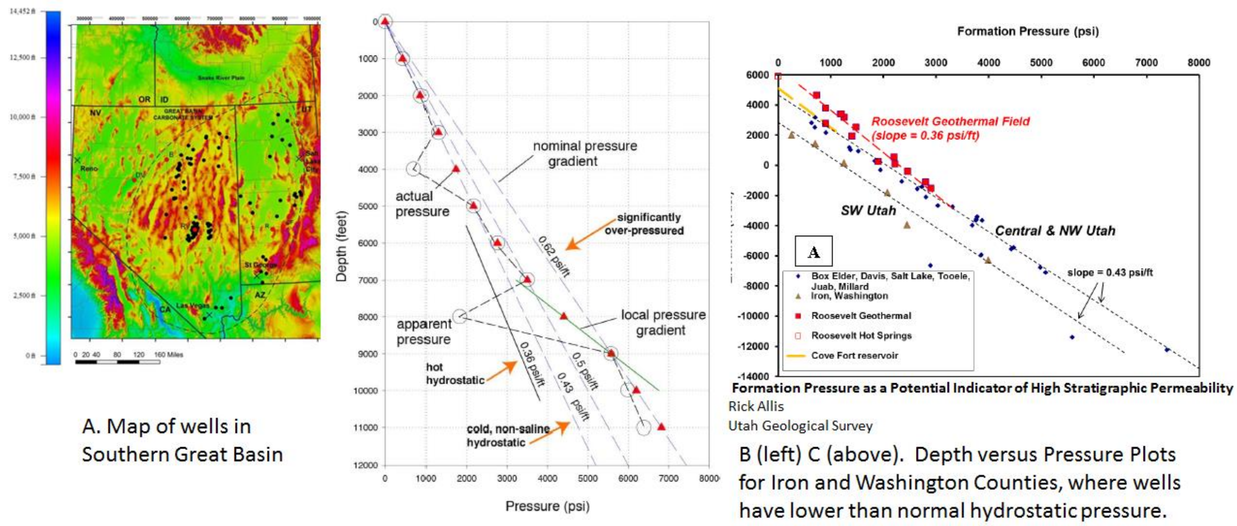


Figure 13. A. Map of wells showing hydrostatic pressure in the Southern Great Basin. B. Plot of normal pressure gradient as water builds up in the subsurface, and the actual pressure gradient for wells in the southern part of the Great Basin. C. Pressure gradients for geothermal wells and water wells in Washington and Iron Counties, Utah.

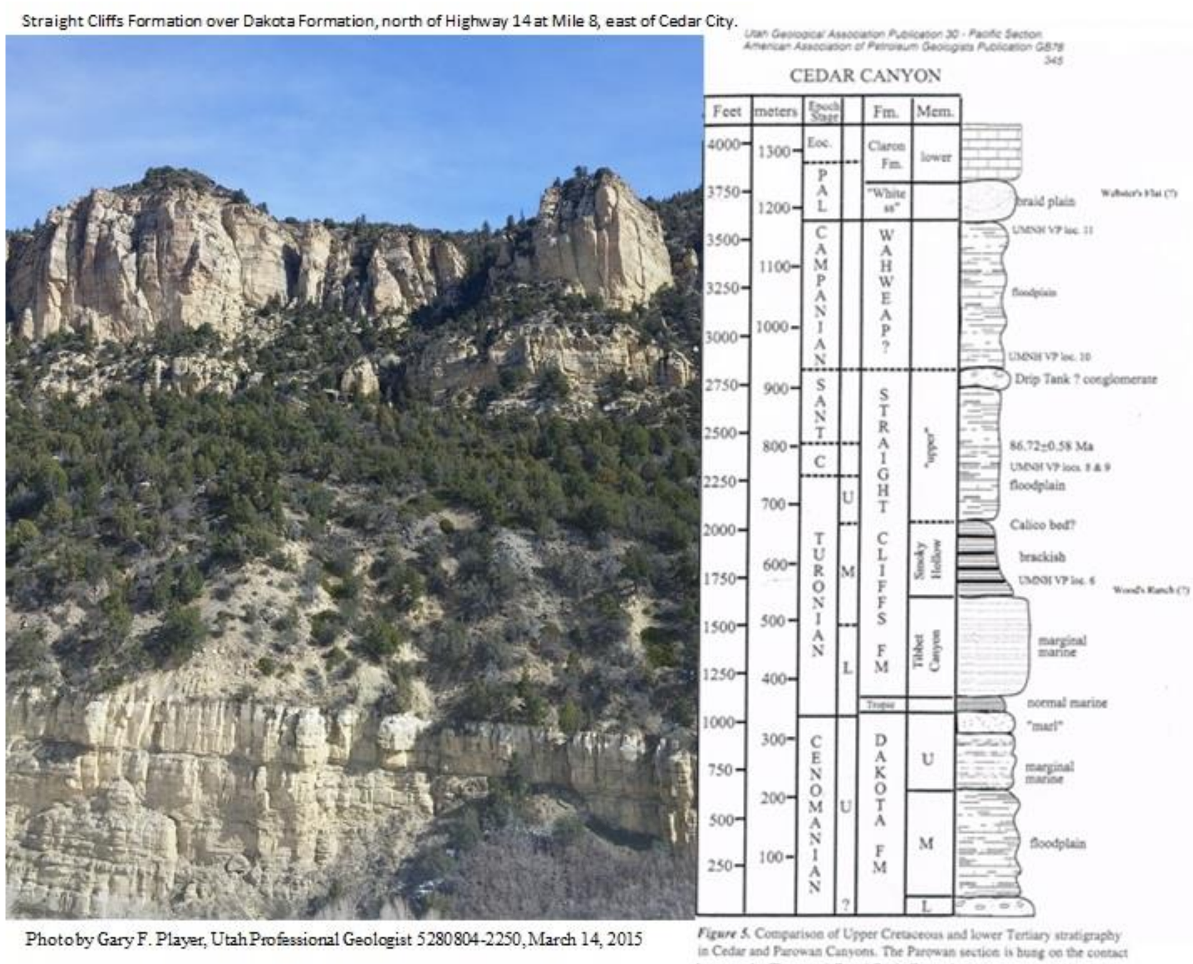


Figure 14. Cretaceous Straight Cliffs to Dakota Sandstone up Cedar Canyon where the landslide regularly happens.

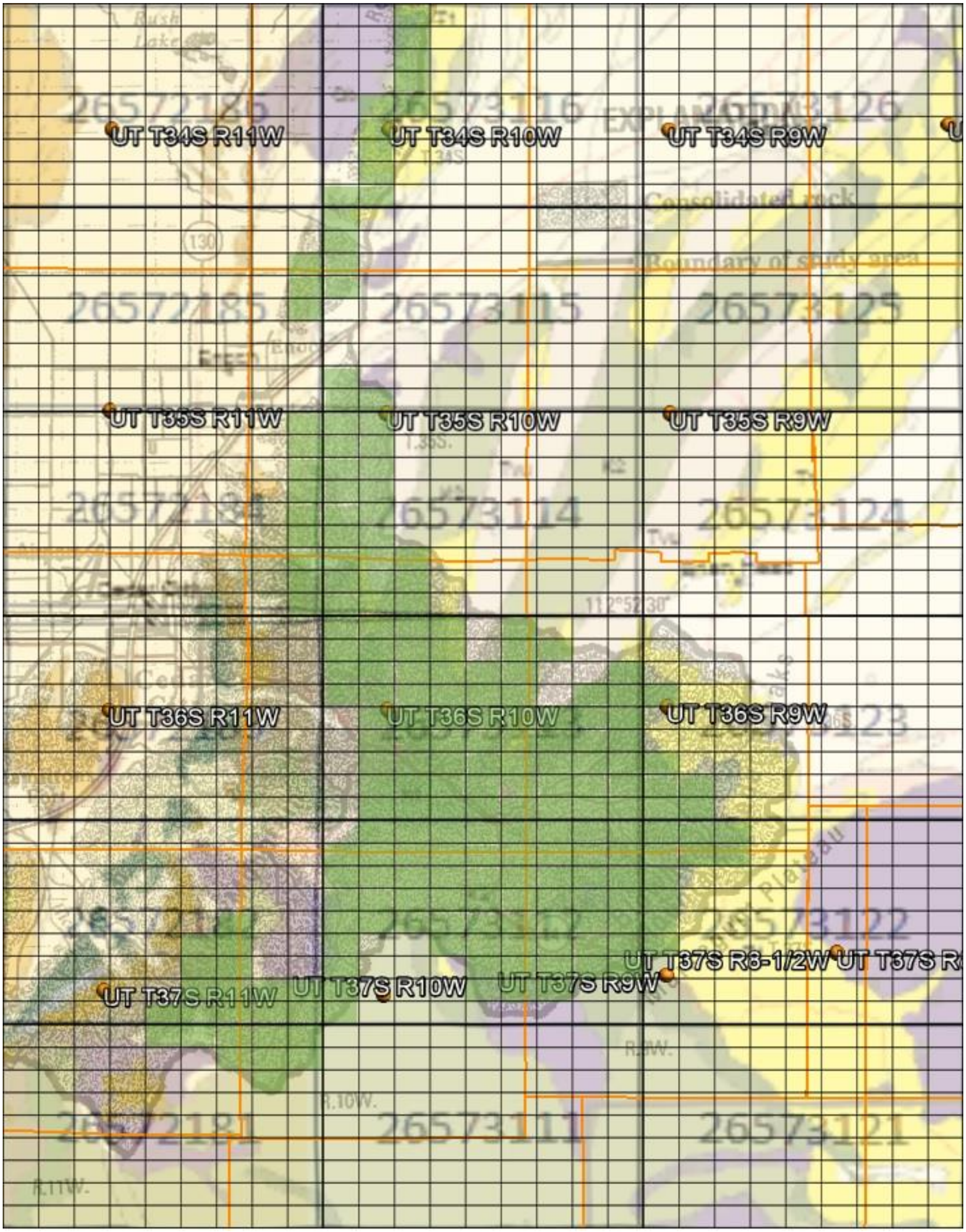


Figure 15. Extent of the largely untapped Cretaceous Aquifer (green) is about 8,620 square miles.

Figure 16. Extent of the largely untapped Fractured Quartz Monzonite Aquifer (gold) is about 20,195 square miles.

Figure 17. Shows the extent of water coming out of the fractured quartz monzonite at Blowout Pit at Iron Mountain.

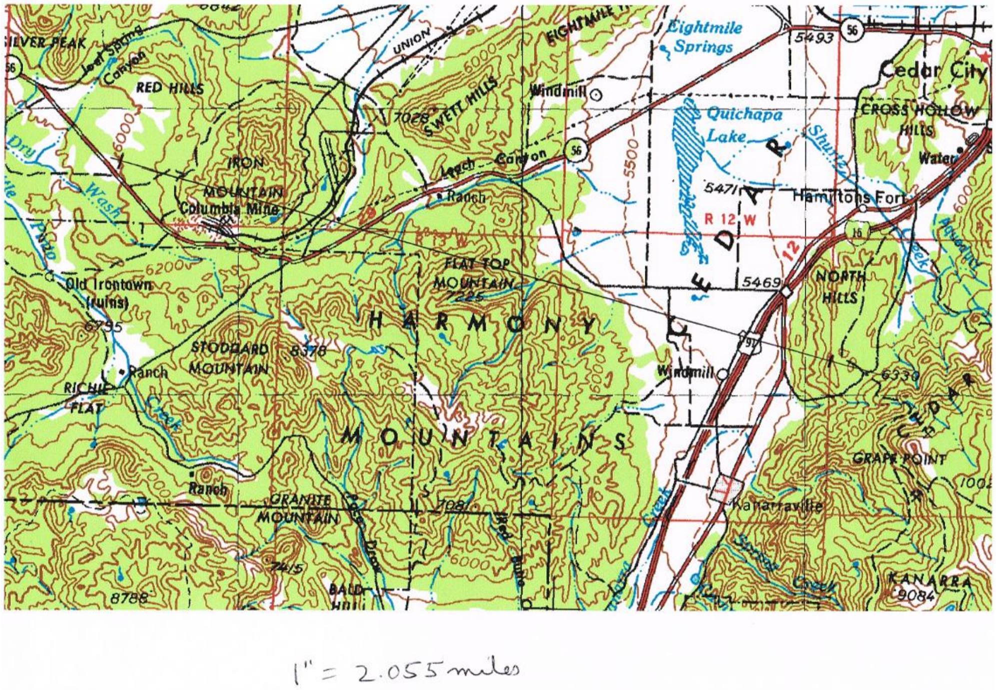


Figure 18. Location of cross-section in Figure 19 from Blowout Pit across the southern end of Cedar Valley.

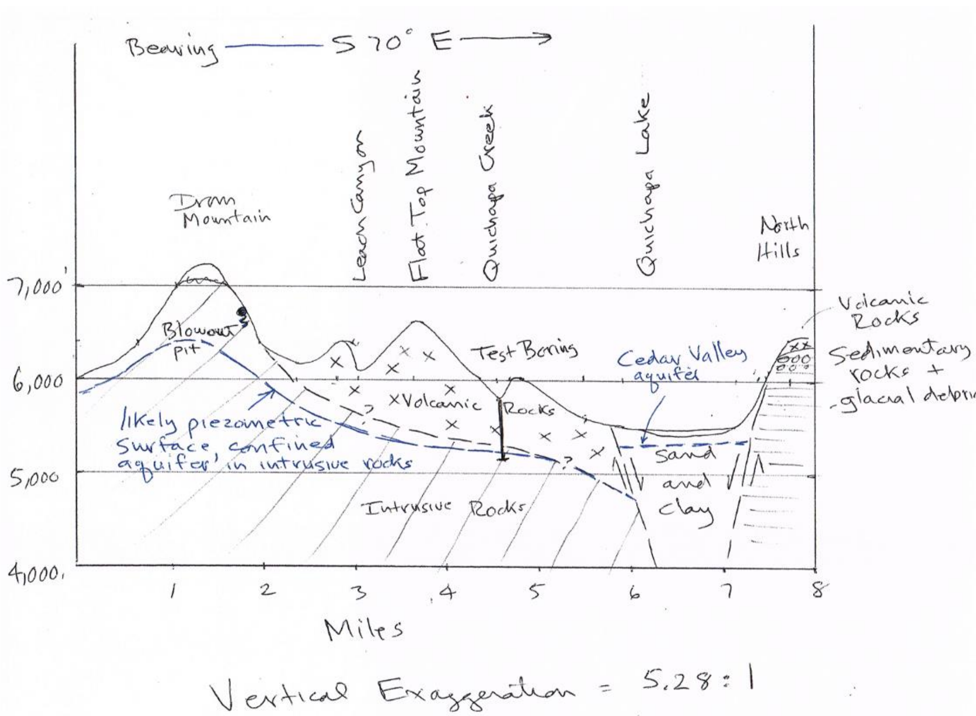


Figure 19. Cross-Section from Blowout Pit to North Hills on the other side of the Cedar Valley Aquifer.

SPECIFIC OPPORTUNITIES

If this is an acceptable approach, we can add the material put together for the CICWCD call for proposals.

Figure 20 shows a cross-section from Lund to Blowout Pit to Leigh Hill to Red Hill to Woods Ranch. Figure 21 shows the thrust structure of beds underneath the Red Hill. Figure 22 shows the extent of the Cedar Valley Aquifer in the same format as Figure 16 and Figure 17.

This discussion of the number of wells might be limited to annual recharge. One idea is to set some area around each well in these new aquifers and limiting water production to the combination of snow pack and precipitation falling on this surrounding area each year. Say the area is 5 square miles, then there is an opportunity for 1,724 new wells in the Cretaceous Aquifer and 4,039 new wells in the Quartz Monzonite. At 3,000 acre-feet per well, this approach could capture 5,172,000 acre-feet from the Cretaceous and 12,117,000 acre-feet from the Quartz Monzonite from annually replenished water.

In addition, Figure 23 introduces using the deviated hole energy supply from above the landslide area can also be added to the description. Once a comprehensive document is prepared, we can pull off parts of the document for different audiences.

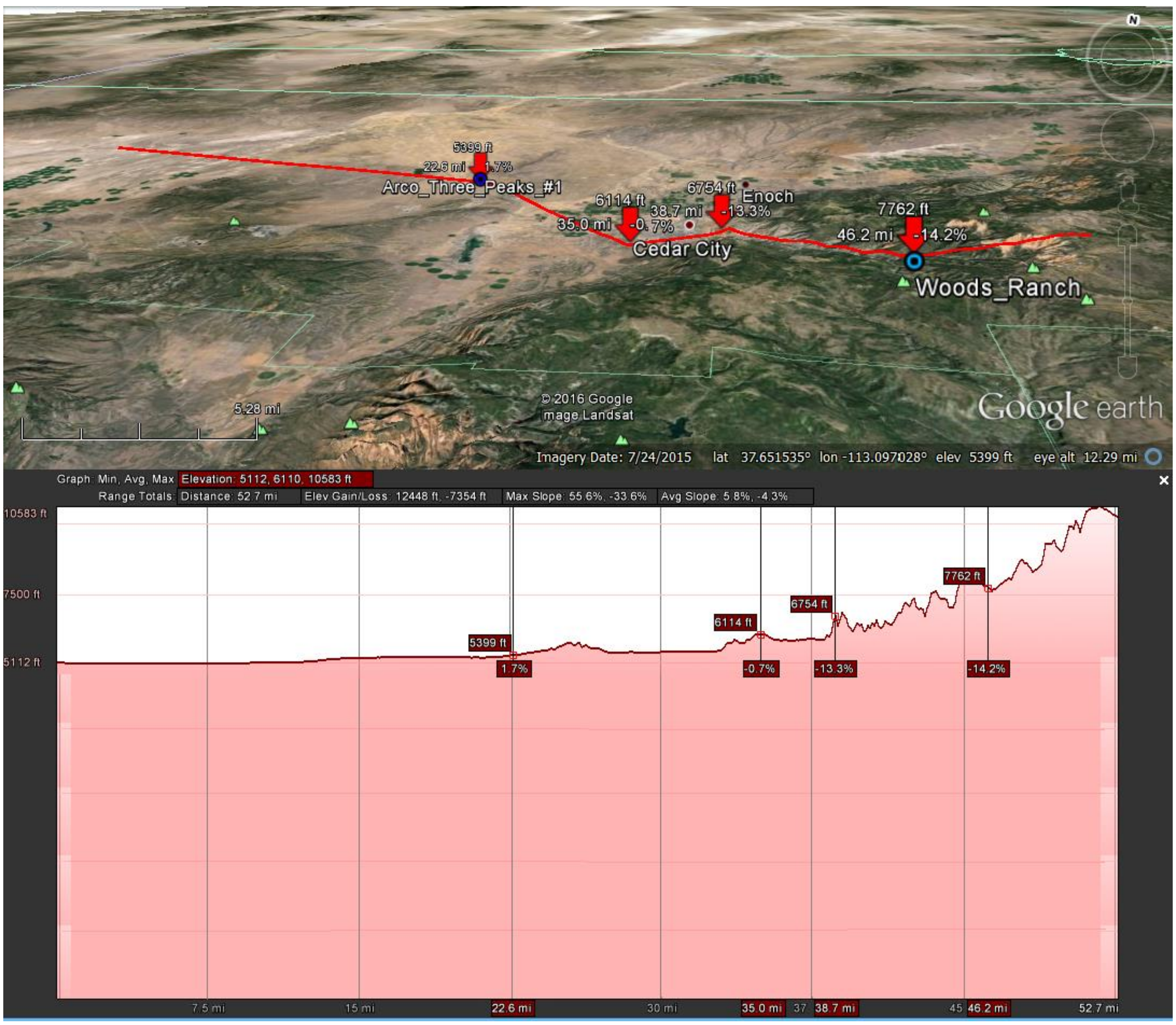


Figure 20. Cross-Section Lund to Blowout Pit to Leigh Hill to Red Hill to Woods Ranch.

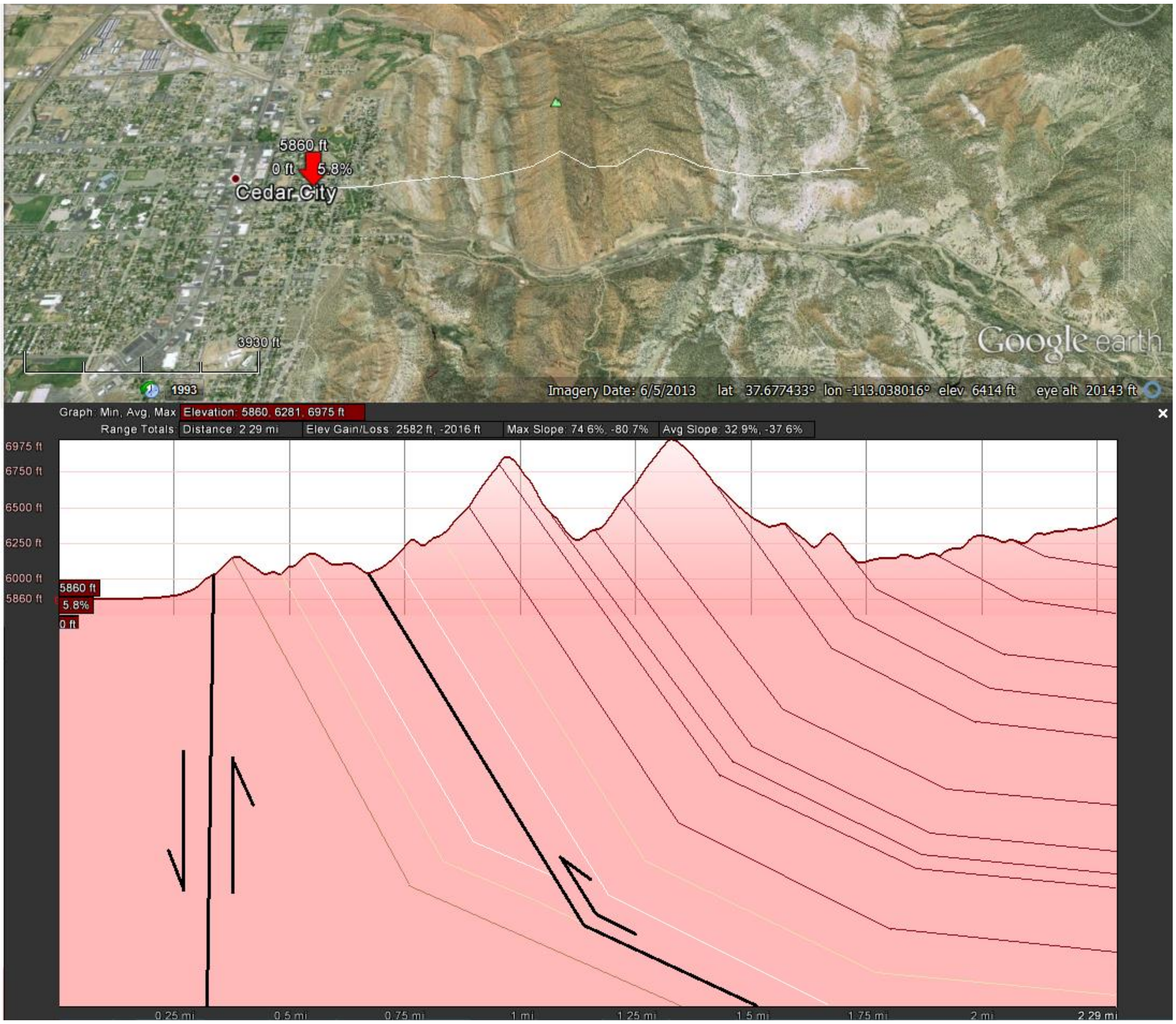


Figure 21. Thrust structure underneath the Red Hills.

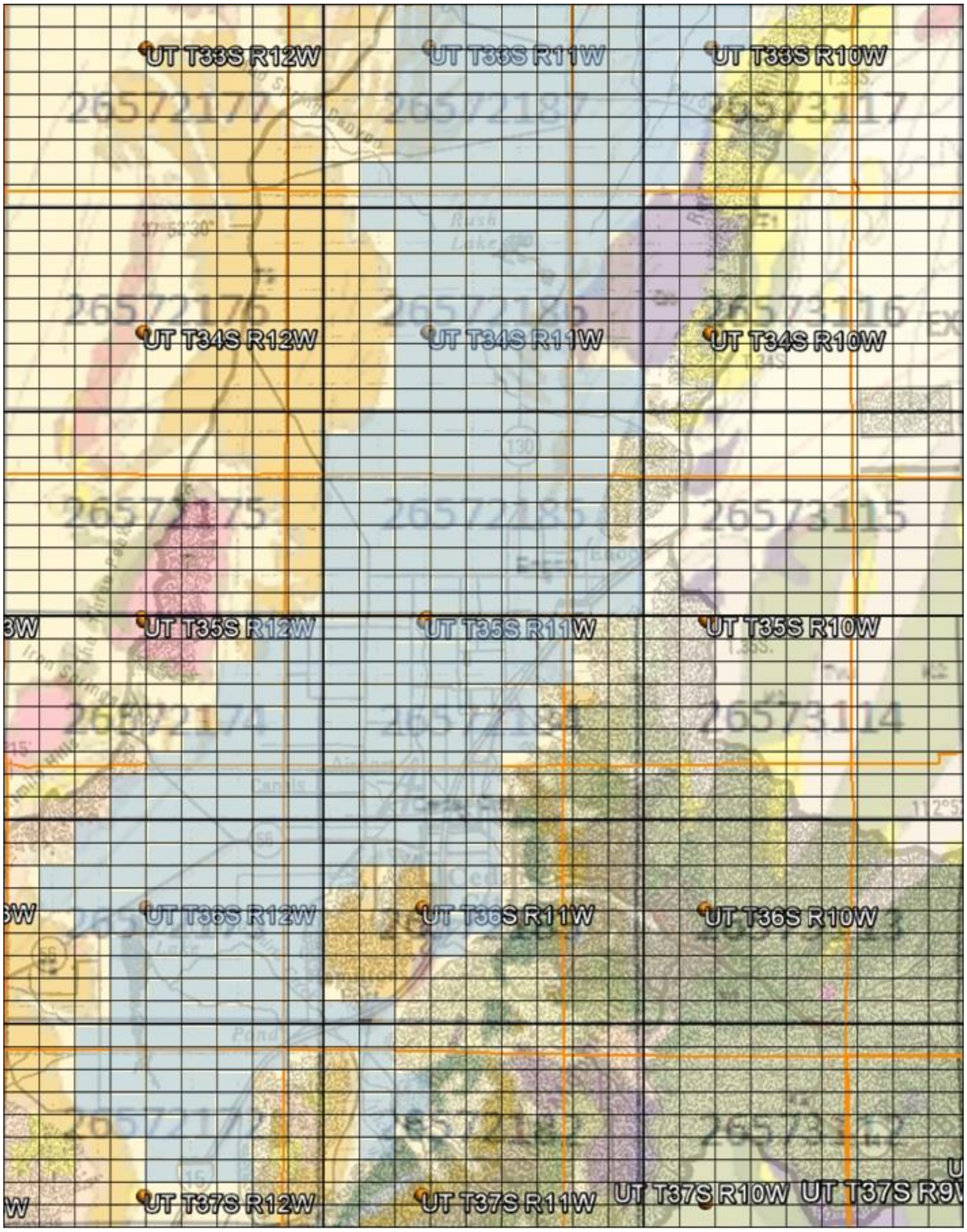


Figure 22. The Cedar Valley Aquifer (blue) is about 13,667 square miles in size.

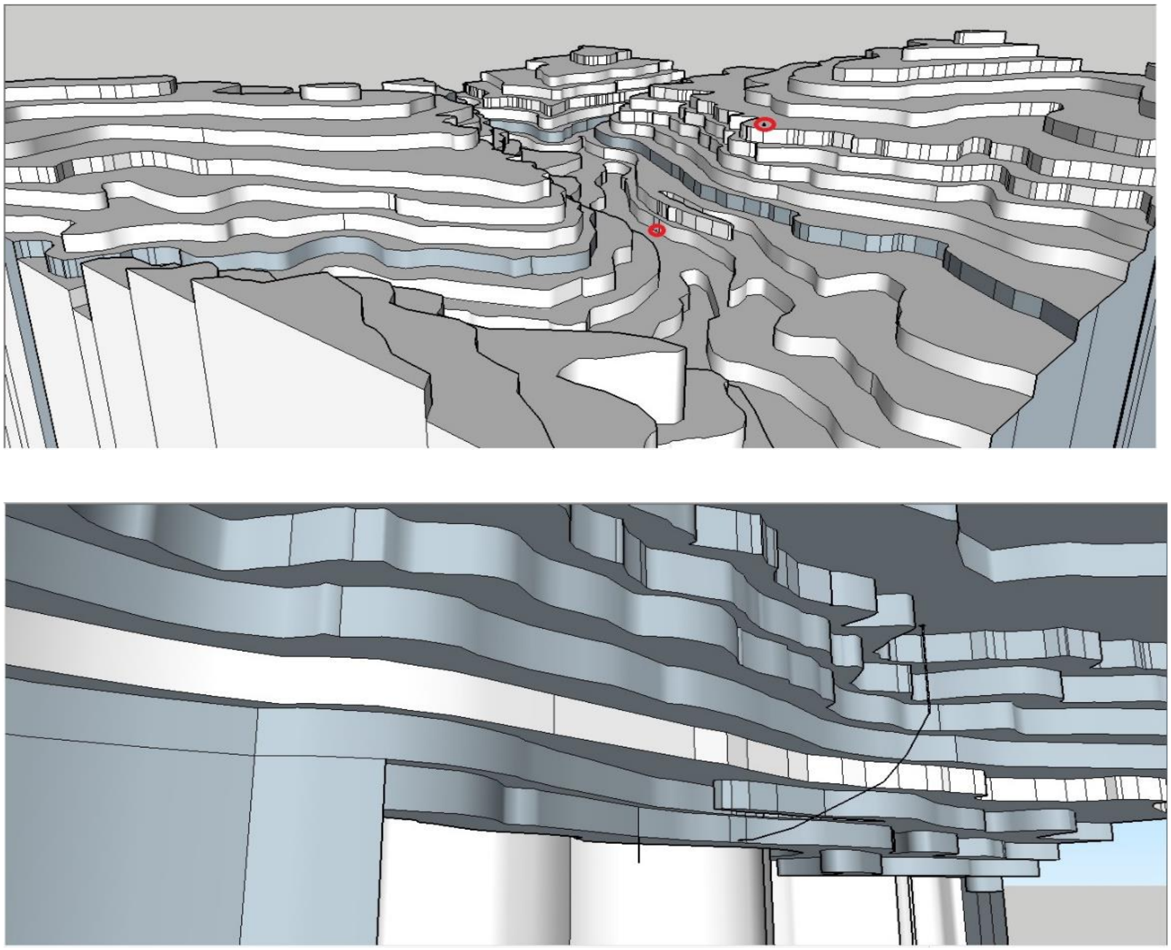


Figure 22: Deviate hole from Straight Cliffs to Dakota Sandstone which, with turbines in the well, could be a new source of energy.

See also:

- http://www.walden3d.com/IronCounty
- http://www.walden3d.com/IronCounty/intro
- http://www.walden3d.com/IronCounty/CedarValleyWater/
- http://www.walden3d.com/IronCounty/ig/IronCounty/IC_3_Approaches.html
- http://www.walden3d.com/IronCounty/ig/IronCounty/IC_3_Aquifers.html
- http://www.walden3d.com/IronCounty/ig/IronCounty/IC_CVA.html
- http://www.walden3d.com/IronCounty/ig/IronCounty/IC_KA.html
- http://www.walden3d.com/IronCounty/ig/IronCounty/IC_QMA.html