

## **REPORT ON HYDROGEOLOGY OF HOT SPRINGS**

### **WITH SPECIFIC ANALYSIS OF WITCHER AND RIVERBEND APPLICATION**

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SUBMITTED PRO BONO TO:

Artesian Bath House, The Martin Family Trust, William Martin Trustee,  
La Paloma Spa, Tierra de Sueno Inc.

Hot springs in a rift zone, such as the Rio Grande, are produced by magmatic heating of subsurface waters wherein excess pressure forces the water/gas/chemical mixture to the surface through a network of fractures. These fractures would otherwise be tightly closed due to the geodynamic stresses from gravity compression due to the overlaying mass of rock and sediments. Such hot springs are thus in a delicate balance between these natural forces which, if disrupted by natural or human-induced actions, can cause irreversible changes to the flow of the hot waters.

#### **The Witcher Report**

Issues claimed to be addressed in the report prepared for Riverbend Hot Springs and Spa, Cloverleaf Trust Org., are:

- A) Availability of water to satisfy application;
- B) Nature and extent of the claimed water right;
- C) Whether granting the application would result in impairment to existing water rights;
- D) Whether granting the application would be detrimental to the public welfare of the state;
- E) Whether granting the application would be contrary to the conservation of water within the state.

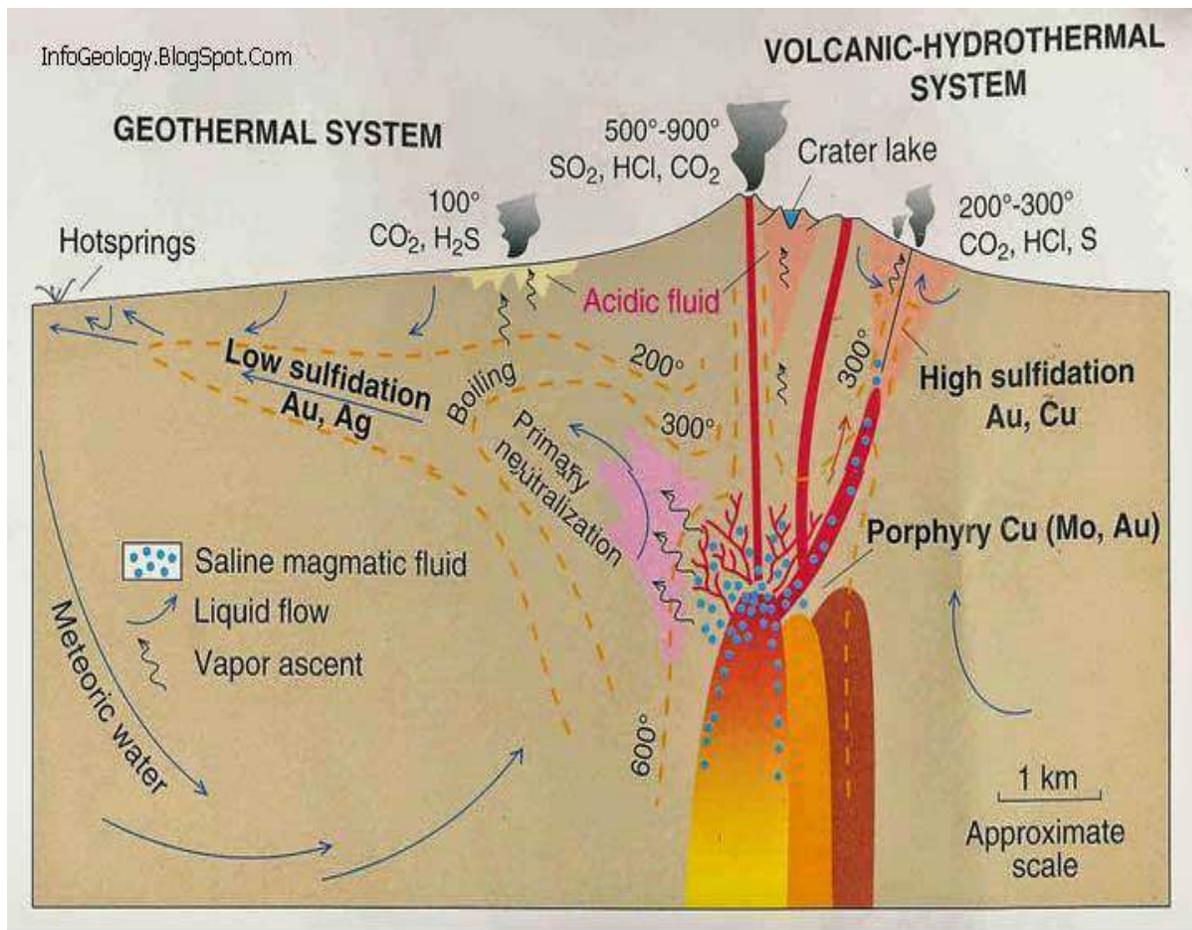
The report claims that it outlines the facts of the HS-1311 application that address the above issues, especially issues D and E:

- 1) Relevant local geology and hydrogeology;
- 2) Subsurface geology encountered in well HS-1101 POD1;
- 3) Construction of well HS-1101 POD1;

- 4) Pump test of HS-1101 POD1;
- 5) Natural discharge of the Hot Springs District geothermal system to the Rio Grande;
- 8) Flow requirements with heat and evaporative loss of existing and planned spa pool buildout;
- 9) Disposition of water after spa use.

## Relevant Local Geology and Hydrology

Witcher copies and follows Person's fallacious arguments of a non-magmatic heat source for the TorC hot springs. He uses diagrams from Person's (2013) report which were paid for by TorC and I assume without their permission and given to him by Person which smells like collusion between them. All other scientific analyses of the TorC hydrology especially Theis (1941), the considered expert on the subject, conclude that a magmatic source of the hot water is incontrovertible. The Truth or Consequences Hot Springs are in the active Rio Grande Rift which is being subject to extreme stresses and intense hydrothermal activity, as depicted below.

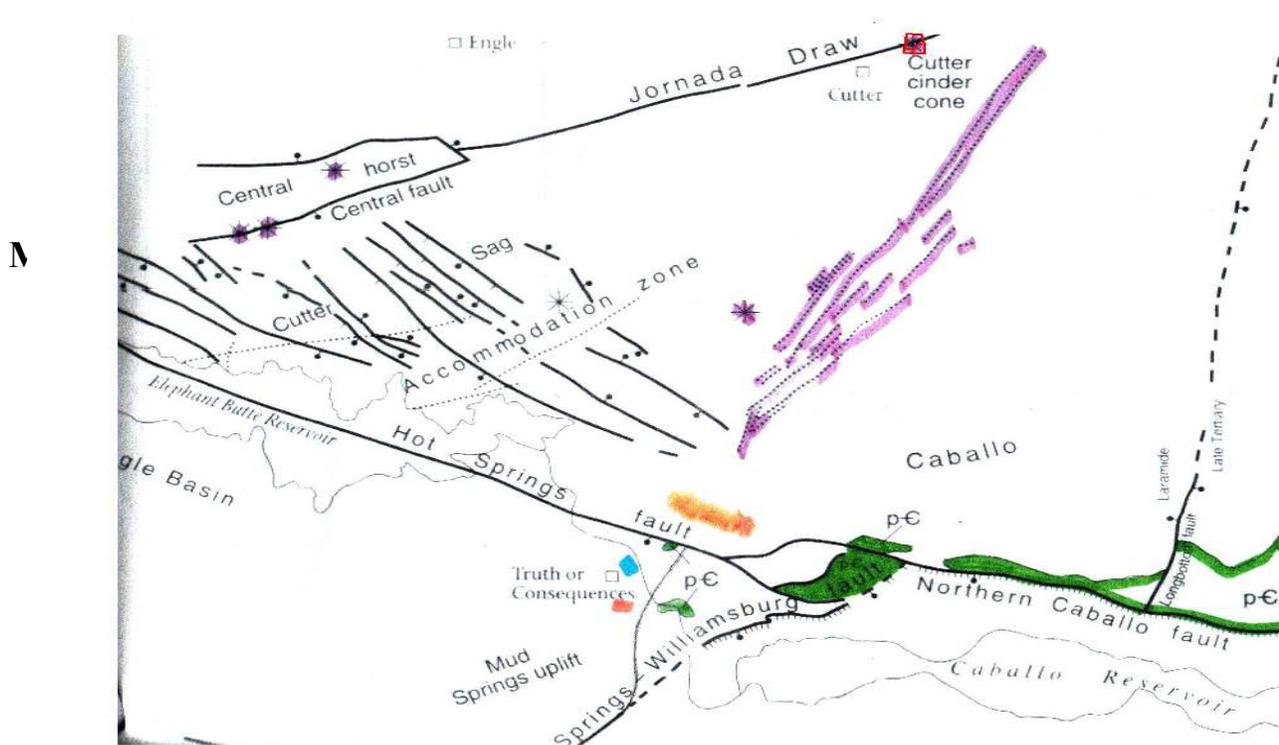


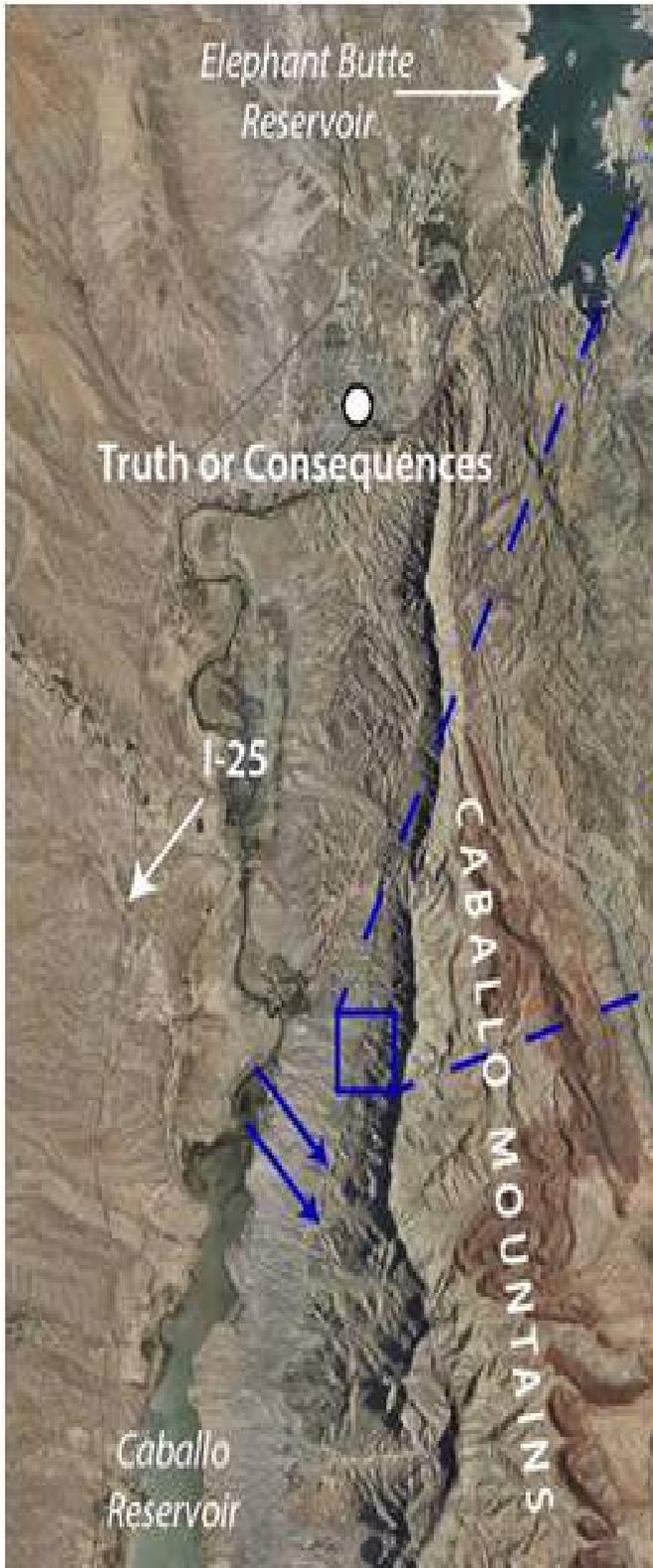
The local geology confirms the phenomena displayed in the above illustration. The geologic map below is based on the Seager and Mack (2003) Memoir 49 and with additions by Dr. John B. Davies and William Martin. North is to the left.

As is readily observed, recent magmatic activity is expressed by Cinder Cones, basalt dikes and intense hydrothermal alteration of rocks to the east and south of TorC. The famous La Tortuga Turtleback cone that dominates the TorC skyline is an eroded cinder cone which produced the intense hydrothermal alteration which starts immediately to the east of the Rio Grande that separates this zone from TorC.

None of these indicators of subsurface magmatic activity occur to the north of TorC where Person and Witcher incomprehensibly argue that the hot water originates. Even Person's fellow authors disagreed with his modeling of the source being from the north around Mud Springs area with age of the waters being inconsistent (P.pg27) and the limestone aquitard bounding the north edge of TorC acts as a barrier forcing the hot water from the southeast up into the artesian flows of the Hot Springs district (P.pg13 lied claiming from the north).

Blue : Artesian Hot Springs, Orange : Hydrothermal alteration  
 Purple : Basalt Dikes, Green : Granitic Basement Rock





*Scarp of the Caballo fault, 15-20 m high in inset photo. This fault ruptured the surface as recently as 2,000-5,000 years ago.*

## **Hot Springs Water Source**

The well HS=1101 POD1 was drilled to a depth of 240ft and ended in a rock unit that is the basement red granite that is shown in green on the above geology map. Witcher, realizing that this knowledge could prejudice their claim that the water was not connected with the hot springs source, tried to claim it as debris flow even though in previous papers he stated that the granite was the source aquifer for the hot springs.

He uses Person's fabrications to claim that the water is coming from the north where there is not a sufficient basin to hold enough water at the height, volume and pressure necessary. Theis (1941) calculated the amount of basin water volume necessary for the hot water source and the only such basin viable nearby is the basin to the east. A deep well drilled there has almost identical chemical composition to those of the Hot Springs.

Person's fellow authors also deride his model of flows from the north with showing the inconsistency in age of water from northern wells and the Hot Springs and also proving that the hot water flows from the east and being forced upward by the limestone aquitard cropping out to the north and west of TorC as can be easily observed at tank hill.

Person's graduate student who performed the electrical geophysical survey on the east bank of the Rio Grande also proved the presence there of huge volumes of saline water at depth with a plume rising toward the Hot Springs district (P.pg34). One can only assume that Person or other more powerful entities forced these dissenting authors to suppress their objections in order to propagate the false model assumed by Person and Witcher which enables the entities to claim that Riverbend pumping does not infringe on the prior water rights of the artesian water owners of the Hot Springs district.

## **Chemical Composition of Relevant Hot Waters**

We examine the chemical content of the water from the Riverbend deep well in comparison to that of La Paloma spa and that of the Artesian Bath house. The Riverbend water and that of La Paloma were both analyzed by Ward & Co. of Nebraska so that no argument can be raised concerning the methods and results of the analyses. The Artesian Bath house water was sampled and analyzed by Los Alamos Laboratories in a 1985 USA survey concerning the effects of nuclear explosions at the Almagordo site. The results are presented below in a spreadsheet format that allows both visual and numerical similarities to be readily obtained.

CHEMICAL	COMPOSITIOIN	RIVERBEND	LA PALOMA	ARTESIAN
	DATE TAKEN	02/12/20	12/30/20	05/31/87
	SAMPLER Analyser	FOERSTNER Ward	CYNDI Ward	Los Alamos Los Alamos
DEPTH OF	SAMPLE	240	0	176
	feet			
	Temperature			108.2
	pH	7.4	7.2	7
TDS	ppm	2882	2957	2697.5
ELEC COND	mmho/cm	4.8	4.93	
CATIONS	me/L	42.8	44.7	
ANIONS	me/L	47.5	27.2	
SODIUM	ppm	735	759	751
POTASSIUM		56	59	56
CALCIUM		159	170.5	163
MAGNESIUM		17	20	15.3
CaCO3		468	511	
NITRATE		0.4	0.3	0.2
SULFATE		28	35	75.1
CHLORIDE		1480	718	1360
CARBONATE		<1.0	<1	
BICARBON8		210	271	220
ALKALINITY		172	223	
FLUORIDE		2.41	2.96	3.06
IRON		<0.01	0.02	0.02

0.9668061566

Numerically, the correlation between the Riverbend deep source water and that of the surface artesian water of La Paloma spa is shown in the bottom line i.e. 0.9668 which is close to exact similarity so that no argument can be made except that they are from the same source aquifer. Similarly, visual comparison of the Riverbend source and that from the deep source of Artesian Bath House hot water proves again the same aquifer source for both.

The source of these hot waters is from the granite aquifer that is the basement rock which underlies the whole geological column and channels the hot waters originating in the basin of the Jornada Del Muerto. One deep well has been drilled in the Jornada del Muerto in which an anomalous temperature was observed—Victoria Land and Cattle Company No. 1 (10S.1W.25.100). The well with land surface altitude of 4809 ft was

drilled during 1951 and 1952. Original total depth was 6055 ft. The hole was plugged back and the casing was perforated from 1270 to 1348 ft. Two samples analyzed by the state chemist contained 2540 and 2400 ppm dissolved solids. The shut-in water level was 164 ft above the land surface on July 8, 1955, the well was flowing 900 gpm, and the water temperature was 94°F. These values of dissolved solids concentration are almost identical to that of the above TorC samples and the extreme artesian head shows that such pressures are quite capable of forcing the hot water down to the lower elevations of the TorC area again proving the source of the Hot Springs water being from the east and south.

### **Effects of Pumping on the Hot Springs Artesian Flows**

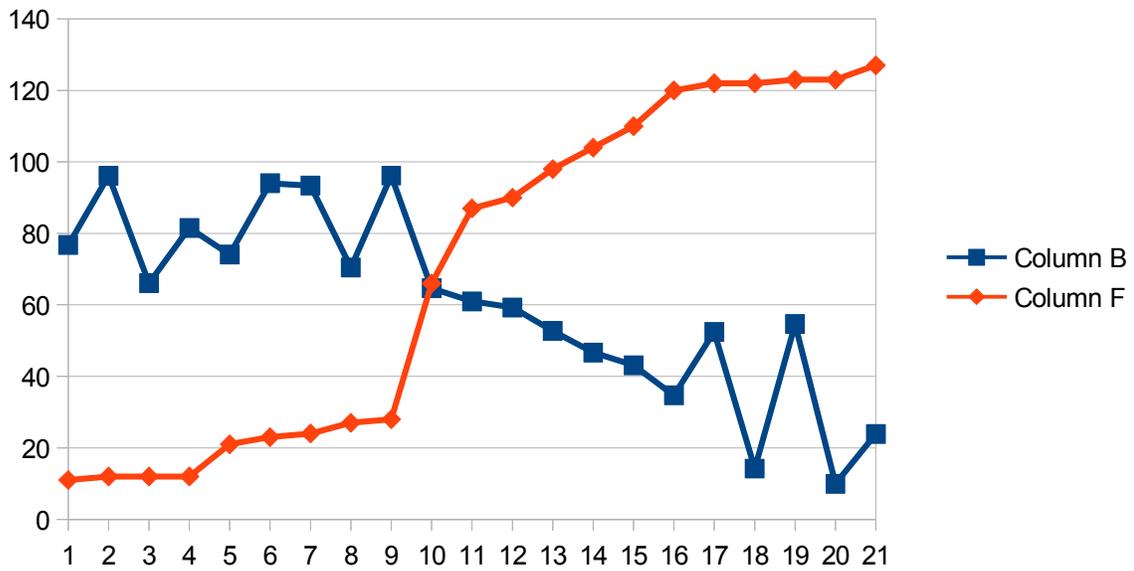
Both reports concerning the artesian hot springs flows conveniently ignore and avoid the necessary incorporation into their models of faults and fractures. These are the major conduits of the hot water forced upward and out through the main original artesian flows. Just as excess water pressure opens cracks as used in the process of fracking, so can even slight drops in water pressure caused by minimal pumping cause these feeder cracks to close over a period of time. A small decrease in the apertures of feeder cracks can cause large decreases in flow discharges through these fracture dominated springs, as has resulted in the TorC hot springs district.

The Person's report was contracted by TorC to address the fundamental question: Have thermal and hydrologic conditions changed since the time of the Theis et al. (1941) study? Person says his fallacious models and inconsistent geohydrologic analyses were inconclusive which is to be expected from his deliberate lack of investigation and ignoring of relevant evidence that we present below.

The spreadsheet data below contains in Column A the date and year of the measured flow rate of the artesian hot water from the Artesian Bath House at 312 Marr St, TorC with the date being taken as close to Oct1 as possible. Column B contains the flow rate for that date in gallons per minute. Column C is the temperature of the artesian flow on that date. Column E contains the number of wells completed for that particular year with data supplied by the NM State Engineer. Column F is the sum total of said completed wells upto and including the particular year.

The figure below plots the flow rate versus the total number of wells so completed upto and including the specific year. The correlation between these two number sequences is 88% which would be even higher if the flow rates were averaged over their particular years. Such a high correlation confirms without any doubt that in 2006 when a large number of new wells were permitted and completed that pumping has had and still does have a drastic and damaging effect on the artesian hot springs flow rates.

ARTESIAN	Bath House	WELL	NUMBER OF WELLS COMPLETED	TOTAL WELLS
Year Date	FLOW gpm	TEMP		
10/01/93	76.73	106		11
10/15/94	96.15		1	12
10/31/95	66.08	107	0	12
09/10/96	81.53	107	0	12
09/29/01	74.08	108.3	2	21
08/14/02	94.04	107.8	2	23
09/21/03	93.36	108.4	1	24
10/18/04	70.43	107.8	3	27
07/10/05	96.16	108.5	1	28
10/02/06	64.66	108.3	38	66
09/30/07	60.98	108.3	21	87
09/30/08	59.29	108.8	3	90
09/28/10	52.73	108.8	8	98
09/30/11	46.66	111.2	6	104
10/12/12	43.11	108.7	6	110
10/17/14	34.69	109	10	120
01/12/16	52.45	109	2	122
10/01/16	14.21	108.6	0	122
10/01/17	54.65	108.9	1	123
11/07/18	9.95	108.8	0	123
10/01/19	23.9	108.8	4	127



## **Pump Test Analysis**

Witcher and Person collaborated on a drawdown test of the well HS-01101 POD 1 as shown in their diagram. They used a standard simplest Theis model to claim that the test showed that a 300gpm production would cause a 1ft drawdown in wells within 1000s of ft distance. Even Theis(1941) acknowledged his simplistic model was not valid for a hot springs aquifer. Just a quick perusal of aquifer tests in Wikipedia shows the many reasons for its invalidity including upward flows, fractured media, etc.

Thus little belief can be attached to Witcher's self serving claims. In fact, both Person and Witcher appear to be ignorant of the effect of water pressure on a fractured system like that feeding the hot springs. They appear to be 40 years behind the real science whereby fracking has shown how increased water/fluid pressure opens the fractures impacted by the fluids. Similarly but opposite in effect, in such a dynamic media decreased water pressure due to pumping closes the subsurface fractures leading to permanent decreases in upward hot water flow as proven in the above figure.

## **Conclusion**

The above analyses have demonstrated the following conclusions both from a hydrogeological aspect and the collusion between Witcher and Person that aimed to allow Riverbend to illegally appropriate the artesian hot springs waters.

1. Witcher and Person both deliberately used fallacious models and arguments based on invalid assumptions to recommend additional pumping.
2. Rift geology demands a magmatic source of heating of the water with all geological signs proving the water came from the south/east as opposed to their north argument which they did in order to protect the Riverbend wells in their impacting of the NM water law of prior appropriation for subsurface water flows, as upstream of existing stakeholders water cannot be accessed and tapped.
3. The prior appropriation is confirmed by chemical analyses of the Riverbend water from the proposed well that has almost identical composition to that of La Paloma Spa and Artesian Bath House signifying the same source. It also has similar composition to the water found in a deep well in the Engle basin to the east.
4. The damaging effect of pumping on the water rights of the original stakeholders, especially La Paloma Spa and Artesian Bath House, is proven in the comparison of hot water artesian flow rates of Artesian Bath House versus the total number of wells

completed. The exceptionally high degree of correlation, as shown in the figure above, proves that the drastic decline in flow rate was caused by the rapid increase in the number of pumping wells since 2006 and thus again proves the evidence of illegal appropriation of subsurface water flows.

## **Recommendations**

The connection between illegal pumping and the loss of natural artesian flows can be further shown through analysis of the hourly change of flow rates and/or artesian water heights. Preliminary measurements show decreased flow rates during the midday hours when the illegal pumping usually occurs. It is recommended that such measurements be performed over a consistent time periods of as many days as possible. Using available pumping data from the City and/or the electrical company as to the times of most use by pumping licensees correlation can be shown.

Davies and Archambeau (1997a,b) proved the fundamental linkage between water pressures and tectonic activity by which the drilling of wells can have far-reaching effects. Further research is necessary to computer model these probable effects on the TorC artesian flows.

The computer models done by Pearson et al.(2013) are not realistic and should be redone using the real flows and geohydrology that is resulting in the TorC artesian basin. These realistic models should examine the effect of the proposed RiverBend deep well on the natural artesian flows.

## **References**

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