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## The Link between Aquifer Water, Low-Rank Coal, and Kidney Disease in the Gulf Coast States

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### ABSTRACT

Recent studies in Texas and Arkansas have demonstrated a link between groundwater in the Carrizo-Wilcox Aquifer that has been in communication (contact) with low-rank coals and a degenerative kidney disease resulting in dialysis treatment (End Stage Renal Disease, or ESRD, referred to here as the Lignite-Water Syndrome). No comparable study had been conducted in Louisiana where the Carrizo-Wilcox Aquifer and associated low-rank coals extend into northwest Louisiana. A detailed analysis of dialysis patients on a zip-code level indicated that the people living in this region have a substantially higher incidence of patients on dialysis than does the rest of the state (30/10,000 vs. 22.37/10,000). Neither ethnicity nor age appears to be confounding factors. Data for six of the eight parishes (Bossier, Caddo, De Soto, Natchitoches, Sabine, and Webster) that produce Carrizo-Wilcox water for human consumption show that the incidence of dialysis treatment jumps to 51/10,000, a statistically significant 2.5 times the average of the rest of the state. In fact, the data indicate that the health of as many as 40% of the dialysis patients in northwest Louisiana have been impacted by drinking water from the Carrizo-Wilcox Aquifer. A study of the effectiveness of commercial zeolite filters, catalytic carbon filters, and activated charcoal filters was inconclusive.

### INTRODUCTION

According to the University of Michigan's Annual Data report on kidney disease in the United States, approximately 750,000 Americans are diagnosed with End-Stage Renal Disease (ESRD) (University of Michigan Health, 2019). ESRD is the final stage of chronic kidney disease

and is diagnosed when a patient's kidneys can no longer support one's body. ESRD can be caused by a multitude of conditions, but the most common include diabetes, kidney disease, and kidney infections. (Mayo Clinic, 2019)

The most common treatments for ESRD are kidney transplants and dialysis; currently, around 75,000 patients in the US are diagnosed with ESRD and are candidates for a kidney transplant. Every year nearly 125,000 new cases of ESRD are registered in America. Researchers have determined that the average incidence of ESRD in America is around 22.55 patients per ten thousand citizens (Mayo Clinic, 2019). Louisiana has an average incidence of 22.37 patients per ten thousand citizens.

Since the 1950s, researchers have investigated the causes of Balkan Endemic Nephropathy (BEN), a fatal kidney disease that occurs in areas of the Balkan states where local drinking water is in communication with low-rank coals (Feder et al., 1991; Finkelman et al, 1991). They have concluded that one of the major factors may be the leaching of organic compounds from low-rank coals (lignite) in communication with aquifers supplying drinking water.

Recently, Chakraborty et al. (2017) looked for the cause of ESRD in East Texas. They discovered that one of the conditions that led to BEN in Texas was the proximity of lignite and drinking water; they speculated that the organics leached from the lignite by the groundwater was a primary factor for the high incidence rate of ESRD. They concluded that the organics in the water from the Carrizo-Wilcox Aquifer was the leading cause of ESRD in East Texas. Ojeda (2017) concluded that drinking water from the Carrizo-Wilcox Aquifer was a causative factor in the high incidence of ESRD in southwestern Arkansas. We refer to this health issue as the Lignite-Water Syndrome.

## METHODS

We took a two-pronged approach to this issue. First, we looked at the statistical relationships between the incidence of ESRD in Louisiana parishes ([Fig. 1](#)) and access to water from the Carrizo-Wilcox Aquifer. Then we collected Carrizo-Wilcox water directly from a commercial well in northwestern Louisiana and attempted to determine the efficiency of various commercial filters in removing the organic compounds.

For this experiment, two gallons of Carrizo-Wilcox well water was extracted (Monday, January 18, 2021) from Fillmore, Louisiana, at Well #3 located at 32°34'17.6"N, 93°31'09.3"W, as shown in [Figure 2](#).

Originally, we intended to analyze the samples using gas chromatography-mass spectroscopy (GC-MS) to determine the organic compounds in the samples. However, because COVID-19 caused many university laboratories to close and commercial laboratories were charging several hundred dollars for each sample we were unable to find a reasonable source for the GC-MS analysis. We therefore decided to look at the total organic carbon (TOC) of each water sample. The analyses were conducted by a commercial laboratory (Pace Analytical, Allen, Texas).

Organic contaminants pose a threat to the validity of this study, so the collection receptacles were cleaned with water and rinsed with 70% isopropyl alcohol and allowed to evaporate. The collected water samples were stored away from light and heat.

The filtration equipment used in the experiment was a countertop water filter housing and three loose backwashing filtration media (coconut shell activated carbon, Centaur catalytic carbon, and zeolite/Micro-Z). Six experiments were run using commercial distilled water as a control.

The experiments conducted were as follows. Sample JIK 1 was the control/head sample. It contained only the Carrizo-Wilcox water. JIK 2 was the distilled water filtered through the zeolite/Micro-Z particulates. JIK 3 was the Carrizo-Wilcox water filtered through the zeolite/Micro-Z particulates. JIK 4 was the distilled water filtered through the Centaur catalytic carbon particulates. JIK 5 was the Carrizo-Wilcox water filtered through the Centaur catalytic carbon particulates. JIK 6 was the distilled water filtered through the coconut shell activated carbon particulates. JIK 7 was the Carrizo-Wilcox water filtered through coconut shell activated carbon particulates. JIK 8 was another Carrizo-Wilcox water control. JIK 9 was unfiltered distilled water. All

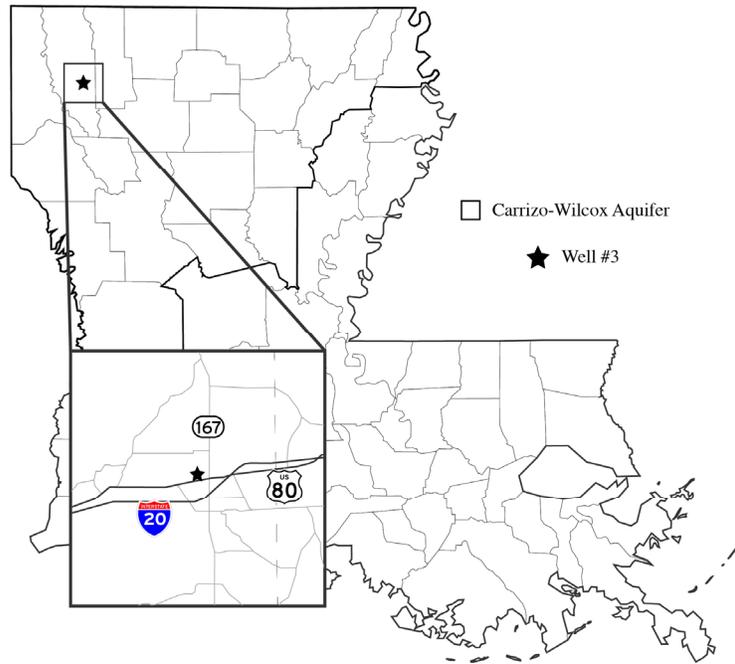


Figure 1. Location of the Fillmore Well #3. The dark outline indicates the extent of the Carrizo-Wilcox Aquifer in Louisiana as described by the U.S. Geological Survey (2021).



Figure 2. Well #3 producing Carrizo-Wilcox water.

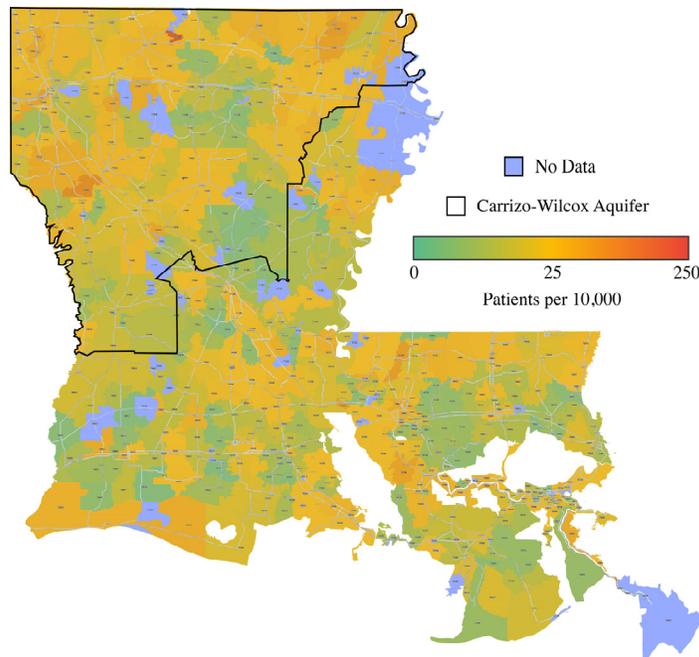
nine samples were then analyzed by an accredited commercial analytical laboratory (Pace Analytical) for TOC levels.

## RESULTS

A detailed statistical analysis of dialysis patients on a zip-code level indicated that the people living in this region have a substantially higher incidence of patients on dialysis than does the rest of the state (30/10,000 vs. 22.37/10,000) (Table 1 and Figures 3-5). Neither ethnicity nor age appears to be confounding factors. Data for six of the eight parishes (Bossier, Caddo, De Soto, Natchitoches, Sabine, and Webster) that produce Carrizo-Wilcox water for human consumption show that the incidence of dialysis treatment jumps to 51/10,000, a statistically significant 2.5 times the average of the rest of the state. In fact, the data indicate that the health of as

**Table 1. ESRD incidence of the patients per ten thousand residents in the United States, the State of Louisiana, northwestern Louisiana, and Webster Parish.**

Location	ESRD Patients	Population	Patients/10,000
United States	746,557	331,002,651	22.55
State of Louisiana	10,401	4,648,794	22.37
Northwestern Louisiana Area north of the heavy outline (calculated for residential use of Carrizo- Wilcox water)	1,549	516,203	30.00
Webster Parish	121	1,626	744.15



**Figure 3. Incidence of ESRD patients by zip code in Louisiana. The data range from 3 patients/10,000 to 185 patients/10,000.**

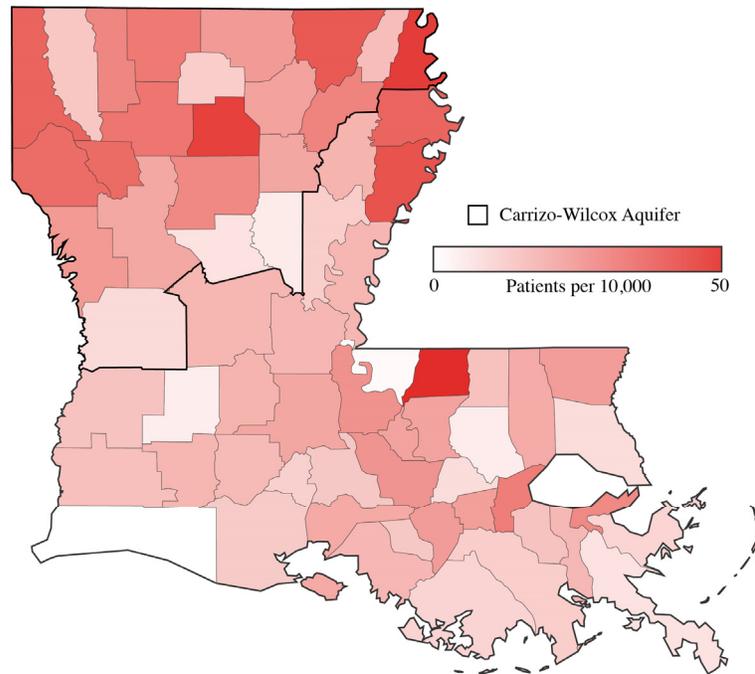


Figure 4. The incidence of ESRD patients by parish in Louisiana. The data used were averaged on a parish basis. The data range from 4 patients/10,000 to 53 patients/10,000.

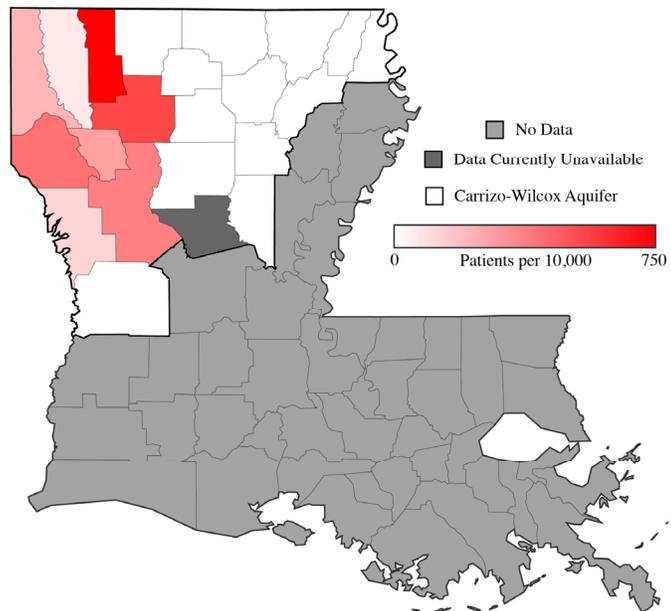


Figure 5. The incidence of ESRD patients by parish in Louisiana based upon the population who use water from the Carrizo-Wilcox Aquifer for residential purposes. The data range from 0 patients/10,000 to 743 patients/10,000.

many as 40% of the dialysis patients in northwestern Louisiana have been impacted by drinking water from the Carrizo-Wilcox Aquifer.

Results of the TOC analysis ([Table 2](#)) were inconclusive. We believe that the filter material provided had residual carbon that was leached during the experiment. We recommend that future experiments thoroughly leach the filter material prior to filtering the target well water.

## SUMMARY AND CONCLUSIONS

We found that the incidence of ESRD likely stems from drinking water from the Carrizo-Wilcox Aquifer that is in communication with the low-rank coals in the formation. In the north-west corner of Louisiana, the incidence of ESRD patients is almost 3000 per million. Webster Parish, a small rural parish where most residential water comes from wells, has an incidence rate of 74,415, 33 times higher than the U.S. average.

The TOC data in [Table 2](#) likely reflect organics in the filter material so we consider these results to be inconclusive.

Nearly 125,000 Americans are diagnosed with ESRD yearly (U.S. Renal Data System, 2019), with over 10,000 cases in Louisiana alone. Per Kamen and Finkelman (2020), nearly \$73 million in health fees and a half-million deaths can be avoided if ESRD was diagnosed and treated properly.

The implications of this study are important in order to determine whether certain filters function adequately in removing the organic moieties that contribute to ESRD.

Although these results are compelling, they do not demonstrate cause and effect. We have demonstrated that there is a statistically significant difference in the incidence of ESRD in those Louisiana Parishes where people are drinking water from the Carrizo-Wilcox Aquifer compared to the rest of the state.

The Lignite-Water Syndrome is a serious health problem that likely affects many thousands of people in at least three Gulf Coast states. Studies should be conducted to determine if it also occurs in other Gulf Coast states.

**Table 2. Results of the TOC tests.**

Sample	Water Source	Filter	TOC (mg/L)
JIK1	Carrizo-Wilcox	N/A	4.59
JIK2	Distilled Water	Zeolite/Micro-Z	4000
JIK3	Carrizo-Wilcox	Zeolite/Micro-Z	978
JIK4	Distilled Water	Centaur Catalytic Carbon	478
JIK5	Carrizo-Wilcox	Centaur Catalytic Carbon	29.6
JIK6	Distilled Water	Coconut Shell Activated Charcoal	255
JIK7	Carrizo-Wilcox	Coconut Shell Activated Charcoal	5.45
JIK8	Carrizo-Wilcox	N/A	1.06
JIK9	Distilled Water	N/A	1.30

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## NOTES

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