

Study: Comparative Nitrate Levels
in Cottonwood Creek, TX

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Abstract

The purpose of this study was to evaluate levels of nitrate in Cottonwood Creek and see how they compared with historical values in regards to agricultural versus urbanization uses. This nonpoint source pollution is caused by decomposition of organic matter. The study was inconclusive due to unreliable data taken by the Texas Commission for Environmental Quality (TCEQ). Long-term nitrate studies of Cottonwood Creek are needed to quantify inputs and outputs to identify any trends in the data.

Introduction

The Cottonwood Creek watershed is located in Collin and Dallas Counties. While there is a tributary to Spring Creek by the same name, this creek has three separate headwaters which merge into the one creek. Two branches lay west of US Hwy 75 in the city of Richardson, TX. The third branch of the creek lay east of US Hwy 75 in the Dallas area. The confluence of Cottonwood Creek and White Rock Creek occur just north of the Forest Lane exit and US Hwy 75 adjacent to Cottonwood Creek Trail. The area of the creek is noted in figure 1. The drainage basin for Cottonwood Creek is classified as urbanized and is considered part of the Upper Trinity Watershed hydrologic unit HUC 12030105 as described by the USGS (EPA 1). The area of this hydrologic unit is 3582.1 km² (1383.6 mi²) (Gustafson 1). The Trinity River drainage basin starts in the North Texas area and drains to Galveston Bay as noted in figure 2.

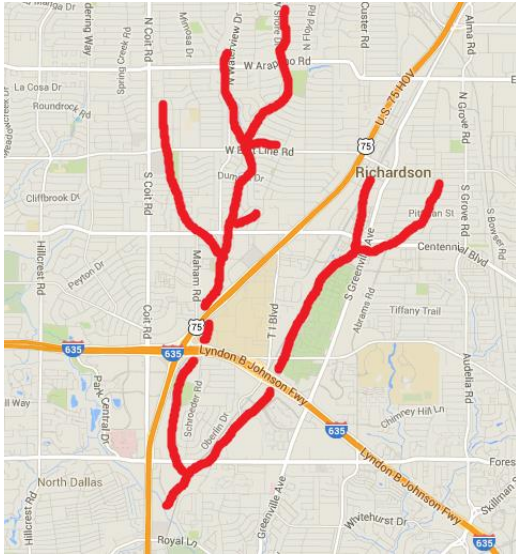


Figure 1: Map of Cottonwood Creek



Figure 2: Map of the Trinity River Basin

The Texas Commission on Environmental Quality sponsored several water samples of Cottonwood Creek from approximately 1980-1990 (TCEQ 1). These sites were not tested in regular intervals, and therefore the results were not useful, but did give a reference to fluctuations in the tested nitrate values. The testing sites exact GPS locations were given by the TCEQ and it was these sites that were used for this comparative study.

Tests have shown that forests are nitrate sinks whereas urban areas are strong contributors of nitrate (Basnyat 65). The hypothesis based in these results indicated that urbanized areas would have a higher nitrate value than agricultural areas. Since the areas around Cottonwood Creek were once forests it was believed that as the population increased the nitrate levels would increase as well. This would mean that the urbanization and nitrate levels would be dependent. The alternate hypothesis would mean that that these variables are independent.

Experimental Design

This was a field study conducted in the cities of Richardson and Dallas. Historical data for the desired creek was uploaded and then analyzed to find the exact latitude and longitude of each site. The sites were plotted in Google maps and scouted on the ground for accuracy prior to beginning the study. Each access point was documented by photograph for a total of 18 sites. The Hunt branch consisted of sites 1-3. The Main branch testing sites were numbered 4-11. The remaining testing sites, the Floyd branch of the creek, were delineated 12-18. A map including the tested creek points are listed in the Appendix.

The water samples were obtained and tested between the dates of April 15, 2014 and April 20, 2014 from the hours of 8am-10am. These times were strictly followed to decrease possible daily fluctuations. Although the area received rain on April 12th, collection did not begin until April 15th to ensure as accurate levels as possible.

Sites 13-18 were chosen to test the third branch of the creek to compare to the other two branches. A map of Cottonwood Creek from the Texas Stream Team website is included (Fig. 2) to show a topographical view and the confluence with White Rock Creek (Texas 1).

Materials

A Vernier Lab Quest, Vernier nitrate probe and two known nitrate value were used. The GIS 'GPS Tracks' iPhone application was used to determine GPS location and

altitude of each site monitored to ensure the right location was sampled. Prior to sampling the sites were plotted on Google maps to determine the best point of entry into the segment of the creek being tested. A letter was obtained by a sponsoring professor in case access to private property needed to be requested. Additionally, the USGS White Rock Discharge summary was monitored to account for possible stream flow fluctuations from rain in the drainage basin. A copy of the discharge graphical data set is included in the appendix.

Procedures

Each sample was taken in a catch bucket. The catch bucket was rinsed three times with the sample water before collection. The sample was then tested using a Vernier Lab Quest and attached nitrate probe. The nitrate probe was calibrated before each sample was tested.

Before calibration the nitrate probe was thoroughly rinsed with distilled water. Two different standards were used (1 mg/L, 100 mg/L) to calibrate the nitrate probe. The probe was then thoroughly rinsed with distilled water. The probe was inserted into the sample bucket to the water line indicated on the probe. The readings stabilize after one minute. Each reading was logged along with the corresponding site location.

Data

Each of the 18 test sites were evaluated for nitrate levels. Each test was run in triplicate and an average of the three obtained values were taken and documented. The averages are plotted in the graph below.

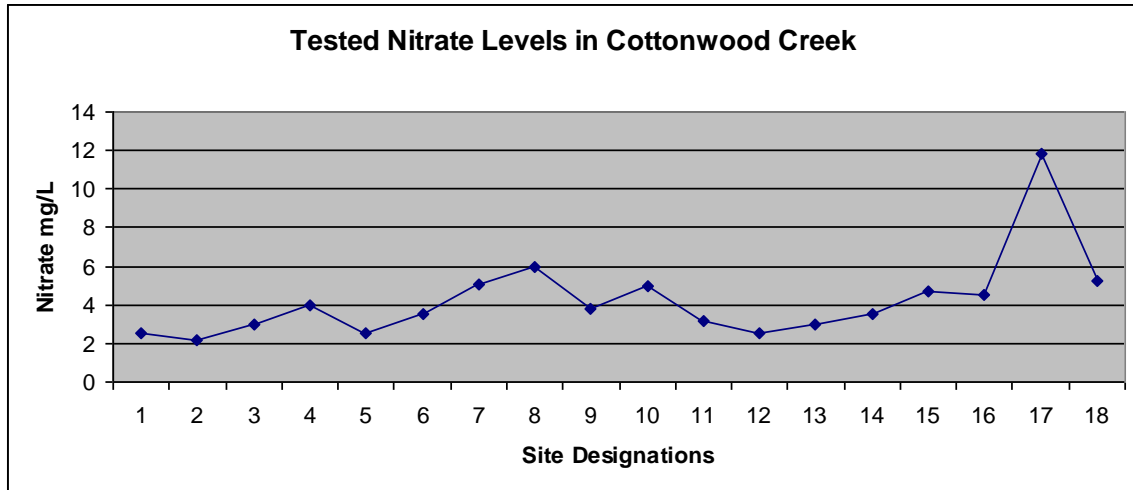


Figure 3: Nitrate levels in Cottonwood Creek

Data Analysis

Data was collected from each testing site and compared to historical results. The historical samples were graphed but were found to be of no statistical relevance. This was due to a lack of description of how the data was collected, at what time the data was collected and collection at irregular intervals. At some sites data was taken over a 10 year period but at others the time period was much shorter.

The data downloaded from the STORET database, as taken by the TCEQ, has no listed time of day that the collections were taken. Additionally, collections were taken during different months of the year and at different yearly intervals. As such the data cannot indicate any patterns or long term trends. The historical only shows the nitrate level for that site at that time. There are no records in the STORET data to indicate which method was used for collection. The historical graphs and data are listed in the appendix (Fig.2 – Fig. 11). There are no historical data for points 13-18.

The sample values in this study were collected using a Vernier nitrate probe and collection bucket as opposed to the alternate method of a water test kit. This collection

method might have skewed the data results. Cottonwood Creek is very shallow in some locations and the collection bucket invariably collected some sediment from the creek bed. Great care was taken to collect from moving portions of the creek but sites were limited to the GPS locations as provided by the STORET data and safe access points. As a result, some samples were taken from more stagnant areas of the creek. These more slow-moving areas may not represent accurate nitrate levels because of inadequate mixing. The membrane on the nitrate probe may have been inhibited by bubbles.

The Vernier LabQuest and Vernier nitrate probe proved very difficult to stabilize in order to obtain readings. During the testing sequence an alternate Vernier LabQuest had to be obtained in effort to reduce value fluctuations. After calibrations, the nitrate probe was used in the calibration standards to check for accuracy. There was sometimes as much as 10 mg/L variance in the sampled value versus the known value of each standard.

Historical data for points 1-3 are listed below. Graphs of historical data for the additional points are located in the appendix.

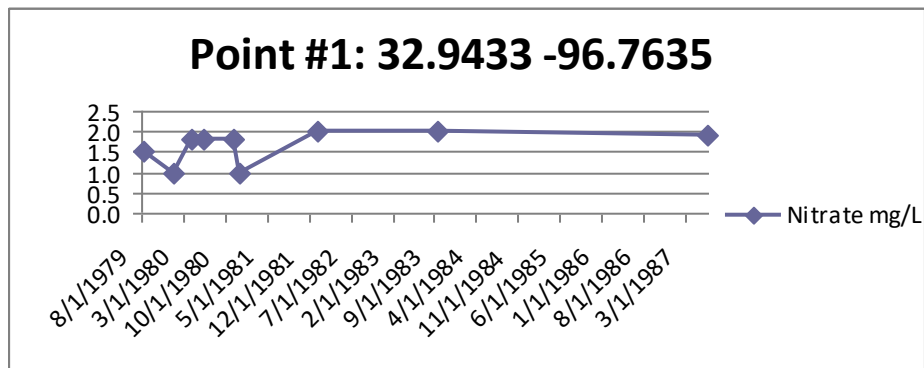


Fig 4. Point #1 Historical Levels: Hunt Branch

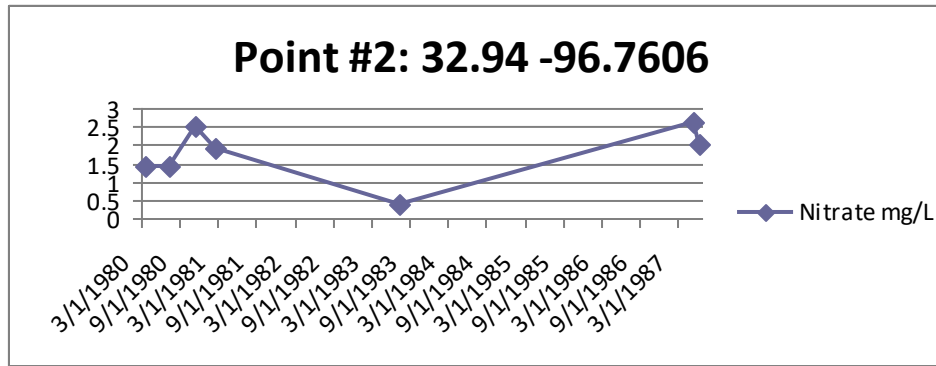


Fig 5. Point #2 Historical Levels: Hunt Branch

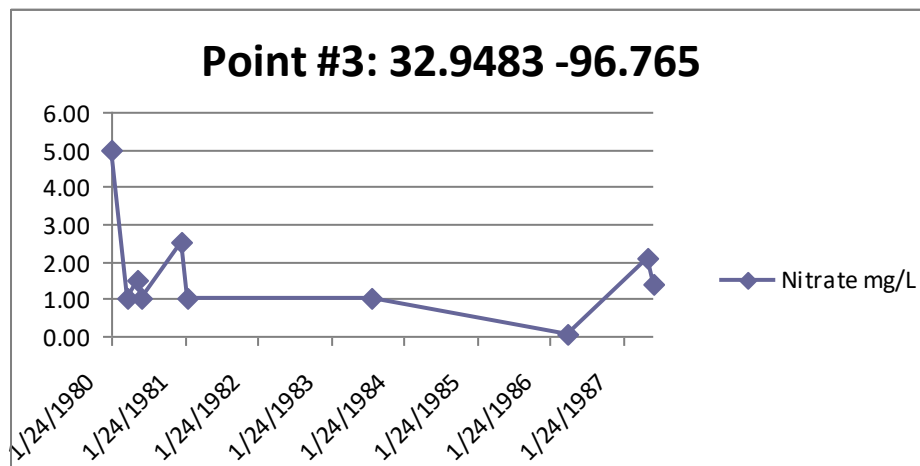


Fig 6. Point #3 Historical Levels: Hunt Branch

Discussion

The sites tested are adjacent to many surface drains and are therefore in constant nitrate flux. Some nitrate testing is being done by the City of Dallas but during 2013 it was only done twice, in April and August at one site on the Floyd branch. Two samples are not enough to provide a clear or accurate data trend. No information on possible nitrate inputs to the HUC 12030105 has been found. Access was denied to the historical data from the City of Dallas for a comparison. Only the last two results were released

from the Floyd branch and the location of the site was also denied. It is hard to determine how the site is being tested as access to this information was also denied. The City of Richardson also declined a call back for information.

There is clearly a need for a third-party independent testing authority to collect and monitor this data. Although, Texas Stream Team is a possibility they do not have any monitors or gauges on Cottonwood Creek. There is only one monitor on White Rock Creek even though there is public support for the group, “For the Love of the Lake” which has made a concerted effort to clean up White Rock Lake. This is troubling since Cottonwood Creek is a major tributary to White Rock Creek.

One of the testing sites, originally delineated as 19, was removed from the list as it was dried up. Although not directly connected to nitrate levels, this result is also alarming. The area of land that includes the Cottonwood Creek watershed is in a stage 3 drought and has been for several years. As the land needs of the surrounding population grows so does the need for water. This growing population, along with the drought, may have already adversely affected Cottonwood Creek. Along many sites were deep canyons with trickles of water running through them. The observed alluvium and erosion suggest that these creeks have had a much larger water volume and wider stream flow in the past. As the water flow diminishes Cottonwood Creek will be subject to greater and greater fluctuations of nitrate because of the lower amounts of clean water.

The creek is especially vulnerable as most of its runoff is collected directly off of US HWY 75 and US HWY 635. There are many visible pipes leading to the creek. Several segments of the HUC 12030105 already have documented annual fish kills due to PCBs and bacteria. Perhaps this is also the fate of Cottonwood Creek.

Conclusion

These results obtained are inconclusive. Since no comparable studies could be analyzed statistically, neither the null or alternate hypotheses could be verified. The nitrate samples were only obtained on a short-term study but instead should be collected consistently over many years at the same site to analyze trends.

Work Cited

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Appendix

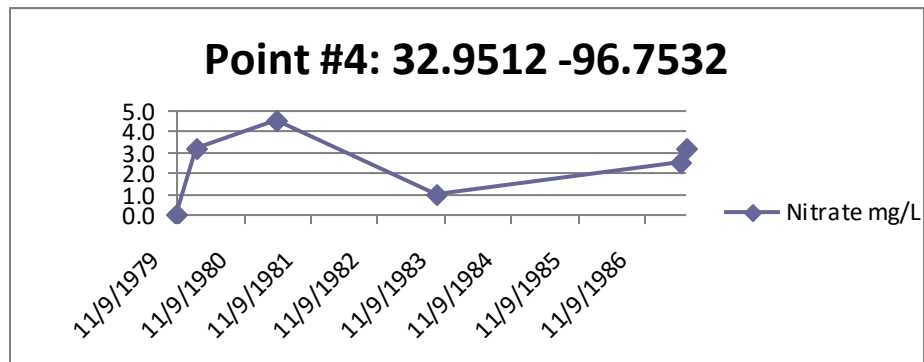


Fig 7. Point #4 Historical Levels: Main Branch

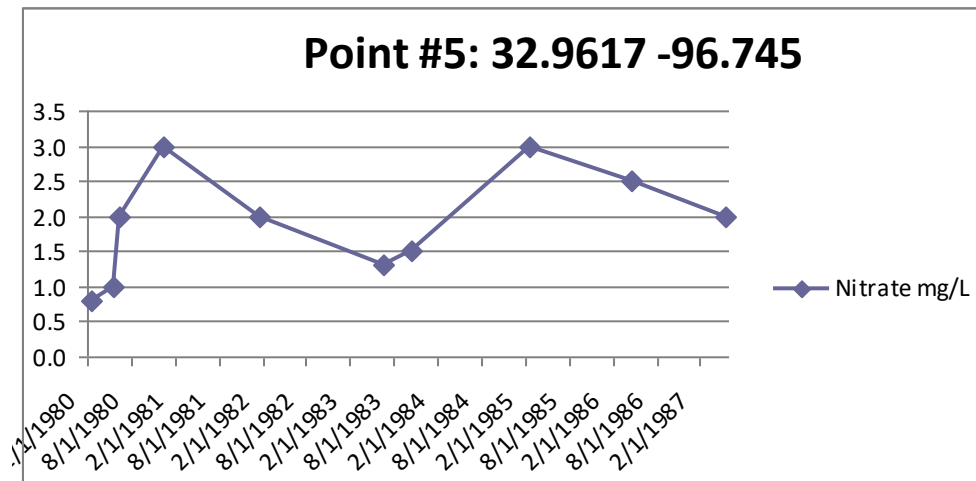


Fig 8. Point #5 Historical Levels: Main Branch

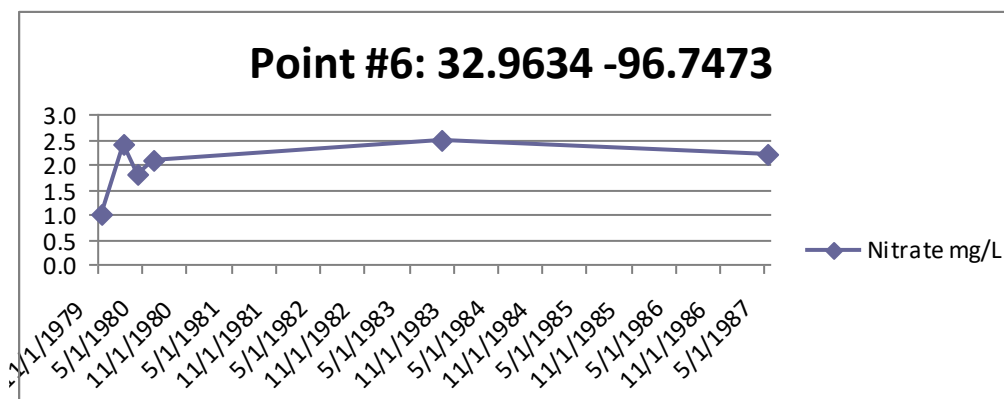


Fig 9. Point #6 Historical Levels: Main Branch

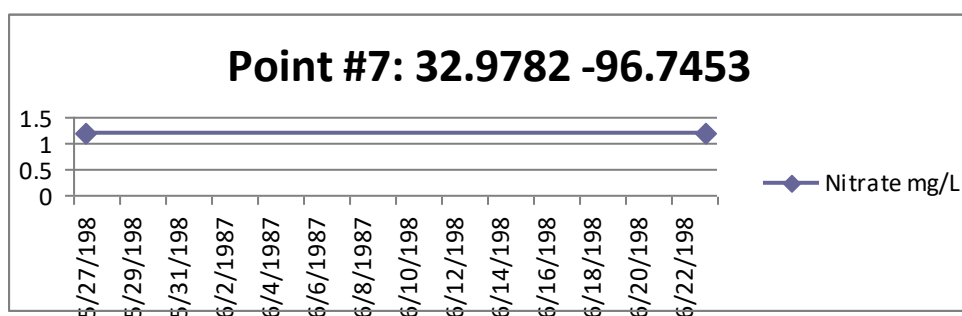


Fig 10. Point #7 Historical Levels located on Main Branch

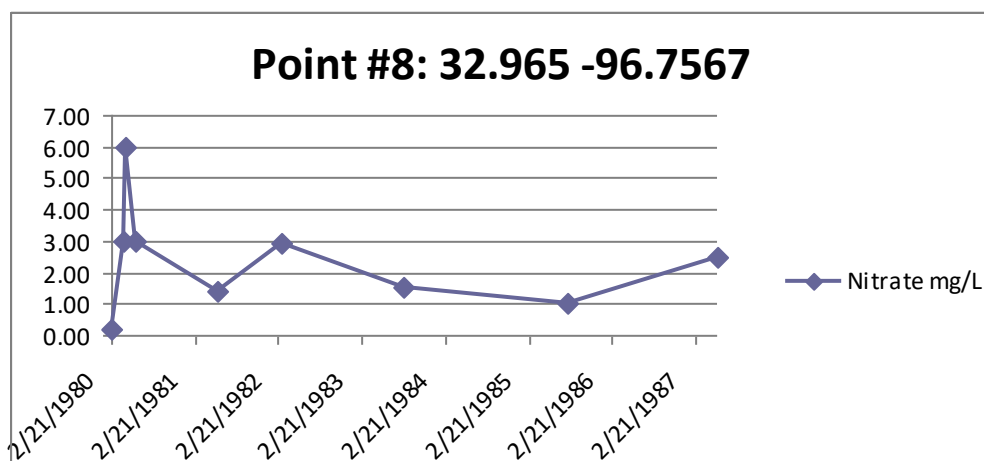


Fig 11. Point #8 Historical Levels: Main Branch

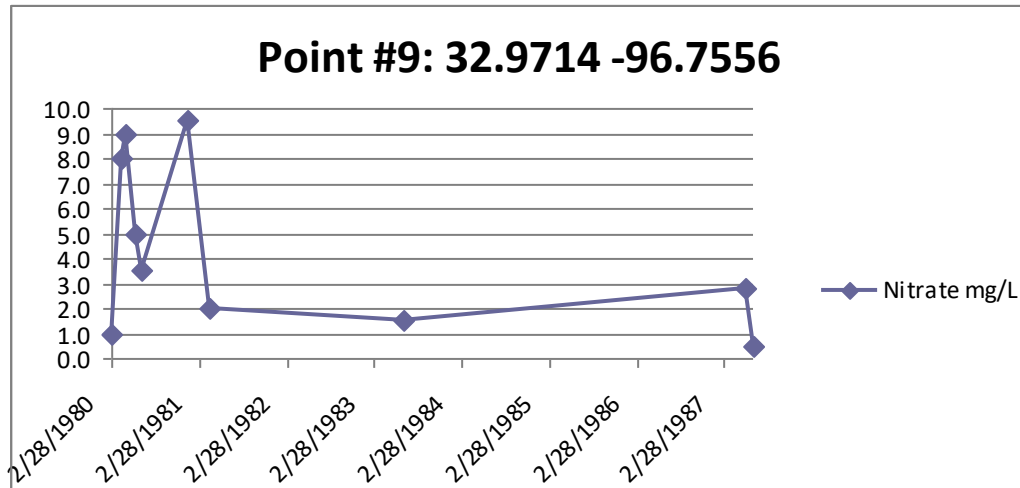


Fig 12. Point #9 Historical Levels: Main Branch

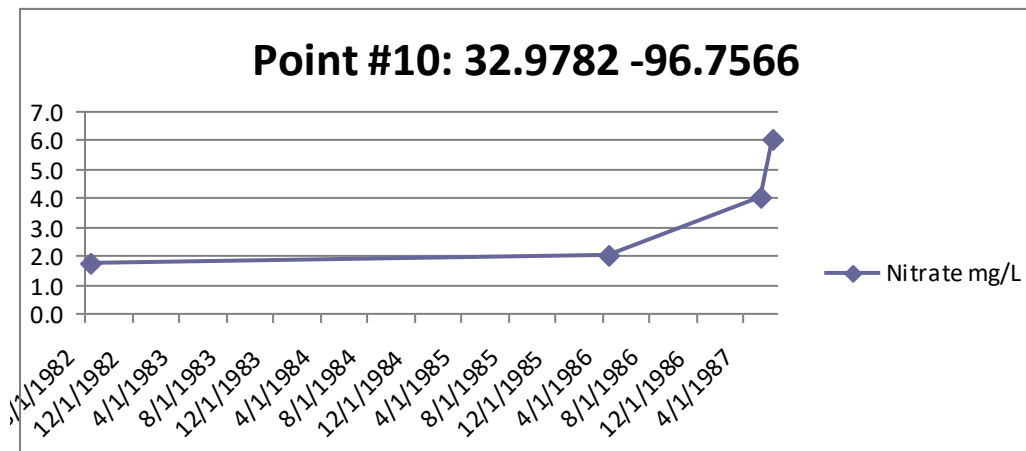


Fig 13. Point #10 Historical Levels: Main Branch

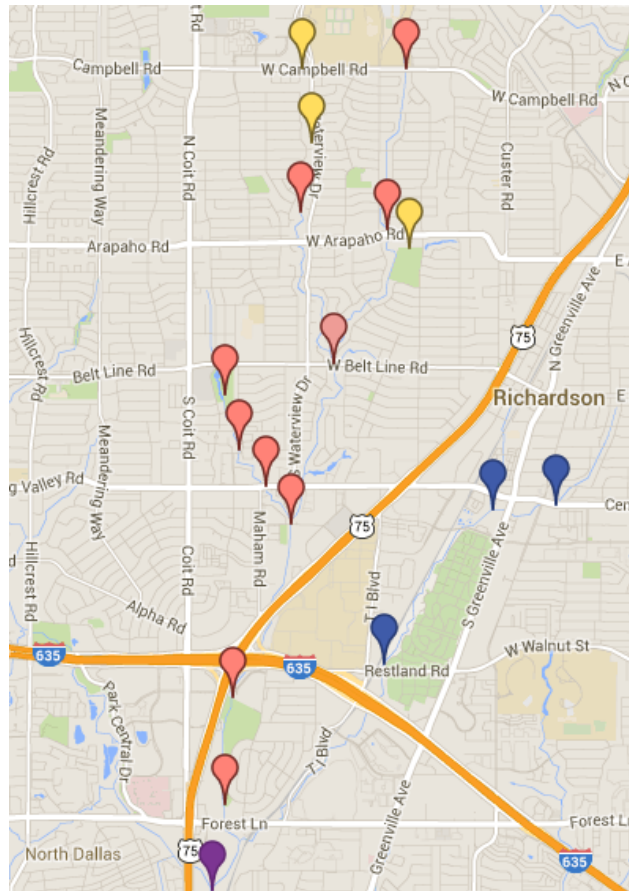


Fig 14: Historical Testing points plotted with Google Maps.
 Red- Hunt/Main Branches of Cottonwood Creek
 Blue- Floyd Branch of Cottonwood Creek
 Purple- Confluence of Cottonwood and White Rock Creeks



Fig. 15: Texas Stream Team Map of Cottonwood Creek

Trinity River Basin	
Segment 0803B - White Rock Creek (unclassified water body)	
Water body description:	From the confluence of Lake Livingston northeast of Trinity in Trinity County to the upstream perennial portion of the stream east of Lovelady in Houston County
Water body classification:	Unclassified
Water body type:	Freshwater Stream
Water body length / area:	38.00 Miles
Use support summary:	Available data indicate that the aquatic life use is supported. The contact recreation and fish consumption uses were not assessed due to insufficient data.
Water quality concerns summary:	Water quality concerns were not assessed due to insufficient data.
Monitoring sites used in the assessment	
Station	Station Description
10696	White rock Creek at SH 94 northeast of Trinity TRA #21

Fig 16 : Texas Commission on Environmental Quality
Trinity River Basin Graphical Study

Trinity River Basin

Segment 0827 - White Rock Lake

Water body description: From White Rock Dam in Dallas County up to the normal pool elevation of 458 feet (impounds White Rock Creek)

Water body classification: Classified

Water body type: Reservoir

Water body length / area: 1,119 Acres

Use support summary: Uses were not assessed due to insufficient data.

Water quality concerns summary: Water quality concerns were not assessed due to insufficient data.

Wastewater dischargers

Permit type	Number of outfalls
Domestic	1

Historical fish kills

Start date	Location	Fish killed	Suspected cause
06/16/1995	White Rock Lake - Intersection of Floyd Road and Loop 635 in Dallas, Texas	300	Organic compound
08/14/1995	White Rock creek - Coyt Road and L.B.J. in Dallas, TX	20	Organic compound
12/01/1995	White Rock Lake downstream of the spillway	2000	Disease

Fig 17: Texas Commission on Environmental Quality
Trinity River Basin Graphical Study

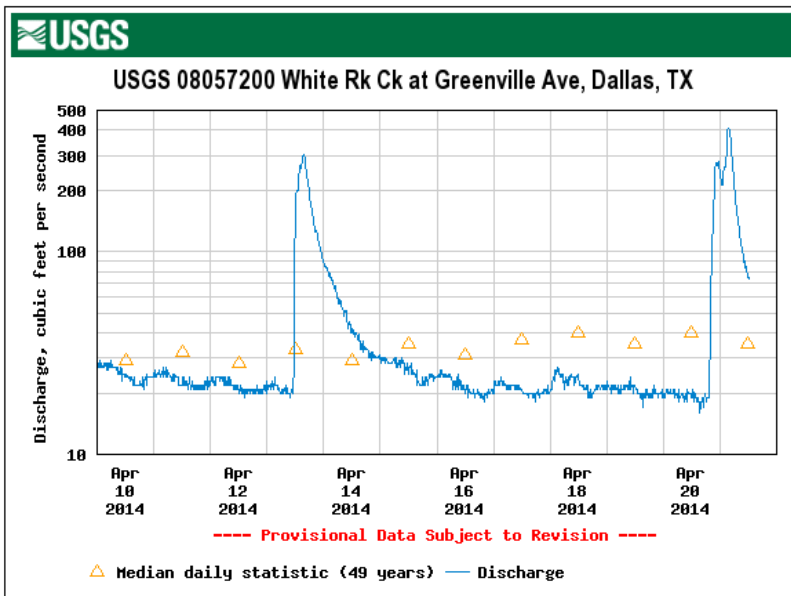


Fig 18: USGS White Rock Creek Discharge 4/10/14 - 4/20/2014