BASE FLOW WATER QUALITY TREND ANALYSIS FOR AUSTIN CREEKS

Prepared by

WATERSHED MANAGEMENT DIVISION

City of Austin

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Trend analyses on baseline water quality were conducted for Austin area creeks. The data used in these analyses are from the U.S. Geological Survey (USGS)/City of Austin Cooperative Monitoring Program. The period of record is 1975-84. The following creeks are included in this analyses - Boggy, Bull, Onion, Walnut, and Williamson. Data for other creeks are insufficient for analysis.

Baseline data are defined as those collected during non-storm event periods (i.e. baseflow conditions). Baseflow is defined as the groundwater discharge into streambeds which sustains flow for the periods between storm events. In some cases (lower Walnut and Williamson Creeks) natural baseflow is augmented by treated sewage discharge.

This report is produced as an addendum to the Stormwater Quality Modeling Study[1] for Austin Creeks published in 1984 by the Watershed Management Division of Public Works.

Conclusions

1. Except for a few cases, data for water quality constituent concentrations generally follow log-normal distributions (i.e., the concentration values, when transformed to logarithm, are normally distributed). This implies that the normal distribution regression and correlation models may be formulated for the trend study.

2. There are significant upward time trends for the concentrations of some water quality constituents for Walnut and Williamson Creeks. The other creeks have no identifiable trends. The identified trends are as follows:

For Walnut Creek at Webberville Road, ammonia nitrogen (NH_3) and total kjeldahl nitrogen (TKN) are significant at 99% and 94% confidence levels, respectively. For Walnut Creek at Southern Pacific Railroad Bridge (below Walnut Creek Wastewater Treatment Plant), nitrate nitrogen (NO_3) and total phosphorous (TP) are significant at 93% confidence level. For Williamson Creek at Jimmy Clay Road (below Williamson Creek Wastewater Treatment Plant), NH_3 and TKN are significant at 95% confidence level.

3. The seasonal variations of water quality constituent concentrations were not studied because of insufficient data. However, the seasonal average concentrations are presented for several creeks in the Stormwater Quality Modeling report[1].

4. Generally speaking, more frequent baseflow water quality sampling would improve the confidence of this time series analysis. At the City's request, the USGS has increased baseflow sampling frequency to supply this information.

Details of Study

The data used were collected under the USGS/City of Austin Cooperative Monitoring Program[2]. Only baseline or non-storm event data were used. The non-storm event condition is considered to exist when less than 0.05 inch rainfall occurs on the day of data collection, or when less than 0.5 inch or 1 inch rainfall occurs one or two days before the data collection. There are no water quality data for some of the Austin area creeks. For Barton, Bear, Shoal, and Slaughter Creeks, the available data were insufficient for analysis. The data from eight USGS gaging stations (see Table 1) for five creeks were studied. The water quality parameters being considered include biochemical oxygen demand (BOD), fecal coliform (FeCol), total suspended solids (TSS), total dissolved solids (TDS), nitrate nitrogen (NO_3), ammonia nitrogen (NH_3), total

Kjeldahl nitrogen (TKN), total phosphorous (TP), and total organic carbon (TOC).

The SAS[3] statistical computer programs were used for analysis. It is assumed that the data of constituent concentrations or their logarithmic transformations versus time can be fitted to normal regression and correlation models[4] (specifically, normal error regression models and normal correlation model). The models require that all the variables in a regression equation have normal distributions (the independent variable can be a constant). In this connection, the concentration data and their logarithmic transformations for each parameter and for each USGS station were examined for normality. In general, the data can be fitted to log-normal distributions. For some stations, however, the values of TDS, NO_3, NH_3, or TP can be approximated by either normal or log-normal distributions. The goodness of fit to normal distributions is judged by examining the normal probability plot and a test-statistic specified by the SAS program: Shapiro-Wilk W statistic when N __ 50 or Kolomogorov D statistic when N 50, where N is the number of non-missing values.

The logarithms of concentration values for each parameter were regressed on time (years) for examination of trend. The residual plots from the regressions were examined. The residuals or errors are independent from the regressional variables and are normally distributed. The independent variable time, is a known constant (a specific year). Since the dependent variable and the error term in the regression equations are normally distributed, the equations are considered as normal regression and correlation models[4]. Therefore, the regressions and the corresponding correlations can be tested for statistical significance without complexity. The F-distribution and Student's-t tests were used to determine if there are any significant trends.

In designing a statistical test it is customary to choose a level of significance of .05 or .01. In this study a level of 0.05 was chosen for tests of significance on the trend. This means that the probability of a statement concerning a trend being wrong is about 5%, i.e., it is about 95% confident that a statement concerning the trend is right. If a trend is significant at less than the 0.05 level, it must be significant at the 0.05 level. For Williamson Creek at Jimmy Clay Road below Williamson Creek Wastewater Treatment plant discharge, there is a significant increase over time in NH_3 and TKN concentration. The level of significance for the F or Student's -t test is 0.05. For Walnut Creek at Webberville Road, (downstream of areas in the watershed undergoing rapid urbanization) there is an increase in NH_3 concentration at 0.01 significant level. In some cases the increase is significant at a level of close to but greater than 0.05. For example, the increases in NO_3 and TP concentrations for Walnut Creek at Southern Pacific Railroad Bridge, below the Walnut Creek Wastewater Treatment Plant discharge, were significant at the 0.07 level. The increase of TKN for Walnut Creek at Webberville Road is significant at about the 0.06 level. The increases in concentration for other parameters are not significant at the 0.1 level at this time. The results of the study are summarized in Table 1. The graphs of the significant trends are shown in Figures 1-6.

The results of the study are limited by the quantity of data used for analysis. For the period 1975-79, there are sufficient data points - about three or more for each year. However, for the period 1980-83, the data for each year for most constituent parameters are generally less than two. As random sampling is an important factor for statistical analysis, this limited data may bias the results of the study. In order to determine the trends for water quality conditions more conclusively it is suggested that sufficient baseline water quality data be collected during the next three or more years. These data, when combined with the available record, shall provide a data base of longer period with unbiased mean for each year of the period. The USGS has amended its baseline water quality sampling program to include quarterly sampling of all monitored watersheds. These data should supply the basis necessary for establishing water quality trends at higher confidence levels.

References

1. City of Austin, "Stormwater Quality Modeling for Austin Creeks". Prepared by Watershed Management Division, Department of Public Works, November 1984.

2. USGS, "Hydrologic Data for Urban Studies in the Austin, Texas Metropolitan Area", prepared in cooperation with the City of Austin and the Texas Department of Water Resources, 1975-1984.

3. SAS Institute, "SAS User's Guides: Basics and Statistics". Version 5 Edition, Gary, North Carolina, 1985.

4. Neter, J and etc., "Applied Linear Regression Models", Richard D. Irwin, Inc., Homewood, Illinois 60430.

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TABLE 1
Water Quality Data Trend
Analysis for Austin Creeks
(Under Baseflow Condition)

CREEK	Period of data	Water Quality Parameter***								
		BOD	F.Col	TSS	TPS	NO_3	NH_3	TKN	TP	TOC
Boggy at Hwy 183	75-84	NS*	NS	NS	NS	NS	NS	NS	NS	NS
Bull at Loop 360	78-84	NS	NS	NS	NS	NS	NS	NS	NS	NS
Onion near Driftwood	75-84	NS	NS	NS	NS	NS	NS	NS	NS	NS
Onion at Hwy 183	75-84	NS	NS	NS	NS	NS	NS	NS	NS	NS
Walnut at Webberville	76-84	NS	NS	NS	NS	NS	s	S	NS	NS
Walnut at S.P.R.B.	76-84	NS	NS	NS	NS	S	NS	NS	S	NS
Williamson at Oak Hill	75-84	NS	NS	NS	NS	NS	NS	NS	NS	NS
Williamson at Jimmy Clay Rd	75-84	NS	NS	NS	NS	NS	s**	s	NS	NS
All Other Creeks	Various Data Insufficient for Analysis									

* NS means statistically insignificant at 90% confidence level, i.e., no significant change of concentrations during the study period.

** s means statistically significant at 95% or greater confidence level, i.e., significant change in concentration occurred during the study period.

S means statistically significant at 90 to 95 confidence level.

*** All units except FeCol. are mg/l, and FeCol is colony/100ml.

10W01/34/table1

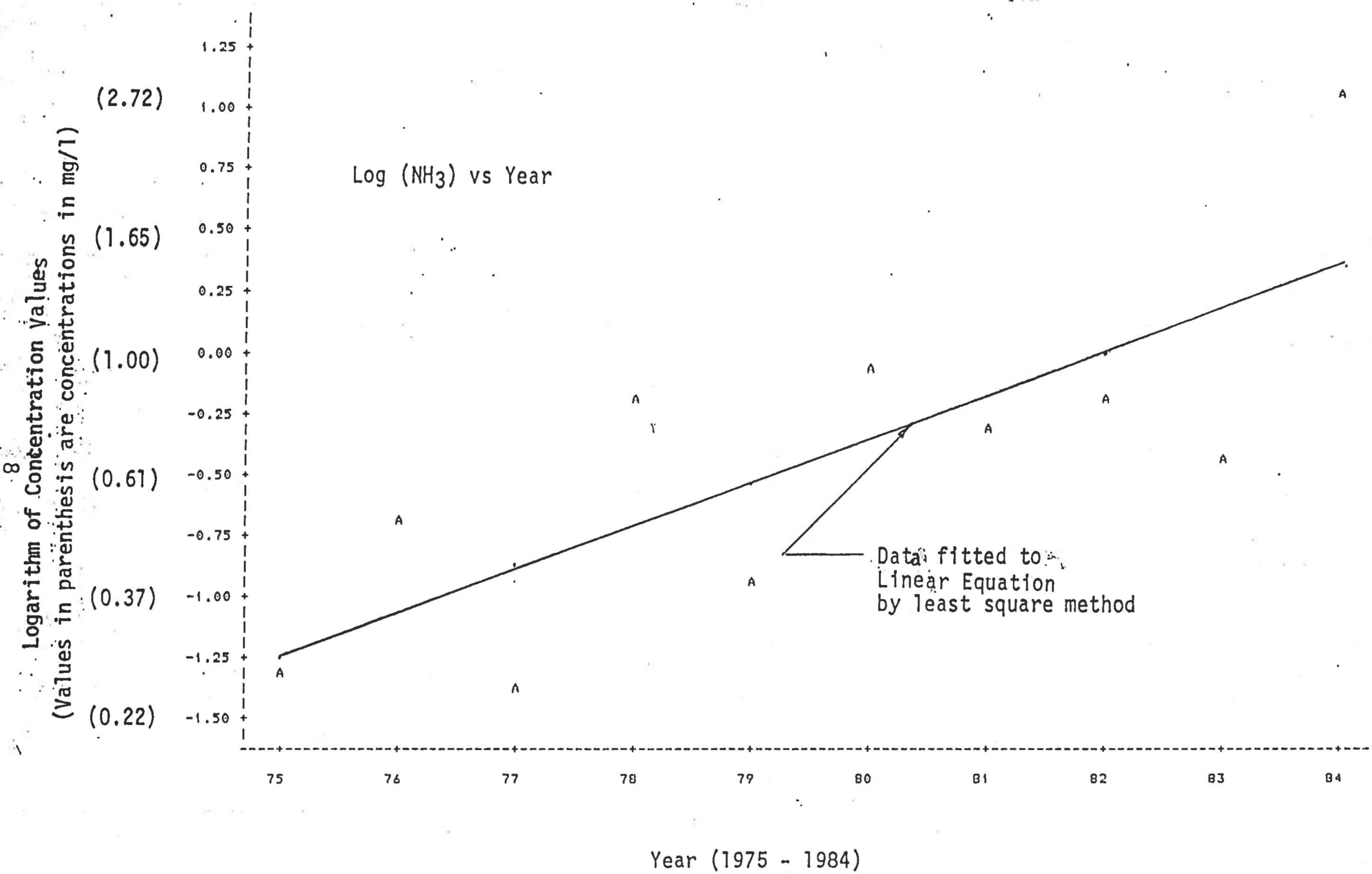

Figure 1. Trend Analysis for NH_3 concentration: Data for Williamson Creek at Jimmy Clay Road

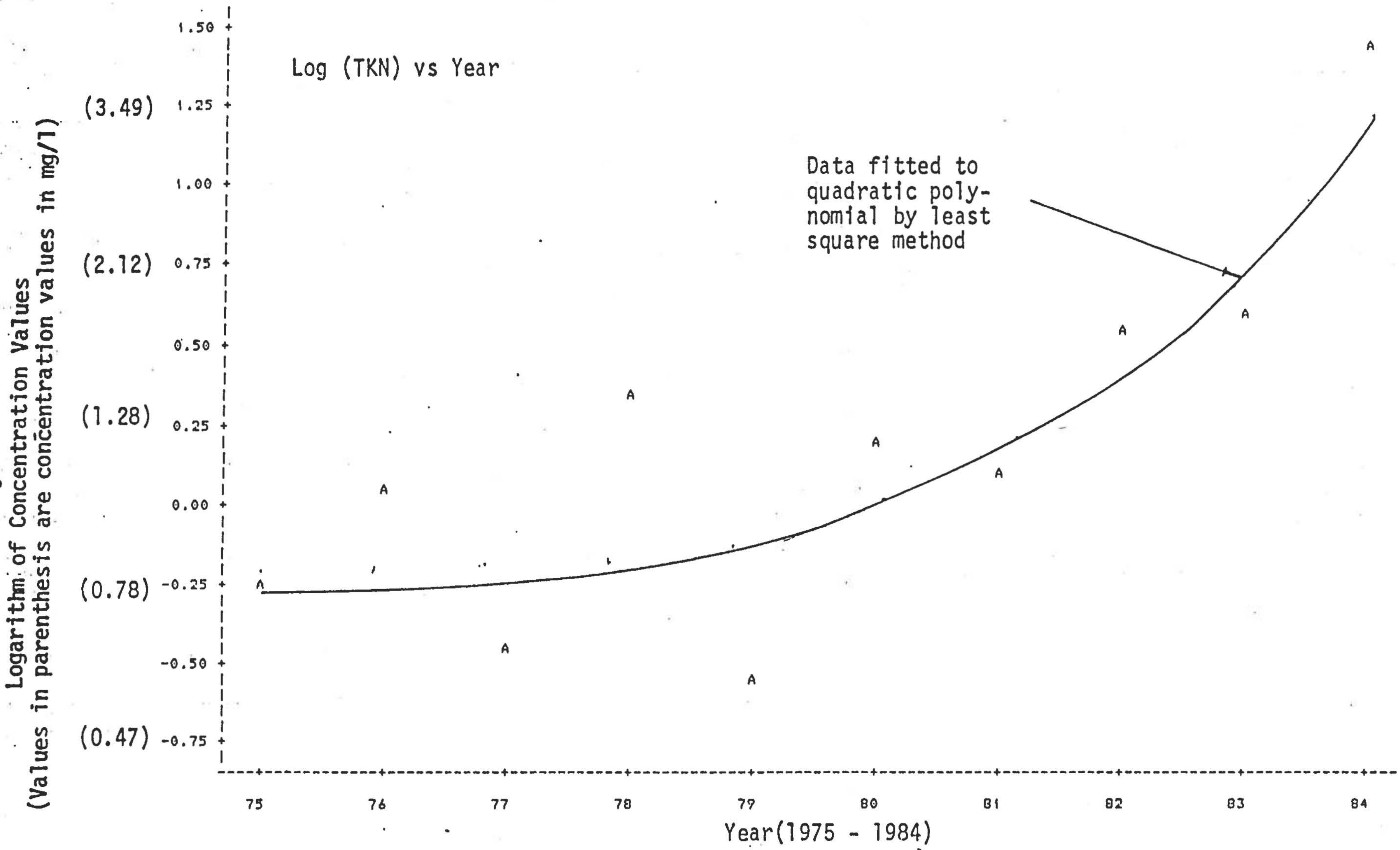

Figure 2. Trend Analysis for TKN Concentration Data for Williamson Creek at Jimmy Clay Road

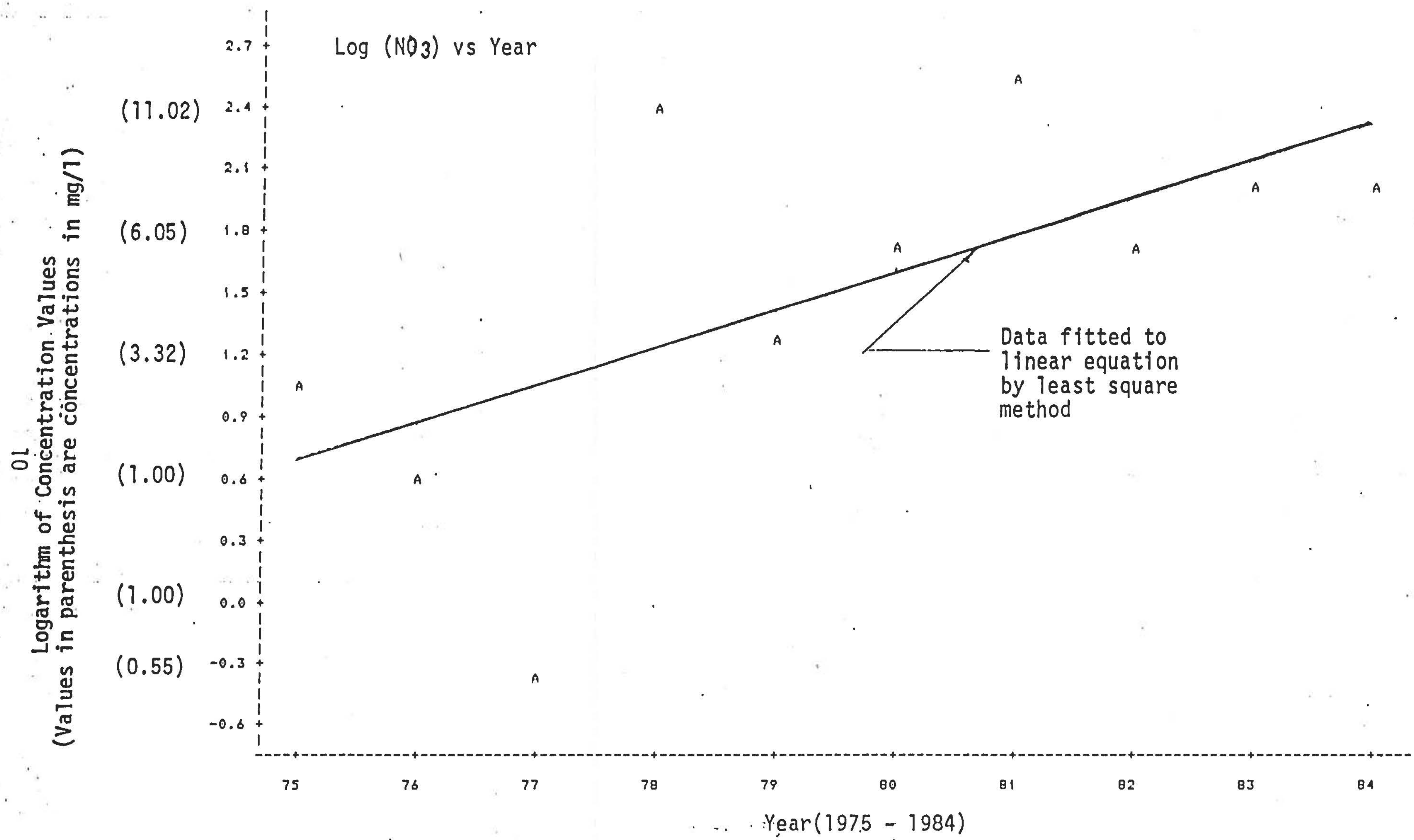

Figure 3. Trend Analysis for NO_3 Concentration Data for Walnut Creek at Southern Pacific Railroad Bridge

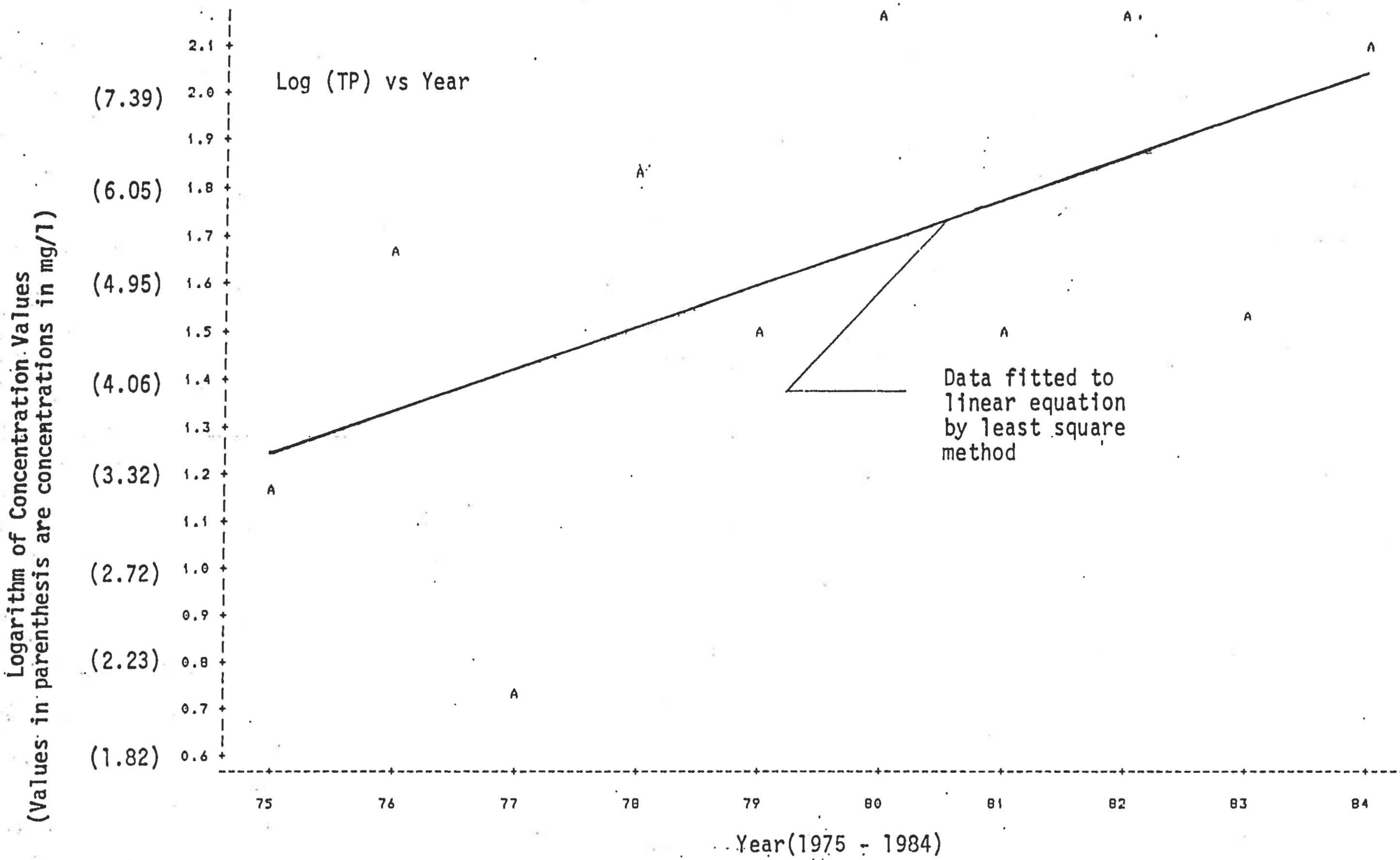

Figure 4. Trend Analysis for TP Concentration Data for Walnut Creek at Southern Pacific Railroad Bridge

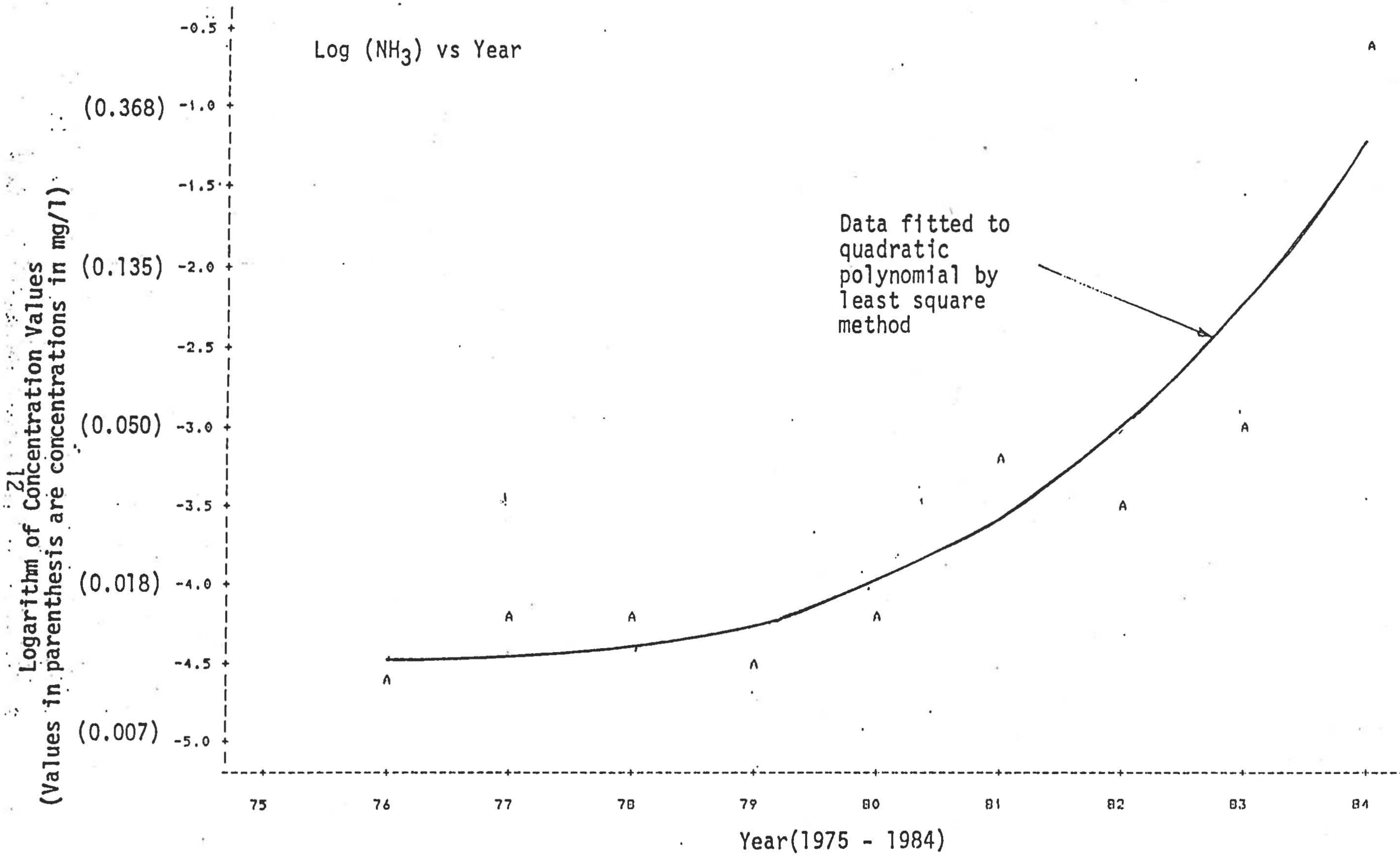

Figure 5. Trend Analysis for NH_3 concentration data for Walnut Creek at Webberville Road

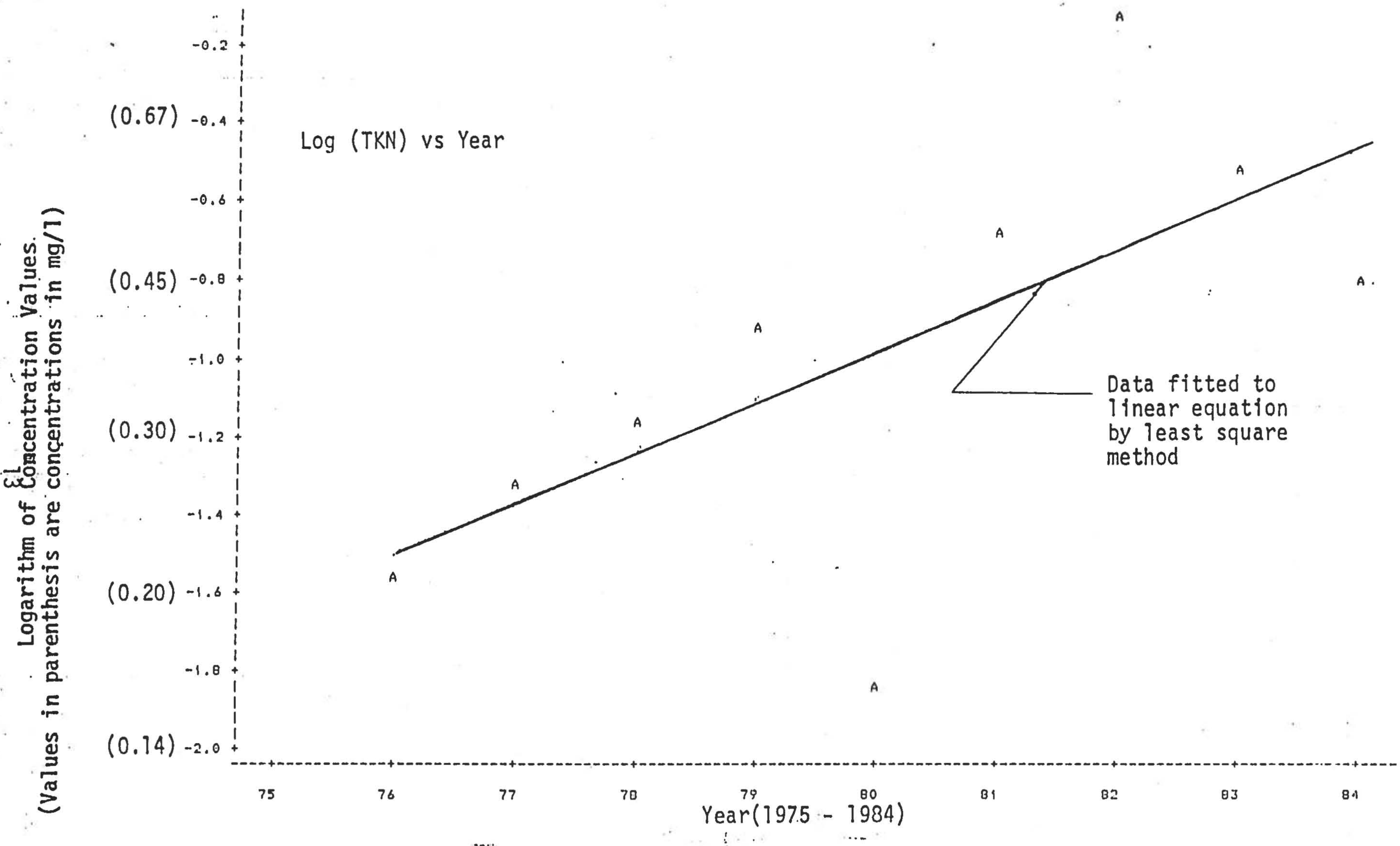

Figure 6. Trend Analysis for TKN Concentration Data for Walnut Creek at Webberville Road