Appendix C: Environmental Engineering - Water Quality Addendum For Chicago Area Waterway Systems (CAWS) Dredged Material Management Plan (DMMP)

April 2020

US Army Corps of Engineers
Chicago District

CHICAGO DEPARTMENT OF TRANSPORTATION

Chicago Area Waterway System (CAWS)
Dredged Material Management Plan (DMMP)

Appendix C: Environmental Engineering – Water Quality Addendum

A. Current Illinois Environmental Protection Agency Water Pollution Control Permit.

B. Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility (CDF), Calumet Harbor, Illinois, Jan. 2011.

C. Chicago Area Confined Disposal Facility (CDF) – Trend Analyses:

1. Chicago Area CDF Data Analysis - 1984 through 2005, Apr. 2006.

2. Chicago Area CDF Data Analysis - 1997 through 2010, Jan. 2011.

3. Chicago Area CDF Data Analysis - 2010 through 2015, Feb. 2016.

D. Recent Maintenance Dredging and Routine Monitoring Reports:

1. Calumet Harbor and River – Water Quality Monitoring Year 2013.

2. Calumet Harbor and River – Water Quality Monitoring Year 2015.

3. Water Quality Monitoring Report for Routine Monitoring Event at Chicago Area Confined Disposal for Water Year 2014.

4. Water Quality Monitoring Report for Routine Mo0nitoring Event at Chicago Area Confined Disposal for Water Year 2016.

Notes:
This water quality addendum is for Appendix C, Environmental Engineering, of the Chicago Area Waterways System (CAWS) Dredged Material Management Plan (DMMP), and it includes the results and analyses of water and sediment samples collected in accordance with the monitoring program for the Chicago Area Confined Disposal Facility (CDF).

The CDF was constructed by the U.S. Army Corps of Engineers (USACE), Chicago District, between 1982 and 1984, and the facility is located south of the entrance channel for the Calumet River in Lake Michigan (Calumet Harbor). The Chicago District performs maintenance dredging to remove the sediment that accumulates within the Calumet Harbor and River Federal navigation channel, and the CDF was constructed for the placement and confinement of the dredged material.

An overview of environmental regulations applicable for CDFs is provided in Section 1.6 of the USACE Upland Testing Manual[1]. The regulations for permits for dredged or fill material are described in Section 404 of the Clean Water Act (CWA), and Section

[1] U.S. Army Corps of Engineers. 2003. "Evaluation of dredged material proposed for disposal at island, nearshore, or upland confined disposal facilities - Testing Manual," Technical Report ERDC/EL TR-03-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

404(b)(1) explains that placement sites are to be specified through the application of environmental guidelines, which are provided in Title 40 of the Code of Federal Regulations (CFR), Part 230 (40 CFR 230).

The Illinois Environmental Protection Agency (Illinois EPA) regulates the Chicago Area CDF through a five (5)-year Water Pollution Control Permit, and the current permit, Number 2016-EO-60898, was issued to the USACE, Chicago District, on June 7, 2016 and is set to expire on May 31, 2021. The Illinois EPA permit has been included in Section A, at the beginning of this addendum.

The above-mentioned permit contains seven (7) Special Conditions, and Special Condition 2 directs the Chicago District to monitor the Chicago Area CDF in accordance with the Corps of Engineers report entitled Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility [CDF], Calumet Harbor, Illinois, January 2011 and as modified by Tables 1, 2, and 3 of this Special Condition. Although the title of the Corps of Engineers report cited in Special Condition 2 implies it is the “proposed” sampling plan, this plan was reviewed by the Illinois EPA and is the current sampling plan. The Corps of Engineers report (sampling plan) cited by Special Condition 2 is provided in Section B of this addendum, immediately after the Illinois EPA permit. The sampling plan was developed to monitor the water quality in the vicinity of the CDF and help evaluate whether the CDF might be causing adverse impacts to the quality of the surrounding water in Calumet Harbor and/or the Calumet River.

Special Condition 4 of the Illinois EPA permit requires the USACE, Chicago District, to provide a report containing the data from the beginning of the project to the time of the next permit renewal submission in the application for renewal of the permit. The purpose of the report is to analyze the data and show historical trends for the parameters tested. Section C of this addendum includes three (3) trend analyses; the first analysis includes the data from 1984 through 2005, the second analysis includes the data from 1997 through 2010, and the third analysis includes the data from 2010 through 2015.

Section D of this addendum contains recent maintenance dredging and routine water quality monitoring reports. The data received from the laboratory have been summarized in these reports, but, in order to reduce the file size and avoid problems with downloading and reading this addendum, the appendix that contains the actual laboratory reports and associated quality control data were not included. Due to the large amount of information, the actual laboratory reports and associated quality control data, or other maintenance dredging and routine water quality monitoring reports, will be provided upon request.

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION CONTROL PERMIT

LOG NUMBERS: 2016-60898

PERMIT NO.: 2016-EO-60898

FINAL PLANS, SPECIFICATIONS, APPLICATION AND SUPPORTING DOCUMENTS
PREPARED BY: Corps of Engineers Chicago District

DATE ISSUED: June 7, 2016

SUBJECT: Corps of Engineers Chicago District- Chicago Area Confined Disposal Facility

PERMITTEE TO OWN AND OPERATE

Corps of Engineers Chicago District
231 South LaSalle Street, Suite 1500
Chicago, IL 60604-1437

Permit is hereby granted to the above designated permittee(s) to operate water pollution control facilities described as follows:

The facilities include a 43 acre confined disposal facility (CDF) for dredged material from the Chicago area including Calumet River and Harbor. The two settling basins, north and south, have a combined capacity of approximately 1.45 million gallons. Water from the settling basins is pumped to two (2) 34 foot diameter dual media filter cells and is discharged to the Calumet River.

This permit renews and replaces Permit No. 2011-EA-1347 which was previously issued for the herein permitted facility.

This operating permit expires on May 31, 2021.

This permit is issued subject to the following Special Condition(s). If such Special Condition(s) require(s) additional or revised facilities, satisfactory engineering plan documents must be submitted to this Agency for review and approval for issuance of a Supplemental Permit.

SPECIAL CONDITION 1: A pump with a capacity of 500 gallons per minute shall be used during mechanical dredging operations to carry wastewater to the filter cells in order to reduce the volume of liquids in the CDF in direct proportion to the incoming sediment and wastewater volume during dredging and disposal events. During hydraulic dredging operations a pump with a capacity of 2,250 gallons per minute shall be used to carry wastewater to the filter cells in order to reduce the volume within the CDF in direct proportion to the incoming sediment and wastewater volume during dredging and disposal events. Pumping to the filter cells is not required during minor dredging events equal to or less than 2,000 cubic yards when the mechanically dredged material is placed upland and out of the liquid contents of the CDF.

SPECIAL CONDITION 2: Monitoring shall be conducted in accordance with the Corps of Engineers report entitled "Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, Illinois, January 2011 and as modified by Tables 1, 2, and 3 of this Special Condition. In accordance with Section 4 of the above cited document, the permittee shall monitor:

THE STANDARD CONDITIONS OF ISSUANCE INDICATED ON THE REVERSE SIDE MUST BE COMPLIED WITH IN FULL. READ ALL CONDITIONS CAREFULLY.

SAK: DRG:2016-60898_State Permit_10Mar16.docx

cc: IEPA, DWPC, FOS, DesPlaines
Records
DRG

BUREAU OF WATER

Alan Keller, P.E.
Manager, Permit Section
Division of Water Pollution Control

i) For mechanical dredging, the parameters in the first part of Table 2 and all the parameters in Table 3, except for PCBs;

ii) For hydraulic dredging, all the parameters in Table 2 and Table 3, except PCBs;

iii) For dredged material from the Chicago River that is disposed at the Chicago Area CDF, the permittee shall monitor for polychlorinated Biphenyls (PCBs) in addition to parameters specified by dredging method in item i or ii above; and

iv) At least once during each calendar year when no dredging occurs, all parameters in Table 1. Monitoring shall include at least one of the wells CH-18-81 or CH-19-81.

Table 1: Current Routine (Annual) Monitoring Parameters for Non-Dredging Years

Parameter	Required Reporting Limit, mg/L unless otherwise noted
Chromium (Total)	0.005
Manganese	0.005
Zinc (Total)	0.005
Ammonia as Nitrogen	0.01
Total Kjeldahl Nitrogen	0.2
(Total) Phosphorus	0.005
Total Suspended Solids	1.0
Total Dissolved Solids	1.0
Temperature	±0.1° C
pH	±0.01 units

Table 2: Current Dredging Water Quality Monitoring Parameters

Parameter	Required Reporting Limit, mg/L unless otherwise noted
Chromium (Total)	0.005
Manganese	0.005
Zinc (Total)	0.005
Ammonia as Nitrogen	0.01
Total Kjeldahl Nitrogen	0.2
(Total) Phosphorus	0.005
Total Suspended Solids	1.0
Total Dissolved Solids	1.0
Temperature	±0.1° C

pH	±0.01 units
Total PCBs	0.1 μg/L

Table2: Additional Hydraulic Dredging Parameters	
Arsenic (Total)	0.01
Barium (Total)	0.1
Cadmium (Total)	0.0015
Copper (Total)	0.01
Cyanide (Total)	0.005
Lead (Total)	0.005
Mercury (Total)*	0.0002 μg/L
Nickel (Total)	0.025
Oil & Grease	1
Dissolved Oxygen	±0.1
Hardness	2

* Low-Level Mercury by method 1631.

Table 3: Sediment Grab Sample Monitoring Parameters During Dredging

Parameter	Required Reporting Limit, mg/Kg unless otherwise noted
Arsenic (Total)	1
Barium (Total)	5
Cadmium (Total)	1
Chromium (Total)	1
Copper (Total)	2.5
Lead (Total)	5
Mercury (Total)*	0.02
Manganese (Total)	5
Nickel (Total)	5
Zinc (Total)	2
Total Solids (%)	1%
Total Volatile Solids (%)	1%
Cyanide	0.2
Chemical Oxygen Demand	100
Ammonia Nitrogen	0.5
Oil & Grease	10
Total Phosphorus	1
Total PCBs	0.01
Total Organic Carbon	100

SPECIAL CONDITION 3: Reports of all analytical results shall be submitted to the Illinois EPA on a monthly basis for hydraulic dredging operations and on an annual basis for mechanical dredging operations.

SPECIAL CONDITION 4: A report containing data from the beginning of the project to the time of the next permit renewal submission shall be provided in the application for the renewal of the permit. The permittee shall provide an analysis of these data showing trends for the parameters tested. A separate analysis of the current permit data shall be provided in addition to the historical analysis. All data will be accounted for and correlated with locations currently used (i.e., BACK 1, 2, 3, ND 1, 2, 3, RIV 1, 2, 3, CDF 1, 2, 3, and CH 18, 19, 20, etc.).

SPECIAL CONDITION 5: Upon completion, the site shall be covered with a five (5) foot thick clay and topsoil cap, graded to drain, and seeded and mulched to prevent erosion. Any alternative cover including use of dredged material will require modification of this permit and review of supporting documentation that such use will not cause water pollution or impact to health and environment.

SPECIAL CONDITION 6: For minor dredging events of 2,000 cubic yards or less of mechanically dredged material, one pre-dredging sampling event and one during dredging sampling event shall be conducted. Such sampling shall be at the locations and for the parameters indicated in Special Condition No. 2 except filter cell and CDF pond sampling will not be required.

i) If the mechanically dredged material is placed by truck directly in the CDF, no rehandling area sampling will be required. TSS monitoring shall be conducted for minor mechanical dredging events of less than 2,000 cubic yards instead of turbidity measurements.

ii) In years when a minor dredging event of 2,000 cubic yards or less occur, no separate annual monitoring event is required.

iii) The minor dredging event shall be reported in accordance with the permit Special Conditions 3 and 4.

SPECIAL CONDITION 7: The three CDF pond sample sites, CDF-001, CDF-002, and CDF-003 have been relocated to the south basin cell. Future reports shall include the location of the three CDF pond sample points on a map.

READ ALL CONDITIONS CAREFULLY:
STANDARD CONDITIONS

The Illinois Environmental Protection Act (Illinois Revised Statutes Chapter 111-12. Section 1039) grants the Environmental Protection Agency authority to impose conditions on permits which it issues.

1. Unless the construction for which this permit is issued has been completed, this permit will expire (1) two years after the date of issuance for permits to construct sewers or wastewater sources or (2) three years after the date of issuance for permits to construct treatment works or pretreatment works.

2. The construction or development of facilities covered by this permit shall be done in compliance with applicable provisions of Federal laws and regulations, the Illinois Environmental Protection Act, and Rules and Regulations adopted by the Illinois Pollution Control Board.

3. There shall be no deviations from the approved plans and specifications unless a written request for modification of the project, along with plans and specifications as required, shall have been submitted to the Agency and a supplemental written permit issued.

4. The permittee shall allow any agent duly authorized by the Agency upon the presentations of credentials:

   a. to enter at reasonable times, the permittee's premises where actual or potential effluent, emission or noise sources are located or where any activity is to be conducted pursuant to this permit;

   b. to have access to and copy at reasonable times any records required to be kept under the terms and conditions of this permit;

   c. to inspect at reasonable times, including during any hours of operation of equipment constructed or operated under this permit, such equipment or monitoring methodology or equipment required to be kept, used, operated, calibrated and maintained under this permit;

   d. to obtain and remove at reasonable times samples of any discharge or emission of pollutants;

   e. to enter at reasonable times and utilize any photographic, recording, testing, monitoring or other equipment for the purpose of preserving, testing, monitoring, or recording any activity, discharge, or emission authorized by this permit.

5. The issuance of this permit:

   a. shall not be considered as in any manner affecting the title of the premises upon which the permitted facilities are to be located;

   b. does not release the permittee from any liability for damage to person or property caused by or resulting from the construction, maintenance, or operation of the proposed facilities;

   c. does not release the permittee from compliance with other applicable statutes and regulations of the United States, of the State of Illinois, or with applicable local laws, ordinances and regulations;

   d. does not take into consideration or attest to the structural stability of any units or parts of the project;

   e. in no manner implies or suggests that the Agency (or its officers, agents or employees) assumes any liability, directly or indirectly, for any loss due to damage, installation, maintenance, or operation of the proposed equipment or facility.

6. Unless a joint construction/operation permit has been issued, a permit for operating shall be obtained from the agency before the facility or equipment covered by this permit is placed into operation.

7. These standard conditions shall prevail unless modified by special conditions.

8. The Agency may file a complaint with the Board for suspension or revocation of a permit:

   a. upon discovery that the permit application contained misrepresentations, misinformation or false statement or that all relevant facts were not disclosed; or

   b. upon finding that any standard or special conditions have been violated; or

   c. upon any violation of the Environmental Protection Act or any Rules or Regulation effective thereunder as a result of the construction or development authorized by this permit.

Proposed Water Quality Monitoring
at the Chicago Area Confined Disposal Facility,
Calumet Harbor, Illinois
January 2011

1. Purpose

Since the construction of the Chicago Area confined disposal facility (CDF) in 1982 – 1984, the U.S. Army Corps of Engineers (USACE), Chicago District has collected water quality samples in the vicinity of the CDF in order to monitor the CDF's impact on water quality in the harbor. Based on the data collected to date, and presented in "Chicago Area Confined Disposal Facility Data Analysis, 1997 through 2010", January 2011, a statistical analysis indicates the CDF is not impacting water quality in Lake Michigan or the Calumet River. In addition, more than 25 years of routine and dredging event monitoring, presented in annual reports, have not indicated short-term or dredging event based impacts. This document summarizes the historical water quality sampling program for the Chicago CDF, and details a modified sampling plan that will better serve the needs of all agencies while still protecting the water resources near the CDF.

2. Background

The Chicago Area CDF is a diked facility for the placement and containment of contaminated dredged materials from the deep-draft federal navigation projects in Chicago, Illinois. The Chicago Area CDF is an in-water structure specifically designed to receive the dredged materials and to prevent their reentry into the harbor. The CDF was constructed in 1982-1984 and is located in Calumet Harbor, adjacent to the Iroquois Landing port terminal and north of Calumet Park. The facility is maintained and operated by USACE, Chicago District, under the authority of Public Law 91-611, Section 123.

Since the construction of the CDF, the USACE, Chicago District has monitored water quality in the vicinity of the facility in compliance with Section 401 water quality certification requirements and the applicable Illinois Environmental Protection Agency (IEPA) water pollution control permit. The current permit, number 2006-EA-0864, was issued November 9, 2006, and it expires November 1, 2011. The modified water quality monitoring plan detailed below is proposed for the permit renewal.

3. Historical Water Quality Monitoring in Calumet Harbor

Historically, there have been two distinct schedules for water quality monitoring in conjunction with the Chicago Area CDF; routine monitoring and dredging event monitoring. For dredging event monitoring, the sampling program is intensified because dredging and disposal events present the greatest opportunity for impact to the water quality of Calumet Harbor. The specifics of the routine and dredging event monitoring are discussed in the following subsections:

3.1 Routine Water Quality Monitoring

The current schedule for routine monitoring is that one sampling event per year is performed; only during non-dredging years. Monitoring includes sampling from a minimum of one well on Iroquois Landing, samples from Lake Michigan, composite samples from just outside the CDF dikes (in Lake Michigan), samples from the Calumet River in the vicinity of the CDF filter cell discharge point, and samples from within the CDF pond. The parameters for monitoring include: chromium, manganese, zinc, ammonia nitrogen, total phosphorus, Total Kjeldahl Nitrogen (TKN), pH, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS). Ground water elevation data are also collected. Figure 1 shows the current sampling locations.

3.2 Dredging Event Water Quality Monitoring

The dredging event water quality monitoring is conducted in order to establish the water quality before, during, and after the dredging event. The current schedule for dredging monitoring is that water quality samples are collected twice per week during the week before dredging starts and during the week after dredging is finished. In addition, while dredging operations are in progress, samples are collected on a once-per-week schedule. Samples are collected at the same monitoring points shown in Figure 1. Additional TSS monitoring is conducted during dredging, and those locations are shown in Figure 2.

To provide a real time comparison that allows for faster implementation of dredging operation modifications, USACE, Chicago District has been performing turbidity monitoring in lieu of the TSS samples that have been historically collected. Since 2006, a Hydrolab®, or similar equipment with a nephelometric turbidity meter, has been used for monitoring. Turbidity values are measured at each location and depth once per week and the values recorded in NTUs. Turbidity measurements are also taken once a week at the rehandling area. At the start of a dredging operation, concurrent nephelometric measurements and grab samples for laboratory TSS analysis are collected to provide a correlation between the turbidity meter results and laboratory suspended solids results. The correlation samples are taken during the week of pre-dredging monitoring and during the first week of dredging operations.

The parameters monitored during dredging include all of the routine monitoring parameters, plus arsenic, cadmium, copper, cyanide, lead, mercury, nickel, oil and grease, temperature, dissolved oxygen, and hardness. Reporting limits for the routine and dredging event monitoring parameters are given in Tables 1 and 2.

A sediment grab sample is collected from the dredging barge on a weekly basis during dredging and analyzed for the parameters listed in Table 3.

3.3 Summary of Results from Past Monitoring

A report titled "Chicago Area Confined Disposal Facility Data Analysis, 1997 through 2010", January 2011, presents a trend analysis and statistical comparison of data collected at the various sampling locations, during both routine and dredging event monitoring. There are some trends in the water quality data over time, and it is evident that the water quality within the CDF is

becoming worse as the CDF has filled with sediment. However, the Lake Michigan and Calumet River monitoring locations do not show the same trends, and the data indicate the CDF is not causing the degradation of water quality near the CDF over time.

In general, the samples collected from Iroquois Landing have not shown obvious trends, and the groundwater quality below Iroquois Landing has been variable, but typically poor due to past lakefill activities. The existing wells have been in use for more than 25 years, and they are in fair to poor condition. The poor quality of the Iroquois Landing groundwater is not a result of CDF operation; water level data indicate that the direction of groundwater flow is from Iroquois Landing toward Lake Michigan (toward the CDF). Overall, the individual monitoring well data showed different trends, and the trend analysis did not indicate the CDF was impacting the groundwater.

Table 1: Current Routine (Annual) Monitoring Parameters for Non-Dredging Years

Parameter	Required Reporting Limit, mg/L unless otherwise noted
Chromium (Total)	0.005
Manganese	0.005
Zinc (Total)	0.005
Ammonia as Nitrogen	0.01
Total Kjeldahl Nitrogen	0.2
(Total) Phosphorus	0.005
Total Suspended Solids	1.0
Total Dissolved Solids	1.0
Temperature	$\pm 0.1^{o}C$
pH	±0.01 units

Figure 1: Current Chicago Area CDF Monitoring Locations

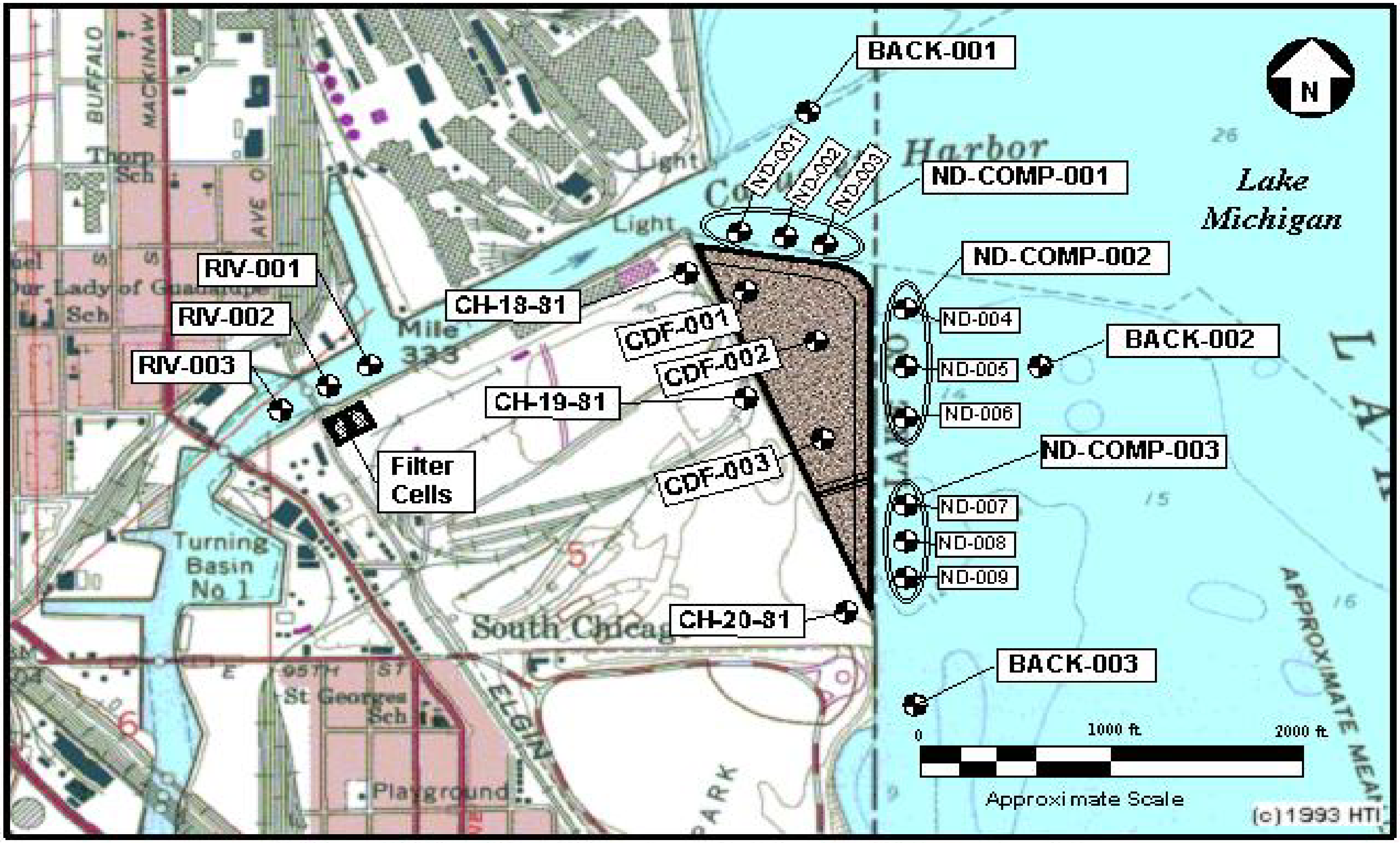
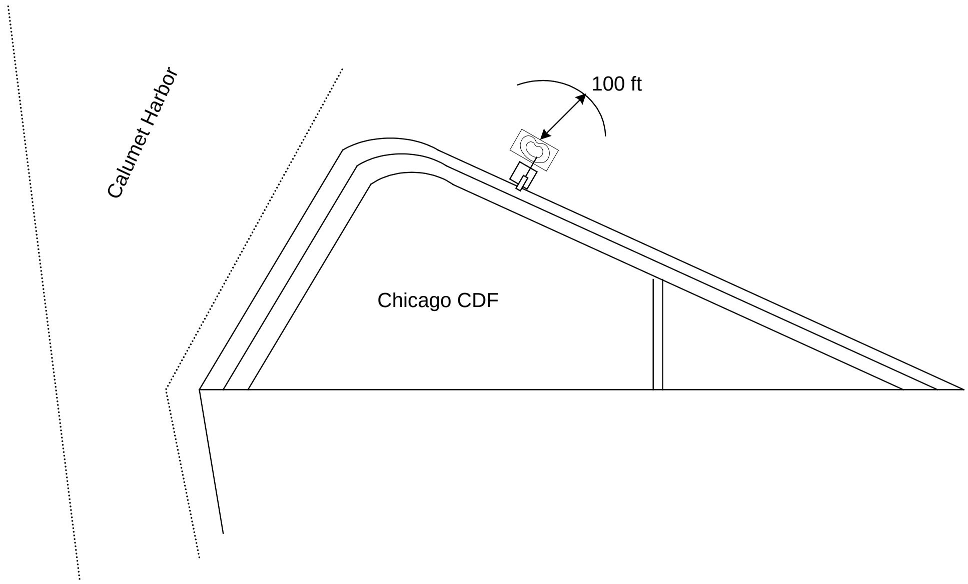
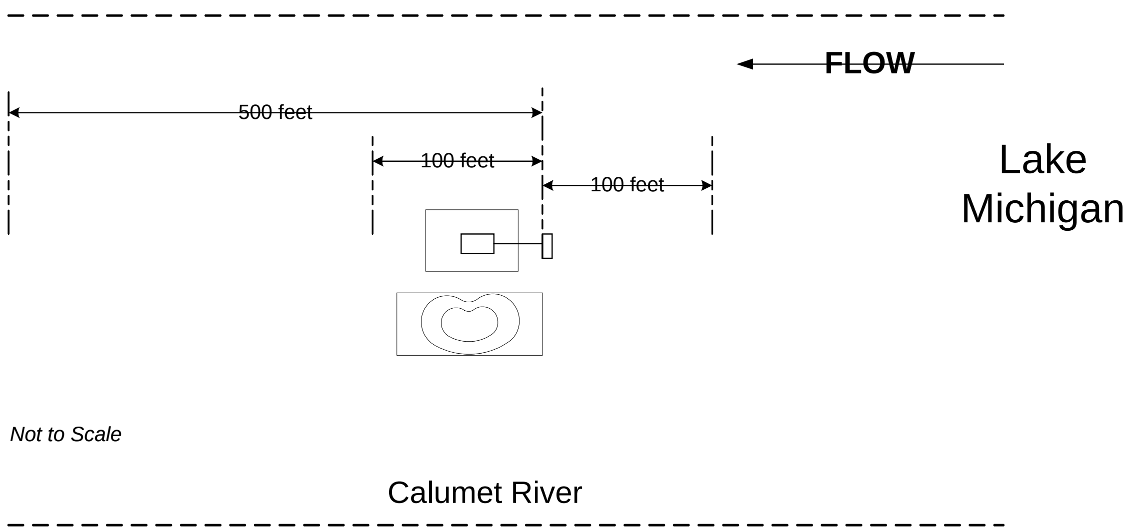


Figure 2: Event Suspended Solids Monitoring Locations



a. Rehandling area



b. Dredging operation

Table 2: Current Dredging Water Quality Monitoring Parameters

Parameter	Required Reporting Limit, mg/L unless otherwise noted
Chromium (Total)	0.005
Manganese	0.005
Zinc (Total)	0.005
Ammonia as Nitrogen	0.01
Total Kjeldahl Nitrogen	0.2
(Total) Phosphorus	0.005
Total Suspended Solids	1.0
Total Dissolved Solids	1.0
Temperature	±0.1^{o}C
pH	±0.01 units
Total PCB	0.1 µg/L
Additional Hydraulic Dredging Parameters	
Arsenic (Total)	0.01
Barium (Total)	0.1
Cadmium (Total)	0.005
Copper (Total)	0.01
Cyanide (Total)	0.005
Lead (Total)	0.005
Mercury (Total)*	0.0002 µg/L
Nickel (Total)	0.025
Oil & Grease	1
Dissolved Oxygen	±0.1
Hardness	2

*Low-level Mercury by method 1631.

Table 3: Sediment Grab Sample Monitoring Parameters During Dredging

Parameter	Required Reporting Limit, mg/Kg unless otherwise noted
Arsenic (Total)	1
Barium (Total)	5
Cadmium (Total)	1
Chromium (Total)	1
Copper (Total)	2.5
Lead (Total)	5
Mercury (Total)	0.02
Manganese (Total)	5
Nickel (Total)	5
Zinc (Total)	2
Total Solids (%)	1%
Total Volatile Solids (%)	1%
Cyanide	0.2
Chemical Oxygen Demand	100
Ammonia Nitrogen	0.5
Oil & Grease	10
Total Phosphorus	1
Total PCBs	0.05
Total Organic Carbon	100

4. Proposed Sampling Plan

The proposed sampling plan is a modification of the 1997 monitoring plan, which provides the basis for data collection. Monitoring during dredging operations will continue, as described below, since dredging events represent the greatest opportunity for impact to the water quality in and around the Calumet Harbor. In addition, routine monitoring will continue to be performed for one event per year; only during non-dredging years.

Presently, there is only a small amount of water remaining in the primary settling basin in the northern portion of the CDF due to the additional placement of dredged material into the facility. Consequently, in the future, it is proposed that the sample locations that have historically been in the primary settling basin be moved to the secondary settling basin in the southern portion of the facility. The filter cell influent and effluent would continue to be monitored (sample locations designated as CH-00-02 and CH-00-03, respectively) during dredging operations when water is being discharged from the filter cell to the Calumet River. The filter cell influent would provide data on the water quality inside the CDF. Figure 3 shows the proposed Chicago Area CDF monitoring locations.

A minimum of one of the Iroquois Landing wells will continue to be monitored. The monitoring well at location CH-20-81 was inadvertently buried and possibly damaged during the construction of a new fence around the perimeter of the Chicago Port District property. Although the USACE, Chicago District will attempt to find and possibly repair this well, it is likely that monitoring well location CH-20-81 will not be sampled in the future. In addition, the monitoring well at location CH-19-81 is in poor condition, so sampling from this well is unreliable. The monitoring well at location CH-18-81 is presently the only monitoring well that remains in fair condition, and the USACE, Chicago District anticipates a minimum of one well on Iroquois Landing will be sampled.

4.1 Dredging Monitoring: Lake Michigan, in CDF, River, and Landing Well Monitoring

A comprehensive sampling program would be implemented during dredging events. The sampling locations shown in Figure 3 would be sampled according to the frequency described below:

1. During the week before dredging starts and during week after the dredging event is finished, water quality samples would be collected twice per week, and,
2. While dredging, samples would be collected on a once-per-week schedule.

For the monitoring wells, a minimum of one of the Iroquois Landing wells will be monitored, and the filter cell influent and effluent would continue to be monitored (sample locations designated as CH-00-02 and CH-00-03, respectively) during dredging operations when water is being discharged from the filter cell to the Calumet River.

All of the samples would be analyzed for the comprehensive list of contaminants and water quality parameters listed in Table 2. Total PCB measurements would also be made when dredging occurs in the Chicago River with the dredged material placed in the Chicago Area CDF, and additional metals would be monitored during hydraulic dredging.

The above proposed monitoring during dredging events covers the requirements for annual monitoring. During years when a dredging event occurs, there will not be an annual (routine) monitoring event. During non-dredging years, monitoring will be as described in Section 4.4.

4.2 Dredging Monitoring: Near Dredge and Rehandling Area Suspended Solids Monitoring

The three sampling stations around the dredging operation are: 100 feet upstream, 100 feet downstream, and 500 feet downstream of the centerline of the dredge (see Figure 2). The upstream samples are collected to establish background suspended solids concentrations in the river. As the dredge relocates to different stations, the sampling locations remain the same in relation to the dredge and the flow of the river. Samples are collected at the surface and mid-depth of the water column, at the distances from the dredging operation shown in Figure 2.

The purpose of the suspended solids monitoring is to ensure that dredging operations are not causing excessive turbidity and solids resuspension. The suspended solids monitoring is a relative comparison of the background and near dredge conditions. USACE, Chicago District

will continue to perform turbidity monitoring in lieu of the TSS samples that have been historically collected, as explained earlier.

4.3 Dredging Monitoring: Sediment Sampling

A sediment grab sample will be taken from the dredging barge on a weekly basis during dredging. The sediment would be analyzed for the parameters listed in Table 3.

4.4 Annual (Routine) Monitoring

During non-dredging years, one routine monitoring event will be conducted. Monitoring locations are shown in Figure 3. A minimum of one of Iroquois Landing wells will continue to be monitored. It is anticipated that monitoring location CH-19-81 may need to be discontinued due to the poor condition of the well. The parameters for the routine monitoring are given in Table 1.

4.5 Proposed Reporting

For mechanical dredging operations, a report documenting the results of the dredging event monitoring would be submitted to IEPA on an annual basis during years in which dredging occurs. For hydraulic dredging operations, analytical results would be submitted to IEPA on a monthly basis. For non-dredging years, a report documenting the results of the annual monitoring event would be submitted to IEPA.

5. Summary of the New Sampling Program

The proposed sampling plan will continue to ensure water quality information is collected during the times when the water is most likely to be impacted; during dredging. Maintaining essentially the same monitoring locations and parameters will help assure that the data are comparable to past results. Basically, this proposed water quality monitoring plan is nearly identical to the plan proposed in 2006. However, due to the additional placement of dredged material into the facility, there is only a small amount of water remaining in the primary settling basin in the northern portion of the CDF. Consequently, it is necessary to propose that the monitoring locations that have historically been in the primary settling basin be moved to the secondary settling basin in the southern portion of the facility. The current plan also notes that one of the Iroquois Landing monitoring well locations, CH-20-81, was inadvertently buried or damaged. Consequently, it is unlikely that this well will be monitored in the future.

Figure 3: Proposed Chicago Area CDF Monitoring Locations

Enclosure 1

CHICAGO AREA CONFINED DISPOSAL FACILITY
DATA ANALYSIS
1984 through 2005

US Army Corps of Engineers, Chicago District
111 N. Canal, Suite 600
Chicago, Illinois

April 2006

Table of Contents

Tables

Figures

Introduction

The US Army Corps of Engineers (USACE), Chicago District operates the Chicago Area Confined Disposal Facility (CDF) under the Illinois Environmental Protection Agency (IEPA) Water Pollution Control Permit No. 2001-EA-4691, dated December 7, 2001 (Appendix A). The permit renews and replaced Permit No. 1997-EA-3213 and expires December 1, 2006. The permit provides Standard Conditions, and is also subject to Special Conditions. Special Condition 2 states "Monitoring shall be conducted in accordance with the [USACE] report entitled 'Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, IL', submitted as part of the February 6, 1997 application." A copy of the current permit, including the monitoring plan, is included in Appendix A.

Purpose

The purpose of this report is to comply with Special Condition 4 of the current operating permit: "A report containing data from the beginning of the project to the time of the next permit renewal submission shall be provided in the application for the renewal of the permit. The permitee shall provide an analysis of these data showing trends for the parameters tested. All data will be accounted for and correlated with locations currently used." This report includes a discussion of the data collected and a trend analysis for those data.

Project Description

The Chicago Area confined disposal facility (CDF) is a diked facility for the disposal and containment of dredged sediment from the deep-draft federal navigation projects in Chicago, Illinois. The Chicago Area CDF is an in-water structure designed to receive dredged materials and to prevent the reentry of material or residuals into the Calumet River or Harbor or into Lake Michigan. The CDF was constructed in 1982-1984, and is located in Calumet Harbor, adjacent to the Iroquois Landing port terminal and north of Calumet Park. The facility is operated and maintained by USACE, Chicago District under the authority of Public Law 91-611, Section 123. Since the construction of the CDF, USACE Chicago District has monitored water quality in the vicinity of the facility in compliance with the applicable IEPA Water Pollution Control Permit.

Figures 1 and 2 show the CDF vicinity and facility. The general operation of the CDF is for dredged material including entrained water to be placed mechanically, via trucks or cranes, into the CDF. As the material settles, water is drained through filter cells and discharged into the Calumet River downstream from Lake Michigan. The dredged material remains in the CDF; since the CDF is still operating, the sediment is uncovered. Water in the form of rain or snow can enter the CDF. During large storms, waves from Lake Michigan may also overtop the dike crest. As documented in the annual water quality reports (see references), the water level in the CDF fluctuates with the Lake

Michigan water level. Any drainage of water from the CDF is through the filter cells; the filter cell influent and effluent is monitored during discharges. The filter cells are typically only operated during dredging operations. Dredging operations occur periodically, when shoaling causes navigational problems. The CDF has remaining capacity, and it is anticipated that the facility will continue to be used for dredged materials from the Calumet River and Harbor and the Chicago River and Harbor for a number of years.

The Chicago Area CDF was constructed from dikes of limestone with a synthetic liner placed over the core of the dikes on the inside face, and larger stone as a cover to protect against wave action. Adjacent to the CDF dikes on the west side is Iroquois Landing. Iroquois Landing is part of the Chicago Regional Port District property. In 1982-1984, when the CDF was constructed, the southern half of the property was an on-going landfill operation for municipal and steel mill industrial solid wastes. Iroquois Landing was constructed on a landfill composed of slag, cinders, ash, and foundry sand. There is also coal, earth, wood, iron and steel, and miscellaneous material distributed through the blast furnace and foundry wastes. The landing is relatively impermeable (water ponds readily on the surface following rainfalls), and does not support vegetation. It is likely that in the poorly sorted and highly varied landfill material a continuous water table does not exist. The perched groundwater at Iroquois Landing reflects the varied characteristics of the fill material.

Water Quality Monitoring Plan

The Chicago Area CDF water quality monitoring plan includes routine monitoring and monitoring during dredging events. The water quality monitoring plan was modified in 1997 with the renewal of the IEPA Water Pollution Control Permit, as detailed in the USACE document "Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, IL". The plan sample locations, parameters, and schedule were revised to provide a standardized and more meaningful and cost-effective data set, and allow for quantitative comparisons between the monitoring locations over time and for meaningful comparisons between the data sets.

Monitoring Locations

The current monitoring locations are shown in Figures 3 and 4 for routine and dredging operation monitoring. The pre-1997 monitoring locations are shown in Figure 5. The current samples collected for both routine monitoring and monitoring during dredging events include: three individual CDF stations (CDF-001, CDF-002, and CDF-003); three near-dike composite samples composited from nine near-dike sampling locations (ND-COMP-001, ND-COMP-002, and ND-COMP-003); three landing well locations (CH-18-81, CH-19-81, and CH-20-81); three background Calumet Harbor/Lake Michigan sampling locations (BACK-001, BACK-002, and BACK-003); and three river sampling locations (RIV-001, RIV-002, and RIV-003). In addition, during dredging operations suspended solids monitoring occurs around the dredging operation and the sediment

rehandling areas. The influent and effluent for the filter cells through which the CDF is drained are also monitored during dredging.

Monitoring Parameters

The parameters and required detection limits (RDLs) for routine monitoring and monitoring during dredging events are given in Table 1. Due to the potential for impacts during dredging events, the samples collected during dredging events are analyzed for a more comprehensive list of parameters.

Table 1: Monitoring Parameters and Detection Limits

Parameter	**Required Detection Limit** (mg/L, unless noted)
Parameters, Routine and During Dredging Monitoring	
Chromium (total)	0.005
Manganese (total)	0.005
Zinc (total)	0.005
Ammonia as Nitrogen	0.001
Phosphorus	0.005
Total Kjeldahl Nitrogen (as N)	0.2
pH	± 0.01 units
Total Dissolved Solids (TDS)	5.0
Total Suspended Solids (TSS)	5.0
Additional Parameters During Dredging Monitoring	
Arsenic (total)	0.002
Cadmium (total)	0.02
Copper (total)	0.02
Cyanide (total)	0.01
Lead (total)	0.005
Mercury (total)	0.0002
Nickel (total)	0.02
Oil & Grease	5.0
Temperature	± 0.1 °C
Dissolved Oxygen	± 0.1 mg/L
Hardness	10.0

Monitoring Schedule

Routine monitoring is conducted three times per year; the approximate dates of sample collection are March-April, July-August, and October-December. Routine monitoring is

not conducted if dredging is occurring; during dredging operations a more extensive monitoring schedule is followed.

During dredging monitoring is conducted on a set frequency. Two weeks before and two weeks after the dredging event, water quality samples are collected twice a week. During dredging, samples are collected on a once a week schedule except for two consecutive weeks of twice a week sampling, scheduled at the approximate halfway point of the dredging event. Table 2 gives a summary of the dredging events which have occurred since the construction of the Chicago Area CDF.

Table 2: Dredging Events

Year of Operation	Location of Dredging	Volume of Dredged Material
Oct. – Dec. 1984	Calumet River	100,000 yd^3
July – Sept. 1985	Calumet River	108,000 yd^3
May – June 1986	Chicago Harbor & Chicago River	62,000 yd^3
April – June 1989	Calumet River	70,000 yd^3
May 1991	Calumet River	3,100 yd^3
December 1994	Calumet River	62,000 yd^3
Aug. 2000 – April 2001	Calumet River, Calumet Harbor, Breakwater	206,000 yd^3
Sept. – Dec. 2001	Calumet Harbor	291,000 yd^3
June 2002	Obstruction Removal in Calumet River	1000 yd^3
Sept. – Dec. 2003	Calumet River	135,000 yd^3

Before 1997, a different monitoring schedule and locations were used. The former monitoring locations are shown in Figures 5 and 6. Sampling location 1 is approximately equal to the current "CDF" sampling location, that is, the sample is taken from the standing water within the dikes of the CDF. Sampling location 4 (a and b) is near the current river samples. Sampling locations 5, 6, and 7 are outside the CDF in Lake Michigan, and are similar to the current "near CDF" sample locations. Sampling location 8 (a and b) is further outside the CDF into Lake Michigan and is assumed to be similar to the current background sample locations. These sampling data were collected only during dredging events, which occurred in 1984, 1985, 1986, 1989, and 1994.

Monitoring wells Ch-18-81, CH-19-81, and CH-20-81 were sampled on a routine basis, with the sample frequency varying by parameter. The "dike" monitoring wells (CH-04-83, CH-05-83, CH-07-84, CH-08-84, CH-09-84, CH-10-84 and CD-11-87) were sampled on a routine basis before 1997, but have not been sampled since 1997.

Data Analysis

As required by IEPA Water Pollution Control Permit No. 2001-EA-4691 Special Condition #4, a statistical analysis of the monitoring data was performed. The analysis included an evaluation of the data, a determination of seasonal trends, a time trend analysis, and an analysis of variance to determine whether data from the various sampling locations were significantly different. These analyses are discussed further, below.

Data

The data collected at the Chicago Area CDF fall into two distinct groups: 1984 to 1997 and 1997 to present. The two groups of data had different sampling frequencies and locations, and some different parameters. Because of these differences, it is difficult to use all of the data for a single comprehensive analysis. In addition, there are data collected during dredging events, and data collected during routine monitoring. The dredging events occurred only periodically, and are useful only in comparison to the routine monitoring, to determine whether the dredging operation had an impact on water quality in the area of the CDF. The routine data collected in the CDF, Calumet Harbor and Calumet River from 1997 – 2005 can be used to investigate seasonal trends, time trends, and to compare locations.

The limited data collected before 1997 in Calumet Harbor, Calumet River, and the CDF are not sufficient in number and were not collected on a regular basis (these locations were only monitored during dredging events before 1997). Because the pre-1997 dredging event data were only for limited, discrete events, there is limited analysis that can be done on the pre-1997 dredging event data. Due to the lack of an established background dataset there is no basis for comparison.

The landing monitoring well data for CH-18-81, CH-19-81, and CH-20-81 were monitored on a different frequency pre-1997, however the well location and the parameters monitored are the same for the entire period so that some analyses can be done using the complete period of record data set. The dike well locations (CH-04-83, CH-05-83, CH-07-84, CH-08-84, CH-09-84, and CH-10-84) were sampled routinely from 1984 to 1997, however there was no background sample location. Well CH-11-87 was only monitored for PCBs, and the data were always non-detectable so no statistical analysis can be done for this well. For the well locations where data exist, a trend analysis was done. Comparative statistics were also determined for these well data, however no comparison was done to the CDF, Calumet River, and Lake Michigan data since there is no reason to believe that the Iroquois Landing groundwater quality is related to these surface waters.

In general, the data used for the statistical analysis were collected between 1997 and 2005 during routine monitoring three times per year, and during the three dredging events that occurred within that timeframe. Data for Ammonia Nitrogen, Chromium, Manganese, Zinc, Total Phosphorus, Total Kjeldahl Nitrogen (TKN), Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) were used. As discussed above, for each monitoring location, three samples were collected (Figure 3). The samples locations were all treated

as one data source, for example Back 001, Back 002, and Back 003 were all used to describe “background Lake Michigan” because there is no statistical difference between the samples taken for a given monitoring location. However, the three landing monitoring wells were treated as separate sampling points; there are differences between the three wells. The monitoring locations are referred to in this discussion as: background (locations Back 001, Back 002, Back 003, or location 8 for pre-1997 data); near CDF (ND-Comp 001, ND-Comp 002, ND-Comp 003 or locations 5, 6, 7 for pre-1997 data), river (Riv 001, Riv 002, Riv 003, or location 4 for pre-1997 data); in CDF (CDF 001, CDF 002, CDF 003, or location 1 for pre-1997 data); MW 18 (CH-18-81); MW 19 (CH-19-81); MW 20 (CH-20-81).

Environmental data include measurements of constituents at trace levels. Typically, concentrations below some set limit (the detection limit) cannot be measured reliably; the un-measurable concentrations are presumed to fall between zero and the detection limit. Such data sets are referred to as “left-censored,” since the lower (left) end of the dataset is truncated at the detection limit. There are various ways to handle data that are reported as “non-detectable.” The three methods typically used for statistical analysis of data sets with non-detectable data are 1) zero is used for non-detectable concentrations; 2) one-half the detection limit is used for non-detectable concentrations; or 3) the detection limit is used for non-detectable concentrations (USACE WES, 1995). In this study, for statistical calculations the detection limit was used in place of data that were reported as non-detectable. This approach is considered appropriate when the percent of “censored” data is less than 20%, and the variances are equal (USACE WES, 1995). These assumptions are true for all of the data sets except Chromium. The Chromium data were more than 80% non-detectable. No data substitution methods are considered adequate when the data set is more than 80% censored (USACE WES, 1995). Because of the lack of measurable chromium concentrations, no conclusions can be drawn regarding chromium concentrations. The chromium data are not discussed further in the analysis below.

The raw data have been reported previously in other publications (see references), and thus are not included in this report. However, Appendix B includes plots of the data that were used for the analysis, including the routine and dredging monitoring data from 1984 to 2005 and monitoring well data (1984 to 2005 for the landing wells, and 1984 to 1997 for the dike wells).

Analytical Methods

Analysis of data was done using statistical functions of Microsoft Excel The statistical add-in package Analyse-it was used for obtaining descriptive statistics and non-parametric analysis of variance (ANOVA). The specific statistical calculations are discussed further, below. The analyses conducted were:

1. The data were examined for seasonal variations, both during routine monitoring and during dredging events.

2. For the routine monitoring data from Lake Michigan, Calumet Harbor, Calumet River and the CDF, a trend analysis of the data over time was conducted, using the routine monitoring data from 1997 through 2005. For the Iroquois Landing monitoring wells, a trend analysis of the data over time was conducted using the monitoring data from 1984 through 2005 or from 1997 through 2005, depending on the parameter. (Note that not all parameters were measured consistently over time throughout the 21 years of monitoring.) For the dike wells, a trend analysis of the data was conducted using the monitoring data from 1984 to 1997.

3. Both the routine monitoring and dredging event monitoring data from 1997 through 2005 were compared to determine whether there are significant differences based on monitoring location. The intent of this analysis was to determine whether the CDF was having an impact on water quality outside the facility.

Seasonality

The routine monitoring occurs in roughly spring, summer, and fall. Dredging events can occur year round, although high waves in the winter can limit activities. Because the data were taken during different seasons, there is the possibility of seasonal variation in the data, which would need to be controlled for in any analysis. The data were examined for seasonal variations, and no statistically significant variation between seasons was found, with the exception of the ammonia data for Lake Michigan (the background sampling location). Background Lake Michigan ammonia data show a significant difference between the routine monitoring (spring, summer, fall) and the dredging event (2000, 2001, and 2003) background samples (fall and winter). The background Lake Michigan ammonia concentrations measured during dredging were significantly lower than the routine monitoring background Lake Michigan ammonia concentrations. This difference is likely due to the seasonal difference between the routine monitoring, which occurs during warmer weather, and the dredging events that occurred during colder weather. Since no other dataset showed a seasonal effect, the background data collected during dredging events were combined with the routine monitoring background data to make one larger background Lake Michigan data set for each parameter. This was not done for the ammonia data.

Time Variation (Time Trend)

The trend analysis of the data was based on a calculation of significance. The data were plotted as concentrations verses time. For each data set, a linear relationship between time and concentration was assumed. The regression data (trendline slope and standard error of the slope), were calculated in MS Excel using the regression analysis tools. The slope of each linear trendline was divided by the standard error of the slope. The result was compared to the t-value for a two tailed test at the 95% level of significance (ie. a value of ±1.96.) The data for the regression analysis are given in Appendix C. Based on this calculation, the data sets listed in Table 3 were found to have a significant time relationship.

Before 1997 when a new monitoring program was implemented, the current monitoring locations were not used for routine monitoring, with the exception of the landing wells (MW-18, MW-19, and MW-20). Wells 18, 19, and 20 were monitored on a quarterly or semi-annual basis, however some parameters (Total Zinc, Total Phosphorus, Total Manganese) were not monitored throughout the entire period from 1984 to 2005. For ammonia, TDS, TKN, and TSS it was possible to do a time trend analysis using data from 1984 through 2005 for wells 18, 19, and 20. For zinc, phosphorus and manganese, only the data for wells 18, 19, and 20 from 1997 through 2005 were used for the time trend analysis. For the surface water monitoring locations, data from 1997 through 2005 were used for the time trend analysis, since pre-1997 the same monitoring locations were not used and the locations used were only monitored during the periodic dredging operations. For the dike wells, data from 1984 to 1997 were used.

Table 3: Sampling data sets that show a time trend.

Parameter	Sampling location +/- indicates direction of trend
Ammonia	Background (-) Near CDF (-) River (-) MW 19 (-) MW 20 (-) MW 4 (+) MW 9 (-) MW 10 (-)
Manganese	CDF(+) MW 18 (-) MW 20 (+) MW 4 (+) MW 9 (-) MW 10 (-)
Total Dissolved Solids	CDF (+) MW 4 (+) MW 7 (+) MW 9 (+) MW 10 (+)
Total Kjeldahl Nitrogen	CDF (+) MW 5 (-) MW 7 (-) MW 8 (-) MW 9 (-) MW 10 (-)
Total Phosphorus	Background (-) Near CDF (-) River (-) CDF (+) MW 7 (-) MW 9 (-) MW 10 (-)

Parameter	Sampling location +/- indicates direction of trend
Total Suspended Solids	Background (+) CDF (+) MW 5 (-) MW 8 (-) MW 10 (-)
Zinc	Background (-) MW 7 (-) MW 9 (-)

Based on the trend analysis, some conclusions can be drawn regarding the water quality during routine monitoring events.

1. Background Lake Michigan samples show decreasing ammonia, phosphorus, and zinc. This may be attributed to less non-point source run-off or other improvements in southern Lake Michigan water quality due to Clean Water Act compliance by others. The Lake Michigan samples did show an increasing trend in TSS, and there is no readily available explanation for this. Because the background Lake Michigan sample location should not be impacted either by the CDF or by dredging operations, these trends are not caused by or related to the conditions in the CDF.

2. The Near CDF data also show less ammonia and phosphorus over time. As with the Lake Michigan background samples this trend does not appear to be caused by or related to conditions in the CDF.

3. The Calumet River data show a similar trend in decreasing nutrient concentrations over time as found in the Lake Michigan and Near CDF samples. This finding is not surprising since the river is strongly influenced by Lake Michigan (water flows generally into the river from Lake Michigan.) Again, these trends do not appear to be caused by or related to conditions in the CDF.

4. Data from samples collected inside the CDF show a strong time variant. Manganese, Phosphorus, TKN, TDS, and TSS all show an *increasing* trend over time. This is not an unexpected trend. The CDF is now more full of sediment, and with less water there is more turbidity and more partitioning of compounds to the water column from the sediment. Although data indicate that some water quality parameters are increasing inside the CDF over time, there is no apparent impact outside the CDF since the river and near CDF samples do not follow the same trends.

5. The monitoring wells show variable trends, with some parameters increasing over time and some parameters decreasing over time in various dike and landing wells. These trends do not appear to be consistent with or reflect the conditions in the CDF, since the trends are not consistent between the CDF and the various wells. The groundwater quality issues at Iroquois Landing are well documented since the area is a landfill site, and it is likely that the monitoring well trends reflect variations in

groundwater quality over time. In any event, the trends in the monitoring wells do not appear to be related to the CDF operation.

None of the trend data indicate that the increasing concentrations within the CDF are causing increasing concentrations in the River or Lake Michigan, ie., the CDF is not impacting water quality. In fact, the data support the notion that water in southern Lake Michigan is generally improving in quality.

Comparison of Locations

The data for the seven monitoring locations (background Lake Michigan, near CDF in Lake Michigan, Calumet River, in the CDF, MW 18, MW 19, and MW 20) were compared to determine the whether there are statistically significant differences in the results from the monitoring locations. In addition, data from the post-1997 dredging events (in 2000/2001, 2001, and 2003) were compared to the routine monitoring data. The dredging events are referred to as dredging event 2000/2001 (D2000), dredging event 2001 (D2001), and dredging event 2003 (D2003), respectively. The pre-1997 data were not compared to current data for determining the significance of monitoring location since the monitoring parameters and locations are not the same as the 1997 to 2005 monitoring. Figure 3 shows the monitoring locations; there are three sampling locations for each of the Lake Michigan, Calumet River and CDF monitoring areas.

The data sets for the monitoring locations were compared using a comparison of means. Appendix D gives the comparative descriptives for each data set. For each data set, the mean, standard deviation, standard error, and 95% confidence interval were calculated. Box plots are also shown, and outliers are visible on the box plots. In general, outliers were not deleted from the dataset, since there was no clear basis for eliminating outliers and because environmental monitoring data can vary due to factors not controlled for in this study.

The Mann-Whitney U test (the Wilcoxon rank-sum test) was used to evaluate the significance of sampling location.   The Mann-Whitney test is a non-parametric independent two-group comparison, which compares the distribution of the means of the sample sets and determines if a statistical difference is detected among the groups. The Mann-Whitney test is analogous to the parametric Students t-Test, which tests the null hypothesis between two independent groups assuming a normal distribution.

In general, parametric tests such as the Students t-Test are based on the assumption that the data follow a normal (or otherwise known) distribution and that the data can be measured on a continuous scale. Non-parametric tests are used when the assumptions inherent in the parametric tests either cannot be met or are unknown. For example, non-parametric tests are used when the distribution of the data is not known (or is not known to be normal), or when the sample size is small. In the case of the Chicago CDF water quality monitoring data, a non-parametric test was used because it cannot be assumed that the data are distributed normally and because some data sets, such as the dredging event data sets, are small.

The null hypothesis used for this analysis is that the data are similar to the background data, that is, there is no difference between data sets collected at the various monitoring points. The p-values calculated for the test represent the probability of making a "Type 1 error." A Type 1 error is the error of rejecting the null hypothesis when it should be accepted. In this case, given our null hypothesis, a Type 1 error would be the finding that the data sets from two locations are different, when in fact they are equal. A p-value can vary between <0.0001 to 1.0. When the p-value is greater than 0.05 for a 95% confidence level there is a greater chance of a Type 1 error, or in other words, for our case the two data sets cannot be determined to be significantly different. When the p-value is less than 0.05 (corresponding to 95% confidence), there is a low chance of a Type 1 error, or, for our case the two data sets are found to be significantly different.

The data sets were compared to background Lake Michigan concentrations, and the various dredging event data were compared to the routine monitoring results for the same parameters and locations. For the data sets analyzed, Table 4 gives a summary of the monitoring locations that were found to be significantly different based on location. The table lists the parameters that were found to be significantly different.

Based on the comparison of the data sets, some conclusions can be made regarding water quality in and around the CDF. First, a clear conclusion is that the water quality in the CDF is significantly different than the water quality in Lake Michigan for all parameters, including both routine monitoring data and dredging event monitoring data. This is not unexpected based on the sediment quality; the sediment from the Calumet and Chicago Harbors is known to contain metals and nutrients and for this reason is placed in the CDF. As the CDF has filled, the water quality in the CDF has become relatively worse as demonstrated by the time trend analysis.

The Calumet River water quality is also typically different from the background conditions. The Calumet River flow direction depends on the lake level and on other factors, although the flow direction is generally considered to be from the Lake. However, the comparatively shallow river water quality is impacted by boat traffic and various point source discharges, as well as by non-point run-off and groundwater flow. In addition, during storm events the flow direction may be toward the lake, if the locks are opened to control water levels on the Cal-Sag canal. Despite the statistical differences between the background monitoring data and the river data, there is no evidence that the CDF is impacting the river. Discharges from the filter cells during dredging events were monitored and the filter cells were meeting water quality standards for discharge. The filter cell data are discussed in the various dredging event monitoring reports.

Table 4: Significantly Different by Location at the 95% Confidence Level

	Near CDF	River	In CDF	D2000 Near CDF	D2000 River	D2000 In CDF	D2001 Near CDF	D2001 River	D2001 In CDF	D2003 Near CDF	D2003 River	D2003 In CDF
Background	NH_3 TKN TP Zn	NH_3 Mn TDS TKN TP TSS Zn	NH_3 Mn TDS TKN TP TSS Zn	Mn TKN Zn	Mn TDS TKN TP TSS Zn	Mn TDS TKN TP TSS Zn	Mn TKN TSS Zn	Mn TDS TKN TSS Zn	Mn TDS TKN TP TSS Zn	TKN Zn	Mn TDS TKN TSS	Mn TDS TKN TP TSS Zn
Near CDF				NH_3 TP			NH_3 Mn TKN TP TSS			NH_3 TKN TP		
River					NH_3 Mn TDS TP			NH_3 TKN TP Zn			NH_3 TDS TKN TP	
In CDF						NH_3 TKN TP			NH_3 Mn TKN TP TSS			NH_3 Mn TDS TKN TP TSS
D2000 Background*					NH_3	NH_3						
D2001 Background*								NH_3	NH_3			
D2003 Background*											NH_3	NH_3

*Only Ammonia data were broken out between routine background and dredging event background, since these data showed a seasonal effect. For other datasets, the routine monitoring background and the dredging event background were combined, since the background data did not show a statistical difference.

The data locations in the columns are typically higher than the comparison location in the rows. Appendix D gives the comparative statistics.

The Near CDF monitoring location is more similar to the background Lake Michigan water quality, with the exception of nutrient parameters. In general, the ammonia, phosphorus and total Kjeldahl nitrogen concentrations are different between the background monitoring location and the near dike monitoring location. A reasonable explanation for this finding is the shallower water and the algal growth on the stone dikes surrounding the CDF. It is likely that the shallower, warmer water with a shallow surface area supports more biological activity than the colder, deeper background monitoring location. In addition, the near shore area may be impacted by surface run-off. However, given the non-significance of the metals data, as well as the TSS data, it is unlikely that the CDF is impacting the near CDF water quality.

Zinc measurements were typically different from the background monitoring location for all other monitoring locations for both routine monitoring and dredging event monitoring. The cause of this is not known.

Conclusions

Based on the analyses presented above, it can be concluded that the concentrations of the monitoring parameters are increasing over time within the CDF pond. There are significant differences between the background Lake Michigan monitoring data and the data from other monitoring locations. However, there is no systematic trend in the data which would indicate that the monitoring locations are being impacted by the CDF. A comparison of data based on monitoring location also allows only the conclusion that the CDF and River are significantly different from Lake Michigan. Other trends in data and parameters are either not consistent over location or over time. Routine and dredging event data reports (see references for reports previously submitted) have not indicated any short term or event based impacts during the last 22 years of monitoring. Based on the analyses in this report and on the data presented during the last 22 years of routine monitoring and dredging event monitoring, it can be concluded that the CDF is not causing short or long term water quality impacts in Lake Michigan or the Calumet River.

References

USACE, June 1984, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1983, Chicago District, Chicago, Illinois.

USACE, May 1985, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1984, Chicago District, Chicago, Illinois.

USACE, April 1985, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations , October 1984 to December 1984, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, February 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations July 1985 to September 1985, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, October 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1986 to July 1986, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, May 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1985, Chicago District, Chicago, Illinois.

USACE, June 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1986, Chicago District, Chicago, Illinois.

USACE, July 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1987, Chicago District, Chicago, Illinois.

USACE, December 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1988, Chicago District, Chicago, Illinois.

USACE, December 1989, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1989 Through June 1989, Randolph & Associates, Inc. for Chicago District.

USACE, June 1990, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1989, Chicago District, Chicago, Illinois.

USACE, June 1993, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1990, Chicago District, Chicago, Illinois.

USACE, March 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1991, Chicago District, Chicago, Illinois.

USACE, May 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1992, Chicago District, Chicago, Illinois.

USACE, Sep 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1993 Calendar Year, Chicago District, Chicago, Illinois.

USACE, April 1995, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1994 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE Waterways Experiment Station, July 1995, Environmental Effects of Dredging Technical Notes: Guidelines for Statistical Treatment of Less Than Detection Limit Data in Dredged Sediment Evaluations, Waterways Experiment Station Environmental Laboratory, Vicksburg, Mississippi.

USACE, November 1995, Report on Maintenance Dredging of Calumet River (12/2/94 through 12/31/94), Volume I, Chicago District, Chicago, Illinois.

USACE, August 1996, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1995 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE, March 1997, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1996 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE, June 2000, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 99 (October 98 to September 99), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, July 2001, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2000 (October 1999 to September 2000), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, June 2002, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2001 (October 2000 to September 2001), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, July 2002, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging July 2000 to April 2001, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, September 2002, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging September 2001 to December 2001, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, April 2003, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2002 (October 2001 to October 2002), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, January 2004, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2003 (October 2002 to October 2003), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, August 2004, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging October 2003 to December 2003, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, December 2004, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Year (November 2003 to November 2004), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, February 2006, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Water Year 2005, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

Figures

Figure 1: Chicago Area Confined Disposal Facility Vicinity

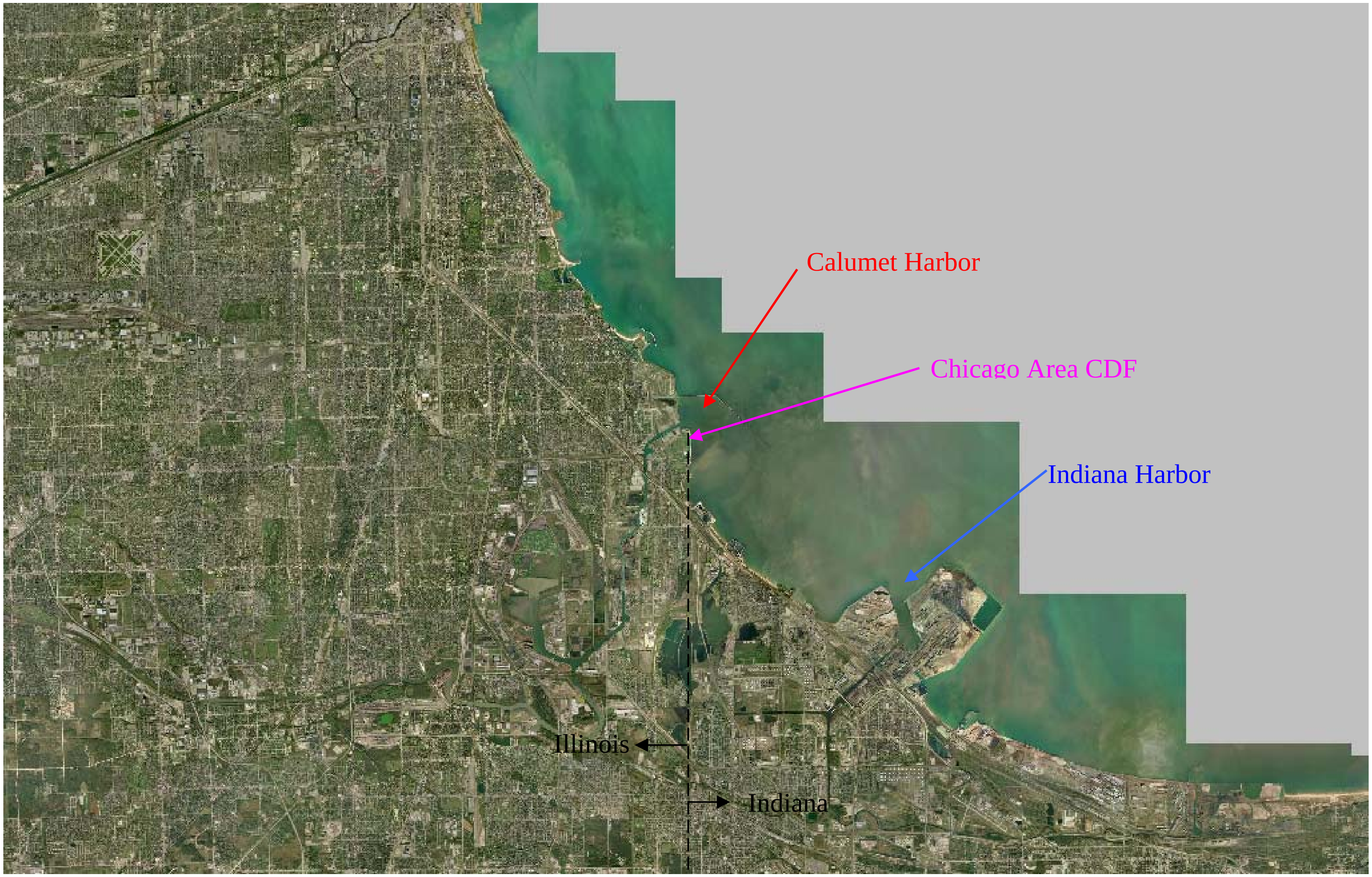


Figure 2: Chicago Area CDF Facility

Figure 3: Current Monitoring locations

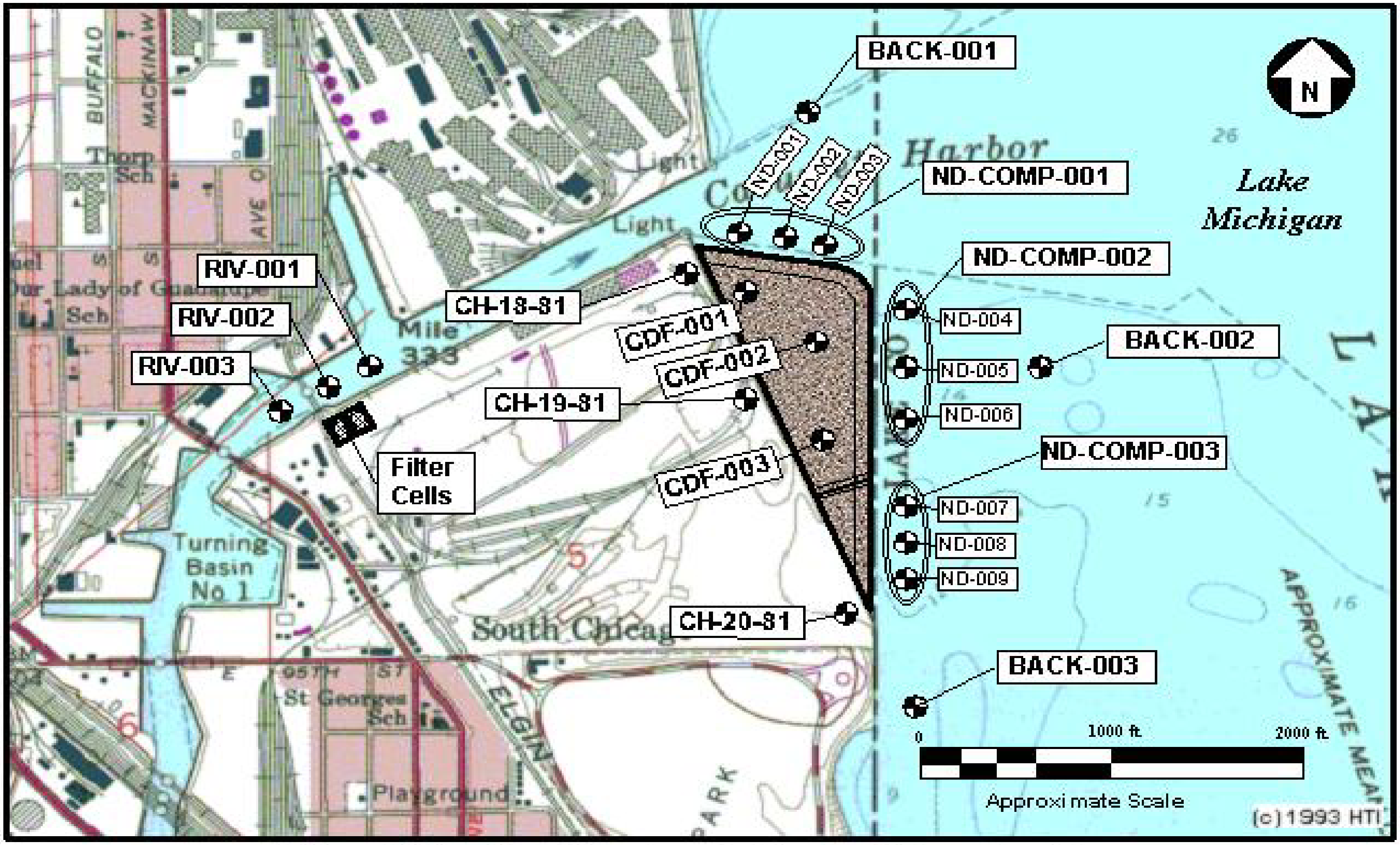
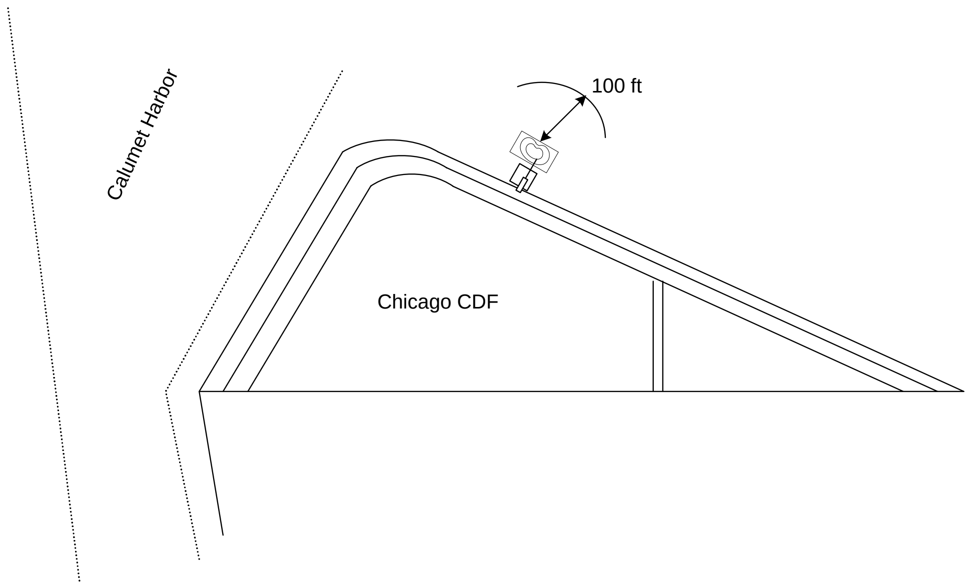
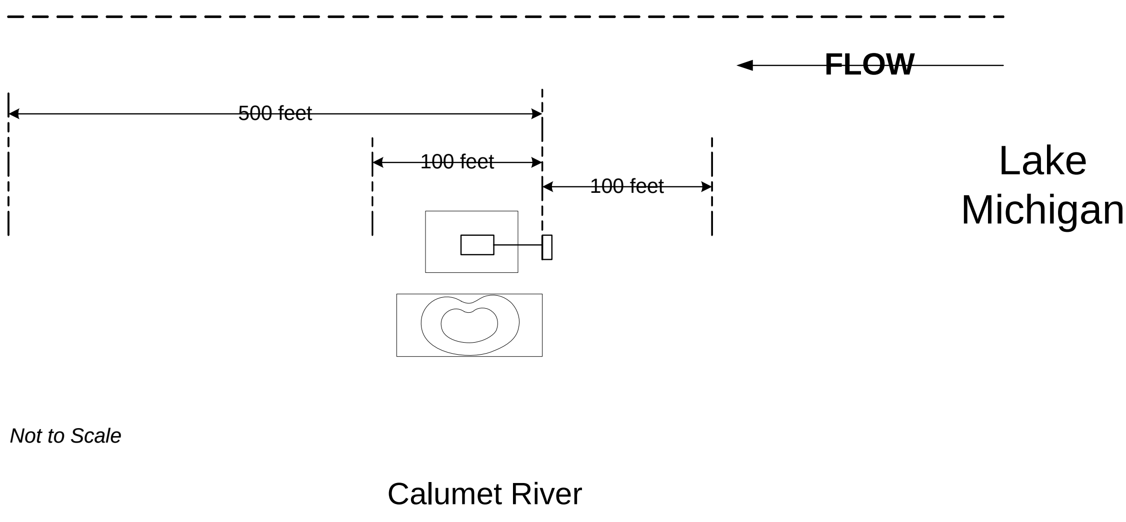


Figure 4: Dredging Operation Monitoring Locations



a. Rehandling area



b. Dredging operation

Figure 5: Past (Pre-1997) Well Monitoring Locations

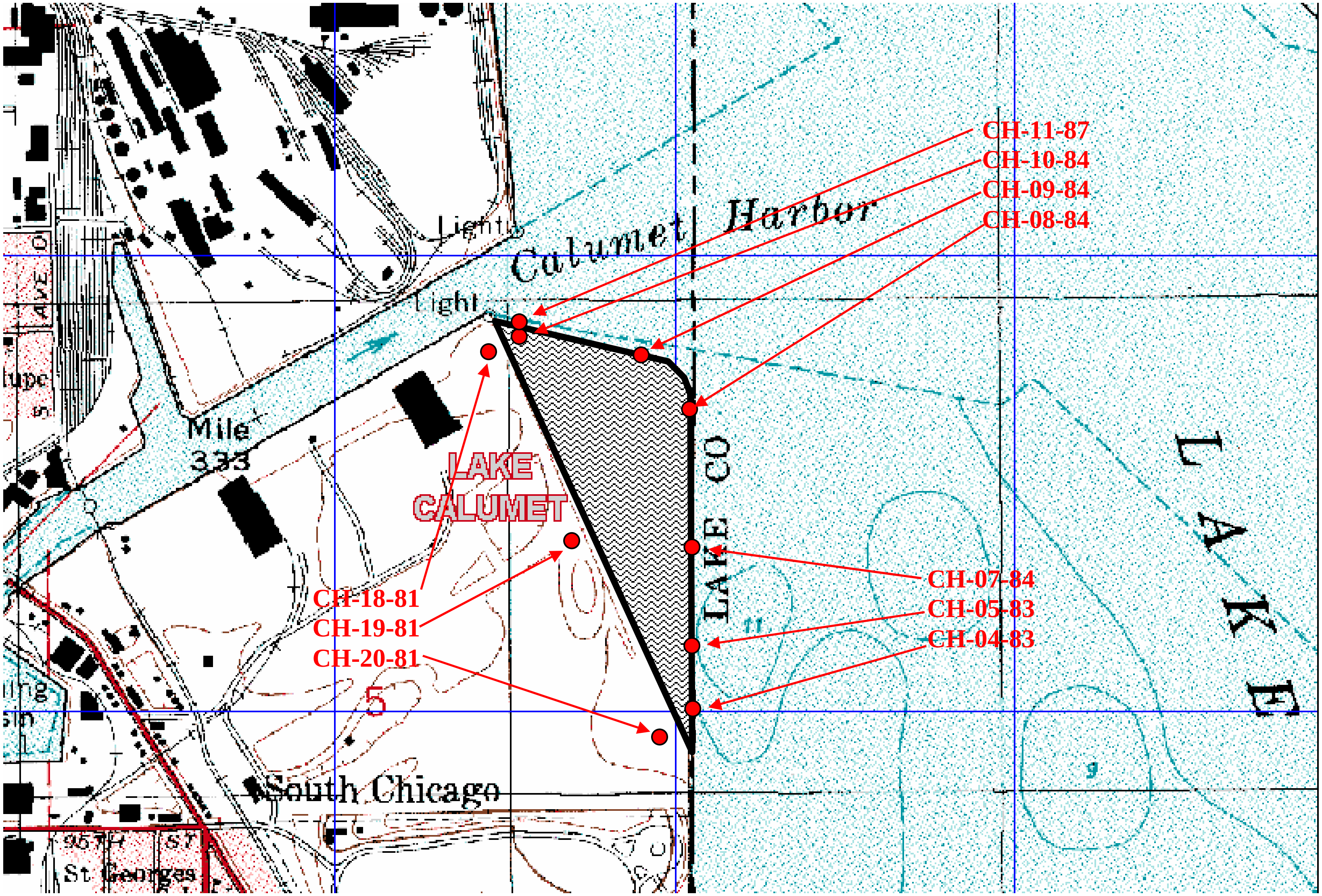
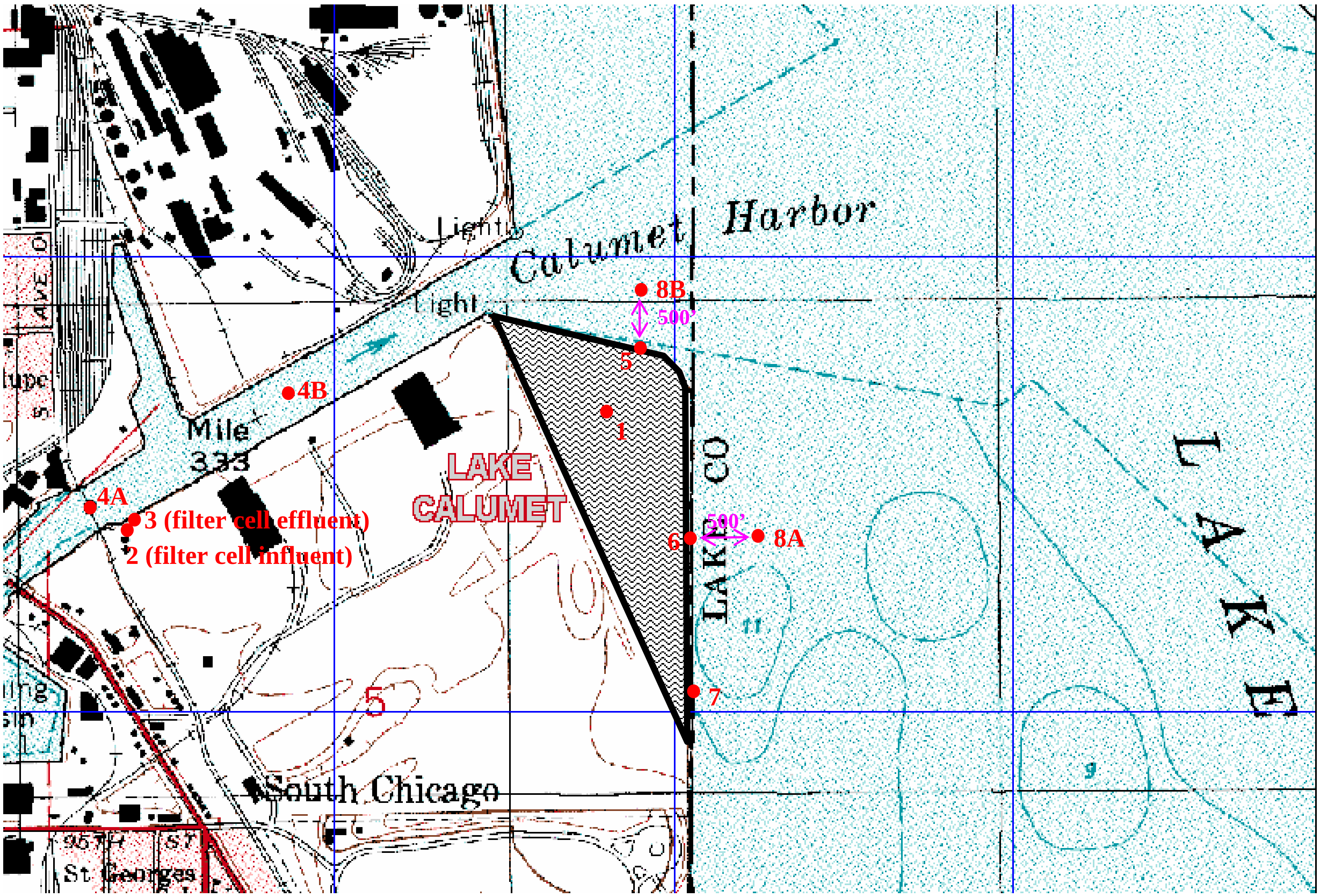


Figure 6: Past (Pre-1997) Dredging Event Monitoring Locations



Appendix A: Water Pollution Control Permit

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION CONTROL PERMIT

LOG NUMBERS: 4691-01

PERMIT NO.: 2001-EA-4691

FINAL PLANS, SPECIFICATIONS, APPLICATION AND SUPPORTING DOCUMENTS
PREPARED BY: Chicago District Corps of Engineers

DATE ISSUED: December 7, 2001

SUBJECT: Chicago District Corps of Engineers – Chicago Area Confined Disposal Facility

PERMITTEE TO OPERATE

Chicago District Corps of Engineers
111 North Canal Street
Chicago, IL 60606

Permit is hereby granted to the above designated permittee(s) to operate water pollution control facilities described as follows:

The facilities include a 43 acre confined disposal facility (CDF) for dredged material from the Chicago and Calumet Rivers. The settling basin has a capacity of approximately 1.45 million gallons. The settling basin discharges to two (2) 34 foot diameter dual media filters cells, with discharge to the Calumet River.

This permit renews and replaces Permit No. 1997-EA-3213 which was previously, issued for the herein permitted facility.

This operating permit expires on December 1, 2006.

This permit is issued subject to the following Special Conditions(s). If such Special Condition(s) require(s) additional or revised facilities, satisfactory engineering plan documents must be submitted to this Agency for review and approval for issuance of a Supplemental Permit.

THE STANDARD CONDITIONS OF ISSUANCE INDICATED ON THE REVERSE SIDE MUST BE COMPLIED WITH IN FULL. READ ALL CONDITIONS CAREFULLY.

BJY:JRA:

DIVISION OF WATER POLLUTION CONTROL

cc: IEPA, DesPlaines Region
Records
Binds

Bruce J. Yurdin
Manager, Watershed Management Section
Bureau of Water

IEPA Permit - 1

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION CONTROL PERMIT

LOG NUMBERS: 4691-01

PERMIT NO.: 2001-EA-4691

FINAL PLANS, SPECIFICATIONS, APPLICATION AND SUPPORTING DOCUMENTS
PREPARED BY: Chicago District Corps of Engineers

DATE ISSUED: December 7, 2001

SUBJECT: Chicago District Corps of Engineers – Chicago Area Confined Disposal Facility

SPECIAL CONDITION 1: A pump with a capacity of 2250 gallons per minute shall be used during dredging operations to carry wastewater to the filter cells in order to reduce the volume within the CDF in direct proportion to the incoming sediment and wastewater volume during dredging and disposal events.

SPECIAL CONDITION 2: Monitoring shall be conducted in accordance with the Corps of Engineers report entitled "Water Quality Monitoring at the Chicago Area confined Disposal Facility, Calumet Harbor, IL", submitted as part of the February 6, 1997 application. In addition to these monitoring parameters, the permittee shall monitor for:

i) Temperature, in routine monitoring as specified in Section 5.2.1 of the above cited report; and

ii) Polychlorinated biphenyls (PCBs), if dredged material for the Chicago River is disposed at the Chicago Area CDF, in accordance with the list of established "Target Parameters During Dredging Events" as specified under Section 5.2.2 of the above cited reports.

SPECIAL CONDITION 3: Reports of all analytical results shall be submitted to the Illinois EPA on a monthly basis for hydraulic dredging operations and on an annual basis for mechanical dredging operations.

SPECIAL CONDITION 4: A report containing data from the beginning of the project to the time of the next permit renewal submission shall be provided in the application for the renewal of the permit. The permittee shall provide an analysis of these data showing trends for the parameters tested. All data will be accounted for and correlated with locations currently used (i.e., BACK 1, 2, 3, ND 1, 2, 3, RIV 1, 2, 3, CDF 1, 2, 3, and CH 18, 19, 20, etc.).

SPECIAL CONDITION 5: Upon completion, the site shall be covered with a five (5) foot thick clay and topsoil cap, graded to drain, and seeded and mulched to prevent erosion.

READ ALL CONDITIONS CAREFULLY:
STANDARD CONDITIONS

The Illinois Environmental Protection Act (Illinois Revised Statutes, Chapter 111-1 2, Section 1039) grants the Environmental Protection Agency authority to impose conditions on permits which it issues.

Unless the construction for which this permit is issued has been completed, this permit will expire (1) two years after the date of issuance for permits to construct sewers or wastewater sources or (2) three years after the date of issuance for permits to construct treatment works or pretreatment works.

The construction or development of facilities covered by this permit shall be done in compliance with applicable provisions of Federal laws and regulations, the Illinois Environmental Protect Act, and Rules and Regulations adopted by the Illinois Pollution Control Board.

3. There shall be no deviations from the approved plans and specifications unless a written request for modification of the project, along with plans and specifications as required, shall have been submitted to the Agency and a supplemental written permit issued

4. The permittee shall allow any agent duly authorized by the Agency upon the presentation of credentials:

   a. to enter at reasonable times, the permittee's premises where actual or potential effluent, emission or noise sources are located or where any activity is to be conducted pursuant to this permit.

   b. to have access to and copy at reasonable times any records required to be kept under the terms and conditions of this permit.

   c. to inspect at reasonable times, including during any hours of operation of equipment constructed or operated under this permit, such equipment or monitoring methodology or equipment required to be kept, used, operated, calibrated and maintained under this permit.

   d. to obtain and remove at reasonable times samples of any discharge or emission of pollutants

   to enter at reasonable times and utilize any photographic, recording, testing, monitoring or other equipment for the purpose of preserving, testing, monitoring, or recording any activity, discharge, emission authorized by this permit.

5. The issuance of this permit:

   shall not be considered as in any manner affecting the title of the premises upon which the permitted facilities are to be located;

   b. does not release the permittee from any liability for damage to person or property caused by or resulting from the construction, maintenance, or operation of the proposed facilities;

   does not release the permittee from compliance with other applicable statutes and regulations of the United States, of the State of Illinois, or with applicable local laws, ordinances and regulations;

   d. does not take into consideration or attest to the structural stability of any units or parts of the project;

   e. in no manner implies or suggests that the Agency (or its officers, agents or employees) assumes any liability, directly or indirectly, for any loss due to damage, installation, maintenance, or operation of the proposed equipment or facility.

6. Unless a joint construction/operation permit has been issued, a permit for operating shall be obtained from the Agency before the facility or equipment covered by this permit is placed into operation.

7. These standard conditions shall prevail unless modified by special conditions.

8. The Agency may file a complaint with the Board for suspension or revocation of a permit:

   a. upon discovery that the permit application contained misrepresentations, misinformation or false statement or that all relevant facts were not disclosed; or

   b. upon finding that any standard or special conditions have been violated; or

   upon any violation of the Environmental Protection Act or any Rule or Regulation effective thereunder as a result of the construction or development authorized by this permit.

FEB 0 6 1997

Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, IL

1. Purpose

Since the construction of the Chicago Area confined disposal facility (CDF) in 1982-1984, the U.S. Army Corps of Engineers (USACE), Chicago District has collected water quality samples in the vicinity of the CDF in order to monitor the CDF's impact on water quality in the harbor. Based on the data collected to date, USACE believes that the sampling program for the Chicago CDF can be improved. This report summarizes the historical water quality sampling program for the Chicago CDF, discusses some weaknesses in the design of the current sampling program, and details a modified sampling program that will address the weaknesses of the old plan and is believed to better monitor, and thereby, protect the natural water resources in Calumet Harbor.

2. Background

The Chicago Area CDF is a diked facility for the disposal and containment of polluted dredged materials from the deep-draft federal navigation projects in Chicago, Illinois. The Chicago Area CDF is an in-water structure specifically designed to receive polluted dredged materials and to prevent their reentry into the harbor. The CDF was constructed in 1982-1984 and is located in Calumet Harbor, adjacent to the Iroquois Landing port terminal and north of Calumet Park. The facility is operated and maintained by USACE, Chicago District under the authority of Public Law 91-611, Section 123.

Since the construction of the CDF, USACE Chicago District has monitored water quality in the vicinity of the facility in compliance with Section 401 certification requirements and the applicable Illinois Environmental Protection Agency water pollution control permit. The current water permit, number 1992-EA-0476, was issued May 14, 1992 with supplemental permit special conditions 2iii and 2v issued March 5, 1993. The current permit will expire May 1, 1997.

3. Historical Water Quality Monitoring in Calumet Harbor

Historically, there have been two distinct schedules for water quality monitoring in conjunction with Chicago Area CDF. Routine monitoring takes place on a set schedule (monthly, quarterly, or semi-annually based on sampling location and sample parameter) throughout the year. Additionally, during U.S. Army Corps of Engineers managed dredging events an intensified sampling program is instituted in order to better observe the impact that dredging and disposal

IEPA Permit - 4

Enclosure 3

events have on water quality in the harbor. Specifics of the routine and event-based monitoring programs are discussed in the following subsections.

3. Routine Water Quality Monitoring Program

Routine monitoring throughout the year consists of obtaining samples from nine (9) monitoring wells and one (1) surface water station (see Figure 1) for the parameters and according to the sampling schedule shown in Table 1. .Routine water quality samples are collected from six (6) wells in the CDF dike wall, three (3) landing wells, and one (1) near-dike surface water station.

3.2 Water Quality Monitoring During Dredging Events

The dredging and disposal events present the greatest opportunity for impact to water quality in Calumet Harbor. Because of this opportunity for impact, a separate monitoring program is instituted during dredging events in Calumet Harbor. The dredging event sampling program is conducted in order to establish the water quality before, during, and after the dredging event. Monitoring is conducted at the stations shown in Figure 2 according the schedule given below.

1. For two weeks before and two weeks after the dredging event water quality samples are collected twice-a-week, and
2. During dredging, samples are collected on a once-a-week schedule except for one week of twice-a-week sampling.

Water quality samples are collected from three (3) in-harbor, near-dike locations, two (2) river samples, three (3) wells in the CDF dike wall, two (2) background samples, and one (1) composite sample is collected from the CDF.

Station 1 is a composite sample from the CDF pond. Stations 2 and 3 test the filter cell influent and effluent respectively in order to determine the efficiency of the filtration process. Stations 4A and 4B are river samples used to analyze the impact of the filter cell effluent on river water quality. Samples 5, 6, and 7 measure the impact of the CDF and the rehandling operation on water quality near the dike. Stations CH-09-84, CH-07-84, and CH-04-84 are shallow wells that are monitored for indication of any contaminant breach through in the dike walls. Finally, Stations 8A and 8B are background samples, outside the range of influence of the CDF, that are used for comparison purposes.

Additionally, water samples are collected from around the dredging and rehandling areas and analyzed for total suspended solids (TSS) in order to assess the performance of the dredging program during the dredging and rehandling

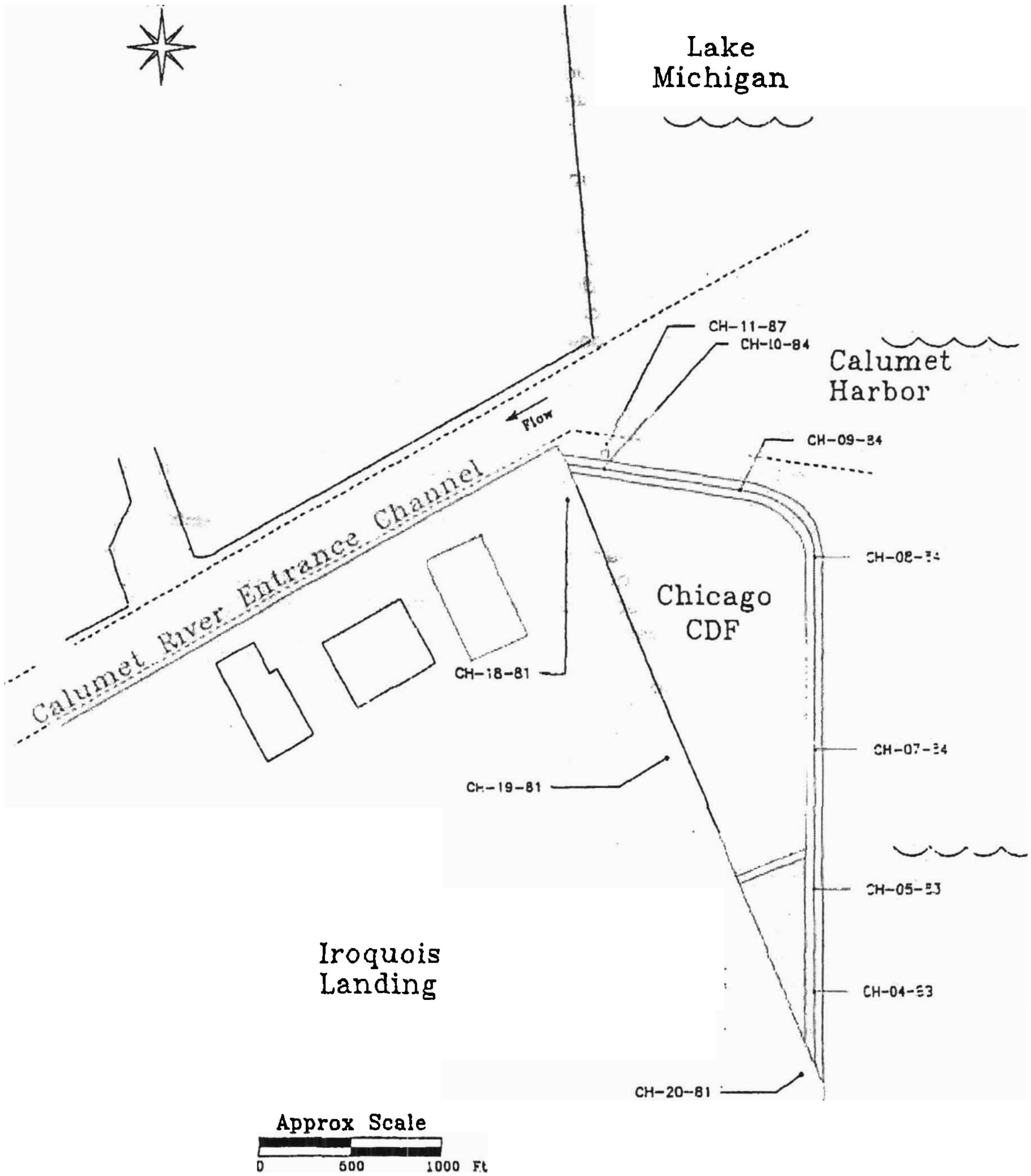


Figure 1. Current Sampling Locations during Routine Monitoring.

IEPA Permit - 6

Parameter	Dike Wells CH-4,5,7,8,9,10	Landing Wells CH-18,19,20	Surface Station CH-11[2]
Total Suspended Solids (Residue, Non-Filterable)	M	S	M
Total Dissolved Solids - 180° (Residue, Filterable)		S	
pH (field)	M	Q	M
Temperature (field)	M	Q	M
Dissolved Oxygen			
Hardness (total as $CaCO_3$)		S	
Ammonia-Nitrogen (Dissolved NH3-N)	M	S	M
Phosphorus (total)	M	S	M
Oil and Grease (Freon-IR)	M	S	M
Iron (dissolved)		S	
Lead (dissolved)	S	S	M
Zinc (dissolved)		S	M
Cyanide (total)	S	S	M
PCBs (total) (wells 0.1 µg/L)	M	S	M
Mercury (dissolved)	M		M
Manganese (dissolved)	M		M
Arsenic (dissolved)	S		M
Cadmium (dissolved)	S		M
Chromium (dissolved)	S		M
Copper (dissolved)	S		M
Nickel (dissolved)	S		M
Total Kjeldahl Nitrogen (as N)	M		M

Note: 1. Frequency monitored (M = Monthly, Q = Quarterly, S = Semi-Annually)
2. Harbor water surface station samples taken directly from dock.

Table 1. Current Monitoring Schedule for the Chicago CDF

IEPA Permit - 7

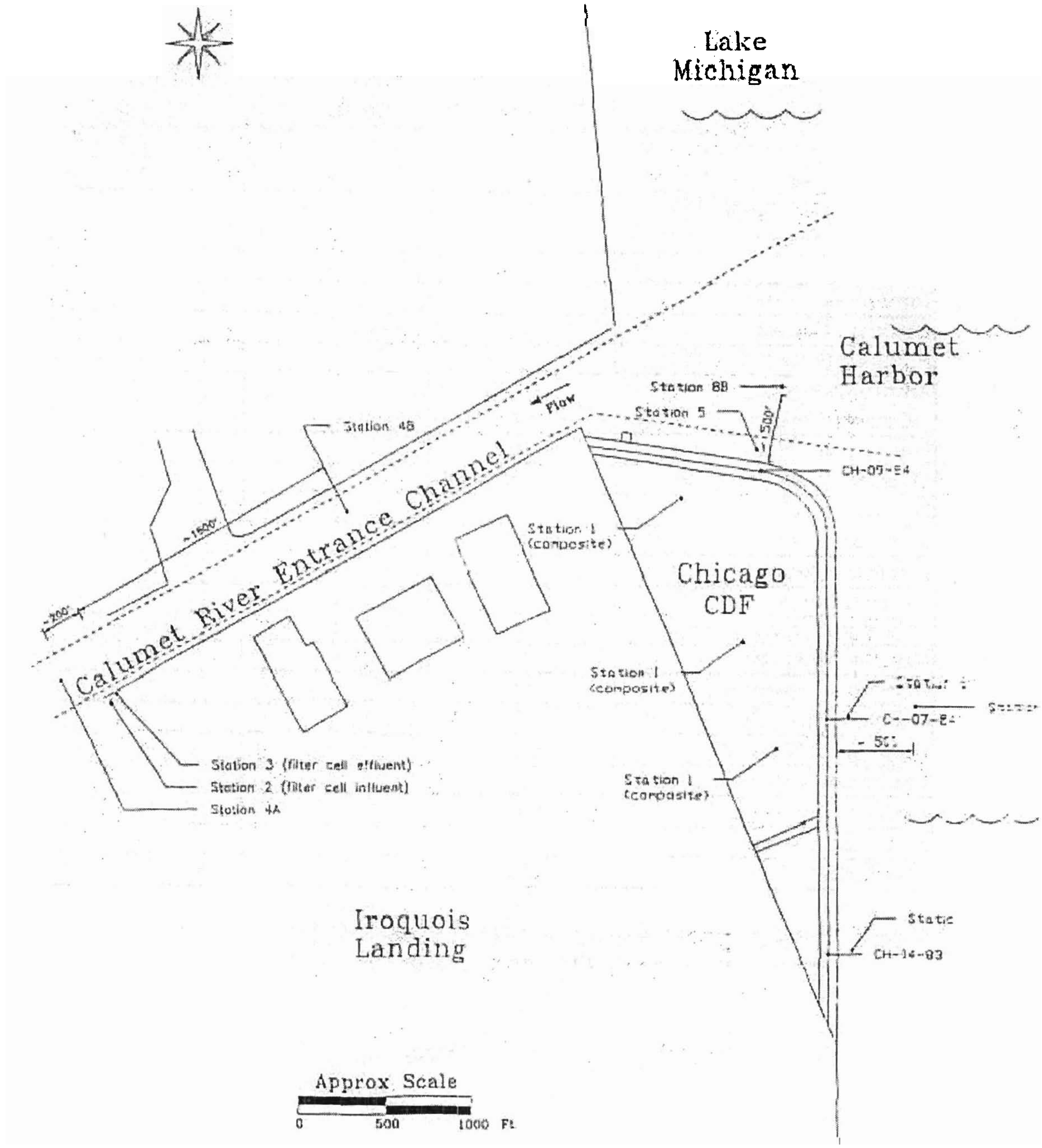


Figure 2. Current Sampling Locations during Dredging/Disposal Events.

IEPA Permit - 8

operations. During dredging operations, TSS samples are collected once a week from the sampling locations shown in Figure 3.

3.3 Summary of Results from Historical Monitoring Program

USACE has submitted yearly reports to IEPA detailing the results of the sampling operations. Sporadic spikes in contaminant concentrations have been noted at several of the sampling locations, including background stations located well outside the CDF's zone of influence. However, to date, there has been no indication that the operation of the CDF has had a negative impact on the water quality of Calumet Harbor. Additionally, the large number of "non-detects" in the data sets hamper statistical analysis of the data that has been gathered to date.

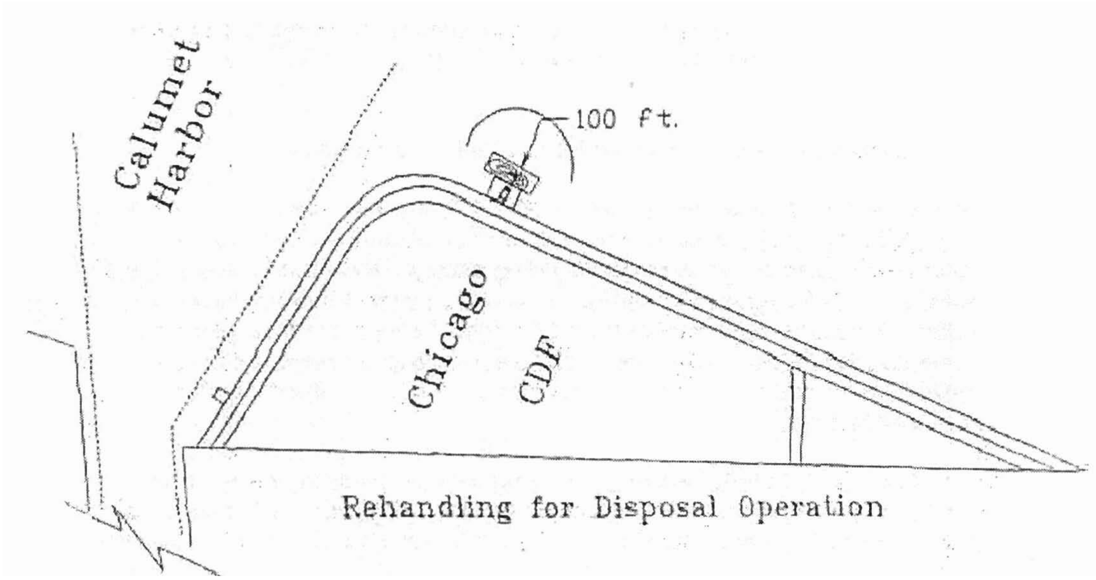
Analytical results from TSS monitoring during the five dredging events indicate that the re-suspension of solids that occurs during the dredging and rehandling operations is a localized, short-term impact. TSS data indicate that this impact quickly decreases with time and distance from the work zones.

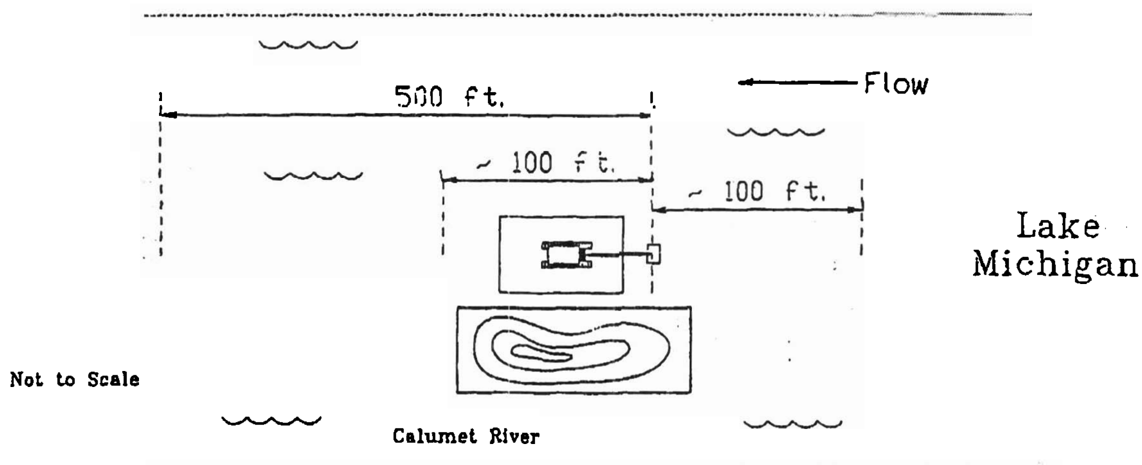
4. Deficiencies in the Design of the Current Monitoring Program

Several shortcomings in the design of the current monitoring programs limit the ability to perform meaningful, statistical comparisons across sampling locations and sampling events. The major deficiencies of the current program include:

1. Differences in the sampling environments at the various sampling locations make it difficult to make statistical comparisons between sampling locations. Due to the differences in sampling environments present in the dike wells versus background harbor samples, (i.e., "pseudo-groundwater" vs. surface water) it is problematic to identify the cause of any differences that might appear. The water quality in the shallow wells is potentially impacted by Harbor water quality, CDF water quality, and the limestone environment of the dike where the wells are finished. The differences in sampling environments make it difficult to ascertain the cause of any differences in contaminant concentration at the various sampling locations and complicate a direct statistical comparison between the data sets collected at the different locations.

2. Sampling locations are different during dredging events than during routine monitoring. Varying the sampling locations prevents the collection of a standardized long-term data set. This hampers the ability of the sampling program to detect any long-term changes in the water quality in Calumet Harbor.





Dredging Operation

Figure 3. TSS Monitoring Locations during Dredging/Rehandling Operations

7

3. The large number of non-detect results from sample analysis complicates quantitative statistical comparisons. As can be seen from the calculations performed in *USACE* (1995), a large number of data transformations are required in order to compare data sets with large proportions of "non-detect" data. This results in less powerful statistical comparisons. Additionally, the large number of "non-detects" are evidence that: (1) the CDF is performing its function of preventing the release of sediment into the harbor, and (2) the current sampling program is inefficient in terms of the quality of data collected.

4. Monitoring wells placed within the perimeter dike can potentially miss any discrete contaminant plumes that might occur. Research by *Pranger and Schroeder* (1986) showed that seepage through the dike walls of shoreline CDFs occurs in discrete fingers. This being the case, monitoring wells placed within the perimeter dike can potentially miss any of the discrete contaminant plumes that might occur.

5. The dike wells are susceptible to vandalism and damage. In an effort to deter vandalism of the monitoring wells at the site, USACE installed locking caps installed on each of the wells and erected a 10-foot high chain link fence around the site. Even after instituting these protective measures, the dike wells have be the target of vandalism throughout the life of the CDF. A wide variety of items have been dropped and poured down the wells adversely affecting the ability to collect samples and the validity of laboratory analysis. This diminishes the usefulness and power statistical comparisons between the water samples taken from the wells and the background locations.

6. No background samples are collected during routine monitoring for comparison to the other sampling locations. This shortcoming prevents analysis of natural and man-induced variances in Calumet Harbor water quality. This prevents determining if the CDF is the cause of any changes in water quality that may occur.

Differing sampling environments and the varying environmental influences have made it difficult to definitively ascertain the effect, if any, the CDF has had on water quality in the harbor. This limits the effectiveness of the current sampling program as a leak detection tool. Additionally, there are several inefficiencies inherent in the current monitoring program that can be avoided by implementing modifications to the Chicago CDF monitoring plan. The changes will result in a more efficient monitoring plan that will increase the probability of detecting any releases that may occur.

5. Proposed Monitoring Plan with Modifications

After analyzing and assimilating the water quality data that has been collected to date, USACE, Chicago District believes that a more meaningful, cost effective, and efficient routine monitoring plan should be implemented for monitoring the Chicago CDF. This section discusses the proposed changes to both the routine and dredging event monitoring programs for the Chicago CDF. Implementing these changes will increases the probability of detecting a release from the CDF and furnish a standardized, long-term data set for performing statistical analysis. The new monitoring program will also provide better insight into the long-term impact of the CDF on Calumet Harbor water quality and better protect the natural resources of Calumet Harbor.

5.1 Proposed Sampling Locations

The proposed locations for collection of both routine monitoring and dredging event samples are shown in Figure 4. The new sampling locations include:

1. Three (3) individual CDF stations, CDF-001, CDF-002, and CDF-003,
2. Three (3) near-dike composite samples, ND-COMP-001, ND-COMP-002, and ND-COMP-003 composited from nine near-dike sampling locations ND-001, ND-002, ND-003, ND-003, ND-004, ND-005, ND-006, ND-007; ND-008, and ND-009. The near-dike stations will be located in the harbor, near enough to the dike wall to obtain a representative sample, but at an appropriate distance to maintain safety and to avoid contamination of the samples by fines and solids washing off of the dike wall.
3. Three (3) landing well locations, CH-18-81, CH-19-81, and, CH-20-81.
4. Three (3) background sampling locations, BACK-001, BACK-002, and BACK-003. Two of the background stations will be located in the harbor approximately 1000' from the dike wall and the third background station will be located approximately 1000' south of the CDF and 50' offshore of the landing.
5. Three (3) river sampling locations, RIV-001, RIV-002, and RIV-003. The river samples would be located 200' upstream of the filter cell effluent, at the filter cell effluent, and 200' downstream of the filter cell effluent, respectively.

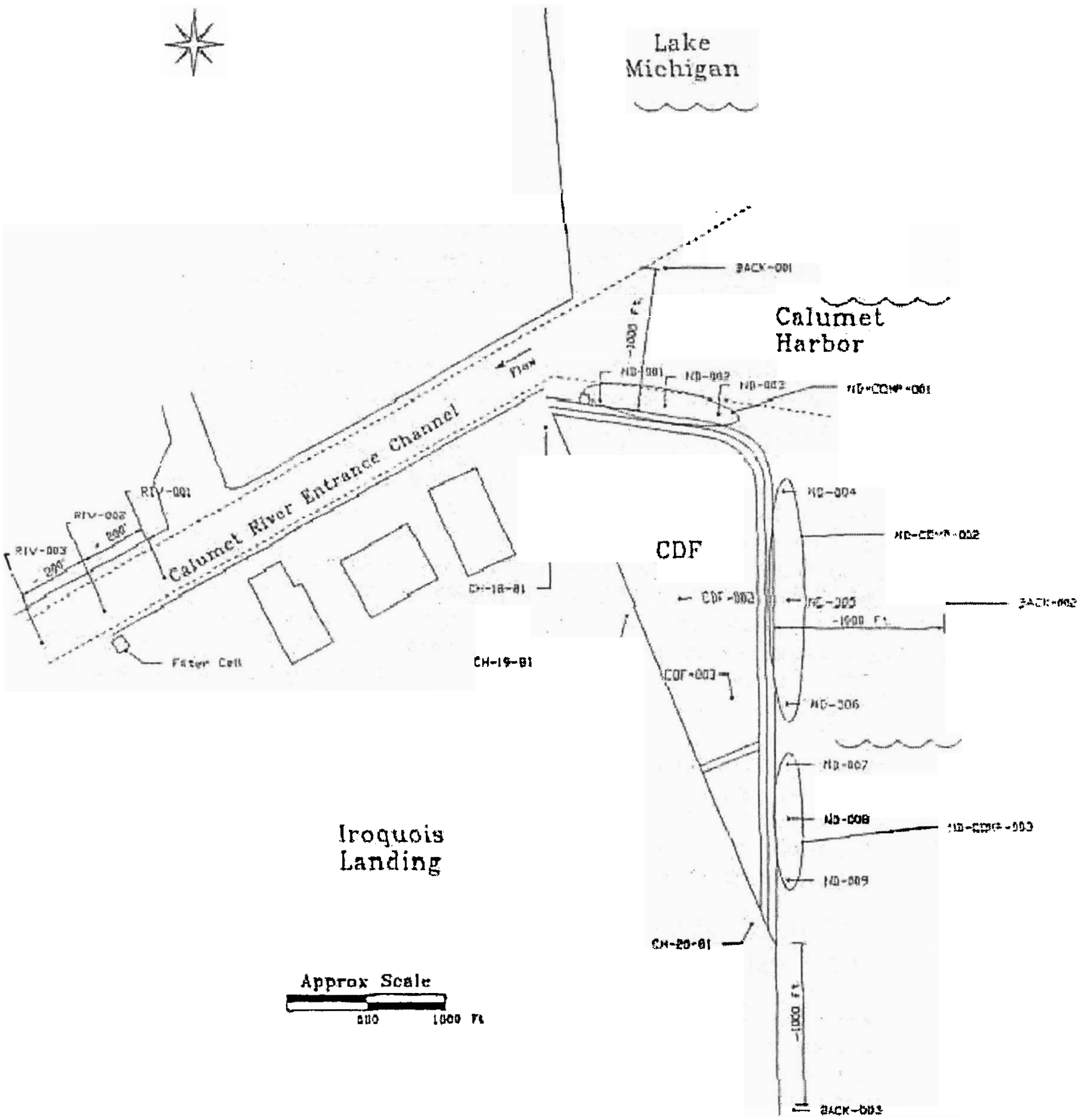


Figure 4. Proposed Sampling Locations during Routine Monitoring and Dredging Events

5.2 Proposed Target Parameters and Required Detection Limits

5.2.' Target Parameters During Routine Monitoring

A major shortcoming in the current monitoring program for the Chicago CDF is the large number of "non-detect" results present in the data sets collected to date. The "non-detects" have made it difficult to directly compare data from the various sampling locations. This makes it difficult to quantify the impact of the CDF on Calumet Harbor water quality and to detect a breach of the CDF. Additionally, the large number of non-detects is an indication that the current monitoring program is inefficient in terms or costs and the amount of information it provides.

In order to provide a standardized water quality data set and allow for more meaningful comparisons between sampling locations, USACE proposes targeting sample analysis to the smaller, more meaningful parameter set during routine monitoring. Based on historical results, chromium, manganese, zinc, phosphorus, ammonia, and total kjeldahl nitrogen (TKN) are the contaminants *most likely to occur at detectable levels at all sampling locations. Therefore*, it would be expected that monitoring the concentrations of these six contaminants could provide an indication of contaminant migration from the CDF. Contaminant concentrations significantly above background levels could be an indication of a leak or release from the CDF. Additionally, large *differences in pH levels, total suspended solids (TSS), and/or Total Dissolved Solids* (TDS) concentrations could indicate potential problems with the performance of the CDF.

The proposed parameter set is listed in Table 2 along with their corresponding RDLs. The parameter list contains three metals, three nutrients, and three general water quality parameters. This new parameter set and corresponding RDLs should provide a more complete and useful data set for quantitative analysis and statistical comparisons between sampling locations.

5.2.2 Target Parameters During Dredging Events

Due to the potential for impact during dredging events, the samples will be analyzed for a more comprehensive parameter list. Samples will be analyzed for each of the parameters listed in Table 3. RDLs are also listed for each parameter.

Parameter	Required Detection Limit (mg/L)
Chromium (total)	0.005
Manganese (total)	*0.005*
Zinc (total)	0.005
Ammonia as Nitrogen	0.01
Phosphorus	0.005
Total Kjeldahl Nitrogen (as N)	0.2
pH	1.0 - 14.0
Total Suspended Solids	5.0
Total Dissolved Solids	5.0

Table 2. Proposed Parameters List for Routine Monitoring

IEPA Permit - 15

Parameter	Required Detection Limit (mg/L)
Parameter from Routine Monitoring	
Chromium (total)	0.005
Manganese	0.005
Zinc	
Ammonia as Nitrogen	
Phosphorus	
Total Kjeldahl Nitrogen (as N)	0.2
pH	±0.01 units
Total Suspended Solids	5.0
Total Dissolved Solids	5.0
Additional Parameters	
Arsenic (total)	0.002
Cadmium (total)	0.02
Copper (total)	0.02
Cyanide (total)	0.01
Lead (total)	0.005
Mercury (total)	0.0002
Nickel (total)	0.02
Oil & Grease	5.0
Temperature	±0.1 °C
Dissolved Oxygen	±0.1 mg/L
Hardness	10.0

Table 3. Proposed Parameters List and RDLs for Dredging Event Monitoring

IEPA Permit - 16

Sampling Frequencies

Sampling Frequencies During Routine Monitoring

USACE has collected routine water quality samples since 1986. The results of this monitoring indicate that the CDF is performing its task of retaining dredged materials within the boundaries of the facility. Additionally, there is no indication that the CDF is adversely impacting the water quality of Calumet Harbor. As noted earlier, the current monitoring plan has several deficiencies and inefficiencies, and the current sampling frequencies (monthly) are excessive and overly costly.

Considering the monitoring results from the period of record (10 years) and a significant safety concern with collection open water samples from the lake and CDF dike wall during winter months, the USACE proposes collecting water quality samples for CDF monitoring three times per year. Approximate dates of sample collection would be March-April, July-August, and November-December. All sampling locations (Near-Dike, Background, River, CDF, and Landing Wells) will be sampled during these three, yearly sampling events.

5.3.2 Sampling Frequencies During Dredging Event Monitoring

Due to the potential for impact during dredging events a more comprehensive sampling program should be implemented during dredging events than during routine monitoring. The sampling locations would be sampled according to the frequencies outlined below:

1. For two weeks before and two weeks after the dredging event water quality samples are collected twice-a-week, and
2. During dredging, samples are collected on a once-a-week schedule except for two consecutive weeks of twice-a-week sampling (scheduled at the approximate half-way point of the dredging event).

These samples will be analyzed for the comprehensive list of contaminants and water quality parameters listed in Table 3.

5.4 Additional Data Collection

5.4.1 Groundwater Elevations

Groundwater elevation data from the Iroquois Landing monitoring wells has been collected to determine the direction of groundwater flow between the

IEPA Permit - 17

landing and the CDF pond. Historical groundwater elevations and lake and CDF pond water levels indicate that groundwater flow has been from Iroquois landing towards the CDF pond and Calumet Harbor. Water level measurements will be collected from the landing wells (CH-18-81, CH-19-81, and CH-20-81) during the monitoring events. These elevations will be compared to the CDF pond and Lake Michigan water elevations in order to determine the direction of flow between landing groundwater, the CDF pond, and Calumet Harbor.

5.4.2 Total Suspended Solids Monitoring During Dredging Events

In order to continue to assess the performance of the dredging operation during the dredging and rehandling of sediment, water quality samples will be collected around the dredging and rehandling areas and analyzed for total suspended solids (TSS). During dredging, TSS samples will be collected once a week from the same sampling locations shown in Figure 3.

5.5 Reporting

Yearly reports documenting the results of the routine monitoring program will be submitted to IEPA. Additionally, a separate report for each dredging event will be prepared to document the results of monitoring during dredging in order to assess the performance of the dredging operations

6. Advantages of the New Sampling Program

The new sampling locations would have several major advantages over the current sampling locations.

1 An important advantage of the new sampling program is that the sampling locations will be standardized across routine monitoring and dredging events in order to provide a uniform, long-term data set for quantitative analysis. Standardization of the sampling locations will also allow for comparisons of contaminant concentrations during dredging and non-dredging events.

2. The use of three (3) near-dike composite samples from nine (9) near-dike sampling locations in place of the dike well locations has two advantages over the current plan. First, the nine (9) sampling locations provides a greater area of coverage than the three (3) dike wells. This addresses the problem of discrete fingers of contaminant plumes as discussed in *Pranger and Schroeder* (1986). Second, using near-dike stations allows for plume dispersion (if the dike wall is

IEPA Permit - 18

breached), thereby increasing the probability of detecting a release at one of the sampling locations. Using near-dike stations also would constitute a mixing zone allowance as provided for in Section 131 of Act 40 of the Code of Federal Regulations.

3. The collection of three (3) samples from each of the sampling environments (CDF, river, near-dike, landing wells, and background) allows for analysis of the variation within a given sampling environment and provides for more valid statistical comparisons.

4. The new parameter set will increase the cost effectiveness of the monitoring program by reducing the number of "non-detect" data appearing in the data sets. This will reduce the complexity and increase the validity and power of statistical comparisons made using the data sets.

5. The addition of sampling locations in Calumet River will provide an indication of any impacts to water quality due to dredging operations and/or a breach in the CDF. Currently, there is not any data available regarding water quality in Calumet River during non-dredge periods for comparison to the dredging event data.

6. Similar environments of the sampling locations will allow for a more direct and useful comparison between sampling stations.

7. Monitoring background locations during routine monitoring will allow for the calculation and analysis of natural and man-induced (besides the CDF) variances in contaminant concentrations. The background samples can be used for comparisons with the other sampling locations.

This revised sampling plan will provide more meaningful and cost-effective data set and allow for quantitative comparisons between the sampling locations over time. Additionally, by monitoring the proposed station, USACE will be able to collect a standardized data set during dredging and non-dredging periods and make more meaningful comparisons between the data sets.

7. References

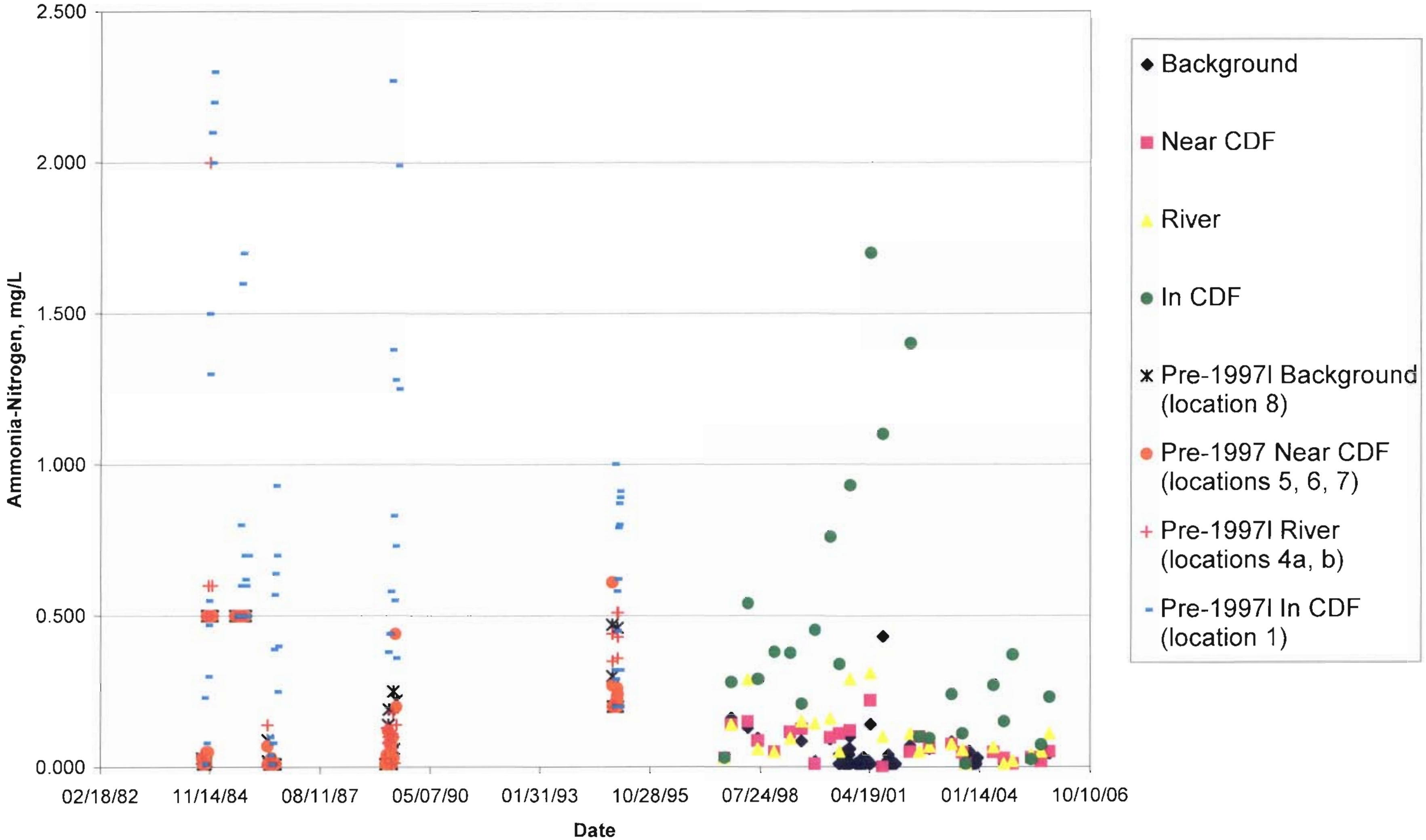
Pranger, S.A., and P.R. Schroeder, 1986, "Dye Tracer Studies at the Kenosha, Manitowoc, Milwaukee, and Kewaunee Harbors Combined Disposal Facilities", *Miscellaneous Paper D-86-4*, Depart of the Army Waterways Experiment Station, Vicksburg, MS.

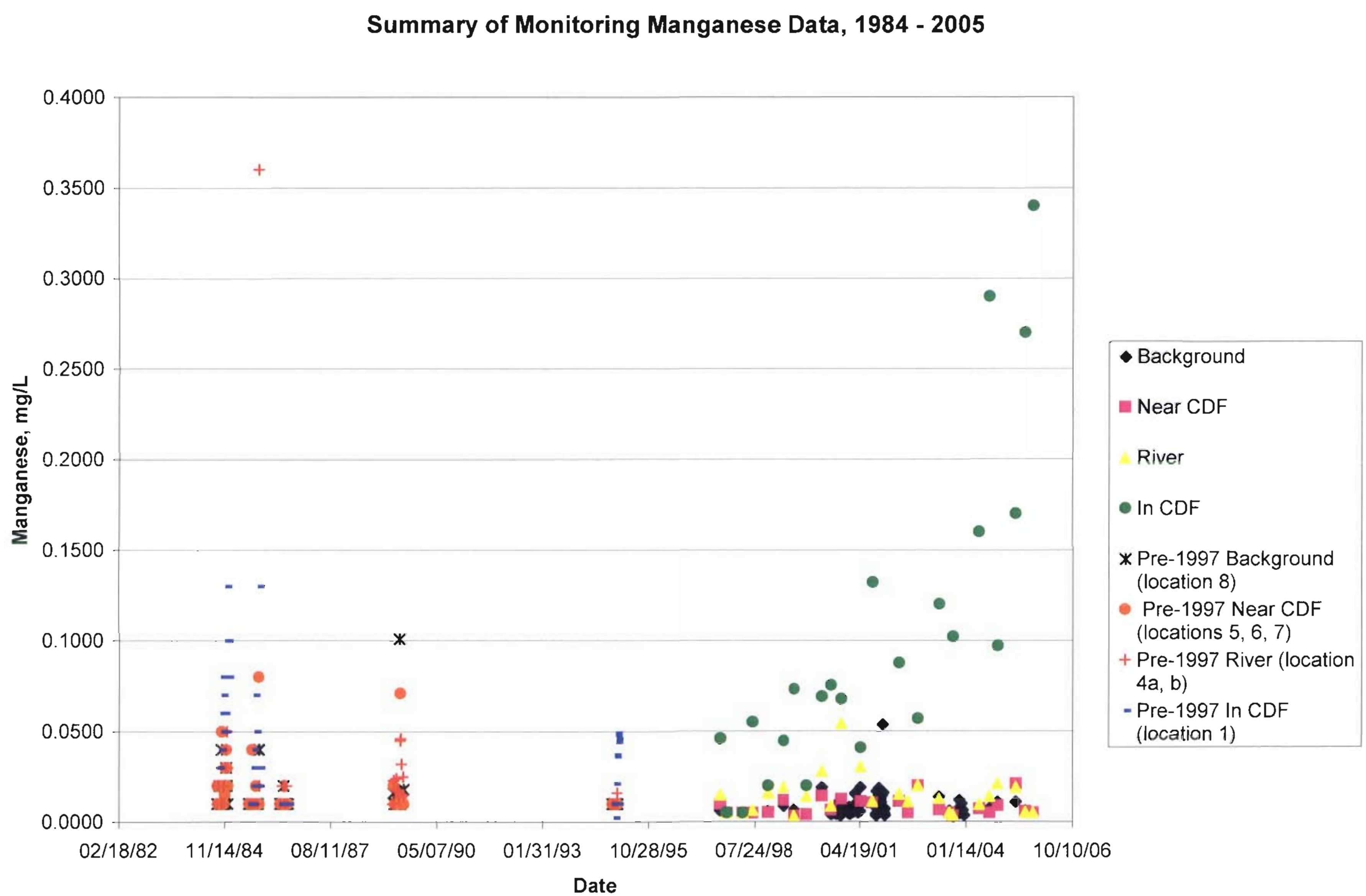
USACE, 1995, "Report on Maintenance Dredging of Calumet River (12/2/94 through 12/31/94), Prepared by U.S. Army Corps of Engineers, Chicago District, November, 1995.

IEPA Permit - 20

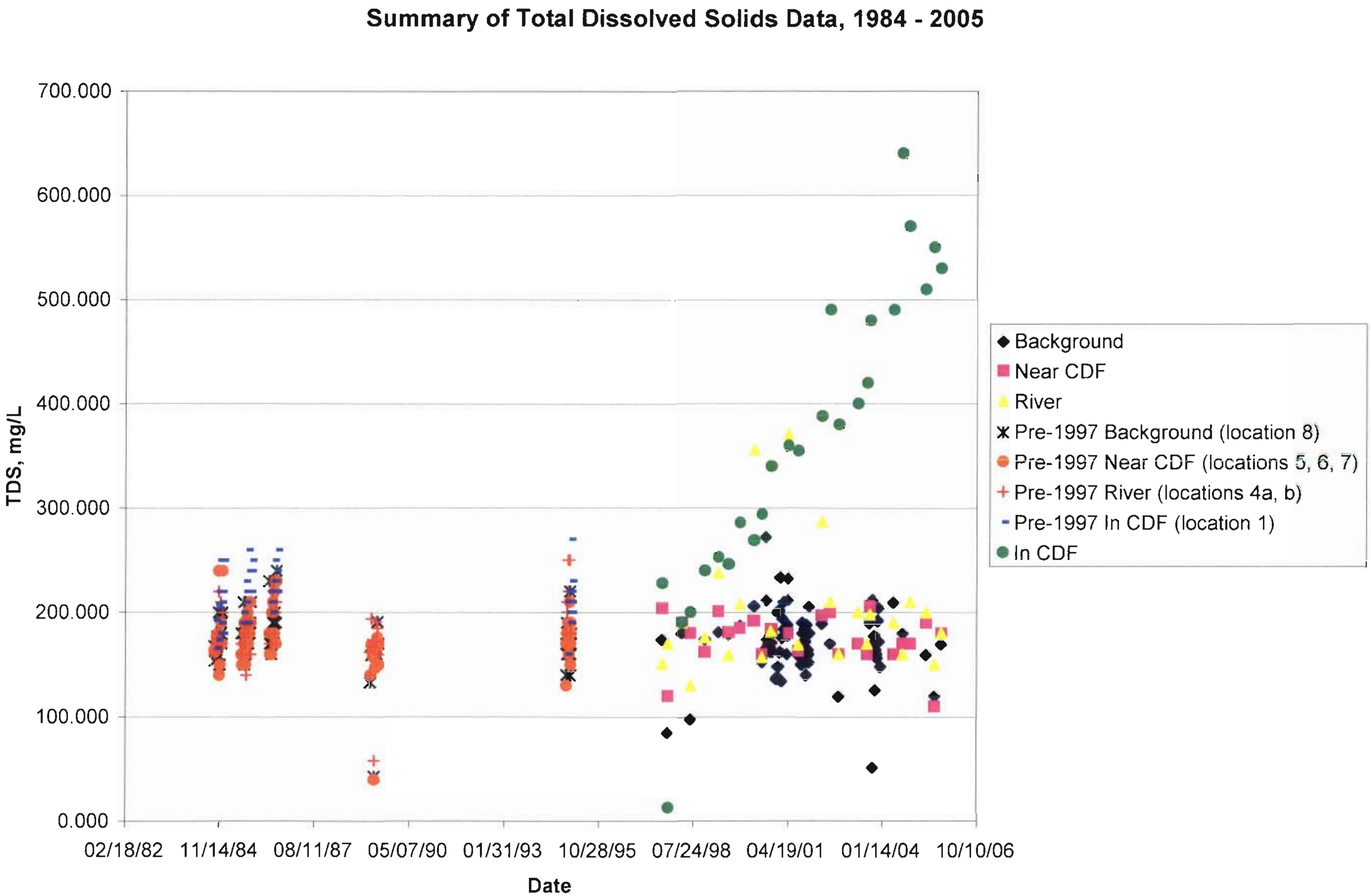
Appendix B: Data Plots

Summary of Monitoring Ammonia Data, 1984 - 2005

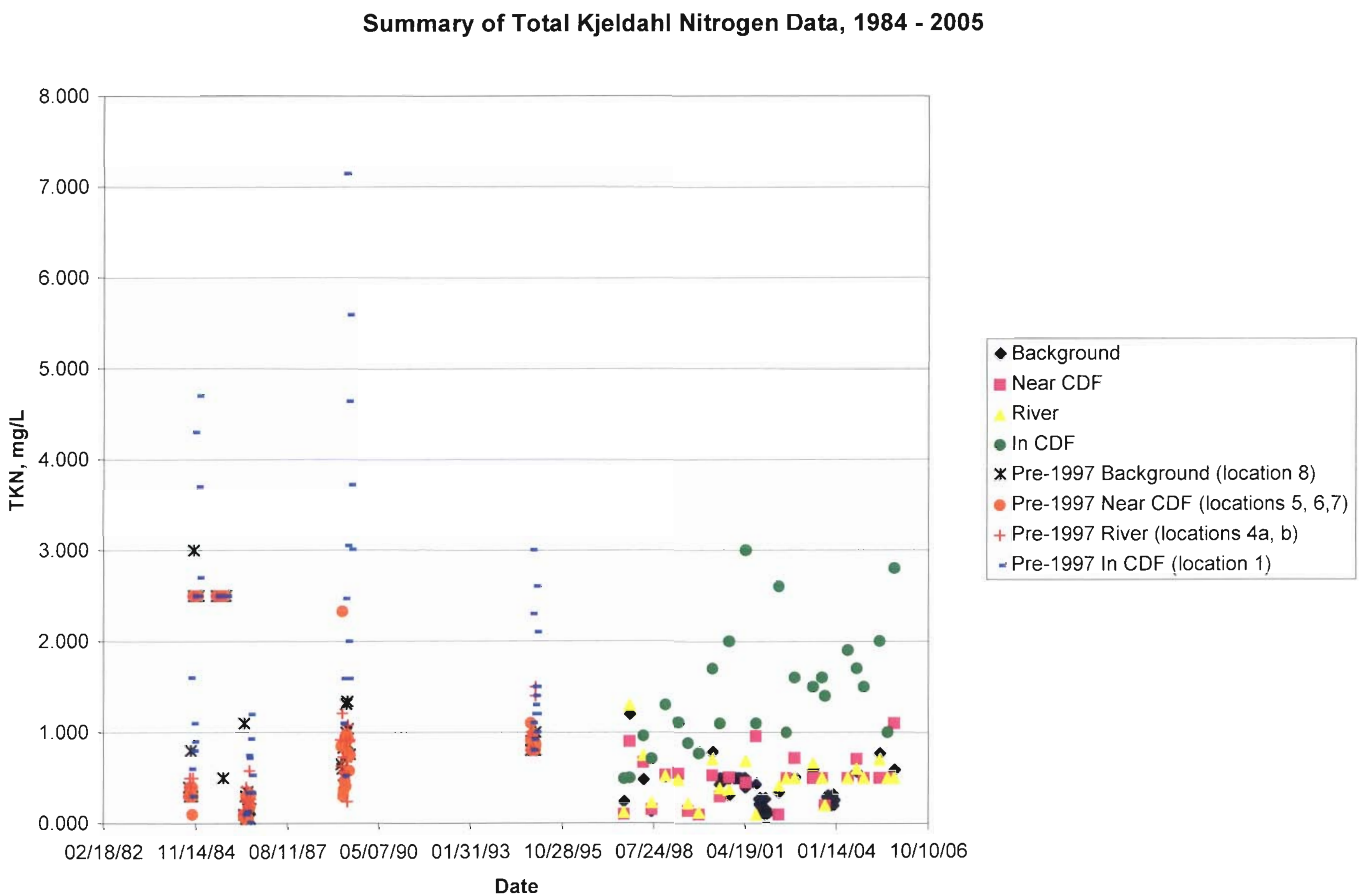




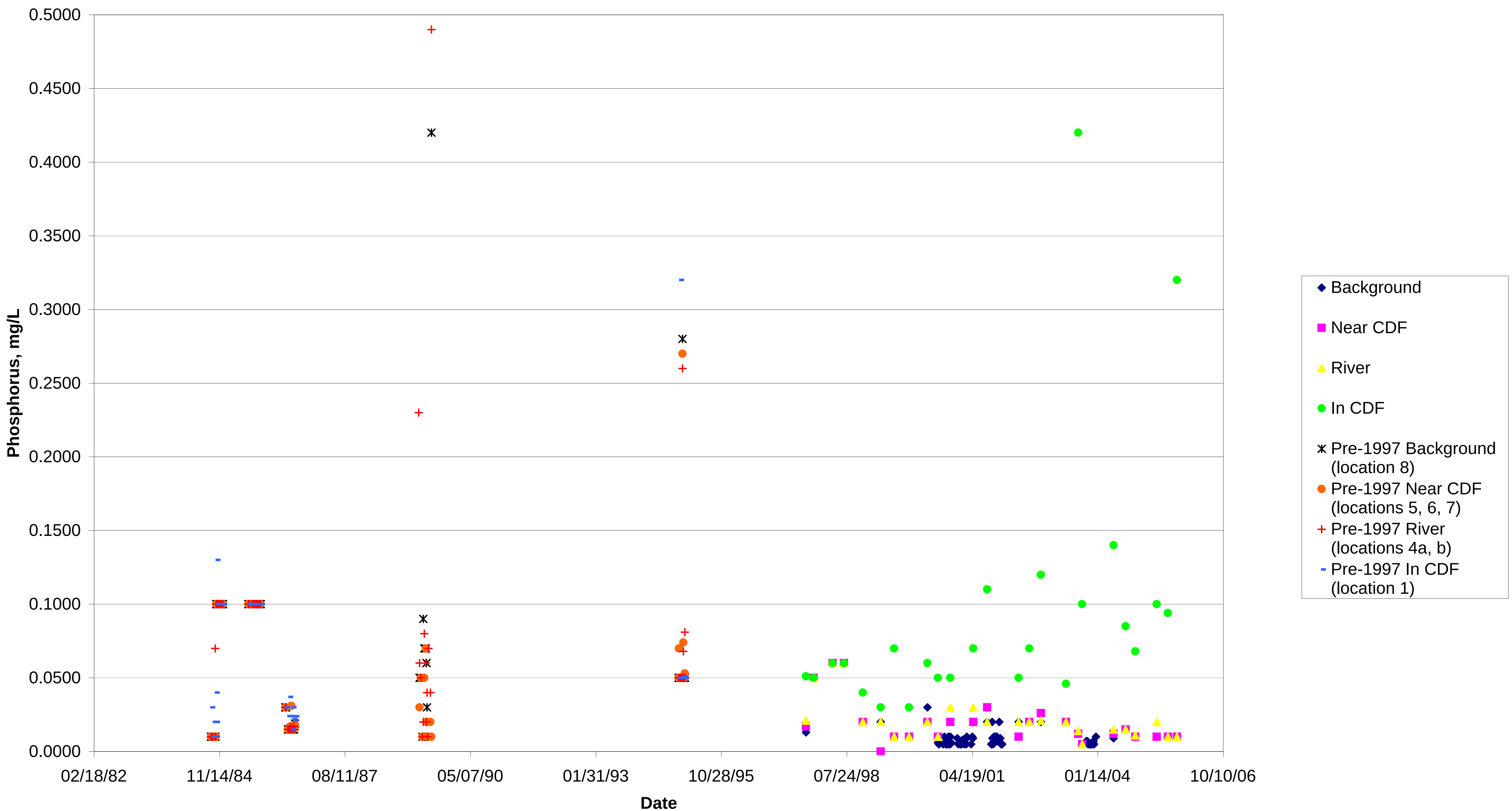
Summary of Monitoring Manganese Data, 1984 - 2005
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Manganese, mg/L
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
Date
Background
Near CDF
River
In CDF
Pre-1997 Background (location 8)
Pre-1997 Near CDF (locations 5, 6, 7)
Pre-1997 River (location 4a, b)
Pre-1997 In CDF (location 1)

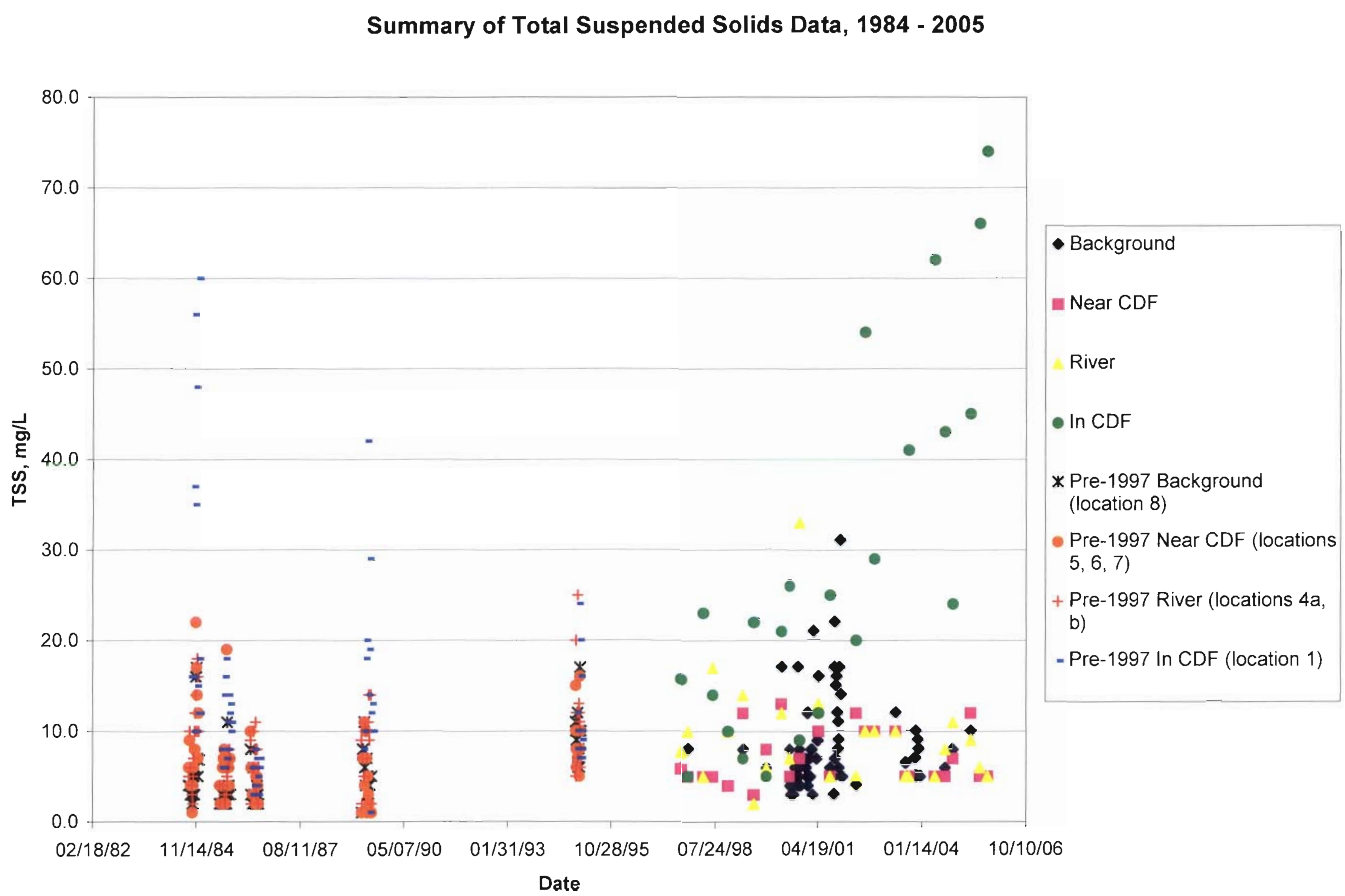


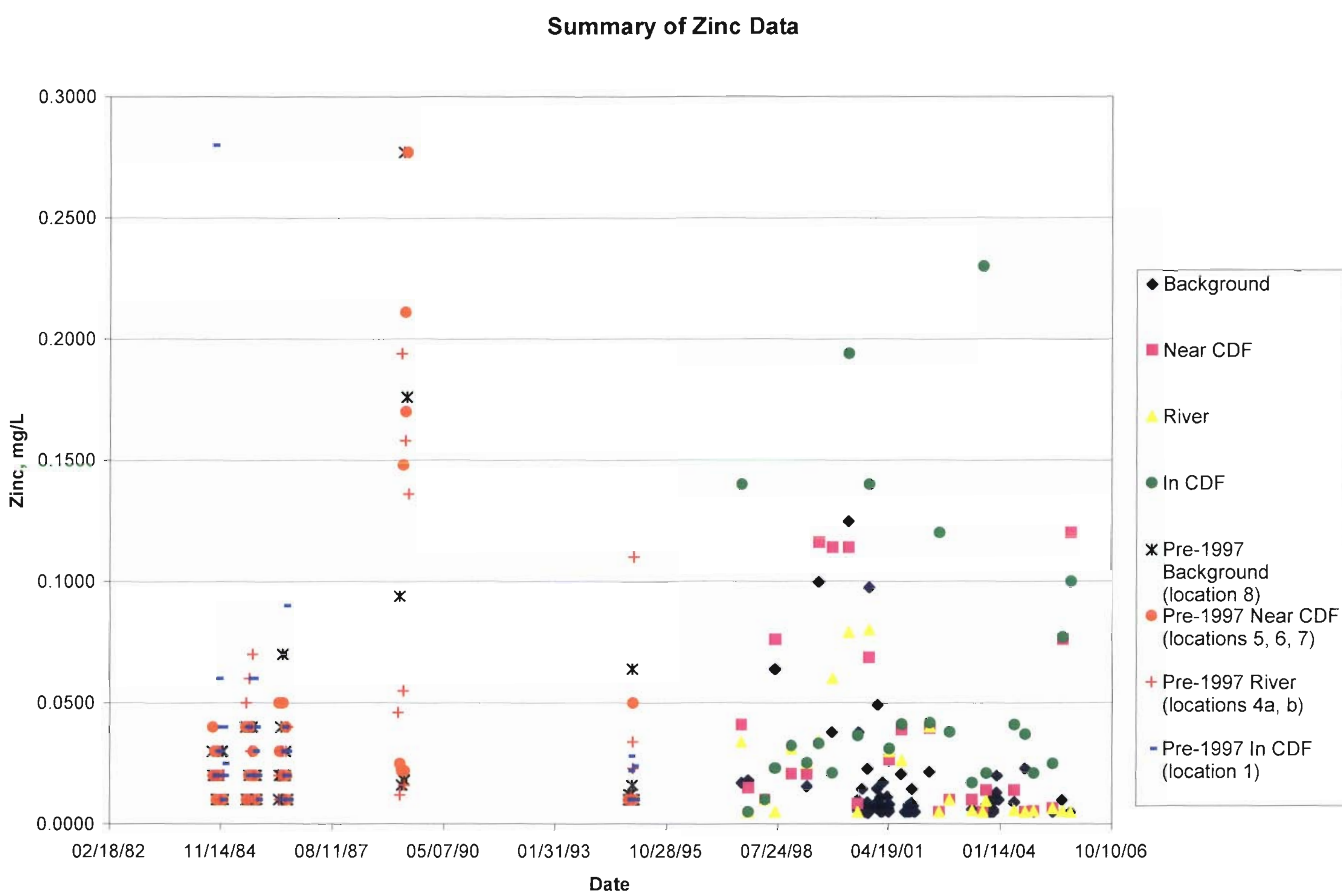
Summary of Total Dissolved Solids Data, 1984 - 2005
700.000
600.000
500.000
400.000
300.000
200.000
100.000
0.000
TDS, mg/L
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
Date
Background
Near CDF
River
Pre-1997 Background (location 8)
Pre-1997 Near CDF (locations 5, 6, 7)
Pre-1997 River (locations 4a, b)
Pre-1997 In CDF (location 1)
In CDF


Summary of Total Kjeldahl Nitrogen Data, 1984 - 2005
TKN, mg/L
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
Date
Background
Near CDF
River
In CDF
Pre-1997 Background (location 8)
Pre-1997 Near CDF (locations 5, 6,7)
Pre-1997 River (locations 4a, b)
Pre-1997 In CDF (location 1)

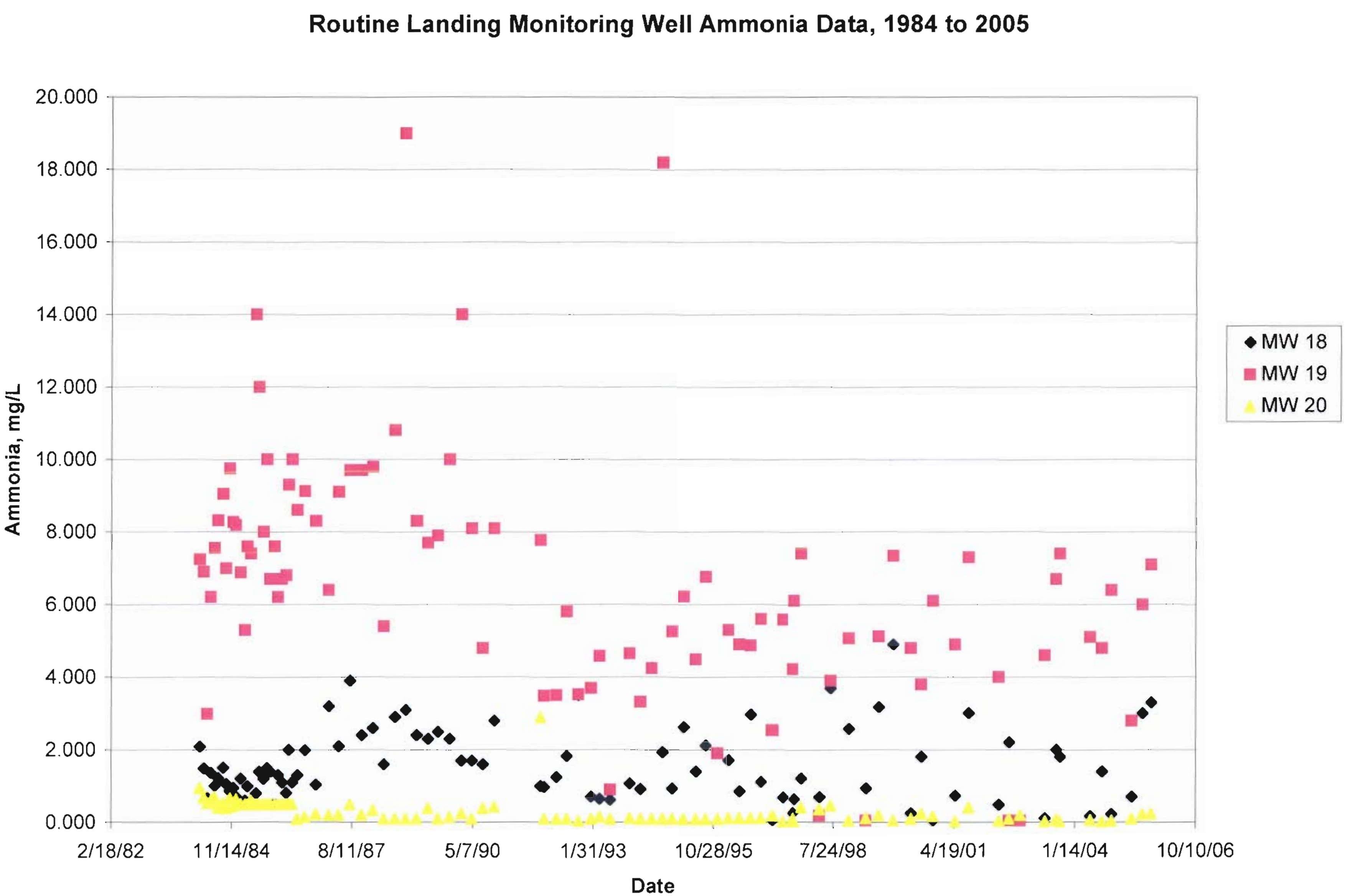
Summary of Total Phosphorus Data, 1984 - 2005

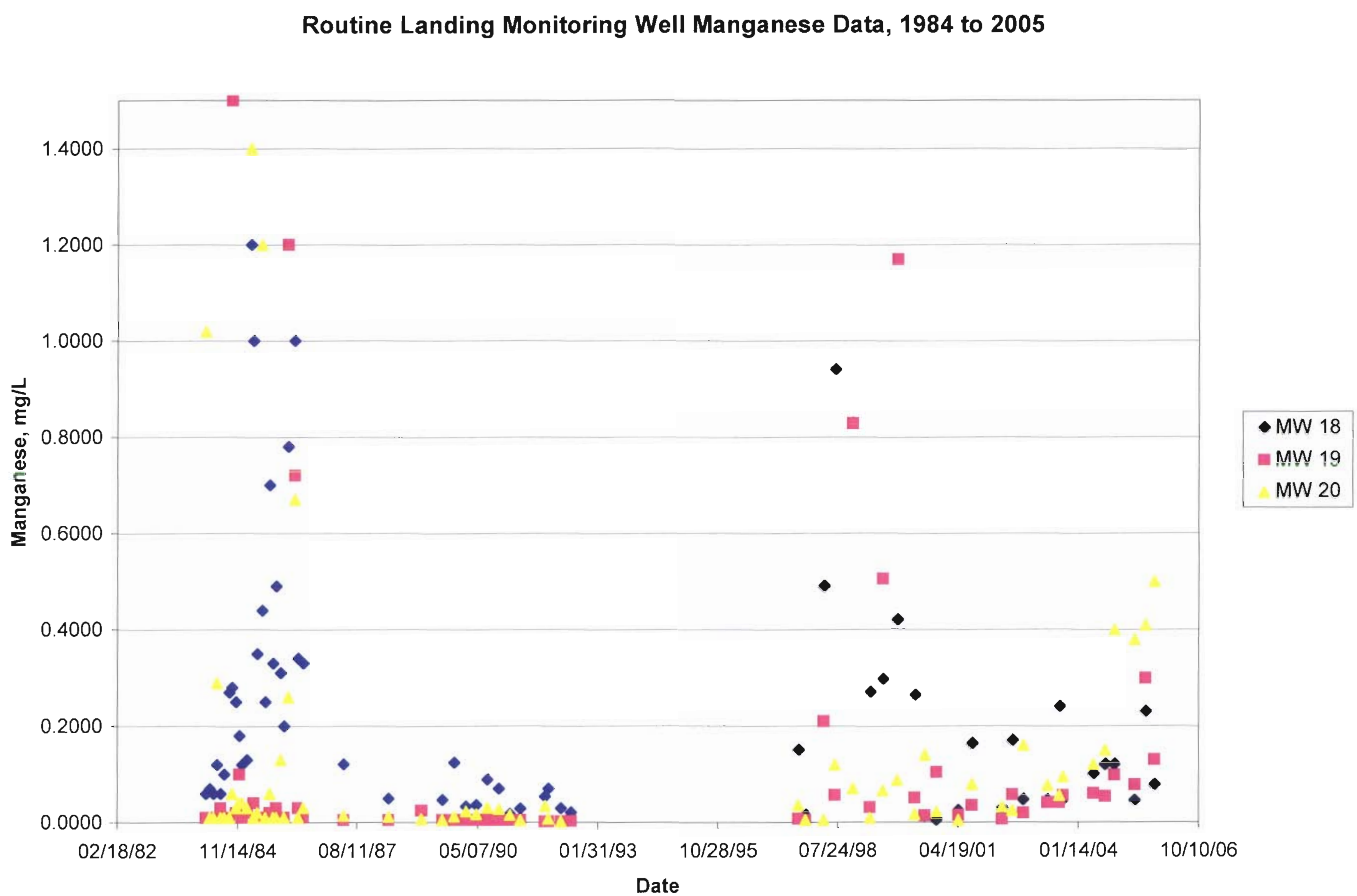


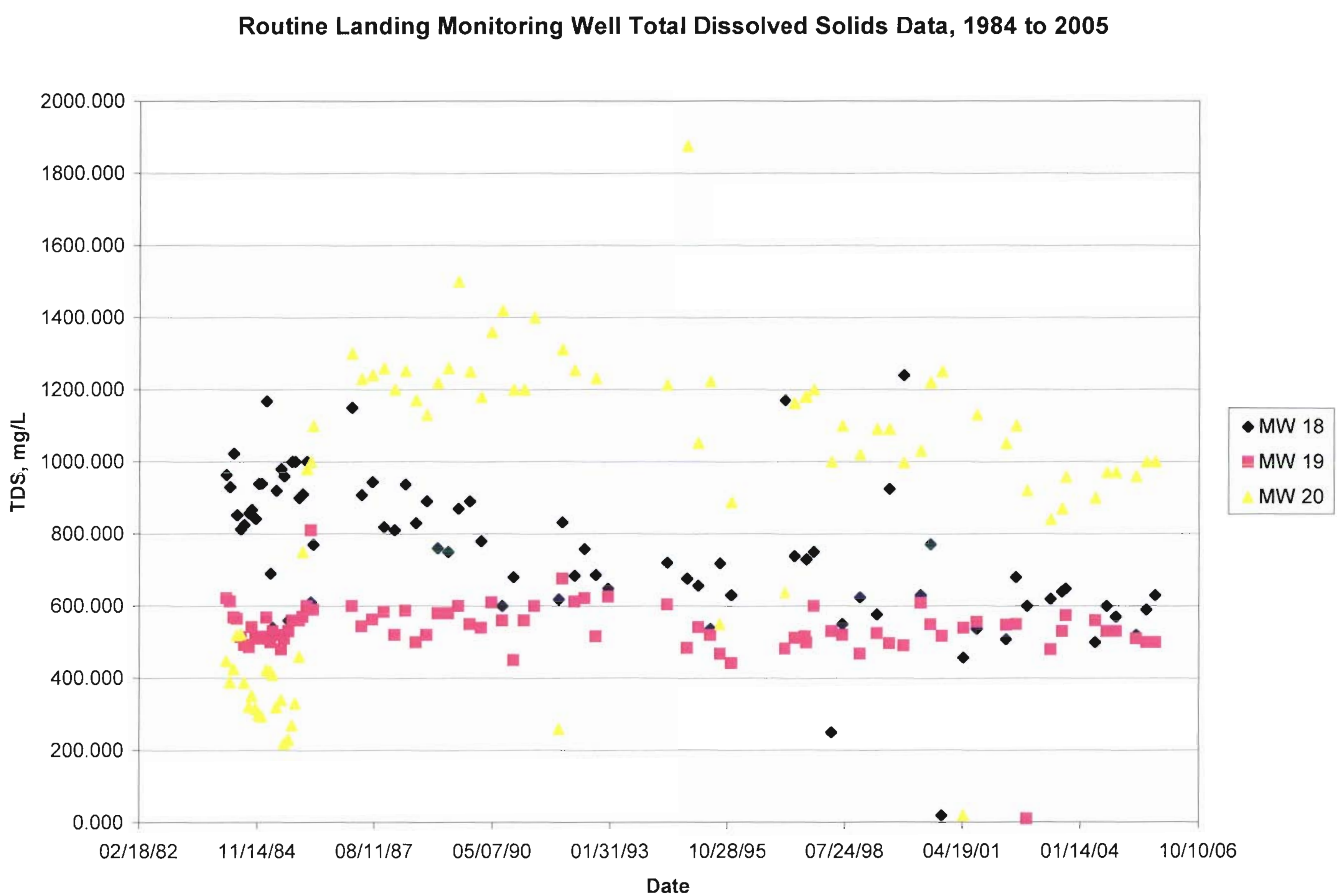

Summary of Total Suspended Solids Data, 1984 - 2005
TSS, mg/L
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
Date
Background
Near CDF
River
In CDF
Pre-1997 Background (location 8)
Pre-1997 Near CDF (locations 5, 6, 7)
Pre-1997 River (locations 4a, b)
Pre-1997 In CDF (location 1)



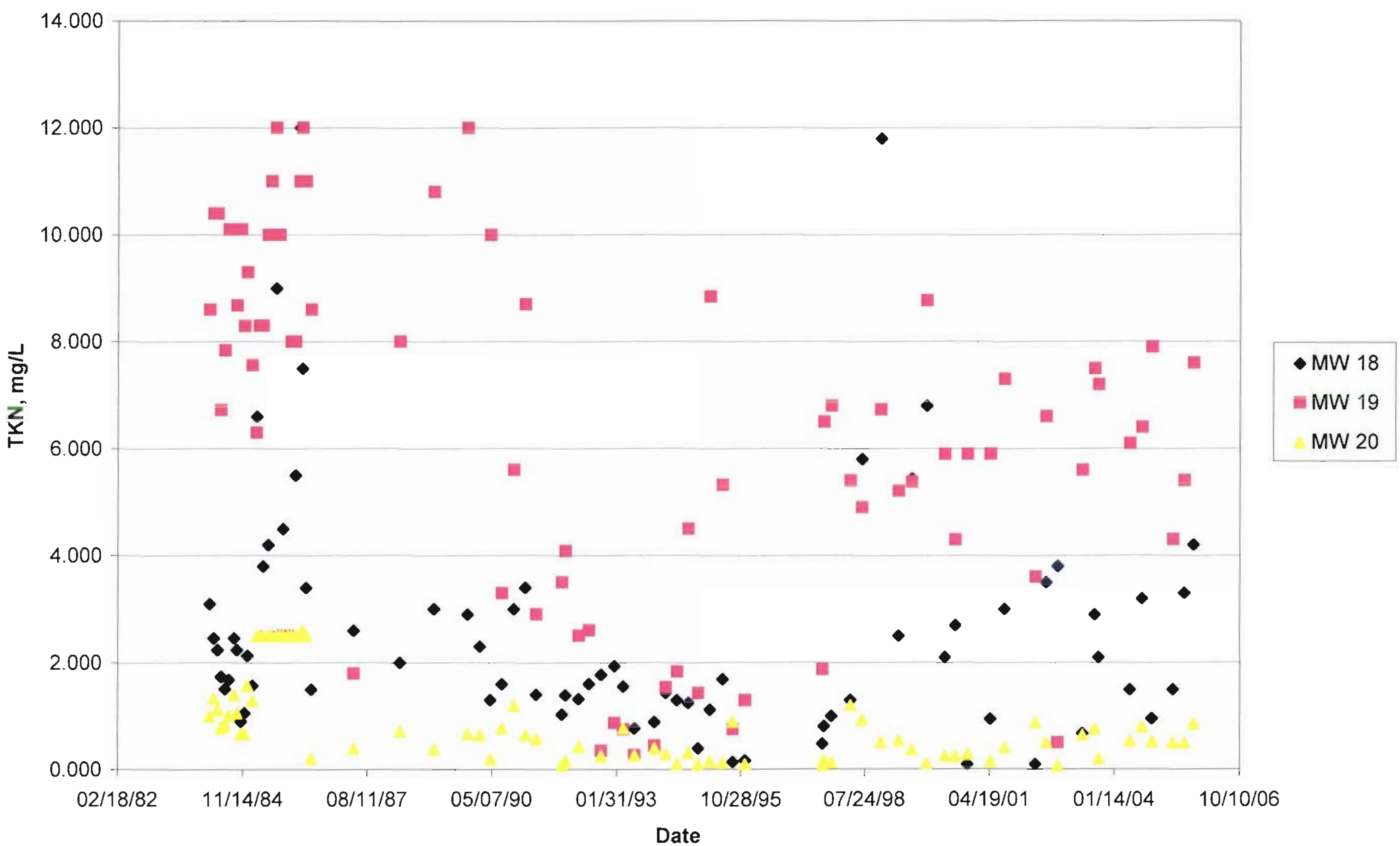
Summary of Zinc Data
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Zinc, mg/L
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
Date
Background
Near CDF
River
In CDF
Pre-1997 Background (location 8)
Pre-1997 Near CDF (locations 5, 6, 7)
Pre-1997 River (locations 4a, b)
Pre-1997 In CDF (location 1)


Routine Landing Monitoring Well Ammonia Data, 1984 to 2005
20.000
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
Ammonia, mg/L
2/18/82
11/14/84
8/11/87
5/7/90
1/31/93
10/28/95
7/24/98
4/19/01
1/14/04
10/10/06
Date
MW 18
MW 19
MW 20

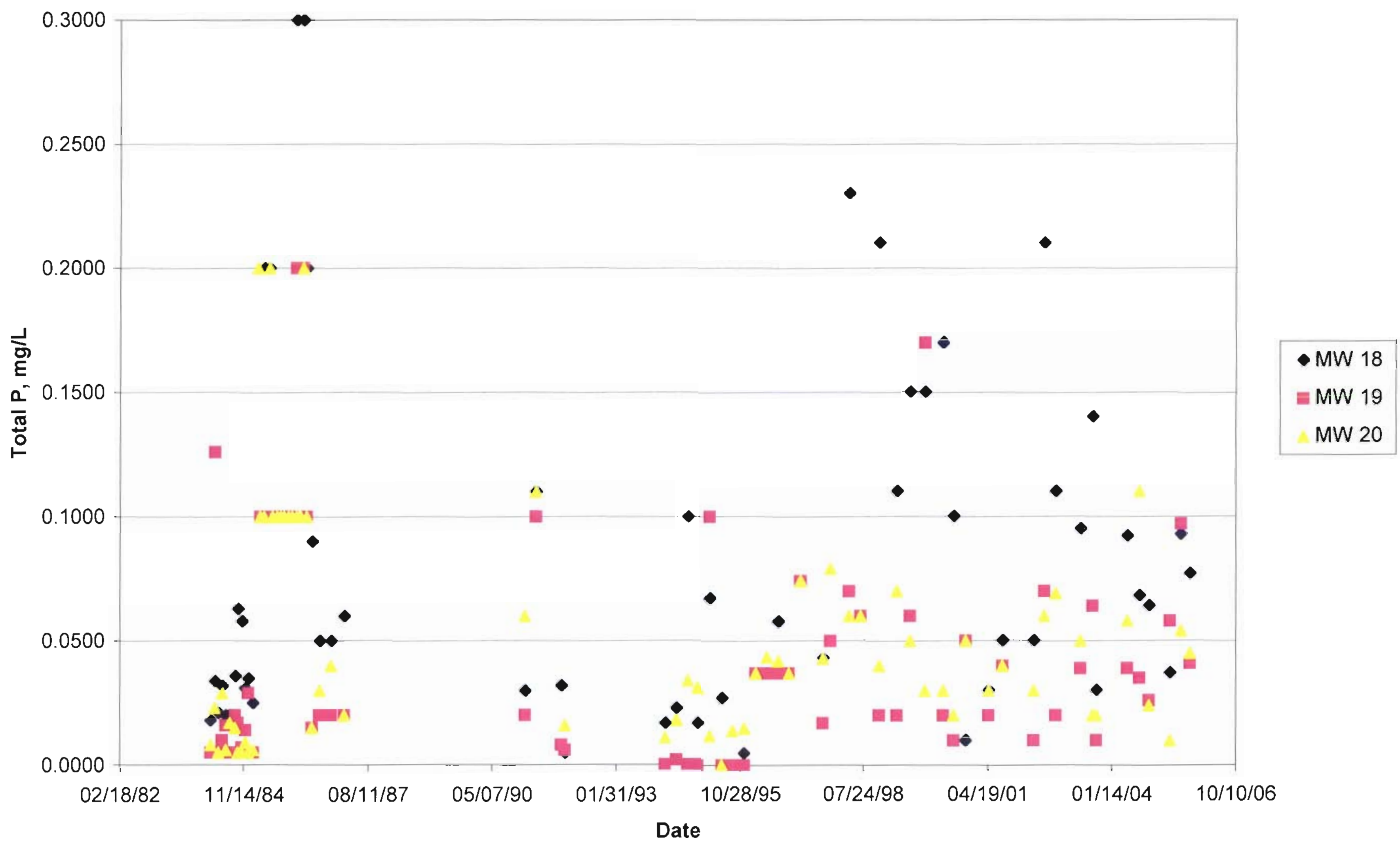

Routine Landing Monitoring Well Manganese Data, 1984 to 2005
Manganese, mg/L
1.4000
1.2000
1.0000
0.8000
0.6000
0.4000
0.2000
0.0000
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
Date
MW 18
MW 19
MW 20


Routine Landing Monitoring Well Total Dissolved Solids Data, 1984 to 2005
TDS, mg/L
2000.000
1800.000
1600.000
1400.000
1200.000
1000.000
800.000
600.000
400.000
200.000
0.000
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
04/19/01
01/14/04
10/10/06
Date
MW 18
MW 19
MW 20

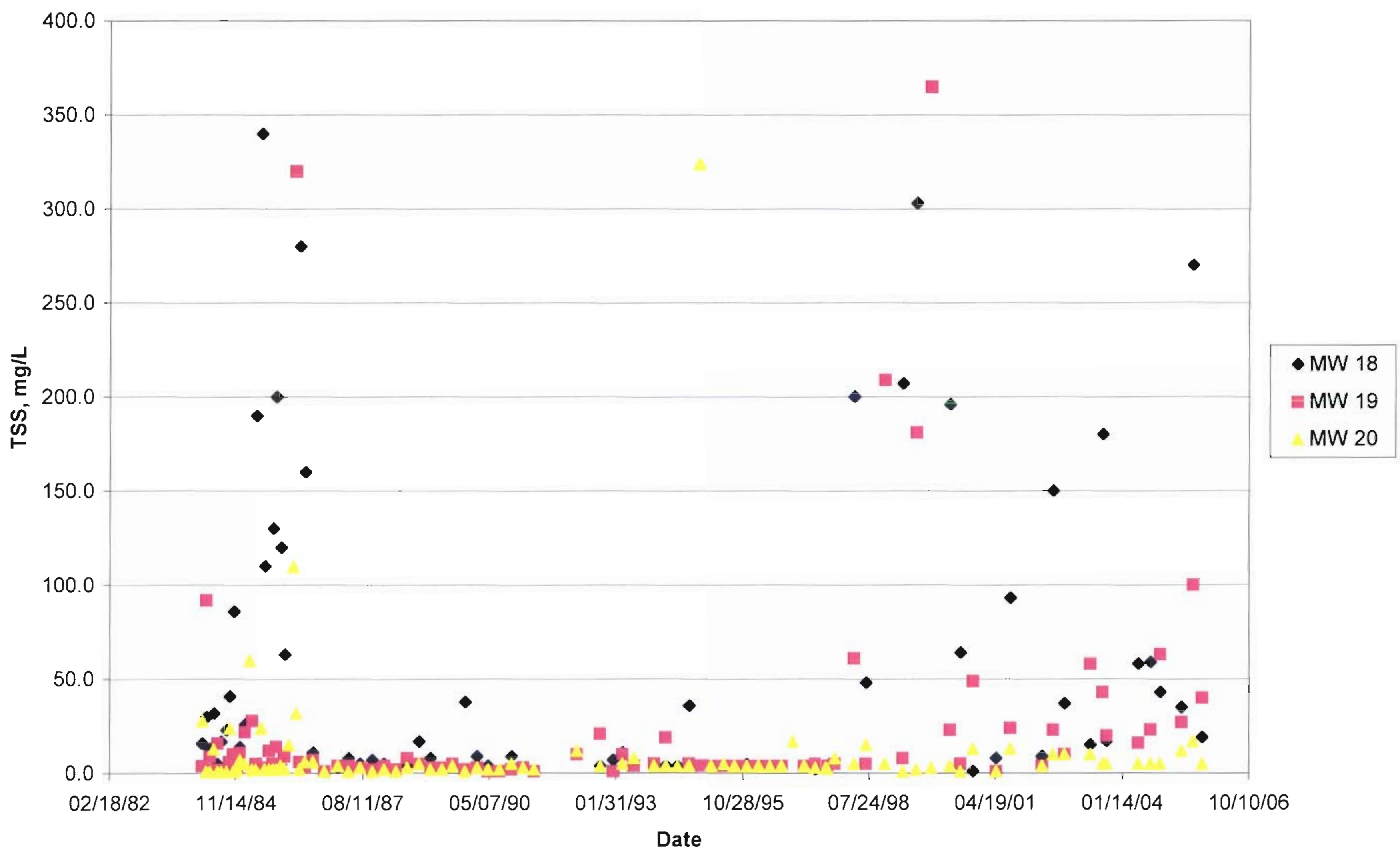
Routine Landing Monitoring Wells Total Kjeldahl Nitrogen Data, 1984 to 2005



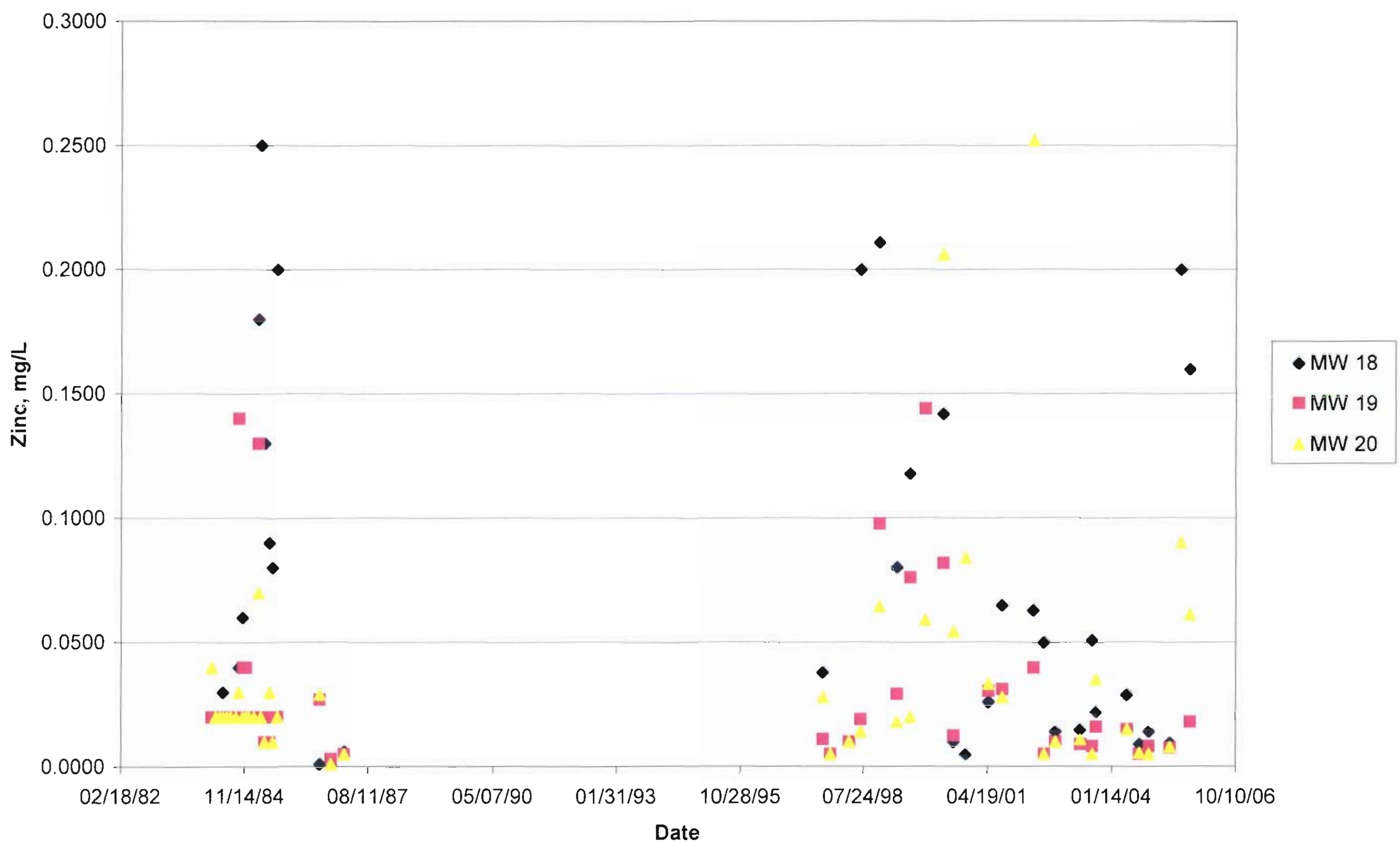
Routine Landing Monitoring Wells Total Phosphorus Data, 1984 to 2005

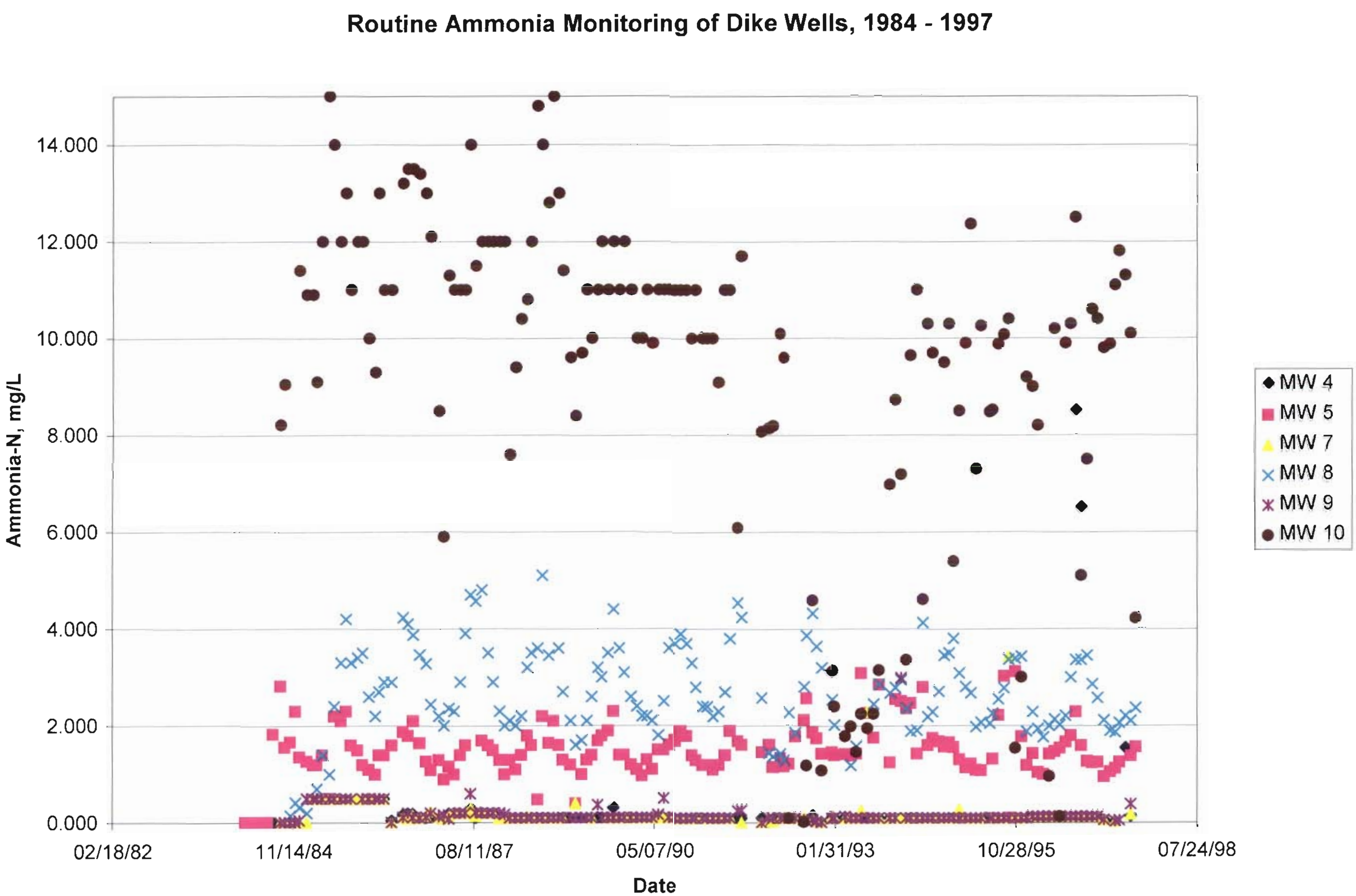


Routine Landing Monitoring Well Total Suspended Solids Data, 1984 to 2005



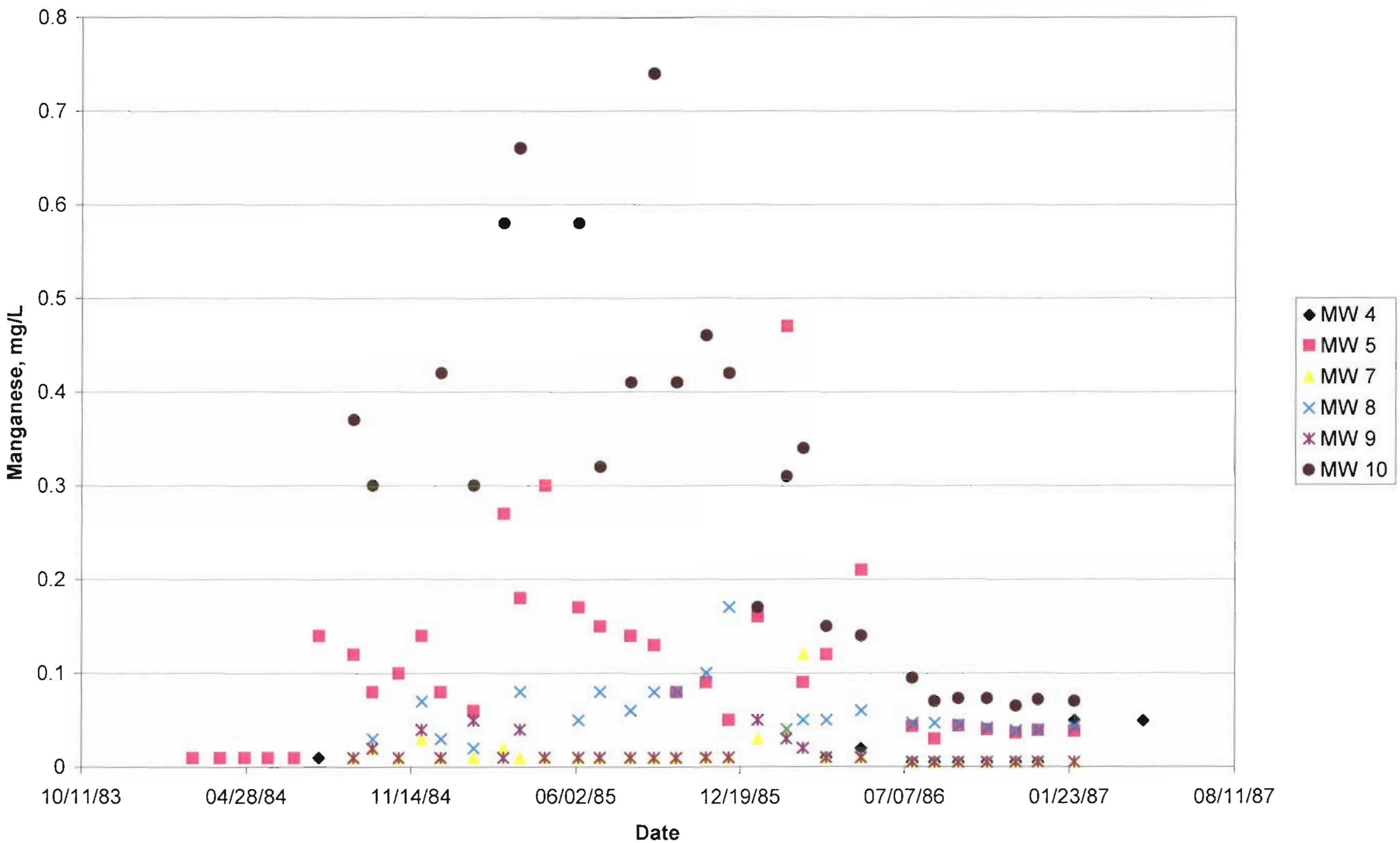
Routine Landing Monitoring Well Total Zinc Data, 1984 to 2005

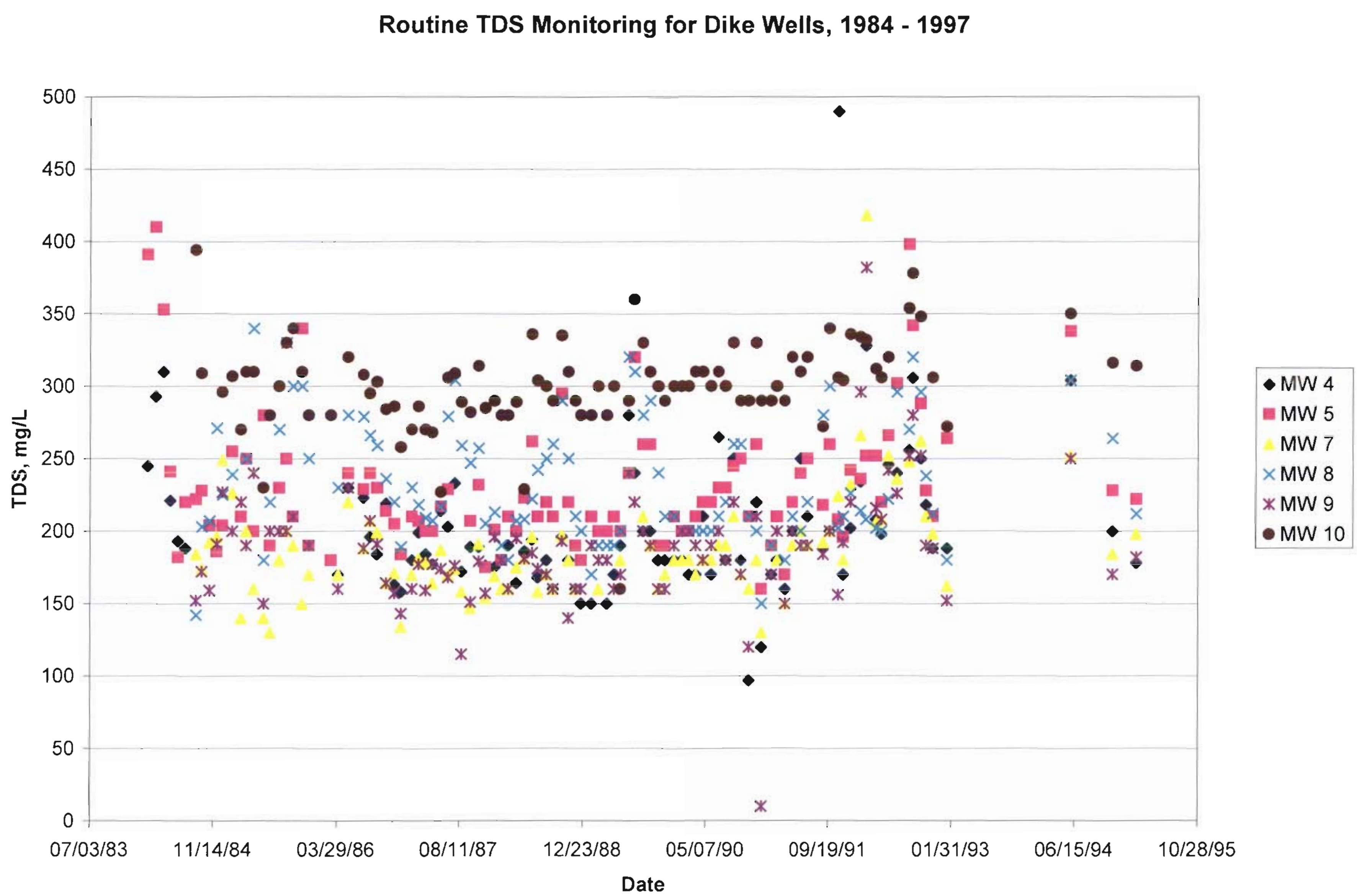


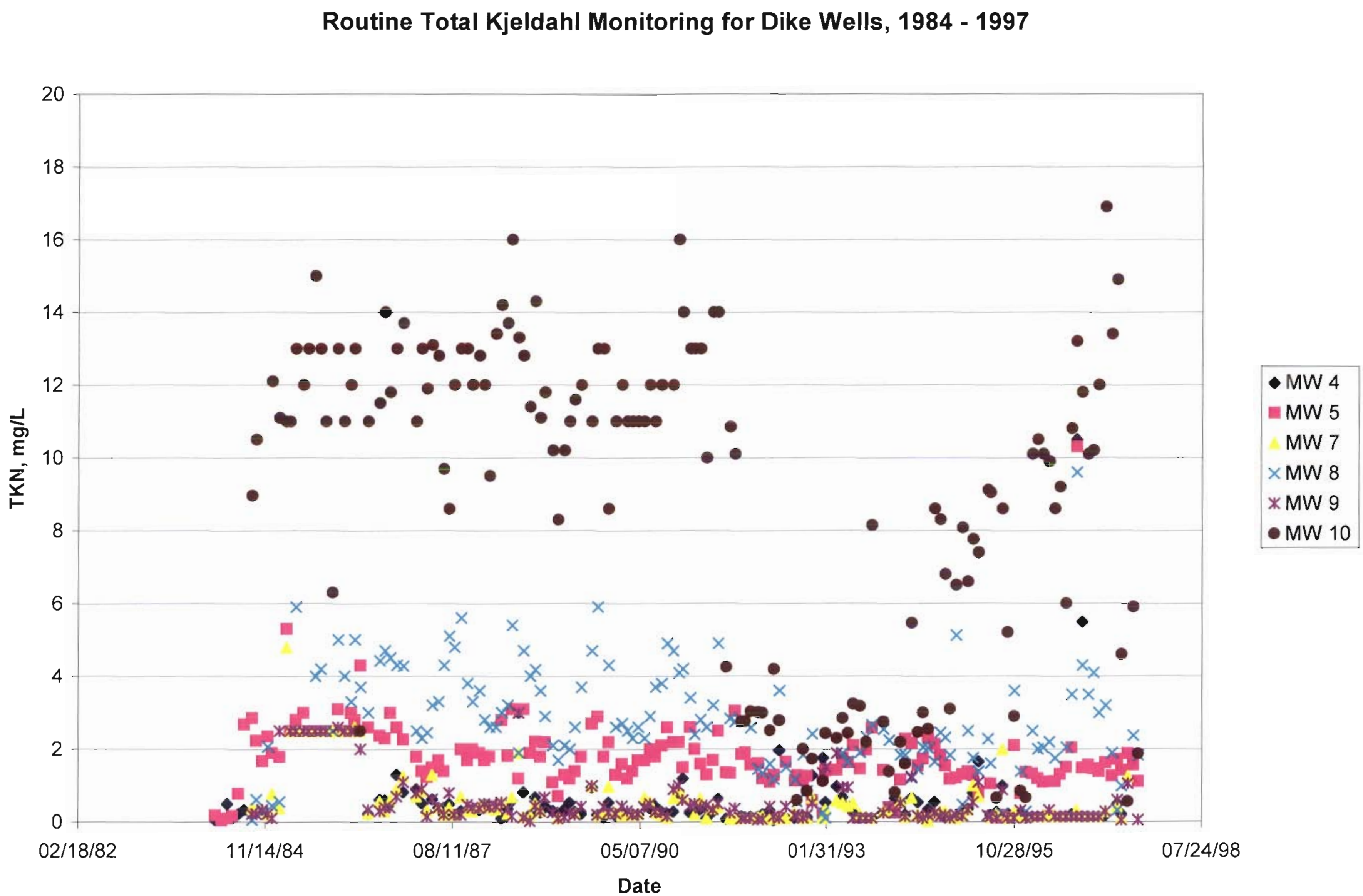


Routine Ammonia Monitoring of Dike Wells, 1984 - 1997
Ammonia-N, mg/L
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
Date
MW 4
MW 5
MW 7
MW 8
MW 9
MW 10

Routine Monitoring Manganese Data for Dike Wells, 1984 - 1997

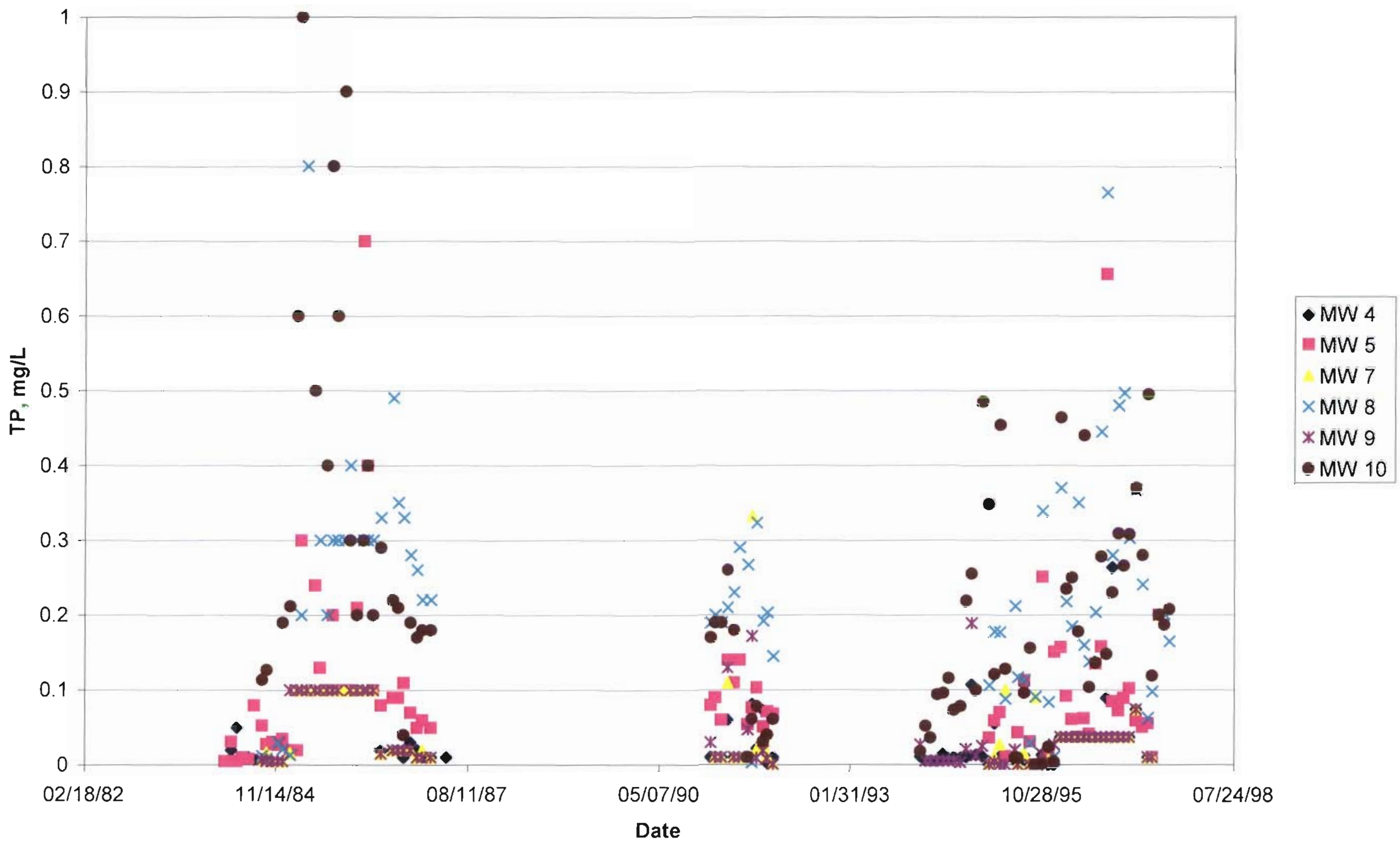


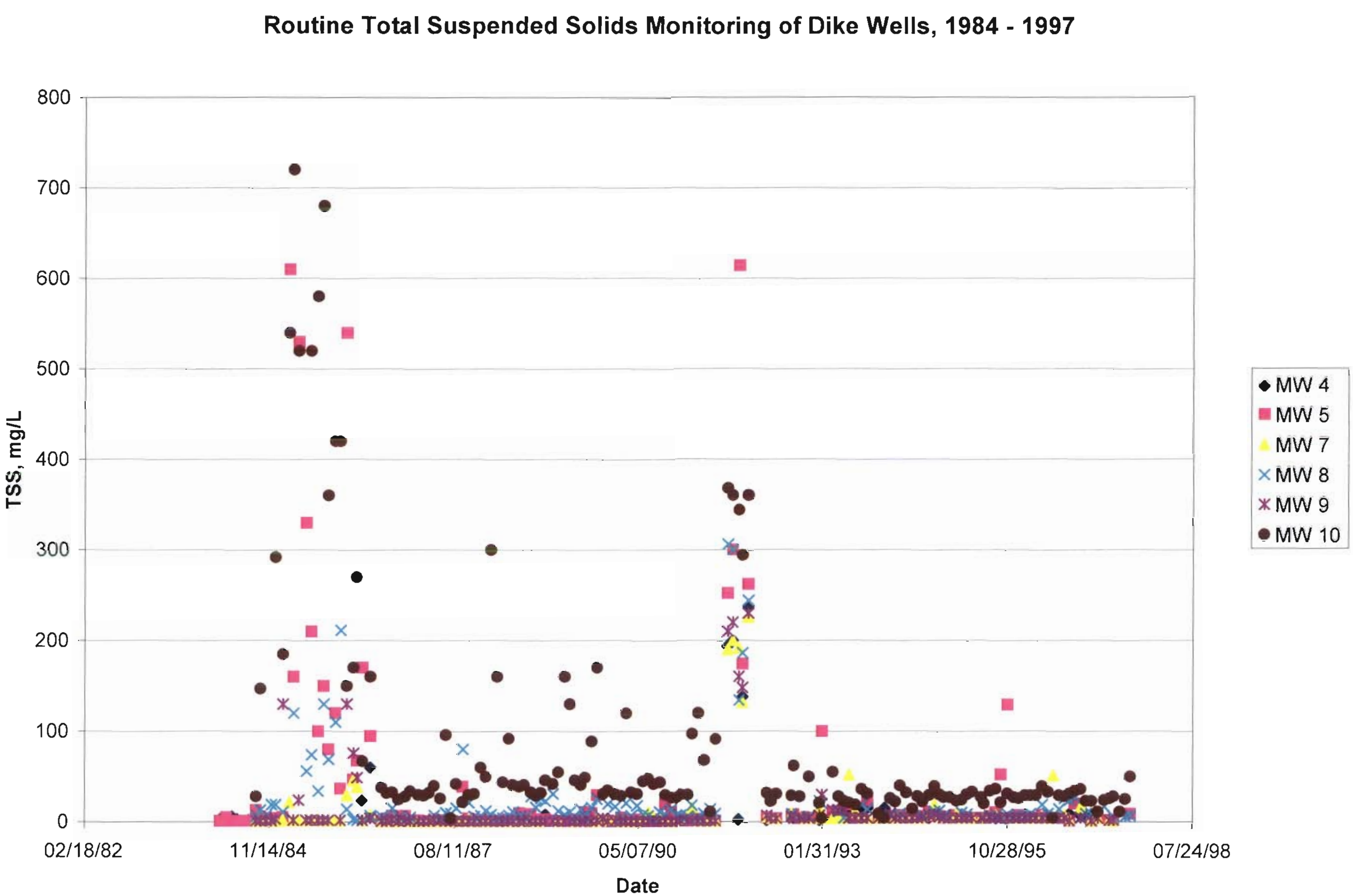

Routine TDS Monitoring for Dike Wells, 1984 - 1997
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
07/03/83
11/14/84
03/29/86
08/11/87
12/23/88
05/07/90
09/19/91
01/31/93
06/15/94
10/28/95
Date
MW 4
MW 5
MW 7
MW 8
MW 9
MW 10



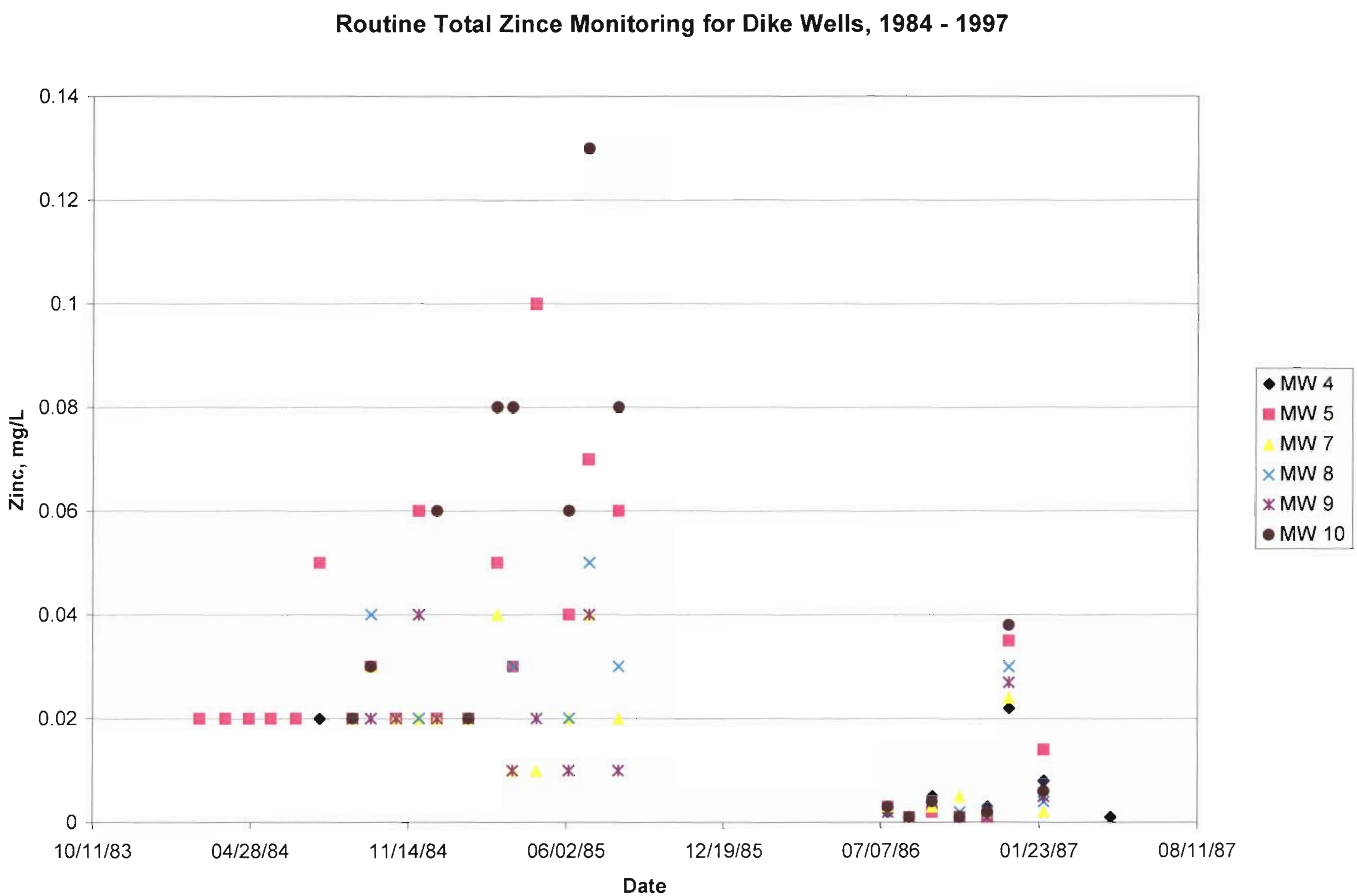
Routine Total Kjeldahl Monitoring for Dike Wells, 1984 - 1997
TKN, mg/L
0
2
4
6
8
10
12
14
16
18
20
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
Date
MW 4
MW 5
MW 7
MW 8
MW 9
MW 10

Routine Total Phosphorus Monitoring for Dike Wells, 1984 - 1997





Routine Total Suspended Solids Monitoring of Dike Wells, 1984 - 1997
TSS, mg/L
800
700
600
500
400
300
200
100
0
02/18/82
11/14/84
08/11/87
05/07/90
01/31/93
10/28/95
07/24/98
Date
MW 4
MW 5
MW 7
MW 8
MW 9
MW 10



Routine Total Zince Monitoring for Dike Wells, 1984 - 1997
Zinc, mg/L
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
10/11/83
04/28/84
11/14/84
06/02/85
12/19/85
07/07/86
01/23/87
08/11/87
Date
MW 4
MW 5
MW 7
MW 8
MW 9
MW 10

Appendix C: Regression Statistics

SUMMARY OUTPUT **Ammonia**

Background

Regression Statistics	
Multiple R	0.19699677
R Square	0.038807727
Adjusted R Square	0.035411288
Standard Error	0.059058269
Observations	285

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.039852521	0.039853	11.42600405	0.000826097
Residual	283	0.987069781	0.003488		
Total	284	1.026922302			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.75859706	0.214315558	3.539627	0.000468266	0.336741958	1.1804522	0.33674196	1.18045216
X Variable 1	-1.94665E-05	5.75891E-06	-3.38024	0.000826097	-3.0802E-05	-8.131E-06	-3.08E-05	-8.1307E-06

SUMMARY OUTPUT **Ammonia**

Near CDF

Regression Statistics	
Multiple R	0.507296942
R Square	0.257350187
Adjusted R Square	0.247176902
Standard Error	0.042813121
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.046367861	0.046368	25.29666522	3.40228E-06
Residual	73	0.133806326	0.001833		
Total	74	0.180174187			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.066488326	0.197871891	5.389792	8.27437E-07	0.672129948	1.4608467	0.67212995	1.4608467
X Variable 1	-2.67735E-05	5.32322E-06	-5.02958	3.40228E-06	-3.7383E-05	-1.616E-05	-3.738E-05	-1.6164E-05

SUMMARY OUTPUT **Ammonia**

River

Regression Statistics	
Multiple R	0.384656843
R Square	0.147960887
Adjusted R Square	0.136289118
Standard Error	0.085153872
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.091921912	0.091922	12.67681794	0.000655893
Residual	73	0.529336275	0.007251		
Total	74	0.621258187			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.502069517	0.393560596	3.816616	0.000281099	0.717703848	2.2864352	0.71770385	2.28643519
X Variable 1	-3.7697E-05	1.05877E-05	-3.56045	0.000655893	-5.8798E-05	-1.66E-05	-5.88E-05	-1.6596E-05

SUMMARY OUTPUT **Ammonia**

ln CDF

Regression Statistics	
Multiple R	0.183216969
R Square	0.033568458
Adjusted R Square	0.02032967
Standard Error	0.44377731
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.499359528	0.49936	2.535614074	0.115624841
Residual	73	14.37649599	0.196938		
Total	74	14.87585552			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	3.663883242	2.051031381	1.786361	0.078193003	-0.42381918	7.7515857	-0.4238192	7.75158566
X Variable 1	-8.78626E-05	5.51776E-05	-1.59236	0.115624841	-0.00019783	2.211E-05	-0.0001978	2.2106E-05

SUMMARY OUTPUT
MW 4

Ammonia

Regression Statistics	
Multiple R	0.175149
R Square	0.030677
Adjusted F	0.023163
Standard E	0.915738
Observatio	131

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	3.423547	3.423546723	4.0825747	0.045398
Residual	129	108.1762	0.838575403		
Total	130	111.5998			

	Coefficients	*'andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-4.22578	2.209544	-1.91251086	0.058027524	-8.59741	0.14586	-8.597413561	0.145859961
X Variable	0.000133	6.57E-05	2.02053822	0.045397909	2.76E-06	0.000263	2.76054E-06	0.000262761

SUMMARY OUTPUT
MW 5

Ammonia

Regression Statistics	
Multiple R	0.046685
R Square	0.002179
Adjusted F	-0.00456
Standard E	0.504733
Observatio	150

ANOVA

	df	SS	MS	F	ignificance F
Regressior	1	0.082353	0.082353424	0.323264852	0.570514
Residual	148	37.70378	0.25475527		
Total	149	37.78613			

	Coefficients	'andard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.978251	0.98653	0.991607776	0.323007328	-0.97125	2.927755	-0.971253382	2.927755242
X Variable	1.68E-05	2.96E-05	0.56856385	0.570513873	-4.2E-05	7.53E-05	-4.16617E-05	7.53191E-05

SUMMARY OUTPUT
MW 7

Ammonia

Regression Statistics	
Multiple R	0.051117
R Square	0.002613
Adjusted R	-0.00413
Standard E	0.343955
Observatio	150

ANOVA

	df	SS	MS	F	ignificance F
Regressior	1	0.045871	0.045870832	0.387733807	0.534451
Residual	148	17.50913	0.118304959		
Total	149	17.555			

	Coefficients	tandard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.598618	0.67228	0.890430166	0.374680133	-0.72989	1.927126	-0.729889286	1.927126185
X Variable	-1.3E-05	2.02E-05	-0.62268275	0.534451276	-5.2E-05	2.73E-05	-5.24185E-05	2.72992E-05

Ammonia

SUMMARY OUTPUT
MW 8

Regression Statistics	
Multiple R	0.041699255
R Square	0.001738828
Adjusted R Square	-0.00500618
Standard Error	1.044092486
Observations	150

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.281029607	0.28103	0.257794789	0.612395061
Residual	148	161.3391097	1.090129		
Total	149	161.6201393			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.549482643	2.040740239	0.759275	0.448895811	-2.48326998	5.5822353	-2.48327	5.58223527
X Variable 1	3.10875E-05	6.12278E-05	0.507735	0.612395061	-8.9906E-05	0.0001521	-8.991E-05	0.00015208

SUMMARY OUTPUT

MW 9

Ammonia

Regression Statistics	
Multiple R	0.175470724
R Square	0.030789975
Adjusted R Square	0.024241259
Standard Error	0.265351221
Observations	150

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.331051328	0.331051	4.701680947	0.031730949
Residual	148	10.42086801	0.070411		
Total	149	10.75191933			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.297880709	0.518644584	2.502447	0.0134209	0.272975496	2.3227859	0.2729755	2.32278592
X Variable 1	-3.37409E-05	1.55607E-05	-2.16834	0.031730949	-6.4491E-05	-2.991E-06	-6.449E-05	-2.991E-06

SUMMARY OUTPUT

Ammonia

MW 10

Regression Statistics	
Multiple R	0.408467
R Square	0.166845
Adjusted F	0.161216
Standard E	3.424778
Observatio	150

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	347.6283	347.6283173	29.63809335	2.11E-07
Residual	148	1735.908	11.72910528		
Total	149	2083.536			

	Coefficients	*'andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	45.72047	6.693931	6.83013792	2.05086E-10	32.49244	58.9485	32.49244219	58.94849507
X Variable	-0.00109	0.000201	-5.444087926	2.11439E-07	-0.00149	-0.0007	-0.001490246	-0.000696493

SUMMARY OUTPUT

Ammonia

MW-18 all data

Regression Statistics	
Multiple R	0.016115
R Square	0.00026
Adjusted R	-0.01061
Standard E	1.025627
Observatio	94

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	0.025138	0.025138385	0.023897818	0.877484
Residual	92	96.77584	1.051911325		
Total	93	96.80098			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.338617	1.469671	0.91082777	0.364766435	-1.58028	4.257511	-1.580276614	4.257511455
X Variable	6.69E-06	4.33E-05	0.15458919	0.877483827	-7.9E-05	9.27E-05	-7.92784E-05	9.26615E-05

SUMMARY OUTPUT

MW 19 all data

Ammonia

Regression Statistics	
Multiple R	0.460452
R Square	0.212016
Adjusted R	0.203451
Standard E	2.900615
Observatio	94

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressioi	1	208.267	208.2670076	24.75370576	3.02E-06
Residual	92	774.0483	8.413568846		
Total	93	982.3153			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	27.21239	4.156433	6.547053943	3.29145E-09	18.95736	35.46742	18.95735574	35.46742464
X Variable	-0.00061	0.000122	-4.975309615	3.01792E-06	-0.00085	-0.00037	-0.000852207	-0.000365938

SUMMARY OUTPUT

MW 20 all data

Ammonia

Regression Statistics	
Multiple R	0.415109
R Square	0.172316
Adjusted F	0.163319
Standard E	0.31377
Observatio	94

ANOVA

	df	SS	MS	F	ignificance F
Regressior	1	1.885699	1.885698589	19.15351408	3.18E-05
Residual	92	9.057569	0.098451834		
Total	93	10.94327			

	Coefficients	'andard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	2.254547	0.449617	5.014373496	2.57395E-06	1.361569	3.147524	1.36156885	3.147524478
X Variable	-5.8E-05	1.32E-05	-4.37647279	3.18086E-05	-8.4E-05	-3.2E-05	-8.42563E-05	-3.16547E-05

SUMMARY OUTPUT **Manganese**

Background

Regression Statistics	
Multiple R	0.12049785
R Square	0.01451973
Adjusted R Square	0.00102
Standard Error	0.00647025
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.50273E-05	4.5E-05	1.075557	0.303116731
Residual	73	0.003056081	4.19E-05		
Total	74	0.003101109			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.0220941	0.029903928	-0.738835	0.462376	-0.081692556	0.037504411	-0.08169256	0.037504411
X Variable 1	8.3432E-07	8.04486E-07	1.037091	0.303117	-7.69014E-07	2.43766E-06	-7.6901E-07	2.43766E-06

SUMMARY OUTPUT **Manganese**

near cdf

Regression Statistics	
Multiple R	0.06088895
R Square	0.00370746
Adjusted R Square	-0.0099404
Standard Error	0.00496227
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.6892E-06	6.6892E-06	0.271652	0.603803315
Residual	73	0.001797562	2.46241E-05		
Total	74	0.001804251			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.0038965	0.022934416	-0.169899382	0.865559	-0.049604798	0.041811712	-0.049604798	0.041811712
X Variable 1	3.2158E-07	6.1699E-07	0.521202481	0.603803	-9.08083E-07	1.55124E-06	-9.08083E-07	1.55124E-06

SUMMARY OUTPUT **Manganese**

river

Regression Statistics	
Multiple R	0.03850802
R Square	0.00148287
Adjusted R Square	-0.0121954
Standard Error	0.02272027
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	5.59624E-05	5.59624E-05	0.10841	0.742904364
Residual	73	0.03768338	0.000516211		
Total	74	0.037739342			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.05214781	0.105007594	0.496609917	0.620956	-0.157132162	0.261427787	-0.157132162	0.261427787
X Variable 1	-9.301E-07	2.82495E-06	-0.329256868	0.742904	-6.56026E-06	4.69999E-06	-6.56026E-06	4.69999E-06

SUMMARY OUTPUT **Manganese**

in cdf

Regression Statistics	
Multiple R	0.47221413
R Square	0.22298619
Adjusted R Square	0.21234216
Standard Error	0.13137371
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.361567195	0.361567195	20.94942	1.8924E-05
Residual	73	1.259910812	0.017259052		
Total	74	1.621478007			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-2.6557701	0.607177518	-4.373959951	3.99E-05	-3.865874018	-1.445666279	-3.865874018	-1.44566628
X Variable 1	7.4764E-05	1.63345E-05	4.577054024	1.89E-05	4.22093E-05	0.000107319	4.22093E-05	0.000107319

SUMMARY OUTPUT Manganese
MW 4

Regression Statistics	
Multiple R	0.5917224
R Square	0.35013539
Adjusted R Square	0.26890232
Standard Error	0.0158433
Observations	10

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.001081918	0.001081918	4.310257	0.071545843
Residual	8	0.002008082	0.00025101		
Total	9	0.00309			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-2.9278492	1.41796894	-2.06481902	0.072813	-6.197691472	0.341992999	-6.197691472	0.341992999
X Variable 1	9.2908E-05	4.47511E-05	2.076115724	0.071546	-1.02878E-05	0.000196105	-1.02878E-05	0.000196105

SUMMARY OUTPUT Manganese
mw 5

Regression Statistics	
Multiple R	0.282131126
R Square	0.079597972
Adjusted R	0.044197894
Standard E	0.095324737
Observatio	28

ANOVA

	df	SS	MS	F	Significance F
Regressior	1	0.020431913	0.0204319	2.24852534	0.1457875
Residual	26	0.236256945	0.0090868		
Total	27	0.256688857			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	3.345821164	2.148946306	1.5569589	0.13157033	-1.0714012	7.76304352	-1.07140119	7.763043516
X Variable	-0.000102786	6.85464E-05	-1.4995084	0.14578748	-0.0002437	3.8113E-05	-0.00024369	3.81132E-05

SUMMARY OUTPUT Manganese
mw 7

Regression Statistics	
Multiple R	0.042577969
R Square	0.001812883
Adjusted R	-0.036578929
Standard E	0.022513879
Observatio	28

ANOVA

	df	SS	MS	F	Significance F
Regressior	1	2.39349E-05	2.393E-05	0.04722057	0.8296685
Residual	26	0.013178744	0.0005069		
Total	27	0.013202679			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.126178924	0.507540003	0.2486088	0.80561665	-0.9170845	1.16944233	-0.91708448	1.169442332
X Variable	-3.51799E-06	1.61893E-05	-0.217303	0.82966852	-3.68E-05	2.976E-05	-3.6796E-05	2.97597E-05

SUMMARY OUTPUT Manganese
mw 8

Regression Statistics	
Multiple R	0.11342487
R Square	0.012865201
Adjusted R	-0.025101522
Standard E	0.183927455
Observatio	28

ANOVA

	df	SS	MS	F	Significance F
Regressior	1	0.011463219	0.0114632	0.33885466	0.5655051
Residual	26	0.879562031	0.0338293		
Total	27	0.89102525			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	2.500809346	4.146355258	0.6031344	0.55164484	-6.0221459	11.0237646	-6.02214587	11.02376456
X Variable	-7.69896E-05	0.000132259	-0.5821122	0.56550509	-0.0003489	0.00019487	-0.00034885	0.000194873

SUMMARY OUTPUT Manganese
mw 9

Regression Statistics	
Multiple R	0.380949819
R Square	0.145122765
Adjusted R	0.112242871
Standard E	0.012852708
Observatio	28

ANOVA

	df	SS	MS	F	Significance F
Regressior	1	0.000729112	0.0007291	4.41372366	0.0454969
Residual	26	0.004294995	0.0001652		
Total	27	0.005024107			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.623876612	0.289744096	2.1531987	0.04075519	0.0282991	1.21945413	0.028299099	1.219454125
X Variable	-1.94167E-05	9.24216E-06	-2.1008864	0.04549689	-3.841E-05	-4.192E-07	-3.8414E-05	-4.192E-07

SUMMARY OUTPUT Manganese
MW 10

Regression Statistics	
Multiple R	0.380792257
R Square	0.145002743
Adjusted R	0.112118233
Standard E	0.46324818
Observatio	28

ANOVA

	df	SS	MS	F	Significance F
Regressior	1	0.946263931	0.9462639	4.40945427	0.0455937
Residual	26	5.579570783	0.2145989		
Total	27	6.525834714			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	22.31781044	10.44320176	2.1370659	0.042168	0.851502	43.7841189	0.851501998	43.78411888
X Variable	-0.000699496	0.000333114	-2.0998701	0.0455937	-0.0013842	-1.477E-05	-0.00138422	-1.477E-05

SUMMARY OUTPUT **Manganese**

MW 18

Regression Statistics	
Multiple R	0.47101125
R Square	0.2218516
Adjusted R Square	0.18801906
Standard Error	0.21768606
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.310734296	0.310734	6.557344	0.017476648
Residual	23	1.089906033	0.047387		
Total	24	1.40064033			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	4.66734079	1.742602967	2.678373	0.013421	1.062496804	8.272184768	1.062496804	8.272184768
X Variable 1	-0.00012	4.68801E-05	-2.560731	0.017477	-0.000217026	-2.30686E-05	-0.00021703	-2.30686E-05

SUMMARY OUTPUT **Manganese**

MW 19

Regression Statistics	
Multiple R	0.22367872
R Square	0.05003217
Adjusted R Square	0.00872922
Standard Error	0.27888291
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.094213275	0.094213	1.211346	0.282451666
Residual	23	1.788840605	0.077776		
Total	24	1.88305388			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.615559	2.232491135	1.171588	0.253357	-2.002694488	7.23381249	-2.00269449	7.23381249
X Variable 1	-6.61E-05	6.00592E-05	-1.100612	0.282452	-0.000190344	5.81399E-05	-0.00019034	5.81399E-05

SUMMARY OUTPUT **Manganese**

MW 20

Regression Statistics	
Multiple R	0.70404997
R Square	0.49568635
Adjusted R Square	0.47375967
Standard Error	0.10341902
Observations	25

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.241788078	0.241788	22.60654	8.5812E-05
Residual	23	0.245996337	0.010695		
Total	24	0.487784416			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-3.8123189	0.827881621	-4.604908	0.000125	-5.524920208	-2.099717641	-5.52492021	-2.099717641
X Variable 1	0.00010589	2.2272E-05	4.754633	8.58E-05	5.9822E-05	0.000151968	5.9822E-05	0.000151968

SUMMARY OUTPUT **TDS**

background

Regression Statistics	
Multiple R	0.1205647
R Square	0.0145359
Adjusted R Square	0.0010363
Standard Error	24.386054
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	640.3325663	640.33257	1.076768932	0.302846499
Residual	73	43411.6141	594.67965		
Total	74	44051.94667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	55.777206	112.7064442	0.4948892	0.622164569	-168.8465654	280.401	-168.846565	280.4009779
X Variable 1	0.0031463	0.003032067	1.0376748	0.302846499	-0.002896606	0.009189	-0.00289661	0.009189206

SUMMARY OUTPUT **TDS**

near cdf

Regression Statistics	
Multiple R	0.0242413
R Square	0.0005876
Adjusted R Square	-0.0131029
Standard Error	23.578282
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	23.86237154	23.862372	0.042922921	0.836447313
Residual	73	40583.2843	555.9354		
Total	74	40607.14667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	148.53683	108.9731178	1.3630594	0.177053453	-68.64642844	365.7201	-68.6464284	365.7200873
X Variable 1	0.0006074	0.002931632	0.2071785	0.836447313	-0.005235367	0.00645	-0.00523537	0.00645011

SUMMARY OUTPUT **TDS**

river

Regression Statistics	
Multiple R	0.0245077
R Square	0.0006006
Adjusted R Square	-0.0130898
Standard Error	331.96148
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4834.623351	4834.6234	0.043871984	0.834675401
Residual	73	8044484.763	110198.42		
Total	74	8049319.387			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-85.070591	1534.245641	-0.055448	0.955933169	-3142.819818	2972.679	-3142.81982	2972.678635
X Variable 1	0.0086453	0.041274803	0.2094564	0.834675401	-0.073615348	0.090906	-0.07361535	0.090905891

SUMMARY OUTPUT **TDS**
in CDF

Regression Statistics	
Multiple R	0.9012593
R Square	0.8122683
Adjusted R Square	0.8096967
Standard Error	58.343573
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1075154.591	1075154.6	315.8528975	3.13858E-28
Residual	73	248489.9957	3403.9725		
Total	74	1323644.587			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-4416.2428	269.6498827	-16.37769	3.75506E-26	-4953.654567	-3878.831	-4953.65457	-3878.830956
X Variable 1	0.1289237	0.007254214	17.772251	3.13858E-28	0.114466069	0.143381	0.11446607	0.143381342

SUMMARY OUTPUT TDS
mw 4

Regression Statistics	
Multiple R	0.30803458
R Square	0.0948853
Adjusted R Sq	0.08357137
Standard Erroi	48.3890968
Observations	82

ANOVA

	df	SS	MS	F	Significance F
Regression	1	19637.23477	19637.23	8.386588	0.004872369
Residual	80	187320.375	2341.505		
Total	81	206957.6098			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-452.464947	225.3061571	-2.008223	0.047994	-900.838481	-4.09141339	-900.838481	-4.09141339
X Variable 1	0.01987542	0.006863154	2.895961	0.004872	0.006217312	0.03353354	0.006217312	0.033533536

SUMMARY OUTPUT TDS
mw 5

Regression Statistics	
Multiple R	0.06016414
R Square	0.00361972
Adjusted R Sq	-0.00605387
Standard Erroı	47.0247003
Observations	105

ANOVA

	df	SS	MS	F	Significance F
Regression	1	827.4457658	827.4458	0.374186	0.542079229
Residual	103	227766.2114	2211.322		
Total	104	228593.6571			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	140.059124	148.8314657	0.941059	0.348877	-155.112977	435.231225	-155.112977	435.2312255
X Variable 1	0.0028053	0.00458602	0.611707	0.542079	-0.00628999	0.01190059	-0.00628999	0.01190059

SUMMARY OUTPUT TDS

mw 7

Regression Statistics	
Multiple R	0.35428072
R Square	0.12551483
Adjusted R Sq	0.11649952
Standard Erroı	35.0740204
Observations	99

ANOVA

	df	SS	MS	F	Significance F
Regression	1	17127.16287	17127.16	13.92241	0.000321035
Residual	97	119328.1301	1230.187		
Total	98	136455.2929			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-266.986586	121.4889975	-2.197619	0.030356	-508.10861	-25.8645616	-508.10861	-25.8645616
X Variable 1	0.01392649	0.00373237	3.731274	0.000321	0.006518774	0.02133421	0.006518774	0.021334214

SUMMARY OUTPUT TDS

mw 8

Regression Statistics	
Multiple R	0.08760902
R Square	0.00767534
Adjusted R Sq	-0.00255481
Standard Erroi	41.7804379
Observations	99

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1309.669142	1309.669	0.750267	0.38852927
Residual	97	169323.6844	1745.605		
Total	98	170633.3535			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	358.491409	144.7186111	2.477162	0.014973	71.26503301	645.717784	71.26503301	645.7177843
X Variable 1	-0.00385106	0.004446027	-0.866179	0.388529	-0.01267519	0.00497308	-0.01267519	0.004973076

SUMMARY OUTPUT TDS
mw 9

Regression Statistics	
Multiple R	0.21257907
R Square	0.04518986
Adjusted R Square	0.03534646
Standard Error	39.711729
Observations	99

ANOVA

	df	SS	MS	F	Significance F
Regression	1	7239.912351	7239.912	4.590878	0.034645212
Residual	97	152971.0775	1577.021		
Total	98	160210.9899			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-106.61174	137.5530402	-0.775059	0.44019	-379.6164411	166.393	-379.616441	166.3929617
X Variable 1	0.00905453	0.004225887	2.142633	0.034645	0.000667311	0.017442	0.000667311	0.017441742

SUMMARY OUTPUT TDS
mw 10

Regression Statistics	
Multiple R	0.27134733
R Square	0.07362937
Adjusted R Sq	0.06407916
Standard Erroi	29.6586701
Observations	99

ANOVA

	df	SS	MS	F	Significance F
Regression	1	6781.744207	6781.744	7.70971	0.006592576
Residual	97	85324.76084	879.6367		
Total	98	92106.50505			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	16.5795048	102.7313678	0.161387	0.872124	-187.313818	220.472827	-187.313818	220.4728274
X Variable 1	0.00876334	0.0031561	2.776637	0.006593	0.002499358	0.01502733	0.002499358	0.015027327

SUMMARY OUTPUT **TDS**

mw 18

Regression Statistics	
Multiple R	0.11895011
R Square	0.01414913
Adjusted R Square	-0.02871395
Standard Error	217.92689
Observations	25

ANOVA

	df	SS	MS	F	Significance F
Regression	1	15677.17936	15677.18	0.330101	0.571177307
Residual	23	1092318.981	47492.13		
Total	24	1107996.16			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1608.55653	1744.530878	0.922057	0.366071	-2000.275637	5217.389	-2000.27564	5217.388693
X Variable 1	-0.02696447	0.046931969	-0.574544	0.571177	-0.124050514	0.070122	-0.12405051	0.07012157

SUMMARY OUTPUT **TDS**

mw 19

Regression Statistics	
Multiple R	0.09692718
R Square	0.00939488
Adjusted R Square	-0.03367491
Standard Error	111.284293
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2701.383095	2701.383	0.218132	0.644861572
Residual	23	284836.4569	12384.19		
Total	24	287537.84			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	924.85488	890.8441004	1.038178	0.309979	-917.9940388	2767.704	-917.994039	2767.7038
X Variable 1	-0.01119312	0.023965794	-0.467046	0.644862	-0.060770071	0.038384	-0.06077007	0.038383837

SUMMARY OUTPUT **TDS**

mw 20

Regression Statistics	
Multiple R	0.25095941
R Square	0.06298063
Adjusted R Square	0.02224065
Standard Error	226.921305
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	79604.34632	79604.35	1.545917	0.226264334
Residual	23	1184345.414	51493.28		
Total	24	1263949.76			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	3252.51889	1816.532248	1.79051	0.086545	-505.2592534	7010.297	-505.259253	7010.297034
X Variable 1	-0.0607612	0.048868974	-1.243349	0.226264	-0.161854238	0.040332	-0.16185424	0.040331838

SUMMARY OUTPUT **TKN**
background

Regression Statistics	
Multiple R	0.150893
R Square	0.022769
Adjusted R Square	0.009382
Standard Error	0.213116
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.077249571	0.07725	1.70084892	0.196274218
Residual	73	3.315531815	0.045418		
Total	74	3.392781387			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.816308	0.98496859	-0.828766	0.40993858	-2.779349123	1.146733	-2.779349123	1.14673268
X Variable 1	3.46E-05	2.6498E-05	1.304166	0.19627422	-1.82527E-05	8.74E-05	-1.82527E-05	8.7368E-05

SUMMARY OUTPUT **TKN**

near cdf

Regression Statistics	
Multiple R	0.1621118
R Square	0.0262802
Adjusted R Square	0.0129416
Standard Error	0.3735101
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.274867041	0.274867	1.970234989	0.164662675
Residual	73	10.18421363	0.13951		
Total	74	10.45908067			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1.9092614	1.726273213	-1.106002	0.272357322	-5.349721277	1.531198	-5.349721277	1.531198495
X Variable 1	6.519E-05	4.64408E-05	1.403651	0.164662675	-2.73698E-05	0.000158	-2.73698E-05	0.000157743

SUMMARY OUTPUT **TKN**

river

Regression Statistics	
Multiple R	0.0422729
R Square	0.001787
Adjusted R Square	-0.0118872
Standard Error	0.2848258
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.010601868	0.010602	0.130684379	0.71876773
Residual	73	5.922179812	0.081126		
Total	74	5.93278168			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.0255075	1.316396067	0.019377	0.984593414	-2.598067867	2.649083	-2.598067867	2.649082848
X Variable 1	1.28E-05	3.54141E-05	0.361503	0.71876773	-5.7778E-05	8.34E-05	-5.7778E-05	8.33826E-05

SUMMARY OUTPUT **TKN**

in cdf

Regression Statistics	
Multiple R	0.5528631
R Square	0.3056576
Adjusted R Square	0.296146
Standard Error	0.5506131
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	9.742657623	9.742658	32.13544254	2.69967E-07
Residual	73	22.13176326	0.303175		
Total	74	31.87442088			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-12.981537	2.544800781	-5.1012	2.57658E-06	-18.05332115	-7.909753	-18.05332115	-7.90975299
X Variable 1	0.0003881	6.84611E-05	5.668813	2.69967E-07	0.00025165	0.000525	0.00025165	0.000524536

SUMMARY OUTPUT TKN

mw 4

Regression Statistics	
Multiple R	0.0543952
R Square	0.0029588
Adjusted R Square	-0.0047107
Standard Error	1.079863
Observations	132

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.449871896	0.449872	0.385790488	0.535607996
Residual	130	151.5935418	1.166104		
Total	131	152.0434137			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-1.10241	2.635908356	-0.418228	0.676470673	-6.317239378	4.112419	-6.317239378	4.112419363
X Variable 1	4.866E-05	7.83413E-05	0.62112	0.535607996	-0.00010633	0.000204	-0.00010633	0.000203648

SUMMARY OUTPUT TKN
mw 5

Regression Statistics	
Multiple R	0.31398312
R Square	0.0985854
Adjusted R Square	0.09253564
Standard Error	0.982877
Observations	151

ANOVA

	df	SS	MS	F	Significance F
Regression	1	15.74246067	15.74246067	16.29575	8.63761E-05
Residual	149	143.941032	0.966047195		
Total	150	159.6834927			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	9.59507121	1.930823037	4.969420306	1.82E-06	5.779739505	13.41040291	5.779739505	13.41040291
X Variable 1	-0.0002337	5.78981E-05	-4.036799102	8.64E-05	-0.000348131	-0.000119316	-0.00034813	-0.000119316

SUMMARY OUTPUT TKN
mw 7

Regression Statistics	
Multiple R	0.47552101
R Square	0.22612023
Adjusted R Square	0.2209264
Standard Error	0.67241112
Observations	151

ANOVA

	df	SS	MS	F	Significance F
Regression	1	19.68438981	19.68438981	43.53637	6.82775E-10
Residual	149	67.36837012	0.452136712		
Total	150	87.05275993			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	9.29450363	1.320925079	7.036359422	6.69E-11	6.684338307	11.90466895	6.684338307	11.90466895
X Variable 1	-0.0002614	3.96096E-05	-6.598209374	6.83E-10	-0.000339621	-0.000183083	-0.00033962	-0.000183083

SUMMARY OUTPUT TKN

mw 8

Regression Statistics	
Multiple R	0.26324514
R Square	0.06929801
Adjusted R Square	0.06305168
Standard Error	1.43884717
Observations	151

ANOVA

	df	SS	MS	F	Significance F
Regression	1	22.96813317	22.96813317	11.09421	0.001091834
Residual	149	308.471897	2.070281188		
Total	150	331.4400302			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	12.0715382	2.826558432	4.270754879	3.46E-05	6.486221597	17.65685483	6.486221597	17.65685483
X Variable 1	-0.0002823	8.47578E-05	-3.330797123	0.001092	-0.000449794	-0.000114829	-0.00044979	-0.000114829

SUMMARY OUTPUT TKN
mw 9

Regression Statistics	
Multiple R	0.47197703
R Square	0.22276231
Adjusted R Square	0.21754595
Standard Error	0.64629992
Observations	151

ANOVA

	df	SS	MS	F	Significance F
Regression	1	17.83784327	17.83784327	42.70455	9.4938E-10
Residual	149	62.23783489	0.41770359		
Total	150	80.07567816			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	8.88335412	1.269630666	6.99680179	8.28E-11	6.374547234	11.39216101	6.374547234	11.39216101
X Variable 1	-0.0002488	3.80714E-05	-6.534871738	9.49E-10	-0.000324022	-0.000173562	-0.00032402	-0.000173562

SUMMARY OUTPUT TKN
mw 10

Regression Statistics	
Multiple R	0.4670587
R Square	0.21814383
Adjusted R Square	0.21289647
Standard Error	4.08869141
Observations	151

ANOVA

	df	SS	MS	F	Significance F
Regression	1	694.9778954	694.9778954	41.57213	1.49085E-09
Residual	149	2490.89222	16.71739745		
Total	150	3185.870115			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	60.6578748	8.032072756	7.551957834	3.99E-12	44.78639342	76.52935612	44.78639342	76.52935612
X Variable 1	-0.0015529	0.000240852	-6.447645657	1.49E-09	-0.002028852	-0.001077	-0.00202885	-0.001077

SUMMARY OUTPUT **TKN**

mw 18

Regression Statistics	
Multiple R	0.203153
R Square	0.041271
Adjusted R Square	-0.000413
Standard Error	2.554166
Observations	25

ANOVA

	df	SS	MS	F	Significance F
Regression	1	6.459181027	6.459181	0.99010046	0.330071724
Residual	23	150.046555	6.523763		
Total	24	156.505736			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	23.2202	20.44640387	1.135662	0.2677942	-19.07635486	65.51675	-19.07635486	65.5167479
X Variable 1	-0.000547	0.000550056	-0.995038	0.33007172	-0.001685203	0.000591	-0.001685203	0.00059055

SUMMARY OUTPUT **TKN**

mw 19

Regression Statistics	
Multiple R	0.019582
R Square	0.000383
Adjusted R Square	-0.043078
Standard Error	1.692125
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.025261971	0.025262	0.00882272	0.925978777
Residual	23	65.85559403	2.863287		
Total	24	65.880856			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	4.635662	13.54566268	0.342225	0.73528924	-23.38563783	32.65696	-23.38563783	32.6569623
X Variable 1	3.42E-05	0.00036441	0.093929	0.92597878	-0.00071961	0.000788	-0.00071961	0.00078807

SUMMARY OUTPUT **TKN**

mw 20

Regression Statistics	
Multiple R	0.177237
R Square	0.031413
Adjusted R Square	-0.0107
Standard Error	0.298948
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.066663464	0.066663	0.74592767	0.396686241
Residual	23	2.055507176	0.08937		
Total	24	2.12217064			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1.586098	2.393114176	-0.662776	0.51406188	-6.536625357	3.364429	-6.536625357	3.36442887
X Variable 1	5.56E-05	6.43804E-05	0.863671	0.39668624	-7.75773E-05	0.000189	-7.75773E-05	0.00018878

SUMMARY OUTPUT **TOTAL P**

background

Regression Statistics	
Multiple R	0.6063215
R Square	0.3676258
Adjusted R Square	0.3589631
Standard Error	0.0130883
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.007269734	0.00727	42.43798	8.16931E-09
Residual	73	0.012505086	0.000171		
Total	74	0.01977482			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.4161207	0.060490771	6.879078	1.74E-09	0.295562718	0.536679	0.29556272	0.53667875
X Variable 1	-1.06E-05	1.62734E-06	-6.514444	8.17E-09	-1.38445E-05	-7.36E-06	-1.3845E-05	-7.358E-06

SUMMARY OUTPUT **TOTAL P**

near cdf

Regression Statistics	
Multiple R	0.4802872
R Square	0.2306758
Adjusted R Square	0.2201371
Standard Error	0.0198435
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.008618866	0.008619	21.88848	1.29632E-05
Residual	73	0.02874468	0.000394		
Total	74	0.037363547			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.4522335	0.091711653	4.931036	4.97E-06	0.269452295	0.635015	0.2694523	0.63501467
X Variable 1	-1.154E-05	2.46726E-06	-4.678512	1.3E-05	-1.64603E-05	-6.63E-06	-1.646E-05	-6.626E-06

SUMMARY OUTPUT **TOTAL P**

river

Regression Statistics	
Multiple R	0.5356344
R Square	0.2869042
Adjusted R Square	0.2771357
Standard Error	0.0150347
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00663894	0.006639	29.37053	7.35252E-07
Residual	73	0.01650098	0.000226		
Total	74	0.02313992			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.3995819	0.069486534	5.750494	1.94E-07	0.26109531	0.538068	0.26109531	0.53806843
X Variable 1	-1.013E-05	1.86935E-06	-5.419459	7.35E-07	-1.38565E-05	-6.41E-06	-1.3856E-05	-6.405E-06

SUMMARY OUTPUT **TOTAL P**
in CDF

Regression Statistics	
Multiple R	0.4564022
R Square	0.208303
Adjusted R Square	0.1974578
Standard Error	0.051312
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.05057053	0.050571	19.20699	3.86416E-05
Residual	73	0.19220339	0.002633		
Total	74	0.24277392			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.9588916	0.237151733	-4.043367	0.000129	-1.431534601	-0.486249	-1.4315346	-0.4862485
X Variable 1	2.796E-05	6.37994E-06	4.382578	3.86E-05	1.52454E-05	4.07E-05	1.5245E-05	4.0676E-05

SUMMARY OUTPUT Total P

mw 4

Regression Statistics	
Multiple R	0.1595637
R Square	0.0254606
Adjusted R Square	0.0097422
Standard Error	0.044392
Observations	64

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.003192049	0.003192	1.619797	0.207872114
Residual	62	0.122180127	0.001971		
Total	63	0.125372176			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.16094	0.150318921	-1.070658	0.288473	-0.461423434	0.139543042	-0.46142343	0.139543042
X Variable 1	5.594E-06	4.39527E-06	1.272713	0.207872	-3.1921E-06	1.43799E-05	-3.1921E-06	1.43799E-05

SUMMARY OUTPUT Total P
mw 5

Regression Statistics	
Multiple R	0.140579
R Square	0.019762
Adjusted R Square	0.008495
Standard Error	0.326189
Observations	89

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.186623355	0.186623	1.753989	0.188844743
Residual	87	9.256747242	0.106399		
Total	88	9.443370598			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.997389	0.659031431	1.513416	0.133799	-0.312507795	2.30728481	-0.312507795	2.30728481
X Variable 1	-2.62E-05	1.97548E-05	-1.324382	0.188845	-6.54277E-05	1.31019E-05	-6.54277E-05	1.31019E-05

SUMMARY OUTPUT Total P

mw 7

Regression Statistics	
Multiple R	0.217561
R Square	0.047333
Adjusted R Square	0.035571
Standard Error	0.051424
Observations	83

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.010642349	0.010642	4.024431	0.048183415
Residual	81	0.214199279	0.002644		
Total	82	0.224841628			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.26591	0.113145097	2.350165	0.021198	0.040786385	0.491032879	0.040786385	0.491032879
X Variable 1	-6.77E-06	3.37371E-06	-2.006099	0.048183	-1.34806E-05	-5.53701E-08	-1.34806E-05	-5.53701E-08

SUMMARY OUTPUT Total P

mw 8

Regression Statistics	
Multiple R	0.030052
R Square	0.000903
Adjusted R Square	-0.011431
Standard Error	0.150325
Observations	83

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.001654605	0.001655	0.07322	0.787393127
Residual	81	1.830414142	0.022598		
Total	82	1.832068747			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.303039	0.330751191	0.916214	0.362274	-0.355052103	0.961130114	-0.355052103	0.961130114
X Variable 1	-2.67E-06	9.86219E-06	-0.270592	0.787393	-2.22913E-05	1.6954E-05	-2.22913E-05	1.6954E-05

SUMMARY OUTPUT Total P

mw 9

Regression Statistics	
Multiple R	0.238616
R Square	0.056937
Adjusted R Square	0.045295
Standard Error	0.045428
Observations	83

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.010092148	0.010092	4.890374	0.029824948
Residual	81	0.167157781	0.002064		
Total	82	0.17724993			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.261775	0.099951665	2.61902	0.010524	0.062902985	0.460647901	0.062902985	0.460647901
X Variable 1	-6.59E-06	2.98031E-06	-2.211419	0.029825	-1.25206E-05	-6.60833E-07	-1.25206E-05	-6.60833E-07

SUMMARY OUTPUT Total P

mw 10

Regression Statistics	
Multiple R	0.26622
R Square	0.070873
Adjusted R Square	0.059402
Standard Error	0.590735
Observations	83

ANOVA

	df	SS	MS	F	Significance F
Regression	1	2.156138977	2.156139	6.178621	0.014987875
Residual	81	28.26637966	0.348968		
Total	82	30.42251864			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	3.546601	1.299755994	2.728667	0.007797	0.960494402	6.13270776	0.960494402	6.13270776
X Variable 1	-9.63E-05	3.87555E-05	-2.485683	0.014988	-0.000173445	-1.92226E-05	-0.000173445	-1.92226E-05

SUMMARY OUTPUT **TOTAL P**

mw 18

Regression Statistics	
Multiple R	0.2581109
R Square	0.0666212
Adjusted R Square	0.0260395
Standard Error	0.0603686
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00598281	0.005983	1.641657	0.212866295
Residual	23	0.08382055	0.003644		
Total	24	0.08980336			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.7161517	0.483258137	1.481924	0.151933	-0.28354254	1.715845983	-0.28354254	1.715845983
X Variable 1	-1.67E-05	1.30008E-05	-1.281272	0.212866	-4.35516E-05	1.02366E-05	-4.3552E-05	1.02366E-05

SUMMARY OUTPUT **TOTAL P**

mw 19

Regression Statistics	
Multiple R	0.0135755
R Square	0.0001843
Adjusted R Square	-0.043286
Standard Error	0.0353605
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.30102E-06	5.3E-06	0.00424	0.948647511
Residual	23	0.028758459	0.00125		
Total	24	0.02876376			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.0630652	0.28306536	0.222794	0.825663	-0.522499332	0.648629696	-0.52249933	0.648629696
X Variable 1	-4.96E-07	7.61512E-06	-0.065112	0.948648	-1.62489E-05	1.52572E-05	-1.6249E-05	1.52572E-05

SUMMARY OUTPUT **TOTAL P**

mw 20

Regression Statistics	
Multiple R	0.1393186
R Square	0.0194097
Adjusted R Square	-0.023225
Standard Error	0.0226639
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.000233845	0.000234	0.455259	0.506574448
Residual	23	0.011813995	0.000514		
Total	24	0.01204784			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.1684559	0.181427166	0.928504	0.362789	-0.206854245	0.543766111	-0.20685424	0.543766111
X Variable 1	-3.29E-06	4.88082E-06	-0.674729	0.506574	-1.339E-05	6.8035E-06	-1.339E-05	6.8035E-06

SUMMARY OUTPUT **TSS**
background

Regression Statistics	
Multiple R	0.224752668
R Square	0.050513762
Adjusted R Square	0.037507101
Standard Error	3.466216725
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	46.66113771	46.66114	3.883684	0.052549622
Residual	73	877.0700623	12.01466		
Total	74	923.7312			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-24.6888933	16.02001524	-1.541128	0.12761	-56.6167593	7.238973	-56.6167593	7.238972649
X Variable 1	0.000849327	0.000430976	1.970706	0.05255	-9.6073E-06	0.001708	-9.6073E-06	0.001708262

SUMMARY OUTPUT **TSS**

near cdf

Regression Statistics	
Multiple R	0.175096155
R Square	0.030658664
Adjusted R Square	0.017380015
Standard Error	3.231857581
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	24.1159168	24.11592	2.308869	0.132957113
Residual	73	762.4779499	10.4449		
Total	74	786.5938667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-16.1080929	14.93686397	-1.078412	0.284401	-45.8772401	13.66105	-45.8772401	13.66105422
X Variable 1	0.000610589	0.000401837	1.519496	0.132957	-0.00019027	0.001411	-0.00019027	0.001411449

SUMMARY OUTPUT **TSS**

river

Regression Statistics	
Multiple R	0.063986182
R Square	0.004094232
Adjusted R Square	-0.00954831
Standard Error	11.34085085
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	38.59830989	38.59831	0.300108	0.585486186
Residual	73	9388.887557	128.6149		
Total	74	9427.485867			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	39.05954893	52.41466933	0.745203	0.458542	-65.4028072	143.5219	-65.4028072	143.5219051
X Variable 1	-0.00077247	0.001410077	-0.547821	0.585486	-0.00358275	0.002038	-0.00358275	0.002037812

SUMMARY OUTPUT **TSS**

in cdf

Regression Statistics	
Multiple R	0.5067908
R Square	0.256837
Adjusted R Square	0.2466566
Standard Error	30.912313
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	24107.89412	24107.89	25.22878	3.49234E-06
Residual	73	69756.69174	955.5711		
Total	74	93864.58587			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-686.36197	142.869235	-4.804127	8.07E-06	-971.1001359	-401.6238	-971.1001359	-401.6238
X Variable 1	0.0193053	0.003843517	5.022826	3.49E-06	0.011645194	0.02696544	0.011645194	0.026965442

SUMMARY OUTPUT TSS
mw 4

Regression Statistics	
Multiple R	0.006914196
R Square	4.78061E-05
Adjusted R Square	-0.00795181
Standard Error	34.29664318
Observations	127

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.029386172	7.029386	0.005976	0.938504586
Residual	125	147032.4667	1176.26		
Total	126	147039.4961			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	3.460174837	85.4668507	0.040486	0.967771	-165.689328	172.6097	-165.689328	172.6096774
X Variable 1	0.000196773	0.002545409	0.077305	0.938505	-0.00484091	0.005234	-0.00484091	0.005234452

SUMMARY OUTPUT TSS
mw 5

Regression Statistics	
Multiple R	0.21638845
R Square	0.04682396
Adjusted R Square	0.04046945
Standard Error	103.027321
Observations	152

ANOVA

	df	SS	MS	F	Significance F
Regression	1	78215.19165	78215.19	7.368622	0.007415307
Residual	150	1592194.328	10614.63		
Total	151	1670409.52			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	566.162627	194.8044542	2.906313	0.004212	181.2474734	951.07778	181.2474734	951.0777796
X Variable 1	-0.0159357	0.00587053	-2.714521	0.007415	-0.02753529	-0.004336	-0.02753529	-0.004336063

SUMMARY OUTPUT TSS
mw 7

Regression Statistics	
Multiple R	0.06586216
R Square	0.00433782
Adjusted R Square	-0.0025765
Standard Error	34.9095126
Observations	146

ANOVA

	df	SS	MS	F	Significance F
Regression	1	764.5571069	764.5571	0.627368	0.42962527
Residual	144	175489.0662	1218.674		
Total	145	176253.6233			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-44.311588	70.21149733	-0.631116	0.528965	-183.089881	94.466704	-183.089881	94.46670438
X Variable 1	0.00167117	0.002109892	0.792066	0.429625	-0.00249919	0.0058415	-0.00249919	0.005841534

SUMMARY OUTPUT TSS
mw 8

Regression Statistics	
Multiple R	0.16592916
R Square	0.02753248
Adjusted R Square	0.02077924
Standard Error	130.311713
Observations	146

ANOVA

	df	SS	MS	F	Significance F
Regression	1	69230.85604	69230.86	4.076926	0.045328451
Residual	144	2445284.521	16981.14		
Total	145	2514515.377			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	561.587506	262.0884623	2.14274	0.033815	43.54999455	1079.625	43.54999455	1079.625017
X Variable 1	-0.0159025	0.007875896	-2.01914	0.045328	-0.03146984	-0.000335	-0.03146984	-0.000335236

SUMMARY OUTPUT TSS
mw 9

Regression Statistics	
Multiple R	0.03677335
R Square	0.00135228
Adjusted R Square	-0.0055828
Standard Error	38.737398
Observations	146

ANOVA

	df	SS	MS	F	Significance F
Regression	1	292.6020702	292.6021	0.194992	0.659456373
Residual	144	216084.3842	1500.586		
Total	145	216376.9863			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	46.5935802	77.91030326	0.598041	0.550752	-107.40198	200.58914	-107.40198	200.5891405
X Variable 1	-0.0010338	0.002341246	-0.441579	0.659456	-0.00566149	0.0035938	-0.00566149	0.003593803

SUMMARY OUTPUT TSS
mw 10

Regression Statistics	
Multiple R	0.4575883
R Square	0.20938705
Adjusted R Square	0.20389669
Standard Error	151.91963
Observations	146

ANOVA

	df	SS	MS	F	Significance F
Regression	1	880189.5024	880189.5	38.13716	6.37293E-09
Residual	144	3323458.662	23079.57		
Total	145	4203648.164			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1985.76977	305.5472252	6.49906	1.24E-09	1381.832751	2589.7068	1381.832751	2589.706785
X Variable 1	-0.0567028	0.009181855	-6.175529	6.37E-09	-0.07485144	-0.038554	-0.07485144	-0.03855419

SUMMARY OUTPUT **TSS**

mw 18

Regression Statistics	
Multiple R	0.2875053
R Square	0.0826593
Adjusted R Square	0.0427749
Standard Error	225.12471
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	105035.2442	105035.2	2.072472	0.163450952
Residual	23	1165666.09	50681.13		
Total	24	1270701.334			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2742.7488	1802.150274	1.521931	0.141657	-985.2780325	6470.77558	-985.2780325	6470.775576
X Variable 1	-0.0697952	0.048482065	-1.439608	0.163451	-0.170087844	0.03049747	-0.170087844	0.03049747

SUMMARY OUTPUT **TSS**

mw 19

Regression Statistics	
Multiple R	0.15903
R Square	0.0252905
Adjusted R Square	-0.0170881
Standard Error	83.786508
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4189.470242	4189.47	0.596775	0.447677194
Residual	23	161464.1154	7020.179		
Total	24	165653.5856			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	572.65459	670.7210392	0.85379	0.402027	-814.8357047	1960.14488	-814.8357047	1960.144882
X Variable 1	-0.0139392	0.018043968	-0.772512	0.447677	-0.051265929	0.02338755	-0.051265929	0.023387551

SUMMARY OUTPUT **TSS**

mw 20

Regression Statistics	
Multiple R	0.2563751
R Square	0.0657282
Adjusted R Square	0.0251077
Standard Error	4.5307817
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	33.2163864	33.21639	1.618103	0.216068009
Residual	23	472.1436136	20.52798		
Total	24	505.36			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-39.462033	36.2694509	-1.088024	0.287855	-114.4910068	35.5669402	-114.4910068	35.56694019
X Variable 1	0.0012412	0.000975733	1.272047	0.216068	-0.000777277	0.00325963	-0.000777277	0.003259633

SUMMARY OUTPUT **ZINC**
background

Regression Statistics	
Multiple R	0.350492776
R Square	0.122845186
Adjusted R Square	0.110829367
Standard Error	0.03065529
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.009607615	0.009608	10.22362125	0.002050641
Residual	73	0.068601516	0.00094		
Total	74	0.078209131			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.478486795	0.141681334	3.377204	0.001176948	0.196116111	0.760857478	0.196116111	0.760857478
X Variable 1	-1.21872E-05	3.81156E-06	-3.19744	0.002050641	-1.97837E-05	-4.5908E-06	-1.97837E-05	-4.5908E-06

SUMMARY OUTPUT **ZINC**
near cdf

Regression Statistics	
Multiple R	0.166841816
R Square	0.027836192
Adjusted R Square	0.014518879
Standard Error	0.033659356
Observations	75

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.002368126	0.002368	2.090225911	0.152523819
Residual	73	0.082705513	0.001133		
Total	74	0.085073639			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.255170907	0.155565401	1.640281	0.105249207	-0.0548707	0.565212513	-0.0548707	0.565212513
X Variable 1	-6.05062E-06	4.18507E-06	-1.44576	0.152523819	-1.43915E-05	2.29023E-06	-1.43915E-05	2.29023E-06

SUMMARY OUTPUT **ZINC**
river

Regression Statistics	
Multiple R	0.202348738
R Square	0.040945012
Adjusted R Square	0.027807272
Standard Error	0.051813924
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.008367068	0.008367	3.116594864	0.081680461
Residual	73	0.195981839	0.002685		
Total	74	0.204348907			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.447810685	0.239471423	1.869996	0.065493963	-0.029455498	0.925076867	-0.029455498	0.925076867
X Variable 1	-1.13732E-05	6.44234E-06	-1.76539	0.081680461	-2.42128E-05	1.46634E-06	-2.42128E-05	1.46634E-06

SUMMARY OUTPUT **ZINC**

in cdf

Regression Statistics	
Multiple R	0.06239448
R Square	0.00389307
Adjusted R Square	-0.0097522
Standard Error	0.04380557
Observations	75

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.000547479	0.000547479	0.285304892	0.594868041
Residual	73	0.140081713	0.001918928		
Total	74	0.140629192			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.0662338	0.202458727	-0.3271473	0.744492739	-0.469733762	0.33726611	-0.46973376	0.33726611
X Variable 1	2.9093E-06	5.44661E-06	0.534139394	0.594868041	-7.94584E-06	1.3764E-05	-7.9458E-06	1.37643E-05

SUMMARY OUTPUT Zinc

mw 5

Regression Statistics	
Multiple R	0.284193132
R Square	0.080765736
Adjusted R Square	0.040799029
Standard Error	0.023986545
Observations	25

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.001163	0.001162691	2.020825379	0.168573472
Residual	23	0.013233	0.000575354		
Total	24	0.014396			

	Coefficients	'andard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.644505671	0.43295	1.488637196	0.150167344	-0.25111991	1.5401313	-0.25111991	1.540131251
X Variable 1	-1.97281E-05	1.39E-05	-1.421557378	0.168573472	-4.8437E-05	8.98E-06	-4.84366E-05	8.98035E-06

SUMMARY OUTPUT Zinc

mw 7

Regression Statistics	
Multiple R	0.623614485
R Square	0.388895026
Adjusted R Square	0.352947674
Standard Error	0.009797102
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.001038	0.001038391	10.81846118	0.004330398
Residual	17	0.001632	9.59832E-05		
Total	18	0.00267			

	Coefficients	*'andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.765938855	0.227919	3.360568773	0.003711222	0.285070936	1.2468068	0.285070936	1.246806774
X Variable 1	-2.39371E-05	7.28E-06	-3.289142925	0.004330398	-3.9292E-05	-8.583E-06	-3.92916E-05	-8.5827E-06

SUMMARY OUTPUT Zinc
mw 8

Regression Statistics	
Multiple R	0.275741453
R Square	0.076033349
Adjusted R Square	0.021682369
Standard Error	0.047728021
Observations	19

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.003187	0.003186718	1.39893245	0.253180784
Residual	17	0.038725	0.002277964		
Total	18	0.041912			

	Coefficients	'andard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.341894731	1.110343	1.208540888	0.243381789	-1.00072388	3.6845133	-1.000723883	3.684513346
X Variable 1	-4.19337E-05	3.55E-05	-1.182764749	0.253180784	-0.00011674	3.287E-05	-0.000116735	3.28677E-05

SUMMARY OUTPUT Zinc
mw 9

Regression Statistics	
Multiple R	0.59100682
R Square	0.349289061
Adjusted R Square	0.311011947
Standard Error	0.010014493
Observations	19

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.000915174	0.000915	9.125271585	0.00770501
Residual	17	0.001704931	0.0001		
Total	18	0.002620105			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.719059324	0.232976779	3.086399	0.006696834	0.227521291	1.210597357	0.227521291	1.210597357
X Variable 1	-2.24721E-05	7.43911E-06	-3.02081	0.00770501	-3.81673E-05	-6.77696E-06	-3.81673E-05	-6.77696E-06

SUMMARY OUTPUT zinc
mw 10

Regression Statistics	
Multiple R	0.27720523
R Square	0.07684274
Adjusted R Square	0.02253937
Standard Error	0.09789461
Observations	19

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.013561061	0.013561061	1.415063927	0.250567103
Residual	17	0.162917045	0.009583356		
Total	18	0.176478105			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	2.76768659	2.277416561	1.215274639	0.240870345	-2.037242304	7.57261548	-2.0372423	7.572615482
X Variable 1	-8.65E-05	7.27195E-05	-1.1895646	0.250567103	-0.000239929	6.692E-05	-0.00023993	6.69202E-05

SUMMARY OUTPUT **ZINC**

mw 18

Regression Statistics	
Multiple R	0.17571594
R Square	0.03087609
Adjusted R Square	-0.0112597
Standard Error	0.12014782
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.010577977	0.010577977	0.73277535	0.400815602
Residual	23	0.332016463	0.014435498		
Total	24	0.34259444			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.90724393	0.96179769	0.943279381	0.355341853	-1.082383473	2.89687133	-1.08238347	2.896871334
X Variable 1	-2.215E-05	2.58746E-05	-0.85602298	0.400815602	-7.56749E-05	3.1376E-05	-7.5675E-05	3.13764E-05

SUMMARY OUTPUT **ZINC**
mw 19

Regression Statistics	
Multiple R	0.02448712
R Square	0.00059962
Adjusted R Square	-0.0428526
Standard Error	0.14212842
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.000278757	0.000278757	0.013799511	0.907506392
Residual	23	0.464611189	0.020200486		
Total	24	0.464889946			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*
Intercept	-0.0655359	1.137755	-0.05760103	0.954563937	-2.419158199	2.28808647	-2.4191582
X Variable 1	3.5956E-06	3.06083E-05	0.117471321	0.907506392	-5.97224E-05	6.6914E-05	-5.9722E-05

SUMMARY OUTPUT **ZINC**

mw 20

Regression Statistics	
Multiple R	0.025243655
R Square	0.000637242
Adjusted R Square	-0.042813313
Standard Error	0.062604464
Observations	25

ANOVA

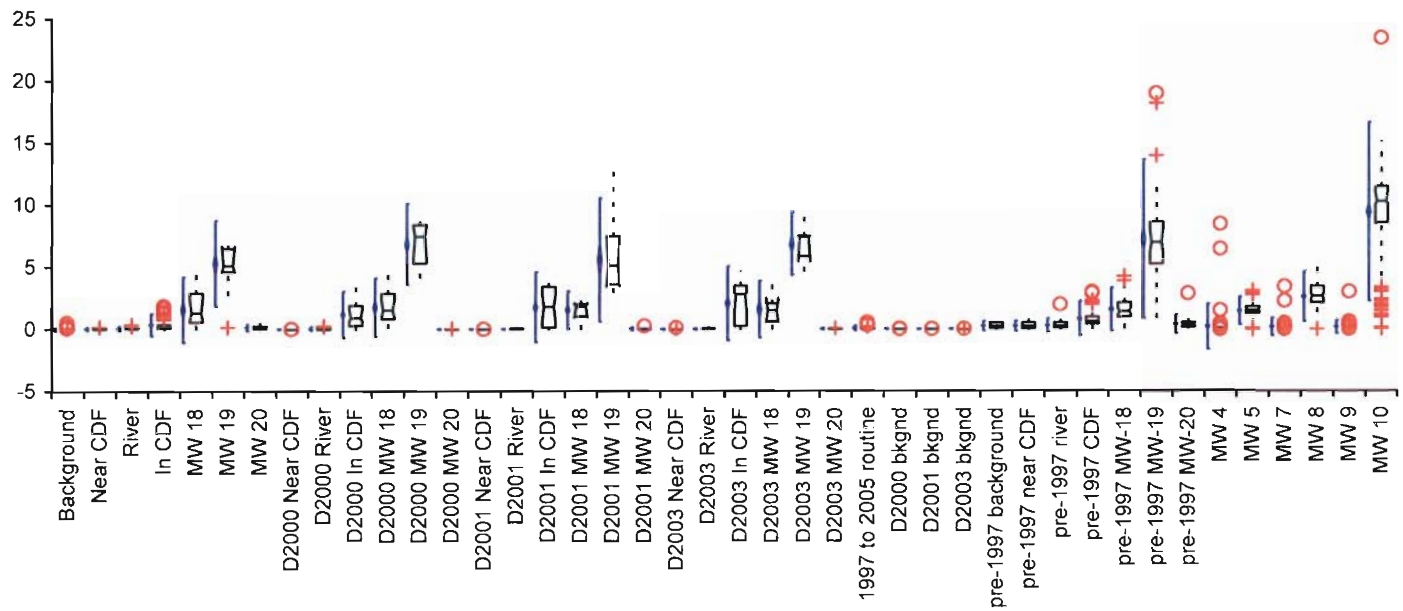
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.75E-05	5.74804E-05	0.014665915	0.904661313
Residual	23	0.090144	0.003919319		
Total	24	0.090202			

	Coefficients	Standard E	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.105704534	0.501156	0.210921319	0.834806253	-0.93101471	1.1424238	-0.931014714	1.142423782
X Variable 1	-1.63274E-06	1.35E-05	-0.121102911	0.904661313	-2.9523E-05	2.626E-05	-2.95229E-05	2.62574E-05

Appendix D: Comparative Descriptives

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Ammonia Nitrogen by date and sample location
Variables	Date by Sample location
Performed by	h6thejm9
Date	29 March 2006



)ate - R1 by Sample location	n	Mean	SD	SE	95% CI of Mean	Median	IQR	95% CI of Median
Background	285	0.0343	0.06013	0.00356	0.0272 to 0.0413	0.0100	0.0300	0.0100 to 0.0100
Near CDF	73	0.0722	0.04989	0.00584	0.0605 to 0.0838	0.0610	0.0670	0.0500 to 0.0790
River	73	0.1027	0.09249	0.01082	0.0811 to 0.1242	0.0660	0.0970	0.0560 to 0.1000
In CDF	75	0.3989	0.44836	0.05177	0.2958 to 0.5021	0.2800	0.2925	0.1700 to 0.3300
MW 18	24	1.6243	1.34788	0.27513	1.0552 to 2.1935	1.3000	2.3000	0.6300 to 2.5700
MW 19	22	5.3141	1.75658	0.37450	4.5353 to 6.0929	5.1100	1.8250	4.6000 to 6.7000
MW 20	25	0.1520	0.13580	0.02716	0.0959 to 0.2081	0.1000	0.1810	0.0500 to 0.2000
D2000 Near CDF	84	0.0163	0.01387	0.00151	0.0133 to 0.0193	0.0100	0.0000	0.0100 to 0.0100
D2000 River	84	0.0599	0.06785	0.00740	0.0452 to 0.0746	0.0300	0.0800	0.0100 to 0.0500

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Ammonia Nitrogen by date and sample location
Variables	Date by Sample location
Performed by	h6thejm9

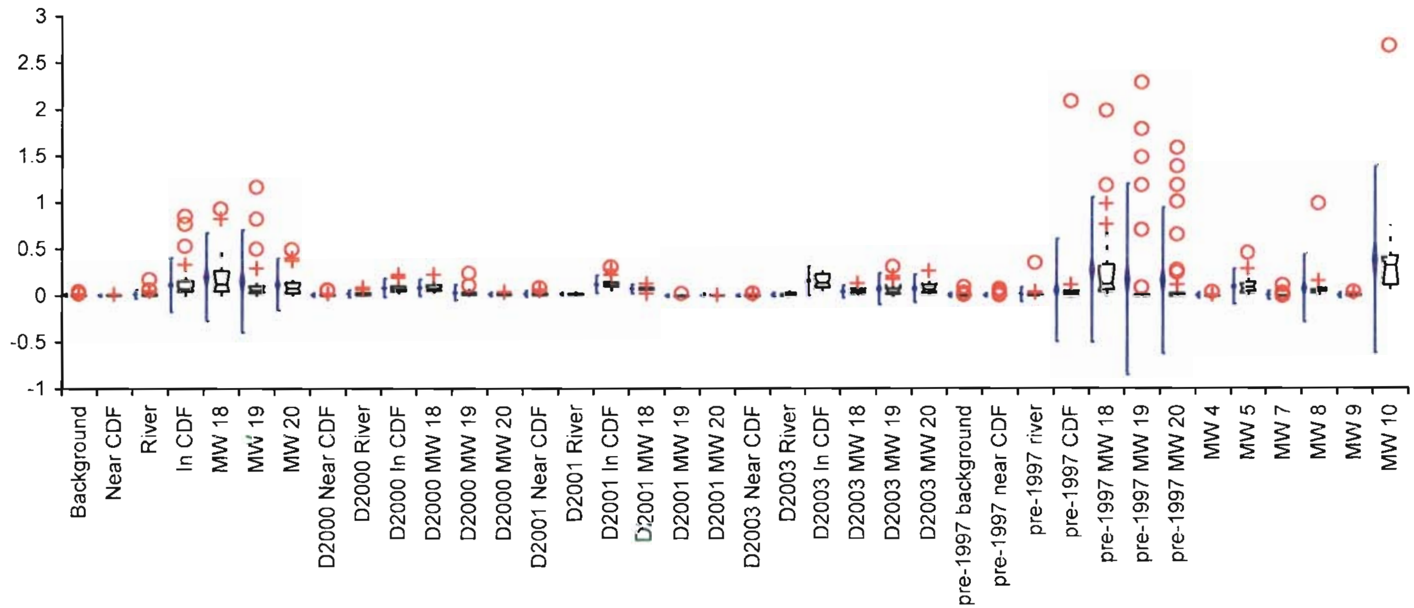
Date 29 March 2006

D2000 In CDF	93	1.1790	0.95880	0.09942	0.9816 to 1.3765	0.8900	1.6300	0.6600 to 1.6000
D2000 MW 18	28	1.7714	1.20480	0.22769	1.3043 to 2.2386	1.5500	2.0425	0.9300 to 2.4000
D2000 MW 19	33	6.8727	1.66250	0.28940	6.2832 to 7.4622	7.5000	3.1000	5.7000 to 8.3000
D2000 MW 20	33	0.0203	0.01723	0.00300	0.0142 to 0.0264	0.0100	0.0200	0.0100 to 0.0200
D2001 Near CDF	57	0.0137	0.00794	0.00105	0.0116 to 0.0158	0.0100	0.0000	0.0100 to 0.0100
D2001 River	57	0.0268	0.01754	0.00232	0.0222 to 0.0315	0.0200	0.0300	0.0200 to 0.0300
D2001 In CDF	57	1.7882	1.43912	0.19062	1.4064 to 2.1701	1.8000	3.2600	0.6100 to 2.8000
D2001 MW 18	19	1.5537	0.77673	0.17819	1.1793 to 1.9281	1.8000	0.9850	0.9300 to 2.1000
D2001 MW 19	19	5.5842	2.54127	0.58301	4.3594 to 6.8091	5.1000	3.8500	3.4000 to 7.5000
D2001 MW 20	19	0.0321	0.05940	0.01363	0.0035 to 0.0607	0.0100	0.0200	0.0100 to 0.0300
D2003 Near CDF	54	0.0172	0.01975	0.00269	0.0118 to 0.0226	0.0100	0.0100	0.0100 to 0.0200
D2003 River	54	0.0354	0.02560	0.00348	0.0284 to 0.0424	0.0300	0.0400	0.0200 to 0.0400
D2003 In CDF	51	2.0906	1.52077	0.21295	1.6629 to 2.5183	2.8000	3.2700	1.5000 to 2.9000
D2003 MW 18	18	1.6100	1.16686	0.27503	1.0297 to 2.1903	1.5000	1.4525	0.5400 to 2.5000
D2003 MW 19	18	6.8722	1.28878	0.30377	6.2313 to 7.5131	7.4000	1.6500	5.4000 to 7.5000
D2003 MW 20	18	0.0361	0.02768	0.00652	0.0223 to 0.0499	0.0300	0.0375	0.0100 to 0.0500
to 2005 routine background	75	0.0872	0.09776	0.01129	0.0647 to 0.1097	0.0580	0.0650	0.0490 to 0.0850
D2000 bkgnd	99	0.0158	0.01450	0.00146	0.0129 to 0.0187	0.0100	0.0000	0.0100 to 0.0100
D2001 bkgnd	57	0.0126	0.00613	0.00081	0.0110 to 0.0143	0.0100	0.0000	0.0100 to 0.0100
D2003 bkgnd	54	0.0174	0.01417	0.00193	0.0135 to 0.0213	0.0100	0.0100	0.0100 to 0.0100
pre-1997 background	79	0.2516	0.19230	0.02164	0.2086 to 0.2947	0.2000	0.4450	0.2000 to 0.2300
pre-1997 near CDF	200	0.2545	0.21169	0.01497	0.2249 to 0.2840	0.2000	0.4725	0.2000 to 0.2400
pre-1997 river	81	0.2870	0.27957	0.03106	0.2252 to 0.3488	0.2000	0.4200	0.2000 to 0.3500
pre-1997 CDF	67	0.8410	0.70255	0.08583	0.6697 to 1.0124	0.6000	0.5700	0.5000 to 0.7300
pre-1997 MW-18	68	1.5750	0.88360	0.10715	1.3611 to 1.7888	1.3850	1.1525	1.1000 to 1.7000
pre-1997 MW-19	69	7.2764	3.25595	0.39197	6.4942 to 8.0585	7.0000	3.3500	6.2100 to 8.0000
pre-1997 MW-20	67	0.3558	0.38159	0.04662	0.2627 to 0.4489	0.2500	0.4000	0.1500 to 0.4400
MW 4	132	0.2318	0.92366	0.08039	0.0727 to 0.3908	0.1000	0.0000	0.1000 to 0.1000
MW 5	152	1.4966	0.56789	0.04606	1.4056 to 1.5876	1.4250	0.5500	1.4000 to 1.5600
MW 7	137	0.1895	0.35787	0.03057	0.1290 to 0.2499	0.1000	0.0300	0.1000 to 0.1000
MW 8	147	2.6170	1.02197	0.08429	2.4504 to 2.7836	2.5800	1.3150	2.3600 to 2.7900
MW 9	146	0.1746	0.27037	0.02238	0.1304 to 0.2188	0.1000	0.0300	0.1000 to 0.1000
MW 10	145	9.4372	3.66763	0.30458	8.8351 to 10.0392	10.2600	2.9200	10.0000 to 11.0000

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Manganese by date and sample location
Variables	Manganese by Sample location
Performed by	h6thejm9

Date 29 March 2006



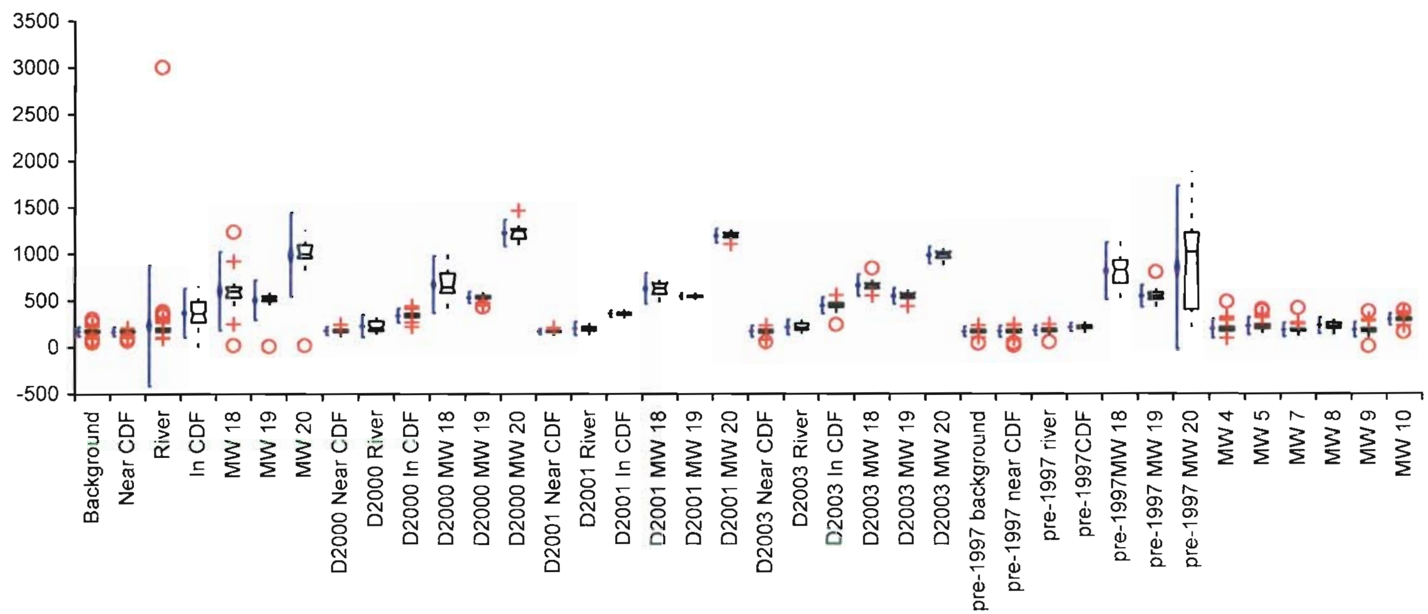
ıganese by Sample location	n	Mean	SD	SE	95% CI of Mean	Median	IQR	95% CI of Median
Background	288	0.00834	0.007099	0.000418	0.00751 to 0.00916	0.00571	0.00563	0.00515 to 0.00630
Near CDF	75	0.00805	0.004938	0.000570	0.00692 to 0.00919	0.00600	0.00490	0.00500 to 0.00729
River	75	0.01758	0.022583	0.002608	0.01239 to 0.02278	0.01300	0.01240	0.00960 to 0.01590
In CDF	75	0.12245	0.148027	0.017093	0.08839 to 0.15650	0.07350	0.11465	0.05810 to 0.10200
MW 18	25	0.20640	0.241578	0.048316	0.10668 to 0.30611	0.12000	0.21700	0.04700 to 0.24000
MW 19	25	0.15922	0.280108	0.056022	0.04360 to 0.27484	0.05600	0.07260	0.03540 to 0.09800
MW 20	25	0.12273	0.142563	0.028513	0.06388 to 0.18157	0.07700	0.11500	0.03290 to 0.12000
D2000 Near CDF	84	0.00979	0.009681	0.001056	0.00769 to 0.01189	0.00672	0.00765	0.00582 to 0.00839
D2000 River	84	0.02251	0.019053	0.002079	0.01838 to 0.02665	0.01540	0.02380	0.01210 to 0.01790

Test	**Comparative descriptives**
	Manganese by date and sample location
Variables	Manganese by Sample location
Performed by	h6thejm9
Date	29 March 2006

D2000 In CDF	96	0.08449	0.050865	0.005191	0.07418 to 0.09480	0.06955	0.06028	0.06300 to 0.08290
D2000 MW 18	29	0.08656	0.045574	0.008463	0.06923 to 0.10390	0.07510	0.05980	0.05520 to 0.09950
D2000 MW 19	34	0.03418	0.043524	0.007464	0.01899 to 0.04936	0.01960	0.02533	0.01430 to 0.03390
D2000 MW 20	34	0.01545	0.010973	0.001882	0.01162 to 0.01928	0.01200	0.01213	0.00768 to 0.01910
D2001 Near CDF	57	0.01972	0.016548	0.002192	0.01533 to 0.02411	0.01490	0.01696	0.01150 to 0.01950
D2001 River	57	0.01540	0.007776	0.001030	0.01334 to 0.01746	0.01330	0.00960	0.01190 to 0.01670
D2001 In CDF	57	0.12162	0.048090	0.006370	0.10886 to 0.13438	0.11100	0.04800	0.10200 to 0.12400
D2001 MW 18	19	0.07371	0.024125	0.005535	0.06208 to 0.08533	0.07240	0.02165	0.06170 to 0.08750
D2001 MW 19	19	0.00825	0.007149	0.001640	0.00480 to 0.01169	0.00538	0.00568	0.00313 to 0.00972
D2001 MW 20	19	0.01164	0.004282	0.000982	0.00957 to 0.01370	0.01090	0.00381	0.00883 to 0.01320
D2003 Near CDF	54	0.00924	0.007120	0.000969	0.00730 to 0.01118	0.00725	0.00678	0.00520 to 0.00930
D2003 River	54	0.01675	0.010719	0.001459	0.01382 to 0.01967	0.01650	0.01863	0.01000 to 0.02200
D2003 In CDF	51	0.15690	0.080255	0.011238	0.13433 to 0.17947	0.13600	0.14500	0.10200 to 0.19100
D2003 MW 18	18	0.05231	0.034312	0.008087	0.03524 to 0.06937	0.04700	0.04500	0.02600 to 0.07200
D2003 MW 19	18	0.08047	0.085745	0.020210	0.03783 to 0.12311	0.04350	0.05775	0.02500 to 0.12200
D2003 MW 20	18	0.08544	0.075546	0.017806	0.04788 to 0.12301	0.05950	0.09200	0.02400 to 0.12500
pre-1997 background	80	0.01364	0.011860	0.001326	0.01100 to 0.01628	0.01000	0.00000	0.01000 to 0.01000
pre-1997 near CDF	201	0.01360	0.010302	0.000727	0.01216 to 0.01503	0.01000	0.00000	0.01000 to 0.01000
pre-1997 river	82	0.01917	0.039146	0.004323	0.01057 to 0.02777	0.01000	0.01000	0.01000 to 0.01000
pre-1997 CDF	55	0.07370	0.280114	0.037771	-0.00203 to 0.14942	0.02100	0.04000	0.01000 to 0.04400
pre-1997 MW 18	42	0.29134	0.396331	0.061155	0.16783 to 0.41484	0.12250	0.27000	0.07000 to 0.27000
pre-1997 MW 19	42	0.19129	0.523110	0.080718	0.02827 to 0.35430	0.01000	0.01625	0.01000 to 0.01000
pre-1997 MW 20	41	0.17572	0.399100	0.062329	0.04975 to 0.30169	0.01700	0.03000	0.01000 to 0.03100
MW 4	16	0.01375	0.014663	0.003666	0.00594 to 0.02156	0.01000	0.00500	0.00500 to 0.01000
MW 5	34	0.10735	0.097314	0.016689	0.07340 to 0.14131	0.08500	0.10075	0.04300 to 0.14000
MW 7	28	0.01589	0.022113	0.004179	0.00732 to 0.02447	0.01000	0.00125	0.01000 to 0.01000
MW 8	27	0.08974	0.184634	0.035533	0.01670 to 0.16278	0.05000	0.03500	0.04000 to 0.07000
MW 9	28	0.01518	0.013641	0.002578	0.00989 to 0.02047	0.01000	0.00875	0.01000 to 0.01000
MW 10	26	0.39608	0.510243	0.100067	0.18999 to 0.60217	0.31500	0.31375	0.14000 to 0.42000

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Total Dissolved Solids by date and sample location
Variables	TDS by Sample Location
Performed by	h6thejm9
Date	29 March 2006



TDS by Sample Location	n	Mean	SD	SE	95% CI of Mean	Median	IQR	95% CI of Median
Background	285	172.6737	25.28699	1.49787	169.7253 to 175.6220	172.0000	24.0000	170.0000 to 174.0000
Near CDF	75	171.1067	23.42531	2.70492	165.7170 to 176.496	172.0000	19.0000	170.0000 to 180.0000
River	75	236.1867	329.80992	38.08317	160.3043 to 312.0690	182.0000	37.5000	170.0000 to 200.0000
In CDF	75	374.5467	133.74262	15.44327	343.7753 to 405.3180	364.0000	219.0000	297.0000 to 400.0000
MW 18	25	606.5600	214.86393	42.97279	517.8685 to 695.2515	600.0000	112.0000	550.0000 to 640.0000
MW 19	25	508.9200	109.45658	21.89132	463.7385 to 554.1015	530.0000	49.0000	500.0000 to 548.0000
MW 20	25	994.6400	229.48763	45.89753	899.9122 to 1089.368	1000.0000	140.0000	970.0000 to 1090.000
D2000 Near CDF	84	176.6190	22.82247	2.49014	171.6663 to 181.5718	172.0000	28.0000	166.0000 to 180.0000
D2000 River	84	229.3571	61.33940	6.69268	216.0457 to 242.6686	207.0000	105.5000	192.0000 to 242.0000

analysed with: Analyse-it + General 1.73

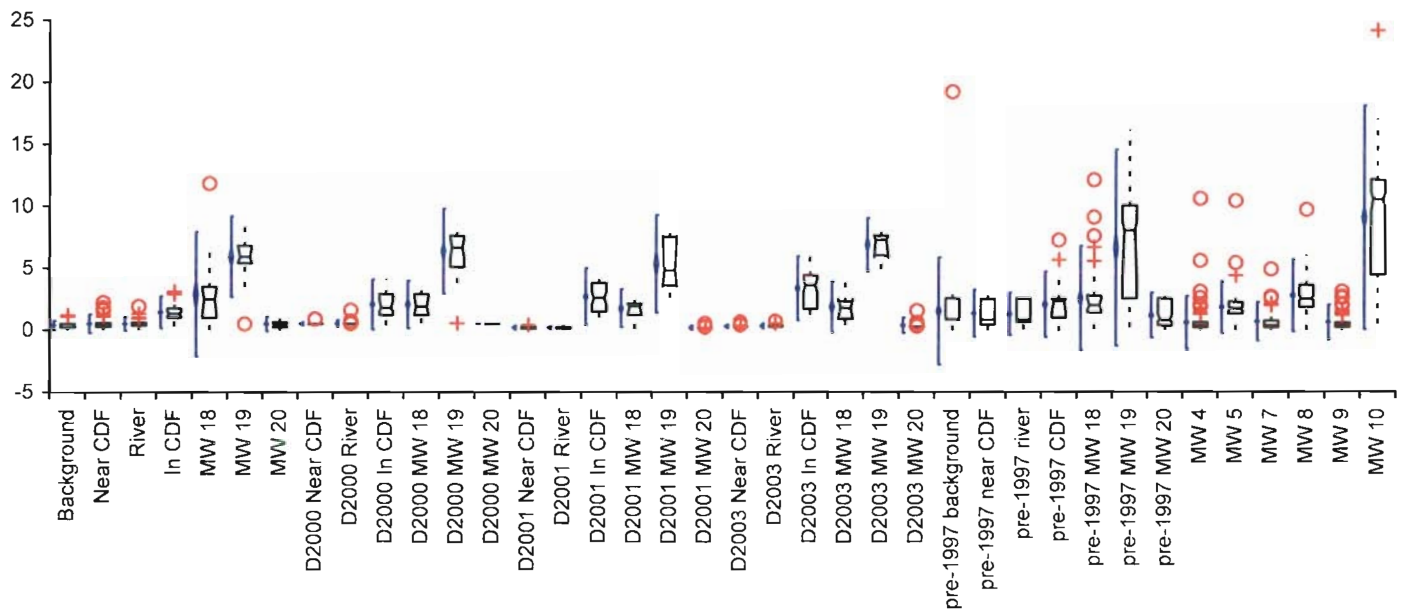
Test	**Comparative descriptives**
	Total Dissolved Solids by date and sample location
Variables	TDS by Sample Location
Performed by	h6thejm9
Date	29 March 2006

D2000 In CDF	96	339.9583	38.23141	3.90198	332.2119 to 347.7047	342.0000	36.0000	332.0000 to 348.0000
D2000 MW 18	29	675.5172	156.11777	28.99034	616.1332 to 734.9013	644.0000	208.0000	588.0000 to 770.0000
D2000 MW 19	34	534.5882	31.38241	5.38204	523.6384 to 545.5381	544.0000	28.0000	528.0000 to 550.0000
D2000 MW 20	34	1229.1176	72.75395	12.47720	1203.7326 to 1254.503	1255.0000	100.0000	1180.0000 to 1260.000
D2001 Near CDF	57	170.3509	14.65860	1.94158	166.4614 to 174.2403	172.0000	16.0000	166.0000 to 174.0000
D2001 River	57	202.0351	36.64597	4.85388	192.3116 to 211.7586	192.0000	44.0000	186.0000 to 212.0000
D2001 In CDF	57	360.0351	18.34390	2.42971	355.1678 to 364.9024	358.0000	28.0000	354.0000 to 362.0000
D2001 MW 18	19	633.2632	84.63834	19.41737	592.4688 to 674.0575	634.0000	111.0000	570.0000 to 696.0000
D2001 MW 19	19	546.6316	16.78693	3.85119	538.5405 to 554.7226	544.0000	22.0000	534.0000 to 558.0000
D2001 MW 20	19	1198.9474	39.14286	8.97999	1180.0811 to 1217.814	1200.0000	45.0000	1180.0000 to 1230.000
D2003 Near CDF	54	175.0370	30.15868	4.10408	166.8053 to 183.2688	180.0000	29.0000	172.0000 to 188.0000
D2003 River	54	218.8519	40.82101	5.55504	207.7099 to 229.9938	206.0000	68.5000	196.0000 to 230.0000
D2003 In CDF	51	451.2941	44.67451	6.25568	438.7292 to 463.8590	452.0000	45.0000	446.0000 to 460.0000
D2003 MW 18	18	669.6667	59.94605	14.12942	639.8562 to 699.4771	670.0000	51.0000	632.0000 to 690.0000
D2003 MW 19	18	553.8889	43.51861	10.25743	532.2476 to 575.5302	550.0000	49.0000	528.0000 to 586.0000
D2003 MW 20	18	991.0000	46.08049	10.86128	968.0847 to 1013.915	996.0000	62.5000	958.0000 to 1030.000
pre-1997 background	79	171.6835	27.00453	3.03825	165.6349 to 177.7322	170.0000	30.0000	167.0000 to 180.0000
pre-1997 near CDF	198	172.0505	29.86837	2.12265	167.8645 to 176.2365	170.0000	30.0000	170.0000 to 173.0000
pre-1997 river	81	184.4074	26.68135	2.96459	178.5077 to 190.3071	180.0000	30.0000	180.0000 to 190.0000
pre-1997CDF	54	216.2037	23.98221	3.26357	209.6578 to 222.7496	220.0000	30.0000	210.0000 to 220.0000
pre-1997MW 18	55	821.0545	155.78135	21.00555	778.9410 to 863.1681	830.0000	245.5000	758.0000 to 890.0000
pre-1997 MW 19	57	552.6316	60.00346	7.94765	536.7105 to 568.5526	550.0000	73.0000	520.0000 to 568.0000
pre-1997 MW 20	56	859.7143	447.12568	59.74968	739.9733 to 979.4553	1026.0000	826.7500	519.0000 to 1200.000
MW 4	87	203.2874	51.36823	5.50725	192.3393 to 214.2354	189.0000	43.0000	180.0000 to 200.0000
MW 5	102	231.5784	47.46618	4.69985	222.2552 to 240.9017	220.0000	44.5000	210.0000 to 229.0000
MW 7	90	187.5778	37.66857	3.97062	179.6883 to 195.4673	180.0000	29.0000	178.0000 to 190.0000
MW 8	97	233.0515	42.14790	4.27947	224.5569 to 241.5462	220.0000	58.0000	210.0000 to 238.0000
MW 9	97	188.0000	40.81181	4.14381	179.7746 to 196.2254	188.0000	36.0000	180.0000 to 190.0000
MW 10	94	301.1596	31.15494	3.21339	294.7784 to 307.5407	300.0000	25.7500	296.0000 to 307.0000

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	TKN by sample location and date
Variables	TKN by Sample location
Performed by	h6thejm9

Date 27 March 2006



TKN by Sample location	n	Mean	SD	SE	95% CI of Mean	Median	IQR	95% CI of Median
Background	285	0.3748	0.18425	0.01091	0.3534 to 0.3963	0.5000	0.3000	0.3400 to 0.5000
Near CDF	75	0.5131	0.37595	0.04341	0.4266 to 0.5996	0.5000	0.3000	0.4600 to 0.5000
River	75	0.5012	0.28315	0.03270	0.4361 to 0.5664	0.5000	0.2400	0.5000 to 0.5000
In CDF	75	1.4400	0.65630	0.07578	1.2890 to 1.5910	1.3000	0.7500	1.1000 to 1.5000
MW 18	25	2.8816	2.55364	0.51073	1.8275 to 3.9357	2.5000	2.5000	1.3000 to 3.3000
MW 19	25	5.9076	1.65681	0.33136	5.2237 to 6.5915	5.9000	1.4200	5.4000 to 6.7300
MW 20	25	0.4801	0.29736	0.05947	0.3574 to 0.6029	0.5000	0.4100	0.2500 to 0.5350
D2000 Near CDF	84	0.5093	0.05983	0.00653	0.4963 to 0.5223	0.5000	0.0000	0.5000 to 0.5000
D2000 River	83	0.5204	0.12375	0.01358	0.4933 to 0.5474	0.5000	0.0000	0.5000 to 0.5000

analysed with: Analyse-it + General 1.73

Test | **Comparative descriptives**
TKN by sample location and date

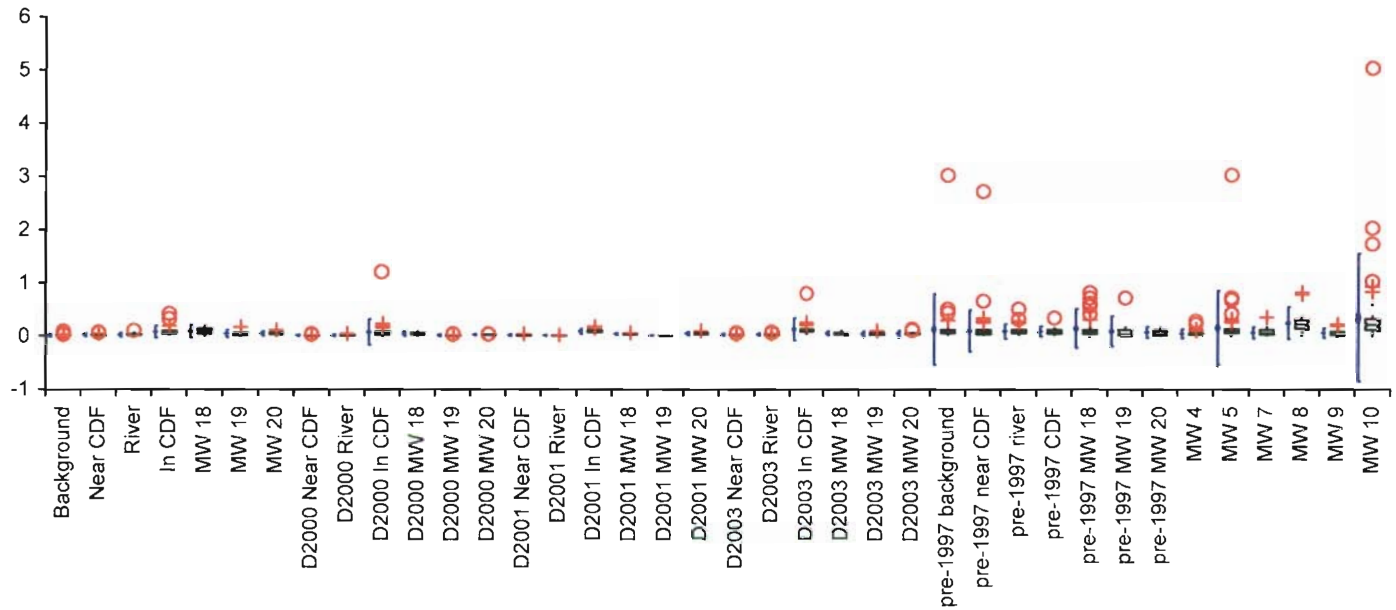
Variables | TKN by Sample location

Performed by | h6thejm9 — **Date** | 27 March 2006

D2000 In CDF	95	2.0475	1.02562	0.10523	1.8385 to 2.2564	1.8000	1.7000	1.5000 to 2.4000
D2000 MW 18	29	2.0428	0.97058	0.18023	1.6736 to 2.4119	1.9000	1.7000	1.2000 to 2.8000
D2000 MW 19	34	6.3247	1.73953	0.29833	5.7178 to 6.9317	6.6500	2.5250	5.8000 to 7.5000
D2000 MW 20	34	0.5000	-	-	- to -	0.5000	0.0000	0.5000 to 0.5000
D2001 Near CDF	57	0.1775	0.07470	0.00989	0.1577 to 0.1974	0.1600	0.1100	0.1400 to 0.1800
D2001 River	57	0.1835	0.05569	0.00738	0.1687 to 0.1983	0.1900	0.0900	0.1700 to 0.2100
D2001 In CDF	57	2.6702	1.15927	0.15355	2.3626 to 2.9778	2.6000	2.3000	2.0000 to 3.1000
D2001 MW 18	19	1.7284	0.77844	0.17859	1.3532 to 2.1036	1.9000	0.9000	1.2000 to 2.1000
D2001 MW 19	19	5.2842	1.99813	0.45840	4.3211 to 6.2473	4.8000	3.9000	3.5000 to 7.6000
D2001 MW 20	19	0.1311	0.08225	0.01887	0.0914 to 0.1707	0.1000	0.0100	0.1000 to 0.1100
D2003 Near CDF	54	0.2313	0.06936	0.00944	0.2124 to 0.2502	0.2000	0.0300	0.2000 to 0.2000
D2003 River	54	0.2654	0.09486	0.01291	0.2395 to 0.2913	0.2200	0.1125	0.2000 to 0.2500
D2003 In CDF	51	3.3020	1.31552	0.18421	2.9320 to 3.6720	3.6000	2.6500	3.0000 to 4.1000
D2003 MW 18	18	1.8289	1.03408	0.24373	1.3147 to 2.3431	1.7500	1.3925	0.8800 to 2.5000
D2003 MW 19	18	6.8222	1.08766	0.25636	6.2813 to 7.3631	7.2500	1.6250	5.8000 to 7.6000
D2003 MW 20	18	0.3056	0.31298	0.07377	0.1499 to 0.4612	0.2000	0.0000	0.2000 to 0.2000
pre-1997 background	79	1.4557	2.19471	0.24692	0.9641 to 1.9473	0.8000	1.7000	0.8000 to 1.0000
pre-1997 near CDF	200	1.2873	0.96692	0.06837	1.1524 to 1.4221	0.8000	2.0900	0.8000 to 0.9400
pre-1997 river	82	1.2213	0.87402	0.09652	1.0293 to 1.4134	0.8000	1.9075	0.8000 to 0.9400
pre-1997 CDF	67	2.0030	1.35002	0.16493	1.6737 to 2.3323	2.3000	1.5350	1.4000 to 2.5000
pre-1997 MW 18	55	2.4970	2.13610	0.28803	1.9195 to 3.0744	1.9300	1.3950	1.5500 to 2.5000
pre-1997 MW 19	55	6.5351	4.03390	0.54393	5.4446 to 7.6256	8.0000	7.5000	4.0800 to 8.6800
pre-1997 MW 20	53	1.1094	0.91999	0.12637	0.8559 to 1.3630	0.7800	2.1800	0.5800 to 1.2000
MW 4	131	0.5301	1.08119	0.09446	0.3432 to 0.7170	0.2700	0.3900	0.2200 to 0.3400
MW 5	154	1.7707	1.05983	0.08540	1.6020 to 1.9394	1.6900	0.9175	1.5000 to 1.8000
MW 7	137	0.6064	0.79240	0.06770	0.4726 to 0.7403	0.2800	0.5200	0.2400 to 0.3500
MW 8	145	2.7014	1.48627	0.12343	2.4574 to 2.9454	2.5000	1.7700	2.3700 to 2.7500
MW 9	146	0.5674	0.70684	0.05850	0.4517 to 0.6830	0.2900	0.3825	0.2200 to 0.3900
MW 10	147	8.9801	4.59371	0.37888	8.2313 to 9.7289	10.5000	7.6250	9.5000 to 11.0000

Test	**Comparative descriptives**
	Total Phosporus by date and sample location
Variables	Total Phosporus by Sample location
Performed by	h6thejm9

Date 27 March 2006



osporus by Sample location	n	Mean	SD	SE	95% CI of Mean	Median	IQR	95% CI of Median
Background	285	0.01219	0.012354	0.000732	0.01075 to 0.01363	0.00800	0.00500	0.00700 to 0.00900
Near CDF	74	0.02145	0.015886	0.001847	0.01777 to 0.02513	0.01700	0.01000	0.01200 to 0.02000
River	75	0.02312	0.017683	0.002042	0.01905 to 0.02719	0.02000	0.02000	0.01400 to 0.02000
In CDF	75	0.08012	0.057278	0.006614	0.06694 to 0.09330	0.07000	0.04450	0.06000 to 0.07600
MW 18	25	0.09716	0.061170	0.012234	0.07191 to 0.12241	0.09200	0.09000	0.05000 to 0.11000
MW 19	25	0.04464	0.034619	0.006924	0.03035 to 0.05893	0.03900	0.04000	0.02000 to 0.05800
MW 20	25	0.04608	0.022405	0.004481	0.03683 to 0.05533	0.04500	0.03000	0.03000 to 0.05800
D2000 Near CDF	84	0.00956	0.006794	0.000741	0.00809 to 0.01103	0.00800	0.00400	0.00700 to 0.00900
D2000 River	84	0.01313	0.009448	0.001031	0.01108 to 0.01518	0.01000	0.01300	0.00900 to 0.01000

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Total Phosporus by date and sample location
Variables	Total Phosporus by Sample location
Performed by	h6thejm9

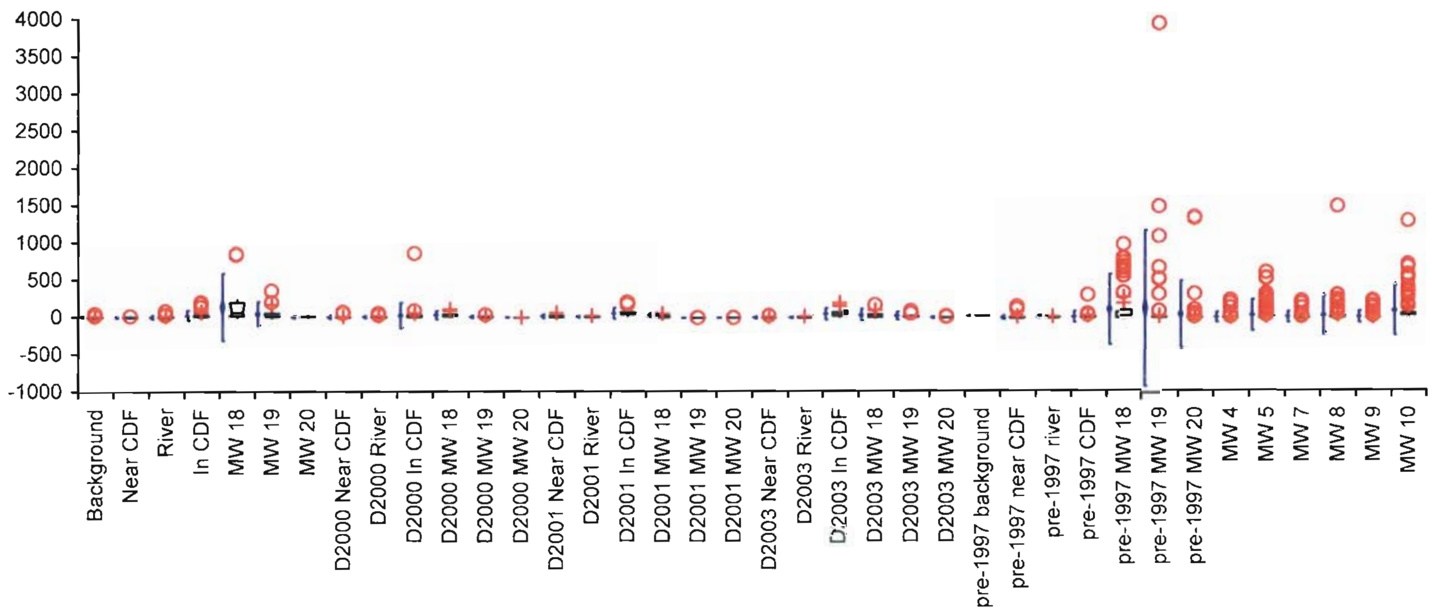
Date 27 March 2006

D2000 In CDF	96	0.07057	0.122980	0.012552	0.04565 to 0.09549	0.05000	0.05000	0.04000 to 0.06000
D2000 MW 18	29	0.04414	0.021467	0.003986	0.03597 to 0.05230	0.04000	0.03000	0.03000 to 0.06000
D2000 MW 19	34	0.01347	0.009199	0.001578	0.01026 to 0.01668	0.01000	0.00450	0.00900 to 0.01000
D2000 MW 20	34	0.02382	0.006970	0.001195	0.02139 to 0.02626	0.02000	0.00250	0.02000 to 0.02000
D2001 Near CDF	57	0.01223	0.007758	0.001028	0.01017 to 0.01429	0.01000	0.01300	0.00900 to 0.01000
D2001 River	57	0.00937	0.004455	0.000590	0.00819 to 0.01055	0.00900	0.00400	0.00800 to 0.01000
D2001 In CDF	57	0.08386	0.024982	0.003309	0.07723 to 0.09049	0.08000	0.03000	0.08000 to 0.09000
D2001 MW 18	19	0.03579	0.009612	0.002205	0.03116 to 0.04042	0.04000	0.01000	0.03000 to 0.04000
D2001 MW 19	19	0.00647	0.001264	0.000290	0.00586 to 0.00708	0.00600	0.00300	0.00500 to 0.00800
D2001 MW 20	19	0.03105	0.014868	0.003411	0.02389 to 0.03822	0.03000	0.02000	0.02000 to 0.04000
D2003 Near CDF	54	0.00972	0.008794	0.001197	0.00732 to 0.01212	0.00600	0.00500	0.00500 to 0.00900
D2003 River	54	0.01230	0.011283	0.001535	0.00922 to 0.01538	0.00800	0.00750	0.00700 to 0.00900
D2003 In CDF	51	0.11314	0.106198	0.014871	0.08327 to 0.14301	0.09000	0.04500	0.08000 to 0.10000
D2003 MW 18	18	0.03556	0.019166	0.004517	0.02602 to 0.04509	0.03000	0.03000	0.02000 to 0.05000
D2003 MW 19	18	0.02483	0.022809	0.005376	0.01349 to 0.03618	0.01500	0.02425	0.00800 to 0.04000
D2003 MW 20	18	0.03444	0.025946	0.006116	0.02154 to 0.04735	0.02500	0.01250	0.02000 to 0.04000
pre-1997 background	79	0.11503	0.338718	0.038109	0.03916 to 0.19089	0.05000	0.06000	0.05000 to 0.10000
pre-1997 near CDF	200	0.08228	0.197579	0.013971	0.05473 to 0.10984	0.05000	0.08000	0.05000 to 0.07800
pre-1997 river	82	0.07123	0.068912	0.007610	0.05609 to 0.08637	0.05000	0.06000	0.05000 to 0.07000
pre-1997 CDF	55	0.06931	0.048823	0.006583	0.05611 to 0.08251	0.05000	0.07000	0.05000 to 0.10000
pre-1997 MW 18	47	0.12823	0.186387	0.027187	0.07350 to 0.18295	0.05770	0.07150	0.03400 to 0.10000
pre-1997 MW 19	47	0.07644	0.142674	0.020811	0.03455 to 0.11833	0.02000	0.09350	0.01500 to 0.10000
pre-1997 MW 20	46	0.05418	0.053999	0.007962	0.03815 to 0.07022	0.03250	0.08575	0.01600 to 0.07400
MW 4	68	0.02971	0.043518	0.005277	0.01918 to 0.04025	0.01100	0.02700	0.01000 to 0.02000
MW 5	75	0.14099	0.355085	0.041002	0.05930 to 0.22269	0.07240	0.06800	0.05900 to 0.09000
MW 7	66	0.04813	0.055167	0.006791	0.03457 to 0.06169	0.03250	0.09000	0.01700 to 0.03700
MW 8	71	0.23083	0.154812	0.018373	0.19419 to 0.26748	0.21000	0.17250	0.19000 to 0.28000
MW 9	80	0.04072	0.046767	0.005229	0.03031 to 0.05112	0.02000	0.06075	0.01000 to 0.03700
MW 10	82	0.32283	0.612340	0.067622	0.18828 to 0.45737	0.19000	0.20300	0.15600 to 0.22000

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Total Suspended Solids by date and sample location
Variables	TSS by Sample location
Performed by	h6thejm9

Date 29 March 2006



TSS by Sample location	n	Mean	SD	SE	95% CI of Mean	Median	IQR	95% CI of Median
Background	285	7.89	6.060	0.359	7.18 to 8.59	5.00	4.00	5.00 to 6.00
Near CDF	75	6.58	3.260	0.376	5.83 to 7.33	5.00	3.50	5.00 to 7.00
River	75	10.35	11.287	1.303	7.76 to 12.95	8.00	6.00	6.00 to 10.00
In CDF	75	31.02	35.615	4.112	22.83 to 39.22	21.00	22.00	18.00 to 25.00
MW 18	25	149.17	230.100	46.020	54.19 to 244.15	58.00	179.00	19.00 to 180.00
MW 19	25	54.68	83.080	16.616	20.38 to 88.97	23.00	50.00	10.00 to 49.00
MW 20	25	6.66	4.589	0.918	4.77 to 8.55	5.00	6.00	4.00 to 10.00
D2000 Near CDF	84	7.79	10.051	1.097	5.60 to 9.97	6.00	5.00	5.00 to 6.00
D2000 River	84	10.79	8.099	0.884	9.03 to 12.54	9.00	6.00	8.00 to 10.00

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Total Suspended Solids by date and sample location
Variables	TSS by Sample location
Performed by	h6thejm9

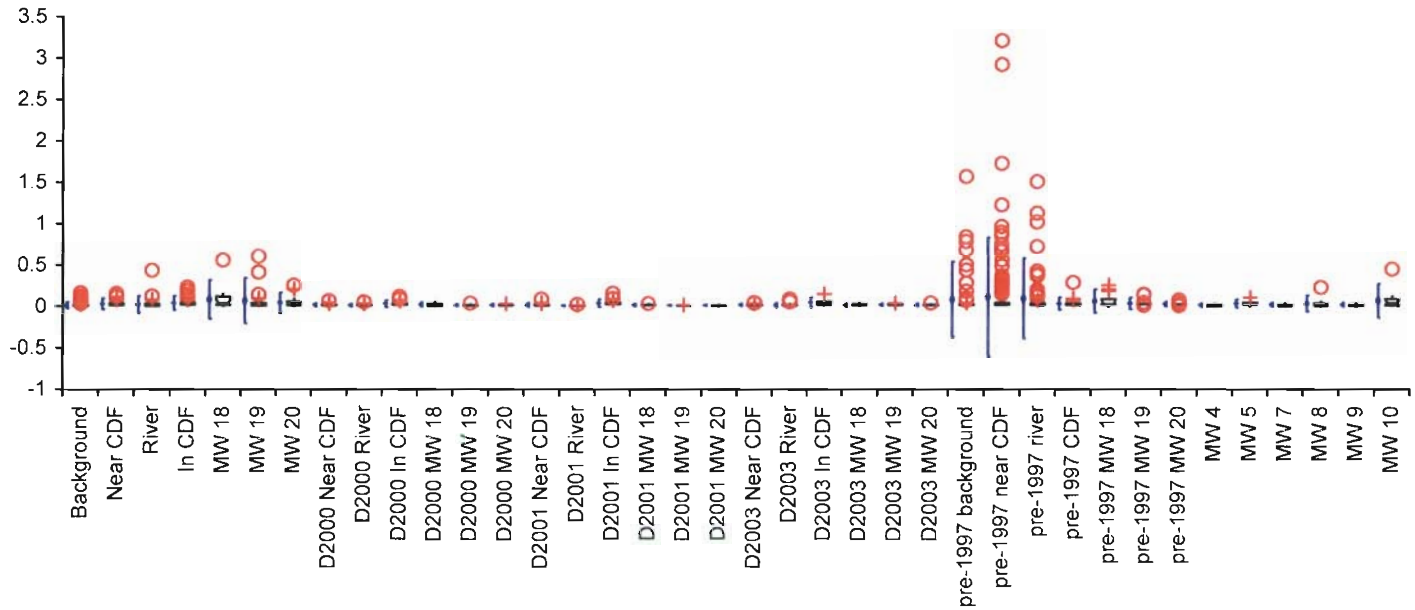
Date 29 March 2006

D2000 In CDF	96	30.42	87.606	8.941	12.67 to 48.17	18.00	19.75	14.00 to 20.00
D2000 MW 18	29	34.97	27.886	5.178	24.36 to 45.57	25.00	27.00	18.00 to 41.00
D2000 MW 19	34	10.44	8.046	1.380	7.63 to 13.25	8.00	7.75	5.00 to 11.00
D2000 MW 20	34	2.15	1.417	0.243	1.65 to 2.64	2.00	1.25	1.00 to 2.00
D2001 Near CDF	57	17.16	13.702	1.815	13.52 to 20.79	14.00	17.00	9.00 to 18.00
D2001 River	57	9.51	5.078	0.673	8.16 to 10.86	8.00	6.00	6.00 to 10.00
D2001 In CDF	57	55.33	37.695	4.993	45.33 to 65.34	45.00	34.00	36.00 to 57.00
D2001 MW 18	19	20.74	13.051	2.994	14.45 to 27.03	15.00	16.00	12.00 to 29.00
D2001 MW 19	19	5.37	1.571	0.360	4.61 to 6.13	5.00	0.00	5.00 to 5.00
D2001 MW 20	19	5.26	0.872	0.200	4.84 to 5.68	5.00	0.00	5.00 to 5.00
D2003 Near CDF	54	8.46	6.350	0.864	6.73 to 10.20	5.50	4.25	5.00 to 7.00
D2003 River	54	9.24	5.013	0.682	7.87 to 10.61	7.50	7.25	6.00 to 10.00
D2003 In CDF	51	56.63	39.392	5.516	45.55 to 67.71	45.00	46.50	32.00 to 56.00
D2003 MW 18	18	38.22	44.243	10.428	16.22 to 60.22	17.50	35.00	11.00 to 47.00
D2003 MW 19	18	28.28	26.178	6.170	15.26 to 41.30	20.50	12.00	10.00 to 26.00
D2003 MW 20	18	6.50	5.067	1.194	3.98 to 9.02	5.00	0.00	5.00 to 5.00
pre-1997 background	79	6.29	3.958	0.445	5.40 to 7.18	5.00	7.00	4.00 to 7.00
pre-1997 near CDF	201	7.48	14.268	1.006	5.49 to 9.46	5.00	7.00	4.00 to 6.00
pre-1997 river	82	8.37	4.723	0.522	7.33 to 9.40	8.00	6.00	6.00 to 10.00
pre-1997 CDF	67	18.70	38.214	4.669	9.38 to 28.02	11.00	8.00	10.00 to 13.00
pre-1997 MW 18	68	118.96	241.060	29.233	60.61 to 177.30	9.50	76.25	5.00 to 17.00
pre-1997 MW 19	68	133.13	533.365	64.680	4.03 to 262.23	4.00	7.00	4.00 to 5.00
pre-1997 MW 20	69	51.13	229.594	27.640	-4.02 to 106.28	4.00	3.00	2.00 to 4.00
MW 4	129	9.91	33.911	2.986	4.01 to 15.82	4.00	3.00	2.00 to 4.00
MW 5	148	38.84	106.422	8.748	21.56 to 56.13	4.00	7.75	4.00 to 4.00
MW 7	133	12.05	36.434	3.159	5.80 to 18.29	3.00	4.00	2.00 to 4.00
MW 8	143	33.31	133.030	11.125	11.32 to 55.30	8.00	11.50	7.00 to 9.00
MW 9	141	12.52	39.274	3.307	5.99 to 19.06	2.00	3.00	1.00 to 4.00
MW 10	146	98.03	170.103	14.078	70.20 to 125.85	33.00	32.50	31.00 to 39.00

analysed with: Analyse-it + General 1.73

Test	**Comparative descriptives**
	Zinc by date and sample location
Variables	Zinc by Sample location
Performed by	h6thejm9

Date 29 March 2006



Zinc by Sample location	n	Mean	SD	SE	95% CI of Mean	Median	IQR	95% CI of Median
Background	285	0.01300	0.018940	0.001122	0.01079 to 0.01521	0.00700	0.00620	0.00640 to 0.00772
Near CDF	75	0.03033	0.033906	0.003915	0.02253 to 0.03813	0.01500	0.02605	0.01000 to 0.02650
River	75	0.02518	0.052550	0.006068	0.01309 to 0.03727	0.01000	0.02400	0.00780 to 0.01600
In CDF	75	0.04187	0.043594	0.005034	0.03184 to 0.05190	0.02500	0.02165	0.02300 to 0.03320
MW 18	25	0.08418	0.119477	0.023895	0.03486 to 0.13350	0.03800	0.10400	0.01400 to 0.08000
MW 19	25	0.06808	0.139178	0.027836	0.01063 to 0.12553	0.01600	0.03090	0.01000 to 0.03110
MW 20	25	0.04503	0.061306	0.012261	0.01973 to 0.07034	0.01990	0.04900	0.01000 to 0.05420
D2000 Near CDF	84	0.01566	0.010546	0.001151	0.01337 to 0.01795	0.01265	0.01036	0.01070 to 0.01510
D2000 River	84	0.01246	0.007893	0.000861	0.01075 to 0.01417	0.00985	0.00830	0.00913 to 0.01230

analysed with: Analyse-it + General 1.73

Test | **Comparative descriptives**
Zinc by date and sample location

Variables | Zinc by Sample location

Performed by | h6thejm9 | **Date** | 29 March 2006

D2000 In CDF	96	0.02973	0.021046	0.002148	0.02546 to 0.03399	0.02380	0.01610	0.02030 to 0.02740
D2000 MW 18	29	0.01956	0.012676	0.002354	0.01474 to 0.02438	0.01610	0.02156	0.00990 to 0.02630
D2000 MW 19	34	0.00994	0.005888	0.001010	0.00789 to 0.01199	0.00829	0.00604	0.00677 to 0.01090
D2000 MW 20	34	0.01231	0.006972	0.001196	0.00988 to 0.01475	0.01110	0.00848	0.00686 to 0.01410
D2001 Near CDF	57	0.01531	0.012603	0.001669	0.01197 to 0.01866	0.01130	0.00910	0.00932 to 0.01510
D2001 River	57	0.00660	0.002455	0.000325	0.00595 to 0.00725	0.00548	0.00206	0.00500 to 0.00639
D2001 In CDF	57	0.03648	0.022171	0.002937	0.03060 to 0.04236	0.03220	0.01610	0.02900 to 0.03640
D2001 MW 18	19	0.01398	0.006258	0.001436	0.01096 to 0.01699	0.01340	0.00520	0.01010 to 0.01660
D2001 MW 19	19	0.00643	0.001904	0.000437	0.00551 to 0.00735	0.00561	0.00247	0.00500 to 0.00766
D2001 MW 20	19	0.00887	0.002837	0.000651	0.00750 to 0.01024	0.00859	0.00367	0.00672 to 0.01050
D2003 Near CDF	54	0.01382	0.007528	0.001024	0.01176 to 0.01587	0.01200	0.00625	0.01000 to 0.01400
D2003 River	54	0.01170	0.011678	0.001589	0.00851 to 0.01488	0.00915	0.00718	0.00760 to 0.01100
D2003 In CDF	51	0.04524	0.029875	0.004183	0.03683 to 0.05364	0.03700	0.03750	0.02300 to 0.05100
D2003 MW 18	18	0.02037	0.009632	0.002270	0.01558 to 0.02516	0.01850	0.01225	0.01400 to 0.02700
D2003 MW 19	18	0.01692	0.007589	0.001789	0.01315 to 0.02070	0.01450	0.00825	0.01200 to 0.02200
D2003 MW 20	18	0.01481	0.008093	0.001908	0.01079 to 0.01884	0.01200	0.00555	0.00960 to 0.01700
pre-1997 background	80	0.08133	0.231787	0.025915	0.02974 to 0.13291	0.01000	0.01150	0.01000 to 0.02000
pre-1997 near CDF	201	0.11283	0.364970	0.025743	0.06207 to 0.16359	0.02000	0.03000	0.01300 to 0.02000
pre-1997 river	82	0.09148	0.246865	0.027262	0.03723 to 0.14572	0.02000	0.02100	0.01000 to 0.02000
pre-1997 CDF	55	0.02962	0.038375	0.005174	0.01924 to 0.03999	0.02000	0.02000	0.02000 to 0.02500
pre-1997 MW 18	21	0.05943	0.071369	0.015574	0.02694 to 0.09192	0.02000	0.06000	0.02000 to 0.08000
pre-1997 MW 19	21	0.03071	0.035814	0.007815	0.01441 to 0.04702	0.02000	0.00000	0.02000 to 0.02000
pre-1997 MW 20	21	0.02214	0.013911	0.003036	0.01581 to 0.02848	0.02000	0.00000	0.02000 to 0.02000
MW 4	14	0.01164	0.009162	0.002449	0.00635 to 0.01693	0.01400	0.01775	0.00100 to 0.02000
MW 5	25	0.02908	0.024491	0.004898	0.01897 to 0.03919	0.02000	0.02000	0.02000 to 0.03500
MW 7	19	0.01632	0.012179	0.002794	0.01045 to 0.02219	0.02000	0.01600	0.00300 to 0.02000
MW 8	18	0.02972	0.049553	0.011680	0.00508 to 0.05436	0.02000	0.02600	0.00400 to 0.03000
MW 9	18	0.01506	0.012360	0.002913	0.00891 to 0.02120	0.01500	0.01575	0.00400 to 0.02000
MW 10	17	0.06206	0.104475	0.025339	0.00834 to 0.11577	0.03000	0.07600	0.00400 to 0.08000

Enclosure 1

CHICAGO AREA CONFINED DISPOSAL FACILITY
DATA ANALYSIS
1997 through 2010

US Army Corps of Engineers, Chicago District
111 North Canal Street, Suite 600
Chicago, Illinois

January 2011

Table of Contents

Tables

Figures

Appendices

Introduction

The U.S. Army Corps of Engineers (USACE), Chicago District operates the Chicago Area Confined Disposal Facility (CDF) under the Illinois Environmental Protection Agency (IEPA) Water Pollution Control Permit No. 2006-EA-0864, issued November 9, 2006 (Appendix A). This permit expires on November 1, 2011. The permit provides Standard Conditions, and it is also subject to Special Conditions. Special Condition 2 states "Monitoring shall be conducted in accordance with the Corps of Engineers report entitled "Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, IL" dated October 2006." This monitoring plan is attached to the current permit, and a copy of the permit and monitoring plan is included in Appendix A.

Purpose

The purpose of this report is to comply with Special Condition 4 of the current operating permit: This condition states "A report containing data from the beginning of the project to the time of the next permit renewal submission shall be provided in the application for the renewal of the permit. The permittee shall provide an analysis of these data showing trends for the parameters tested. A separate analysis of the current permit data shall be provided in addition to the historical analysis. All data will be accounted for and correlated with locations currently used (i.e., BACK 1, 2, 3, ND 1, 2, 3, RIV 1, 2, 3, CDF 1, 2, 3, and CH 18, 19, 20, etc.)." This report includes a discussion of the data collected and a trend analysis for those data.

Project Description

The Chicago Area confined disposal facility (CDF) is a diked facility for the disposal and containment of dredged sediment from the deep-draft federal navigation projects in Chicago, Illinois, and Figure 1 shows an aerial view of the CDF vicinity. The CDF is an in-water structure designed to receive dredged materials and to prevent the reentry of material or residuals into the Calumet River or Harbor or into Lake Michigan. The CDF was constructed between 1982 and 1984, and is located in Calumet Harbor, adjacent to the Iroquois Landing port terminal and north of Calumet Park. The facility is operated and maintained by USACE, Chicago District under the authority of Public Law 91-611, Section 123. Since the construction of the CDF, USACE, Chicago District has monitored water quality in the vicinity of the facility in compliance with the applicable IEPA Water Pollution Control Permit.

The CDF was constructed from dikes of limestone, and large stone was placed as a cover to protect against wave action. As discussed with the IEPA in 1994 and explained in the Supplemental Environmental Impact Statement, dated August 26, 1998, a synthetic liner was placed on the prepared limestone on the disposal side of the dikes, but this liner was subsequently damaged during construction. A silty "sand blanket" was then placed on the disposal side of the dikes to prevent the migration of pollutants, and past monitoring has indicated the sand blanket has been effective at preventing contaminant migration.

Adjacent to the CDF dikes on the west side is Iroquois Landing. Iroquois Landing is part of the Chicago Regional Port District property. Between 1982 and 1984, when the CDF was constructed, the southern half of the property was a landfill operation for municipal and steel mill industrial solid wastes. Iroquois Landing was constructed on a landfill composed of slag, cinders, ash, and foundry sand. There is also coal, earth, wood, iron and steel, and miscellaneous material distributed through the blast furnace and foundry wastes.

Aerial views of the CDF are shown in Figures 2 and 3. During dredging, the general operation of the CDF is for the dredged material, including entrained water, to be placed mechanically, via trucks or cranes, into the CDF. The majority of the dredged material settles in the primary settling basin in the northern portion of the facility. Water from the primary settling basin flows southward through a weir located along the cross-dike to the secondary settling basin. Water from the secondary settling basin is then pumped to the filter cells, where it drains through the filter media, and the effluent is discharged to the Calumet River approximately 3000 feet west of the confluence of the Calumet River and Lake Michigan. The filter cell influent and effluent is monitored during discharges. The dredged material remains within the CDF, and, since it is still in operation, the material has not been covered. Precipitation in the form of rain or snow can enter the CDF, and, during large storms, waves from Lake Michigan may overtop the dike crest. As documented in the annual water quality reports (see references), the water level within the CDF fluctuates, often in correlation to the water level in Lake Michigan. Any drainage of water from the CDF is through the filter cells during dredging operations, and, as mentioned earlier, the filter cell influent and effluent are monitored during discharges. Dredging operations occur periodically, when shoaling causes navigational problems.

The remaining capacity of the CDF is limited. As the CDF nears capacity, the USACE, Chicago District has been working on a Dredged Material Management Plan (DMMP), and the Facility Management Plan has been modified to help extend the life of the CDF. Figure 3 shows the primary settling basin in the northern portion of the CDF, and it can be seen that only a small amount of water remains in the basin. Although much of the water has been displaced, the level of the dredged material remains below the top of the dike. Furthermore, the elevation along the northern and eastern perimeter dikes of the CDF has been increased using precast concrete blocks to accommodate the cover and cap material specified in Special Condition 5 of the current operating permit. Figure 4 shows a view of the blocks placed along the eastern perimeter dike, and the block dimensions are 4 feet high and 6 feet by 6 feet in length and width. The dredged material will be managed so that the maximum height of the material in the vicinity of the dike areas with the precast concrete blocks remains at least two (2) feet below the top of the dike, or bottom of the blocks. The blocks are only for the retention of cover and cap material, and this 2-foot freeboard, which is the elevation difference between the top of the dredged material and the top of the dike, is to prevent runoff from the dredged material from entering Lake Michigan along the perimeter of the CDF where the blocks were placed.

Water Quality Monitoring Plan

The Chicago Area CDF water quality monitoring plan includes routine monitoring and monitoring during dredging events. The water quality monitoring plan was modified in 1997 during the renewal of the IEPA Water Pollution Control Permit to provide a more standardized, meaningful, and cost-effective data set. Subsequently, there have been slight modifications to the monitoring plan during the permit renewals in 2001 and 2006, and the most recent version of the plan was detailed in the Chicago District document titled "Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, Illinois," dated October 2006, which is included with the current permit in Appendix A. The sample locations, parameters, and schedule provide a standardized, meaningful, and cost-effective data set, and allow for quantitative comparisons between the monitoring locations over time and for comparisons between the data sets.

Since only a small amount of water remains in the primary settling basin in the northern portion of the CDF, in the future, the samples collected from the CDF pond will need to be collected from the secondary settling basin in the southern portion of the facility. In order to address this change, the monitoring plan has been revised in the Chicago District document titled "Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, Illinois," dated January 2011, and this document has been submitted with the current permit application.

Monitoring Locations

The monitoring locations are shown in Figures 5 and 6 for routine monitoring and dredging operation monitoring. For comparison, the pre-1997 monitoring locations are shown in Figures 7 and 8. The samples that are currently collected for both routine monitoring and monitoring during dredging events include: three individual CDF stations (CDF-001, CDF-002, and CDF-003); three near-dike composite samples, composited from nine near-dike sampling locations (ND-COMP-001, ND-COMP-002, and ND-COMP-003); three landing well locations (CH-18-81, CH-19-81, and CH-20-81); three background Calumet Harbor/Lake Michigan sampling locations (BACK-001, BACK-002, and BACK-003); and three river sampling locations (RIV-001, RIV-002, and RIV-003). In addition, during dredging operations, suspended solids monitoring occurs around the dredging operation and the sediment rehandling areas, as shown in Figure 6. The influent and effluent for the filter cells through which the CDF is drained are also monitored during dredging.

Monitoring Parameters

The parameters and required detection limits (RDLs) for routine monitoring and monitoring during dredging events are given in Table 1. Due to the potential for adverse impacts during dredging events, the samples collected during dredging events are analyzed for a more comprehensive list of parameters.

Table 1: Monitoring Parameters and Detection Limits

Parameter	**Required Detection Limit** (mg/L, unless noted)
Parameters, Routine and During Dredging Monitoring	
Chromium (total)	0.005
Manganese (total)	0.005
Zinc (total)	0.005
Ammonia as Nitrogen	0.01
Phosphorus	0.005
Total Kjeldahl Nitrogen (as N)	0.2
pH	± 0.01 units
Total Dissolved Solids (TDS)	5.0
Total Suspended Solids (TSS)	5.0
Additional Parameters During Dredging Monitoring	
Arsenic (total)	0.002
Cadmium (total)	0.02
Copper (total)	0.02
Cyanide (total)	0.01
Lead (total)	0.005
Mercury (total)	0.0002
Nickel (total)	0.02
Oil & Grease	5.0
Temperature	± 0.1 °C
Dissolved Oxygen	± 0.1 mg/L
Hardness	10.0

Monitoring Schedule

As indicated above, the greatest potential for adverse impacts to the water quality in and around Calumet Harbor occurs during dredging events, so a comprehensive sampling program, which includes the monitoring of the additional parameters listed in Table 1, is implemented during dredging operations. Since there is less potential for adverse impacts when no dredging occurs, routine monitoring is performed when there are no dredging events scheduled during the year. For years in which there will not be any dredging, a routine monitoring event is conducted once per year, and the routine monitoring does not include the additional parameters listed in Table 1.

For dredging operations, monitoring is to be conducted in accordance with the following frequency: During the week prior to the commencement of dredging and during the week following the completion of dredging, water quality samples are collected twice per week. In other words, during the pre-dredge and post-dredge weeks, there are two (2) sampling events per week. During dredging, samples are collected on a once-per-week schedule. Table 2 gives a summary of past dredging events that have occurred since the construction of the Chicago Area CDF.

Table 2: Dredging Events

Event No.	Year of Disposal Operation	Location of Dredging	Volume of Dredged Material
1	Oct. – Dec. 1984	Calumet River	99,304 yd^3
2	July – Sept. 1985	Calumet River	108,000 yd^3
3	May – June 1986	Chicago Harbor & Calumet River	62,000 yd^3
4	April – June 1989	Calumet River	82,960 yd^3
5	May 1991	Calumet River	3,100 yd^3
6	December 1994	Calumet River	68,195 yd^3
7	Aug. 2000 – Apr. 2001	Calumet River & Harbor Breakwater	205,427 yd^3
8	Sept. – Dec. 2001	Calumet Harbor & Calumet River	290,995 yd^3
9	Sept. – Dec. 2003	Calumet River	135,000 yd^3
10	Sept. – Dec. 2007	Calumet Harbor	131,020 yd^3
11	April 2008	Calumet River	186 yd^3
12	June 2009	Calumet River	600 yd^3
13	Oct. – Dec. 2009	Calumet Harbor	167,404 yd^3
	Total Dredged		1,354,191 yd^3

Prior to 1997, the water quality samples were collected using a different monitoring schedule and alternate locations were used, shown in Figures 7 and 8. Pre-1997 Location 1 was collected from within the CDF, similar to the samples presently acquired from the CDF locations, CDF-001, CDF-002, and CDF-003. The pre-1997 Locations 4(a) and 4(b) were collected from the Calumet River, similar to the samples presently acquired from the river locations, RIV-001, RIV-002, and RIV-003. Pre-1997 Locations 5, 6, and 7 are outside the CDF in Lake Michigan, similar to the samples presently acquired near the CDF at locations, ND-COMP-001, ND-COMP-002, and ND-COMP-003. Pre-1997 Locations 8(a) and 8(b) are further outside the CDF into Lake Michigan, similar to samples presently acquired at the background sample locations, BACK-001, BACK-002, and BACK-003. The pre-1997 data were only collected during dredging events that occurred in 1984, 1985, 1986, 1989, and 1994.

Monitoring wells CH-18-81, CH-19-81, and CH-20-81 were sampled on a routine basis, with the sample frequency varying by parameter. The “dike” monitoring wells (CH-04-83, CH-05-83, CH-07-84, CH-08-84, CH-09-84, CH-10-84 and CD-11-87) were sampled on a routine basis before 1997, but have not been sampled since 1997.

Data Analysis

As required by IEPA Water Pollution Control Permit No. 2006-EA-0864 Special Condition #4, an analysis of the monitoring data was performed. The analysis included an evaluation of the data and a determination of trends; a time trend analysis and an

analysis of variance to determine whether data from the various sampling locations were significantly different. These analyses are discussed further, in the following paragraphs:

Data

The data collected at the Chicago Area CDF fall into two distinct groups: 1984 to 1997 and 1997 to the present. The two groups of data had different sampling frequencies and locations, and some different parameters. Because of these differences, it was difficult to use all of the data for a single comprehensive analysis. In addition, there are data collected during dredging events, and data collected during routine monitoring. The dredging events only occurred periodically, and are useful in comparison to the routine monitoring to determine whether the dredging operations had an impact on water quality in the area of the CDF. The routine data collected in the CDF, Calumet Harbor, and Calumet River from 1997 to the present can be used to investigate seasonal trends, time trends, and to compare locations.

The number of samples collected before 1997 in Calumet Harbor, the Calumet River, and the CDF were often deficient in comparison post-1997 sample collection, and they were not collected on a regular basis (these locations were only monitored during dredging events before 1997). In addition, the pre-1997 data lacked an established background dataset, and, as described earlier, the number of samples and sample locations differed from the post-1997 sampling program. The previously submitted trend analysis of data collected between 1984 and 2005, provided with the 2006 permit renewal application, separates the pre-1997 and post-1997 data due to the differences between these data. Since the older, pre-1997 data has been previously submitted and it is less meaningful, standardized, and representative of the current conditions, trends, and present sampling program, it was not included with this analysis, and the present analysis is primarily focused on data collected since 1997.

Data for ammonia nitrogen, chromium, manganese, zinc, phosphorus, Total Kjeldahl Nitrogen (TKN), Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) were analyzed. As discussed above, for each monitoring location, three samples were collected (Figure 5). The samples locations were all treated as one data source, for example BACK-001, BACK-002, and BACK-003 were all used to describe "background Lake Michigan" because there should be no statistical difference between the samples taken for a given monitoring location. However, the three landing monitoring wells were treated as separate sampling points, because there are differences between the three well locations. The monitoring locations are referred to in this discussion as: background (locations BACK-001, BACK-002, BACK-003); near CDF (ND-COMP-001, ND-COMP-002, ND-COMP-003, river (RIV-001, RIV-002, RIV-003); in CDF (CDF-001, CDF-002, CDF-003; and monitoring wells (MW 18 (CH-18-81); MW 19 (CH-19-81); MW 20 (CH-20-81)).

Environmental data include measurements of constituents at trace levels. Typically, concentrations below some set limit (the detection limit) cannot be measured reliably; the un-measurable concentrations are presumed to fall between zero and the detection limit. Such data sets are referred to as "left-censored," since the lower (left) end of the dataset

is truncated at the detection limit. There are various ways to handle data that are reported as "non-detectable." The three methods typically used for statistical analysis of data sets with non-detectable data are 1) zero is used for non-detectable concentrations; 2) one-half the detection limit is used for non-detectable concentrations; or 3) the detection limit is used for non-detectable concentrations (USACE WES, 1995). In this study, for statistical calculations the detection limit was used in place of data that were reported as non-detectable. This approach is considered appropriate when the percent of "censored" data is less than 20%, and the variances are equal (USACE WES, 1995). These assumptions are true for all of the data sets except chromium. The chromium data were more than 80% non-detectable. No data substitution methods are considered adequate when the data set is more than 80% censored (USACE WES, 1995). Because of the lack of measurable chromium concentrations, no conclusions can be drawn regarding chromium concentrations. The chromium data are not discussed further in the analysis below.

The raw data, including laboratory documentation, have been reported previously in other publications (see references), and thus are not included in this report. However, Appendix B includes plots of the data that were used for the analysis, including the plots of routine and dredging monitoring data from 1997 to 2010 and plots of the monitoring well data (1997 to 2010 for the three (3) landing wells). In addition, Appendix D includes summary statistics for the data sets. It should be noted that during the period from 1997 to 2010, the number of samples collected during dredging was higher than the number collected during routine monitoring. The last routine monitoring event was conducted in 2006, so the most recent data are from dredging event monitoring.

Analytical Methods

Analysis of data was done using statistical functions of Microsoft Excel. The statistical add-in package "Analyse-it" was used for obtaining descriptive statistics and non-parametric analysis of variance (ANOVA). The specific statistical calculations are discussed further, below. The analyses conducted were:

1. The data were examined for seasonal variations, based on the sampling performed during routine monitoring and during dredging events.

2. A trend analysis of the data for the each of the parameters over time was conducted for each location using the routine and dredging event monitoring data from 1997 through 2010.

3. Both the routine monitoring and dredging event monitoring data from 1997 through 2010 were compared to determine whether there were statistically significant differences based on monitoring location. The intent of this analysis was to determine whether the CDF was having an impact on water quality outside the facility.

Seasonality

Routine monitoring has historically been performed in the spring, summer, and fall, whereas dredging event monitoring can occur year round, although high waves and low

temperatures commonly limit winter activity. For this investigation routine monitoring was presumed to occur in the warmer, spring, summer, and fall, months, whereas dredging monitoring was presumed to occur in the cooler, fall and winter, months. The data were examined for seasonal variations by comparing the background concentrations of samples collected during routine monitoring (warmer conditions) to the background concentrations of samples collected during dredging monitoring (cooler conditions), and the analysis indicated that the samples were statistically different for the following parameters: zinc, ammonia, TKN, and phosphorus. For all four (4) of these parameters, the background concentrations in samples acquired during dredging were generally lower on average than the background concentrations in samples acquired during routine monitoring.

For ammonia, TKN, and phosphorus, the difference can be partially attributed to the seasonal and temperature difference between the routine monitoring that primarily occurs during warmer conditions and the dredging monitoring that mainly occurs during cooler conditions. Nutrient parameters often increase during the spring and summer months due to elevated biological activity, increased runoff, and use of fertilizer. The relatively higher level of zinc during routine monitoring compared to the dredging monitoring could be attributed to many different factors, such as the increased biological activity, non-point source discharges, and/or runoff from erosion and weathering during the summer months. However, since these are background levels in Lake Michigan, and the values were higher during routine monitoring, when no dredging or placement activities were in progress, it is unlikely that the elevated levels of zinc or other parameters are associated with the dredging or CDF activities.

Time Variation (Time Trend)

The trend analysis of the data was based on a calculation of significance. The data were plotted as concentrations verses time. For each data set, a linear relationship between time and concentration was presumed. The regression data (trend line slope and standard error of the slope), were calculated with “Analyse-it” in Microsoft Excel using regression analysis tools. The slope of each linear trend line was divided by the standard error of the slope. The result, or t statistic for the slope, was compared to the t-value for a two tailed test at the 95% level of significance (ie. a value of ± 1.96.) The data and plots for the regression analysis are given in Appendix C. Based on this calculation, the data sets listed in Table 3 were found to have a significant time relationship.

Table 3: Sampling Data Sets That Show a Time Trend

Parameter	Sampling location +/- indicates direction of trend
Ammonia	Near CDF routine (-) Near CDF dredging (-) River routine (-) In CDF dredging (-) MW 18 (-) MW 19 (-)
Manganese	Background (-) River dredging (-) In CDF routine (+) In CDF dredging (+) MW 18 (-) MW 19 (-) MW 20 (+)
Total Dissolved Solids	In CDF routine (+) In CDF dredging (+) MW 18 (-) MW 19 (-) MW 20 (-)
Total Kjeldahl Nitrogen	In CDF routine (+) In CDF dredging (-) MW 18 (-) MW 19 (-)
Total Phosphorus	Near CDF routine (-) Near CDF dredging (+) River routine (-) River dredging (+) In CDF routine (+) In CDF dredging (+) MW 18 (-) MW 20 (+)
Total Suspended Solids	Near CDF dredging (-) River dredging (-) In CDF routine (+) MW 18 (-) MW 19 (-) MW 20 (+)
Zinc	Background (-) Near CDF dredging (-)

Based on the trend analysis, the following conclusions can be drawn regarding the water quality during routine monitoring events:

1. Background Lake Michigan samples show decreasing manganese and zinc. This may be attributed to reductions of non-point source runoff or other improvements in southern Lake Michigan water quality due to Clean Water Act compliance by others. Because the background Lake Michigan sample location should not be impacted either by the CDF or by dredging operations, these trends are not caused by or related to the dredging operations or the conditions in the CDF.

2. The Near CDF data show a decreasing trend over time for ammonia, during both routine and dredging monitoring, and a decreasing trend for TSS and zinc during dredging monitoring. Near CDF phosphorus results indicate a decreasing trend over time during routine monitoring, but there is an increasing trend over time during dredging monitoring. Although the phosphorus data show a statistically significant increasing trend in the samples collected during dredging, the average phosphorus value of the Near CDF samples collected during dredging (0.0130 mg/L) was comparable to the average value of the background samples collected during dredging (0.0105 mg/L), and it was lower than the average values of the background and Near CDF samples collected during routine monitoring (0.0204 and 0.0200 mg/L, respectively). Furthermore, the statistical analysis of phosphorus samples collected during dredging was likely influenced by an unusually high outlier value, as shown in the comparative description plots in Appendix D. These trends do not appear to be caused by or related to conditions in the CDF.

3. The data collected from the Calumet River show decreasing trends over time for ammonia during routine monitoring and TSS and manganese during dredging monitoring. Similar to the Near CDF data set for phosphorus, the Calumet River results show a decreasing trend over time during routine monitoring, but there is an increasing trend over time during dredging monitoring. The average phosphorus value of the Calumet River samples collected during dredging (0.0130 mg/L) was comparable to the average value of the background samples collected during dredging (0.0105 mg/L), and it was lower than the average value of the background and Calumet River samples collected during routine monitoring (0.0204 and 0.0213 mg/L, respectively). Similarities between the Near CDF samples and Calumet River samples are not surprising since the river is strongly influenced by Lake Michigan (water generally flows into the Calumet River from Lake Michigan.) Again, these trends do not appear to be caused by or related to conditions in the CDF.

4. The data for samples collected within the CDF showed that ammonia and TKN were decreasing over time during dredging monitoring. However, most of the data from samples collected inside the CDF showed an increasing trend over time due to the filling of the CDF with sediment. This was expected, since when there is less water, there is less dilution and more turbidity and more partitioning of compounds to the water column from the sediment. Manganese, TDS, and phosphorus samples collected inside the CDF during both routine and dredging monitoring showed an increasing trend over time. In addition, TKN and TSS samples collected inside the CDF during routine monitoring showed an increasing trend over time. Although the data indicate that some water quality parameters are increasing inside the CDF over

time, there is no apparent impact outside the CDF since, for most of the parameters, the Calumet River and Near CDF samples do not follow the same trends. For one of the parameters, phosphorus, the Near CDF, Calumet River, and In-CDF samples collected during dredging all showed an increasing trend over time, but, as explained above, the Near CDF and Calumet River samples had average values that were comparable to the average value of the background samples collected during dredging, and they were lower than the average values of the background and corresponding location samples collected during routine monitoring. The average value of phosphorus for samples collected from inside the CDF during dredging (0.1043 mg/L) was approximately an order of magnitude higher than the average values of samples collected from the background locations during dredging. Although the analysis showed statistically significant trends over time for increasing phosphorus in samples collected from the In CDF, Near CDF, and Calumet River locations during dredging, the average values of the phosphorus samples collected during dredging are substantially lower outside the CDF and much more comparable to the background samples collected during dredging. In addition, the other parameters did not follow similar trends, so it seems unlikely that the increasing trend for phosphorus during dredging or the trends in the other parameters outside the CDF were caused by or related to conditions within the CDF.

5. The samples from monitoring wells 18 and 19 show decreasing trends over time for ammonia, manganese, TDS, TKN, and TSS, and monitoring well 18 showed a decreasing trend over time for phosphorus. Monitoring well 20 showed different trends, with one (1) parameter decreasing over time and three (3) parameters increasing over time. In particular, for monitoring well 20, the trend for TDS decreased over time, but the trends for manganese, phosphorus and TSS increased over time. These trends do not appear to be consistent with or reflect the conditions in the CDF, since the trends are inconsistent between the CDF and the various wells. The groundwater quality issues at Iroquois Landing are well documented since the area is a lakefill site, and it is likely that the monitoring well trends reflect variations in groundwater quality over time. Furthermore, the groundwater gradient is from Iroquois Landing into the CDF. Therefore, the trends in the monitoring wells do not appear to be related to the CDF operation.

None of the trend data indicate that the increasing concentrations within the CDF are causing increasing concentrations in the Calumet River or Lake Michigan, i.e. the CDF is not impacting water quality. In fact, with the exception of phosphorus, the data support the notion that water in southern Lake Michigan is generally improving in quality.

Comparison of Locations

The data for the seven (7) monitoring locations (background Lake Michigan, Near CDF in Lake Michigan, Calumet River, in the CDF pond, MW 18, MW 19, and MW 20) were compared to each other to determine the whether there are statistically significant differences in the results from the different monitoring locations. In addition, data from the dredging events were compared to the routine monitoring data. Figure 5 shows the monitoring locations, and there are three sampling locations per sampling event for four

(4) of the monitoring locations; the background Lake Michigan, Near CDF in Lake Michigan, Calumet River, and in the CDF pond areas. Only one sample per event was collected from each of the monitoring well locations, MW 18, MW 19, and MW 20.

The data sets for the monitoring locations were compared using a comparison of means. Appendix D gives the comparative descriptions for each data set. For each data set, the mean, standard deviation, standard error, and 95% confidence interval were calculated. Box plots are also shown, and outliers are visible on the box plots. In general, outliers were not deleted from the dataset, since there was no clear basis for eliminating outliers and because environmental monitoring data can vary due to factors not controlled for in this study.

The Mann-Whitney test was used to evaluate the significance of sampling location. The Mann-Whitney test is a non-parametric independent two-group comparison, which compares the distribution of the means of the sample sets and determines if a statistically significant difference is detected among the groups. The Mann-Whitney test is analogous to the parametric t-test, which tests the null hypothesis between two independent groups assuming a normal distribution.

In general, parametric tests such as the t-test are based on the assumption that the data follow a normal (or otherwise known) distribution and that the data can be measured on a continuous scale. Non-parametric tests are used when the assumptions inherent in the parametric tests either cannot be met or are unknown. For example, non-parametric tests are used when the distribution of the data is not known (or is not known to be normal), or when the sample size is small. In the case of the Chicago CDF water quality monitoring data, a non-parametric test was used because it cannot be assumed that the data are distributed normally and because some data sets are small.

The null hypothesis used for this analysis is that the data are similar to the background data, that is, there is no difference between data sets collected at the various monitoring points. The 2-tailed p-values calculated for the test represent the probability of making a "Type 1 error." A Type 1 error is the error of rejecting the null hypothesis when it should be accepted. In this case, given our null hypothesis, a Type 1 error would be the finding that the data sets from two locations are different, when in fact they are equal. A 2-tailed p-value can vary between <0.0001 to 1.0. When the 2-tailed p-value is greater than 0.05, for a 95% confidence level, there is a greater chance of a Type 1 error, or in other words, for this analysis, the two data sets cannot be determined to be significantly different. When the 2-tailed p-value is less than 0.05, corresponding to 95% confidence, there is a low chance of a Type 1 error, or, for this analysis, the two data sets are found to be significantly different.

The data sets were compared to background Lake Michigan concentrations, and the data from samples collected during dredging events were compared to the routine monitoring results for the same parameters and locations. For the data sets analyzed, Tables 4 and 5 provide a summary of the monitoring locations that were found to be significantly different based on location. The tables list the parameters that were found to be

significantly different at the 95% confidence level. Table 4 summarizes the parameters that were separated because the data showed a seasonal effect on the background samples that were collected during routine and dredging monitoring, and Table 5 summarizes the parameters for which the data did not exhibit a statistically significant seasonal effect on the background samples.

Based on the comparison of the data sets, some conclusions can be reached regarding water quality in and around the CDF. First, an obvious conclusion is that the quality of the water within the CDF is significantly different than the water quality in Lake Michigan for all parameters, including both routine monitoring data and dredging event monitoring data. This is not unexpected based on the sediment quality; the sediment from the Calumet River is known to contain metals and nutrients, and this is the reason it is placed in the CDF. As the CDF has filled, the water quality in the facility has become relatively worse as demonstrated earlier by the time trend analysis. The data also show that the samples collected from within the CDF were statistically different from the other monitoring locations. This indicates that the CDF is adequately confining the sediment and that the CDF is not causing water quality problems in Lake Michigan or the Calumet River.

The Calumet River water quality is also typically different from the background conditions, particularly during dredging, when water temperatures tend to be cooler. The Calumet River flow direction depends on the lake level and on other factors, although the flow direction is generally considered to be from Lake Michigan to the Calumet River. The river water quality is impacted by boat traffic and various point source discharges, as well as by non-point source runoff and groundwater flow. In addition, during storm events the flow direction may be toward the lake, and a substantial flow to Lake Michigan could result if the locks or sluice gates are opened to control water levels on the Calumet-Saganashkee (Cal-Sag) channel. Despite the statistically significant differences between the background Lake Michigan monitoring data and the Calumet River data, there is no strong evidence that suggests the CDF is impacting the river. Discharges from the filter cells during dredging events were monitored, and the filter cells were meeting water quality standards for discharge. The filter cell data are discussed in the various dredging event monitoring reports (see references).

Table 4: Locations – Evidence of Seasonal Effect

	Background Dredging	Near CDF Routine	Near CDF Dredging	River Routine	River Dredging	In CDF Routine	In CDF Dredging
Background Routine	NH_3 TKN TP Zn		NH_3 TKN TP		NH_3 TKN TP Zn	NH_3 TKN TP Zn	NH_3 TKN TP Zn
Background Dredging		NH_3 TKN TP Zn	Zn	NH_3 TKN TP	NH_3 TP Zn	NH_3 TKN TP Zn	NH_3 TKN TP Zn
Near CDF Routine			NH_3 TKN TP Zn	Zn	NH_3 TKN TP Zn	NH_3 TKN TP Zn	NH_3 TKN TP Zn
Near CDF Dredging				NH_3 TKN TP	NH_3 Zn	NH_3 TKN TP Zn	NH_3 TKN TP Zn
River Routine					NH_3 TKN TP	NH_3 TKN TP Zn	NH_3 TKN TP Zn
River Dredging						NH_3 TKN TP Zn	NH_3 TKN TP Zn
In CDF Routine							NH_3 TKN

*For Ammonia, TKN, Total Phosphorus (TP), and zinc the data analysis showed a seasonal effect. In other words, the analysis showed a statistically significant difference at the 95% confidence level between samples collected in Lake Michigan (background) during routine monitoring, which is performed during warmer months, in comparison to Lake Michigan background samples collected during dredging monitoring, which is performed during cooler months. For the other three (3) datasets, shown in Table 5, the routine background and the dredging event background samples were combined, since the background data for routine and dredging monitoring did not show a statistically significant difference. Appendix D gives the comparative statistics.

Table 5: Locations – No Evidence of Seasonal Effect

	Near CDF Routine	Near CDF Dredging	River Routine	River Dredging	In CDF Routine	In CDF Dredging
Background		Mn	Mn TDS TSS	Mn TDS TSS	Mn TDS TSS	Mn TDS TSS
Near CDF Routine			Mn TSS	Mn TDS TSS	Mn TDS TSS	Mn TDS TSS
Near CDF Dredging			Mn TDS	Mn TDS	Mn TDS TSS	Mn TDS TSS
River Routine				TDS	Mn TDS TSS	Mn TDS TSS
River Dredging					Mn TDS TSS	Mn TDS TSS
In CDF Routine						
In CDF Dredging						

*For the datasets shown in Table 5, the routine monitoring background and the dredging event background were combined, since the background data for routine and dredging monitoring did not show a statistically significant difference at the 95% confidence level. Appendix D gives the comparative statistics.

The data from samples collected from the Near CDF monitoring location are frequently similar to the data from the background water quality samples for most parameters. As shown in Tables 4 and 5, none of the parameters sampled from the Near CDF location during routine monitoring showed a statistically significant difference from the background samples collected during routine monitoring. As shown in Tables 4 and 5, for the Near CDF samples collected during dredging, the zinc and manganese parameters are the only ones for which there were statistically significant differences in the data in comparison to the background samples collected during dredging. However, for both these parameters, the average sample values were below the corresponding average values for samples collected from the Calumet River during routine monitoring, when no dredging or CDF activities were occurring. In addition, the near shore area may be impacted by surface runoff. As observed in the 2006 data analysis, zinc measurements were often different from the background monitoring location for the other monitoring locations for both routine monitoring and dredging event monitoring. The cause of this is not known. Since none of the other parameters showed statistically significant differences from the background data set collected during dredging, it is unlikely the CDF is impacting the water quality.

Conclusions

Based on the analyses presented above, it can be concluded that the concentrations of the monitoring parameters are increasing over time within the CDF pond due to the displacement of water and increased placement of dredged material into of the facility. Furthermore, there were often statistically significant differences between the background Lake Michigan monitoring data and the data from the other monitoring locations. However, none of the parameters sampled from the Near CDF location during routine monitoring showed a statistically significant difference from the background samples collected during routine monitoring. In addition, there were no systematic trends in the data that indicated the monitoring locations on the exterior of the facility are being impacted by the CDF. Several parameters, ammonia, TKN, phosphorus, and zinc, showed a seasonal effect, and a trend for samples to have higher concentrations when collected during routine monitoring, which is typically performed when the water temperatures are warmer, in comparison to samples collected during dredging monitoring, which commonly occurs when the water temperatures are cooler. The analysis of sample locations showed that for many parameters, there were statistically significant differences between samples collected from within the CDF and Calumet River in comparison to background Lake Michigan. Other trends in data and parameters were often either not consistent over location or over time. Routine and dredging event data reports (see references for reports previously submitted) have not indicated any short-term or event-based impacts since monitoring began in 1984. Based on the analyses in this report and on the data presented during the routine monitoring and dredging event monitoring, it can be concluded that the CDF is not causing short- or long-term water quality impacts in Lake Michigan or the Calumet River.

References

USACE, June 1984, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1983, Chicago District, Chicago, Illinois.

USACE, May 1985, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1984, Chicago District, Chicago, Illinois.

USACE, April 1985, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations , October 1984 to December 1984, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, February 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations July 1985 to September 1985, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, October 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1986 to July 1986, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, May 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1985, Chicago District, Chicago, Illinois.

USACE, June 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1986, Chicago District, Chicago, Illinois.

USACE, July 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1987, Chicago District, Chicago, Illinois.

USACE, December 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1988, Chicago District, Chicago, Illinois.

USACE, December 1989, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1989 Through June 1989, Randolph & Associates, Inc. for Chicago District.

USACE, June 1990, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1989, Chicago District, Chicago, Illinois.

USACE, June 1993, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1990, Chicago District, Chicago, Illinois.

USACE, March 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1991, Chicago District, Chicago, Illinois.

USACE, May 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1992, Chicago District, Chicago, Illinois.

USACE, Sep 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1993 Calendar Year, Chicago District, Chicago, Illinois.

USACE, April 1995, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1994 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE Waterways Experiment Station, July 1995, Environmental Effects of Dredging Technical Notes: Guidelines for Statistical Treatment of Less Than Detection Limit Data in Dredged Sediment Evaluations, Waterways Experiment Station Environmental Laboratory, Vicksburg, Mississippi.

USACE, November 1995, Report on Maintenance Dredging of Calumet River (12/2/94 through 12/31/94), Volume I, Chicago District, Chicago, Illinois.

USACE, August 1996, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1995 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE, March 1997, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1996 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE, August 1998, Final Supplemental Environmental Impact Statement for Chicago Area Confined Disposal Facility at Calumet Harbor, Chicago, Cook County, Illinois, CELRC-PD-S, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, June 2000, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 99 (October 98 to September 99), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, July 2001, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2000 (October 1999 to September 2000), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, June 2002, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2001 (October 2000 to September 2001), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, July 2002, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging July 2000 to April 2001, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, September 2002, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging September 2001 to December 2001, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, April 2003, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2002 (October 2001 to October 2002), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, January 2004, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2003 (October 2002 to October 2003), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, August 2004, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging October 2003 to December 2003, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, December 2004, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Year (November 2003 to November 2004), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, February 2006, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Water Year 2005, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, April 2006, Chicago Area Confined Disposal Facility Data Analysis, 1984 through 2005, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, April 2007, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Water Year 2006, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, March 2008, Report on Maintenance Dredging of the Calumet Harbor September 6, 2007 – December 11, 2007, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, May 2008, Report on Maintenance Dredging of the KCBX Terminals, Inc. South Ship Berth in the Calumet River, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, January 2010, Report on Maintenance Dredging of the DTE Energy (DTE Chicago Fuels Terminal, L.L.C) Ship Dock Area in the Calumet River, 10730 Burley Avenue, Chicago, Illinois May 19th Through June 16th 2009, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, June 2010, Report on Maintenance Dredging of Calumet Harbor, Water Quality Monitoring Year 2010, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

Figures

Figure 1: Chicago Area Confined Disposal Facility Vicinity

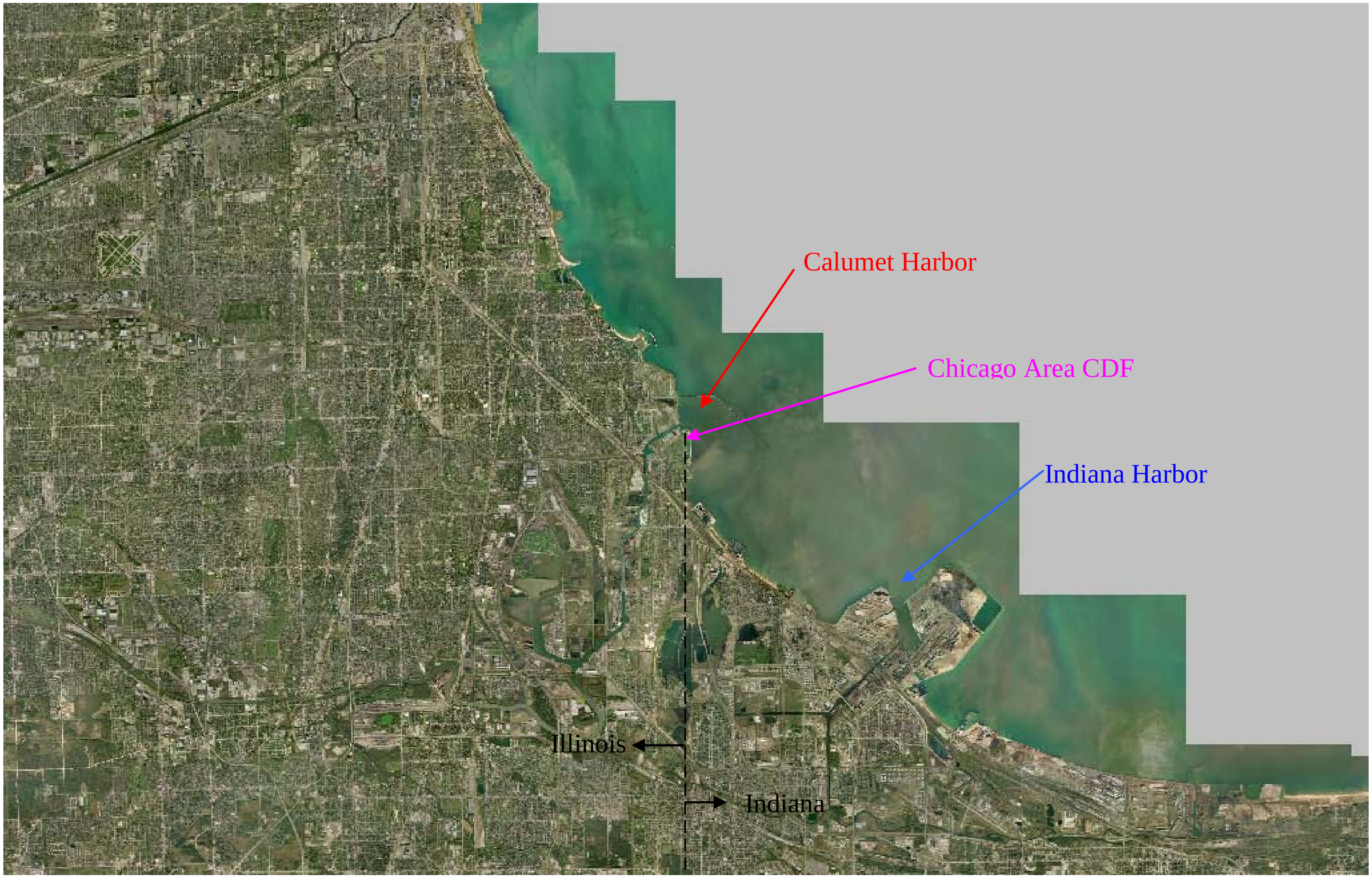


Figure 2: Chicago Area CDF Facility

Figure 3: Chicago Area CDF Facility

Figure 4: Precast Concrete Blocks - East Perimeter

Figure 5: Current Monitoring Locations

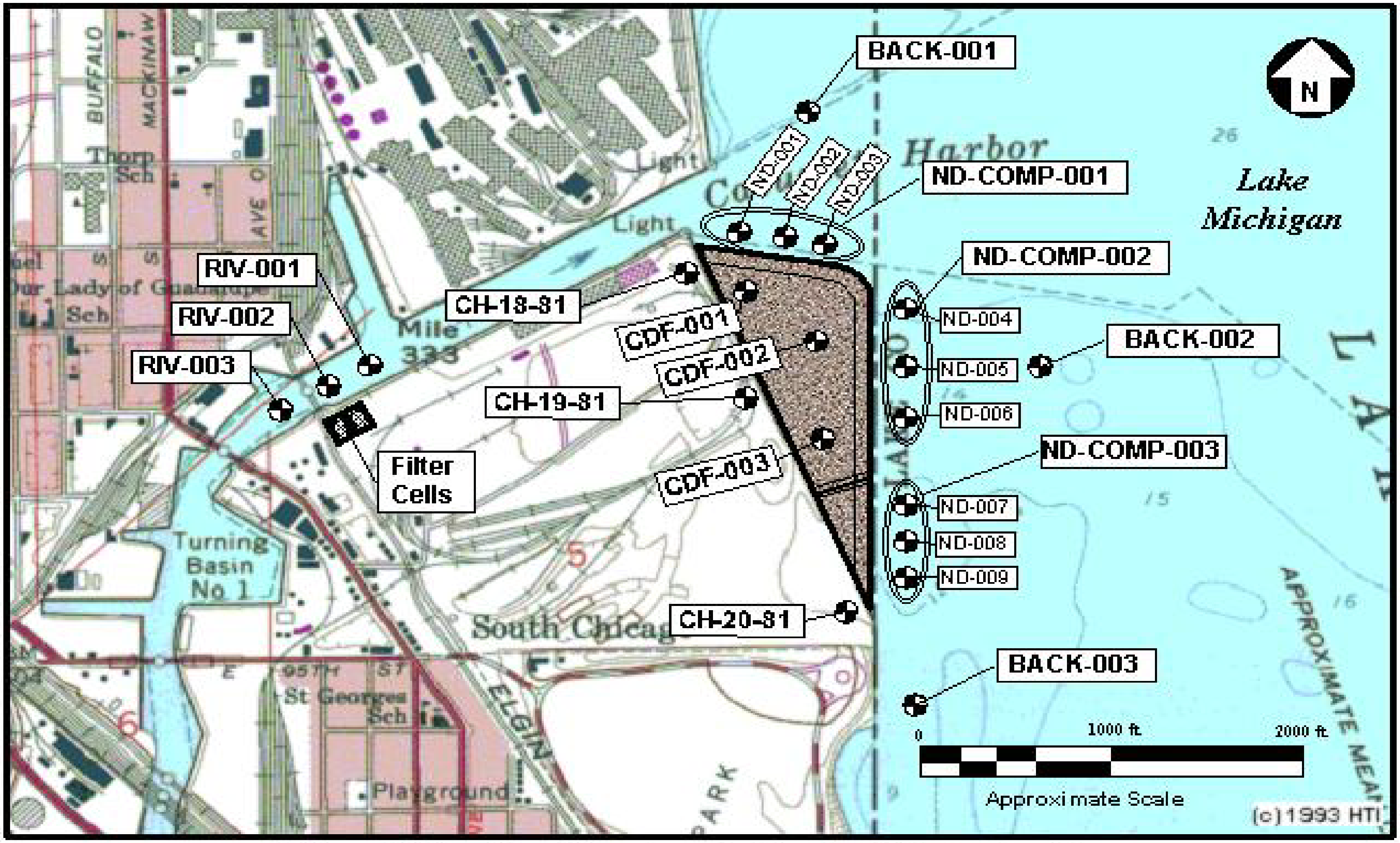
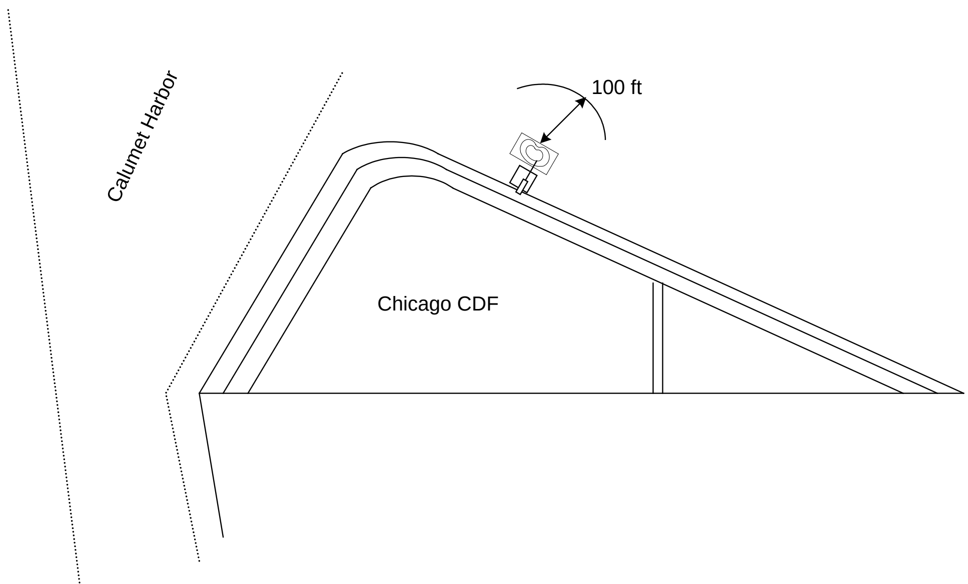
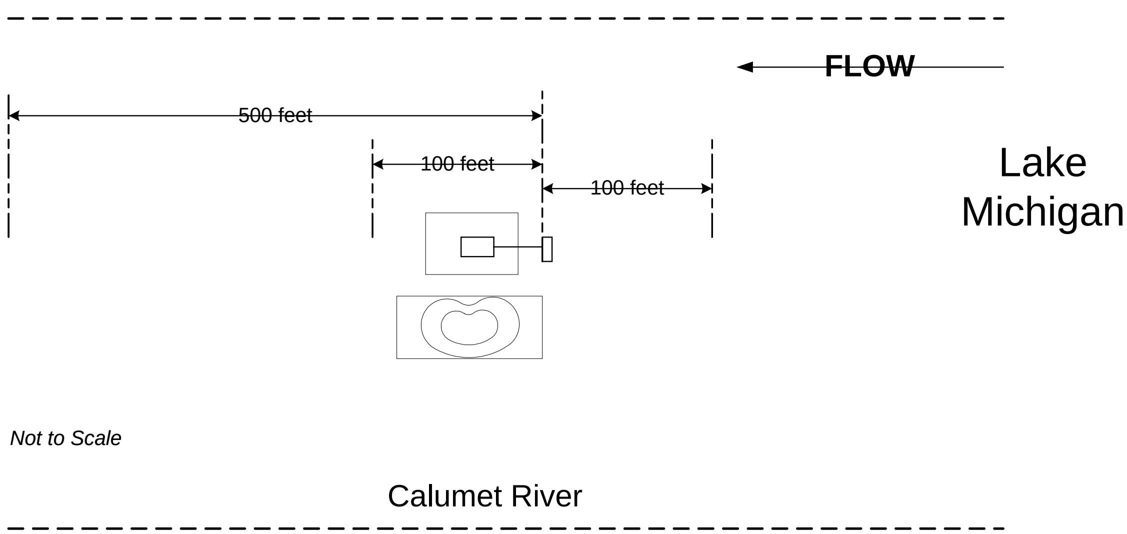


Figure 6: Dredging Operation Monitoring Locations



a. Rehandling area



b. Dredging operation

Figure 7: Past (Pre-1997) Well Monitoring Locations

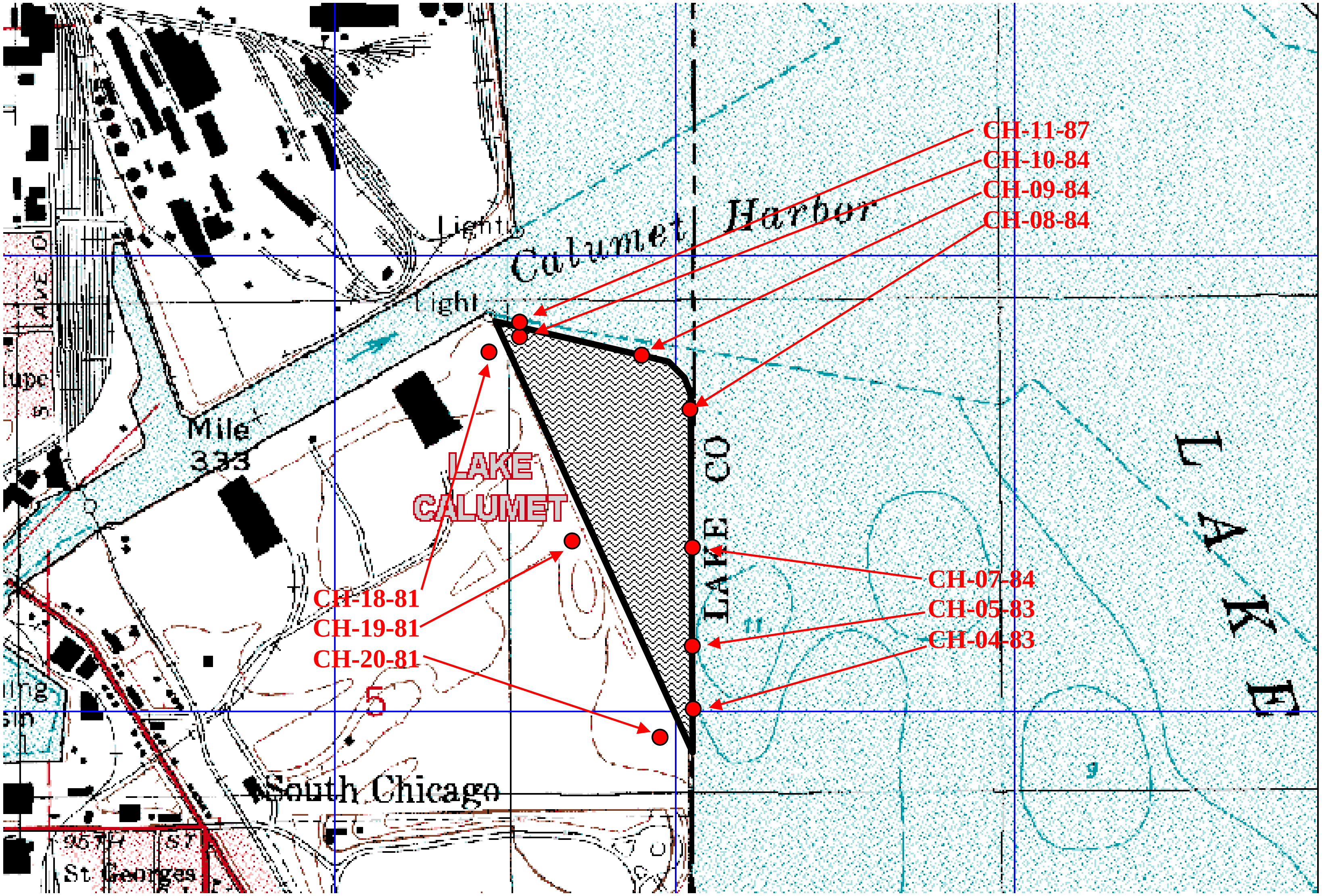
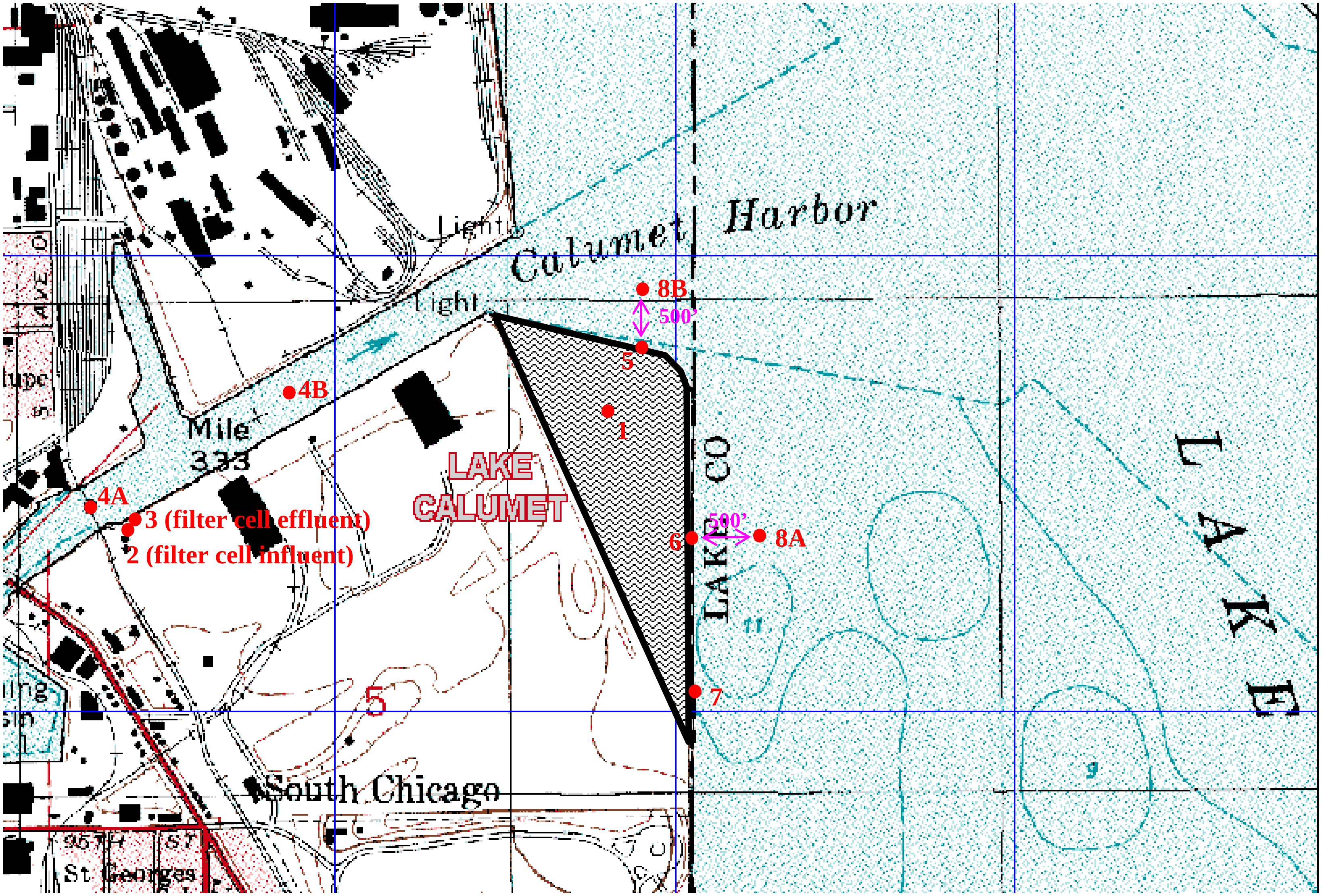


Figure 8: Past (Pre-1997) Dredging Event Monitoring Locations



Appendix A: Water Pollution Control Permit

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION CONTROL PERMIT

LOG NUMBERS: 0864-06

PERMIT NO.: 2006-EA-0864

FINAL PLANS, SPECIFICATIONS, APPLICATION AND SUPPORTING DOCUMENTS
PREPARED BY: Chicago District Corps of Engineers

DATE ISSUED: November 9, 2006

SUBJECT: Chicago District Corps of Engineers – Chicago Area Confined Disposal Facility

PERMITTEE TO OPERATE

Chicago District Corps of Engineers
111 North Canal Street
Chicago, IL 60606

Permit is hereby granted to the above designated permittee(s) to operate water pollution control facilities described as follows:

The facilities include a 43 acre confined disposal facility (CDF) for dredged material from the Chicago and Calumet Rivers. The settling basin has a capacity of approximately 1.45 million gallons. The settling basin discharges to two (2) 34 foot diameter dual media filters cells, with discharge to the Calumet River.

This permit renews and replaces Permit No. 2001-EA-4691 which was previously, issued for the herein permitted facility.

This operating permit expires on November 1, 2011.

This permit is issued subject to the following Special Conditions(s). If such Special Condition(s) require(s) additional or revised facilities, satisfactory engineering plan documents must be submitted to this Agency for review and approval for issuance of a Supplemental Permit.

THE STANDARD CONDITIONS OF ISSUANCE INDICATED ON THE REVERSE SIDE MUST BE COMPLIED WITH IN FULL. READ ALL CONDITIONS CAREFULLY.

BJY:JRA:

DIVISION OF WATER POLLUTION CONTROL

Bruce J. Yurdin
Manager, Watershed Management Section
Bureau of Water

cc: IEPA, DesPlaines Region
Records
Binds

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION CONTROL PERMIT

LOG NUMBERS: 0864-06

PERMIT NO.: 2006-EA-0864

FINAL PLANS, SPECIFICATIONS, APPLICATION AND SUPPORTING DOCUMENTS
PREPARED BY: Chicago District Corps of Engineers

DATE ISSUED: November 9, 2006

SUBJECT: Chicago District Corps of Engineers – Chicago Area Confined Disposal Facility

SPECIAL CONDITION 1: A pump with a capacity of 2250 gallons per minute shall be used during dredging operations to carry wastewater to the filter cells in order to reduce the volume within the CDF in direct proportion to the incoming sediment and wastewater volume during dredging and disposal events.

SPECIAL CONDITION 2: Monitoring shall be conducted in accordance with the Corps of Engineers report entitled "Proposed Water Quality Monitoring at the Chicago Area confined Disposal Facility, Calumet Harbor, IL" dated October 2006. In accordance with Section 4 of the above cited document, the permittee shall monitor:

i) For mechanical dredging, the parameters in the first part of Table 2 and all the parameters in Table 3, except for PCBs;

ii) For hydraulic dredging, all the parameters in Table 2 and Table 3, except for PCBs;

iii) For dredged material from the Chicago River that is disposed at the Chicago Area CDF, the permittee shall monitor for polychlorinated biphenyls (PCBs) in addition to parameters specified by dredging method in item i or ii above; and

iv) At least once during each calendar year when no dredging occurs, all parameters in Table 4. Monitoring shall include at least one of the wells CH-18-81, CH-19-81, or CH-20-81.

SPECIAL CONDITION 3: Reports of all analytical results shall be submitted to the Illinois EPA on a monthly basis for hydraulic dredging operations and on an annual basis for mechanical dredging operations.

SPECIAL CONDITION 4: A report containing data from the beginning of the project to the time of the next permit renewal submission shall be provided in the application for the renewal of the permit. The permittee shall provide an analysis of these data showing trends for the parameters tested. A separate analysis of the current permit data shall be provided in addition to the historical analysis. All data will be accounted for and correlated with locations currently used (i.e., BACK 1, 2, 3, ND 1, 2, 3, RIV 1, 2, 3, CDF 1, 2, 3, and CH 18, 19, 20, etc.).

SPECIAL CONDITION 5: Upon completion, the site shall be covered with a five (5) foot thick clay and topsoil cap, graded to drain, and seeded and mulched to prevent erosion.

READ ALL CONDITIONS CAREFULLY:
STANDARD CONDITIONS

The Illinois Environmental Protection Act (Illinois Revised Statutes Chapter 111-12. Section 1039) grants the Environmental Protection Agency authority to impose conditions on permits which it issues.

1. Unless the construction for which this permit is issued has been completed, this permit will expire (1) two years after the date of issuance for permits to construct sewers or wastewater sources or (2) three years after the date of issuance for permits to construct treatment works or pretreatment works.

2. The construction or development of facilities covered by this permit shall be done in compliance with applicable provisions of Federal laws and regulations, the Illinois Environmental Protection Act, and Rules and Regulations adopted by the Illinois Pollution Control Board.

3. There shall be no deviations from the approved plans and specifications unless a written request for modification of the project, along with plans and specifications as required, shall have been submitted to the Agency and a supplemental written permit issued.

4. The permittee shall allow any agent duly authorized by the Agency upon the presentations of credentials:

   a. to enter at reasonable times, the permittee's premises where actual or potential effluent, emission or noise sources are located or where any activity is to be conducted pursuant to this permit;

   b. to have access to and copy at reasonable times any records required to be kept under the terms and conditions of this permit;

   c. to inspect at reasonable times, including during any hours of operation of equipment constructed or operated under this permit, such equipment or monitoring methodology or equipment required to be kept, used, operated, calibrated and maintained under this permit;

   d. to obtain and remove at reasonable times samples of any discharge or emission of pollutants;

   e. to enter at reasonable times and utilize any photographic, recording, testing, monitoring or other equipment for the purpose of preserving, testing, monitoring, or recording any activity, discharge, or emission authorized by this permit.

5. The issuance of this permit:

   a. shall not be considered as in any manner affecting the title of the premises upon which the permitted facilities are to be located;

   b. does not release the permittee from any liability for damage to person or property caused by or resulting from the construction, maintenance, or operation of the proposed facilities;

   c. does not release the permittee from compliance with other applicable statutes and regulations of the United States, of the State of Illinois, or with applicable local laws, ordinances and regulations;

   d. does not take into consideration or attest to the structural stability of any units or parts of the project;

   e. in no manner implies or suggests that the Agency (or its officers, agents or employees) assumes any liability, directly or indirectly, for any loss due to damage, installation, maintenance, or operation of the proposed equipment or facility.

6. Unless a joint construction/operation permit has been issued, a permit for operating shall be obtained from the agency before the facility or equipment covered by this permit is placed into operation.

7. These standard conditions shall prevail unless modified by special conditions.

8. The Agency may file a complaint with the Board for suspension or revocation of a permit:

   a. upon discovery that the permit application contained misrepresentations, misinformation or false statement or that all relevant facts were not disclosed; or

   b. upon finding that any standard or special conditions have been violated; or

   c. upon any violation of the Environmental Protection Act or any Rules or Regulation effective thereunder as a result of the construction or development authorized by this permit.

Proposed Water Quality Monitoring
at the Chicago Area Confined Disposal Facility,
Calumet Harbor, Illinois
October 2006

1. Purpose

Since the construction of the Chicago Area confined disposal facility (CDF) in 1982 – 1984, the U.S. Army Corps of Engineers (USACE), Chicago District has collected water quality samples in the vicinity of the CDF in order to monitor the CDF's impact on water quality in the harbor. Based on the data collected to date, and presented in "Chicago Area Confined Disposal Facility Data Analysis, 1984 through 2005", April 2006, a statistical analysis indicates that the CDF is not impacting water quality in Lake Michigan or the Calumet River. In addition, more than 20 years of routine and dredging event monitoring, presented in annual reports, have not indicated short term or dredging event based impacts. This document summarizes the historical water quality sampling program for the Chicago CDF, and details a modified sampling plan that will better serve the needs of all agencies while still protecting the water resources near the CDF.

2. Background

The Chicago Area CDF is a diked facility for the disposal and containment of contaminated dredged materials from the deep-draft federal navigation projects in Chicago, Illinois. The Chicago Area CDF is an in-water structure specifically designed to receive the dredged materials and to prevent their reentry into the harbor. The CDF was constructed in 1982-1984 and is located in Calumet Harbor, adjacent to the Iroquois Landing port terminal and north of Calumet Park. The facility is maintained and operated by USACE, Chicago District, under the authority of Public Law 91-611, Section 123.

Since the construction of the CDF, the USACE Chicago District has monitored water quality in the vicinity of the facility in compliance with Section 401 water quality certification requirements and the applicable Illinois Environmental Protection Agency water pollution control permit. In 1997, the original water quality plan was amended and included in the provisions of permit 1997-EA-3213, which was subsequently renewed and replaced by the current permit number 2001-EA-4691. The current permit expires December 1, 2006. The modified water quality monitoring plan detailed below is proposed for the permit renewal.

3. Historical Water Quality Monitoring in Calumet Harbor

Historically, there have been two distinct schedules for water quality monitoring in conjunction with the Chicago Area CDF. Routine monitoring has taken place on a set schedule throughout

the year. Dredging event monitoring is an intensified sampling program during dredging events. Specifics of the routine and event-based monitoring are discussed in the following subsections.

3.1 Routine Water Quality Monitoring

The routine monitoring schedule has, over time, included monitoring on a monthly, quarterly, or semi-annually basis throughout the year. The current schedule includes 3 routine monitoring episodes each year, during the spring, summer, and fall. Monitoring includes samples from three wells on Iroquois Landing, samples from Lake Michigan, composite samples from the just outside the CDF dikes (in Lake Michigan), samples from the Calumet River in the vicinity of the CDF filter cell discharge point, and samples from within the CDF. The parameters monitored include: Chromium, Manganese, Zinc, Ammonia as Nitrogen, Total Phosphorus, Total Kjeldahl Nitrogen, pH, Total Suspended Solids and Total Dissolved Solids. Ground water elevation data are also collected. Figure 1 shows the sampling locations.

3.2 Dredging Event Water Quality Monitoring

Dredging and disposal events present an opportunity for impact to the water quality of Calumet Harbor. The dredging event monitoring is conducted in order to establish the water quality before, during, and after the dredging event. Samples are collected twice a week for two weeks before and two weeks after the dredging event begins, and are collected weekly during dredging except for two consecutive weeks of twice a week sampling approximately during the halfway point of the dredging event. Samples are collected at the same monitoring points shown in Figure 1. Additional TSS monitoring is conducted during dredging, and those locations are shown in Figure 2.

The parameters monitored during dredging events include all of the routine monitoring parameters, plus arsenic, cadmium, copper, cyanide, lead, mercury, nickel, oil and grease, temperature, dissolved oxygen, and hardness. Reporting limits for the routine and dredging event monitoring parameters are given in Table 1.

3.3 Summary of Results from Past Monitoring

A report titled “Chicago Area Confined Disposal Facility Data Analysis, 1984 through 2005”, April 2006, presents a trend analysis and statistical comparison of data collected at the various sampling locations, during both routine and dredging event monitoring. There are some trends in the water quality over time, with water quality in the CDF worsening as the CDF has filled with sediment. However, the Lake Michigan and Calumet River monitoring locations do not show the same trends, indicating that the CDF is not causing a degradation in the near CDF water quality over time.

Iroquois Landing monitoring has not shown strong trends; ground water quality below Iroquois Landing is variable but generally poor due to past fill activities. The existing wells have been in

use for more than 20 years and some have become difficult to sample. The Iroquois Landing ground water quality and the well condition are not caused by the CDF operation; water level data indicate that the direction of groundwater flow is from Iroquois Landing toward Lake Michigan (toward the CDF). The trend analysis does not indicate a correlation between the CDF and the groundwater.

Table 1: Current Monitoring Parameters and Required Reporting Limits

Parameter	Required Reporting Limit, mg/L
Routine and Dredging Event Monitoring	
Chromium (Total)	0.005
Manganese	0.005
Zinc	0.005
Ammonia as Nitrogen	0.01
(Total) Phosphorus	0.005
pH	±0.01 units
Total Kjeldahl Nitrogen	0.2
Total Suspended Solids	5.0
Total Dissolved Solids	5.0
Additional Dredging Event Monitoring	
Arsenic (Total)	0.002
Cadmium (Total)	0.02
Copper (Total)	0.02
Cyanide (Total)	0.01
Lead (Total)	0.005
Mercury (Total)	0.0002
Nickel (Total)	0.02
Oil & Grease	5.0
Temperature	±0.1^{o}C
Dissolved Oxygen	±0.1 mg/L
Hardness	10.0

Figure 1: Chicago Area CDF Monitoring Locations

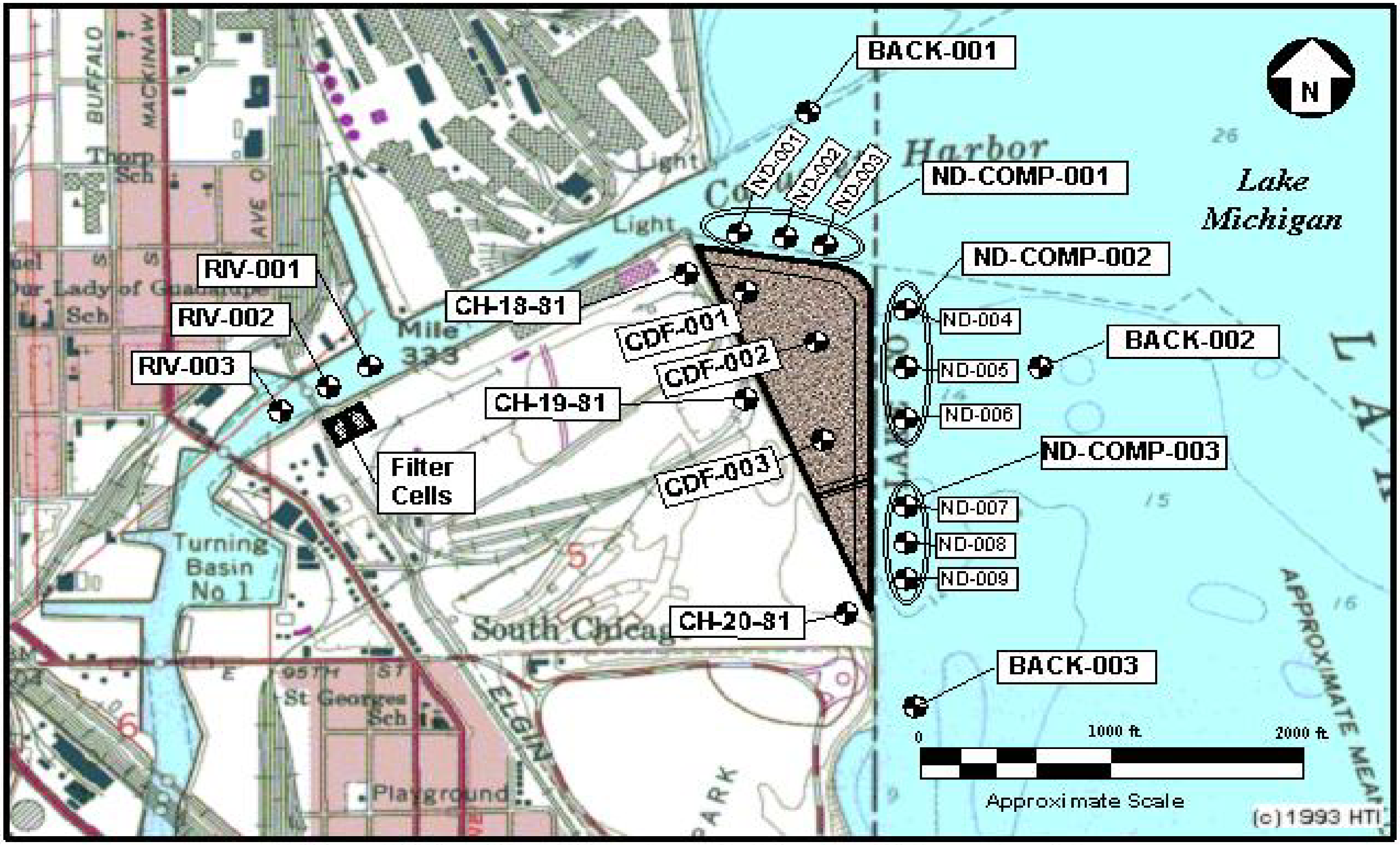
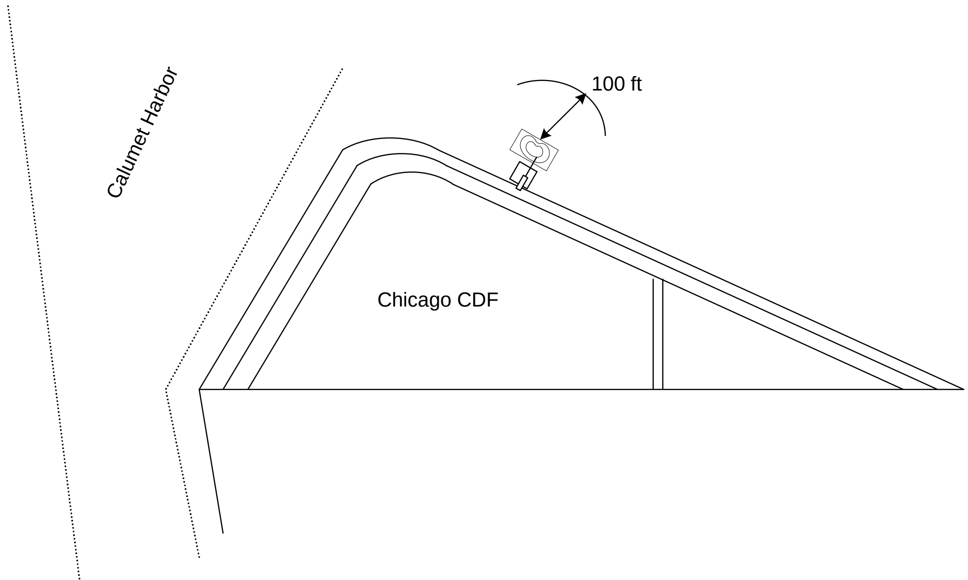
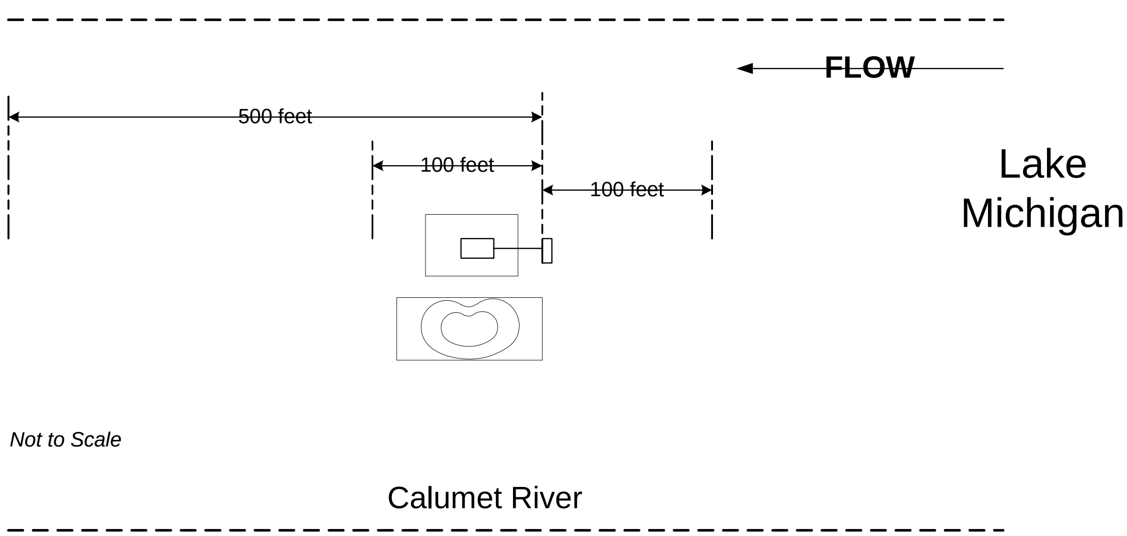


Figure 2: Event Suspended Solids Monitoring Locations



a. Rehandling area



b. Dredging operation

4. Proposed Sampling Plan

The proposed sampling plan is a modification of the 1997 Monitoring Plan. Monitoring during dredging operations will continue, as described below, since dredging events represent the greatest opportunity for impact to the water quality in and around the Calumet Harbor. Routine monitoring will be decreased to one event per year, and will only be performed during non-dredging years. A minimum of one of the three Iroquois Landing wells will continue to be monitored if the existing wells fail or otherwise have problems. It is anticipated that monitoring location CH-19-81 will be discontinued due to the poor condition of the well.

4.1 Dredging Monitoring: Lake Michigan, in CDF, River, and Landing Well Monitoring

A comprehensive sampling program would be implemented during dredging events. The sampling locations shown in Figure 1, except for the monitoring wells, would be sampled according to the frequency described below:

1. For one week before and one week after the dredging event, water quality samples would be collected twice a week, and,
2. During dredging, samples would be collected on a once-a-week schedule.

For the monitoring wells, the same sampling frequency would be followed, except that a minimum of one of the three Iroquois Landing wells will be monitored. All three Iroquois Landing wells will not be monitored.

As the CDF has filled there is less standing water and it has become more difficult to sample. If it becomes impractical to sample within the first basin of the CDF, water samples will be taken in the second basin (south end) of the CDF. The filter cell influent and effluent would continue to be monitored (sample locations designated as CH-00-02 and CH-00-03, respectively) during dredging operations when water is being discharged from the filter cell to the Calumet River. The filter cell influent would provide data on the water quality inside the CDF.

All of the samples would be analyzed for the comprehensive list of contaminants and water quality parameters listed in Table 2. Total PCB measurements would also be made when dredging occurs in the Chicago River with the dredged material placed in the Chicago Area CDF, and additional metals would be monitored during hydraulic dredging.

The above proposed monitoring during dredging events covers the requirements for annual monitoring. During years when dredging occurs, there will not be an annual (routine) monitoring event. During non-dredging years, monitoring will be as described in Section 4.4.

Table 2: Proposed Dredging Water Quality Monitoring Parameters

Parameter	Required Reporting Limit, mg/L unless otherwise noted
Chromium (Total)	0.005
Manganese	0.005
Zinc (Total)	0.005
Ammonia as Nitrogen	0.01
Total Kjeldahl Nitrogen	0.2
(Total) Phosphorus	0.005
Total Suspended Solids	1.0
Total Dissolved Solids	1.0
Temperature	±0.1°C
pH	±0.01 units
Total PCB	0.1 µg/L
Additional Hydraulic Dredging Parameters	
Arsenic (Total)	0.01
Barium (Total)	0.1
Cadmium (Total)	0.005
Copper (Total)	0.01
Cyanide (Total)	0.005
Lead (Total)	0.005
Mercury (Total)*	0.0002 µg/L
Nickel (Total)	0.025
Oil & Grease	1
Dissolved Oxygen	±0.1
Hardness	2

*Low-level Mercury by method 1631.

4.2 Dredging Monitoring: Near Dredge and Rehandling Area Suspended Solids Monitoring

The three sampling stations around the dredging operation are: 100 feet upstream, 100 feet downstream, and 500 feet downstream of the centerline of the dredge (see Figure 2). The upstream samples are collected to establish background suspended solids concentrations in the river. As the dredge relocates to different stations, the sampling locations remain the same in relation to the dredge and the flow of the river. Samples are collected at the surface and mid-depth of the water column, at the distances from the dredging operation shown in Figure 2.

The purpose of the suspended solids monitoring is to ensure that dredging operations are not causing excessive turbidity and solids resuspension. The suspended solids monitoring is a relative comparison of the background and near dredge conditions. To provide a real time comparison that will allow for faster implementation of dredging operation modifications, USACE is proposing to use turbidity monitoring in lieu of the TSS samples that have been

collected in the past. A Hydrolab®, or similar equipment, with a nephelometric turbidity meter would be used for monitoring. Turbidity values would be measured at each location and depth once per week and the values recorded in NTUs. Turbidity measurements will also be taken once a week at the rehandling area. At the start of a dredging operation, concurrent nephelometric measurements and grab samples for laboratory TSS analysis would be taken, to provide a correlation between the turbidity meter results and laboratory suspended solids results. The correlation samples will be taken during the week of pre-dredging monitoring and during the first week of dredging operations.

4.3 Dredging Monitoring: Sediment Sampling

A sediment grab sample will be taken from the dredging barge on a weekly basis during dredging. The sediment would be analyzed for the parameters listed in Table 3.

Table 3: Sediment Grab Sample Monitoring Parameters During Dredging

Parameter	Required Reporting Limit, mg/Kg unless otherwise noted
Arsenic (Total)	1
Barium (Total)	5
Cadmium (Total)	1
Chromium (Total)	1
Copper (Total)	2.5
Lead (Total)	5
Mercury (Total)	0.02
Manganese (Total)	5
Nickel (Total)	5
Zinc (Total)	2
Total Solids (%)	1%
Total Volatile Solids (%)	1%
Cyanide	0.2
Chemical Oxygen Demand	100
Ammonia Nitrogen	0.5
Oil & Grease	10
Total Phosphorus	1
Total PCBs	0.05
Total Organic Carbon	100

4.4 Annual (Routine) Monitoring

During non-dredging years, one routine monitoring event will be conducted. Monitoring locations shown in Figure 1, with the exception of the monitoring wells, will be sampled. A minimum of one of the three Iroquois Landing wells will continue to be monitored if the existing wells fail or otherwise have problems. It is anticipated that monitoring location CH-19-81 will be discontinued due to the poor condition of the well. The parameters for the routine monitoring are given in Table 4.

Table 4: Proposed Routine (Annual) Monitoring Parameters for Non-Dredging Years

Parameter	Required Reporting Limit, mg/L unless otherwise noted
Chromium (Total)	0.005
Manganese	0.005
Zinc (Total)	0.005
Ammonia as Nitrogen	0.01
Total Kjeldahl Nitrogen	0.2
(Total) Phosphorus	0.005
Total Suspended Solids	1.0
Total Dissolved Solids	1.0
Temperature	$\pm 0.1^{o}$C
pH	±0.01 units

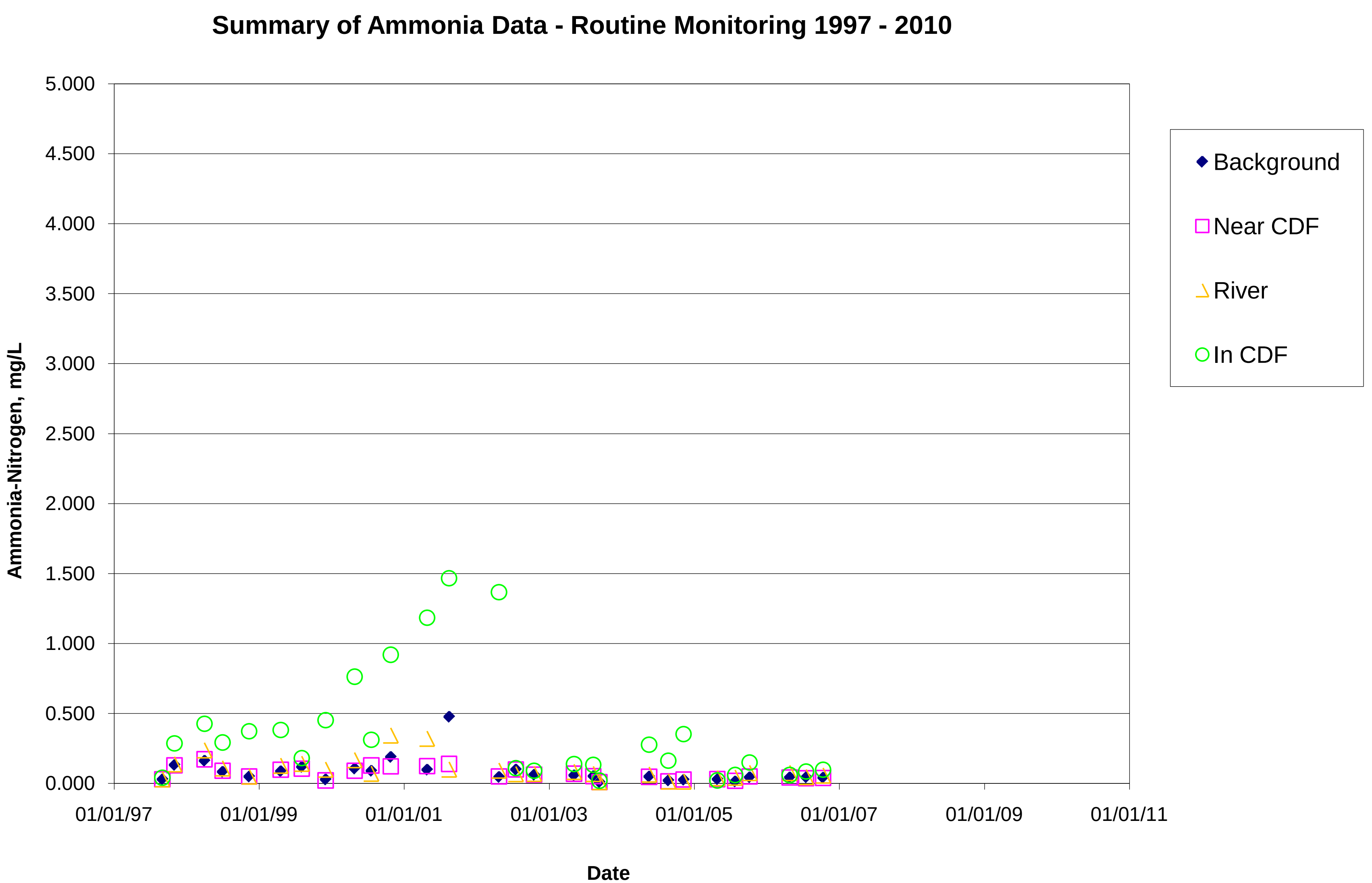
4.5 Proposed Reporting

For mechanical dredging operations, a report documenting the results of the dredging event monitoring would be submitted to IEPA on an annual basis during years in which dredging occurs. For hydraulic dredging operations, analytical results would be submitted to IEPA on a monthly basis. For non-dredging years, a report documenting the results of the annual monitoring event would be submitted to IEPA.

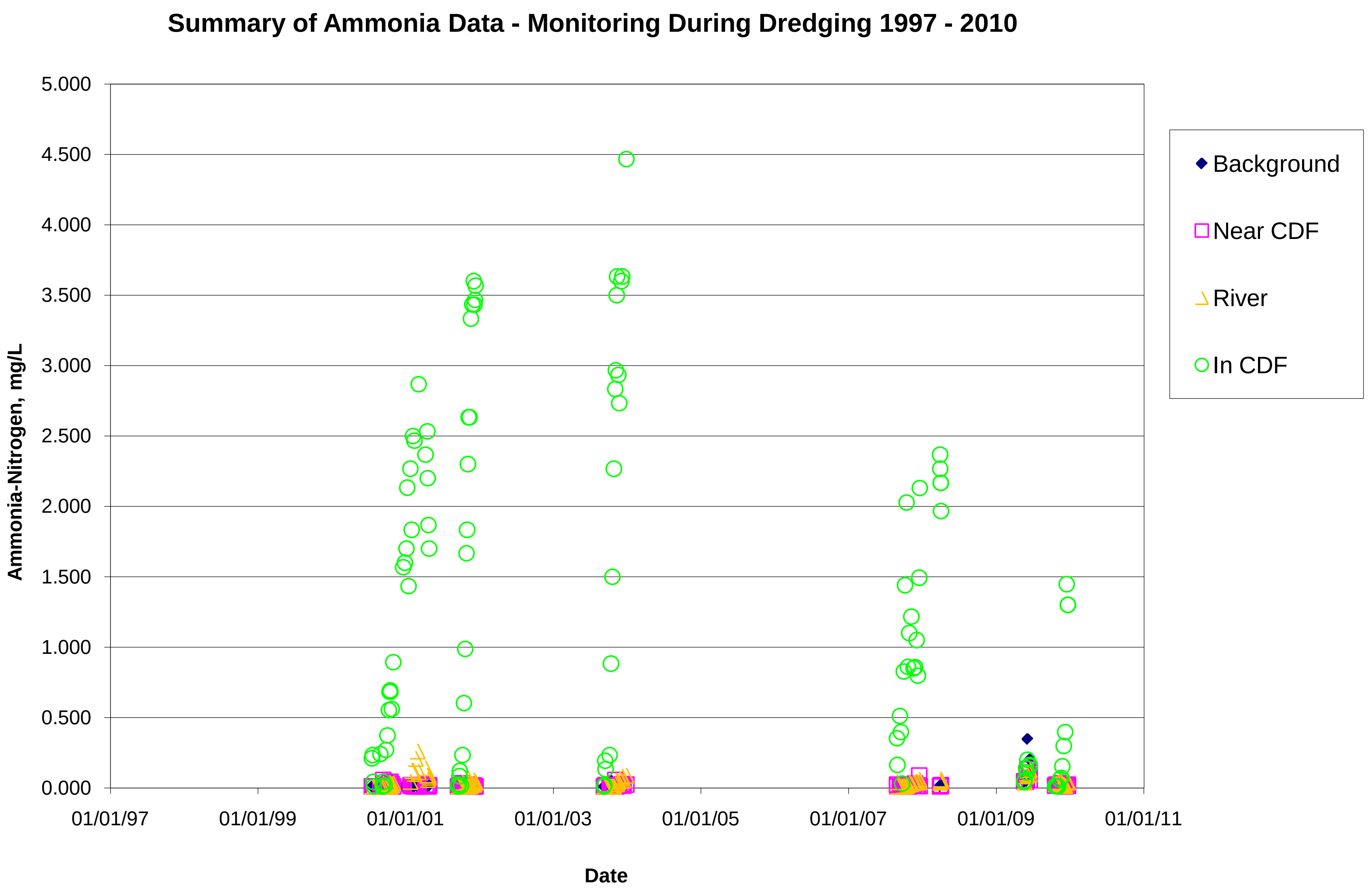
5. Advantages of the New Sampling Program

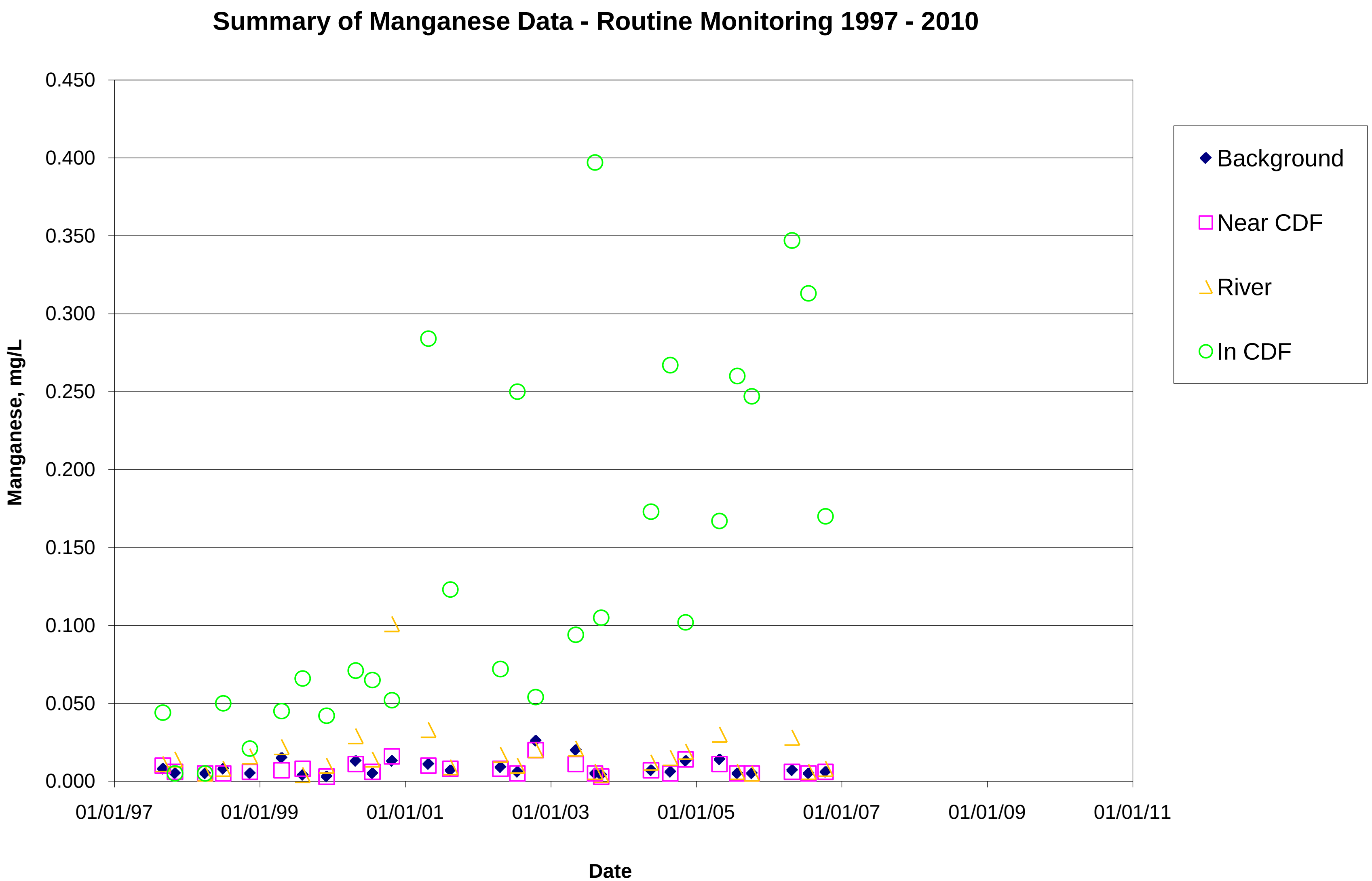
The proposed sampling plan will ensure that water quality information is collected during the times when water quality is most likely to be impacted – during dredging. Continuing with the same monitoring locations and parameters will ensure that the data are comparable to past results. Reducing the routine water quality monitoring is a more cost effective approach, since past monitoring does not indicate water quality impacts from the CDF during non-dredging periods. Continuing to monitor a minimum of one Iroquois Landing well will ensure that groundwater data are available, and continuing one annual monitoring event will provide continuity in the dataset.

Appendix B: Data Plots

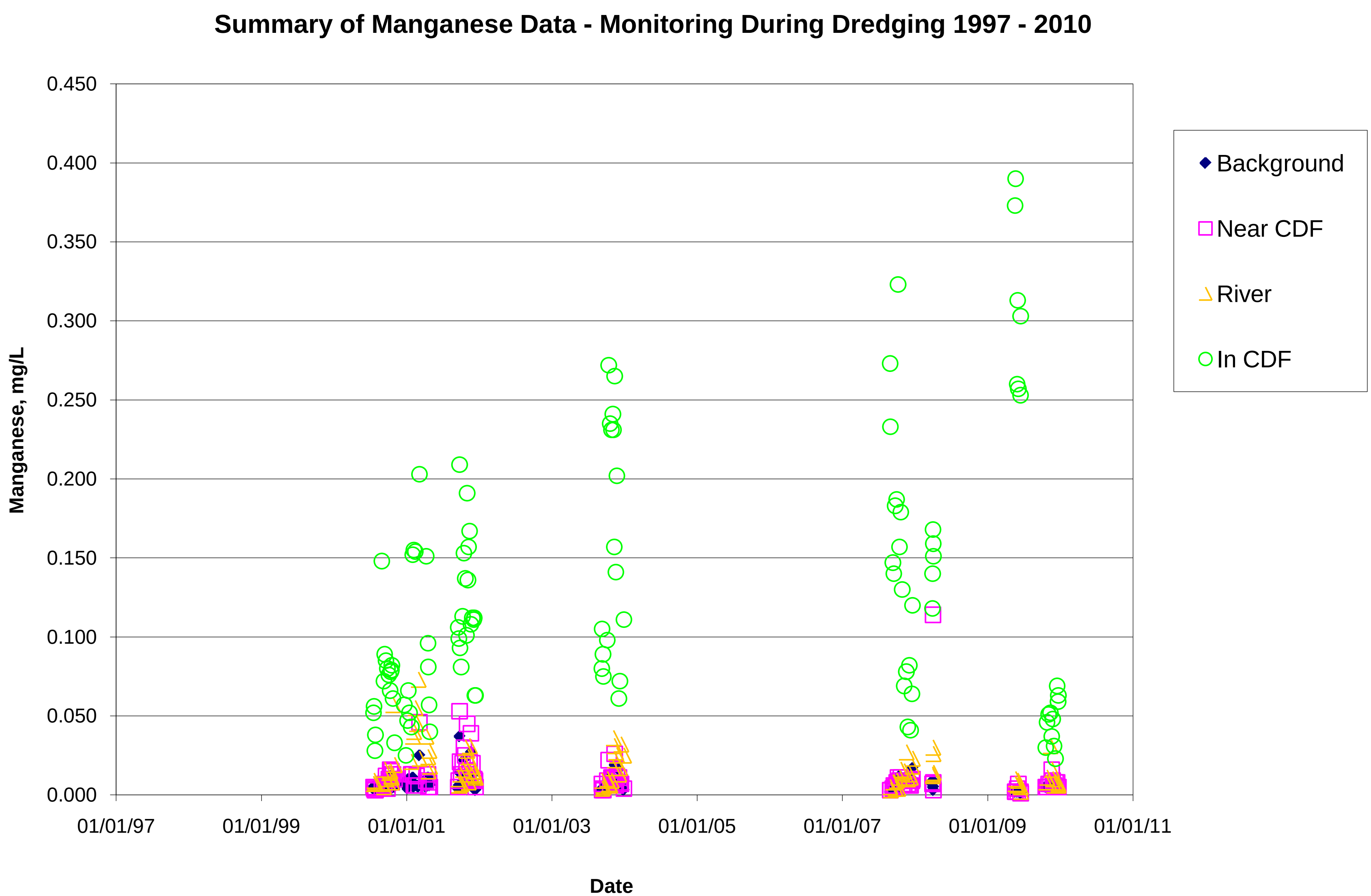


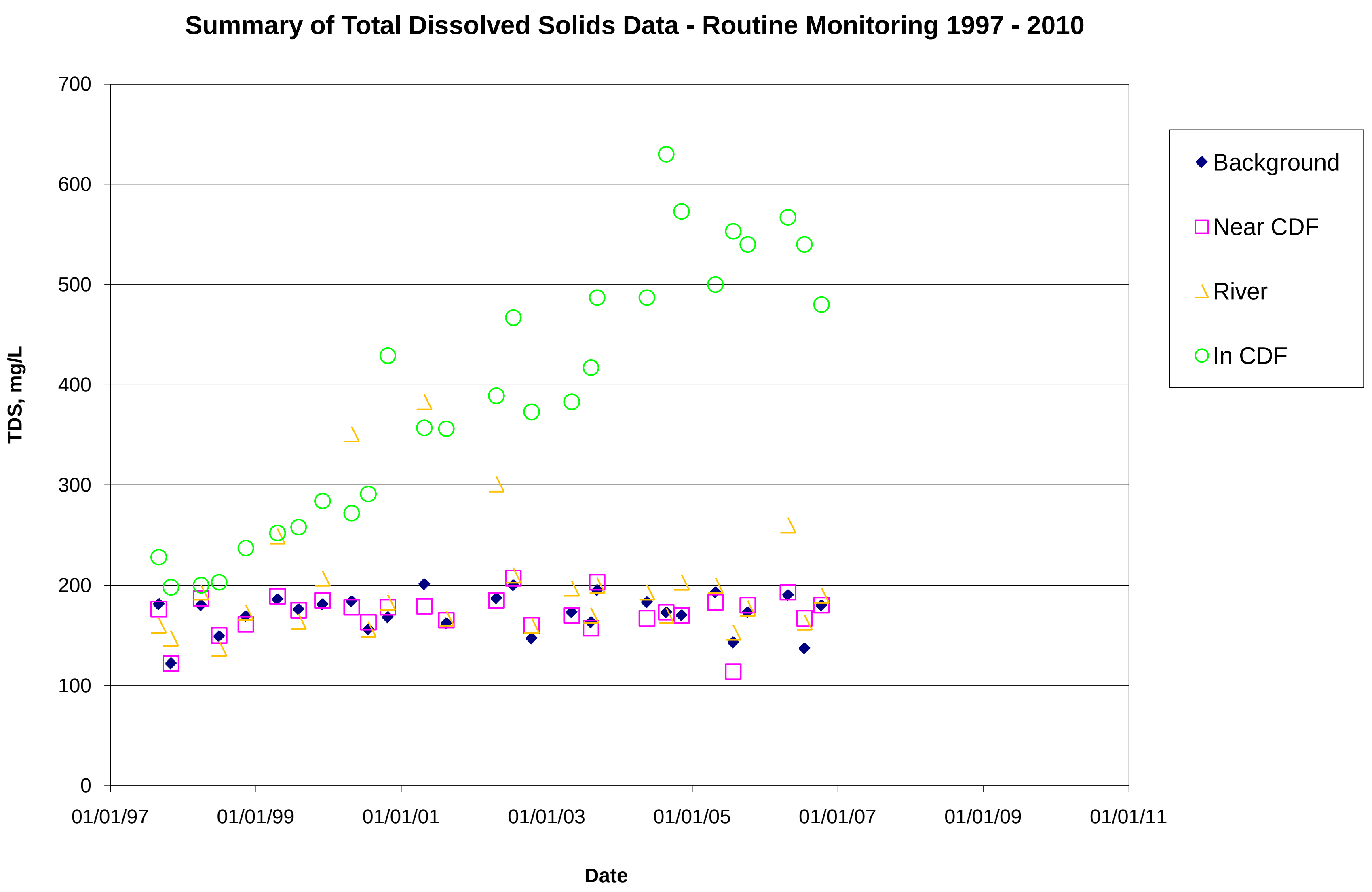
Summary of Ammonia Data - Routine Monitoring 1997 - 2010
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
Ammonia-Nitrogen, mg/L
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

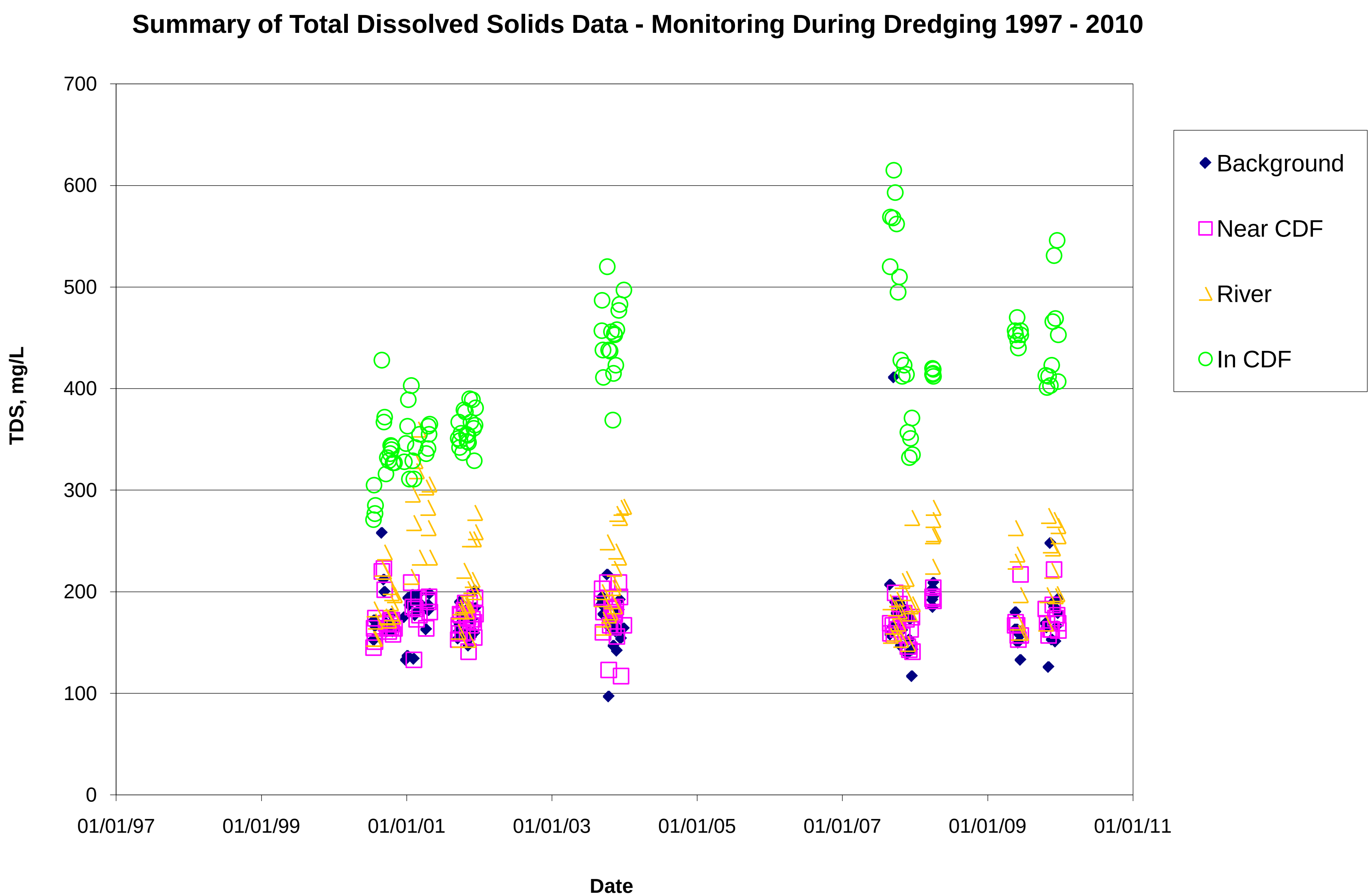

Summary of Ammonia Data - Monitoring During Dredging 1997 - 2010
Ammonia-Nitrogen, mg/L
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

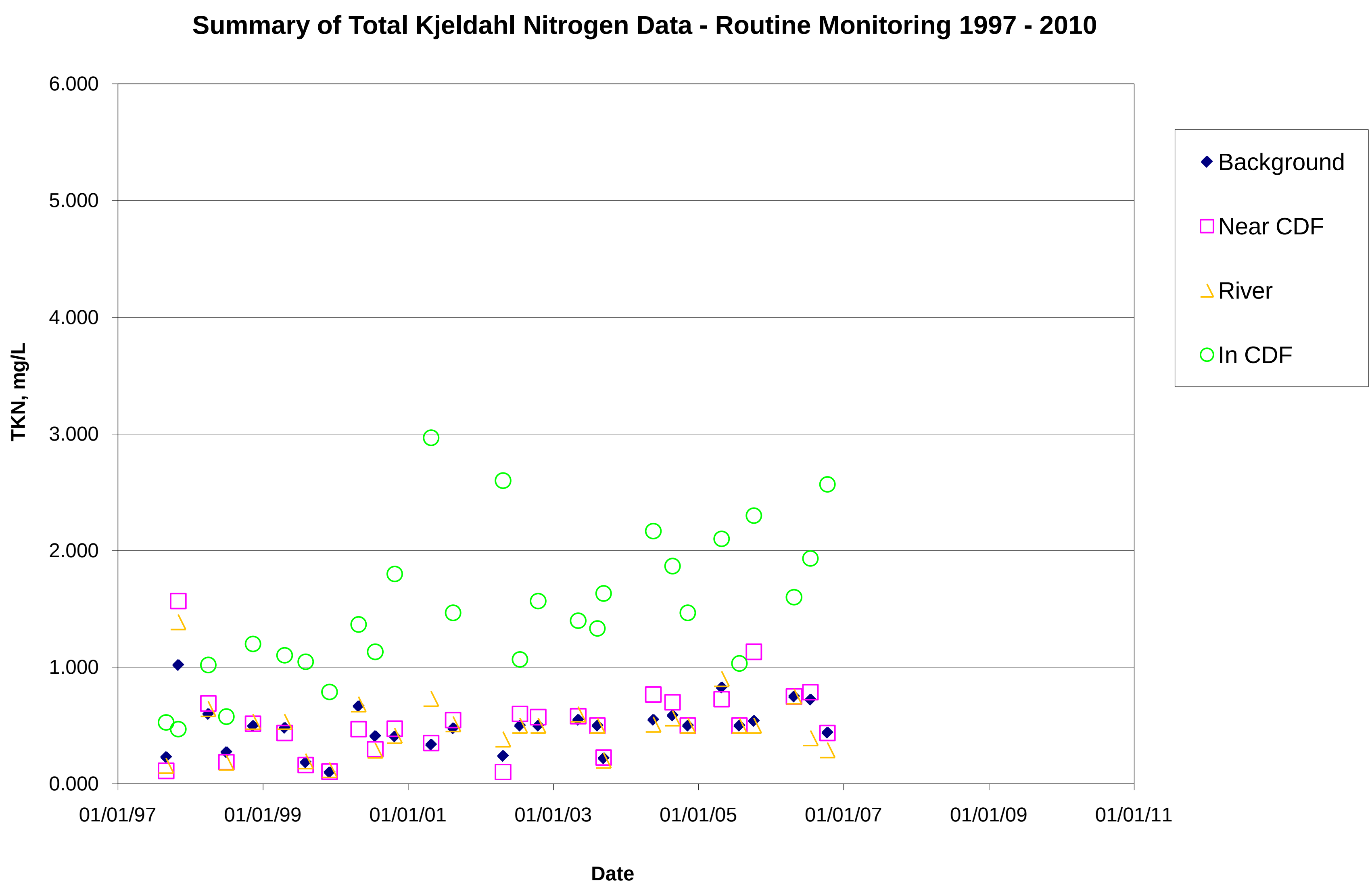


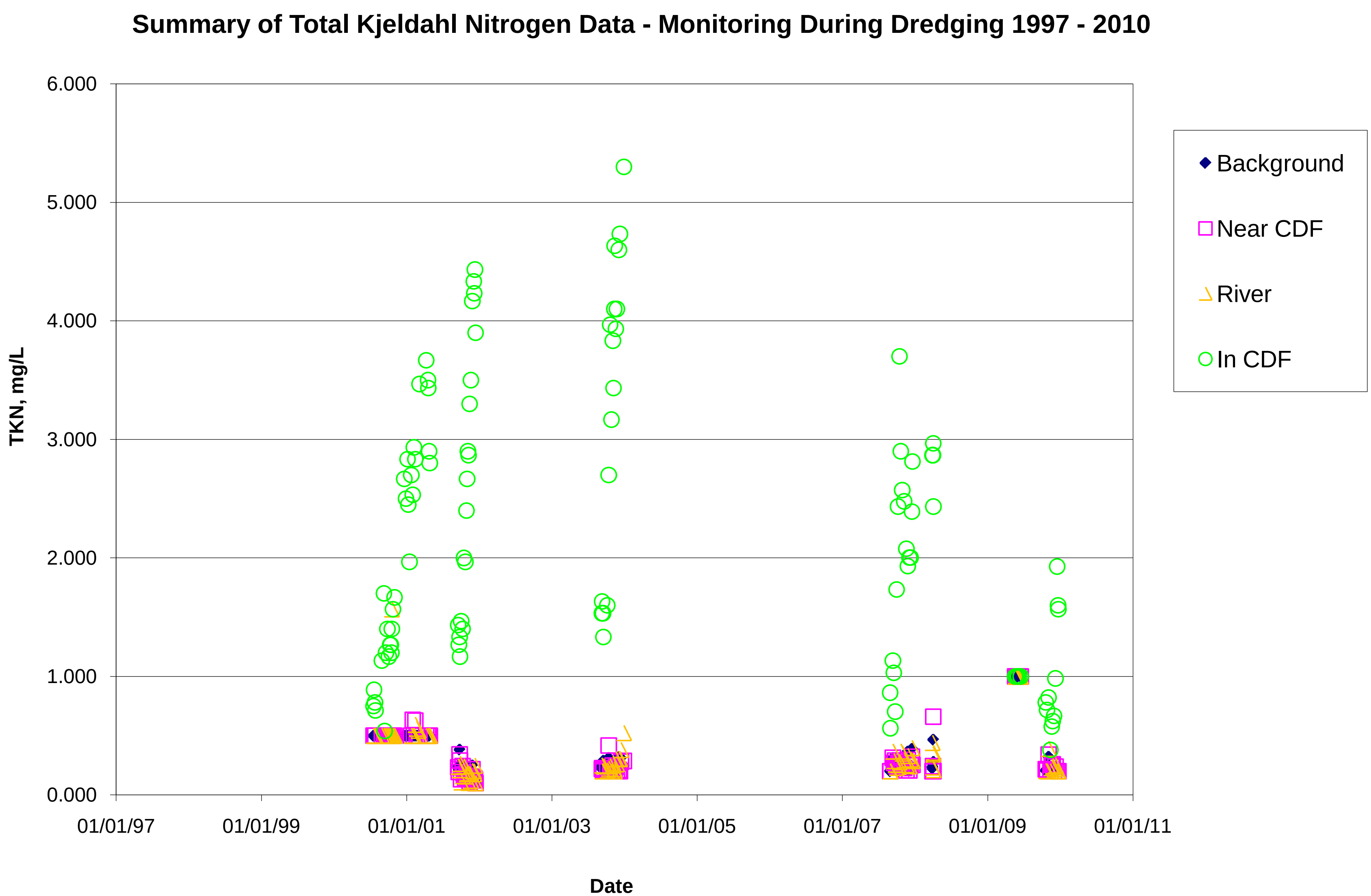
Summary of Manganese Data - Routine Monitoring 1997 - 2010
Manganese, mg/L
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

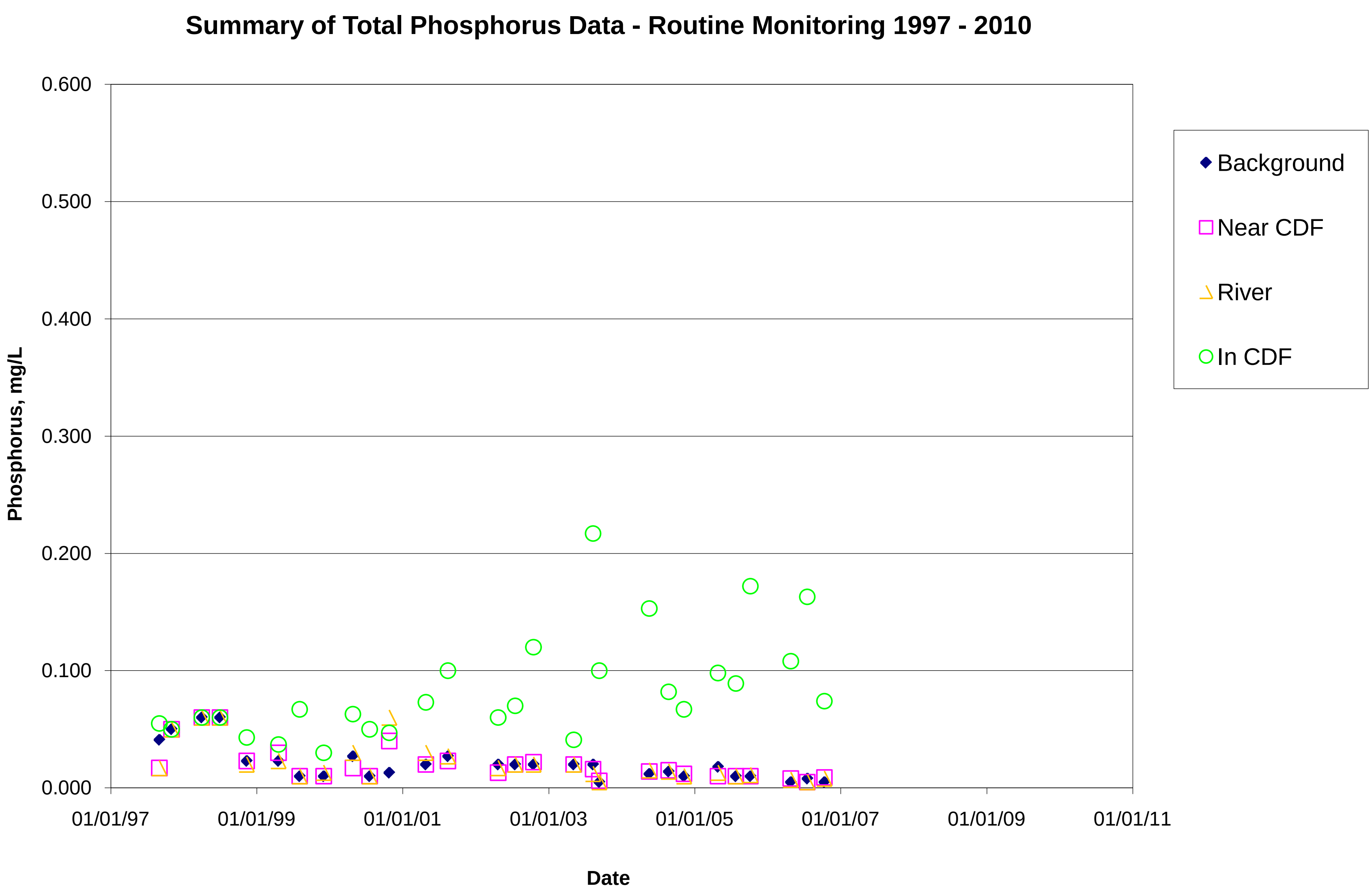

Summary of Manganese Data - Monitoring During Dredging 1997 - 2010
Manganese, mg/L
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF


Summary of Total Dissolved Solids Data - Routine Monitoring 1997 - 2010
TDS, mg/L
700
600
500
400
300
200
100
0
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

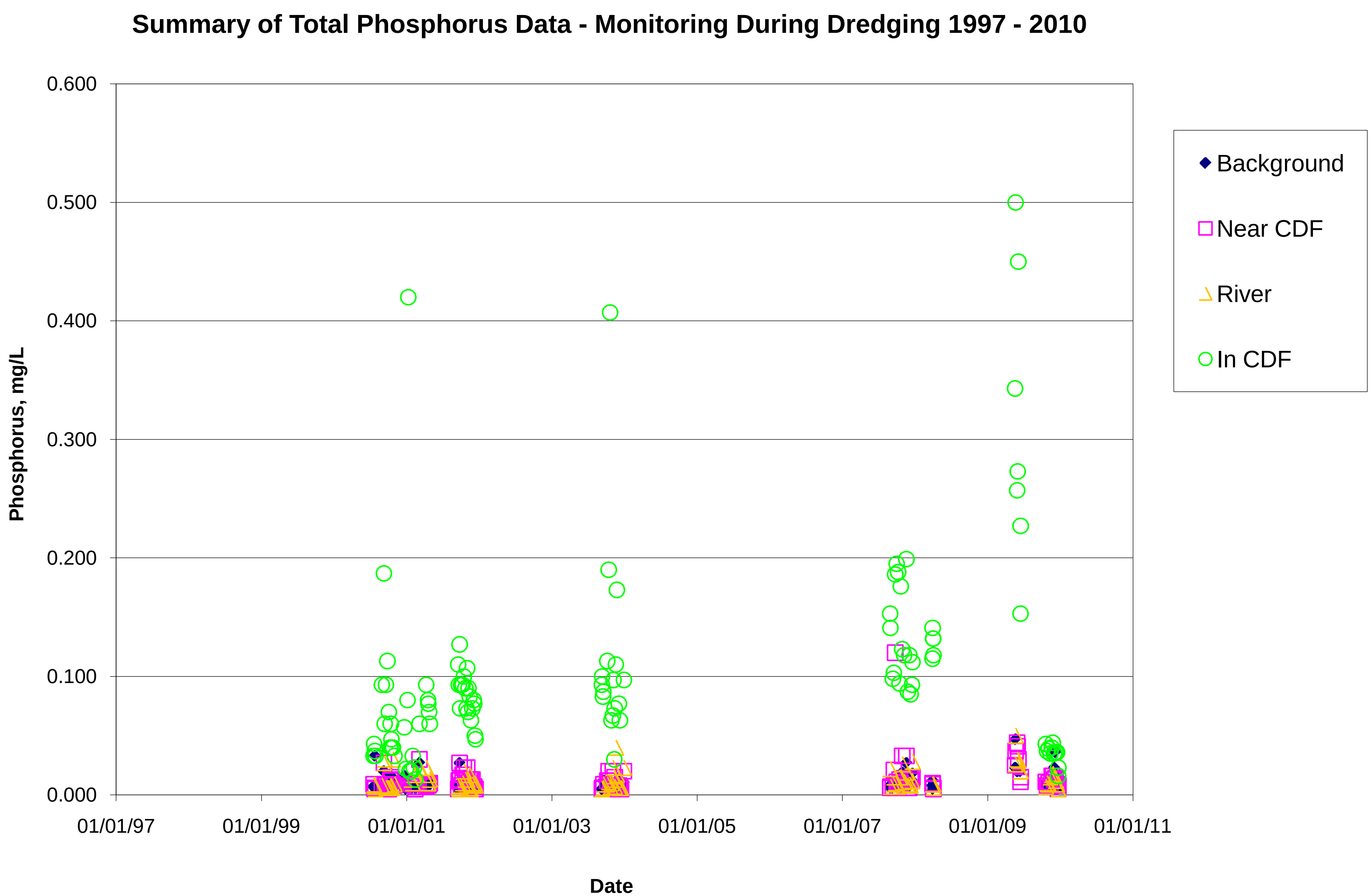

Summary of Total Dissolved Solids Data - Monitoring During Dredging 1997 - 2010
TDS, mg/L
700
600
500
400
300
200
100
0
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF


Summary of Total Kjeldahl Nitrogen Data - Routine Monitoring 1997 - 2010
TKN, mg/L
6.000
5.000
4.000
3.000
2.000
1.000
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

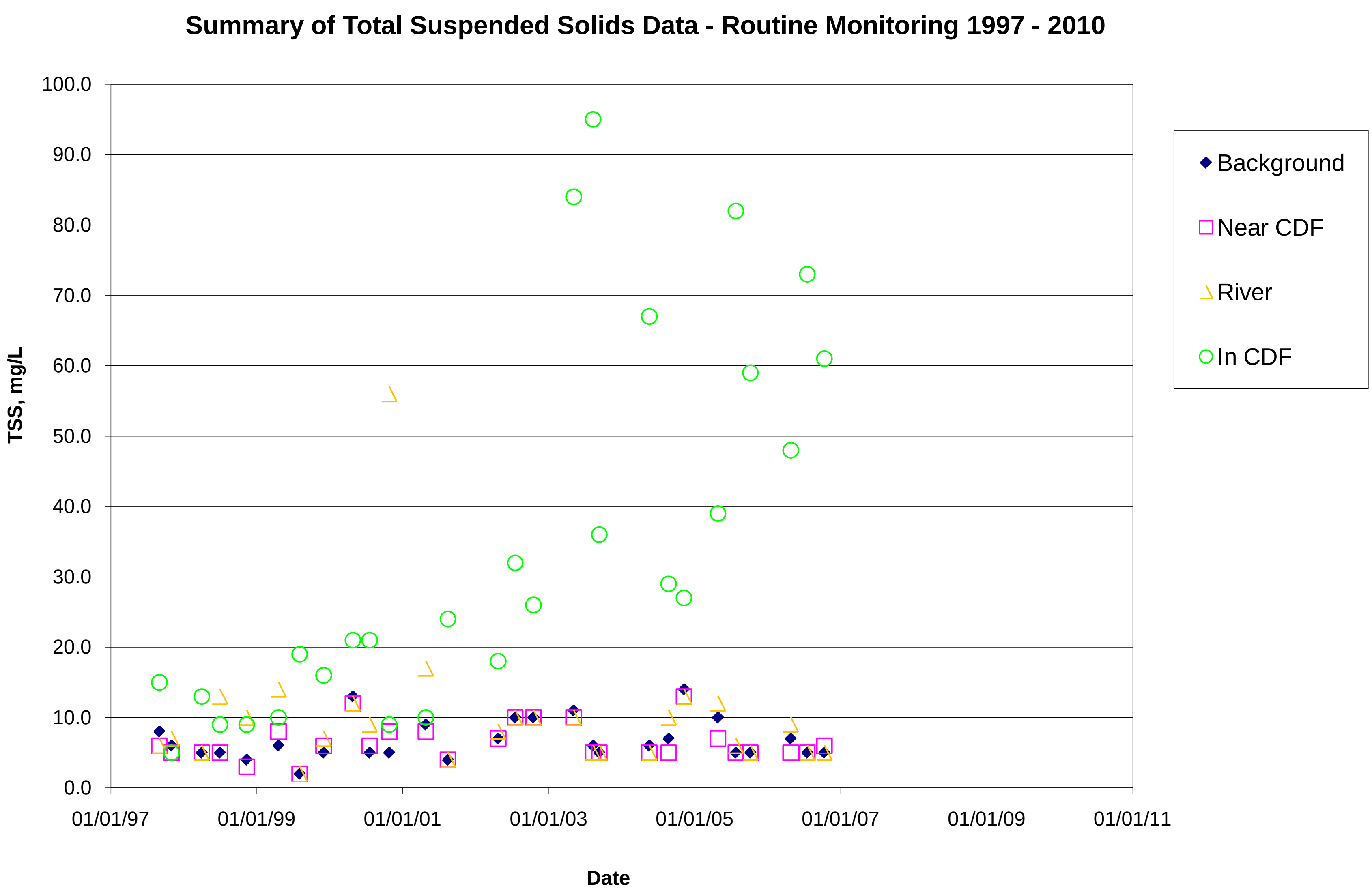

Summary of Total Kjeldahl Nitrogen Data - Monitoring During Dredging 1997 - 2010
6.000
5.000
4.000
3.000
2.000
1.000
0.000
TKN, mg/L
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF



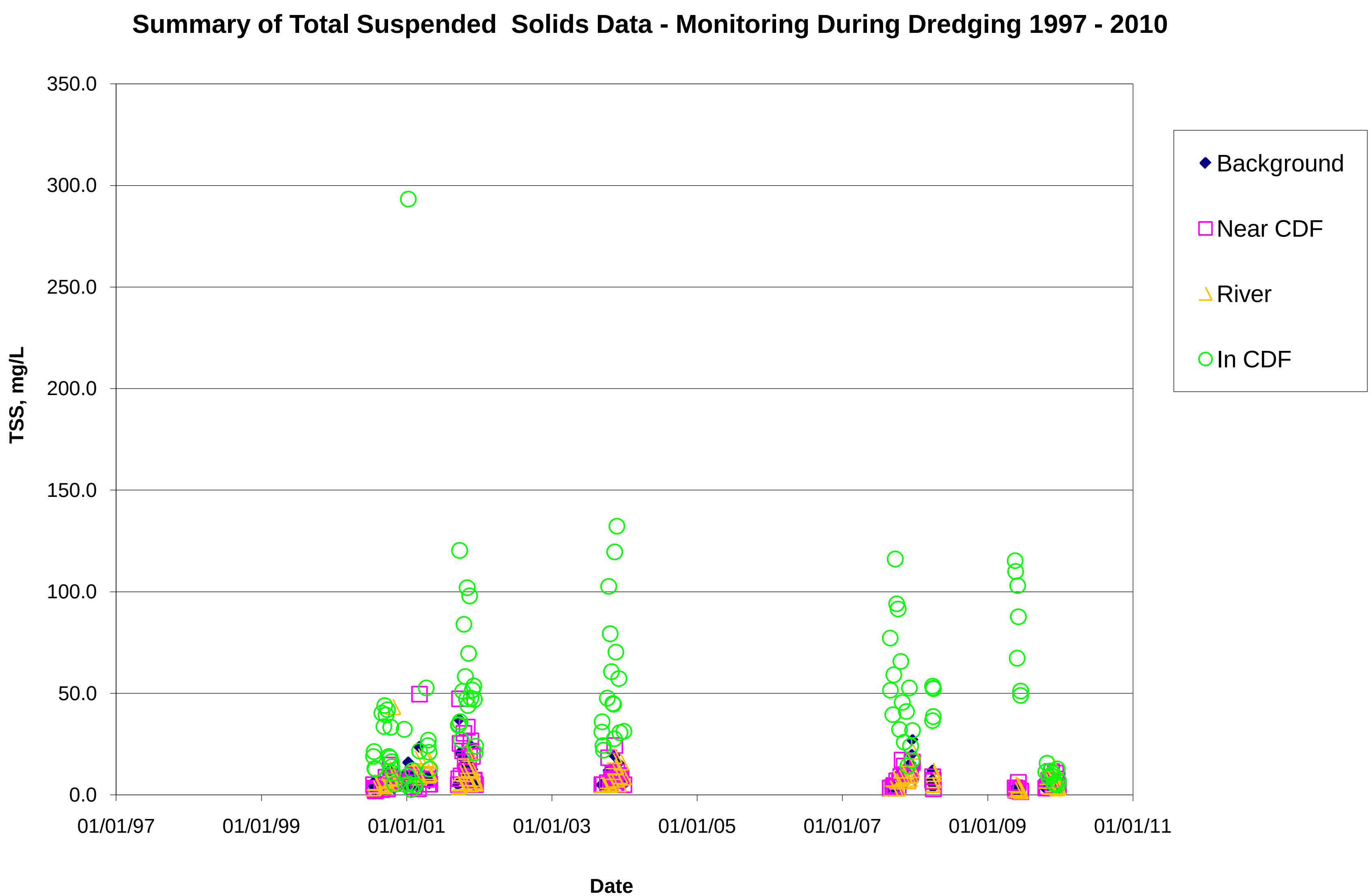
Summary of Total Phosphorus Data - Routine Monitoring 1997 - 2010
Phosphorus, mg/L
0.600
0.500
0.400
0.300
0.200
0.100
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

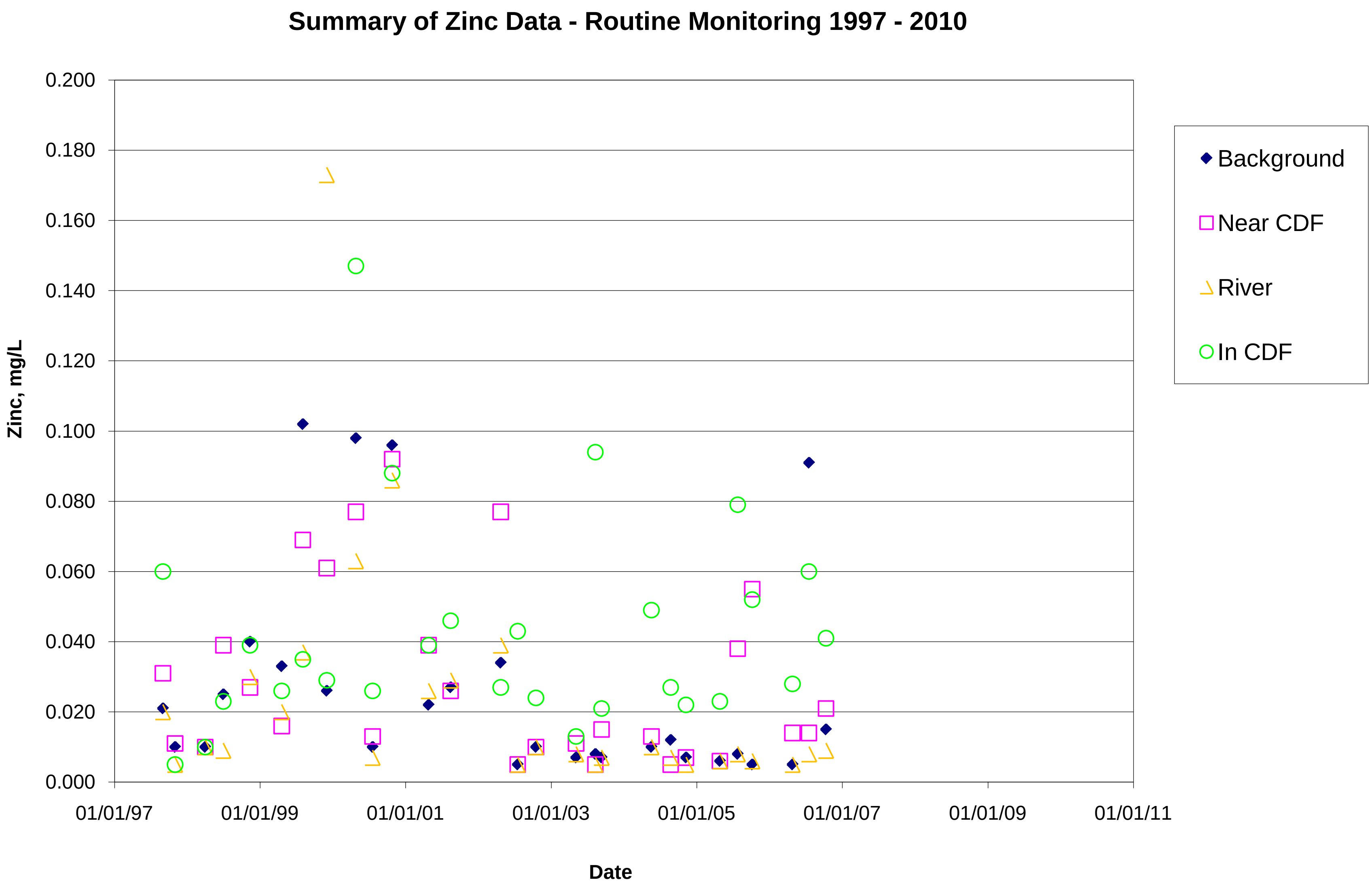


Summary of Total Phosphorus Data - Monitoring During Dredging 1997 - 2010
Phosphorus, mg/L
0.600
0.500
0.400
0.300
0.200
0.100
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

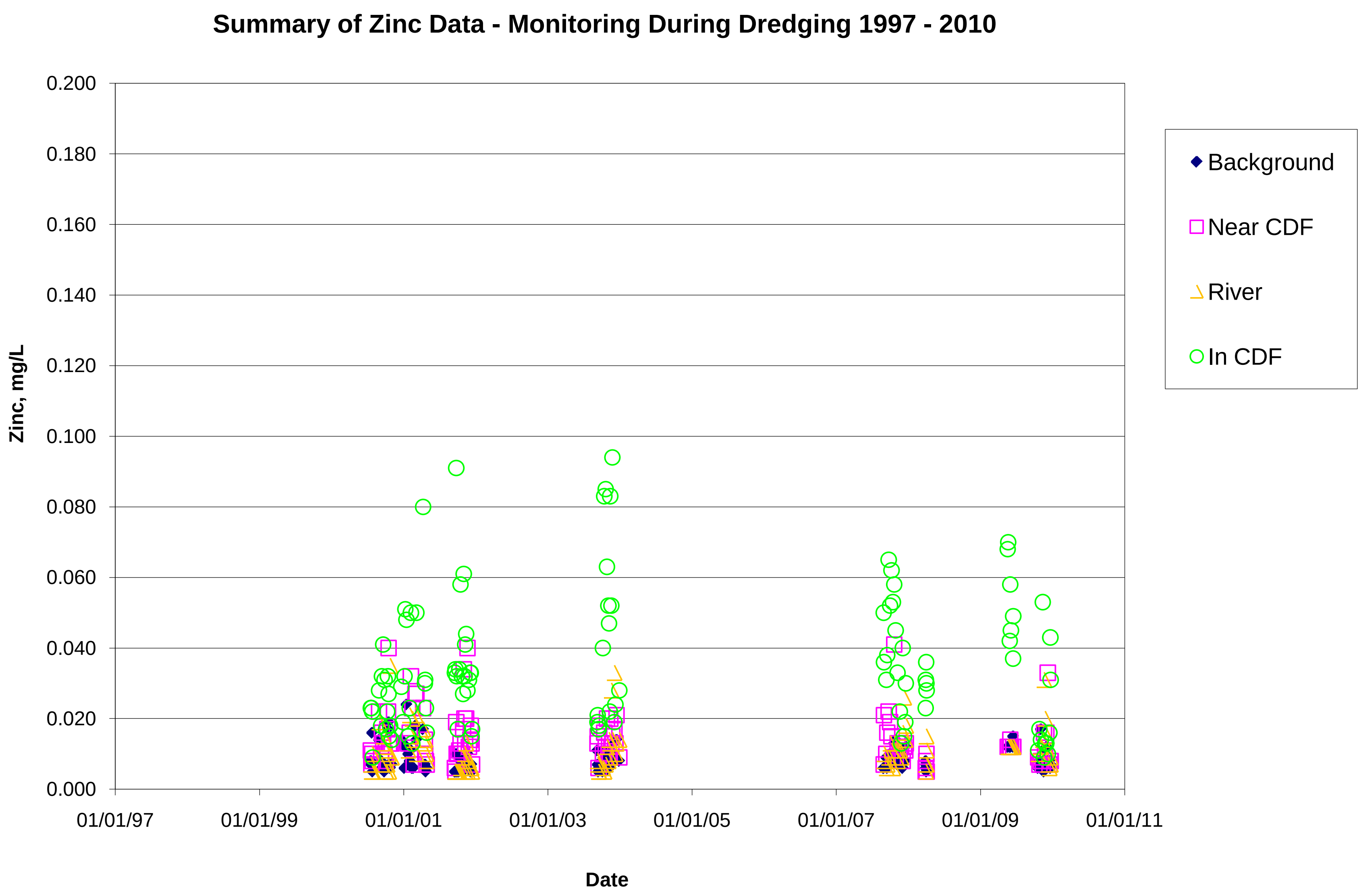


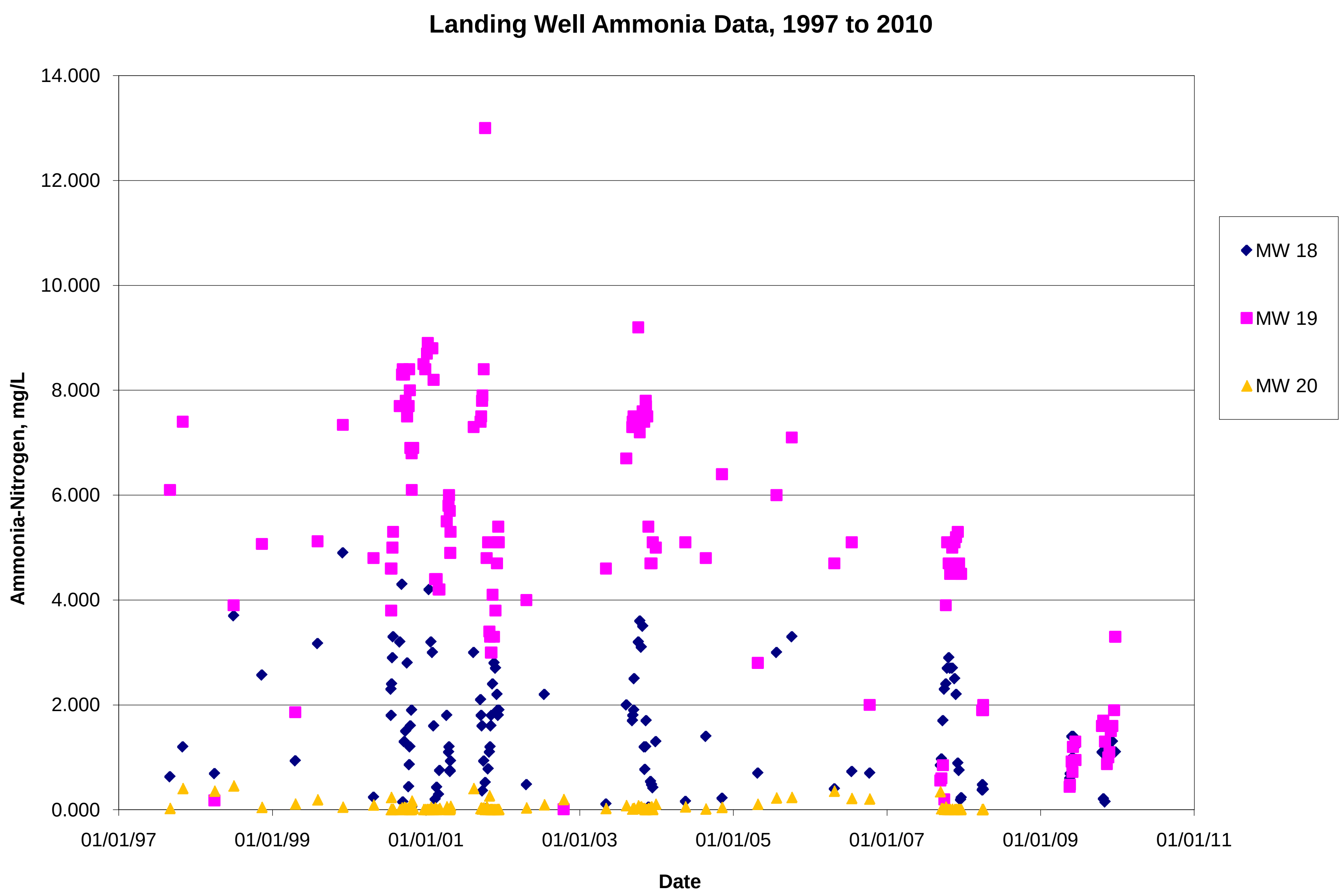
Summary of Total Suspended Solids Data - Routine Monitoring 1997 - 2010
TSS, mg/L
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

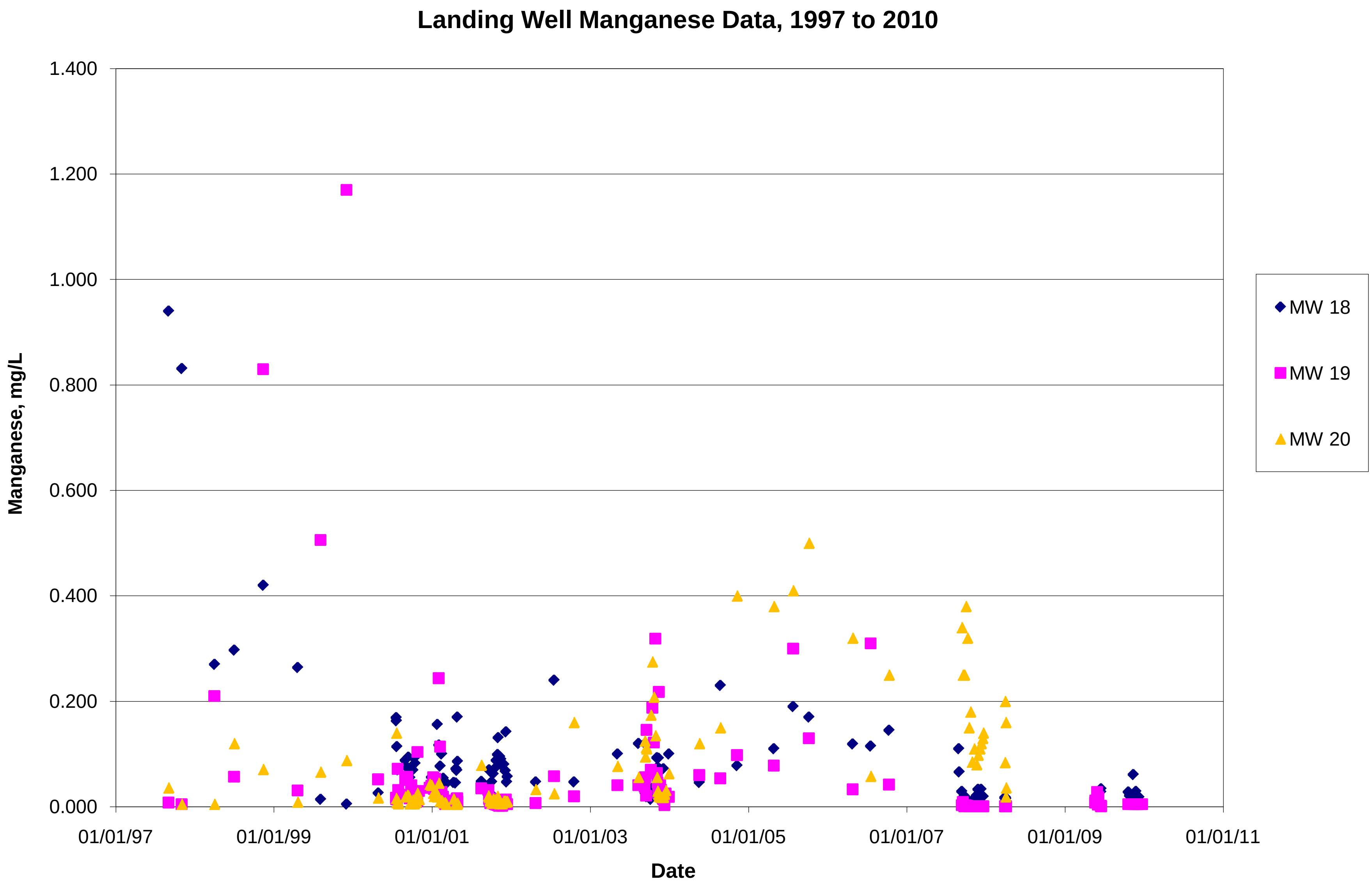

Summary of Total Suspended Solids Data - Monitoring During Dredging 1997 - 2010
TSS, mg/L
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

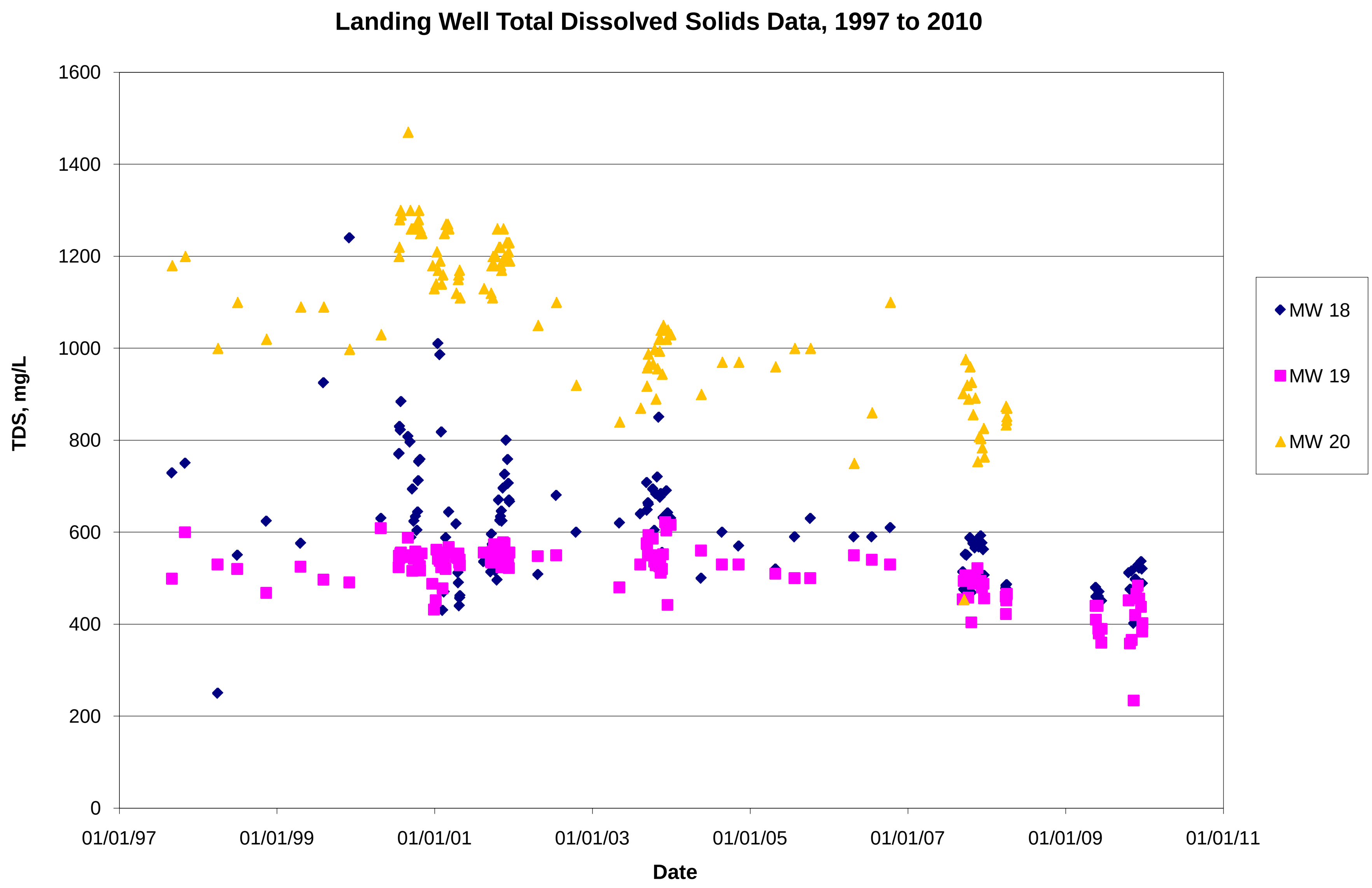


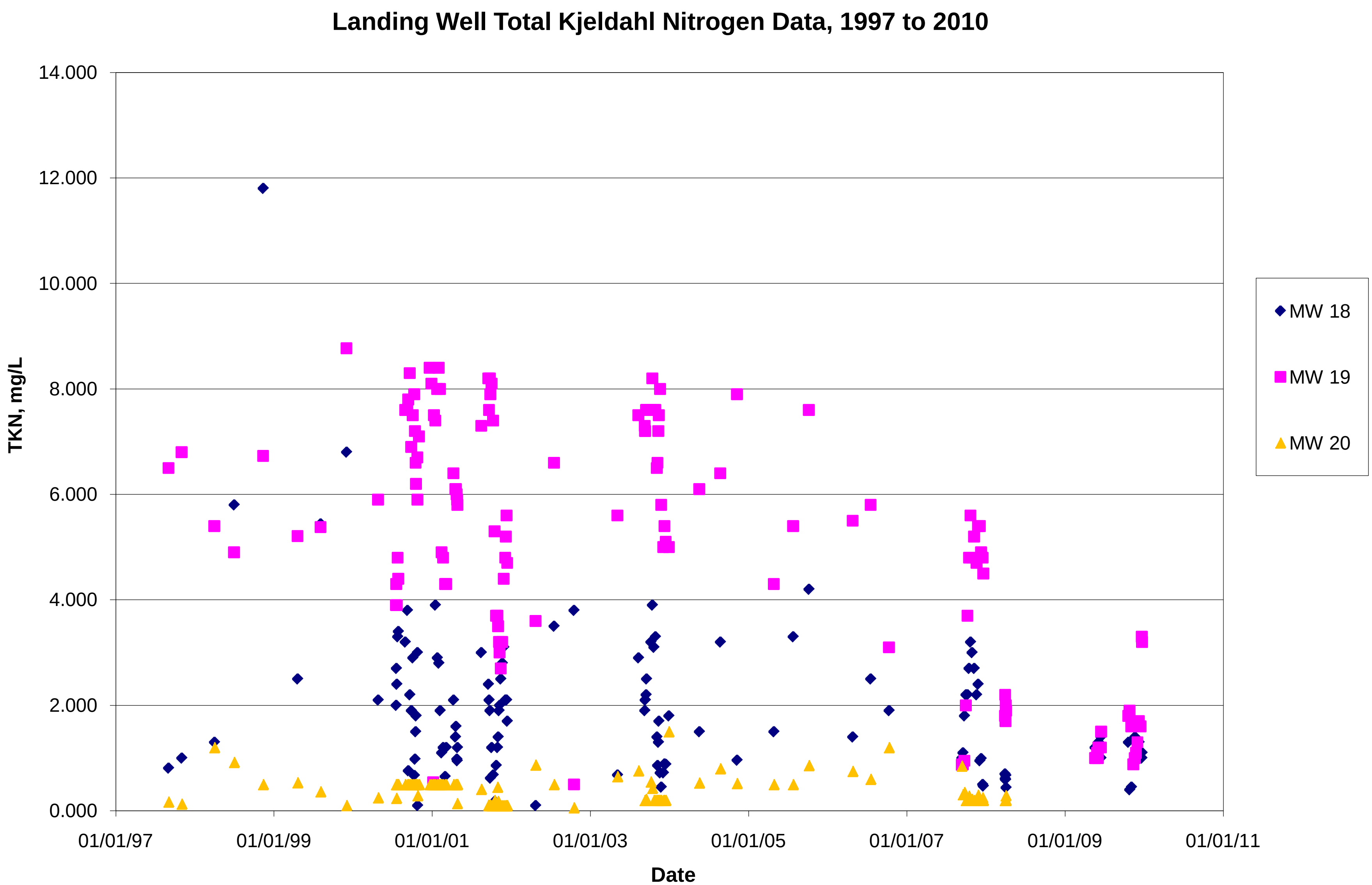
Summary of Zinc Data - Routine Monitoring 1997 - 2010
Zinc, mg/L
0.200
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF


Summary of Zinc Data - Monitoring During Dredging 1997 - 2010
Zinc, mg/L
0.200
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
Background
Near CDF
River
In CDF

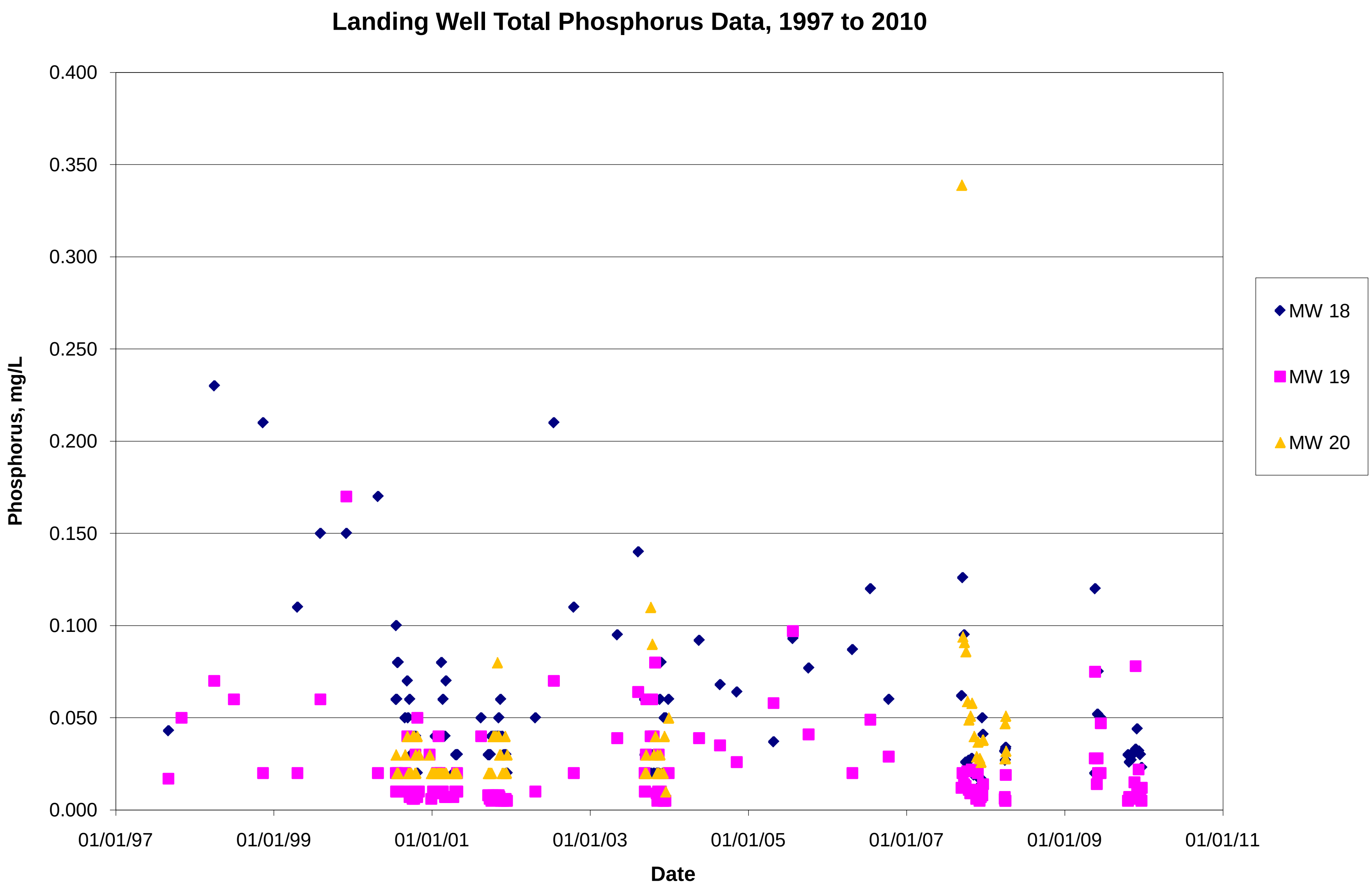

Landing Well Ammonia Data, 1997 to 2010
Ammonia-Nitrogen, mg/L
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
MW 18
MW 19
MW 20

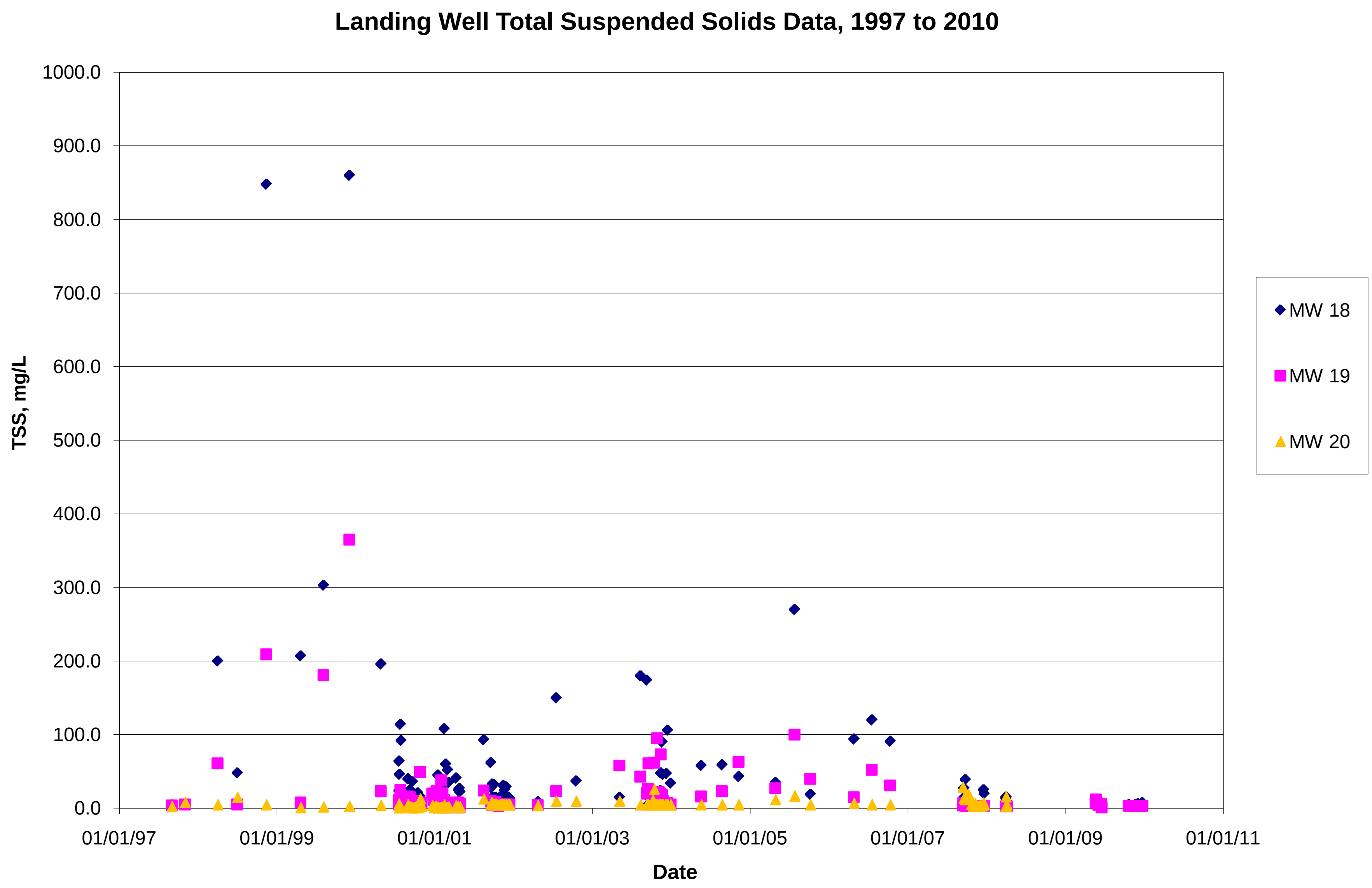

Landing Well Manganese Data, 1997 to 2010
Manganese, mg/L
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
MW 18
MW 19
MW 20

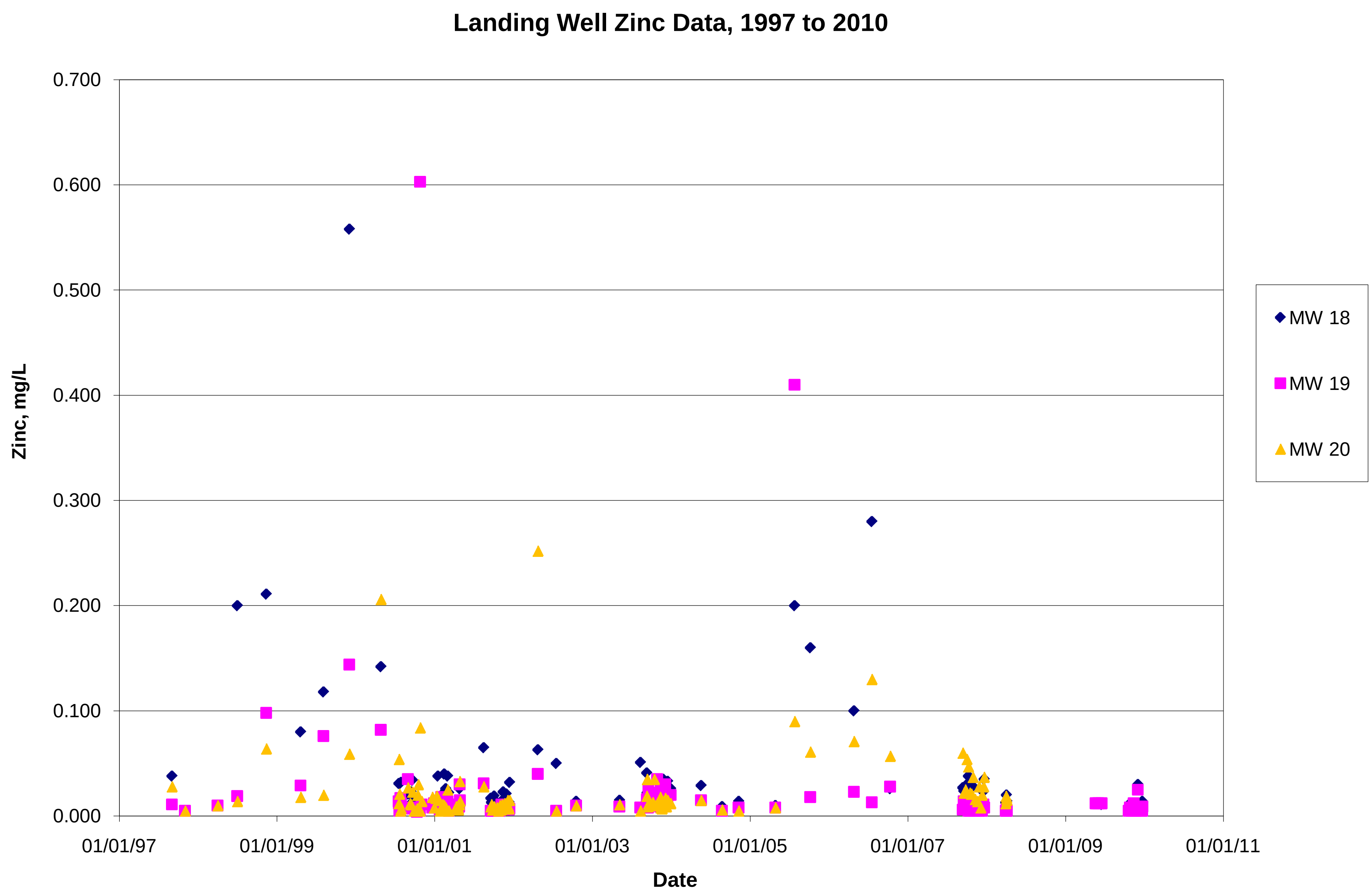

Landing Well Total Dissolved Solids Data, 1997 to 2010
TDS, mg/L
0
200
400
600
800
1000
1200
1400
1600
Date
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
MW 18
MW 19
MW 20



Landing Well Total Kjeldahl Nitrogen Data, 1997 to 2010
TKN, mg/L
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
MW 18
MW 19
MW 20


Landing Well Total Phosphorus Data, 1997 to 2010
Phosphorus, mg/L
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
MW 18
MW 19
MW 20


Landing Well Total Suspended Solids Data, 1997 to 2010
TSS, mg/L
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
MW 18
MW 19
MW 20



Landing Well Zinc Data, 1997 to 2010
Zinc, mg/L
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
01/01/97
01/01/99
01/01/01
01/01/03
01/01/05
01/01/07
01/01/09
01/01/11
Date
MW 18
MW 19
MW 20

Appendix C: Regression Statistics

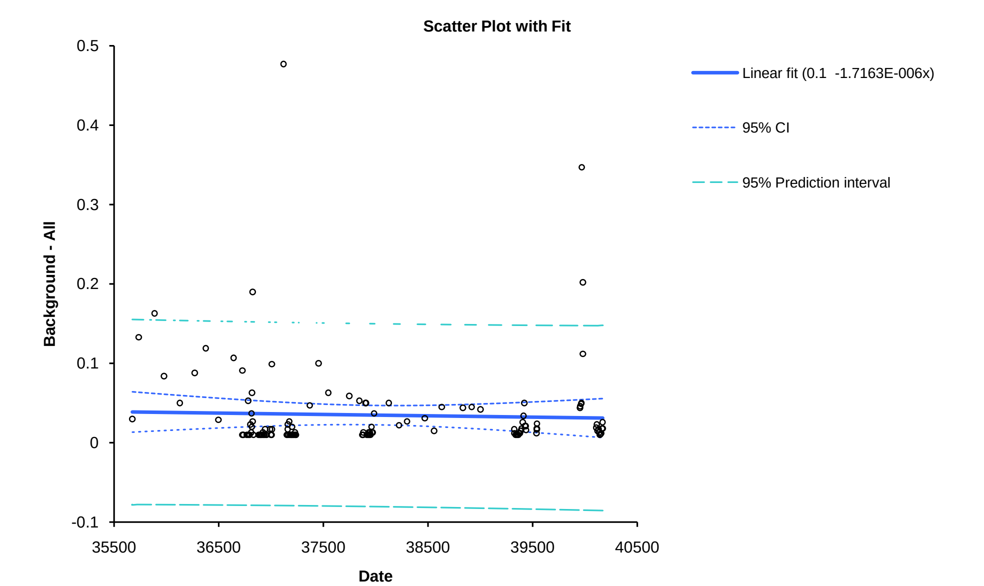
Test	**Regression - Linear**
	Background - All v Date Ammonia
Performed by	h6theres
Date	9 December 2010

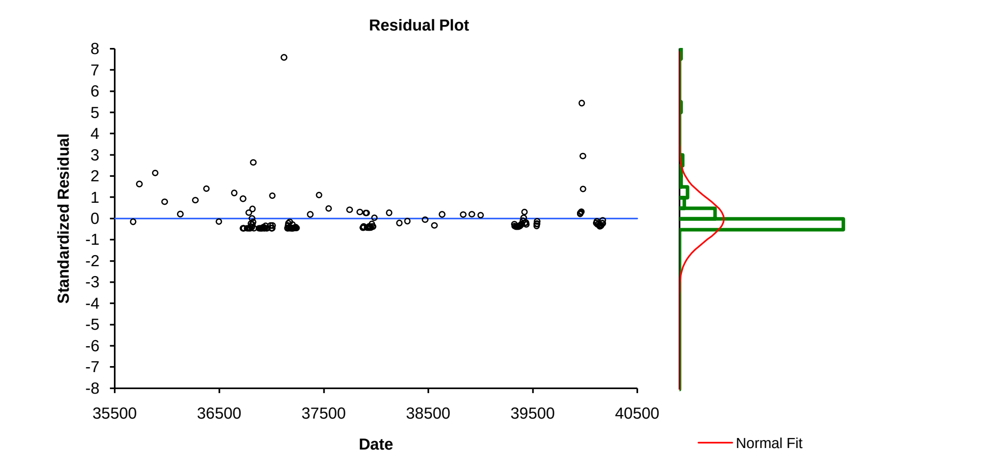
n	138

R^2	0.00
Adjusted R^2	-0.01
SE	0.0580

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.1	-0.2 to 0.4	0.15	0.67	136	0.5035
Slope	-1.7163E-06	-9.4773E-06 to 6.0447E-06	3.9245E-006	-0.44	136	0.6626

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0006	1	0.0006	0.19	0.6626
Residual	0.4577	136	0.0034		
Total	0.4583	137			





Analyse-it v2.09

Test	Regression - Linear
	Near CDF - Routine v Date Ammonia
Performed by	h6theres

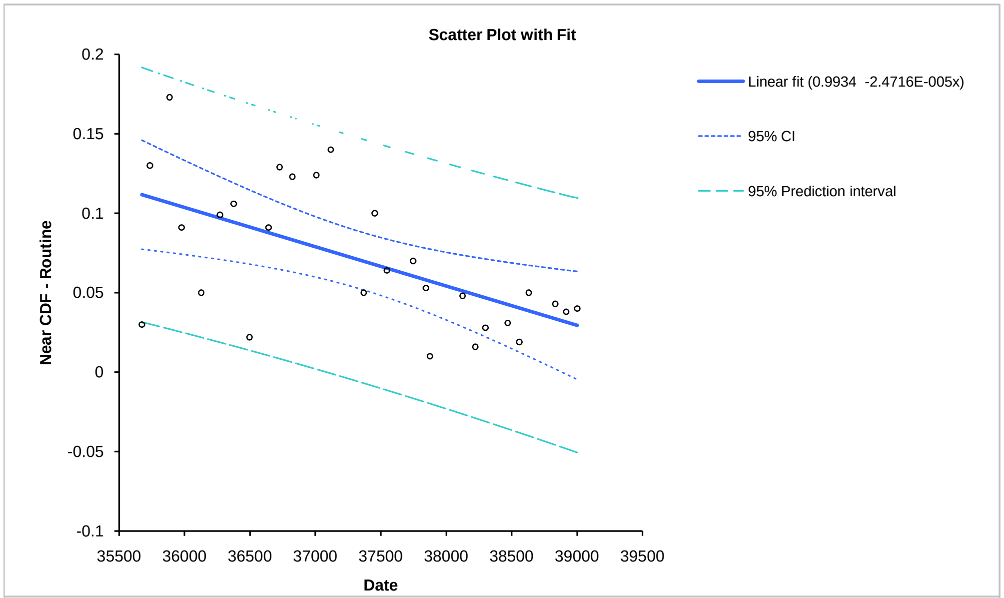
Date: 9 December 2010

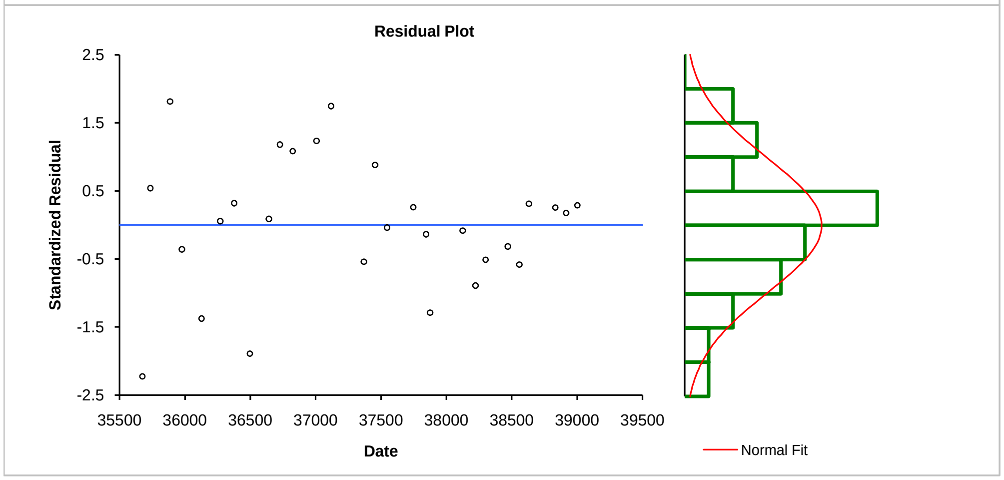
n: 28 (cases excluded: 110 due to missing values)

R^2	0.34
Adjusted R^2	0.32
SE	0.0367

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.9934	0.4778 to 1.5090	0.25082	3.96	26	0.0005
Slope	-2.4716E-05	-3.8516E-05 -1.09E-05	6.7133E-006	-3.68	26	0.0011

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0182	1	0.0182	13.56	0.0011
Residual	0.0350	26	0.0013		
Total	0.0532	27			





Analyse-it v2.09

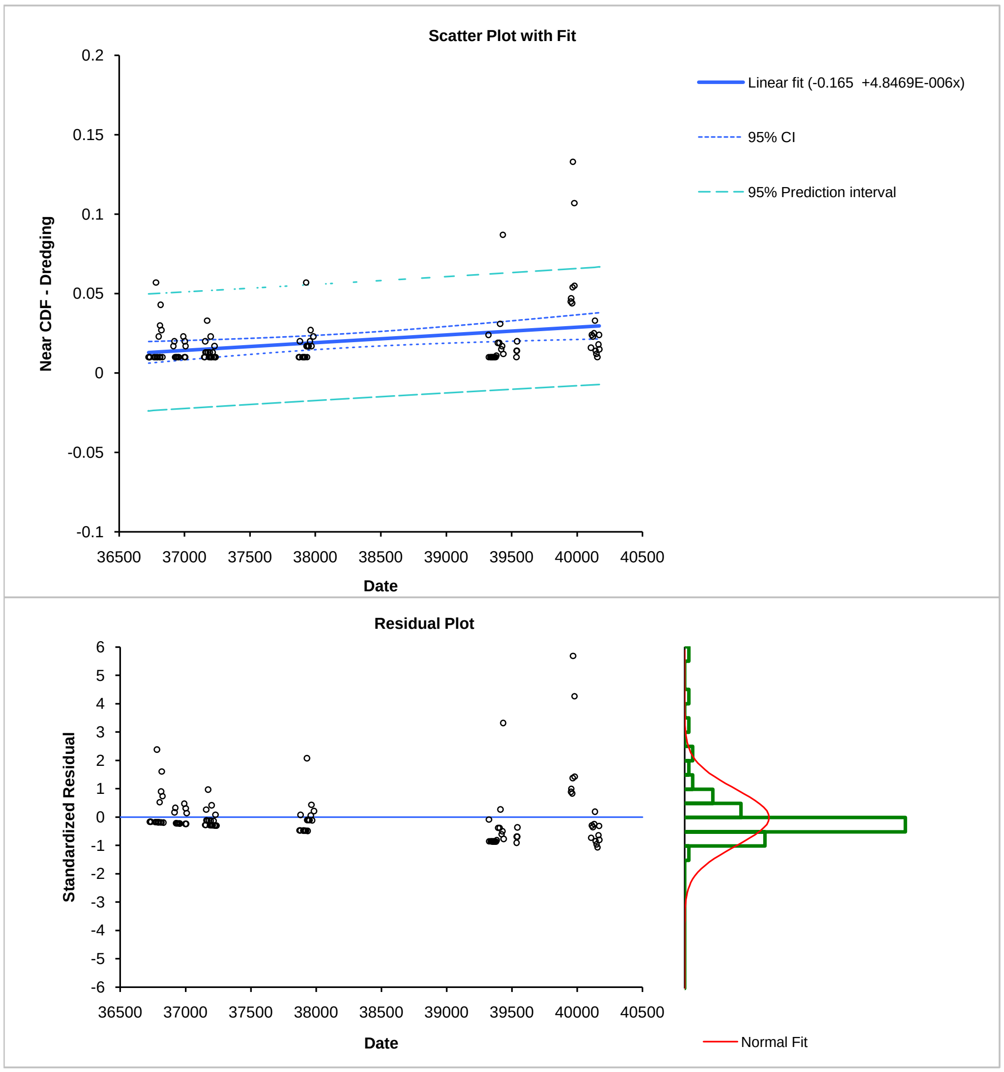
Test	Regression - Linear		
	Near CDF - Dredging v Date	Ammonia	
Performed by	h6theres	Date	9 December 2010

n 105 (cases excluded: 33 due to missing values)

R^2	0.10
Adjusted R^2	0.09
SE	0.0183

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.165	-0.272 to -0.057	0.0542	-3.04	103	0.0030
Slope	4.8469E-06	2.0336E-06 to 7.6602E-06	1.4185E-006	3.42	103	0.0009

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0039	1	0.0039	11.68	0.0009
Residual	0.0346	103	0.0003		
Total	0.0385	104			



Analyse-it v2.09

Test	Regression - Linear
	River - Routine v Date Ammonia
Performed by	h6theres

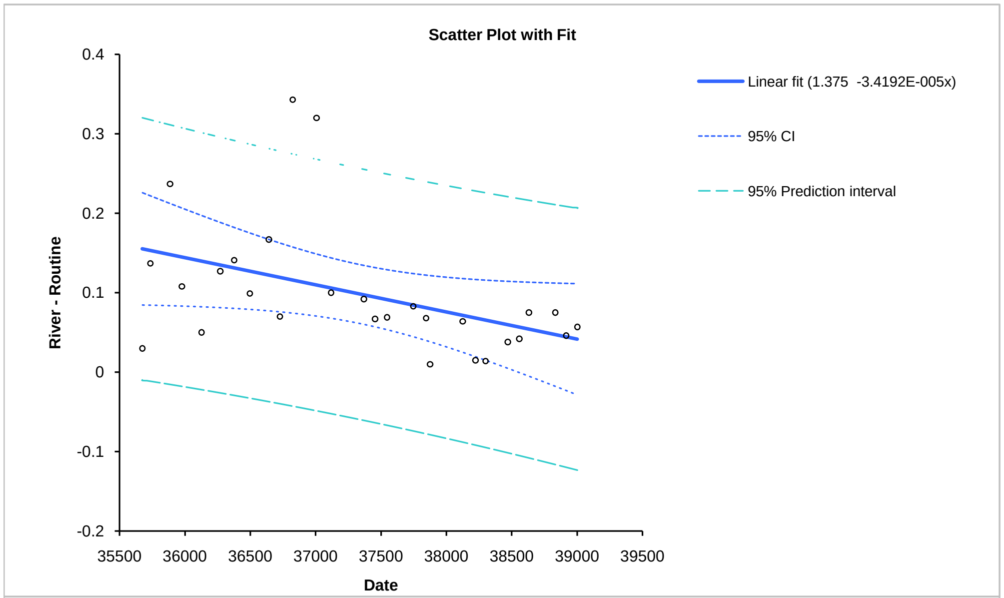
Date 9 December 2010

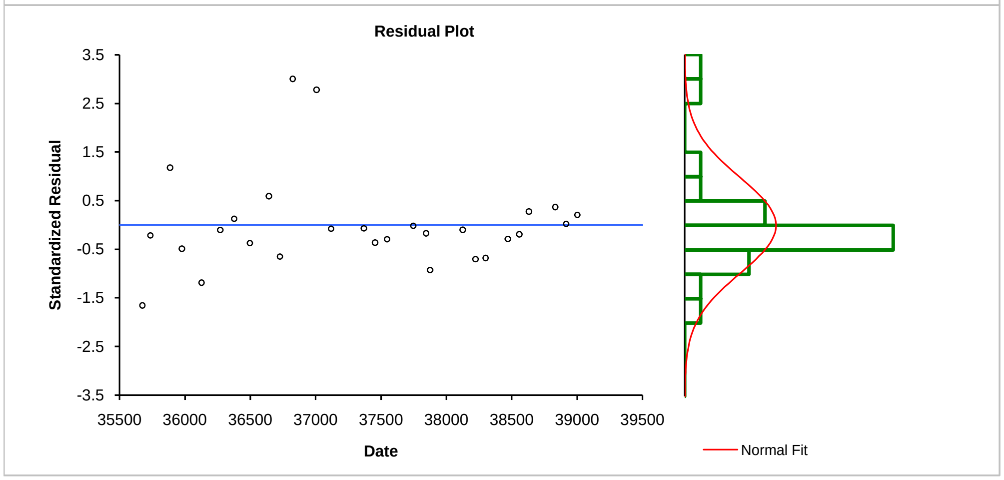
n	28 (cases excluded: 110 due to missing values)

R^2	0.19
Adjusted R^2	0.16
SE	0.0756

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	1.375	0.312 to 2.438	0.5169	2.66	26	0.0132
Slope	-3.4192E-05	-6.2630E-05 -5.75E-06	1.3835E-005	-2.47	26	0.0203

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0349	1	0.0349	6.11	0.0203
Residual	0.1485	26	0.0057		
Total	0.1834	27			





Analyse-it v2.09

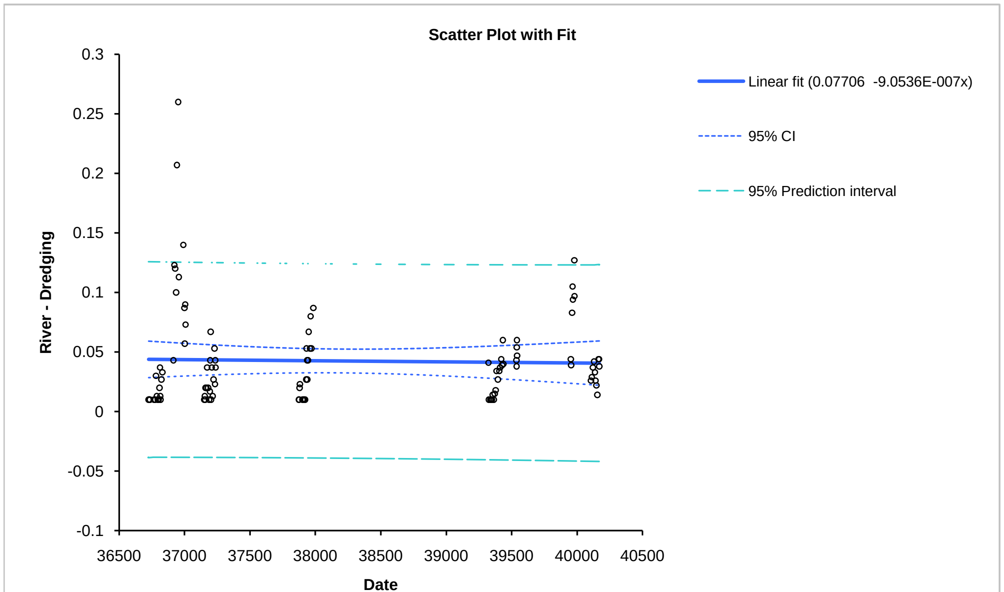
Test	**Regression - Linear**
	River - Dredging v Date Ammonia
Performed by	h6theres
Date	9 December 2010

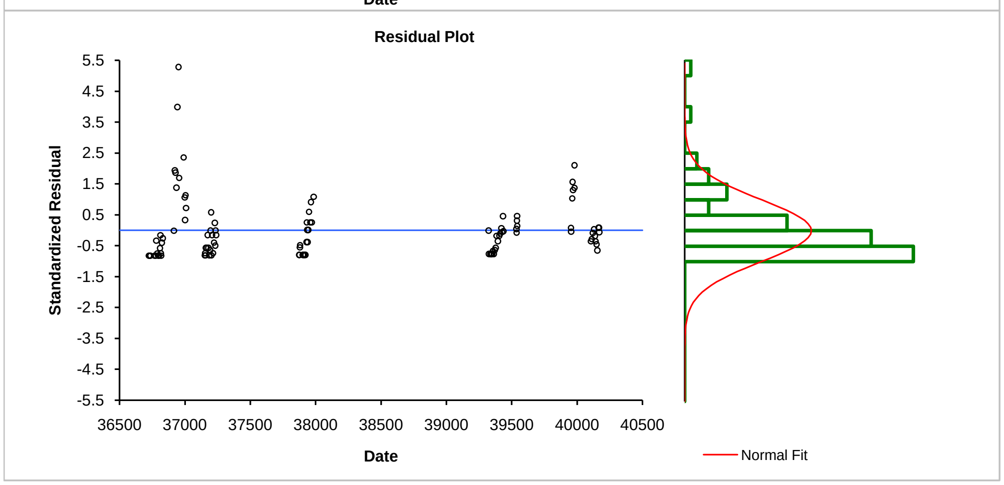
n	105	(cases excluded: 33 due to missing values)

R^2	0.00
Adjusted R^2	-0.01
SE	0.0410

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.07706	-0.16317 to 0.31729	0.121127	0.64	103	0.5261
Slope	-9.0536E-07	-7.1923E-06 to 5.3816E-06	3.1700E-006	-0.29	103	0.7758

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0001	1	0.0001	0.08	0.7758
Residual	0.1728	103	0.0017		
Total	0.1730	104			





Test | **Regression - Linear**

In CDF - Routine v Date   Ammonia

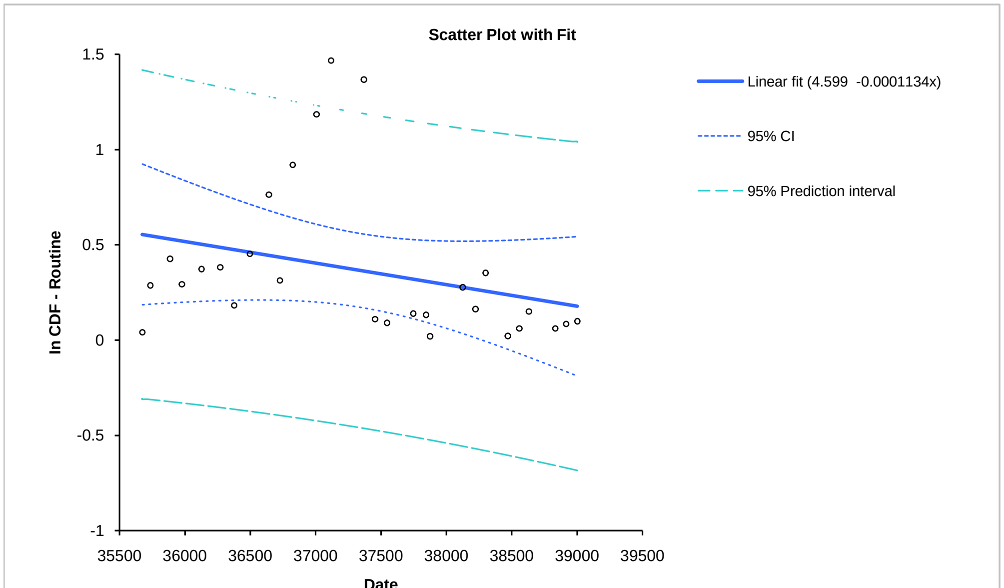
Performed by h6theres   Date 9 December 2010

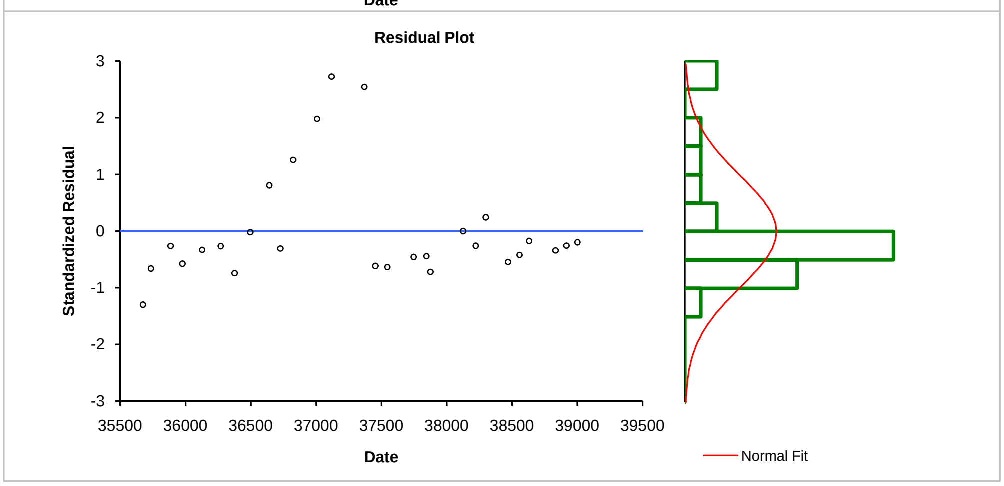
n 28 (cases excluded: 110 due to missing values)

R^2	0.09
Adjusted R^2	0.05
SE	0.3946

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	4.599	-0.948 to 10.147	2.6989	1.70	26	0.1003
Slope	-0.0001134	-0.0002619 to 0.0000351	0.00007223	-1.57	26	0.1286

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.3836	1	0.3836	2.46	0.1286
Residual	4.0486	26	0.1557		
Total	4.4322	27			





Analyse-it v2.09

Test	**Regression - Linear**
	ln CDF - Dredging v Date Ammonia
Performed by	h6theres

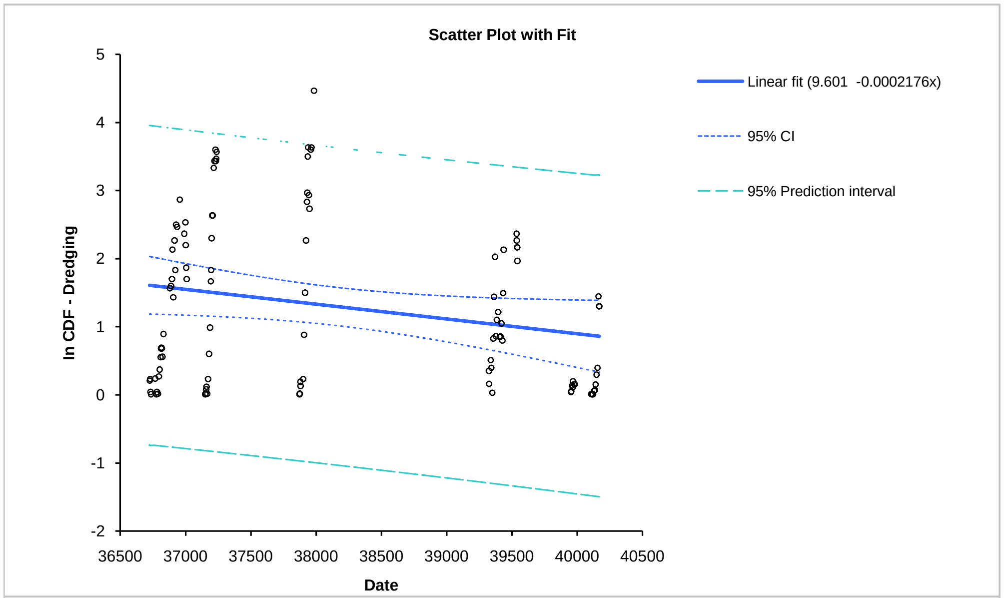
Date 9 December 2010

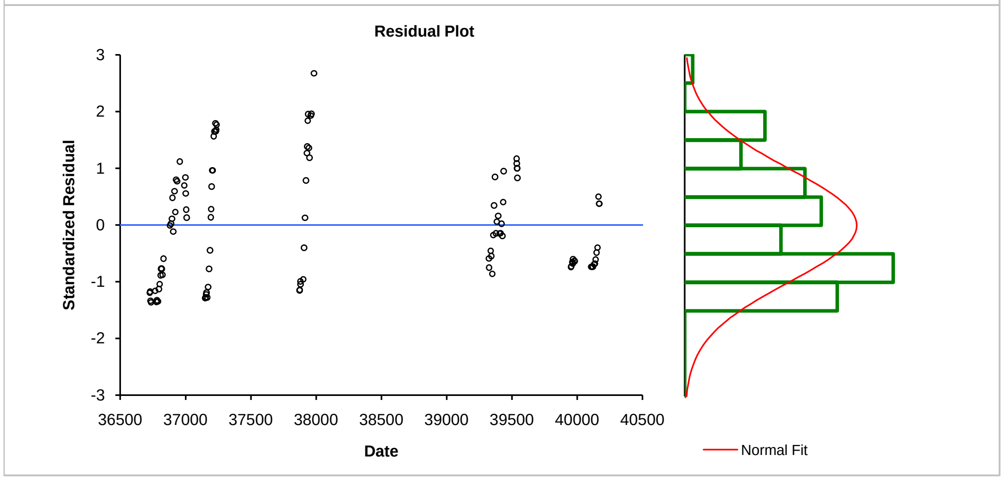
n 107 (cases excluded: 31 due to missing values)

R^2	0.05
Adjusted R^2	0.04
SE	1.1702

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	9.601	2.849 to 16.354	3.4053	2.82	105	0.0057
Slope	-0.0002176	-0.0003945 to -0.0000407	0.00008920	-2.44	105	0.0164

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	8.1485	1	8.1485	5.95	0.0164
Residual	143.7840	105	1.3694		
Total	151.9325	106			





Test	**Regression - Linear**
	MW 18 v Date Ammonia
Performed by	h6theres

Date 9 December 2010

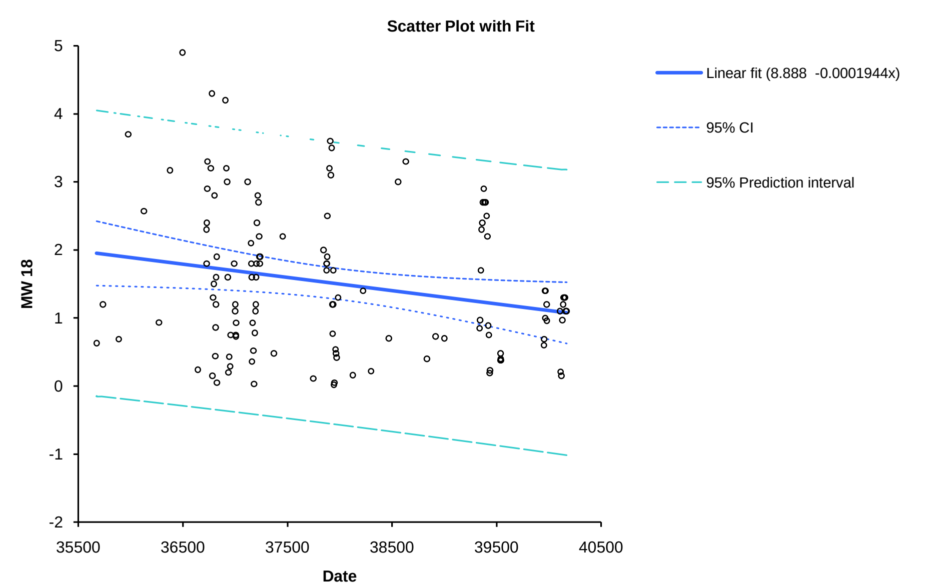
Analyse-it v2.09

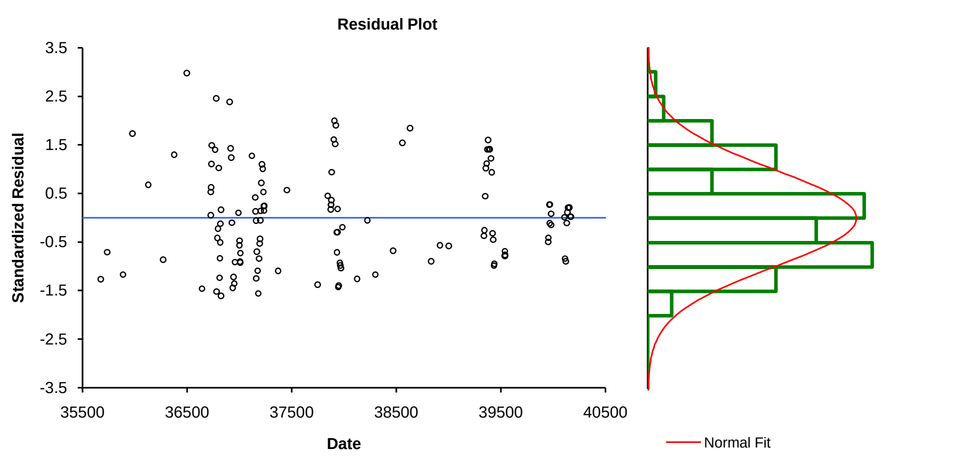
n	130	(cases excluded: 8 due to missing values)

R^2	0.05
Adjusted R^2	0.05
SE	1.0429

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	8.888	3.456 to 14.319	2.7452	3.24	128	0.0015
Slope	-0.0001944	-0.0003373 to -0.0000516	0.00007221	-2.69	128	0.0080

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	7.8860	1	7.8860	7.25	0.0080
Residual	139.2223	128	1.0877		
Total	147.1084	129			





Analyse-it v2.09

Test	**Regression - Linear**
	MW 19 v Date Ammonia
Performed by	h6theres

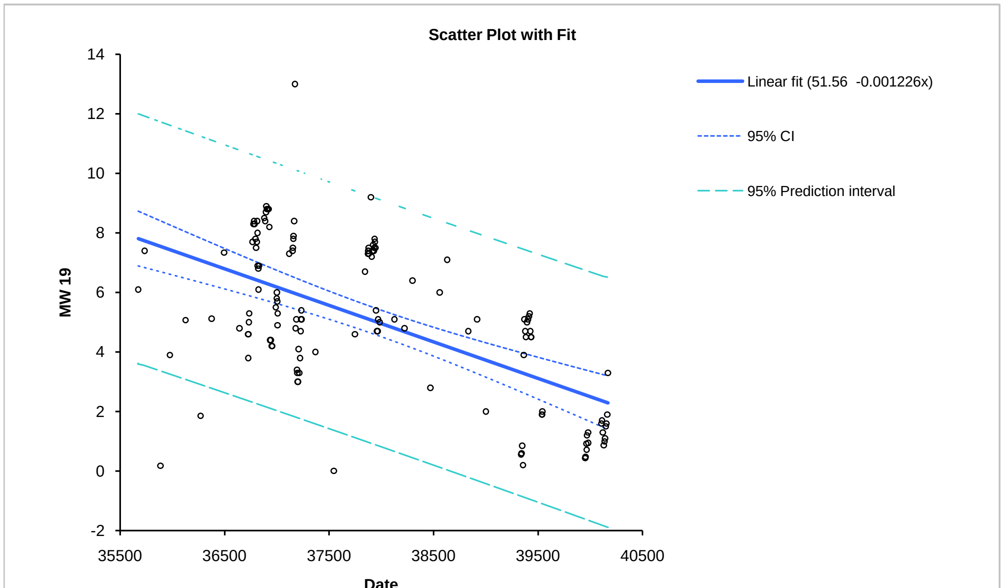
Date 9 December 2010

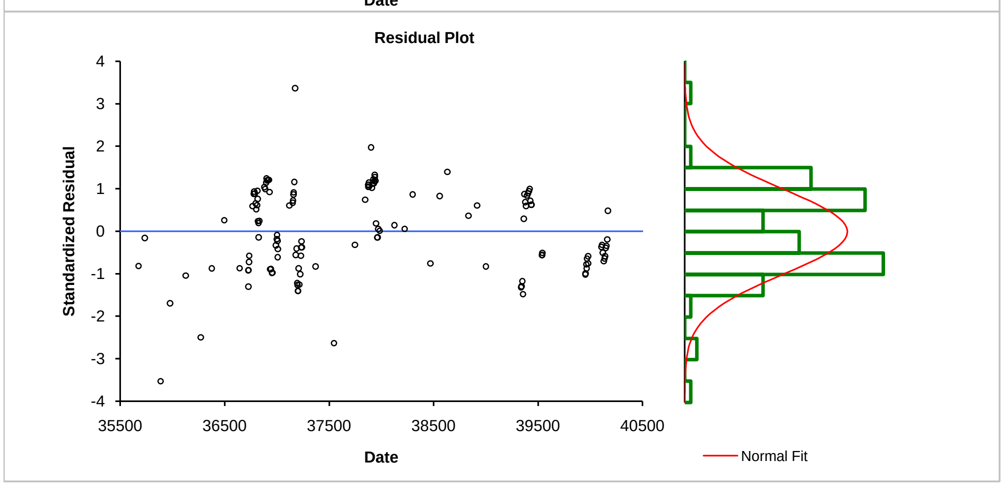
n	135	(cases excluded: 3 due to missing values)

R^2	0.36
Adjusted R^2	0.35
SE	2.0879

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	51.56	40.85 to 62.27	5.413	9.52	133	<0.0001
Slope	-0.001226	-0.001508 to -0.000944	0.0001425	-8.60	133	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	322.6729	1	322.6729	74.02	<0.0001
Residual	579.7677	133	4.3592		
Total	902.4406	134			





Analyse-it v2.09

Test	**Regression - Linear**
	MW 20 v Date Ammonia
Performed by	h6theres

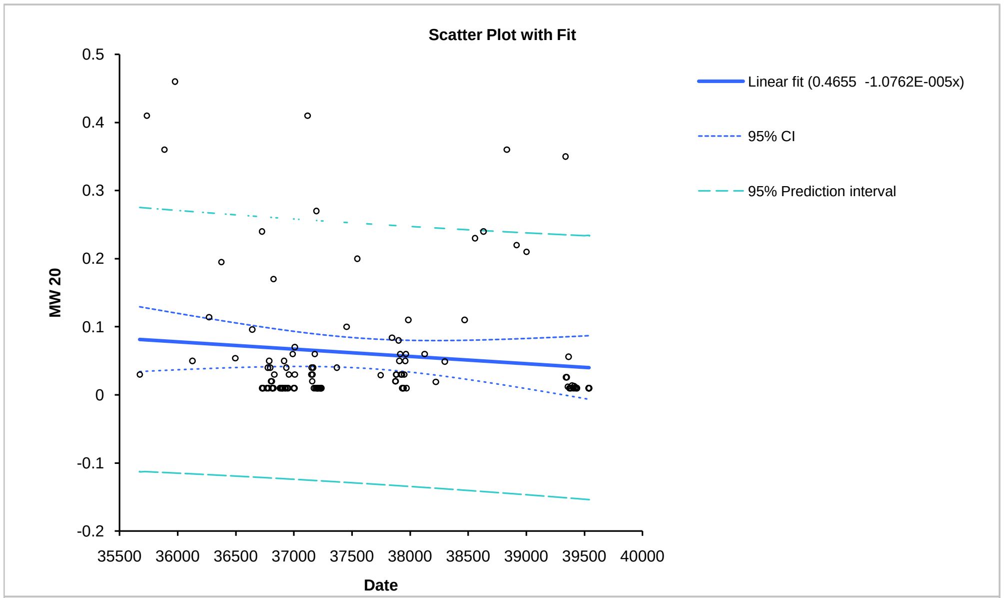
Date 9 December 2010

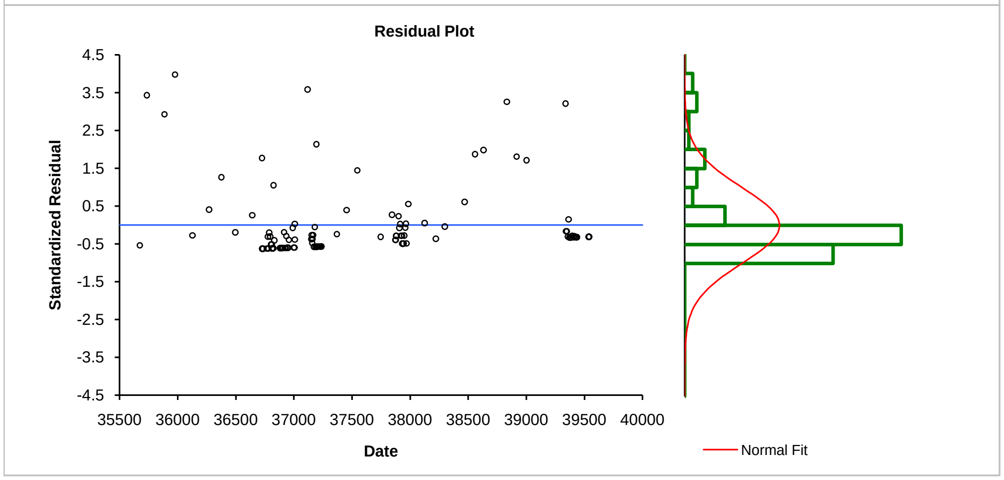
n	118	(cases excluded: 20 due to missing values)

R^2	0.01
Adjusted R^2	0.00
SE	0.0959

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.4655	-0.1835 to 1.1145	0.32768	1.42	116	0.1581
Slope	-1.0762E-05	-2.8004E-05 to 6.4799E-06	8.7052E-006	-1.24	116	0.2189

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0141	1	0.0141	1.53	0.2189
Residual	1.0668	116	0.0092		
Total	1.0808	117			





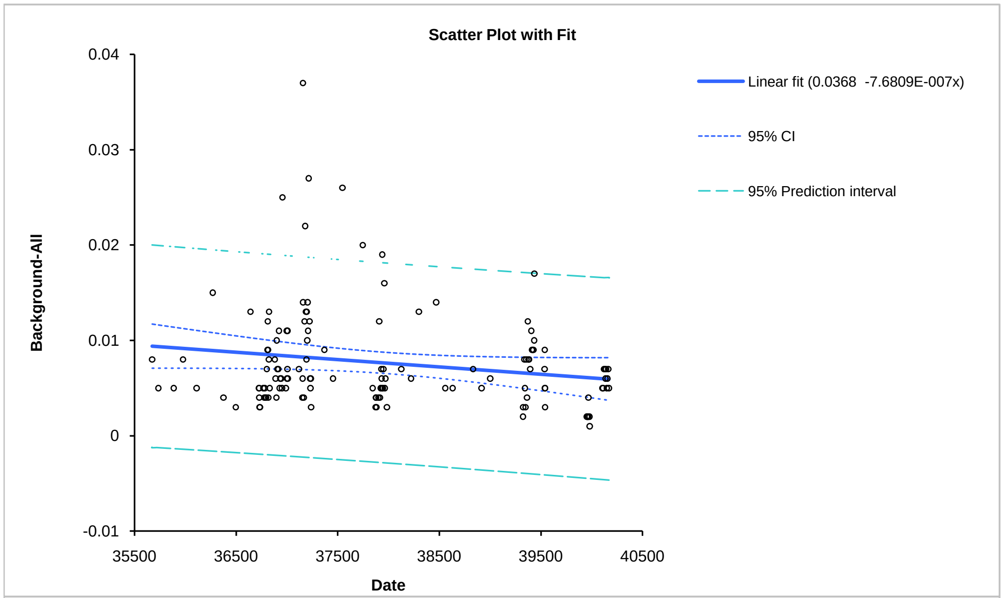
Analyse-it v2.09

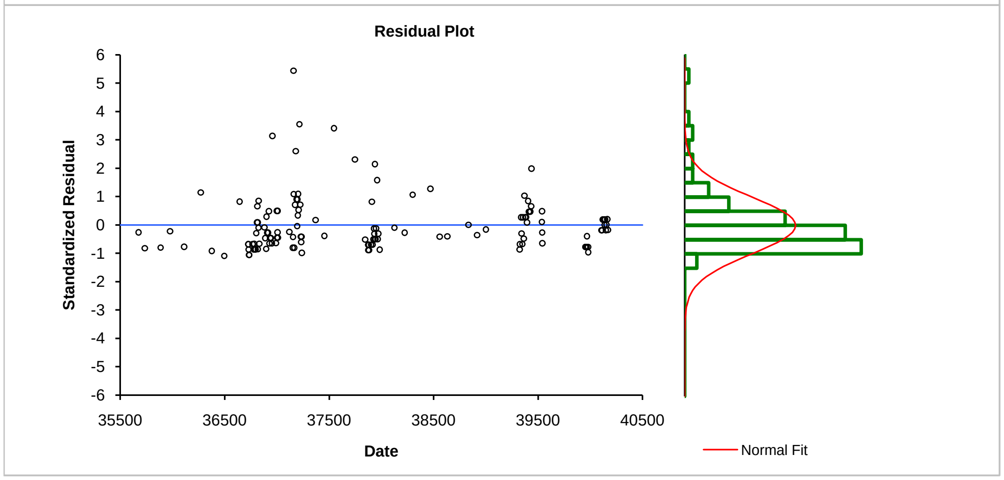
Test	Regression - Linear	Manganese
	Background-All v Date	
Performed by	h6theres	Date 14 December 2010

n	138
R^2	0.03
Adjusted R^2	0.03
SE	0.0053

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.0368	0.0099 to 0.0637	0.01358	2.71	136	0.0076
Slope	-7.6809E-07	-1.4749E-06 -6.13E-08	3.5742E-007	-2.15	136	0.0334

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0001	1	0.0001	4.62	0.0334
Residual	0.0038	136	0.0000		
Total	0.0039	137			





Test	**Regression - Linear**	Manganese
	Near CDF - Routine v Date	
Performed by	h6theres	Date 14 December 2010

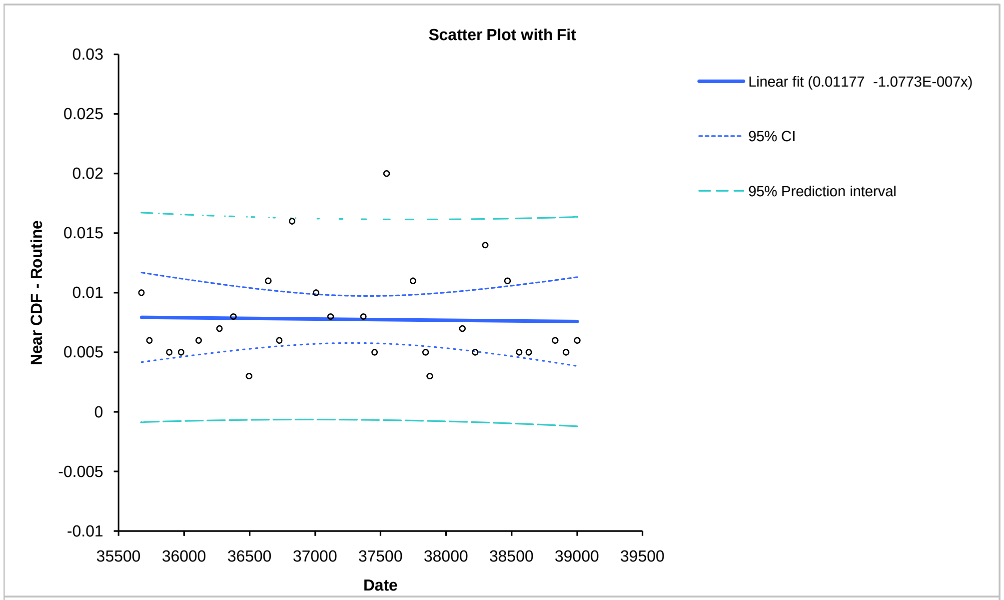
Analyse-it v2.09

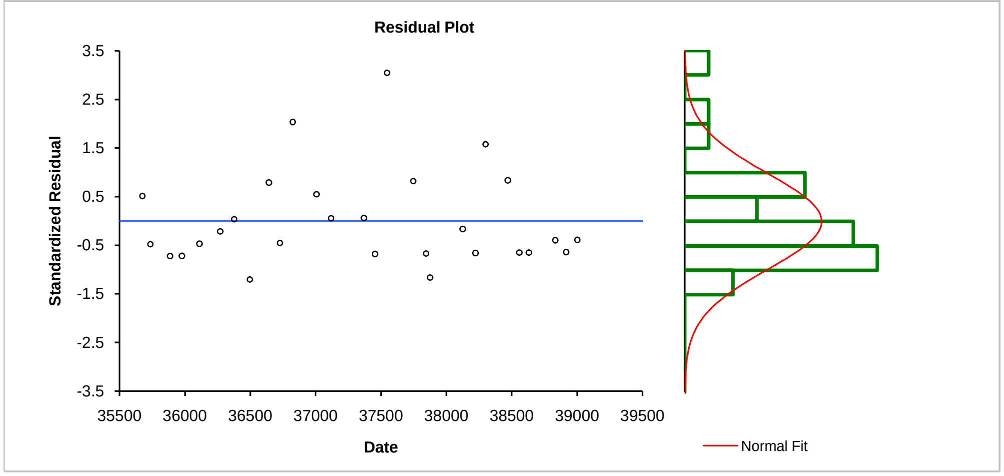
n	28 (cases excluded: 110 due to missing values)

R^2	0.00
Adjusted R^2	-0.04
SE	0.0040

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.01177	-0.04475 to 0.06830	0.027500	0.43	26	0.6721
Slope	-1.0773E-07	-1.6207E-06 to 1.4052E-06	7.3604E-007	-0.15	26	0.8848

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0000	1	0.0000	0.02	0.8848
Residual	0.0004	26	0.0000		
Total	0.0004	27			





Analyse-it v2.09

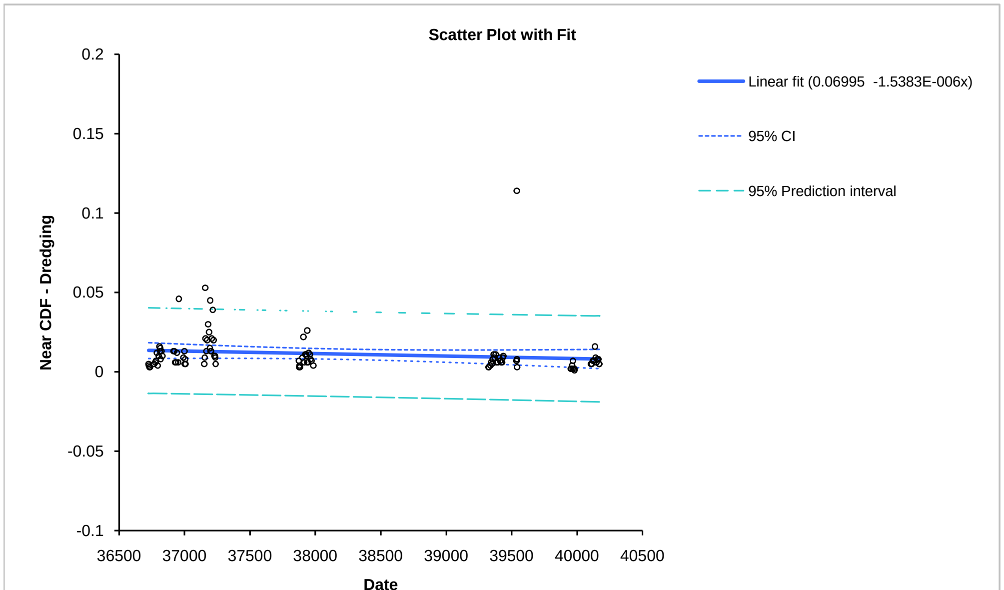
Test	Regression - Linear	Manganese		
	Near CDF - Dredging v Date			
Performed by	h6theres		Date	14 December 2010

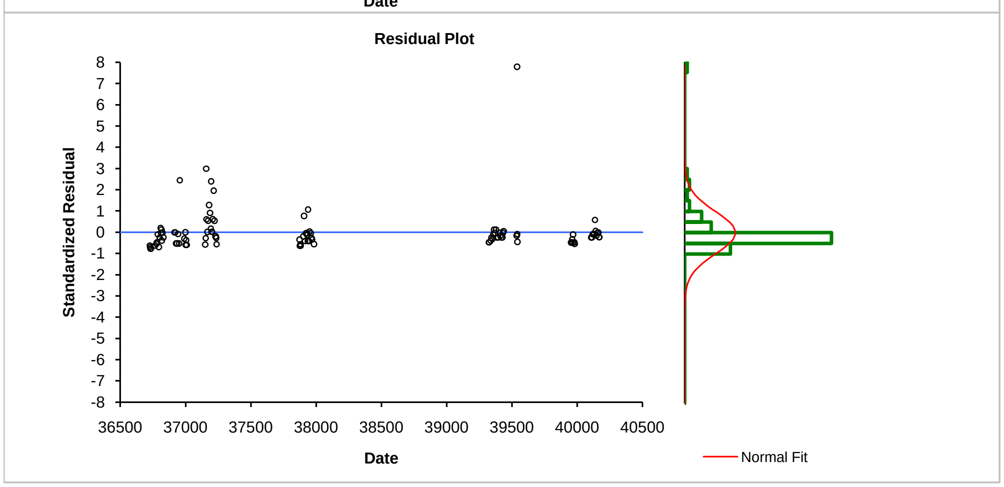
n	105	(cases excluded: 33 due to missing values)

R^2	0.02
Adjusted R^2	0.01
SE	0.0135

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.06995	-0.00896 to 0.14887	0.039792	1.76	103	0.0817
Slope	-1.5383E-06	-3.6036E-06 to 5.2712E-07	1.0414E-006	-1.48	103	0.1427

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0004	1	0.0004	2.18	0.1427
Residual	0.0187	103	0.0002		
Total	0.0190	104			





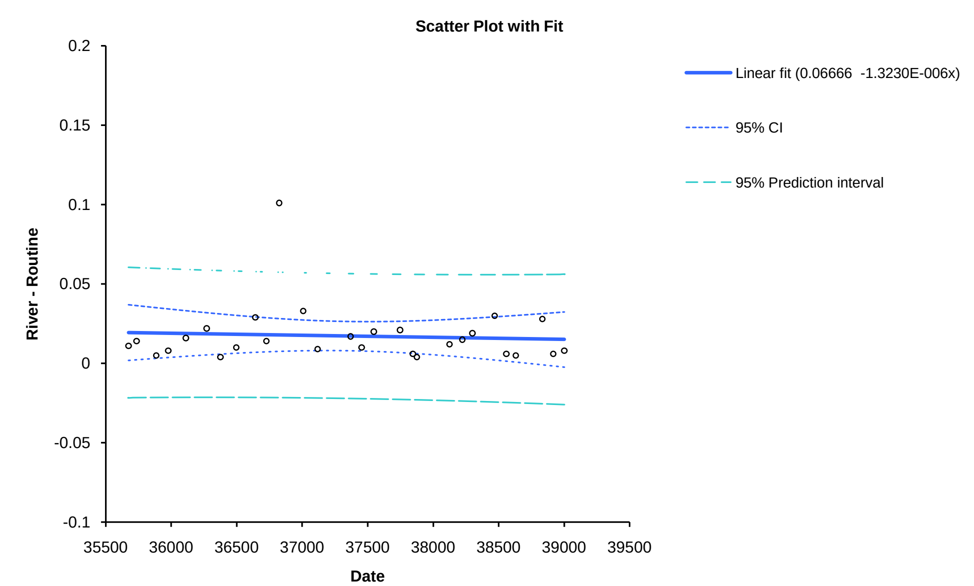
Test	**Regression - Linear**	Manganese
	River - Routine v Date	
Performed by	h6theres	Date: 14 December 2010

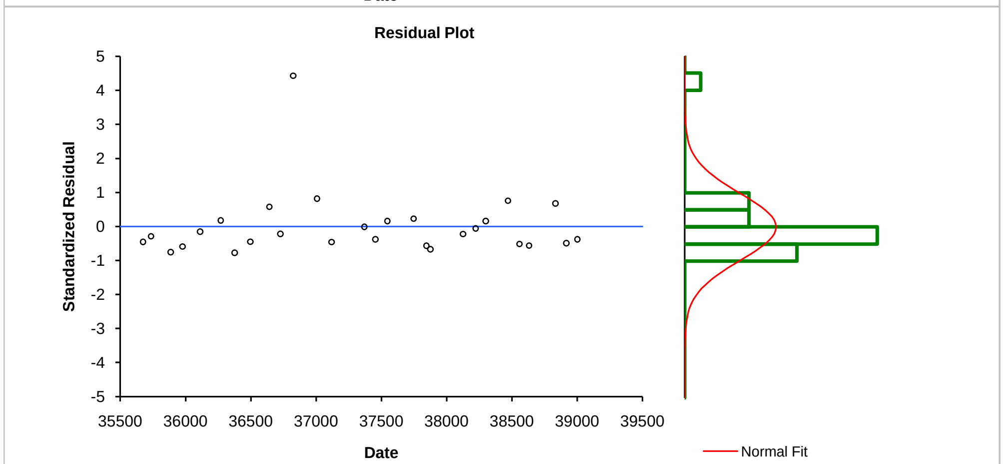
n 28 (cases excluded: 110 due to missing values)

R^2	0.01
Adjusted R^2	-0.03
SE	0.0188

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.06666	-0.19679 to 0.33011	0.128168	0.52	26	0.6074
Slope	-1.3230E-06	-8.3744E-06 to 5.7284E-06	3.4304E-006	-0.39	26	0.7029

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0001	1	0.0001	0.15	0.7029
Residual	0.0091	26	0.0004		
Total	0.0092	27			





Analyse-it v2.09

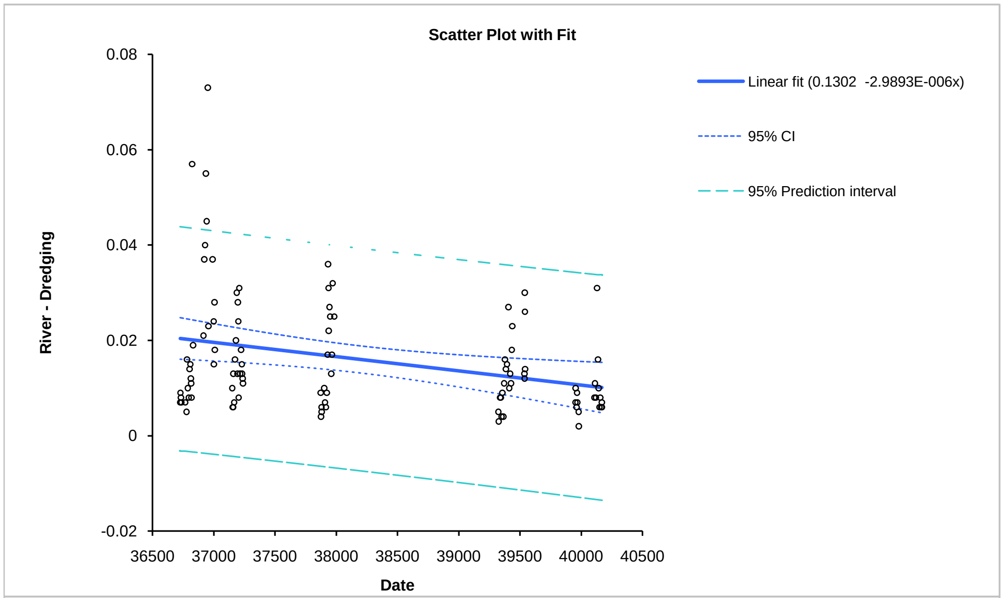
Test	**Regression - Linear**	Manganese		
	River - Dredging v Date			
Performed by	h6theres		Date	14 December 2010

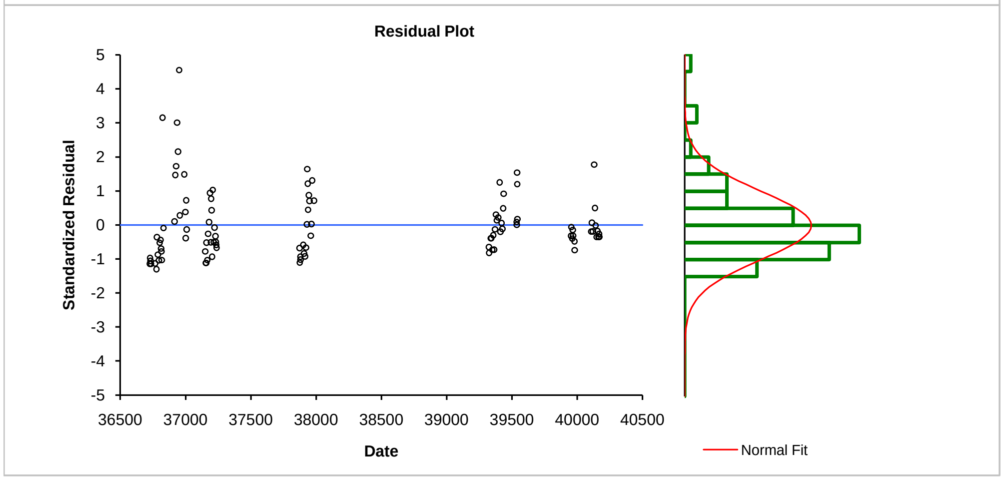
n | 105 (cases excluded: 33 due to missing values)

R^2	0.10
Adjusted R^2	0.09
SE	0.0117

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.1302	0.0615 to 0.1988	0.03462	3.76	103	0.0003
Slope	-2.9893E-06	-4.7861E-06 -1.19E-06	9.0599E-007	-3.30	103	0.0013

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0015	1	0.0015	10.89	0.0013
Residual	0.0141	103	0.0001		
Total	0.0156	104			





Test	**Regression - Linear**	Manganese	
Performed by	In CDF - Routine v Date h6theres	Date	14 December 2010

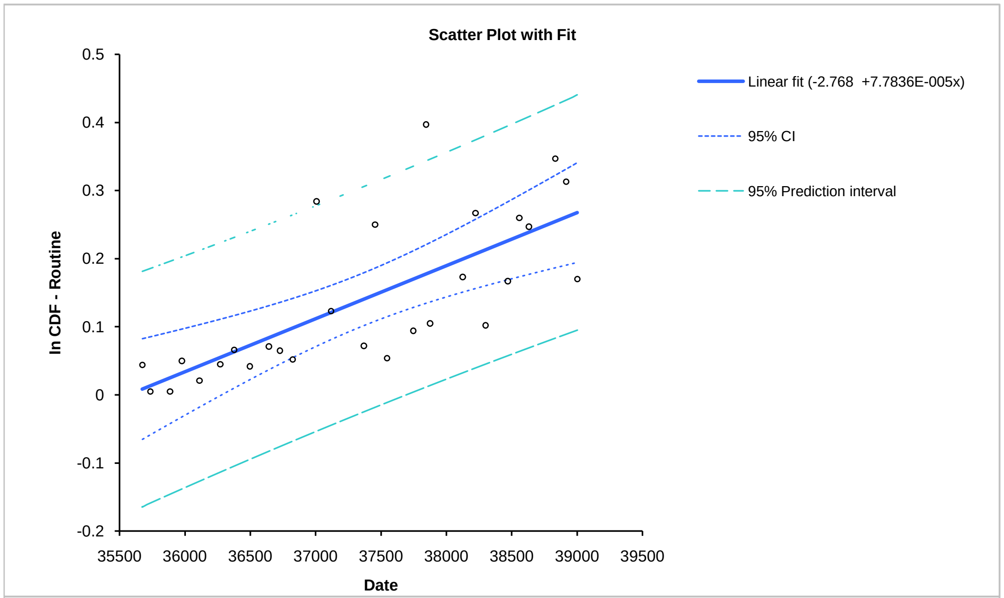
Analyse-it v2.09

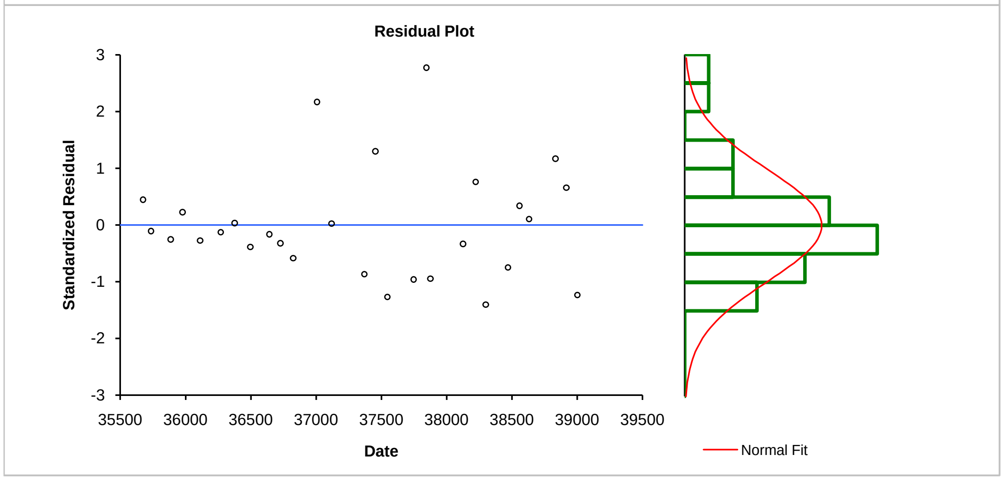
n	28	(cases excluded: 110 due to missing values)

R^2	0.53
Adjusted R^2	0.51
SE	0.0791

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-2.768	-3.879 to -1.657	0.5404	-5.12	26	<0.0001
Slope	7.7836E-05	4.8104E-05 to 1.0757E-04	1.4464E-005	5.38	26	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.1810	1	0.1810	28.96	<0.0001
Residual	0.1625	26	0.0063		
Total	0.3436	27			





Analyse-it v2.09

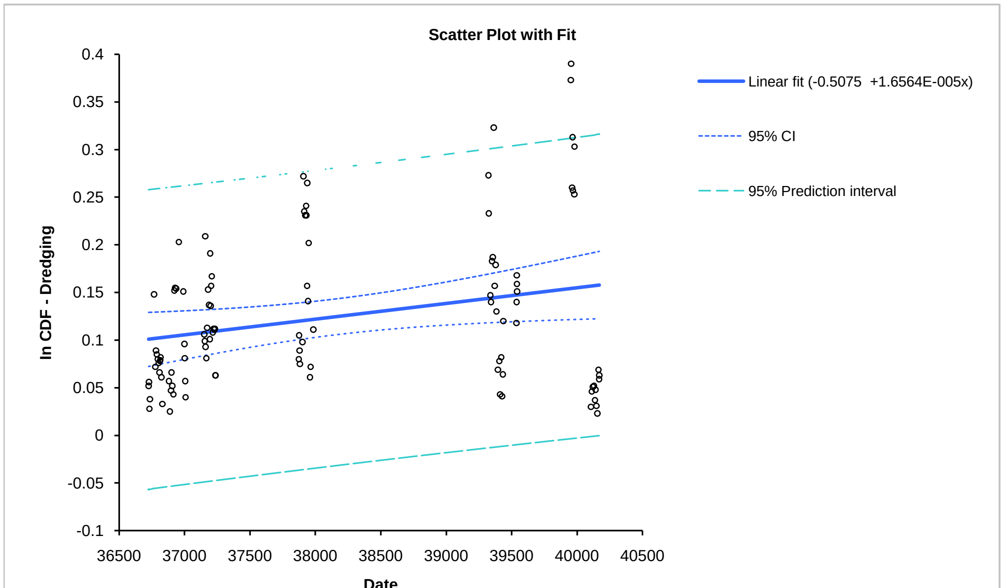
Test	**Regression - Linear**	Manganese	
	ln CDF - Dredging v Date		
Performed by	h6theres	Date	14 December 2010

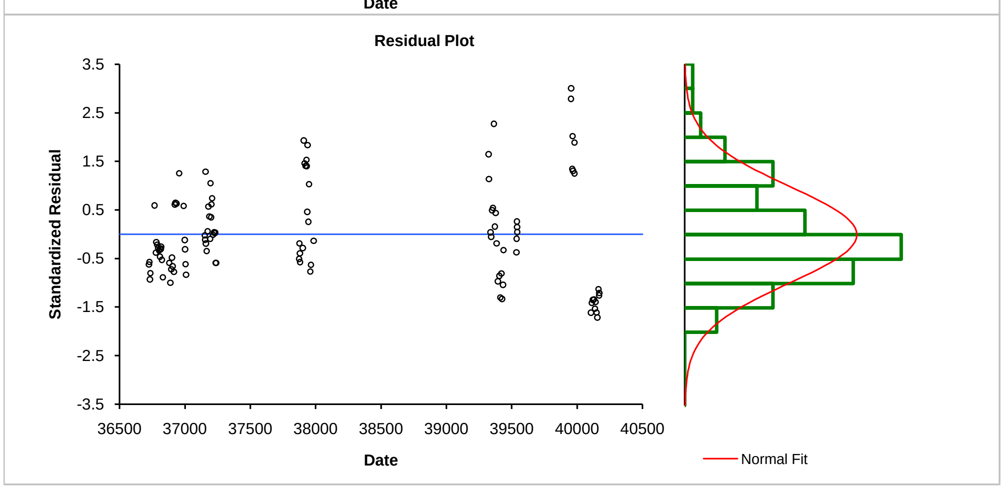
n 107 (cases excluded: 31 due to missing values)

R^2	0.07
Adjusted R^2	0.06
SE	0.0784

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.5075	-0.9601 to -0.0548	0.22829	-2.22	105	0.0284
Slope	1.6564E-05	4.7065E-06 to 2.8421E-05	5.9800E-006	2.77	105	0.0066

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0472	1	0.0472	7.67	0.0066
Residual	0.6462	105	0.0062		
Total	0.6934	106			





Analyse-it v2.09

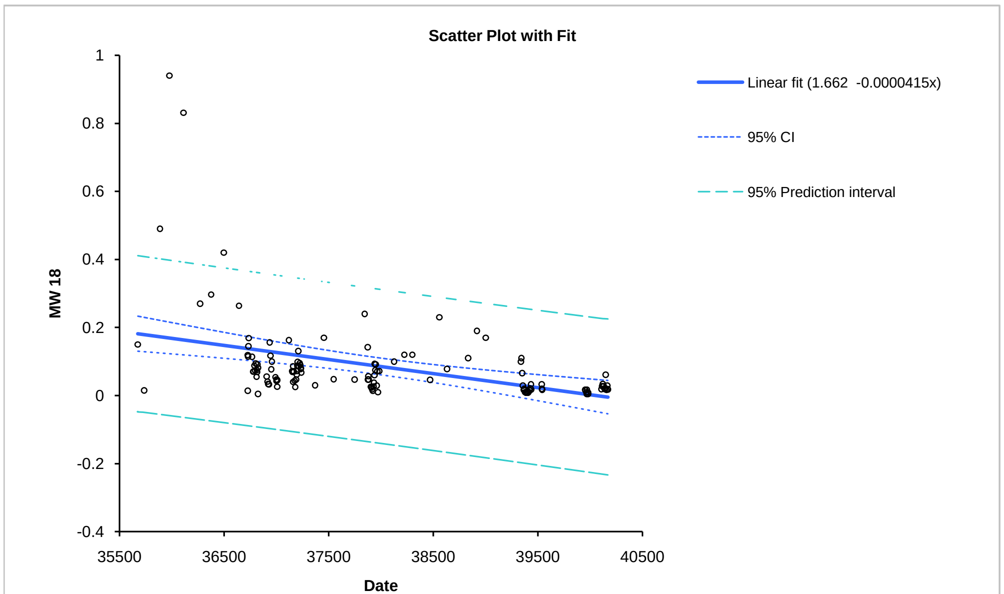
Test	**Regression - Linear**	Manganese
	MW 18 v Date	
Performed by	h6theres	Date: 14 December 2010

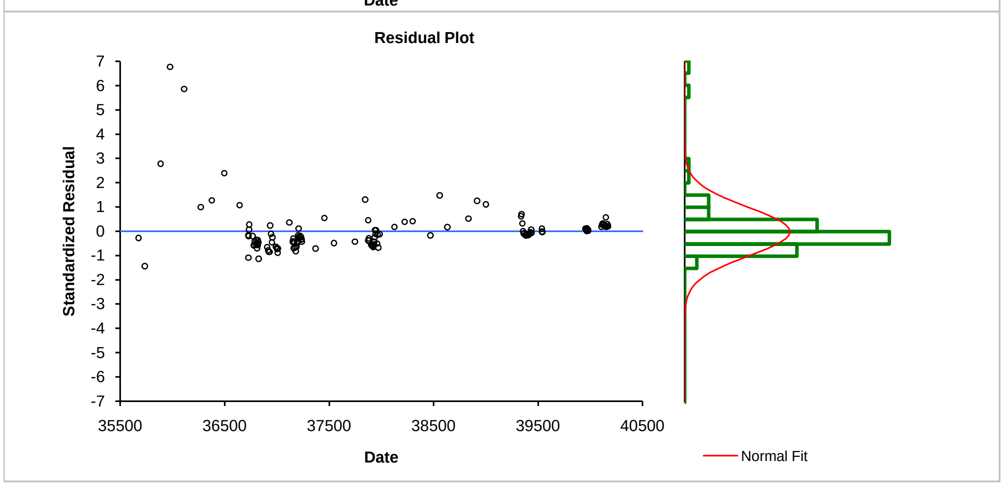
n: 131 (cases excluded: 7 due to missing values)

R^2	0.18
Adjusted R^2	0.17
SE	0.1139

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	1.662	1.070 to 2.255	0.2996	5.55	129	<0.0001
Slope	-0.0000415	-0.0000571 to -0.0000259	0.00000788	-5.27	129	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.3597	1	0.3597	27.74	<0.0001
Residual	1.6731	129	0.0130		
Total	2.0329	130			





Analyse-it v2.09

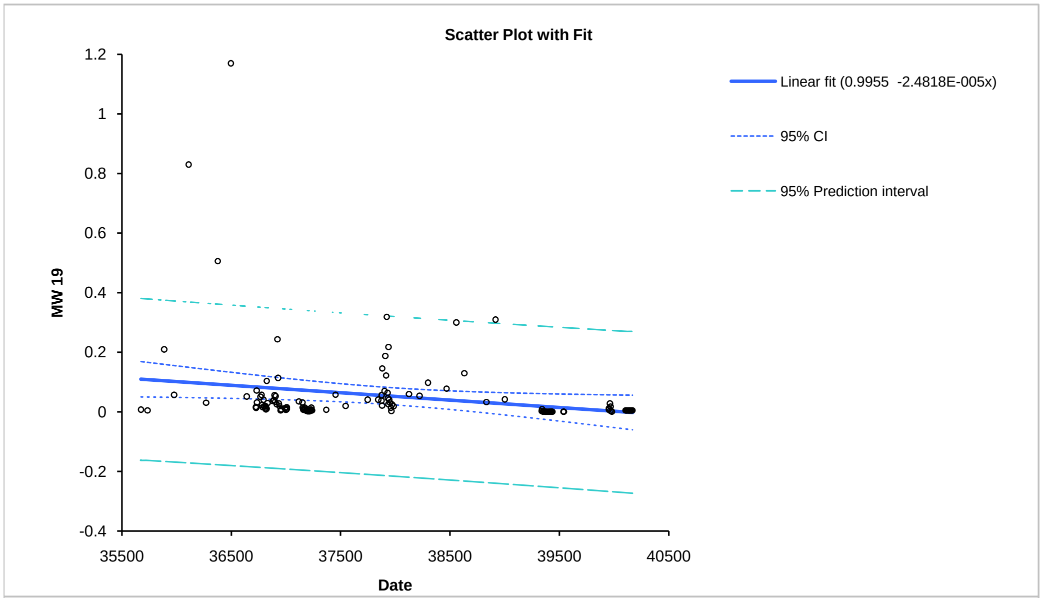
Test	Regression - Linear	Manganese
	MW 19 v Date	
Performed by	h6theres	Date 14 December 2010

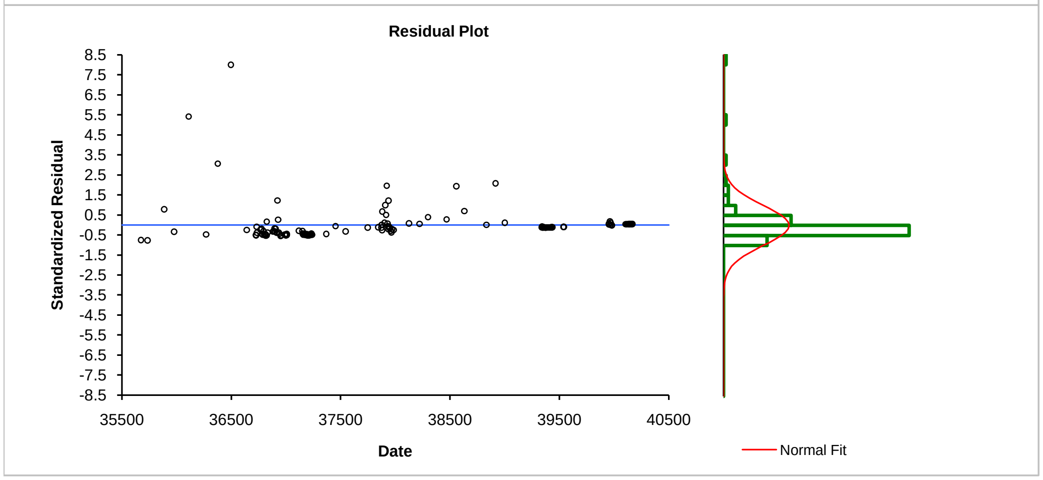
n 136 (cases excluded: 2 due to missing values)

R^2	0.05
Adjusted R^2	0.04
SE	0.1350

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.9955	0.3040 to 1.6870	0.34964	2.85	134	0.0051
Slope	-2.4818E-05	-4.3029E-05 to -6.6075E-06	9.2076E-006	-2.70	134	0.0079

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.1323	1	0.1323	7.27	0.0079
Residual	2.4407	134	0.0182		
Total	2.5731	135			





Analyse-it v2.09

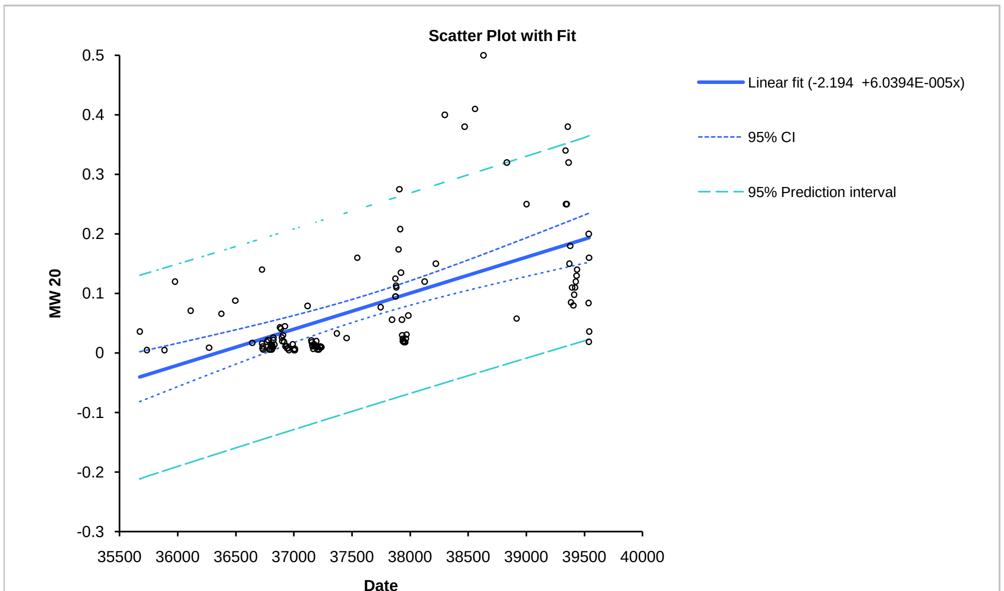
Test	Regression - Linear	Manganese
	MW 20 v Date	
Performed by	h6theres	Date 14 December 2010

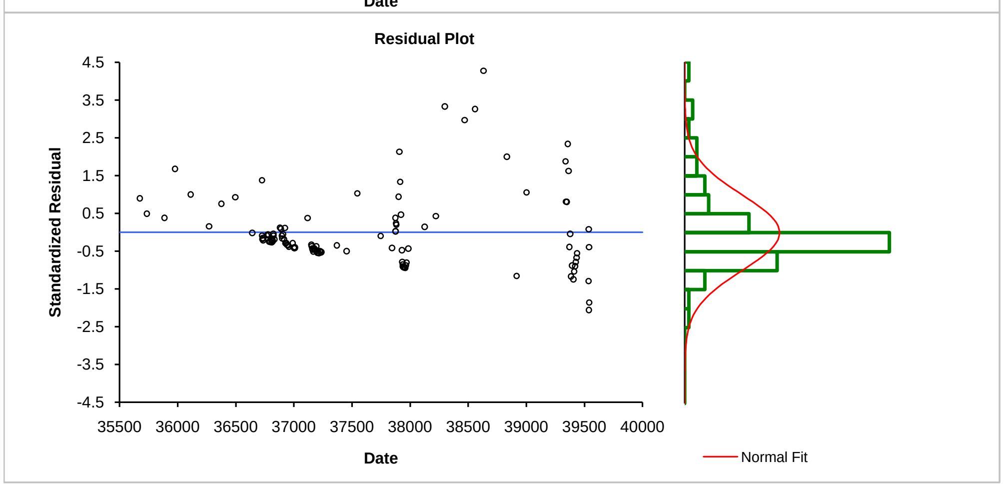
n 118 (cases excluded: 20 due to missing values)

R^2	0.35
Adjusted R^2	0.34
SE	0.0845

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-2.194	-2.767 to -1.622	0.2888	-7.60	116	<0.0001
Slope	6.0394E-05	4.5196E-05 to 7.5593E-05	7.6735E-006	7.87	116	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.4428	1	0.4428	61.95	<0.0001
Residual	0.8292	116	0.0071		
Total	1.2720	117			





Analyse-it v2.09

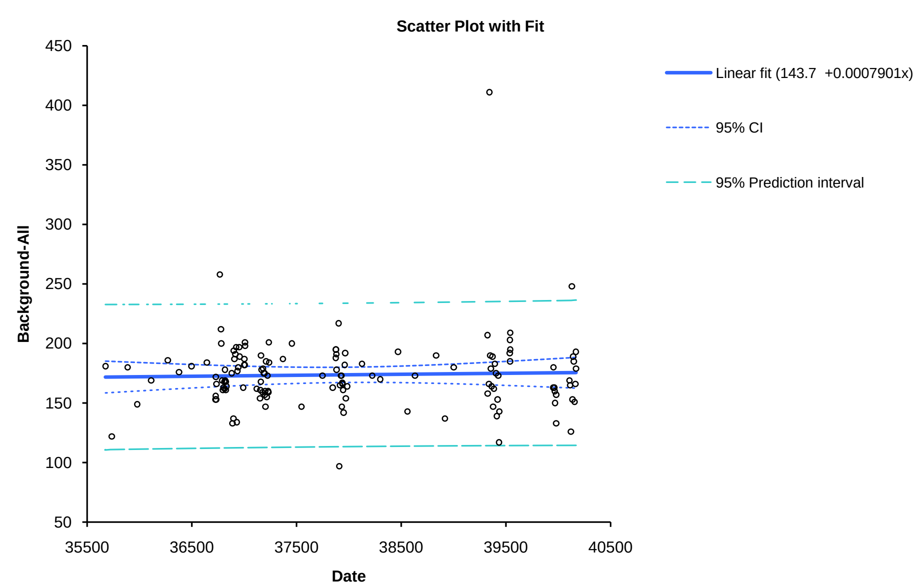
Test	**Regression - Linear**	TDS	
	Background-All v Date		
Performed by	h6theres	Date	17 December 2010

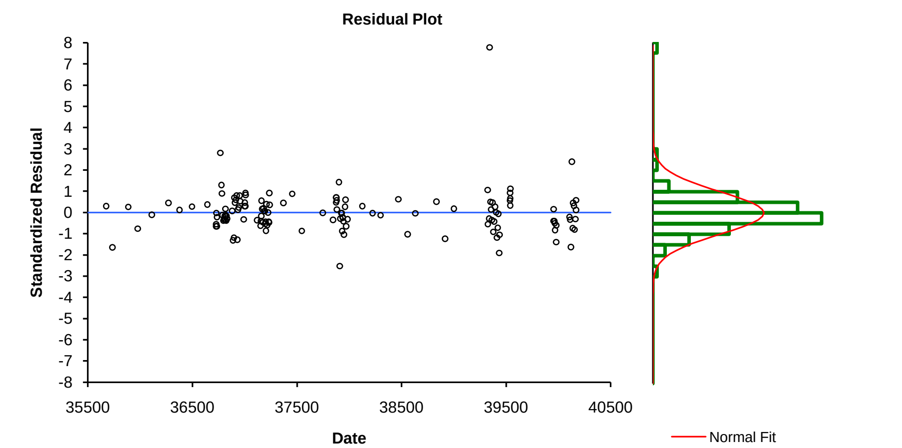
n	138

R^2	0.00
Adjusted R^2	-0.01
SE	30.3

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	143.7	-10.5 to 298.0	77.99	1.84	136	0.0675
Slope	0.0007901	-0.0032693 to 0.0048495	0.00205272	0.38	136	0.7009

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	136.4	1	136.4	0.15	0.7009
Residual	125246.2	136	920.9		
Total	125382.6	137			





Analyse-it v2.09

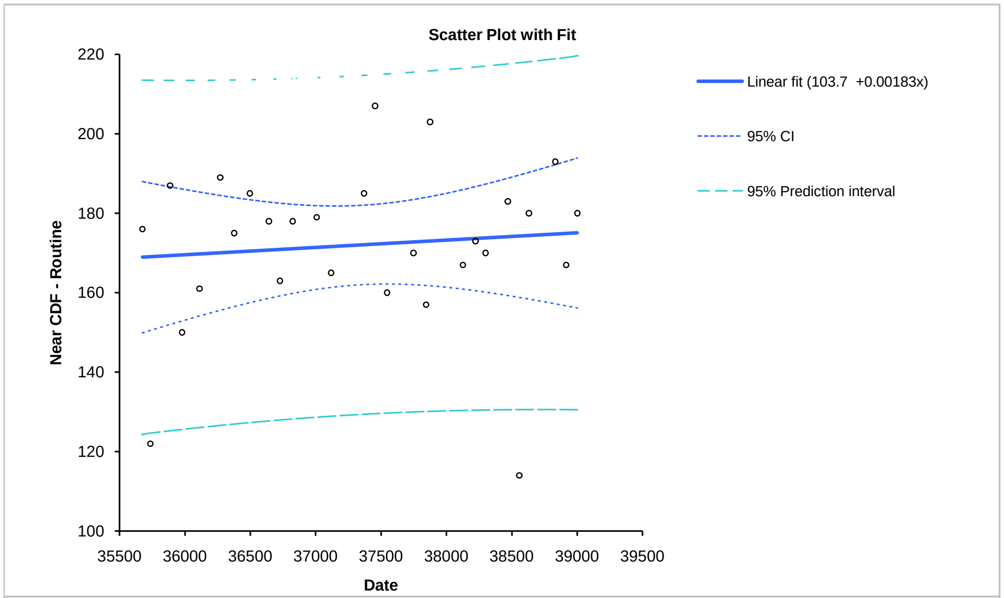
Test	**Regression - Linear**	TDS	
	Near CDF - Routine v Date		
Performed by	h6theres	Date	17 December 2010

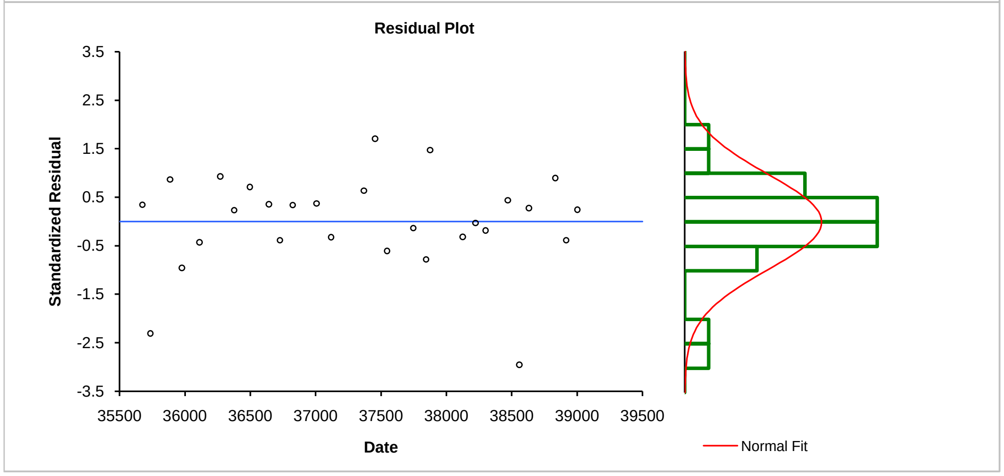
n | 28 (cases excluded: 110 due to missing values)

R^2	0.01
Adjusted R^2	-0.03
SE	20.4

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	103.7	-182.7 to 390.0	139.30	0.74	26	0.4634
Slope	0.00183	-0.00583 to 0.00949	0.003729	0.49	26	0.6276

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	100.1	1	100.1	0.24	0.6276
Residual	10800.9	26	415.4		
Total	10901.0	27			





Analyse-it v2.09

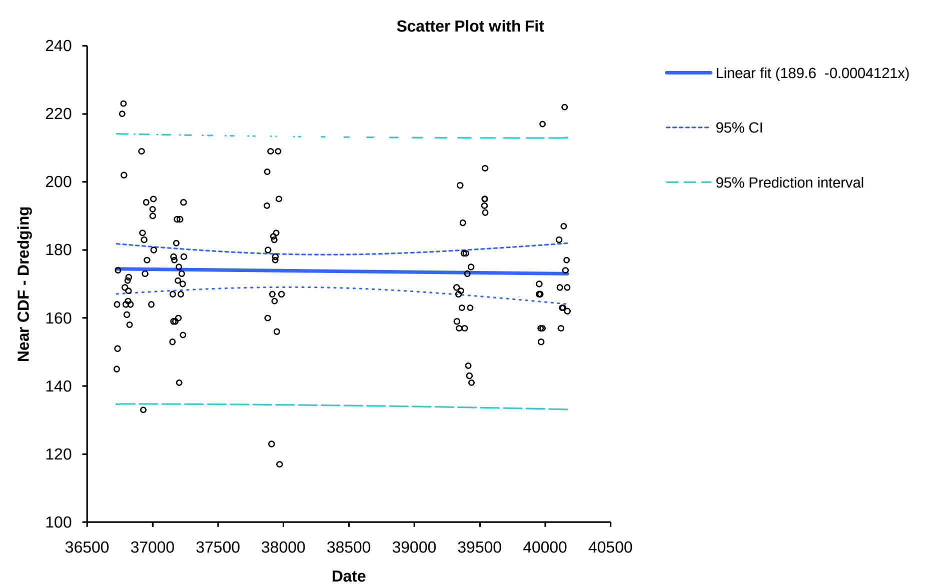
Test	**Regression - Linear** TDS
	Near CDF - Dredging v Date
Performed by	h6theres
Date	17 December 2010

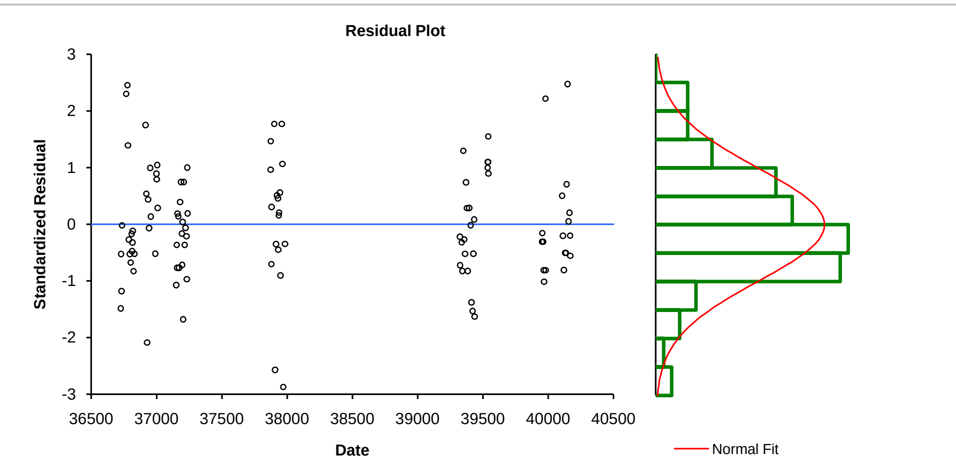
n	105 (cases excluded: 33 due to missing values)

R^2	0.00
Adjusted R^2	-0.01
SE	19.8

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	189.6	73.4 to 305.7	58.55	3.24	103	0.0016
Slope	-0.0004121	-0.0034510 to 0.0026268	0.00153228	-0.27	103	0.7885

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	28.4	1	28.4	0.07	0.7885
Residual	40380.6	103	392.0		
Total	40408.9	104			





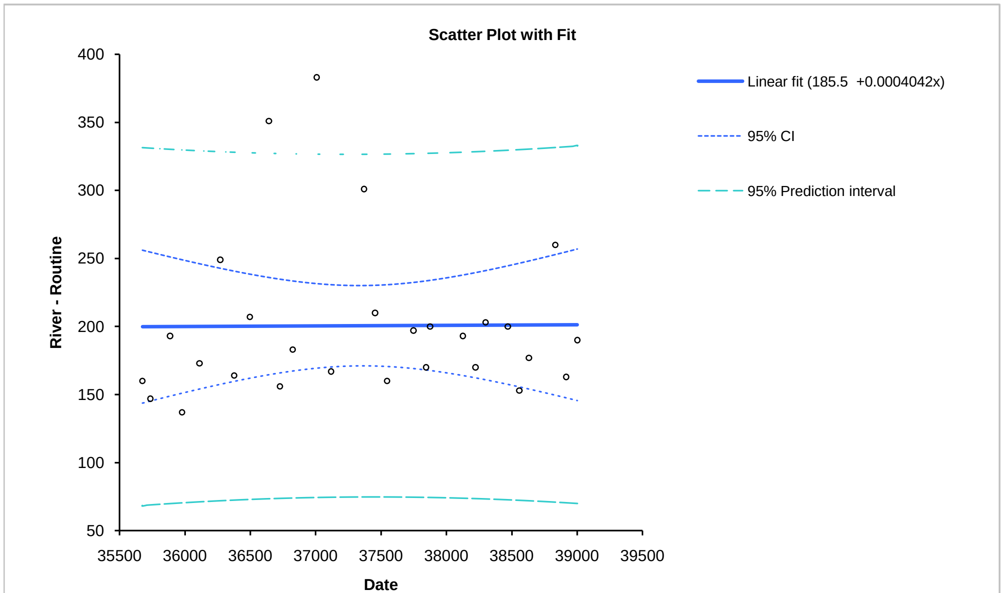
Test	**Regression - Linear**	TDS
	River - Routine v Date	
Performed by	h6theres	Date 17 December 2010

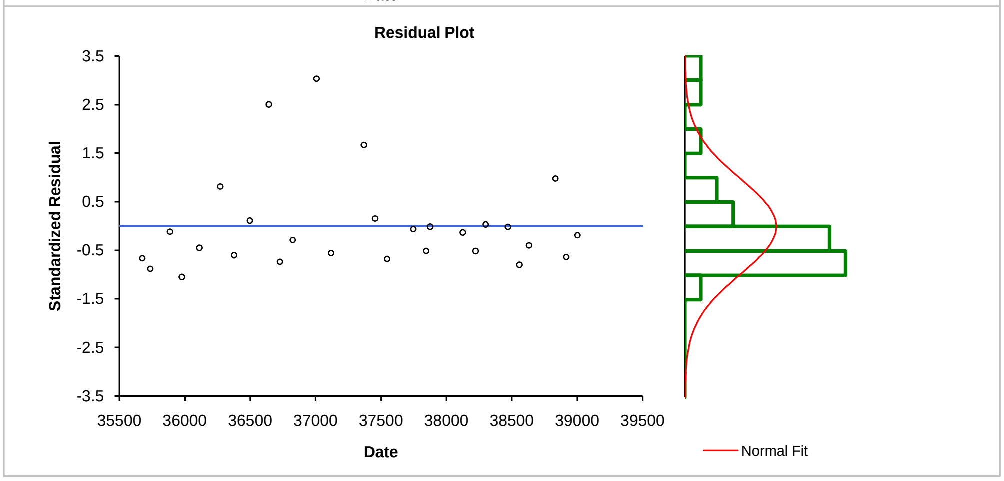
n	28	(cases excluded: 110 due to missing values)

R^2	0.00
Adjusted R^2	-0.04
SE	60.1

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	185.5	-659.5 to 1030.5	411.10	0.45	26	0.6556
Slope	0.0004042	-0.0222134 to 0.0230219	0.01100332	0.04	26	0.9710

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	4.9	1	4.9	0.00	0.9710
Residual	94065.8	26	3617.9		
Total	94070.7	27			





Analyse-it v2.09

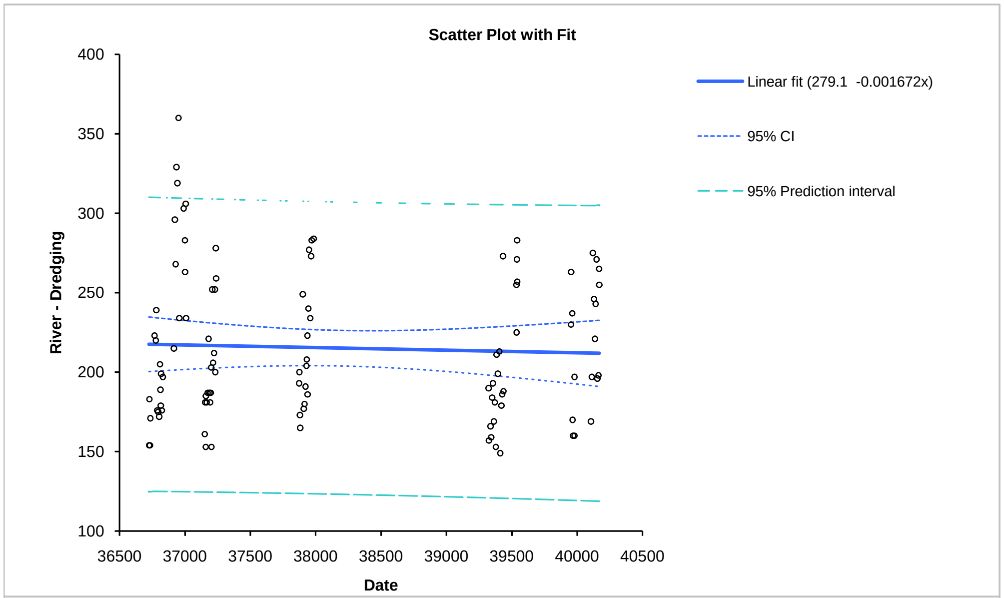
Test	Regression - Linear	TDS	
	River - Dredging v Date		
Performed by	h6theres	Date	17 December 2010

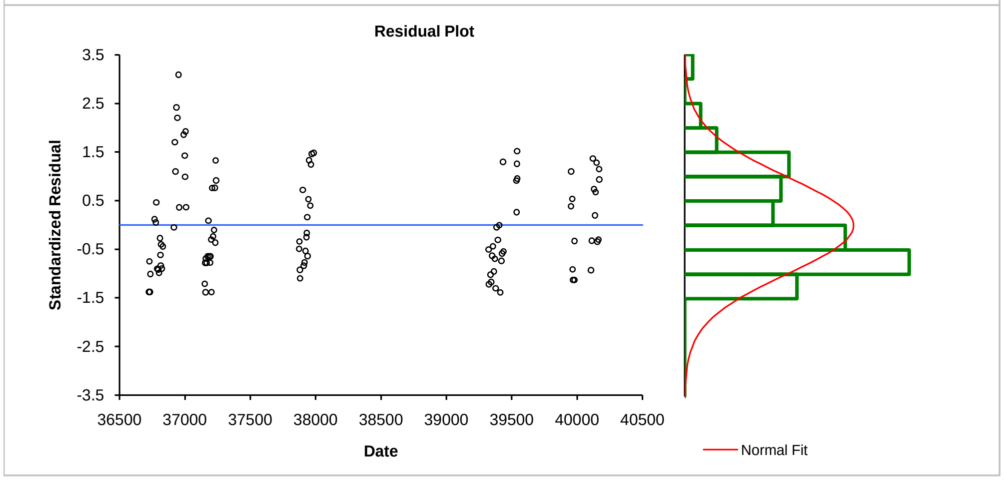
n 105 (cases excluded: 33 due to missing values)

R^2	0.00
Adjusted R^2	-0.01
SE	46.2

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	279.1	8.4 to 549.7	136.48	2.04	103	0.0434
Slope	-0.001672	-0.008756 to 0.005411	0.0035717	-0.47	103	0.6406

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	467.1	1	467.1	0.22	0.6406
Residual	219403.1	103	2130.1		
Total	219870.2	104			





Analyse-it v2.09

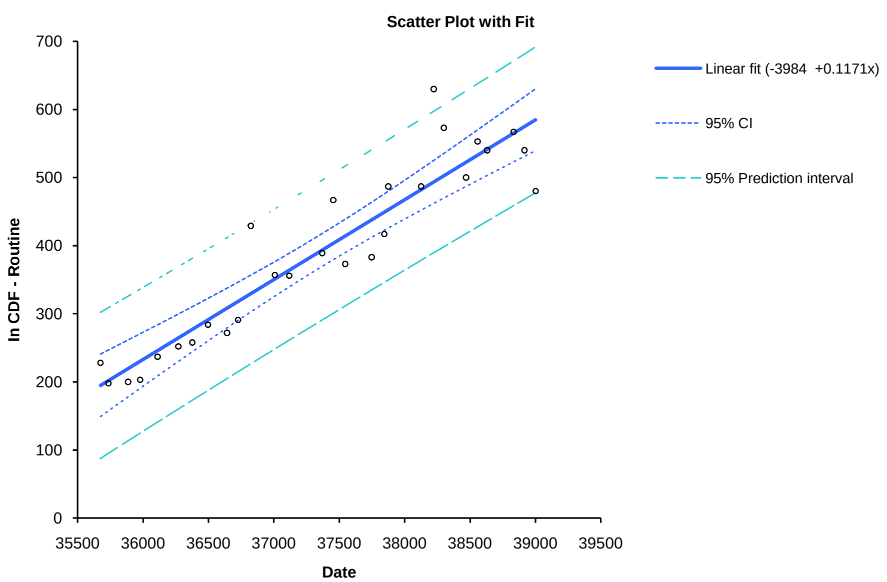
Test	**Regression - Linear**	TDS
	In CDF - Routine v Date	
Performed by	h6theres	Date 17 December 2010

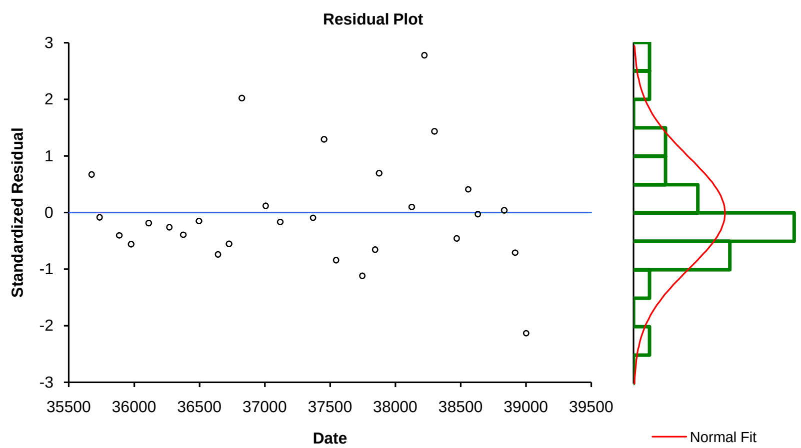
n 28 (cases excluded: 110 due to missing values)

R^2	0.87
Adjusted R^2	0.86
SE	49.1

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-3984	-4674 to -3295	335.5	-11.88	26	<0.0001
Slope	0.1171	0.0987 to 0.1356	0.00898	13.05	26	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	410104.1	1	410104.1	170.21	<0.0001
Residual	62644.6	26	2409.4		
Total	472748.7	27			





Analyse-it v2.09

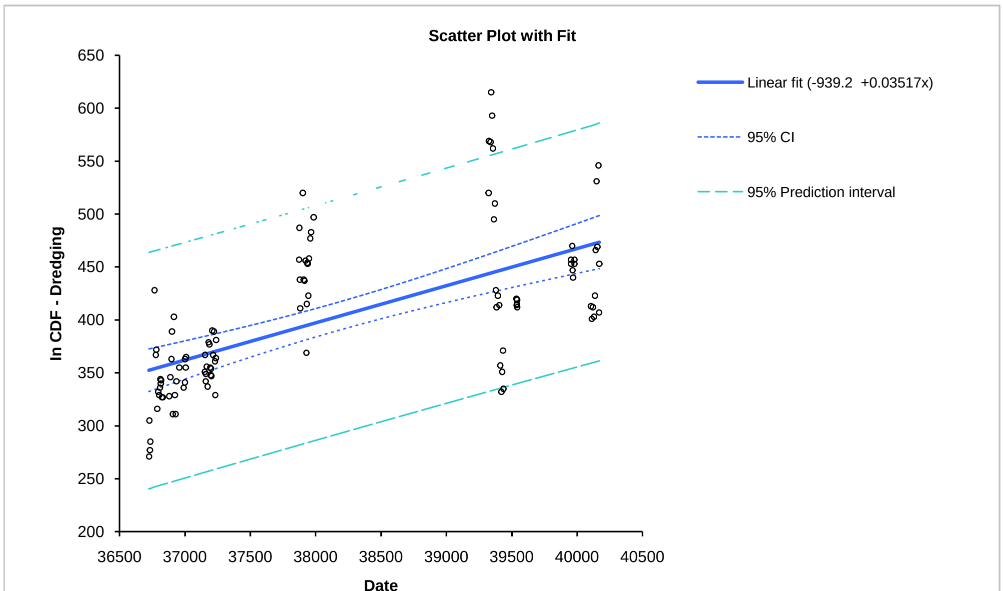
Test	**Regression - Linear**	TDS	
	ln CDF - Dredging v Date		
Performed by	h6theres	Date	17 December 2010

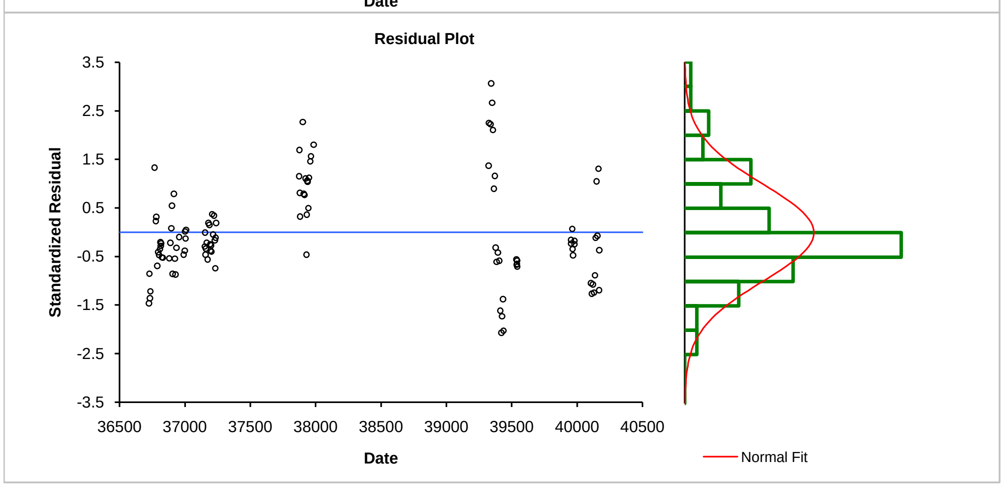
n 107 (cases excluded: 31 due to missing values)

R^2	0.40
Adjusted R^2	0.39
SE	55.6

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-939.2	-1260.1 to -618.2	161.88	-5.80	105	<0.0001
Slope	0.03517	0.02676 to 0.04358	0.004240	8.29	105	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	212867.7	1	212867.7	68.79	<0.0001
Residual	324913.1	105	3094.4		
Total	537780.8	106			





Analyse-it v2.09

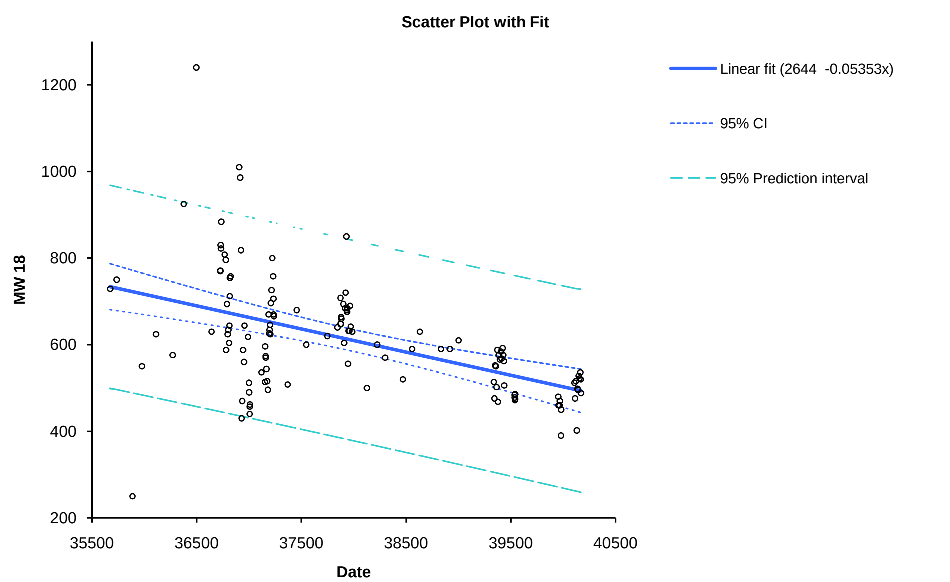
Test	Regression - Linear	TDS
	MW 18 v Date	
Performed by	h6theres	Date: 17 December 2010

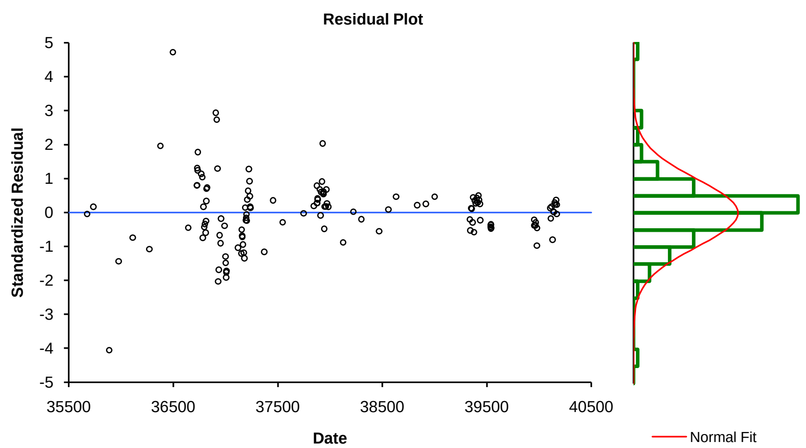
n 130 (cases excluded: 8 due to missing values)

R^2	0.26
Adjusted R^2	0.25
SE	116.4

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	2644	2035 to 3252	307.4	8.60	128	<0.0001
Slope	-0.05353	-0.06953 to -0.03753	0.008084	-6.62	128	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	594568.3	1	594568.3	43.85	<0.0001
Residual	1735702.6	128	13560.2		
Total	2330270.9	129			





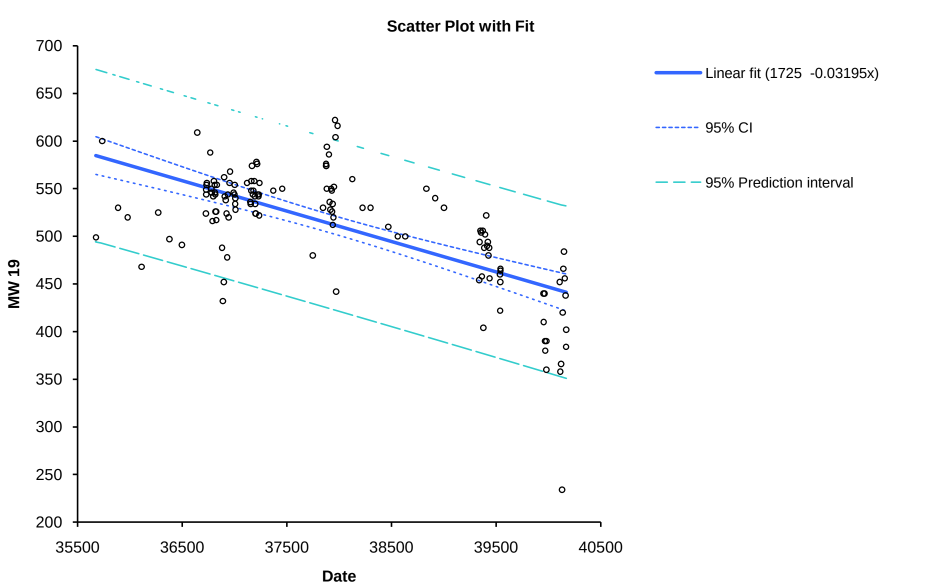
Test	**Regression - Linear**	TDS		
	MW 19 v Date			
Performed by	h6theres		Date	17 December 2010

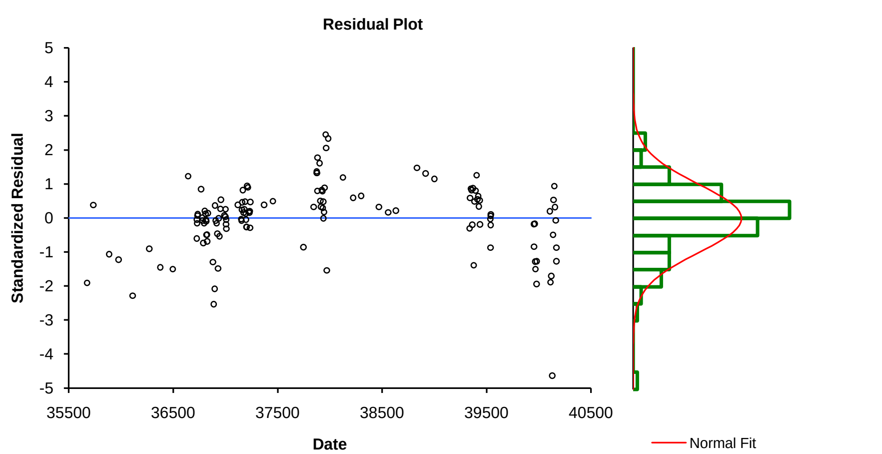
n	135	(cases excluded: 3 due to missing values)

R^2	0.45
Adjusted R^2	0.44
SE	45.0

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	1725	1494 to 1955	116.5	14.80	133	<0.0001
Slope	-0.03195	-0.03802 to -0.02588	0.003069	-10.41	133	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	219199.5	1	219199.5	108.41	<0.0001
Residual	268926.3	133	2022.0		
Total	488125.7	134			





Analyse-it v2.09

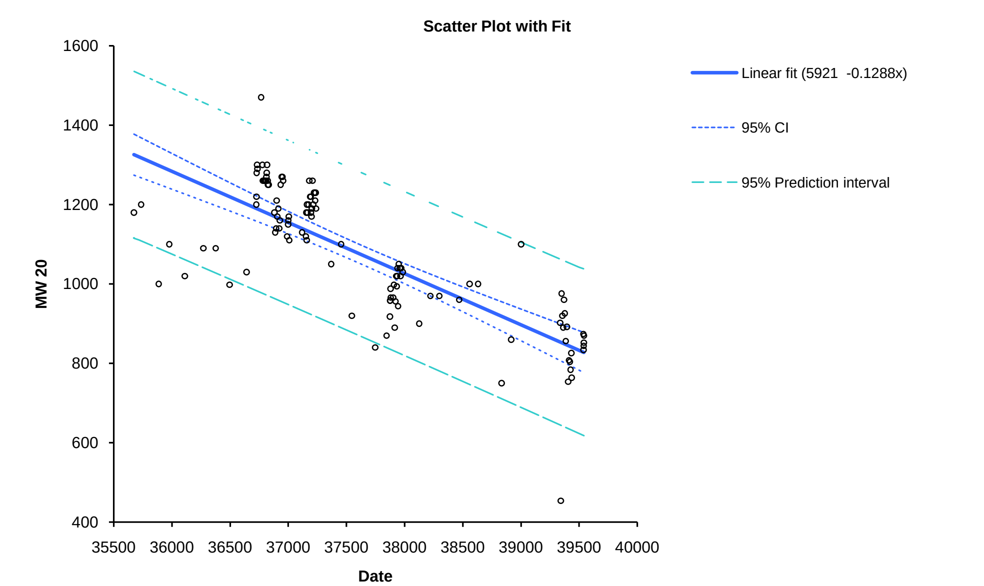
Test	**Regression - Linear**	TDS		
	MW 20 v Date			
Performed by	h6theres		Date	17 December 2010

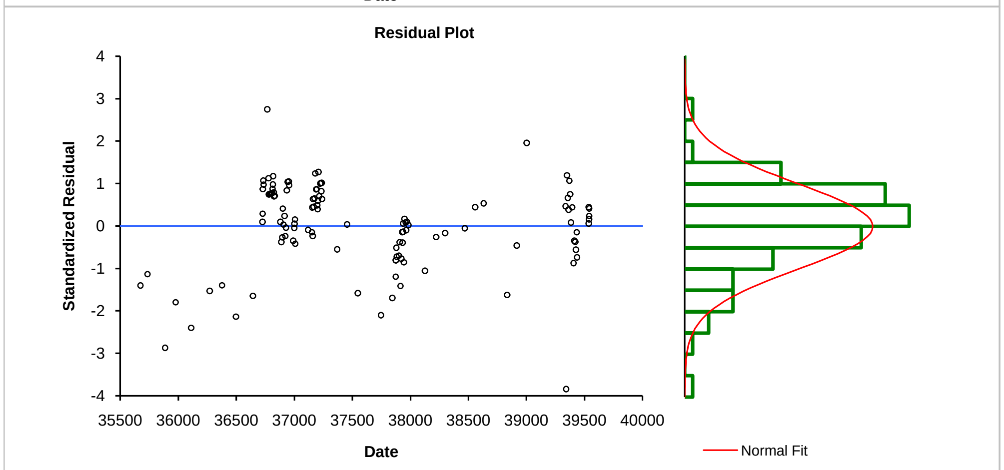
n	117 (cases excluded: 21 due to missing values)

R^2	0.62
Adjusted R^2	0.62
SE	103.7

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	5921	5218 to 6625	355.1	16.68	115	<0.0001
Slope	-0.1288	-0.1475 to -0.1101	0.00943	-13.66	115	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	2008476.0	1	2008476.0	186.60	<0.0001
Residual	1237784.9	115	10763.3		
Total	3246260.9	116			





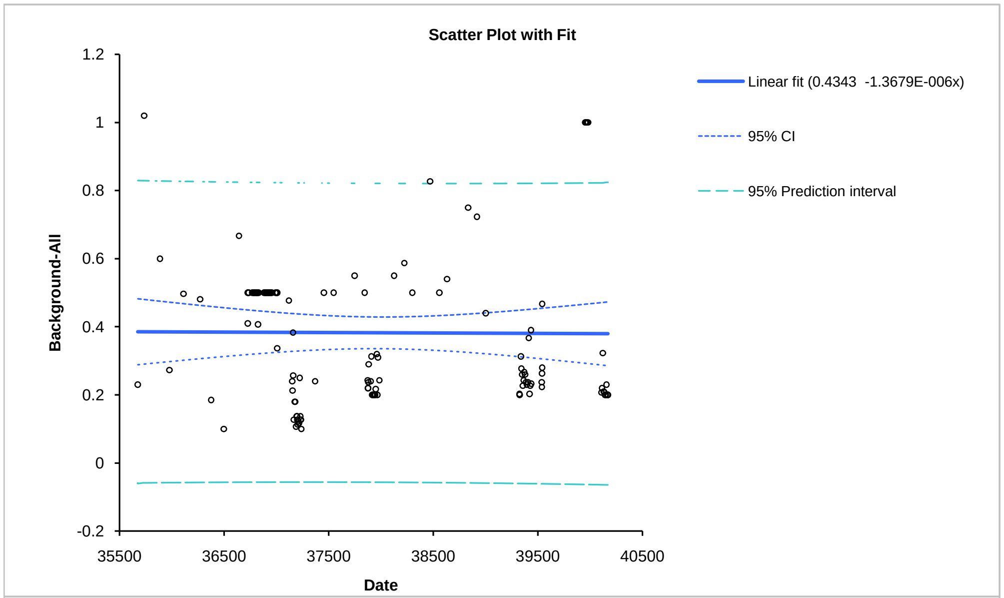
Analyse-it v2.09

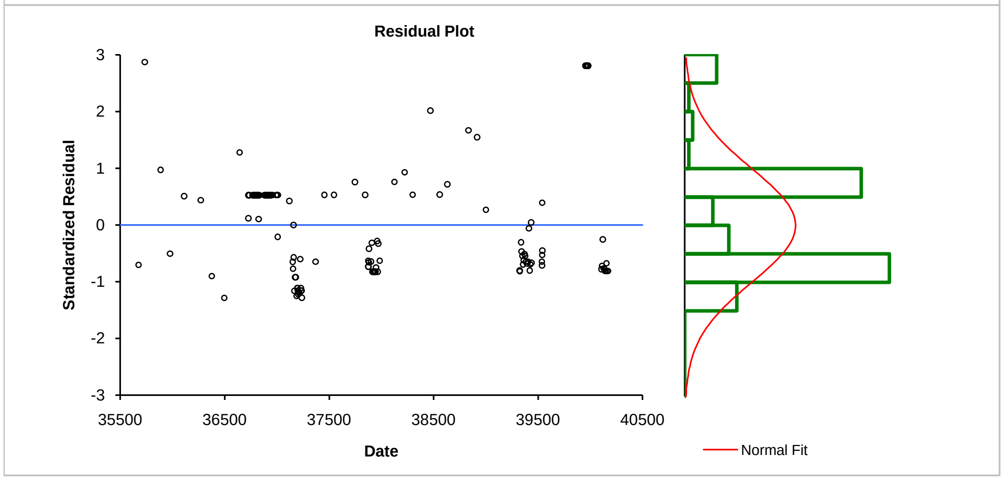
Test	Regression - Linear	TKN
	Background-All v Date	
Performed by	h6theres	Date 17 December 2010

n	138
R^2	0.00
Adjusted R^2	-0.01
SE	0.2209

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.4343	-0.6884 to 1.5570	0.56772	0.77	136	0.4456
Slope	-1.3679E-06	-3.0918E-05 to 2.8182E-05	1.4943E-005	-0.09	136	0.9272

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0004	1	0.0004	0.01	0.9272
Residual	6.6370	136	0.0488		
Total	6.6374	137			





Analyse-it v2.09

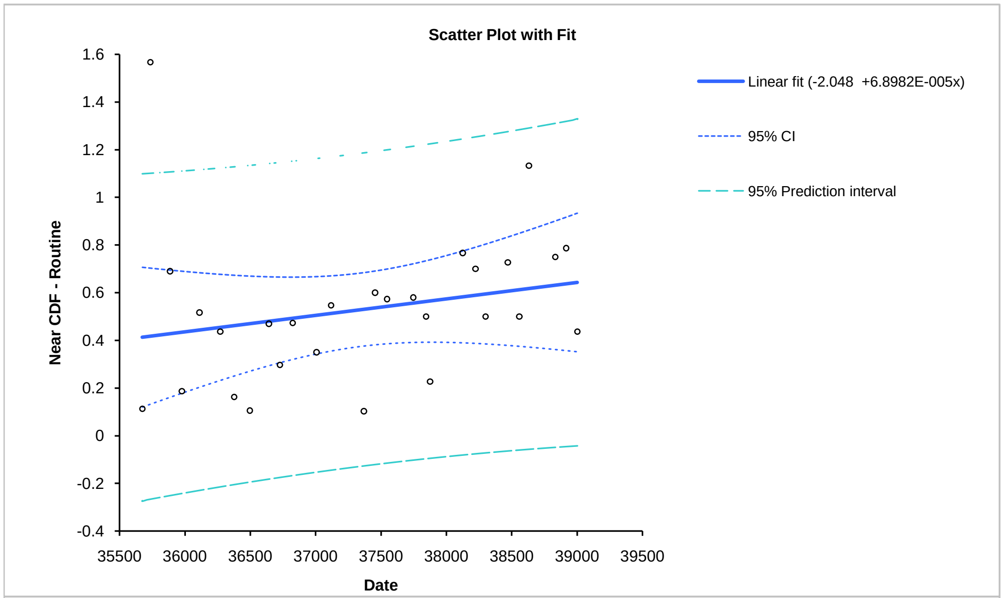
Test	**Regression - Linear**	TKN	
	Near CDF - Routine v Date		
Performed by	h6theres	Date	17 December 2010

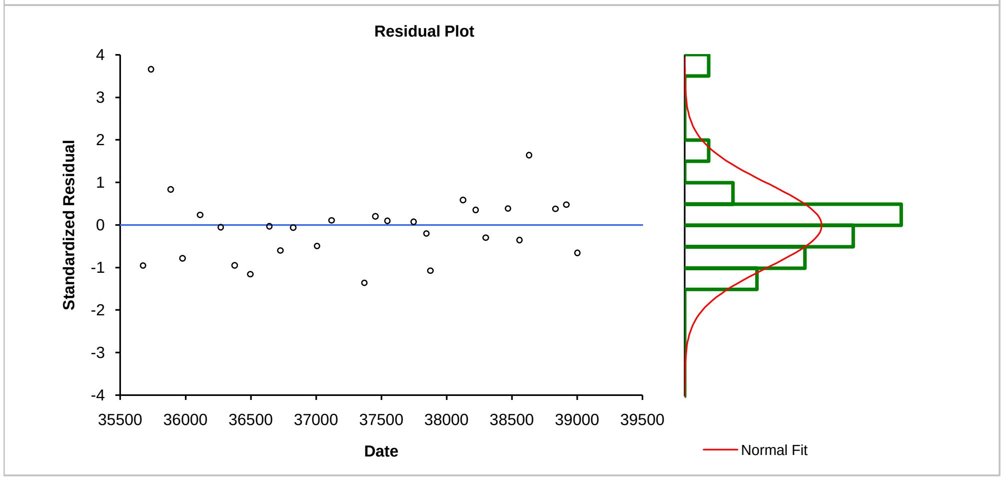
n 28 (cases excluded: 110 due to missing values)

R^2	0.05
Adjusted R^2	0.02
SE	0.3140

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-2.048	-6.460 to 2.364	2.1463	-0.95	26	0.3489
Slope	6.8982E-05	-4.9103E-05 to 1.8707E-04	5.7447E-005	1.20	26	0.2407

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.1422	1	0.1422	1.44	0.2407
Residual	2.5640	26	0.0986		
Total	2.7062	27			





Analyse-it v2.09

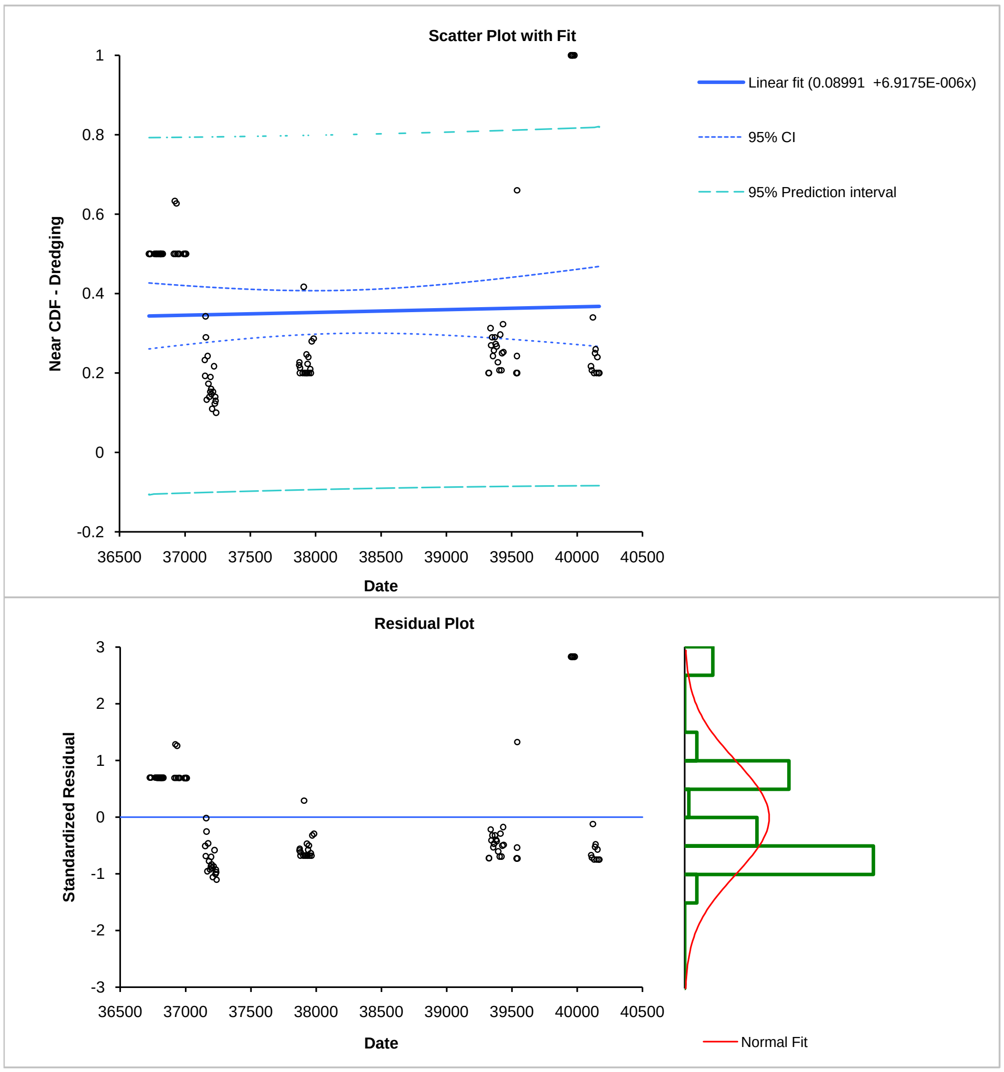
Test	**Regression - Linear**	TKN	
	Near CDF - Dredging v Date		
Performed by	h6theres	Date	17 December 2010

n	105	(cases excluded: 33 due to missing values)

R^2	0.00
Adjusted R^2	-0.01
SE	0.2238

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.08991	-1.22250 to 1.40231	0.661740	0.14	103	0.8922
Slope	6.9175E-06	-2.7429E-05 to 4.1264E-05	1.7318E-005	0.40	103	0.6904

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0080	1	0.0080	0.16	0.6904
Residual	5.1583	103	0.0501		
Total	5.1663	104			



Analyse-it v2.09

Test	**Regression - Linear** TKN
	River - Routine v Date
Performed by	h6theres

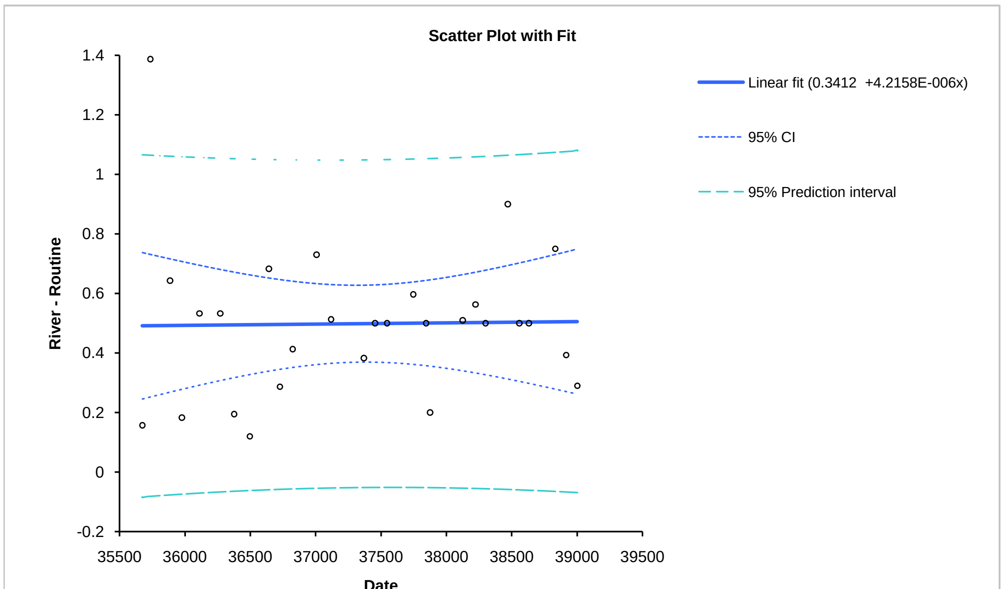
Date 17 December 2010

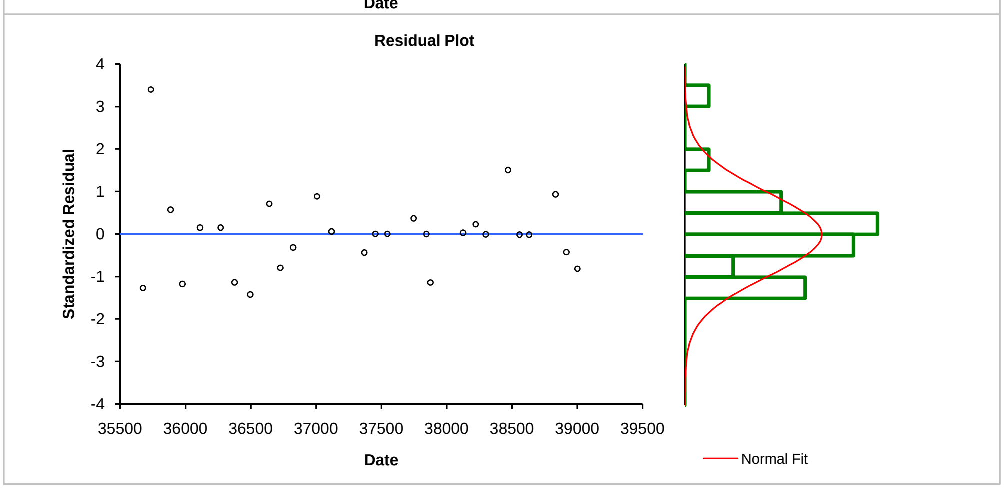
n 28 (cases excluded: 110 due to missing values)

R^2	0.00
Adjusted R^2	-0.04
SE	0.2631

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.3412	-3.3544 to 4.0368	1.79789	0.19	26	0.8509
Slope	4.2158E-06	-9.4698E-05 to 1.0313E-04	4.8121E-005	0.09	26	0.9309

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0005	1	0.0005	0.01	0.9309
Residual	1.7991	26	0.0692		
Total	1.7996	27			





Test	**Regression - Linear**
	River - Dredging v Date TKN
Performed by	h6theres

Date 17 December 2010

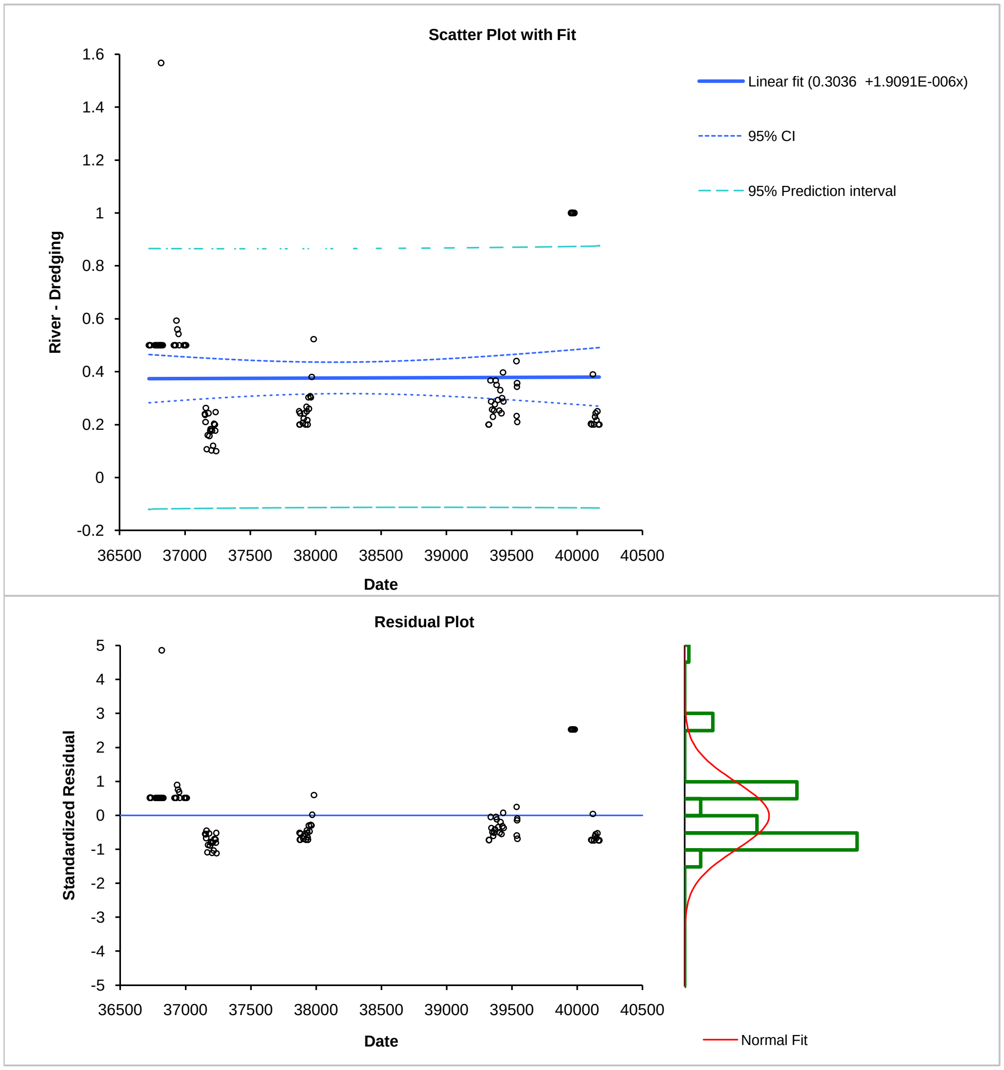
Analyse-it v2.09

n	105 (cases excluded: 33 due to missing values)

R^2	0.00
Adjusted R^2	-0.01
SE	0.2455

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.3036	-1.1361 to 1.7433	0.72594	0.42	103	0.6767
Slope	1.9091E-06	-3.5770E-05 to 3.9588E-05	1.8998E-005	0.10	103	0.9202

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0006	1	0.0006	0.01	0.9202
Residual	6.2077	103	0.0603		
Total	6.2083	104			



Test | **Regression - Linear**

In CDF - Routine v Date TKN

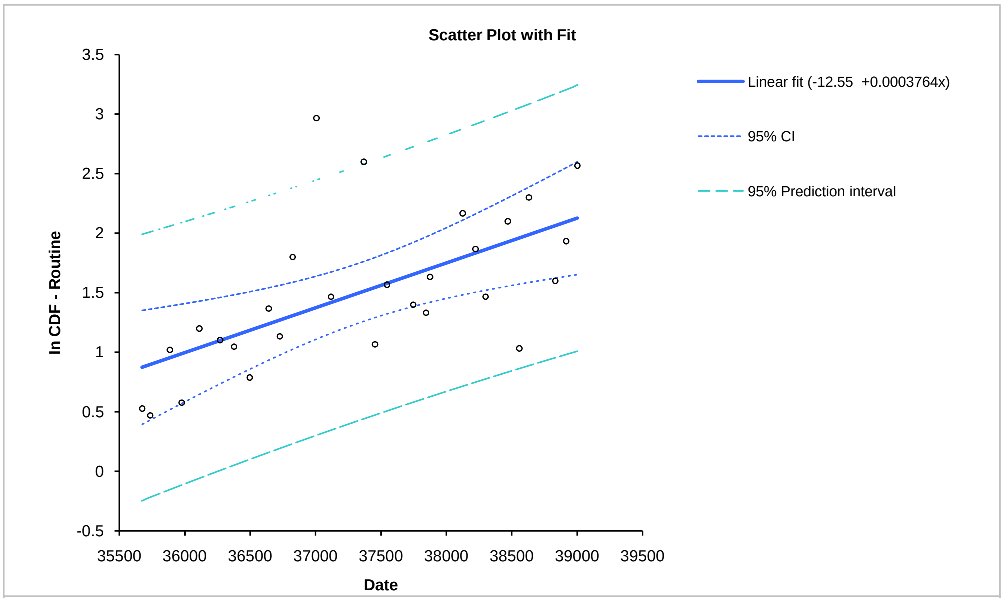
Performed by | h6theres   Date | 17 December 2010

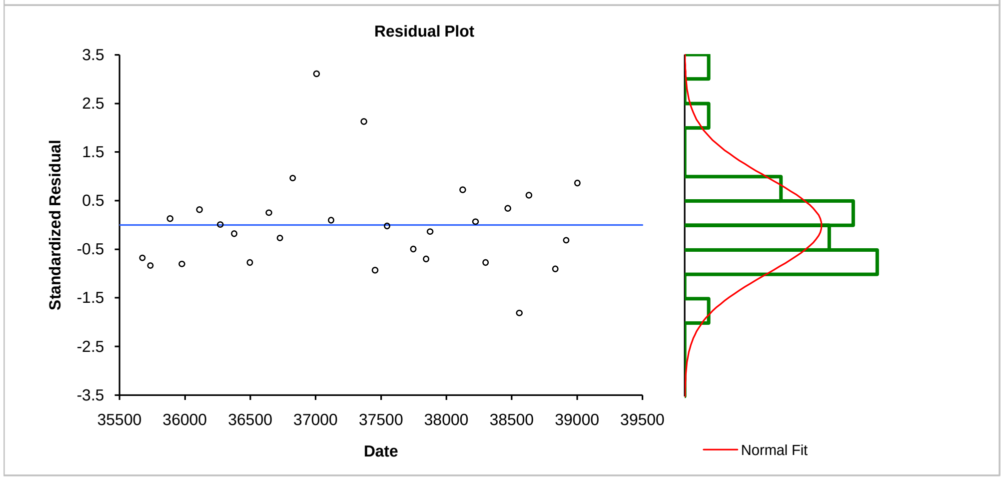
n | 28 (cases excluded: 110 due to missing values)

R^2	0.38
Adjusted R^2	0.36
SE	0.5116

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-12.55	-19.74 to -5.37	3.497	-3.59	26	0.0013
Slope	0.0003764	0.0001840 to 0.0005687	0.00009359	4.02	26	0.0004

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	4.2326	1	4.2326	16.17	0.0004
Residual	6.8046	26	0.2617		
Total	11.0372	27			





Analyse-it v2.09

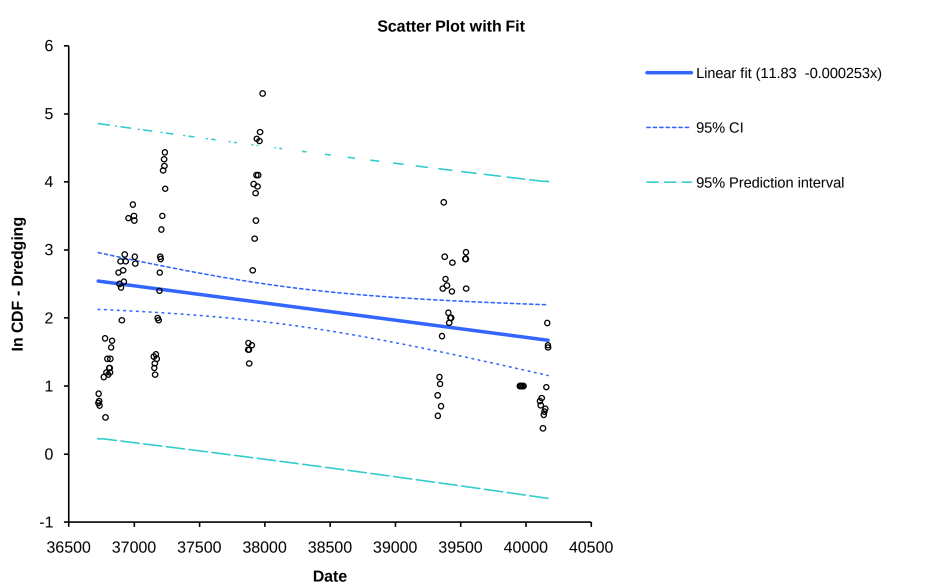
Test	**Regression - Linear**
	ln CDF - Dredging v Date TKN
Performed by	h6theres
Date	17 December 2010

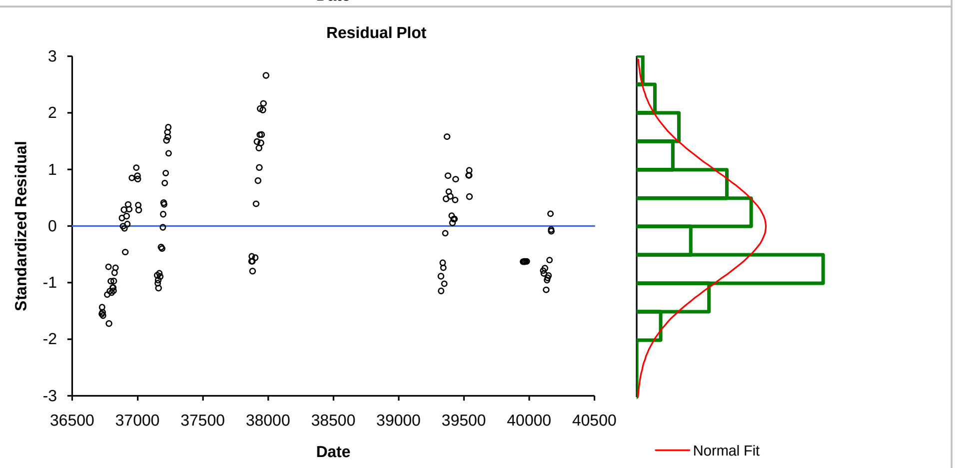
n 107 (cases excluded: 31 due to missing values)

R^2	0.07
Adjusted R^2	0.06
SE	1.1546

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	11.83	5.17 to 18.50	3.360	3.52	105	0.0006
Slope	-0.000253	-0.000427 to -0.000078	0.0000880	-2.87	105	0.0049

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	11.0116	1	11.0116	8.26	0.0049
Residual	139.9799	105	1.3331		
Total	150.9915	106			





Analyse-it v2.09

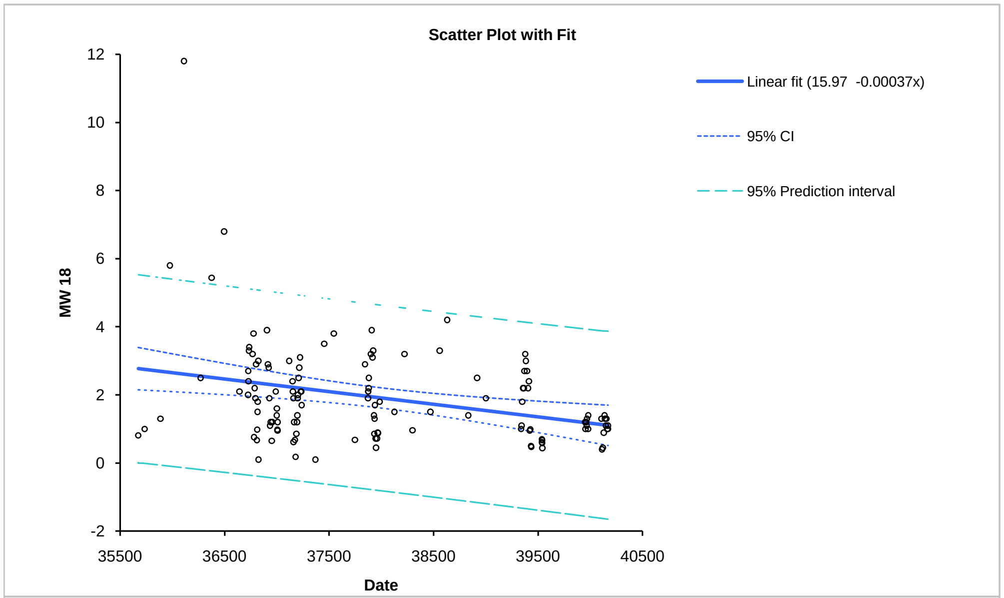
Test	Regression - Linear	TKN
	MW 18 v Date	
Performed by	h6theres	Date 17 December 2010

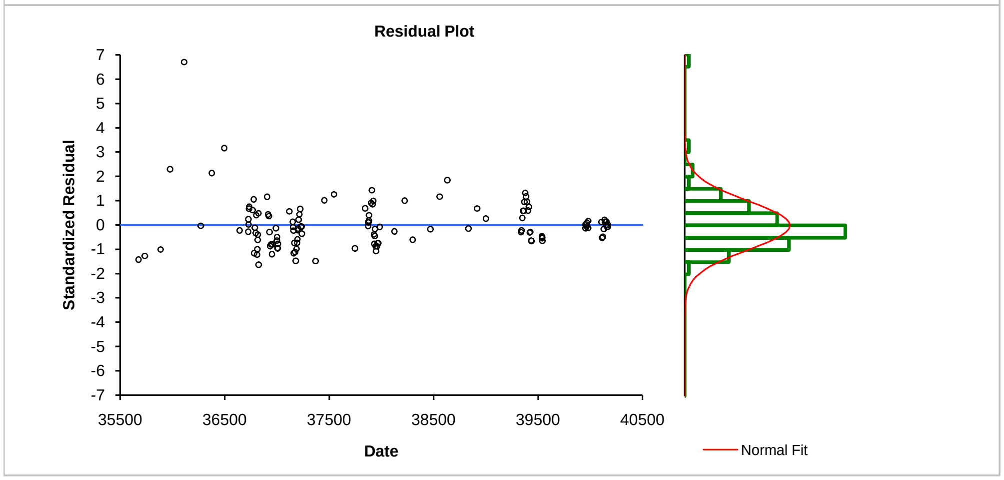
n 131 (cases excluded: 7 due to missing values)

R^2	0.11
Adjusted R^2	0.10
SE	1.3718

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	15.97	8.83 to 23.11	3.608	4.42	129	<0.0001
Slope	-0.00037	-0.00056 to -0.00018	0.000095	-3.90	129	0.0002

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	28.5896	1	28.5896	15.19	0.0002
Residual	242.7585	129	1.8818		
Total	271.3481	130			





Test | **Regression - Linear** TKN

MW 19 v Date

Performed by | h6theres

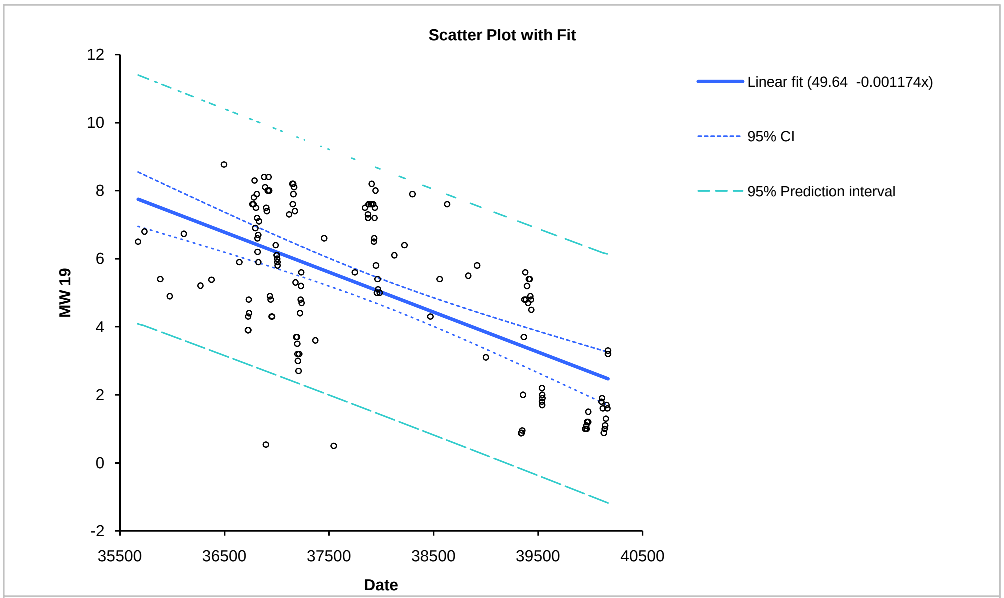
Date | 17 December 2010

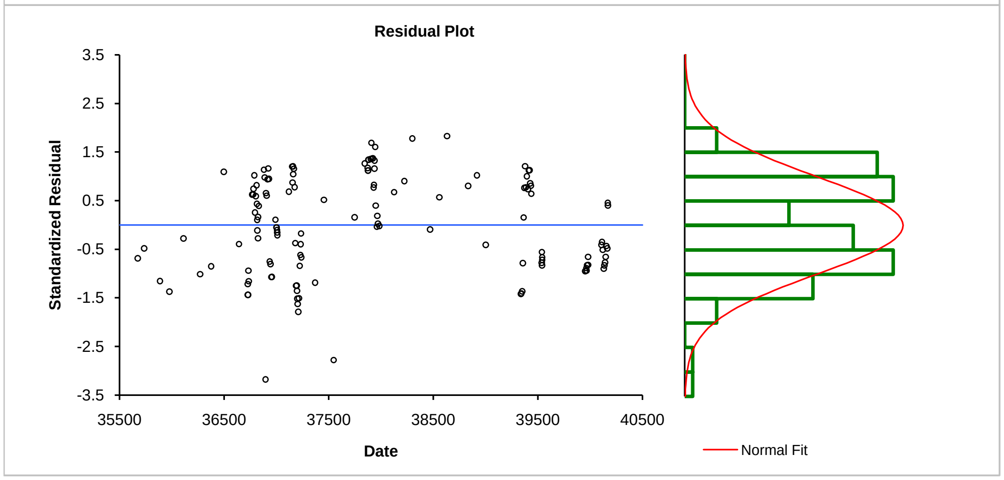
n | 136 (cases excluded: 2 due to missing values)

R^2	0.40
Adjusted R^2	0.40
SE	1.8172

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	49.64	40.33 to 58.95	4.708	10.54	134	<0.0001
Slope	-0.001174	-0.001419 to -0.000929	0.0001240	-9.47	134	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	296.2603	1	296.2603	89.72	<0.0001
Residual	442.4873	134	3.3021		
Total	738.7476	135			





Analyse-it v2.09

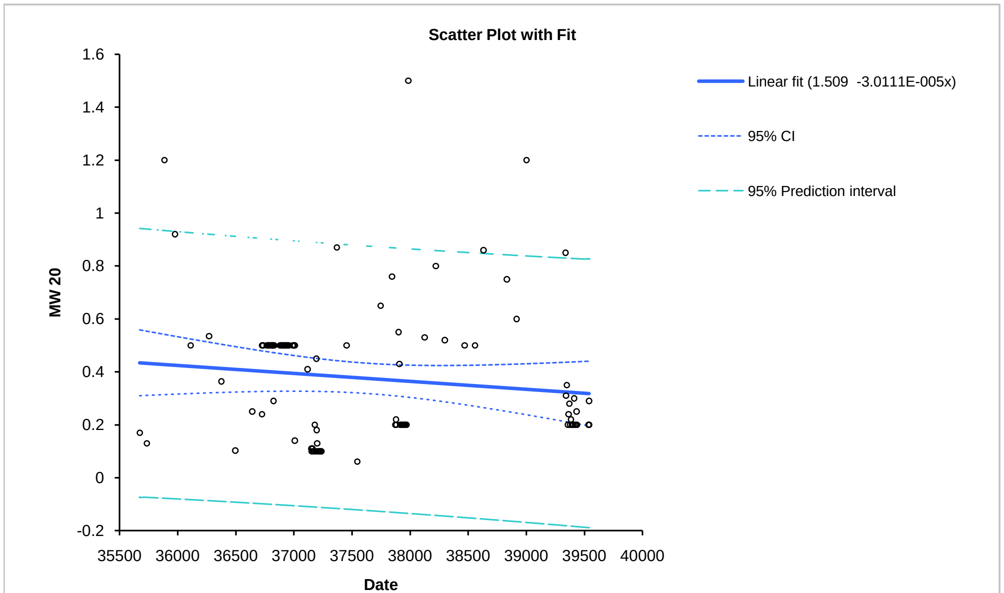
Test	**Regression - Linear**	TKN		
	MW 20 v Date			
Performed by	h6theres		Date	17 December 2010

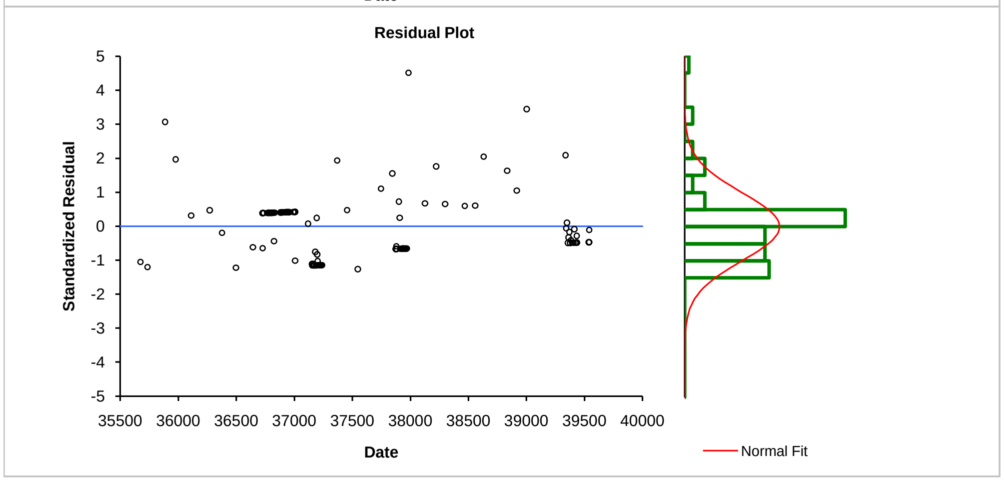
n	118	(cases excluded: 20 due to missing values)

R^2	0.01
Adjusted R^2	0.01
SE	0.2513

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	1.509	-0.192 to 3.209	0.8586	1.76	116	0.0815
Slope	-3.0111E-05	-7.5289E-05 to 1.5068E-05	2.2810E-005	-1.32	116	0.1894

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.1101	1	0.1101	1.74	0.1894
Residual	7.3274	116	0.0632		
Total	7.4375	117			





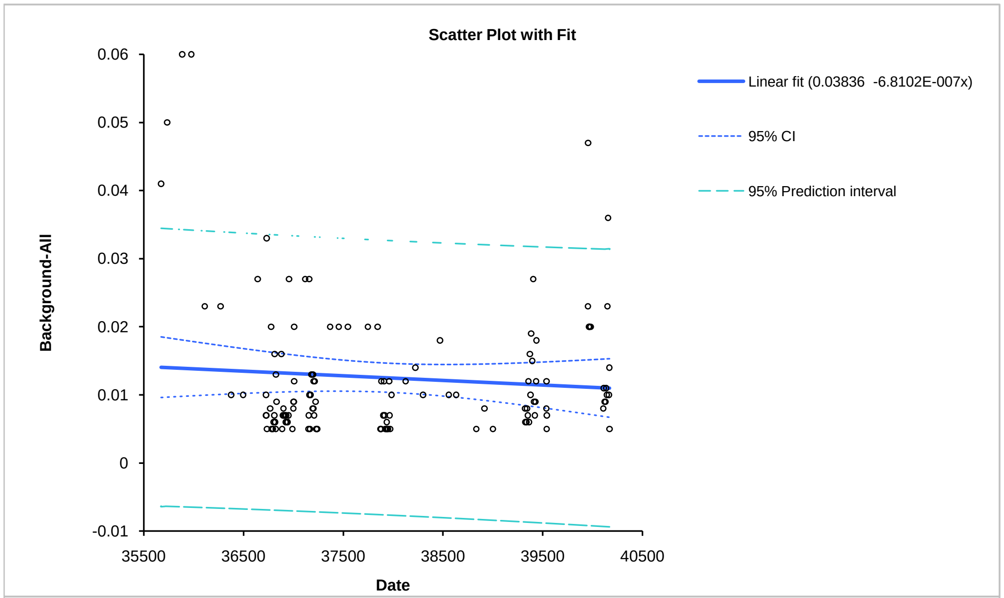
Test	**Regression - Linear**	Phosphorus
	Background-All v Date	
Performed by	h6theres	Date 17 December 2010

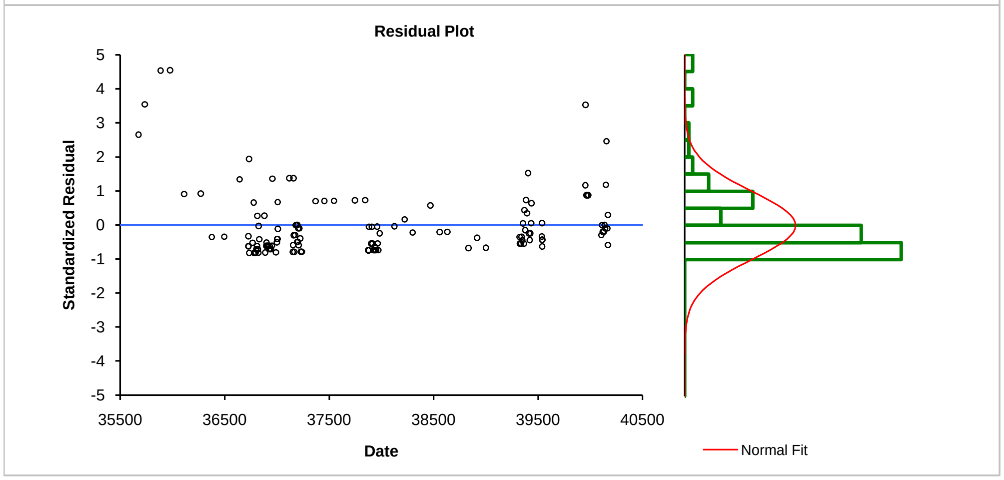
n	138

R^2	0.01
Adjusted R^2	0.00
SE	0.0101

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.03836	-0.01321 to 0.08993	0.026079	1.47	136	0.1436
Slope	-6.8102E-07	-2.0385E-06 to 6.7642E-07	6.8642E-007	-0.99	136	0.3229

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0001	1	0.0001	0.98	0.3229
Residual	0.0140	136	0.0001		
Total	0.0141	137			





Analyse-it v2.09

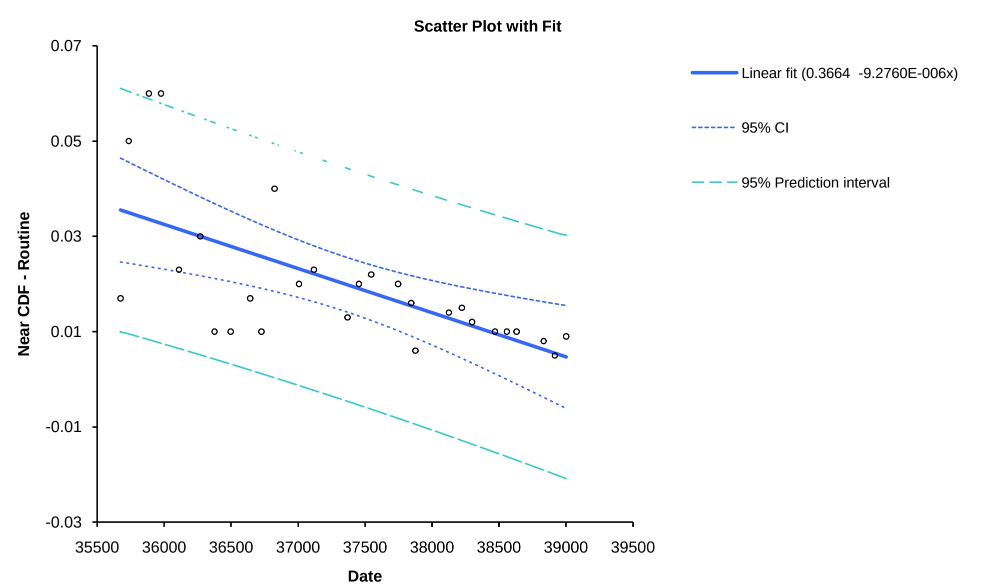
Test	**Regression - Linear**	Phosphorus
	Near CDF - Routine v Date	
Performed by	h6theres	Date: 17 December 2010

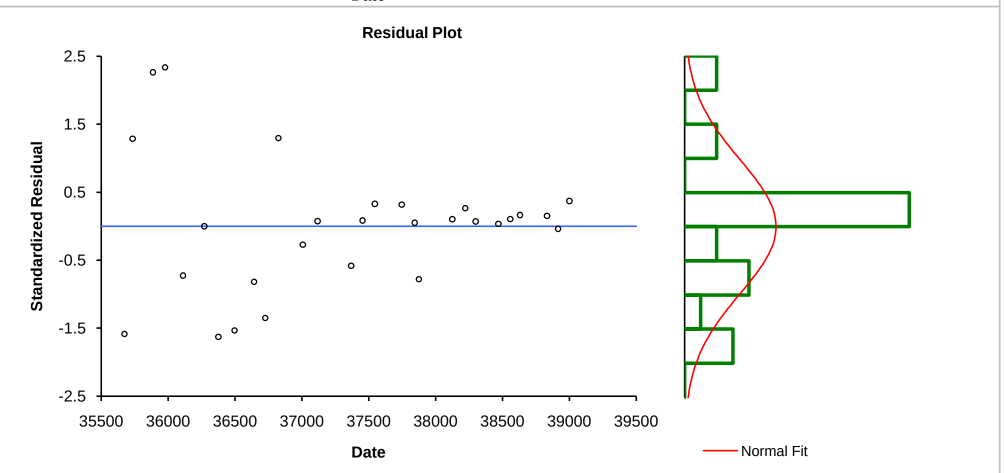
n 28 (cases excluded: 110 due to missing values)

R^2	0.42
Adjusted R^2	0.40
SE	0.0117

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.3664	0.2024 to 0.5305	0.07981	4.59	26	<0.0001
Slope	-9.2760E-06	-1.3667E-05 to -4.8854E-06	2.1360E-006	-4.34	26	0.0002

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0026	1	0.0026	18.86	0.0002
Residual	0.0035	26	0.0001		
Total	0.0061	27			





Test	**Regression - Linear**	Phosphorus	
Performed by	Near CDF - Dredging v Date h6theres	Date	17 December 2010

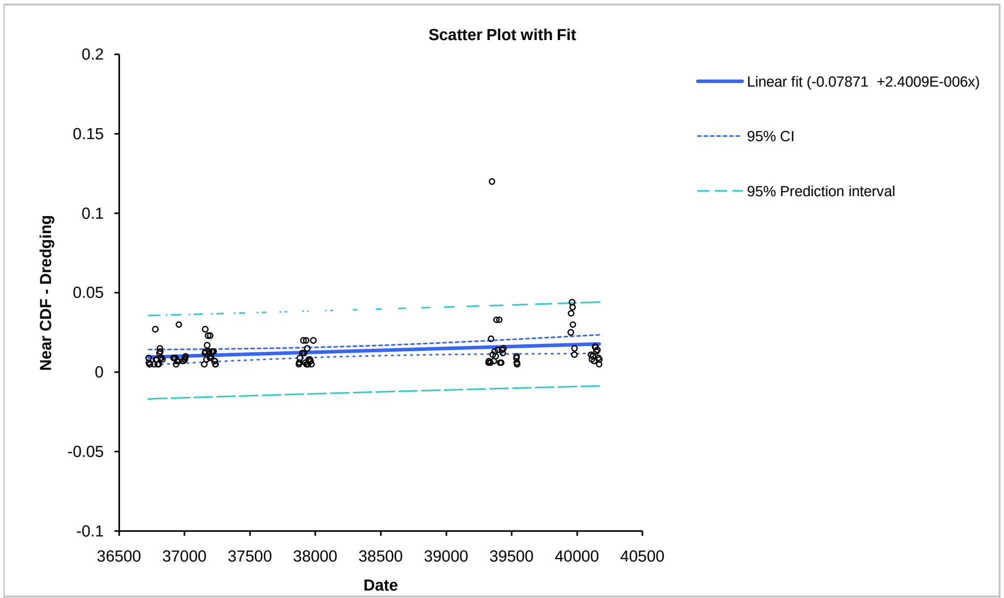
Analyse-it v2.09

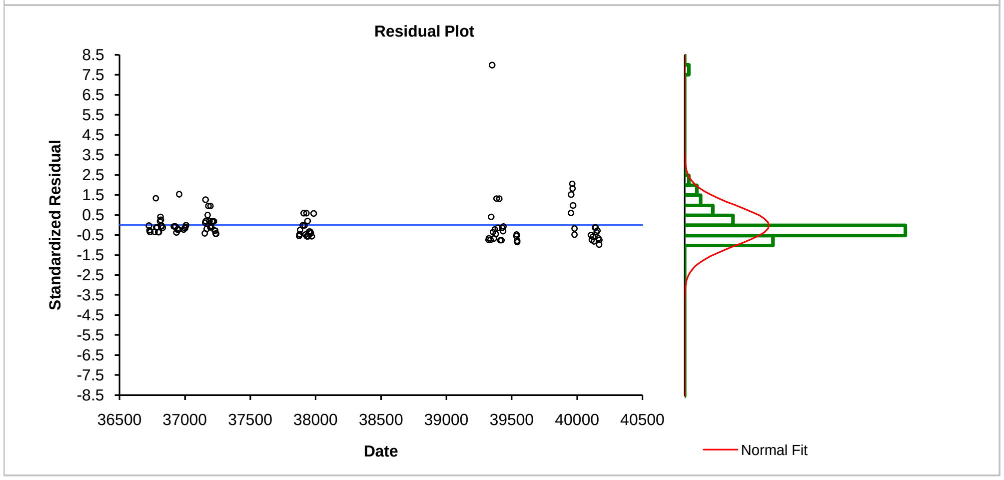
n 105 (cases excluded: 33 due to missing values)

R^2	0.05
Adjusted R^2	0.04
SE	0.0130

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.07871	-0.15521 to -0.00220	0.038574	-2.04	103	0.0439
Slope	2.4009E-06	3.9873E-07 to 4.4030E-06	1.0095E-006	2.38	103	0.0192

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0010	1	0.0010	5.66	0.0192
Residual	0.0175	103	0.0002		
Total	0.0185	104			





Analyse-it v2.09

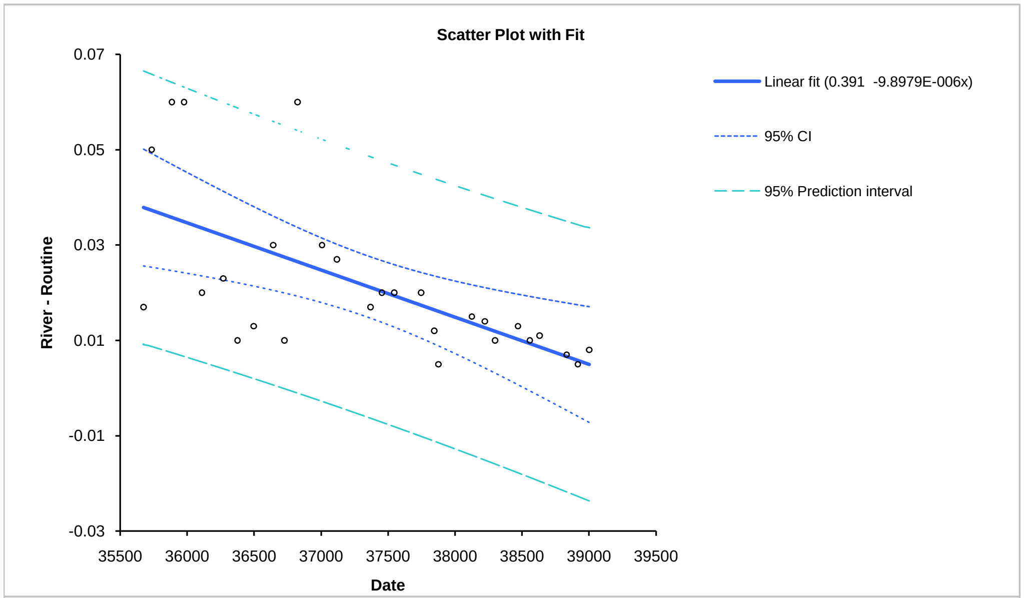
Test	**Regression - Linear**	Phosphorus	
	River - Routine v Date		
Performed by	h6theres	Date	17 December 2010

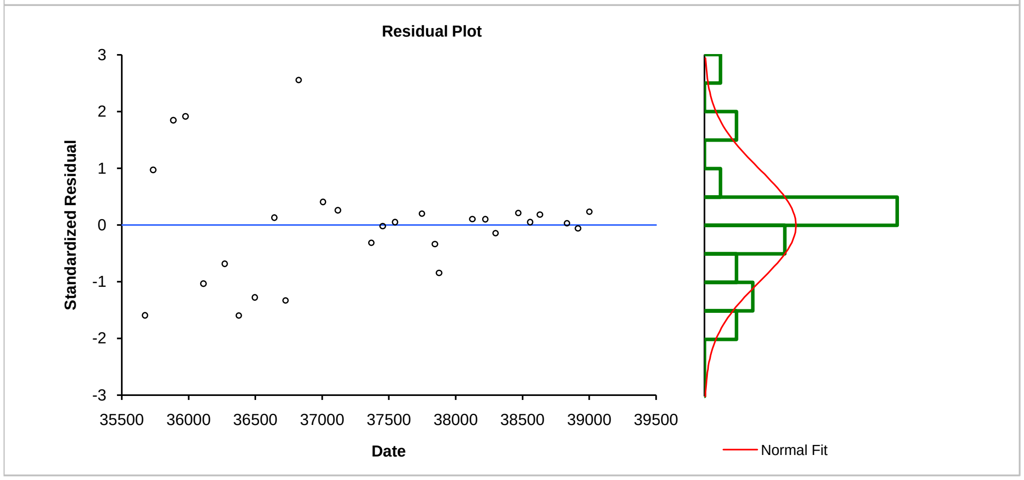
n 28 (cases excluded: 110 due to missing values)

R^2	0.40
Adjusted R^2	0.37
SE	0.0131

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.391	0.207 to 0.575	0.0896	4.36	26	0.0002
Slope	-9.8979E-06	-1.4826E-05 to -4.9694E-06	2.3977E-006	-4.13	26	0.0003

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0029	1	0.0029	17.04	0.0003
Residual	0.0045	26	0.0002		
Total	0.0074	27			





Analyse-it v2.09

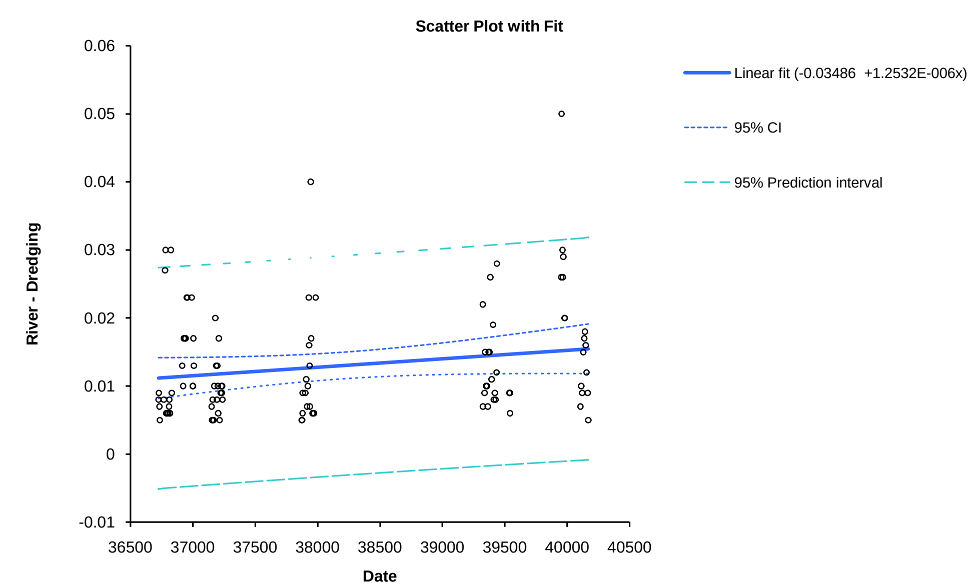
Test	**Regression - Linear**	Phosphorus		
	River - Dredging v Date			
Performed by	h6theres		Date	17 December 2010

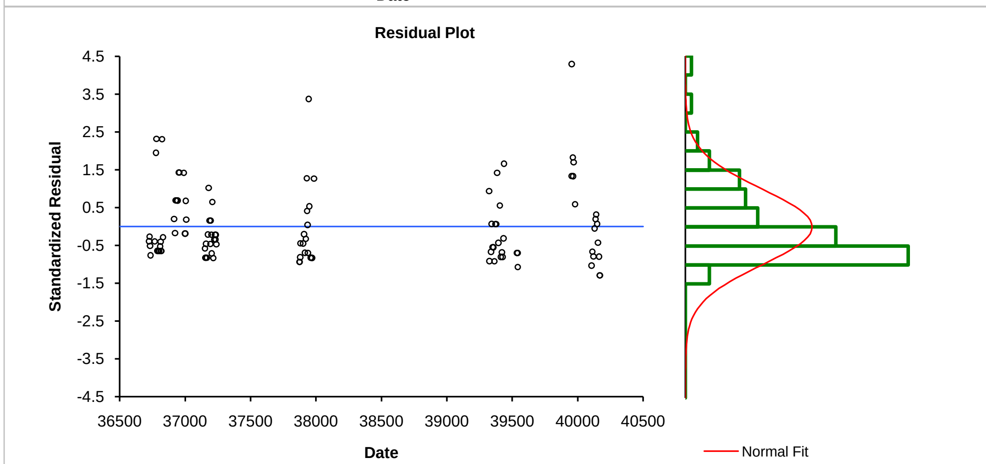
n	105 (cases excluded: 33 due to missing values)

R^2	0.04
Adjusted R^2	0.03
SE	0.0081

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.03486	-0.08236 to 0.01264	0.023952	-1.46	103	0.1486
Slope	1.2532E-06	1.0056E-08 to 2.4964E-06	6.2684E-007	2.00	103	0.0482

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0003	1	0.0003	4.00	0.0482
Residual	0.0068	103	0.0001		
Total	0.0070	104			





Analyse-it v2.09

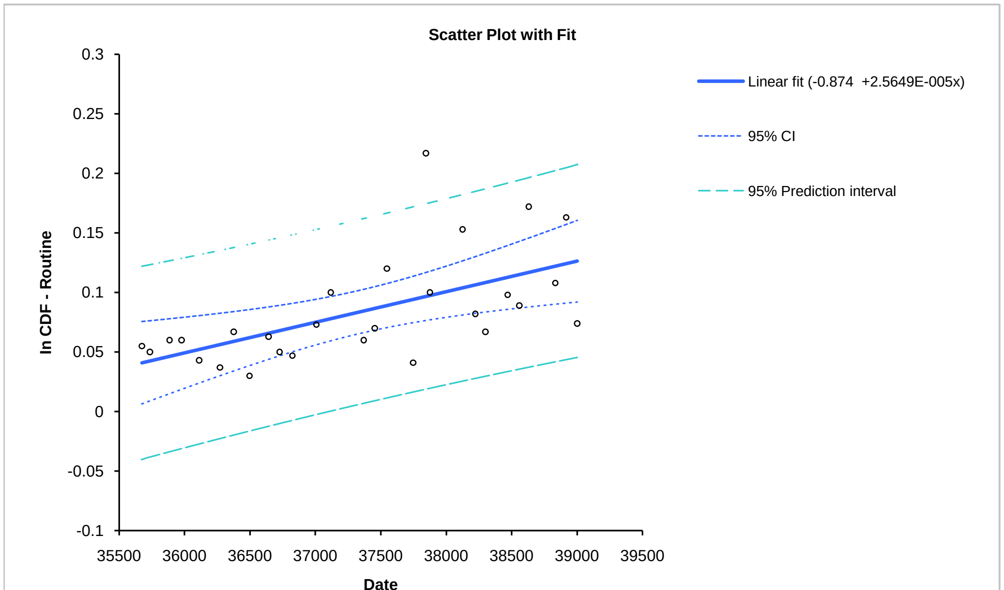
Test	**Regression - Linear**	Phosphorus	
	ln CDF - Routine v Date		
Performed by	h6theres	Date	17 December 2010

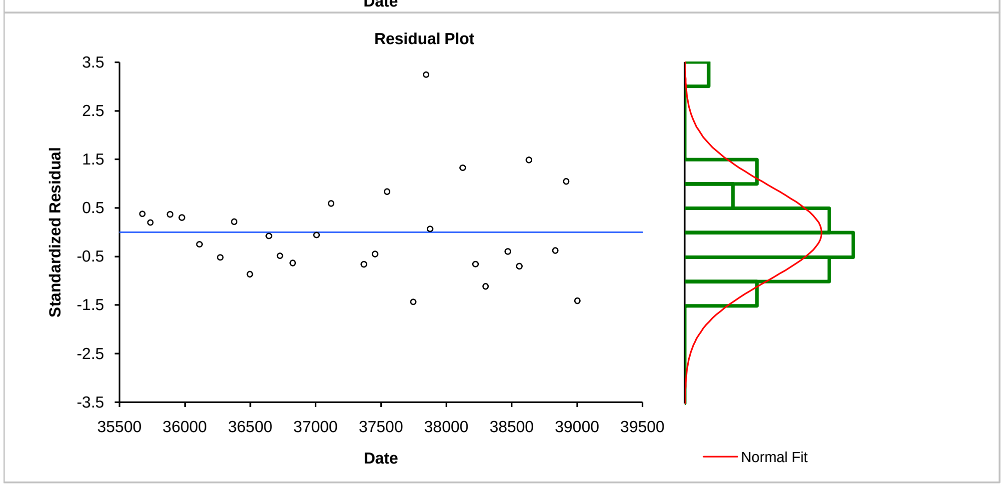
n 28 (cases excluded: 110 due to missing values)

R^2	0.35
Adjusted R^2	0.33
SE	0.0371

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.874	-1.395 to -0.353	0.2534	-3.45	26	0.0019
Slope	2.5649E-05	1.1710E-05 to 3.9588E-05	6.7811E-006	3.78	26	0.0008

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0197	1	0.0197	14.31	0.0008
Residual	0.0357	26	0.0014		
Total	0.0554	27			





Analyse-it v2.09

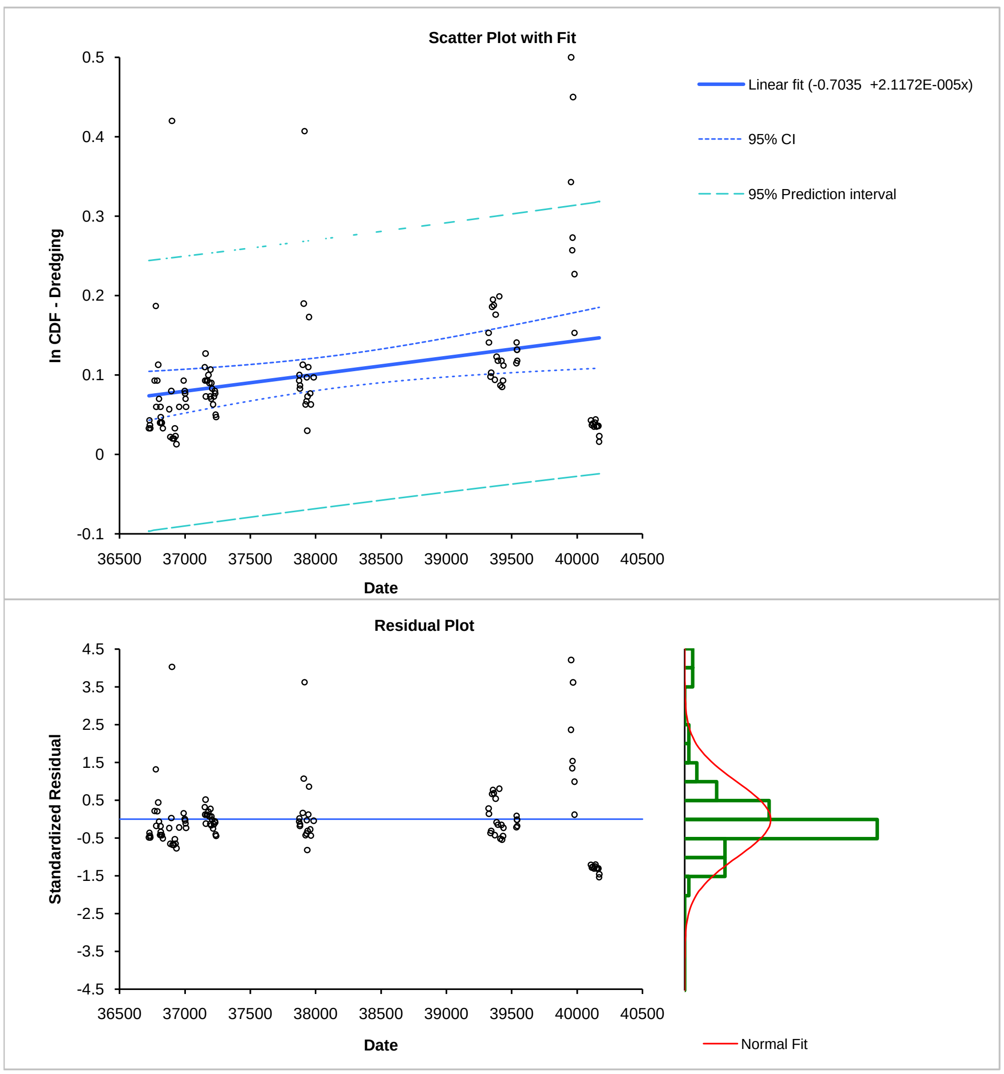
Test	**Regression - Linear**	Phosphorus		
	ln CDF - Dredging v Date			
Performed by	h6theres		Date	17 December 2010

n	107	(cases excluded: 31 due to missing values)

R^2	0.09
Adjusted R^2	0.08
SE	0.0849

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.7035	-1.1935 to -0.2136	0.24710	-2.85	105	0.0053
Slope	2.1172E-05	8.3382E-06 to 3.4006E-05	6.4727E-006	3.27	105	0.0015

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0771	1	0.0771	10.70	0.0015
Residual	0.7571	105	0.0072		
Total	0.8342	106			



Analyse-it v2.09

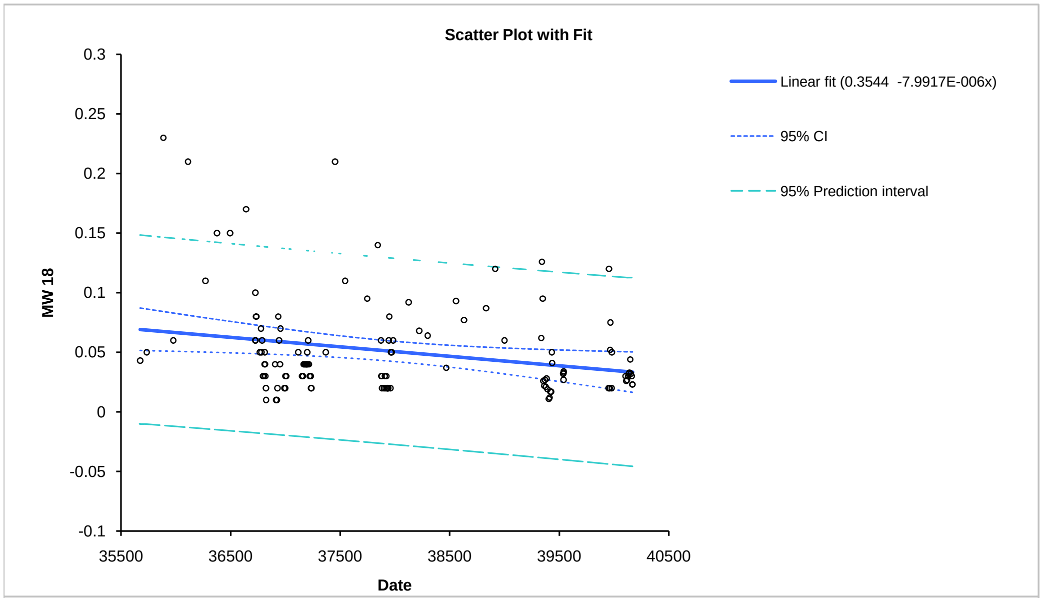
Test	Regression - Linear	Phosphorus
	MW 18 v Date	
Performed by	h6theres	Date 17 December 2010

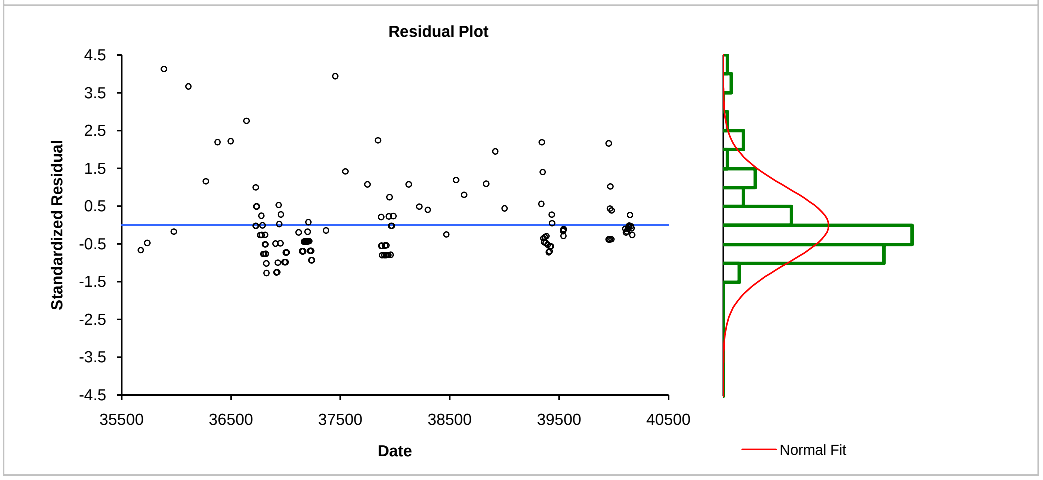
n 131 (cases excluded: 7 due to missing values)

R^2	0.06
Adjusted R^2	0.06
SE	0.0393

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.3544	0.1497 to 0.5590	0.10341	3.43	129	0.0008
Slope	-7.9917E-06	-1.3374E-05 to -2.6093E-06	2.7204E-006	-2.94	129	0.0039

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0133	1	0.0133	8.63	0.0039
Residual	0.1994	129	0.0015		
Total	0.2127	130			





Test	**Regression - Linear**	Phosphorus
	MW 19 v Date	
Performed by	h6theres	Date: 17 December 2010

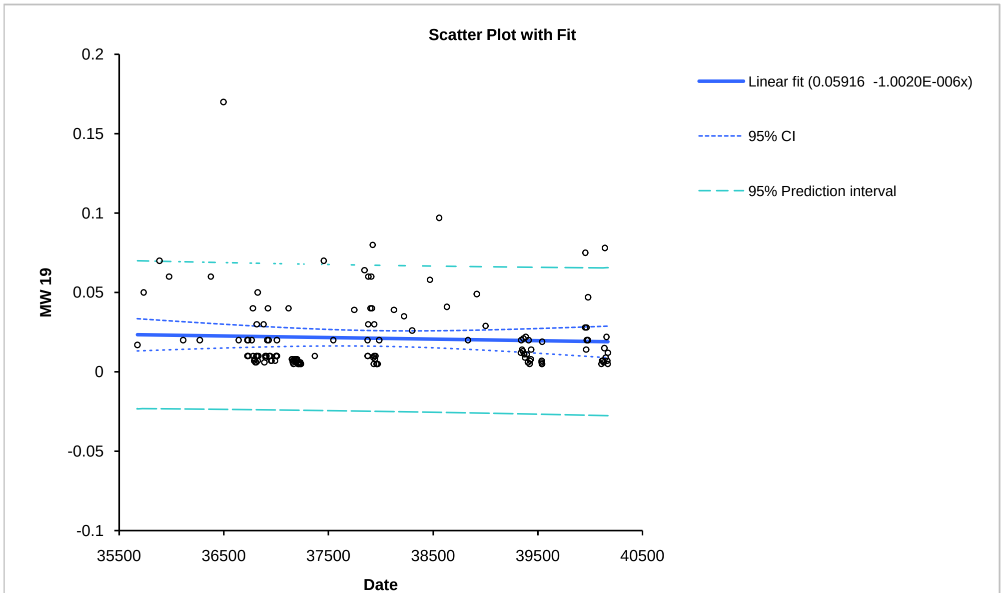
Analyse-it v2.09

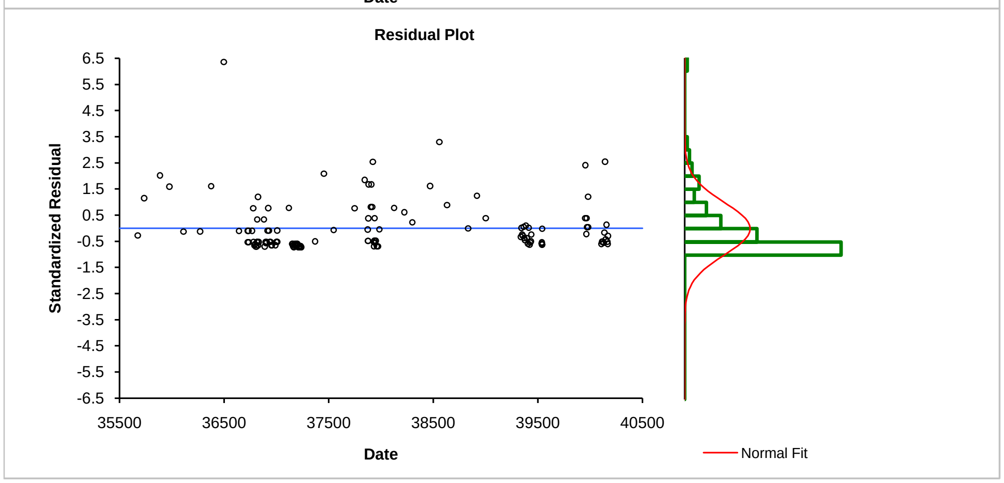
n	136 (cases excluded: 2 due to missing values)

R^2	0.00
Adjusted R^2	0.00
SE	0.0232

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.05916	-0.05962 to 0.17794	0.060057	0.99	134	0.3264
Slope	-1.0020E-06	-4.1301E-06 to 2.1261E-06	1.5816E-006	-0.63	134	0.5274

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0002	1	0.0002	0.40	0.5274
Residual	0.0720	134	0.0005		
Total	0.0722	135			





Analyse-it v2.09

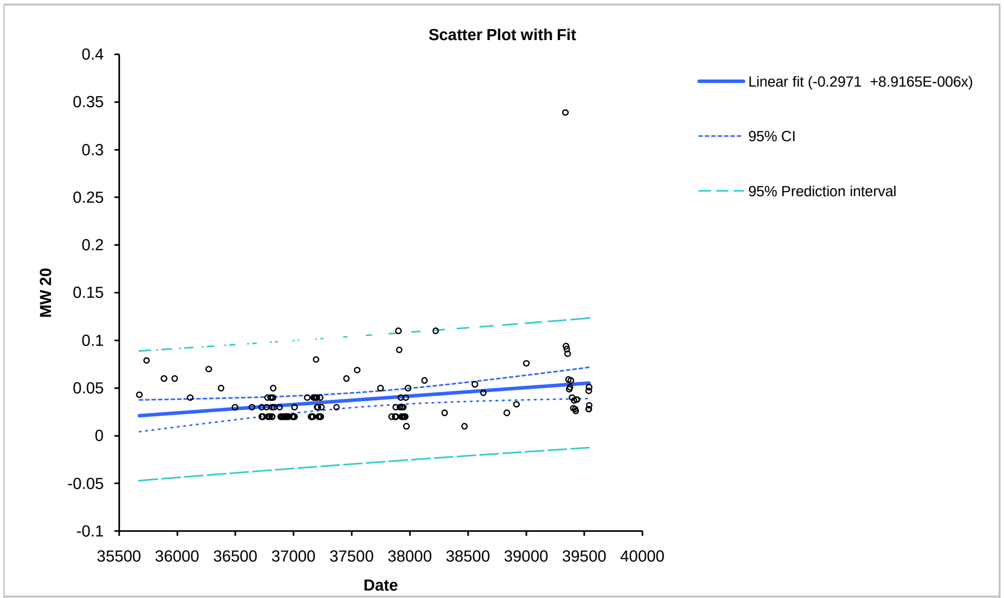
Test	**Regression - Linear**	Phosphorus
	MW 20 v Date	
Performed by	h6theres	Date: 17 December 2010

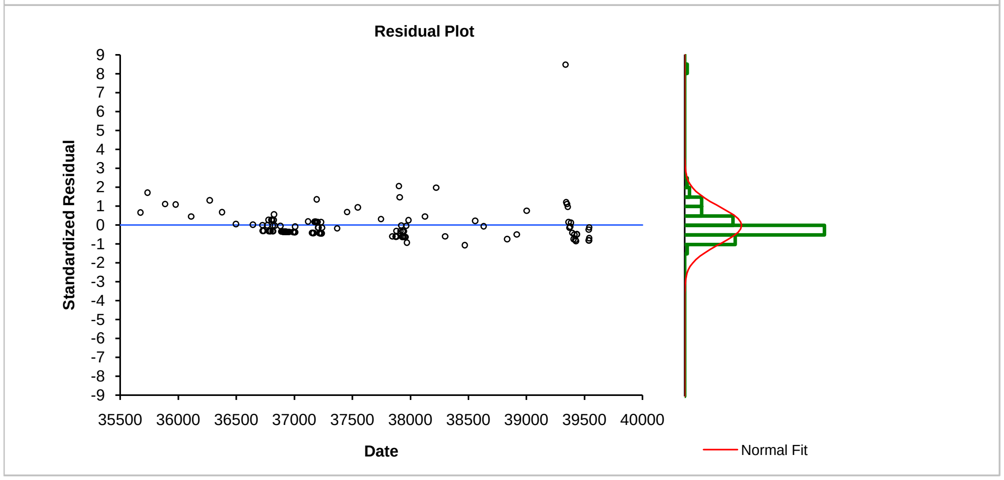
n	118 (cases excluded: 20 due to missing values)

R^2	0.07
Adjusted R^2	0.06
SE	0.0336

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.2971	-0.5246 to -0.0696	0.11487	-2.59	116	0.0109
Slope	8.9165E-06	2.8723E-06 to 1.4961E-05	3.0517E-006	2.92	116	0.0042

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.0097	1	0.0097	8.54	0.0042
Residual	0.1311	116	0.0011		
Total	0.1408	117			





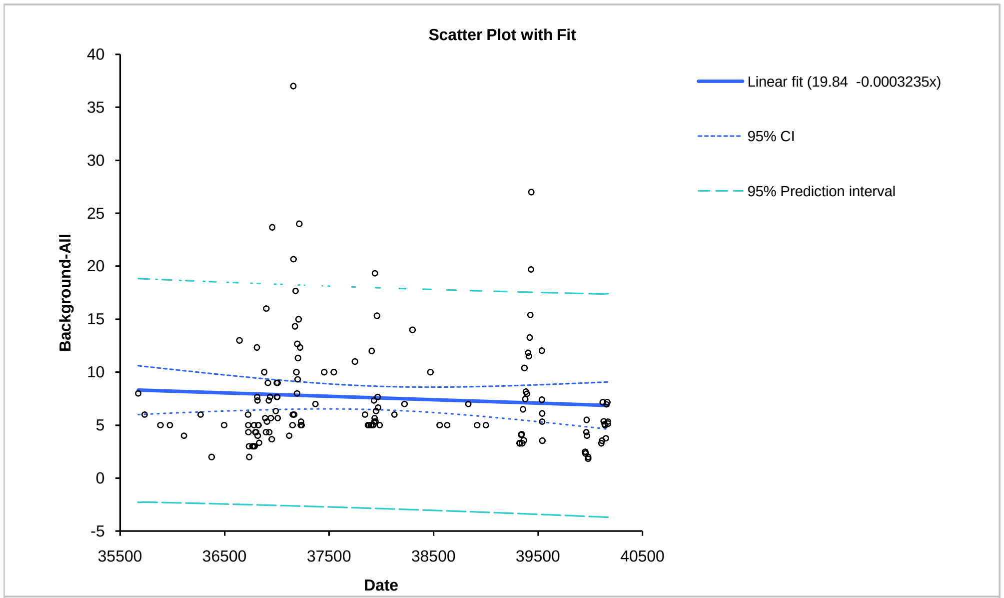
Test	**Regression - Linear**	TSS		
Performed by	Background-All v Date h6theres		Date	17 December 2010

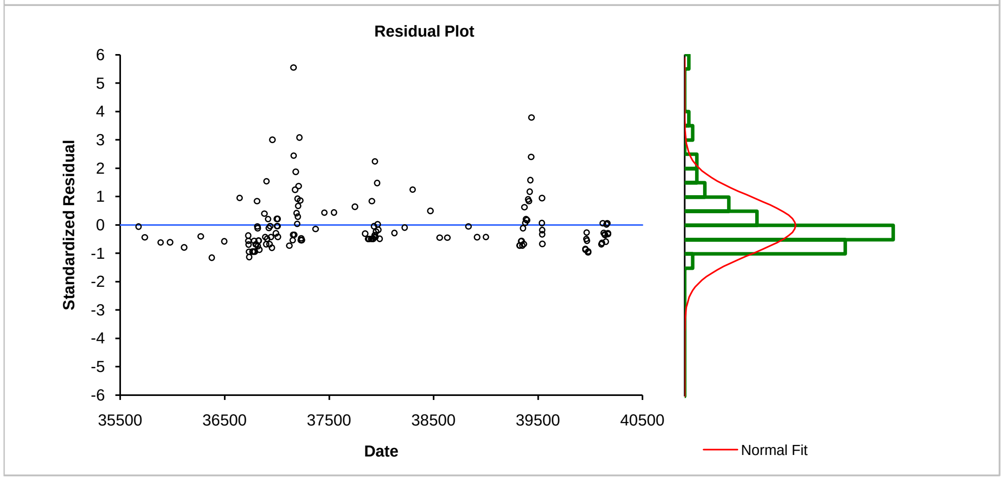
n	138

R^2	0.01
Adjusted R^2	0.00
SE	5.25

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	19.84	-6.85 to 46.53	13.496	1.47	136	0.1438
Slope	-0.0003235	-0.0010260 to 0.0003789	0.00035522	-0.91	136	0.3640

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	22.88	1	22.88	0.83	0.3640
Residual	3750.49	136	27.58		
Total	3773.36	137			





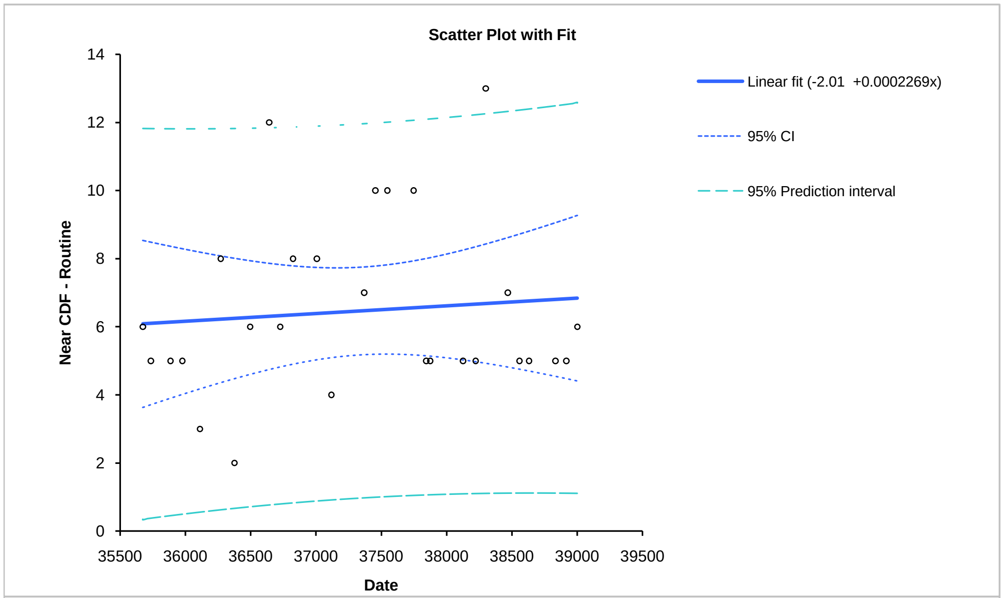
Test	**Regression - Linear**	TSS	
	Near CDF - Routine v Date		
Performed by	h6theres	Date	17 December 2010

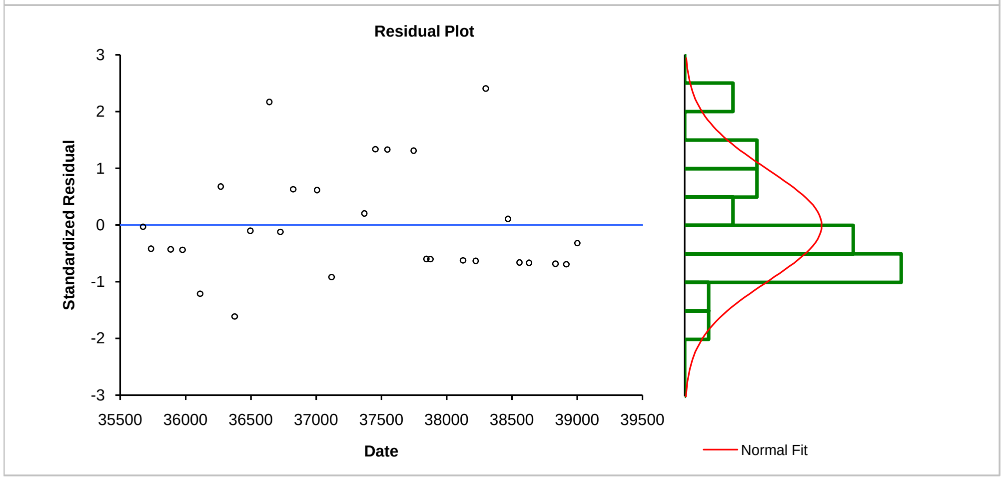
n	28	(cases excluded: 110 due to missing values)

R^2	0.01
Adjusted R^2	-0.03
SE	2.63

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-2.01	-38.92 to 34.90	17.955	-0.11	26	0.9117
Slope	0.0002269	-0.0007609 to 0.0012147	0.00048056	0.47	26	0.6408

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	1.54	1	1.54	0.22	0.6408
Residual	179.43	26	6.90		
Total	180.96	27			





Analyse-it v2.09

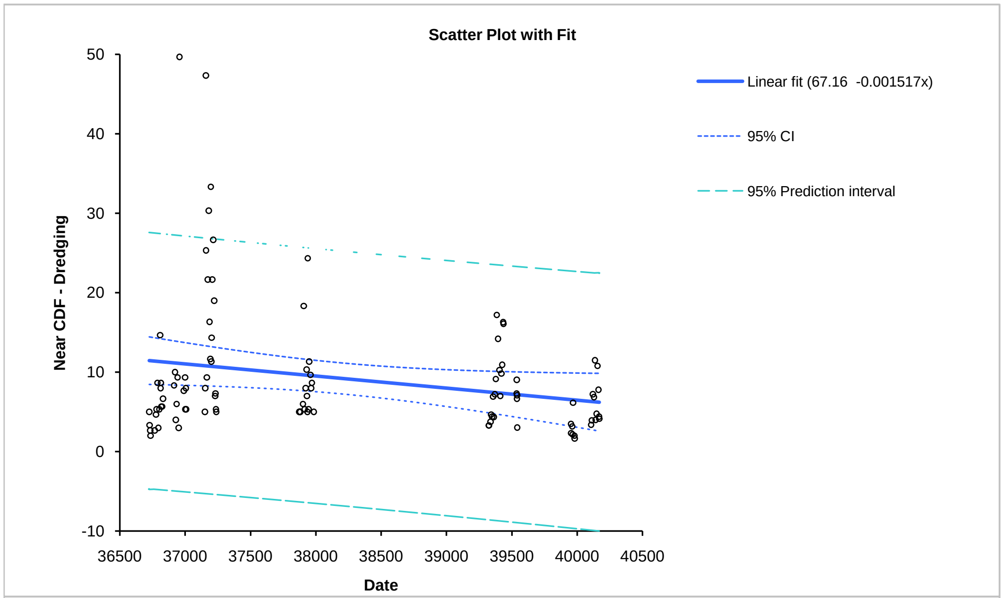
Test	**Regression - Linear** TSS		
	Near CDF - Dredging v Date		
Performed by	h6theres	Date	17 December 2010

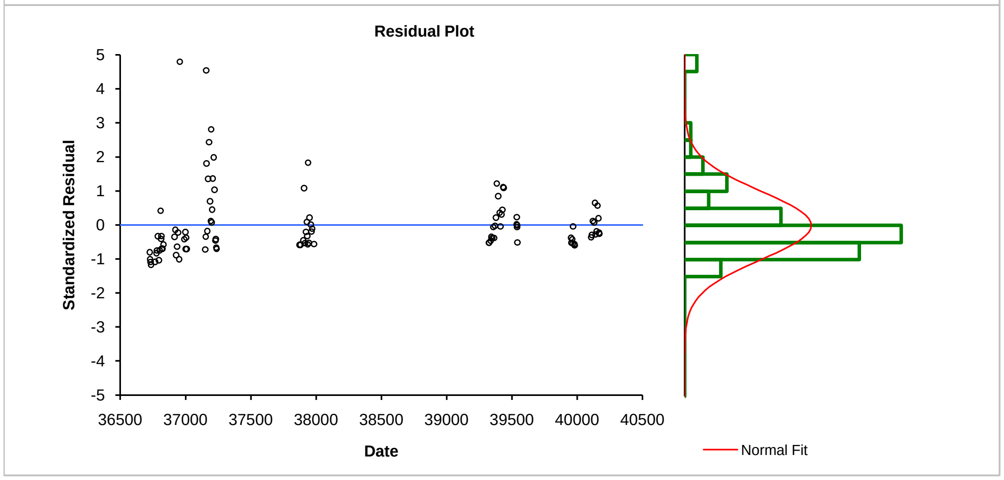
n	105 (cases excluded: 33 due to missing values)

R^2	0.05
Adjusted R^2	0.05
SE	8.04

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	67.16	19.99 to 114.34	23.786	2.82	103	0.0057
Slope	-0.001517	-0.002752 to -0.000283	0.0006225	-2.44	103	0.0165

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	384.39	1	384.39	5.94	0.0165
Residual	6664.61	103	64.70		
Total	7049.00	104			





Analyse-it v2.09

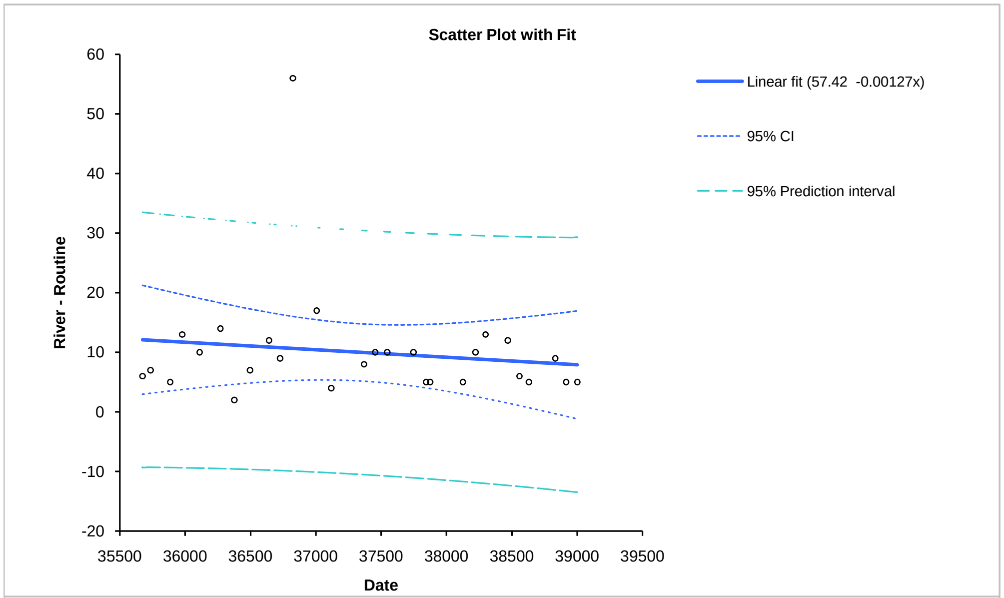
Test	**Regression - Linear**	TSS	
	River - Routine v Date		
Performed by	h6theres	Date	17 December 2010

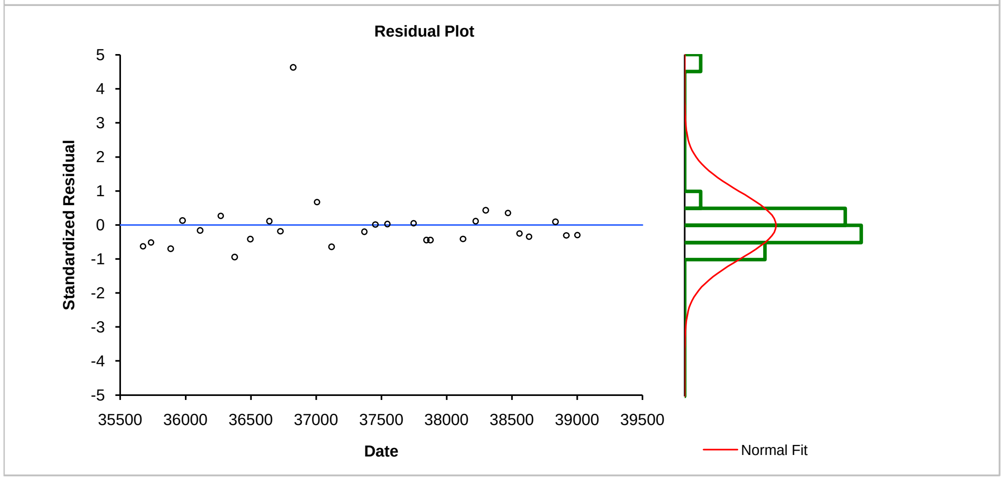
n 28 (cases excluded: 110 due to missing values)

R^2	0.02
Adjusted R^2	-0.02
SE	9.79

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	57.42	-80.06 to 194.90	66.884	0.86	26	0.3985
Slope	-0.00127	-0.00495 to 0.00241	0.001790	-0.71	26	0.4845

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	48.17	1	48.17	0.50	0.4845
Residual	2489.83	26	95.76		
Total	2538.00	27			





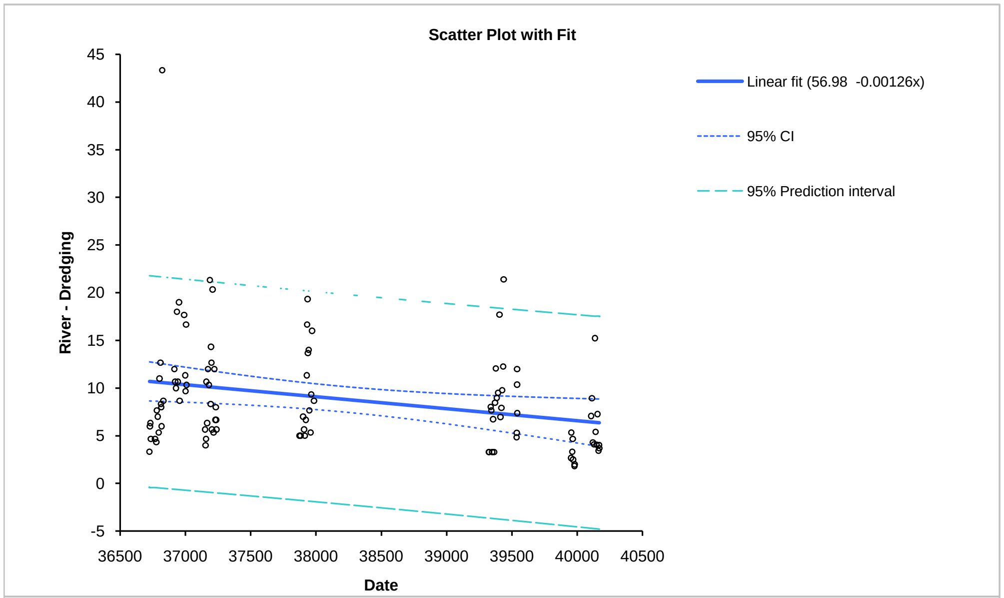
Test	Regression - Linear	TSS
	River - Dredging v Date	
Performed by	h6theres	Date: 17 December 2010

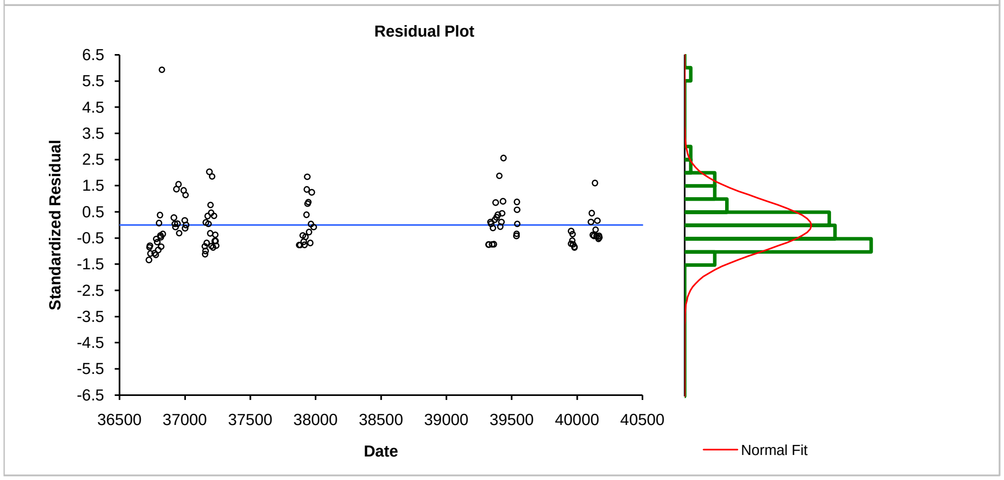
n: 105 (cases excluded: 33 due to missing values)

R^2: 0.08
Adjusted R^2: 0.07
SE: 5.52

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	56.98	24.60 to 89.36	16.327	3.49	103	0.0007
Slope	-0.00126	-0.00211 to -0.00041	0.000427	-2.95	103	0.0039

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	265.16	1	265.16	8.70	0.0039
Residual	3140.17	103	30.49		
Total	3405.33	104			





Analyse-it v2.09

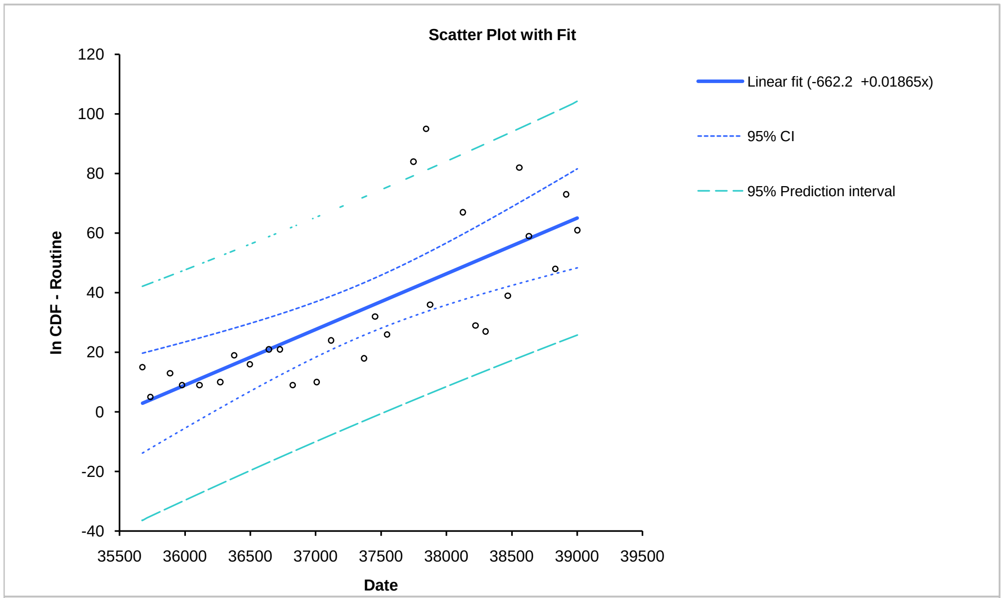
Test	Regression - Linear	TSS
	In CDF - Routine v Date	
Performed by	h6theres	Date: 17 December 2010

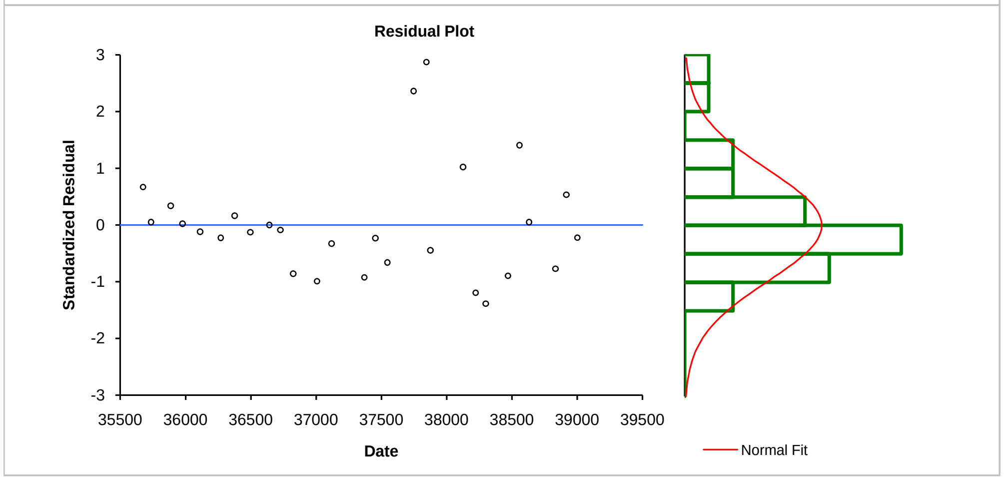
n	28 (cases excluded: 110 due to missing values)

R^2	0.55
Adjusted R^2	0.54
SE	17.95

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-662.2	-914.4 to -410.0	122.69	-5.40	26	<0.0001
Slope	0.01865	0.01190 to 0.02540	0.003284	5.68	26	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	10389.84	1	10389.84	32.24	<0.0001
Residual	8378.26	26	322.24		
Total	18768.11	27			





Analyse-it v2.09

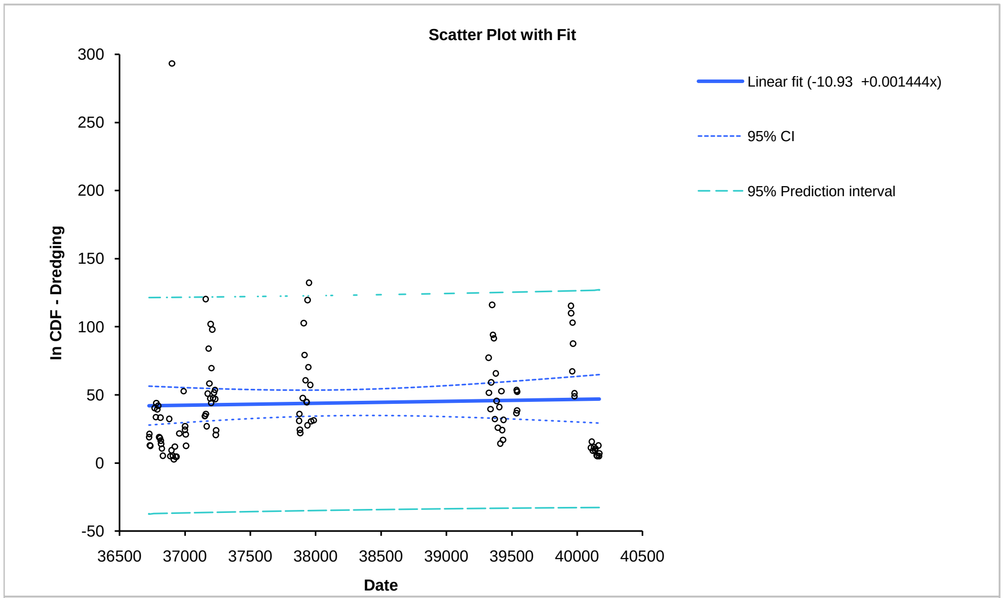
Test	Regression - Linear	TSS
	In CDF - Dredging v Date	
Performed by	h6theres	Date: 17 December 2010

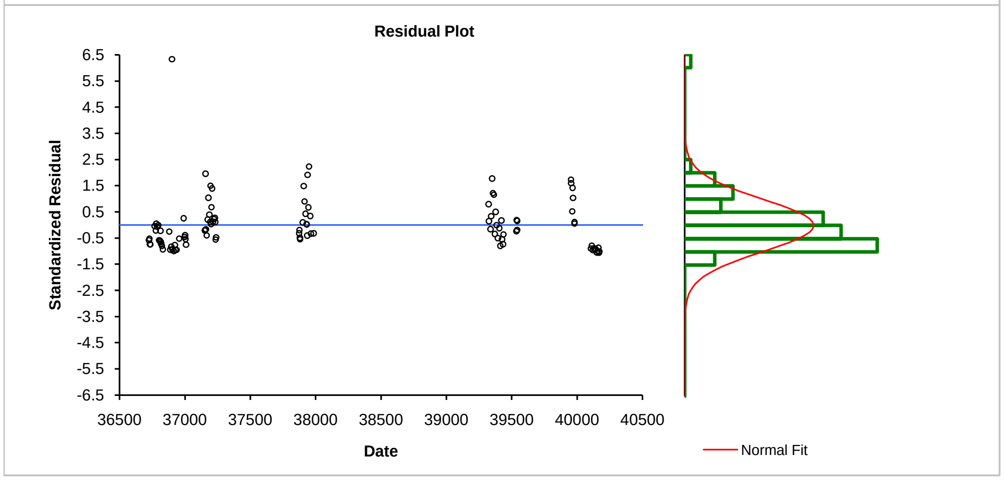
n 107 (cases excluded: 31 due to missing values)

R^2	0.00
Adjusted R^2	-0.01
SE	39.60

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-10.93	-239.42 to 217.56	115.236	-0.09	105	0.9246
Slope	0.001444	-0.004541 to 0.007429	0.0030186	0.48	105	0.6334

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	358.78	1	358.78	0.23	0.6334
Residual	164655.80	105	1568.15		
Total	165014.58	106			





Analyse-it v2.09

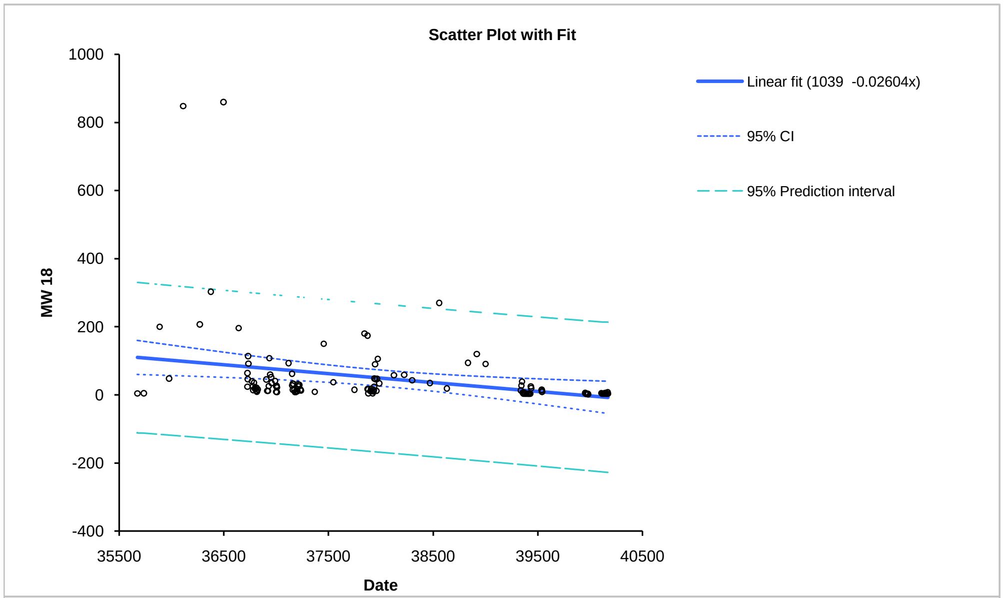
Test	**Regression - Linear**	TSS	
	MW 18 v Date		
Performed by	h6theres	Date	17 December 2010

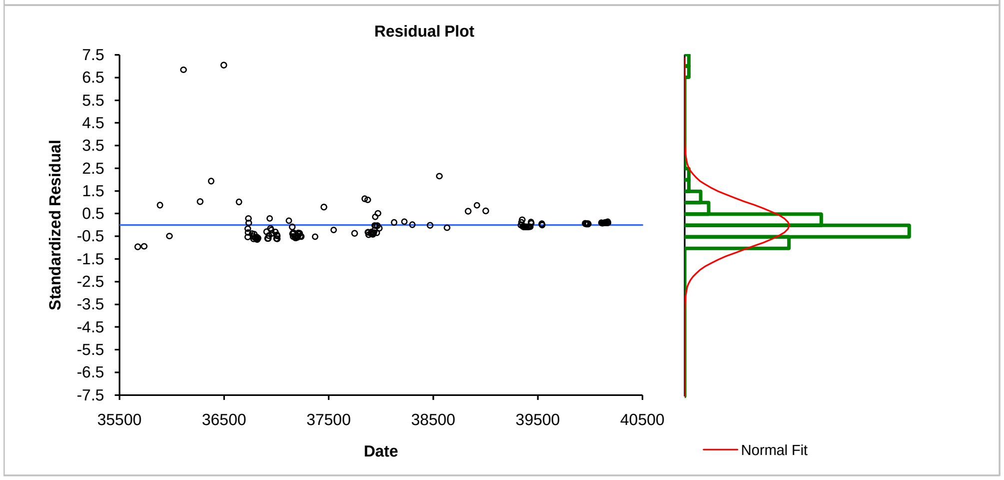
n	130	(cases excluded: 8 due to missing values)

R^2	0.08
Adjusted R^2	0.08
SE	109.53

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	1039	467 to 1611	289.1	3.59	128	0.0005
Slope	-0.02604	-0.04108 to -0.01099	0.007604	-3.42	128	0.0008

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	140682.69	1	140682.69	11.73	0.0008
Residual	1535593.20	128	11996.82		
Total	1676275.89	129			





Test | **Regression - Linear** TSS

MW 19 v Date

Performed by | h6theres

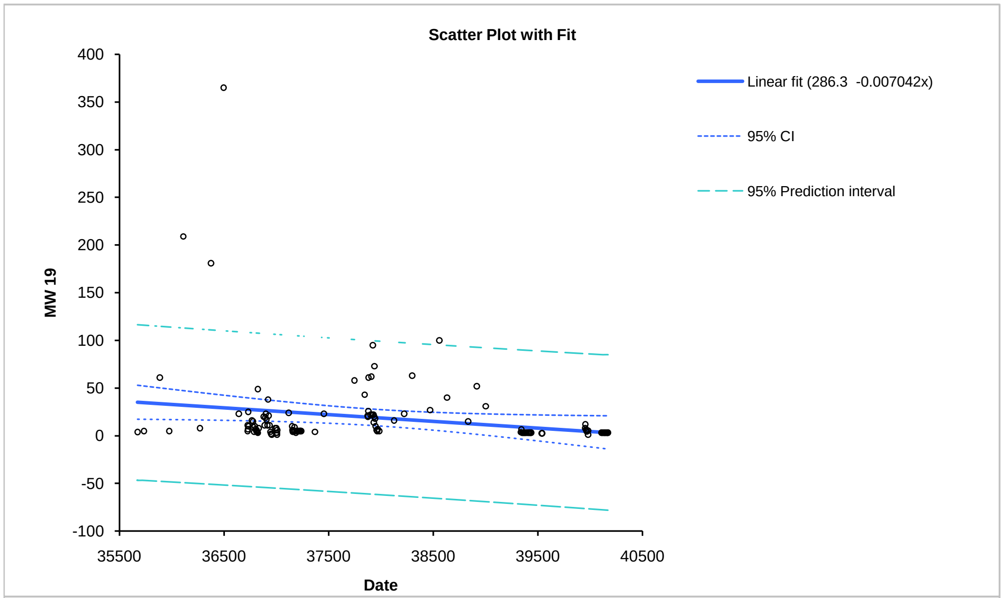
Date | 17 December 2010

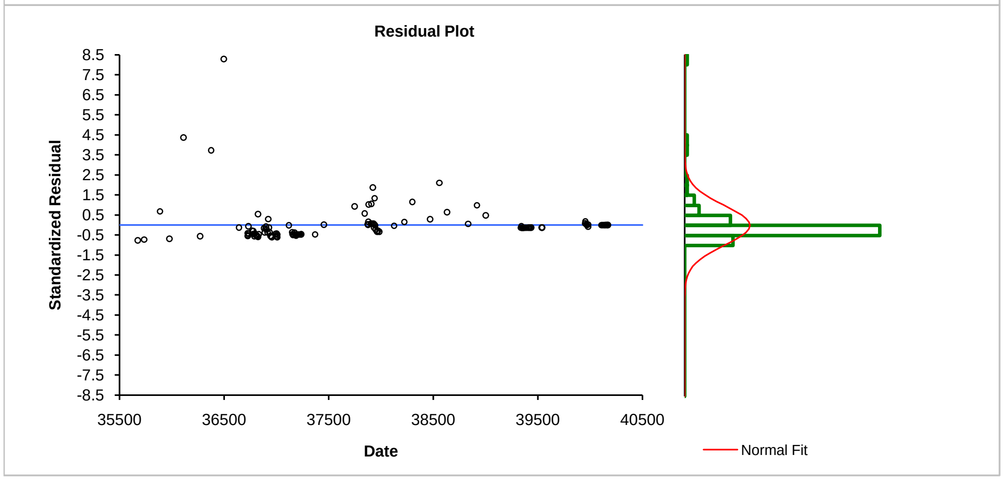
n	135 (cases excluded: 3 due to missing values)

R^2	0.05
Adjusted R^2	0.04
SE	40.49

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	286.3	78.7 to 493.9	104.95	2.73	133	0.0072
Slope	-0.007042	-0.012509 to -0.001576	0.0027635	-2.55	133	0.0120

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	10647.11	1	10647.11	6.49	0.0120
Residual	218057.22	133	1639.53		
Total	228704.33	134			





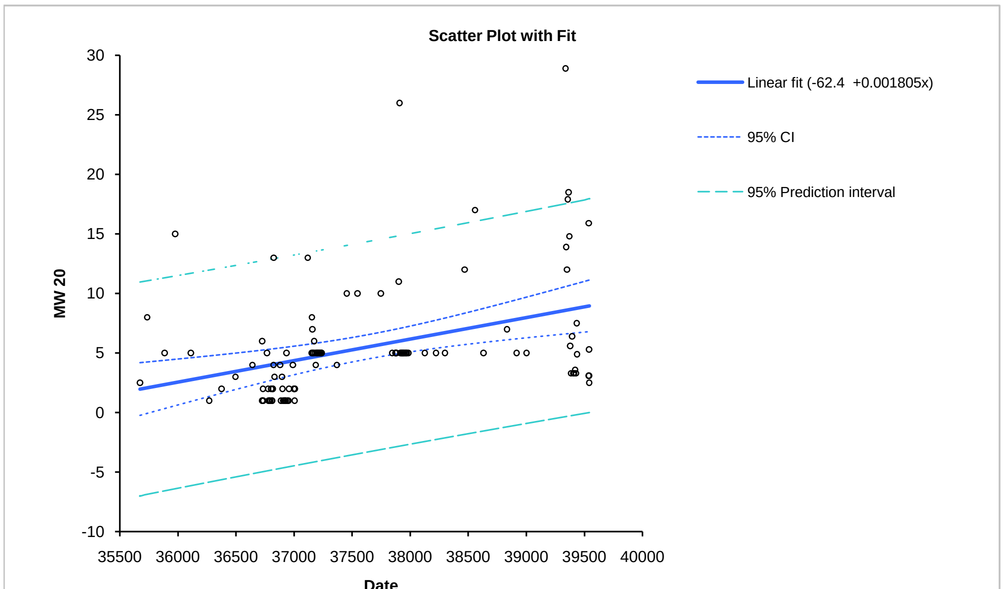
Test	**Regression - Linear**	TSS	
	MW 20 v Date		
Performed by	h6theres	Date	17 December 2010

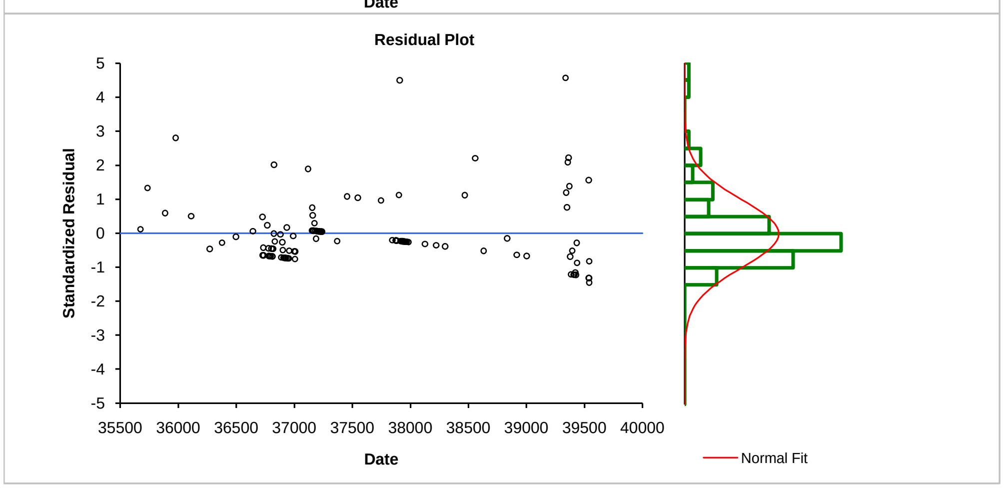
n 117 (cases excluded: 21 due to missing values)

R^2	0.15
Adjusted R^2	0.14
SE	4.44

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-62.4	-92.5 to -32.3	15.20	-4.10	115	<0.0001
Slope	0.001805	0.001005 to 0.002605	0.0004038	4.47	115	<0.0001

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	394.19	1	394.19	19.98	<0.0001
Residual	2269.26	115	19.73		
Total	2663.45	116			





Analyse-it v2.09

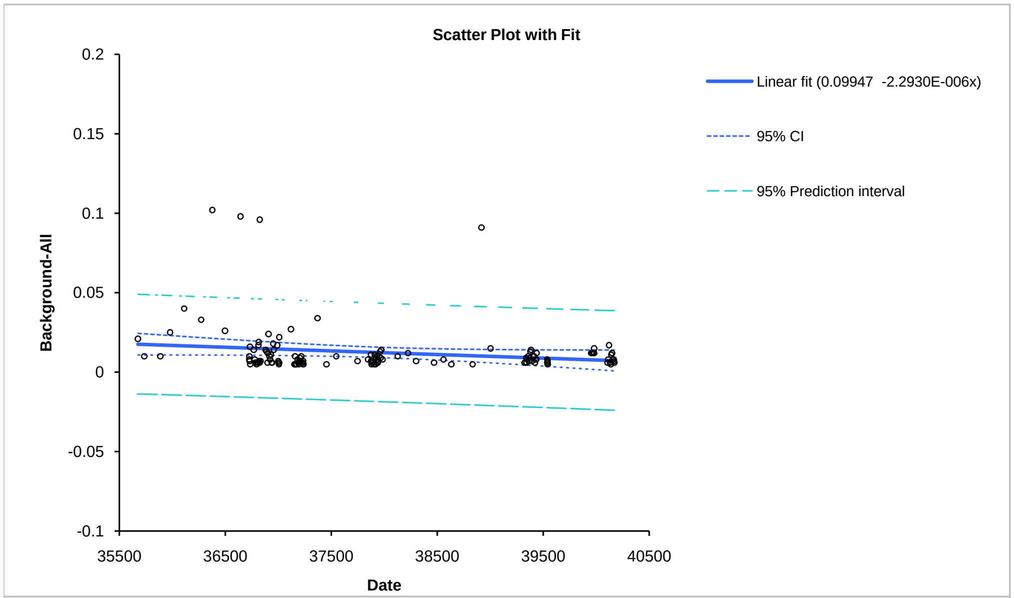
Test	**Regression - Linear**	Zinc
	Background-All v Date	
Performed by	h6theres	Date 16 December 2010

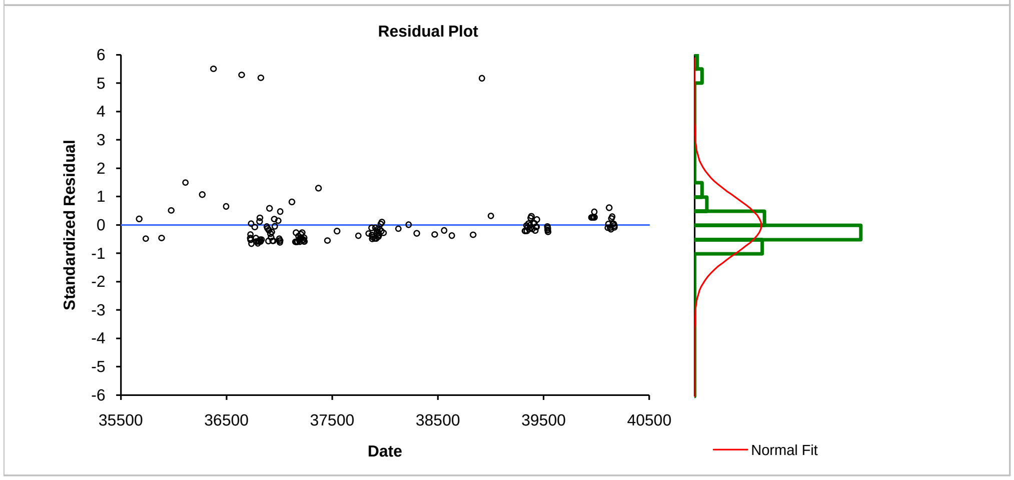
n	138

R^2	0.03
Adjusted R^2	0.03
SE	0.01560

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.09947	0.02019 to 0.17875	0.040090	2.48	136	0.0143
Slope	-2.2930E-06	-4.3797E-06 to -2.0629E-07	1.0552E-006	-2.17	136	0.0315

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00115	1	0.00115	4.72	0.0315
Residual	0.03310	136	0.00024		
Total	0.03425	137			





Analyse-it v2.09

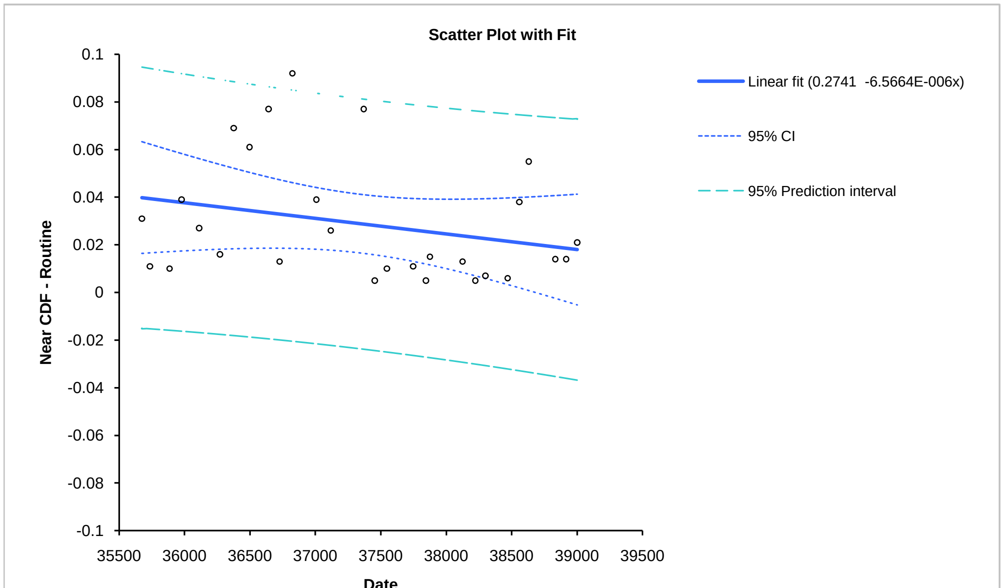
Test	**Regression - Linear**	Zinc		
	Near CDF - Routine v Date			
Performed by	h6theres		Date	16 December 2010

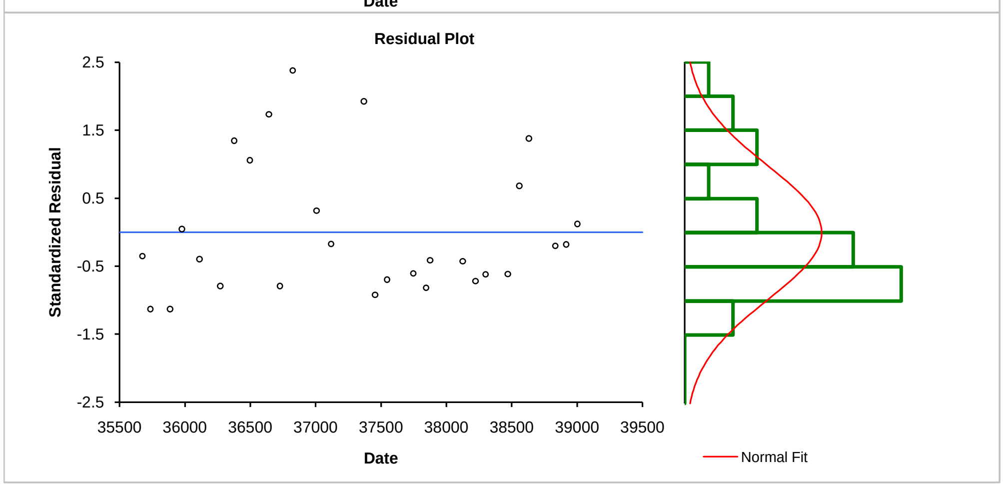
n 28 (cases excluded: 110 due to missing values)

R^2	0.07
Adjusted R^2	0.04
SE	0.02511

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.2741	-0.0786 to 0.6268	0.17159	1.60	26	0.1223
Slope	-6.5664E-06	-1.6007E-05 to 2.8740E-06	4.5927E-006	-1.43	26	0.1647

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00129	1	0.00129	2.04	0.1647
Residual	0.01639	26	0.00063		
Total	0.01768	27			





Test	**Regression - Linear**	Zinc
	Near CDF - Dredging v Date	
Performed by	h6theres	Date: 16 December 2010

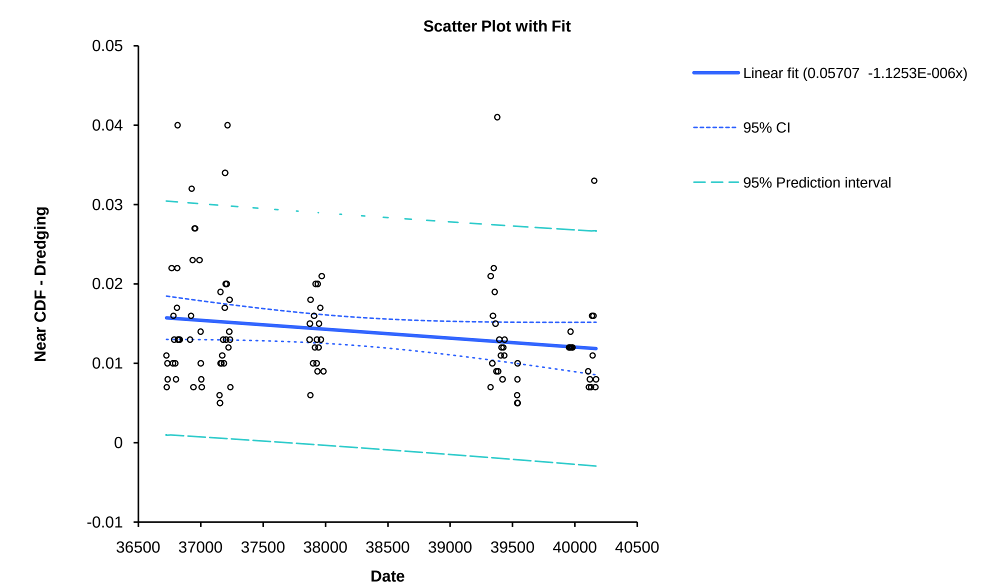
Analyse-it v2.09

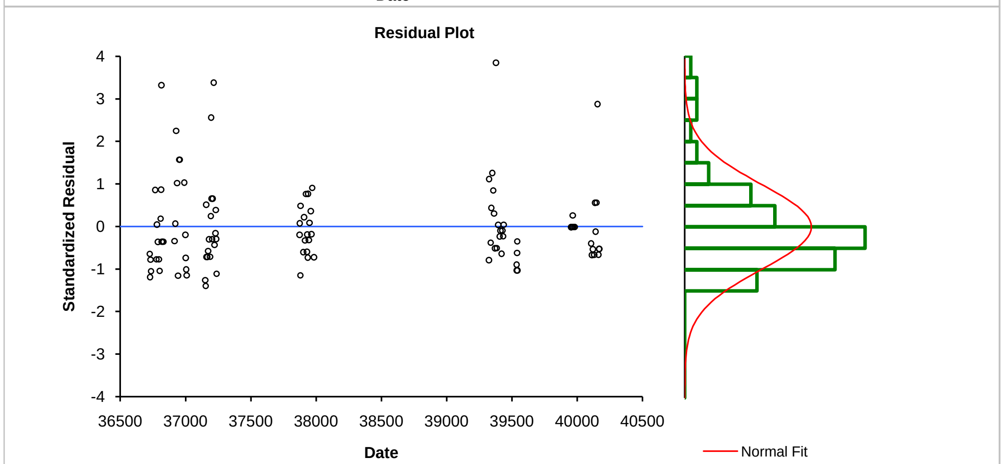
n	105	(cases excluded: 33 due to missing values)

R^2	0.04
Adjusted R^2	0.03
SE	0.00733

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.05707	0.01405 to 0.10009	0.021690	2.63	103	0.0098
Slope	-1.1253E-06	-2.2511E-06 to 4.5038E-10	5.6764E-007	-1.98	103	0.0501

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00021	1	0.00021	3.93	0.0501
Residual	0.00554	103	0.00005		
Total	0.00575	104			





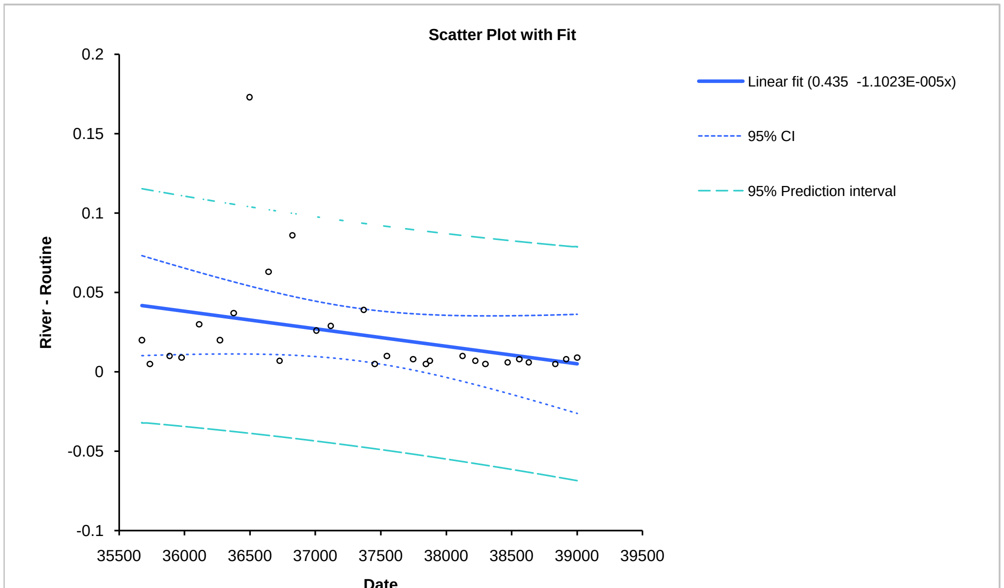
Test	**Regression - Linear**	Zinc	
	River - Routine v Date		
Performed by	h6theres	Date	16 December 2010

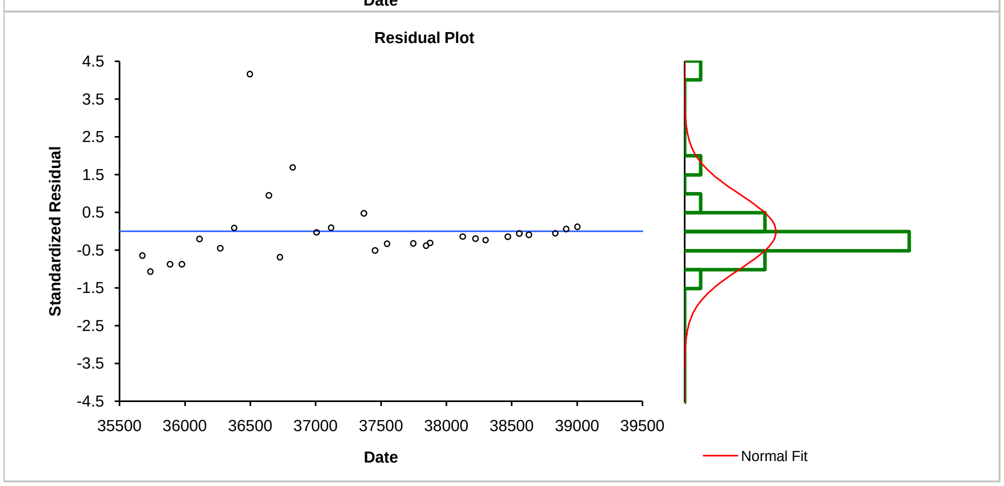
n	28 (cases excluded: 110 due to missing values)

R^2	0.11
Adjusted R^2	0.08
SE	0.03371

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.435	-0.039 to 0.909	0.2304	1.89	26	0.0702
Slope	-1.1023E-05	-2.3697E-05 to 1.6519E-06	6.1661E-006	-1.79	26	0.0855

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00363	1	0.00363	3.20	0.0855
Residual	0.02954	26	0.00114		
Total	0.03317	27			





Analyse-it v2.09

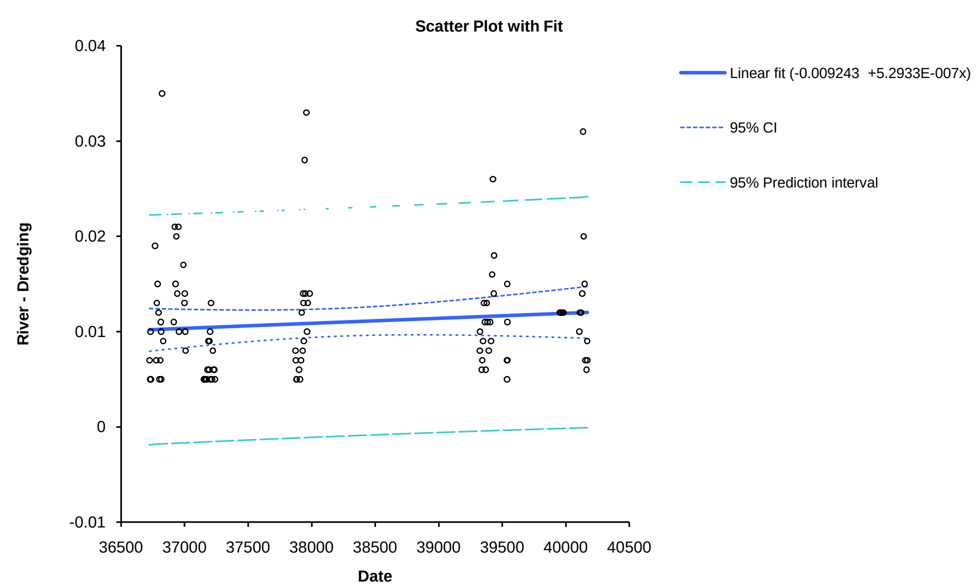
Test	Regression - Linear	Zinc
	River - Dredging v Date	
Performed by	h6theres	Date 16 December 2010

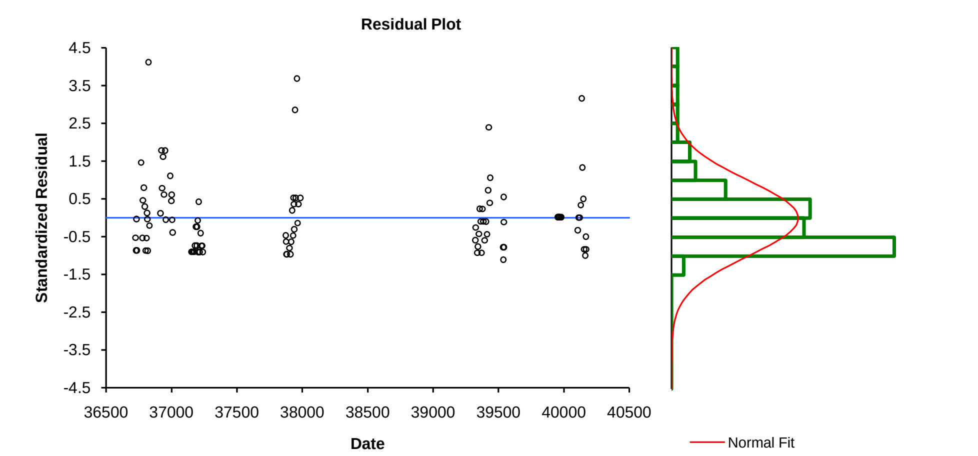
n	105 (cases excluded: 33 due to missing values)

R^2	0.01
Adjusted R^2	0.00
SE	0.00601

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.009243	-0.044469 to 0.025982	0.0177615	-0.52	103	0.6039
Slope	5.2933E-07	-3.9256E-07 to 1.4512E-06	4.6483E-007	1.14	103	0.2575

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00005	1	0.00005	1.30	0.2575
Residual	0.00372	103	0.00004		
Total	0.00376	104			





Analyse-it v2.09

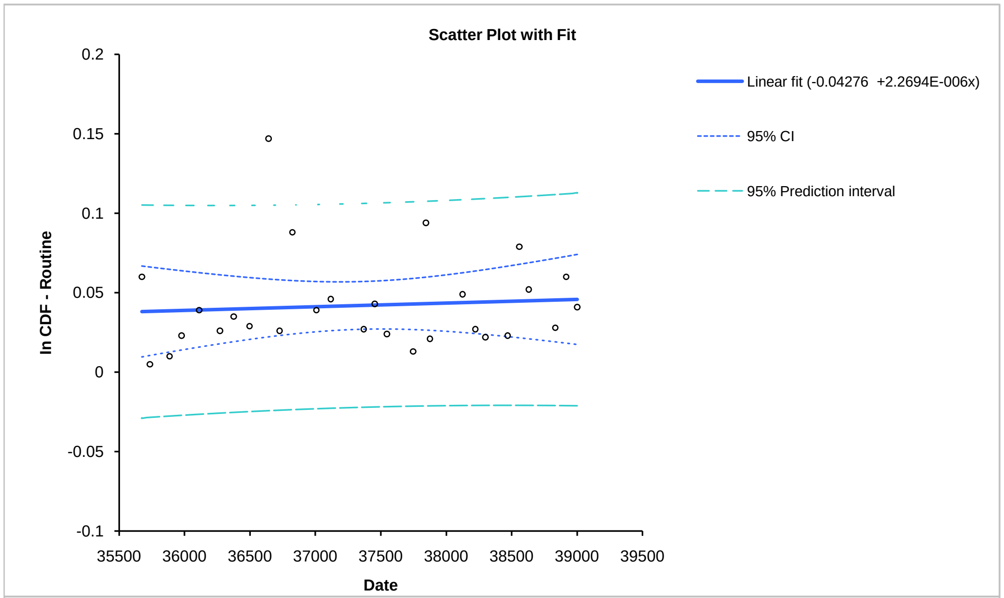
Test	Regression - Linear	Zinc
	In CDF - Routine v Date	
Performed by	h6theres	Date 16 December 2010

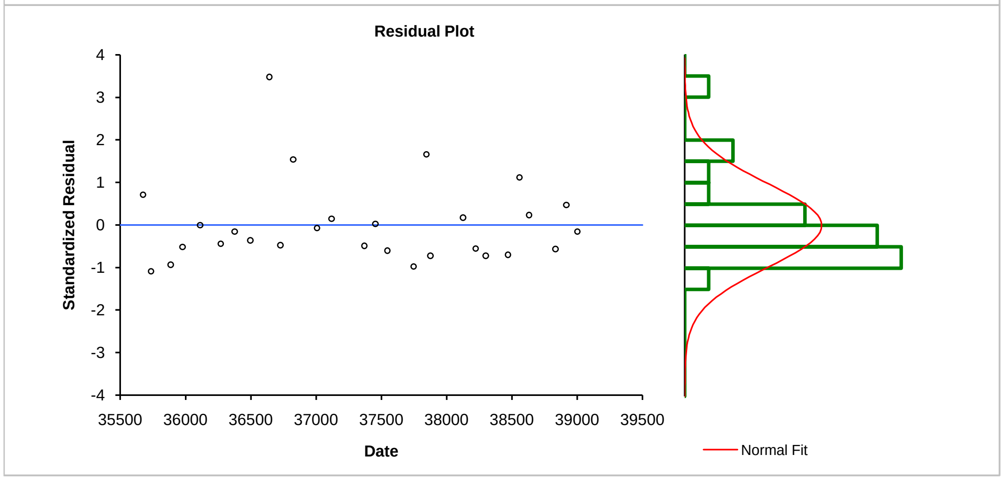
n 28 (cases excluded: 110 due to missing values)

R^2	0.01
Adjusted R^2	-0.03
SE	0.03063

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.04276	-0.47305 to 0.38754	0.209336	-0.20	26	0.8398
Slope	2.2694E-06	-9.2476E-06 to 1.3786E-05	5.6029E-006	0.41	26	0.6888

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00015	1	0.00015	0.16	0.6888
Residual	0.02439	26	0.00094		
Total	0.02454	27			





Analyse-it v2.09

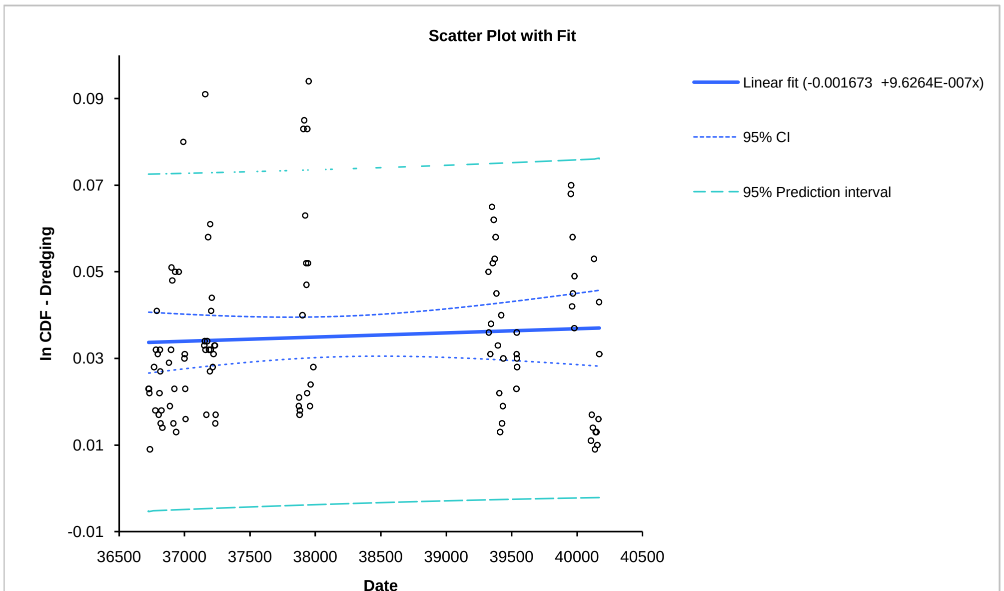
Test	**Regression - Linear**	Zinc		
	ln CDF - Dredging v Date			
Performed by	h6theres		Date	16 December 2010

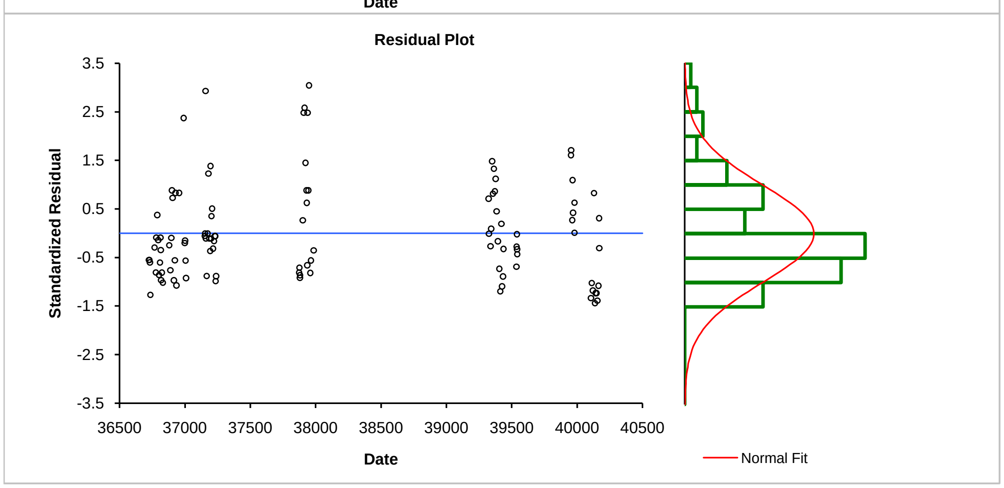
n	107 (cases excluded: 31 due to missing values)

R^2	0.00
Adjusted R^2	-0.01
SE	0.01942

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.001673	-0.113708 to 0.110362	0.0565031	-0.03	105	0.9764
Slope	9.6264E-07	-1.9721E-06 to 3.8974E-06	1.4801E-006	0.65	105	0.5169

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00016	1	0.00016	0.42	0.5169
Residual	0.03959	105	0.00038		
Total	0.03975	106			





Analyse-it v2.09

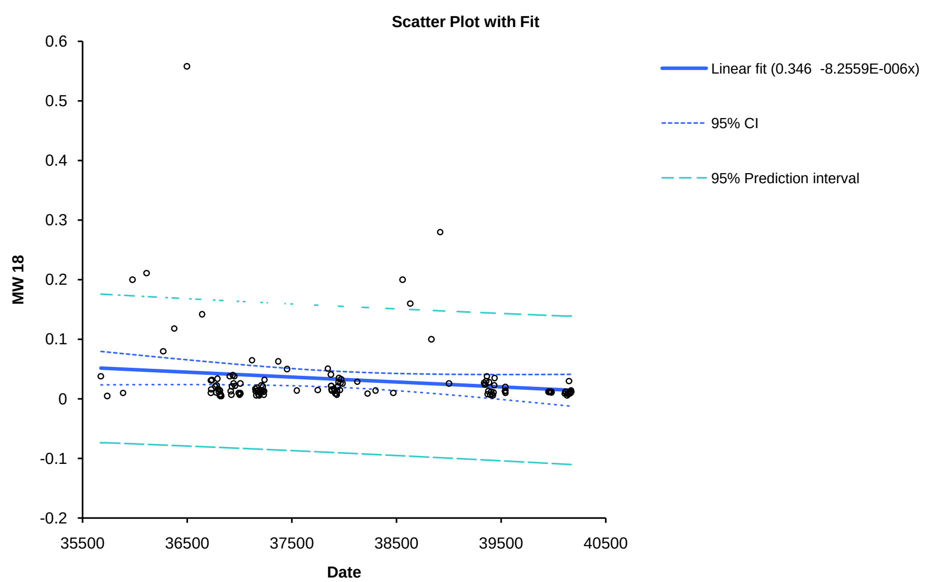
Test	**Regression - Linear**	Zinc	
	MW 18 v Date		
Performed by	h6theres	Date	16 December 2010

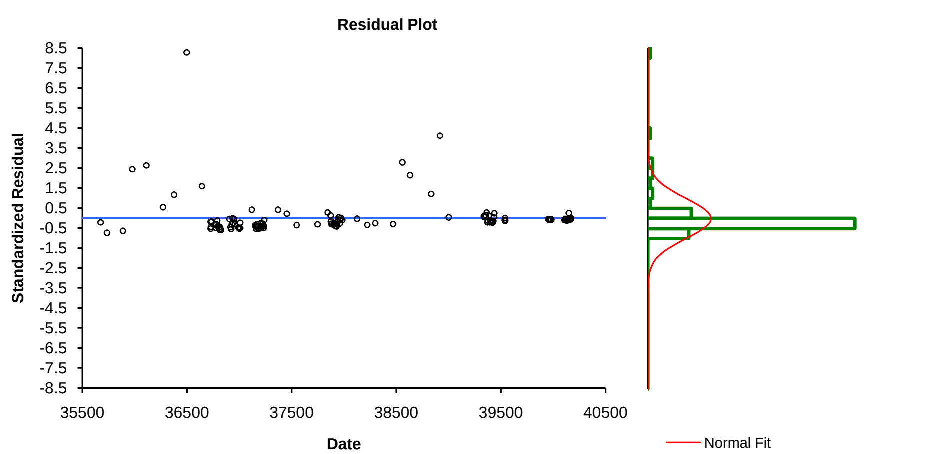
n	131 (cases excluded: 7 due to missing values)

R^2	0.03
Adjusted R^2	0.02
SE	0.06197

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.346	0.023 to 0.669	0.1630	2.12	129	0.0357
Slope	-8.2559E-06	-1.6740E-05 to 2.2832E-07	4.2881E-006	-1.93	129	0.0564

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.01424	1	0.01424	3.71	0.0564
Residual	0.49545	129	0.00384		
Total	0.50969	130			





Analyse-it v2.09

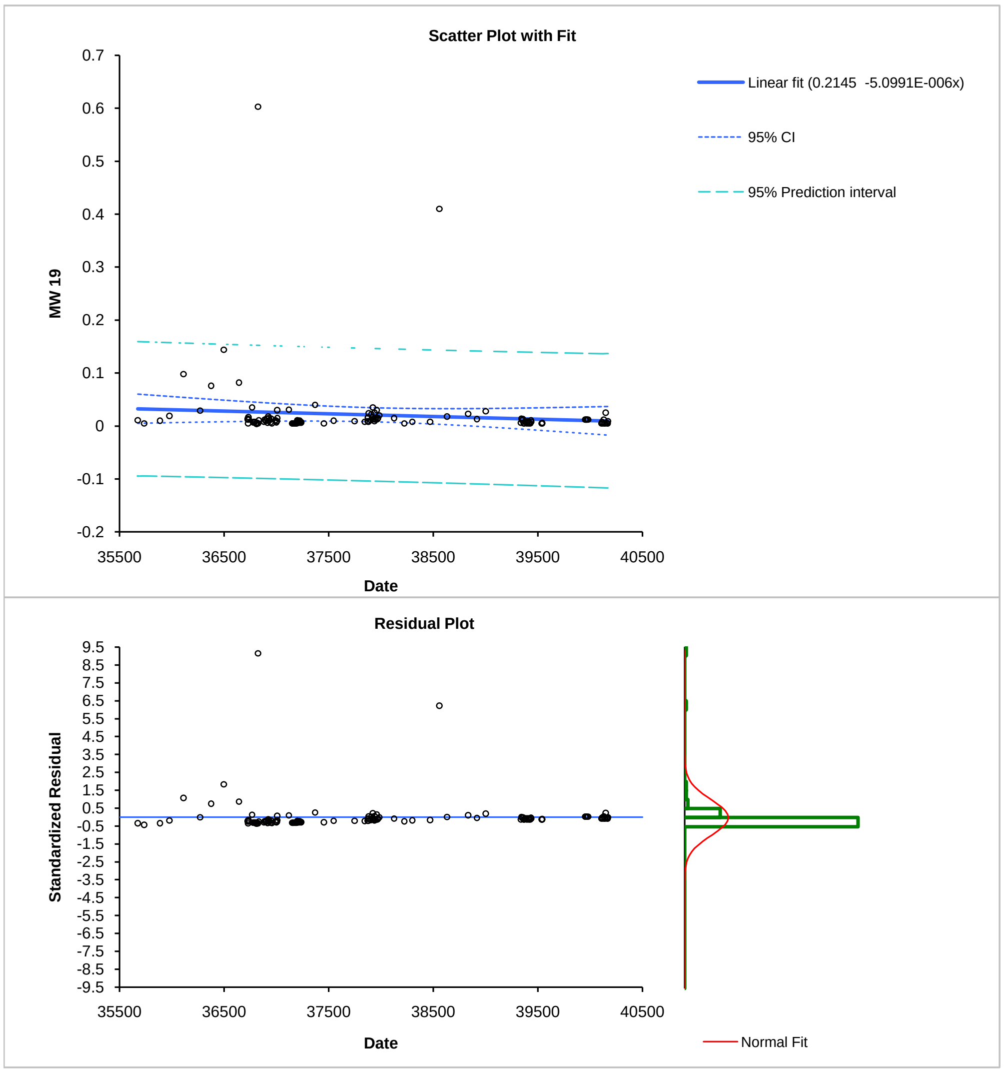
Test	**Regression - Linear**	Zinc	
	MW 19 v Date		
Performed by	h6theres	Date	16 December 2010

n 136 (cases excluded: 2 due to missing values)

R^2	0.01
Adjusted R^2	0.00
SE	0.06300

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	0.2145	-0.1083 to 0.5373	0.16321	1.31	134	0.1911
Slope	-5.0991E-06	-1.3600E-05 to 3.4019E-06	4.2982E-006	-1.19	134	0.2376

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00559	1	0.00559	1.41	0.2376
Residual	0.53187	134	0.00397		
Total	0.53745	135			



Analyse-it v2.09

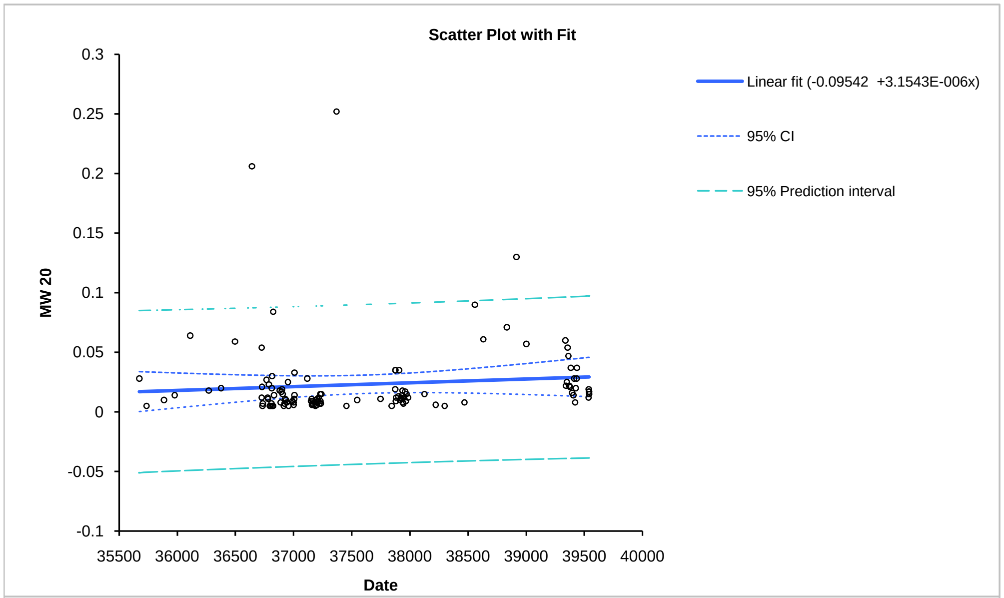
Test	**Regression - Linear**	Zinc	
	MW 20 v Date		
Performed by	h6theres	Date	16 December 2010

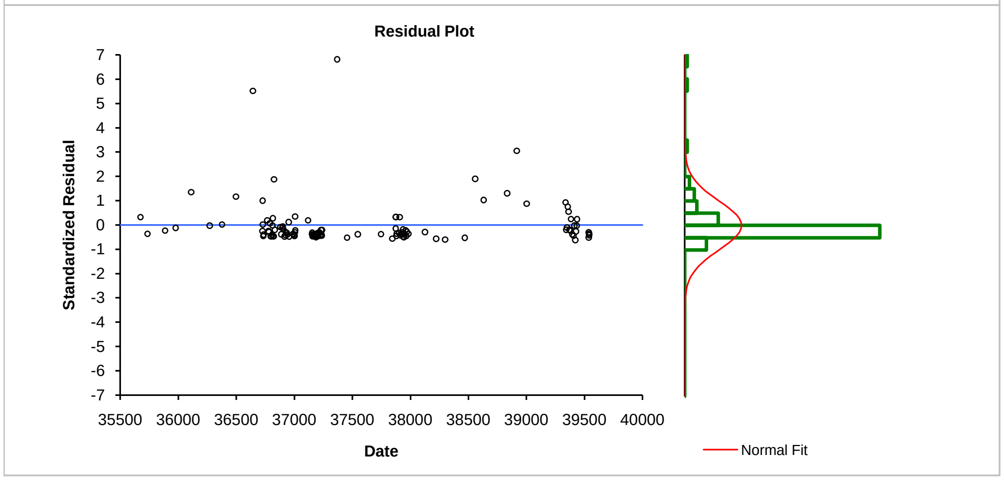
n 118 (cases excluded: 20 due to missing values)

R^2	0.01
Adjusted R^2	0.00
SE	0.03368

Term	Coefficient	95% CI	SE	t statistic	DF	p
Intercept	-0.09542	-0.32331 to 0.13247	0.115058	-0.83	116	0.4086
Slope	3.1543E-06	-2.8998E-06 to 9.2084E-06	3.0566E-006	1.03	116	0.3042

Source of variation	Sum squares	DF	Mean square	F statistic	p
Model	0.00121	1	0.00121	1.06	0.3042
Residual	0.13158	116	0.00113		
Total	0.13279	117			

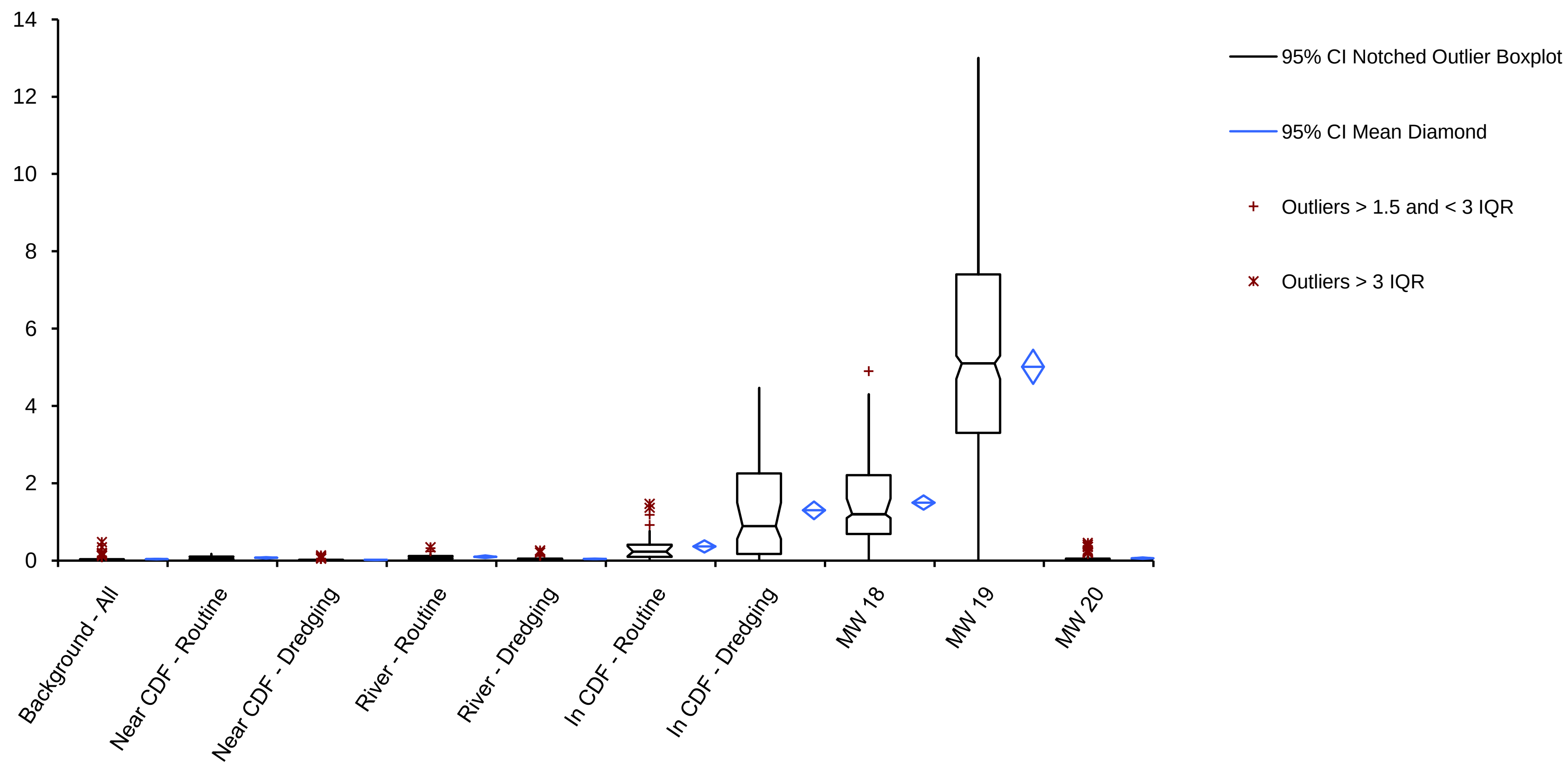




Appendix D: Comparative Descriptives

v2.09

Test	**Describe - Comparative** Ammonia
	Background - All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW 19, MW
Performed by	h6theres Date 8 December 2010



Analyse-it v2.09

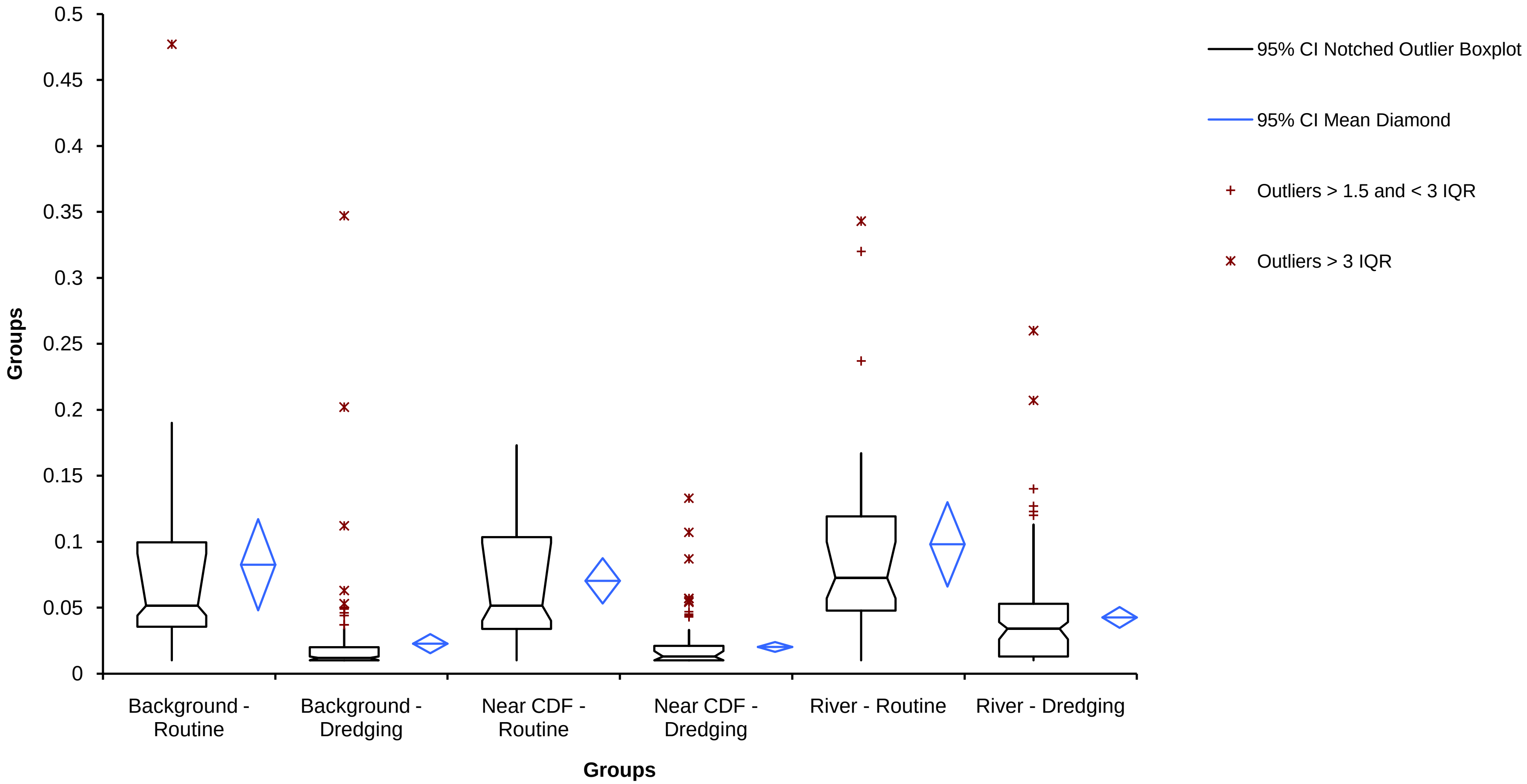
Test	**Describe - Comparative** Ammonia
	Background - All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW 19, MW
Performed by	h6theres — Date 8 December 2010

	n	Mean	95% CI	SE	SD
Background - All	138	0.0348	0.0251 to 0.0446	0.00492	0.05784
Near CDF - Routine	28	0.0703	0.0531 to 0.0875	0.00839	0.04439
Near CDF - Dredging	105	0.0201	0.0164 to 0.0238	0.00188	0.01925
River - Routine	28	0.0980	0.0660 to 0.1300	0.01558	0.08242
River - Dredging	105	0.0425	0.0346 to 0.0504	0.00398	0.04078
In CDF - Routine	28	0.3649	0.2078 to 0.5220	0.07657	0.40516
In CDF - Dredging	107	1.2992	1.0697 to 1.5287	0.11574	1.19722
MW 18	130	1.5000	1.3146 to 1.6853	0.09366	1.06788
MW 19	135	5.0124	4.5706 to 5.4541	0.22335	2.59512
MW 20	118	0.0606	0.0431 to 0.0781	0.00885	0.09611

	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background - All	138	0.010	0.0100	0.0150	0.0120 to 0.0180	0.0370	0.477	0.0270
Near CDF - Routine	28	0.010	0.0339	0.0515	0.0400 to 0.0990	0.1035	0.173	0.0696
Near CDF - Dredging	105	0.010	0.0100	0.0130	0.0100 to 0.0170	0.0210	0.133	0.0110
River - Routine	28	0.010	0.0477	0.0725	0.0570 to 0.1000	0.1191	0.343	0.0714
River - Dredging	105	0.010	0.0130	0.0340	0.0260 to 0.0390	0.0530	0.260	0.0400
In CDF - Routine	28	0.020	0.0943	0.2295	0.1100 to 0.3730	0.4083	1.467	0.3139
In CDF - Dredging	107	0.010	0.1680	0.8930	0.5600 to 1.5000	2.2558	4.467	2.0878
MW 18	130	0.020	0.6900	1.2000	1.1000 to 1.6000	2.2083	4.900	1.5183
MW 19	135	0.010	3.3000	5.1000	4.7000 to 5.3000	7.4000	13.000	4.1000
MW 20	118	0.010	0.0100	0.0200	0.0100 to 0.0300	0.0542	0.460	0.0442

Analyse-it v2.09

Test	**Describe - Comparative**	Ammonia
	Groups: Background - Routine, Background - Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging	
Performed by	h6theres	Date 16 December 2010



Analyse-it v2.09

Test	**Describe - Comparative** Ammonia
	Groups: Background - Routine, Background - Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging
Performed by	h6theres
Date	16 December 2010

Groups	n	Mean	95% CI	SE	SD
Background - Routine	28	0.0826	0.0480 to 0.1172	0.01685	0.08919
Background - Dredging	110	0.0227	0.0154 to 0.0300	0.00369	0.03872
Near CDF - Routine	28	0.0703	0.0531 to 0.0875	0.00839	0.04439
Near CDF - Dredging	105	0.0201	0.0164 to 0.0238	0.00188	0.01925
River - Routine	28	0.0980	0.0660 to 0.1300	0.01558	0.08242
River - Dredging	105	0.0425	0.0346 to 0.0504	0.00398	0.04078

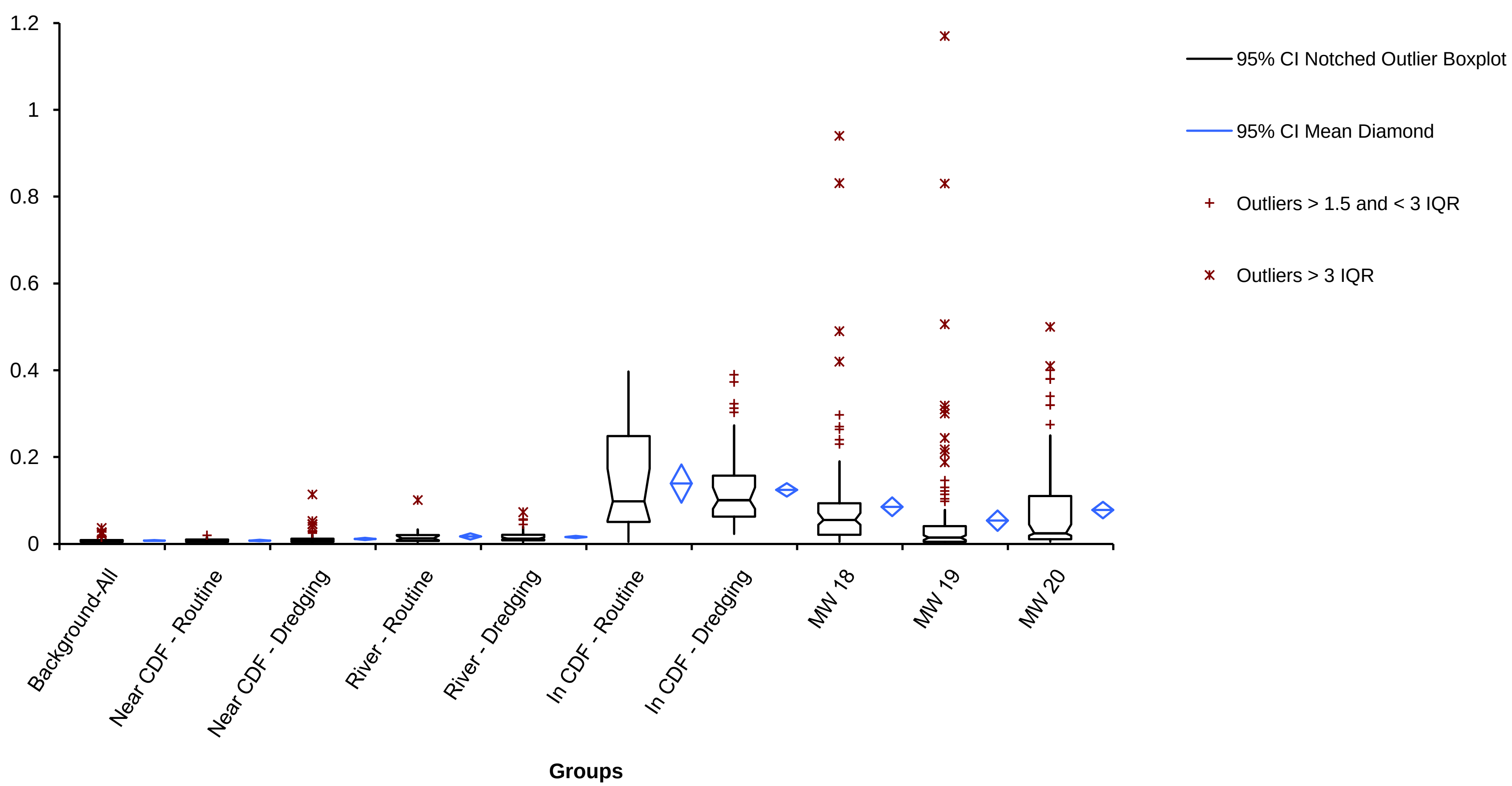
Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background - Routine	28	0.01000	0.0356	0.0515	0.0440 to 0.0910	0.0996	0.4770	0.0640
Background - Dredging	110	0.01000	0.0100	0.0120	0.0100 to 0.0130	0.0200	0.3470	0.0100
Near CDF - Routine	28	0.01000	0.0339	0.0515	0.0400 to 0.0990	0.1035	0.1730	0.0696
Near CDF - Dredging	105	0.01000	0.0100	0.0130	0.0100 to 0.0170	0.0210	0.1330	0.0110
River - Routine	28	0.01000	0.0477	0.0725	0.0570 to 0.1000	0.1191	0.3430	0.0714
River - Dredging	105	0.01000	0.0130	0.0340	0.0260 to 0.0390	0.0530	0.2600	0.0400

Test **Describe - Comparative** Manganese

Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW

Performed by h6theres Date 14 December 2010

v2.09



Analyse-it v2.09

Test **Describe - Comparative** Manganese

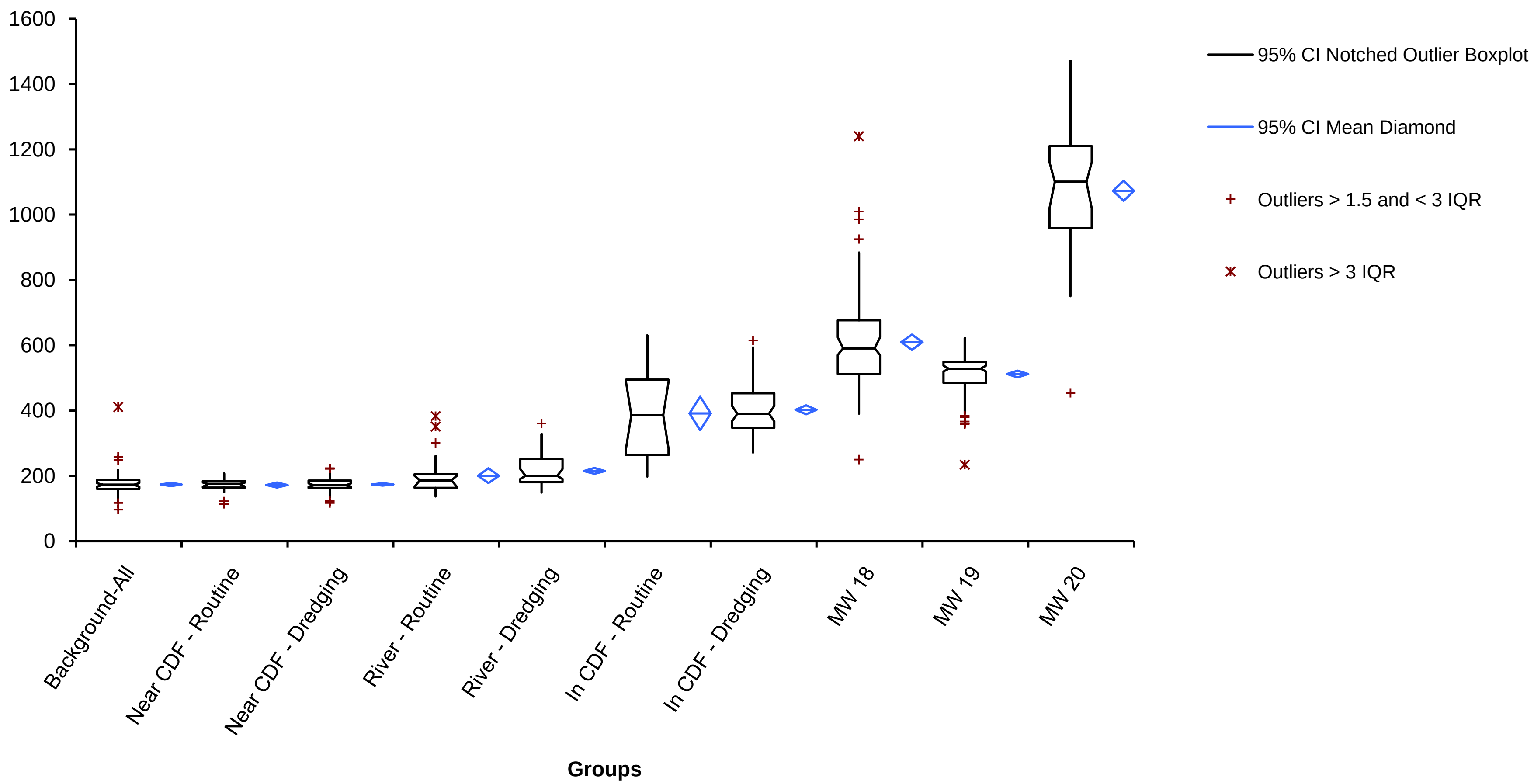
Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW

Performed by h6theres Date 14 December 2010

Groups	n	Mean	95% CI		SE	SD
Background-All	138	0.0076	0.0067	0.0085	0.0005	0.0054
Near CDF - Routine	28	0.0078	0.0062	0.0093	0.0007	0.0039
Near CDF - Dredging	105	0.0112	0.0086	0.0138	0.0013	0.0135
River - Routine	28	0.0173	0.0101	0.0244	0.0035	0.0185
River - Dredging	105	0.0160	0.0136	0.0184	0.0012	0.0123
In CDF - Routine	28	0.1390	0.0952	0.1827	0.0213	0.1128
In CDF - Dredging	107	0.1245	0.1090	0.1400	0.0078	0.0809
MW 18	131	0.0856	0.0640	0.1072	0.0109	0.1251
MW 19	136	0.0536	0.0302	0.0770	0.0118	0.1381
MW 20	118	0.0781	0.0590	0.0971	0.0096	0.1043

Groups	n	Min	1st Quartile	Median	95% CI		3rd Quartile	Max	IQR
Background-All	138	0.0010	0.0050	0.0060	0.0050	0.0070	0.0090	0.0370	0.0040
Near CDF - Routine	28	0.0030	0.0050	0.0060	0.0050	0.0080	0.0100	0.0200	0.0050
Near CDF - Dredging	105	0.0010	0.0050	0.0080	0.0060	0.0090	0.0120	0.1140	0.0070
River - Routine	28	0.0040	0.0068	0.0130	0.0080	0.0190	0.0206	0.1010	0.0138
River - Dredging	105	0.0020	0.0080	0.0120	0.0100	0.0150	0.0213	0.0730	0.0133
In CDF - Routine	28	0.0050	0.0508	0.0980	0.0540	0.1730	0.2488	0.3970	0.1979
In CDF - Dredging	107	0.0230	0.0630	0.1010	0.0810	0.1300	0.1570	0.3900	0.0940
MW 18	131	0.0050	0.0213	0.0550	0.0440	0.0710	0.0938	0.9400	0.0725
MW 19	136	0.0010	0.0050	0.0145	0.0090	0.0200	0.0410	1.1700	0.0360
MW 20	118	0.0050	0.0110	0.0245	0.0190	0.0450	0.1103	0.5000	0.0993

Test	**Describe - Comparative** TDS
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW
Performed by	h6theres Date 17 December 2010



Analyse-it v2.09

Test	**Describe - Comparative**	TDS	
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW		
Performed by	h6theres	Date	17 December 2010

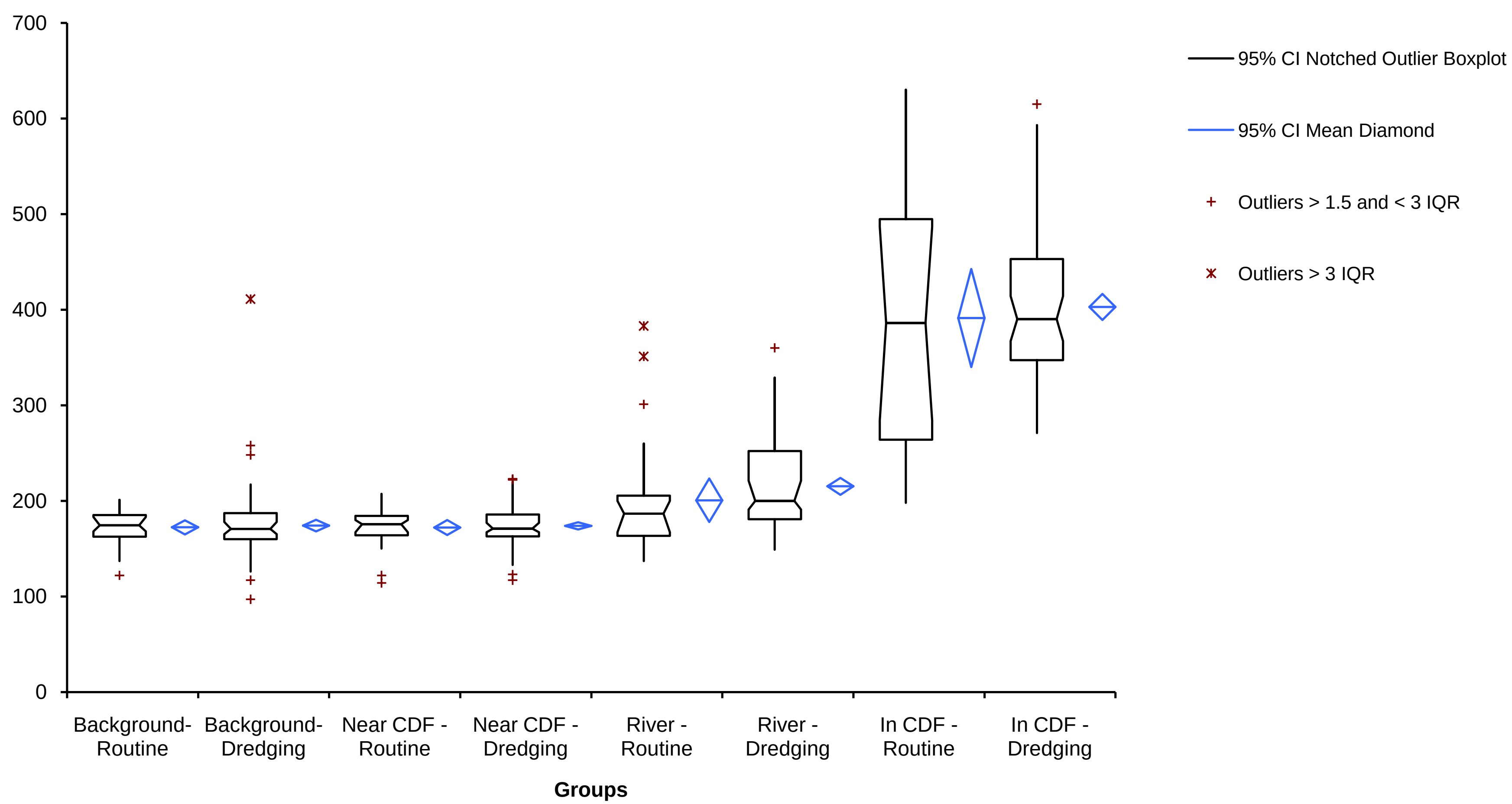
Groups	n	Mean	95% CI	SE	SD
Background-All	138	174	169 to 179	2.6	30.3
Near CDF - Routine	28	172	164 to 180	3.8	20.1
Near CDF - Dredging	105	174	170 to 178	1.9	19.7
River - Routine	28	201	178 to 223	11.2	59.0
River - Dredging	105	215	206 to 224	4.5	46.0
In CDF - Routine	28	391	340 to 442	25.0	132.3
In CDF - Dredging	107	403	389 to 416	6.9	71.2
MW 18	130	609	586 to 633	11.8	134.4
MW 19	135	512	502 to 522	5.2	60.4
MW 20	117	1073	1042 to 1104	15.5	167.3

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-All	138	97	160	173	167 to 178	187	411	27
Near CDF - Routine	28	114	164	176	167 to 180	184	207	20
Near CDF - Dredging	105	117	163	171	167 to 177	186	223	23
River - Routine	28	137	163	187	167 to 200	205	383	42
River - Dredging	105	149	181	200	191 to 221	252	360	71
In CDF - Routine	28	198	264	386	284 to 487	495	630	231
In CDF - Dredging	107	271	347	390	367 to 414	453	615	106
MW 18	130	250	512	591	570 to 624	676	1240	164
MW 19	135	234	485	528	520 to 538	550	622	65
MW 20	117	454	958	1100	1020 to 1160	1210	1470	252

Analyse-it v2.09

Test	**Describe - Comparative** TDS
	Groups: Background-Routine, Background-Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CI
Performed by	h6theres

Date 17 December 2010



Analyse-it v2.09

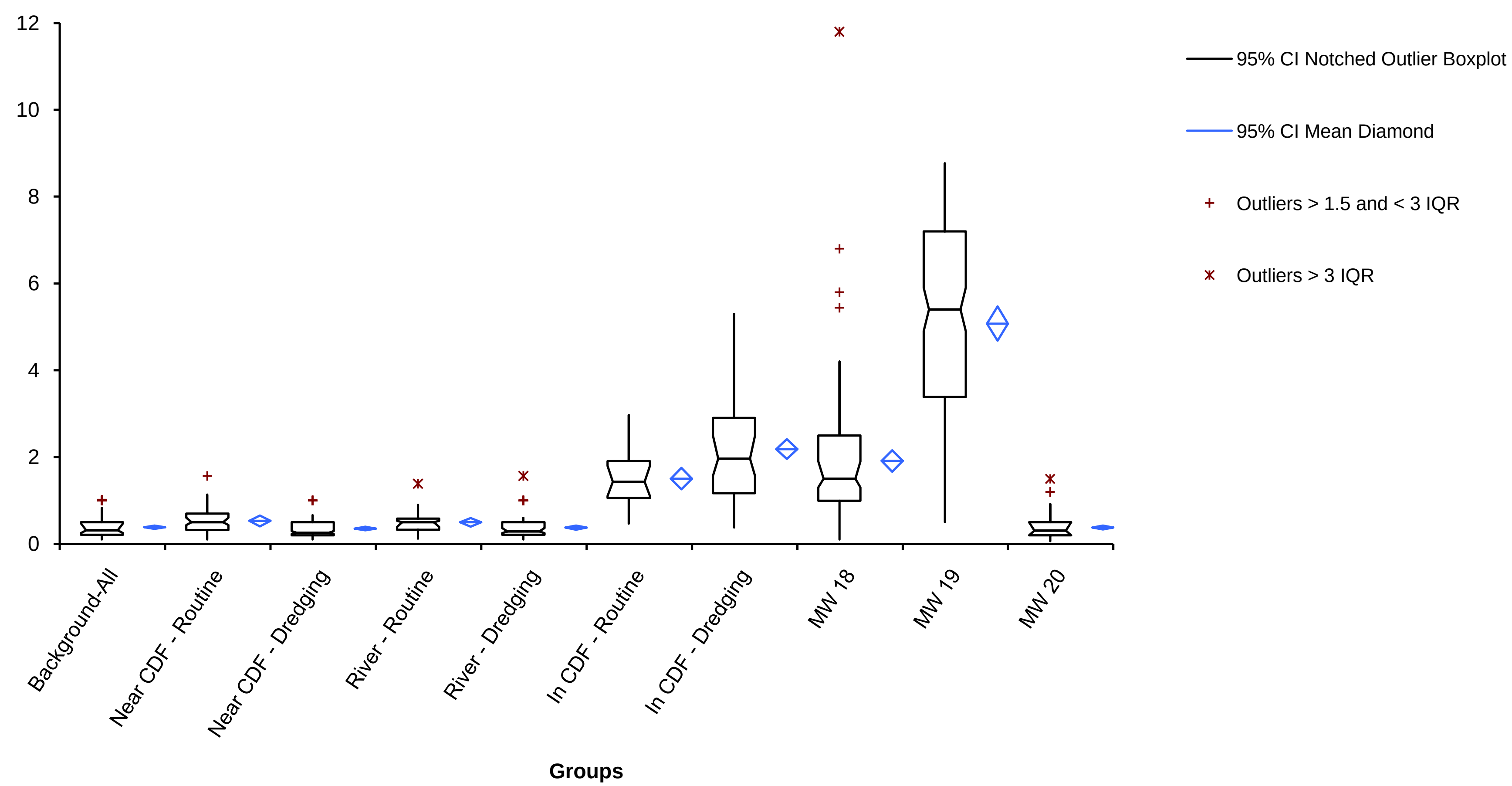
Test	**Describe - Comparative** TDS
	Groups: Background-Routine, Background-Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CI
Performed by	h6theres Date 17 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-Routine	28	172	165 to 180	3.7	19.3
Background-Dredging	110	174	168 to 180	3.1	32.5
Near CDF - Routine	28	172	164 to 180	3.8	20.1
Near CDF - Dredging	105	174	170 to 178	1.9	19.7
River - Routine	28	201	178 to 223	11.2	59.0
River - Dredging	105	215	206 to 224	4.5	46.0
In CDF - Routine	28	391	340 to 442	25.0	132.3
In CDF - Dredging	107	403	389 to 416	6.9	71.2

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-Routine	28	122	162	175	168 to 183	185	201	23
Background-Dredging	110	97	160	171	165 to 178	187	411	27
Near CDF - Routine	28	114	164	176	167 to 180	184	207	20
Near CDF - Dredging	105	117	163	171	167 to 177	186	223	23
River - Routine	28	137	163	187	167 to 200	205	383	42
River - Dredging	105	149	181	200	191 to 221	252	360	71
In CDF - Routine	28	198	264	386	284 to 487	495	630	231
In CDF - Dredging	107	271	347	390	367 to 414	453	615	106

Analyse-it v2.09

Test	**Describe - Comparative** TKN
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW
Performed by	h6theres Date 16 December 2010



v2.09

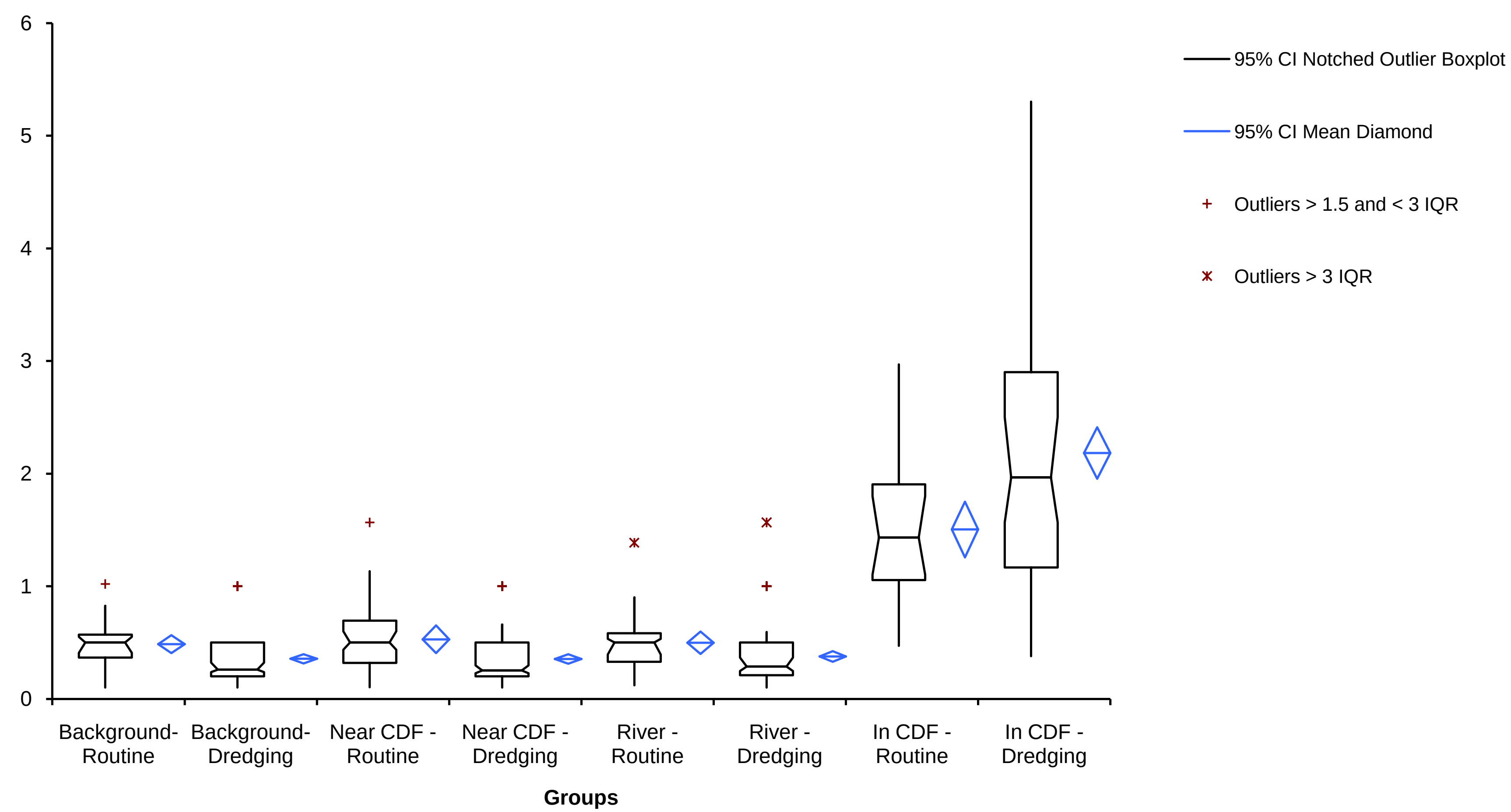
Test	**Describe - Comparative** TKN
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW
Performed by	h6theres — Date: 16 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-All	138	0.3824	0.3453 to 0.4194	0.0187	0.2201
Near CDF - Routine	28	0.5286	0.4058 to 0.6514	0.0598	0.3166
Near CDF - Dredging	105	0.3541	0.3110 to 0.3972	0.0218	0.2229
River - Routine	28	0.4987	0.3986 to 0.5988	0.0488	0.2582
River - Dredging	105	0.3765	0.3292 to 0.4238	0.0238	0.2443
In CDF - Routine	28	1.5036	1.2557 to 1.7515	0.1208	0.6394
In CDF - Dredging	107	2.1837	1.9549 to 2.4124	0.1154	1.1935
MW 18	131	1.9099	1.6602 to 2.1597	0.1262	1.4447
MW 19	136	5.0751	4.6784 to 5.4718	0.2006	2.3393
MW 20	118	0.3757	0.3297 to 0.4217	0.0232	0.2521

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-All	138	0.1000	0.2098	0.3130	0.2500 to 0.4770	0.5000	1.0200	0.2903
Near CDF - Routine	28	0.1030	0.3191	0.5000	0.4370 to 0.6000	0.6958	1.5670	0.3768
Near CDF - Dredging	105	0.1000	0.2000	0.2530	0.2270 to 0.2970	0.5000	1.0000	0.3000
River - Routine	28	0.1200	0.3288	0.5000	0.3930 to 0.5330	0.5828	1.3870	0.2541
River - Dredging	105	0.1000	0.2090	0.2870	0.2470 to 0.3670	0.5000	1.5670	0.2910
In CDF - Routine	28	0.4700	1.0553	1.4335	1.1030 to 1.8000	1.9055	2.9670	0.8502
In CDF - Dredging	107	0.3800	1.1670	1.9670	1.5670 to 2.5000	2.9000	5.3000	1.7330
MW 18	131	0.1000	0.9917	1.5000	1.3000 to 1.9000	2.5000	11.8000	1.5083
MW 19	136	0.5000	3.3833	5.4000	4.9000 to 5.9000	7.2000	8.7700	3.8167
MW 20	118	0.0610	0.2000	0.3050	0.2000 to 0.5000	0.5000	1.5000	0.3000

Analyse-it v2.09

Test	**Describe - Comparative**	TKN
	Groups: Background-Routine, Background-Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CI	
Performed by	h6theres	Date 16 December 2010



Analyse-it v2.09

Test	**Describe - Comparative** TKN
	Groups: Background-Routine, Background-Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CI
Performed by	h6theres Date 16 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-Routine	28	0.4861	0.4074 to 0.5649	0.0384	0.2031
Background-Dredging	110	0.3560	0.3149 to 0.3970	0.0207	0.2173
Near CDF - Routine	28	0.5286	0.4058 to 0.6514	0.0598	0.3166
Near CDF - Dredging	105	0.3541	0.3110 to 0.3972	0.0218	0.2229
River - Routine	28	0.4987	0.3986 to 0.5988	0.0488	0.2582
River - Dredging	105	0.3765	0.3292 to 0.4238	0.0238	0.2443
In CDF - Routine	28	1.5036	1.2557 to 1.7515	0.1208	0.6394
In CDF - Dredging	107	2.1837	1.9549 to 2.4124	0.1154	1.1935

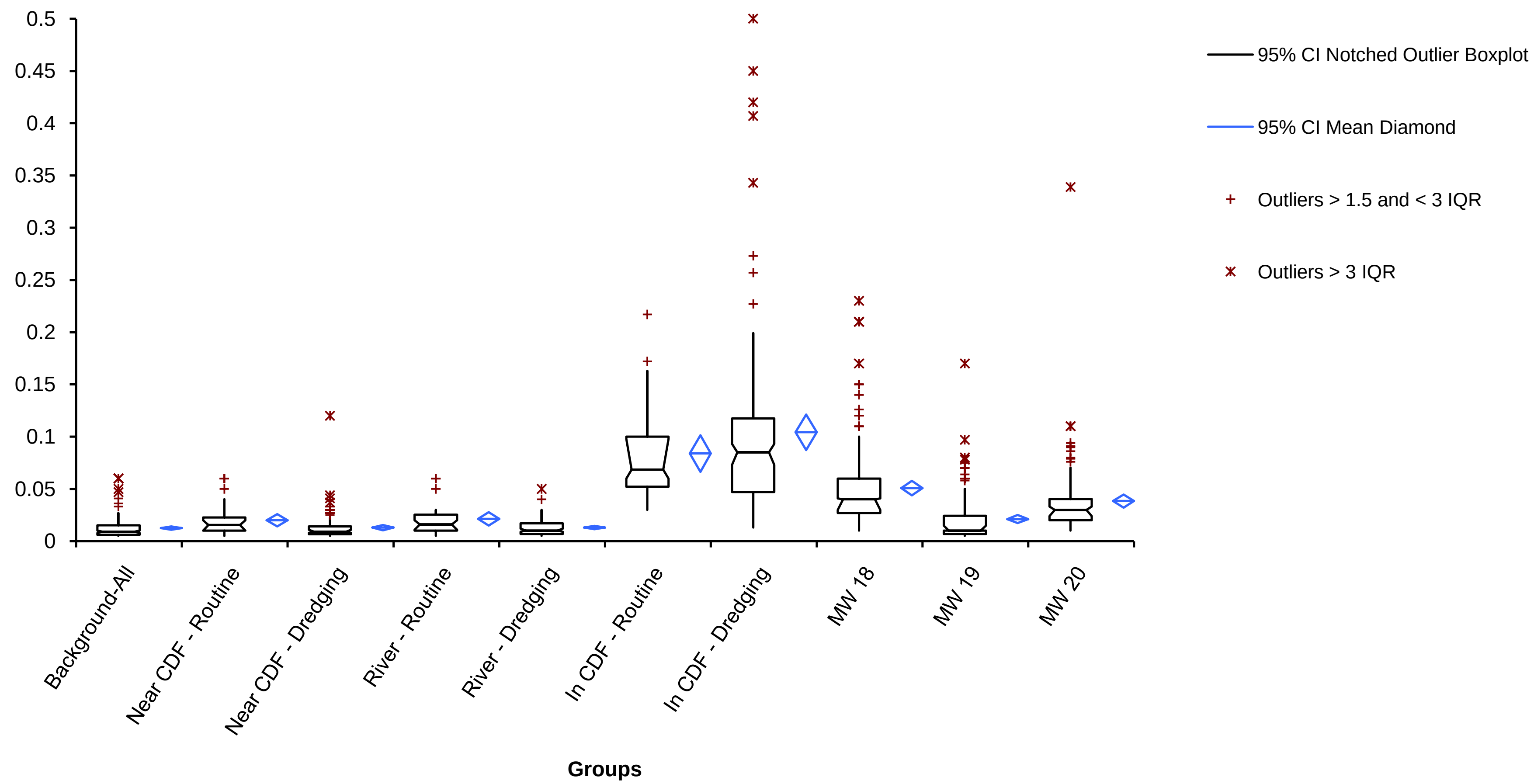
Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-Routine	28	0.1000	0.3662	0.5000	0.4100 to 0.5500	0.5716	1.0200	0.2054
Background-Dredging	110	0.1000	0.2000	0.2600	0.2370 to 0.3230	0.5000	1.0000	0.3000
Near CDF - Routine	28	0.1030	0.3191	0.5000	0.4370 to 0.6000	0.6958	1.5670	0.3768
Near CDF - Dredging	105	0.1000	0.2000	0.2530	0.2270 to 0.2970	0.5000	1.0000	0.3000
River - Routine	28	0.1200	0.3288	0.5000	0.3930 to 0.5330	0.5828	1.3870	0.2541
River - Dredging	105	0.1000	0.2090	0.2870	0.2470 to 0.3670	0.5000	1.5670	0.2910
In CDF - Routine	28	0.4700	1.0553	1.4335	1.1030 to 1.8000	1.9055	2.9670	0.8502
In CDF - Dredging	107	0.3800	1.1670	1.9670	1.5670 to 2.5000	2.9000	5.3000	1.7330

Analyse-it v2.09

Test **Describe - Comparative** Phosphorus

Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW

Performed by h6theres Date 17 December 2010



Analyse-it v2.09

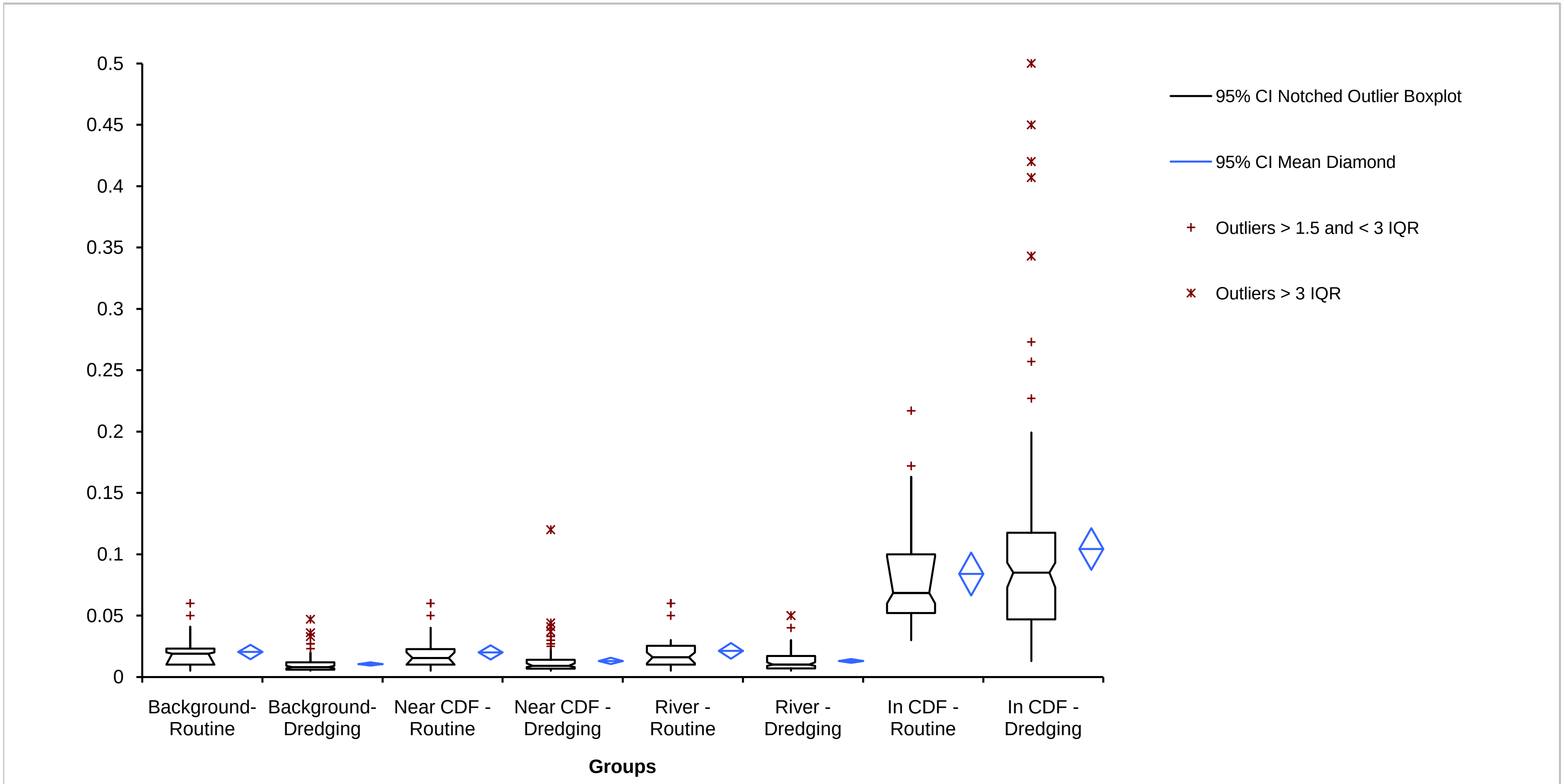
Test	**Describe - Comparative**	Phosphorus
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW	
Performed by	h6theres	Date 17 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-All	138	0.0125	0.0108 to 0.0142	0.0009	0.0101
Near CDF - Routine	28	0.0200	0.0142 to 0.0258	0.0028	0.0151
Near CDF - Dredging	105	0.0130	0.0104 to 0.0156	0.0013	0.0133
River - Routine	28	0.0213	0.0149 to 0.0277	0.0031	0.0165
River - Dredging	105	0.0130	0.0114 to 0.0146	0.0008	0.0082
In CDF - Routine	28	0.0839	0.0663 to 0.1015	0.0086	0.0453
In CDF - Dredging	107	0.1043	0.0873 to 0.1213	0.0086	0.0887
MW 18	131	0.0507	0.0437 to 0.0577	0.0035	0.0405
MW 19	136	0.0211	0.0172 to 0.0251	0.0020	0.0231
MW 20	118	0.0384	0.0321 to 0.0447	0.0032	0.0347

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-All	138	0.0050	0.0060	0.0090	0.0080 to 0.0100	0.0151	0.0600	0.0091
Near CDF - Routine	28	0.0050	0.0100	0.0155	0.0100 to 0.0200	0.0226	0.0600	0.0126
Near CDF - Dredging	105	0.0050	0.0067	0.0090	0.0080 to 0.0110	0.0140	0.1200	0.0073
River - Routine	28	0.0050	0.0100	0.0160	0.0110 to 0.0200	0.0253	0.0600	0.0153
River - Dredging	105	0.0050	0.0070	0.0100	0.0090 to 0.0120	0.0170	0.0500	0.0100
In CDF - Routine	28	0.0300	0.0521	0.0685	0.0600 to 0.0980	0.1000	0.2170	0.0479
In CDF - Dredging	107	0.0130	0.0470	0.0850	0.0730 to 0.0930	0.1175	0.5000	0.0705
MW 18	131	0.0100	0.0270	0.0400	0.0300 to 0.0410	0.0600	0.2300	0.0330
MW 19	136	0.0050	0.0070	0.0100	0.0100 to 0.0150	0.0243	0.1700	0.0173
MW 20	118	0.0100	0.0200	0.0300	0.0240 to 0.0330	0.0403	0.3390	0.0203

Analyse-it v2.09

Test	**Describe - Comparative**	Phosphorus	
	Groups: Background-Routine, Background-Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In Cl		
Performed by	h6theres	Date	17 December 2010



Analyse-it v2.09

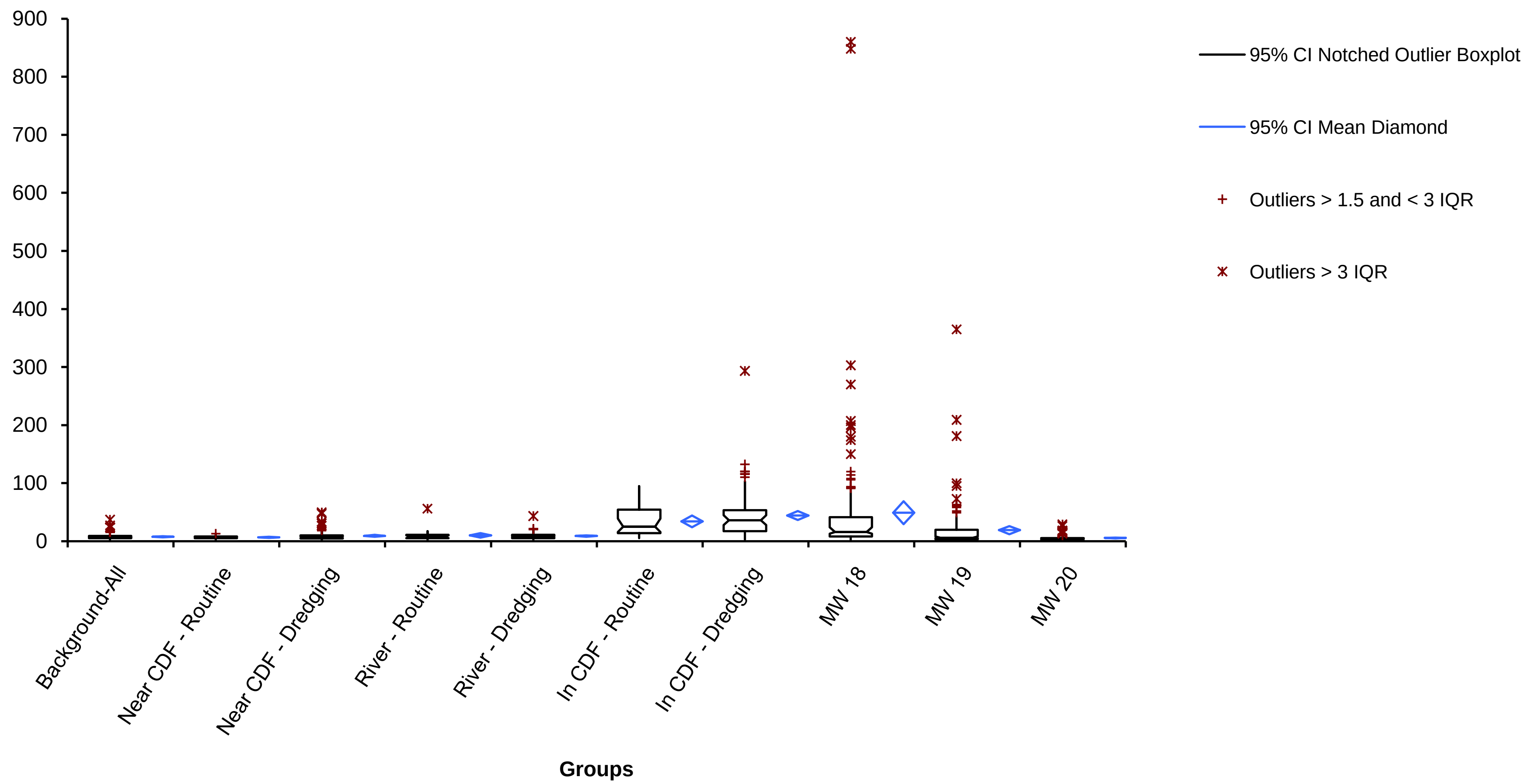
Test	**Describe - Comparative** Phosphorus
	Groups: Background-Routine, Background-Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In Cl
Performed by	h6theres Date 17 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-Routine	28	0.0204	0.0145 to 0.0263	0.0029	0.0152
Background-Dredging	110	0.0105	0.0091 to 0.0119	0.0007	0.0072
Near CDF - Routine	28	0.0200	0.0142 to 0.0258	0.0028	0.0151
Near CDF - Dredging	105	0.0130	0.0104 to 0.0156	0.0013	0.0133
River - Routine	28	0.0213	0.0149 to 0.0277	0.0031	0.0165
River - Dredging	105	0.0130	0.0114 to 0.0146	0.0008	0.0082
In CDF - Routine	28	0.0839	0.0663 to 0.1015	0.0086	0.0453
In CDF - Dredging	107	0.1043	0.0873 to 0.1213	0.0086	0.0887

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-Routine	28	0.0050	0.0100	0.0190	0.0100 to 0.0200	0.0230	0.0600	0.0130
Background-Dredging	110	0.0050	0.0060	0.0080	0.0070 to 0.0090	0.0120	0.0470	0.0060
Near CDF - Routine	28	0.0050	0.0100	0.0155	0.0100 to 0.0200	0.0226	0.0600	0.0126
Near CDF - Dredging	105	0.0050	0.0067	0.0090	0.0080 to 0.0110	0.0140	0.1200	0.0073
River - Routine	28	0.0050	0.0100	0.0160	0.0110 to 0.0200	0.0253	0.0600	0.0153
River - Dredging	105	0.0050	0.0070	0.0100	0.0090 to 0.0120	0.0170	0.0500	0.0100
In CDF - Routine	28	0.0300	0.0521	0.0685	0.0600 to 0.0980	0.1000	0.2170	0.0479
In CDF - Dredging	107	0.0130	0.0470	0.0850	0.0730 to 0.0930	0.1175	0.5000	0.0705

Analyse-it v2.09

Test	**Describe - Comparative**	TSS	
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW		
Performed by	h6theres	Date	17 December 2010



Analyse-it v2.09

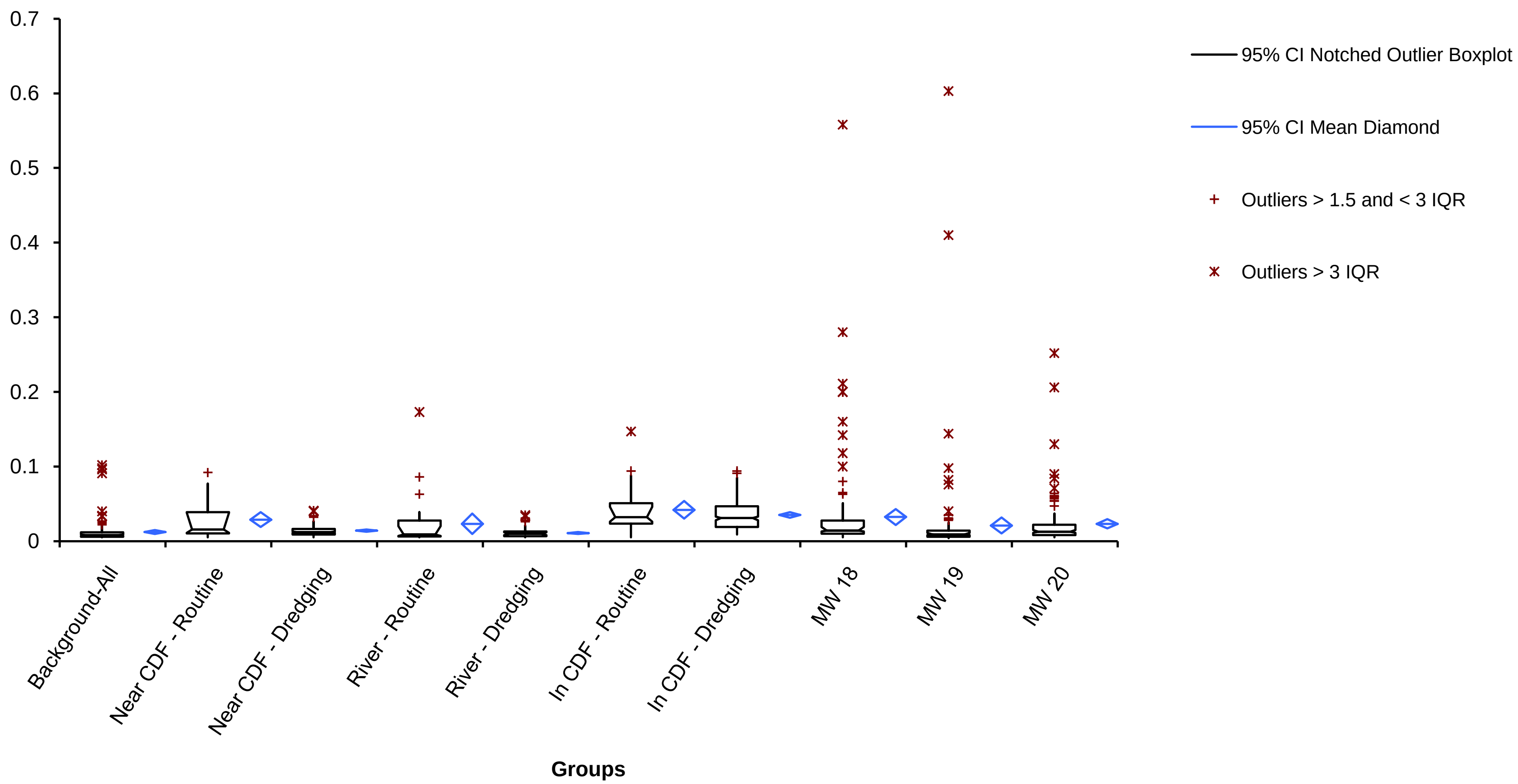
Test	**Describe - Comparative** TSS
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW
Performed by	h6theres
Date	17 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-All	138	7.6	6.7 to 8.4	0.4	5.2
Near CDF - Routine	28	6.5	5.5 to 7.5	0.5	2.6
Near CDF - Dredging	105	9.2	7.6 to 10.8	0.8	8.2
River - Routine	28	10.0	6.2 to 13.8	1.8	9.7
River - Dredging	105	8.9	7.7 to 10.0	0.6	5.7
In CDF - Routine	28	34.2	24.0 to 44.4	5.0	26.4
In CDF - Dredging	107	44.2	36.6 to 51.7	3.8	39.5
MW 18	130	49.1	29.3 to 68.9	10.0	114.0
MW 19	135	19.0	11.9 to 26.0	3.6	41.3
MW 20	117	5.5	4.6 to 6.4	0.4	4.8

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-All	138	1.8	5.0	5.7	5.1 to 6.3	9.0	37.0	4.0
Near CDF - Routine	28	2.0	5.0	5.5	5.0 to 7.0	8.0	13.0	3.0
Near CDF - Dredging	105	1.7	4.7	7.0	5.3 to 8.0	10.1	49.7	5.4
River - Routine	28	2.0	5.0	8.5	5.0 to 10.0	11.2	56.0	6.2
River - Dredging	105	1.8	5.0	7.7	6.3 to 8.7	11.1	43.3	6.1
In CDF - Routine	28	5.0	13.8	25.0	16.0 to 39.0	54.4	95.0	40.6
In CDF - Dredging	107	2.7	17.2	36.0	27.7 to 44.7	53.4	293.3	36.2
MW 18	130	2.0	8.0	16.0	13.1 to 24.0	41.2	860.0	33.2
MW 19	135	1.0	3.3	5.5	5.0 to 8.0	19.8	365.0	16.5
MW 20	117	1.0	2.5	5.0	5.0 to 5.0	5.0	28.9	2.5

Analyse-it v2.09

Test	**Describe - Comparative** Zinc Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW
Performed by	h6theres Date 14 December 2010



Analyse-it v2.09

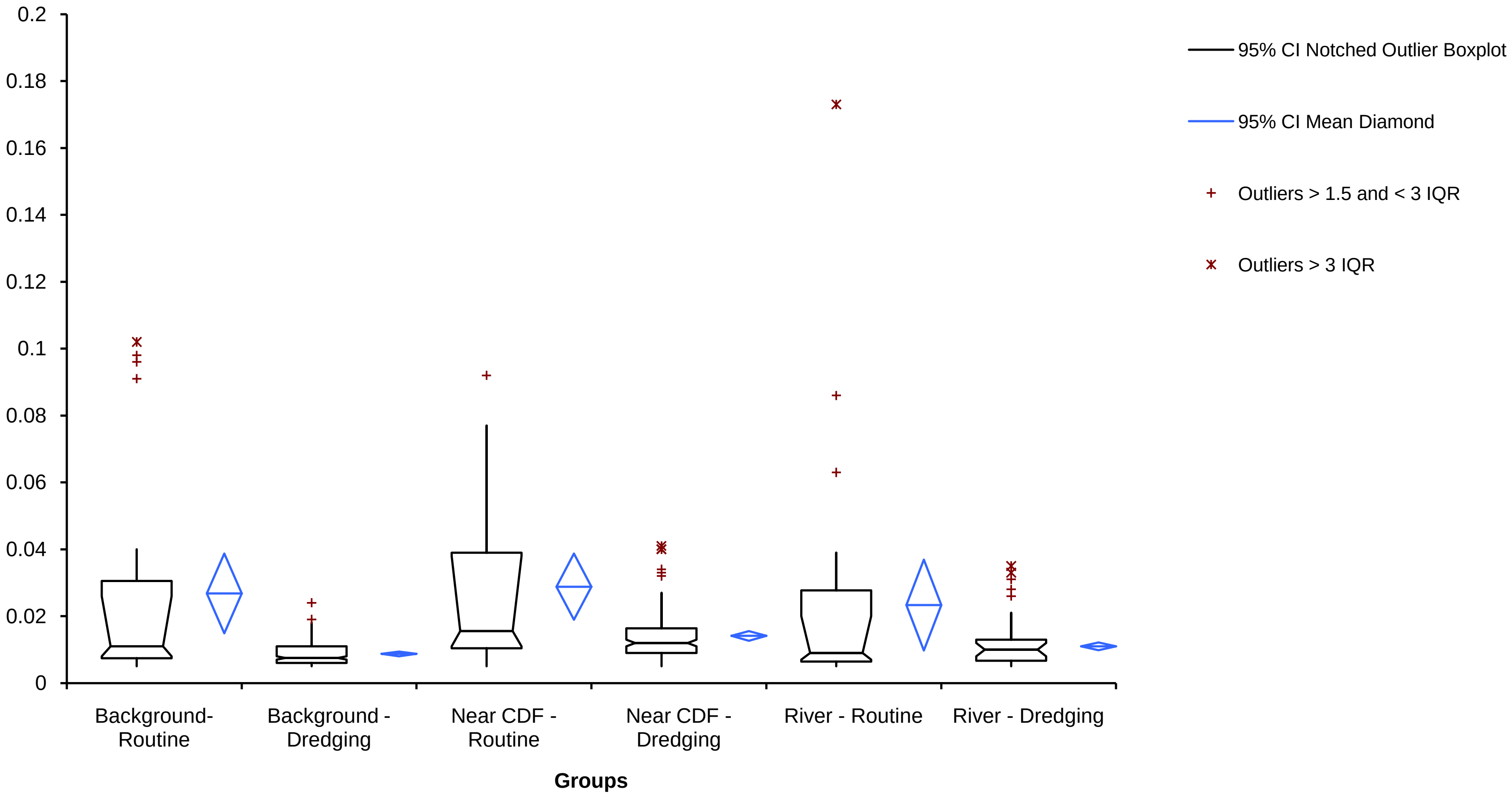
Test	**Describe - Comparative** Zinc
	Groups: Background-All, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging, In CDF - Routine, In CDF - Dredging, MW 18, MW
Performed by	h6theres Date 14 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-All	138	0.0124	0.0097 to 0.0151	0.0013	0.0158
Near CDF - Routine	28	0.0288	0.0189 to 0.0387	0.0048	0.0256
Near CDF - Dredging	105	0.0141	0.0127 to 0.0155	0.0007	0.0074
River - Routine	28	0.0233	0.0097 to 0.0369	0.0066	0.0351
River - Dredging	105	0.0110	0.0098 to 0.0121	0.0006	0.0060
In CDF - Routine	28	0.0420	0.0303 to 0.0537	0.0057	0.0302
In CDF - Dredging	107	0.0351	0.0313 to 0.0388	0.0019	0.0194
MW 18	131	0.0323	0.0215 to 0.0432	0.0055	0.0626
MW 19	136	0.0210	0.0103 to 0.0317	0.0054	0.0631
MW 20	118	0.0233	0.0171 to 0.0294	0.0031	0.0337

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-All	138	0.0050	0.0060	0.0080	0.0070 to 0.0090	0.0120	0.1020	0.0060
Near CDF - Routine	28	0.0050	0.0104	0.0155	0.0110 to 0.0380	0.0390	0.0920	0.0286
Near CDF - Dredging	105	0.0050	0.0090	0.0120	0.0110 to 0.0130	0.0163	0.0410	0.0073
River - Routine	28	0.0050	0.0064	0.0090	0.0070 to 0.0200	0.0278	0.1730	0.0213
River - Dredging	105	0.0050	0.0067	0.0100	0.0080 to 0.0120	0.0130	0.0350	0.0063
In CDF - Routine	28	0.0050	0.0234	0.0320	0.0260 to 0.0460	0.0508	0.1470	0.0273
In CDF - Dredging	107	0.0090	0.0190	0.0310	0.0280 to 0.0330	0.0467	0.0940	0.0277
MW 18	131	0.0050	0.0100	0.0140	0.0130 to 0.0190	0.0278	0.5580	0.0178
MW 19	136	0.0040	0.0060	0.0090	0.0080 to 0.0110	0.0140	0.6030	0.0080
MW 20	118	0.0050	0.0080	0.0125	0.0110 to 0.0150	0.0221	0.2520	0.0141

![Analyse-it logo] v2.09

Test	**Describe - Comparative** Zinc
	Groups: Background-Routine, Background - Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging
Performed by	h6theres Date 16 December 2010



v2.09

Test **Describe - Comparative** Zinc

Groups: Background-Routine, Background - Dredging, Near CDF - Routine, Near CDF - Dredging, River - Routine, River - Dredging

Performed by h6theres

Date 16 December 2010

Groups	n	Mean	95% CI	SE	SD
Background-Routine	28	0.0268	0.0149 to 0.0387	0.0058	0.0307
Background - Dredging	110	0.0087	0.0080 to 0.0094	0.0004	0.0037
Near CDF - Routine	28	0.0288	0.0189 to 0.0387	0.0048	0.0256
Near CDF - Dredging	105	0.0141	0.0127 to 0.0155	0.0007	0.0074
River - Routine	28	0.0233	0.0097 to 0.0369	0.0066	0.0351
River - Dredging	105	0.0110	0.0098 to 0.0121	0.0006	0.0060

Groups	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Background-Routine	28	0.0050	0.0074	0.0110	0.0080 to 0.0260	0.0305	0.1020	0.0231
Background - Dredging	110	0.0050	0.0060	0.0075	0.0070 to 0.0080	0.0110	0.0240	0.0050
Near CDF - Routine	28	0.0050	0.0104	0.0155	0.0110 to 0.0380	0.0390	0.0920	0.0286
Near CDF - Dredging	105	0.0050	0.0090	0.0120	0.0110 to 0.0130	0.0163	0.0410	0.0073
River - Routine	28	0.0050	0.0064	0.0090	0.0070 to 0.0200	0.0278	0.1730	0.0213
River - Dredging	105	0.0050	0.0067	0.0100	0.0080 to 0.0120	0.0130	0.0350	0.0063

Enclosure 1

CHICAGO AREA CONFINED DISPOSAL FACILITY
DATA ANALYSIS
2010 through 2015

U.S. Army Corps of Engineers, Chicago District
231 South LaSalle Street, Suite 1500
Chicago, Illinois 60604-1437

February 2016

Table of Contents

Tables

Figures

Appendices

Introduction

The U.S. Army Corps of Engineers (USACE), Chicago District (from hereafter referred to as the Chicago District) operates the Chicago Area Confined Disposal Facility (CDF) under the Illinois Environmental Protection Agency (Illinois EPA) Water Pollution Control Permit No. 2011-EA-1347, issued December 29, 2011 (Appendix A). This permit is set to expire on November 30, 2016, and this report provides additional information required for the submission of the permit renewal application. The permit presently includes a number of Standard and Special Conditions. According to Special Condition 2 of the permit, “Monitoring shall be conducted in accordance with the Corps of Engineers report entitled “Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, Illinois, January 2011.” Since the monitoring is to be conducted in accordance with this report, the report has been included along with the permit in Appendix A for reference.

Purpose

This report provides supplemental information regarding the operation of the CDF for the five (5)-year permit renewal application. Since the preparation and closure of the facility is not expected to occur within the five (5)-year time period for the next permit, it is not possible to include details concerning the closure of the CDF. This information will be provided in future correspondence. The main purpose of the current report is to comply with Special Condition 4 of the Illinois EPA permit, which states “A report containing data from the beginning of the project to the time of the next permit renewal submission shall be provided in the application for the renewal of the permit. The permittee shall provide an analysis of these data showing trends for the parameters tested. A separate analysis of the current permit data shall be provided in addition to the historical analysis. All data will be accounted for and correlated with locations currently used (i.e., BACK 1, 2, 3, ND 1, 2, 3, RIV 1, 2, 3, CDF 1, 2, 3, and CH 18, 19, 20, etc.).” The purpose of this report is to provide the requested information.

Project Description

The CDF is a diked facility for the disposal and containment of dredged material from the deep-draft federal navigation projects in Chicago, Illinois. Figure 1 shows an aerial view of the general vicinity of the CDF. The CDF was designed to receive and contain dredged materials and prevent the release of the materials into the environment, particularly Calumet Harbor. The facility was constructed between 1982 and 1984, and it is located in Calumet Harbor, directly south of the entrance to the Calumet River. The CDF is situated directly east of the Iroquois Landing ship terminal and north of Calumet Park. Iroquois Landing is currently managed and owned by the Illinois International Port District (IIPD), formerly known as the Chicago Regional Port District. The CDF is operated and maintained by the Chicago District under the authority of Public Law 91-611, Section 123. Since the construction of the CDF, the Chicago District has monitored the water quality in the vicinity of the facility in compliance with the applicable Illinois EPA Water Pollution Control Permit.

The CDF was constructed using rubble mound dikes with a core of prepared (graded) limestone. Additional armor stone was placed over the limestone core to protect the dikes against wave action. As discussed with the Illinois EPA in 1994 and explained in the Supplemental Environmental Impact Statement (EIS), dated August 26, 1998, a low permeability synthetic liner was placed on the prepared limestone on the disposal side of the dikes, but this liner was subsequently damaged during construction. A silty "sand blanket" was then placed on the disposal side of the dikes to prevent the migration of pollutants, and past monitoring has indicated the sand blanket has been effective at preventing the migration of contaminants.

The Iroquois Landing property is located directly to the west of the CDF. Between 1982 and 1984, when the CDF was constructed, the southern half of Iroquois Landing was a landfill for municipal and steel mill solid wastes. Exploratory soil borings performed on Iroquois Landing prior to the construction of the CDF identified the fill as largely being composed of various steel mill waste materials, such as slag, cinders, ash, and foundry sand. The fill material was also found to contain a considerable amount of coke, coal dust, wood, metal, and other miscellaneous waste materials, as well as earthen materials, mainly clay, silt, and sand.

An aerial view of the CDF is shown in Figure 2, and drawings that show a general layout of the facility are provided in Appendix B. During dredging, the dredged material, including the entrained water, is placed within the facility mechanically, via trucks or cranes, into the northern portion of the CDF. Water associated with the dredged material drains southward and eventually flows through drain pipes located within the CDF cross-dike into the southern settling basin. Whenever dredged material is placed into the CDF, water from the southern settling basin is pumped to the filter cells, where it then flows by gravity through filter media. The filter cell effluent is subsequently discharged to the Calumet River, approximately 3,000 feet west of the confluence of the Calumet River with Calumet Harbor/Lake Michigan. Filter cell influent and effluent is periodically monitored whenever the effluent is discharged to the Calumet River. The dredged material remains within the CDF. Precipitation in the form of rain or snow enters the CDF, and, rarely, extraordinarily severe storms may cause large waves in Lake Michigan to occasionally overtop the dike crest along the eastern or northern perimeter of the facility. As documented in past annual water quality reports (see references), the water level within the CDF fluctuates, typically in correlation with the water level of Lake Michigan. As mentioned above, it is important to emphasize that any discharge of water from the CDF is through the filter cells, and whenever effluent from the filter cells is discharged to the Calumet River, the filter cell influent and effluent are periodically monitored.

The remaining capacity of the CDF is limited, and it can be observed from Figure 2 that the northern portion of the CDF has largely been filled with dredged material, with the exception of a small comparatively low area near the cross-dike between the northern portion of the CDF and southern settling basin. As a result, the Chicago District is in the process of completing a Dredged Material Management Plan (DMMP), and

modifications have been made to CDF operations to compensate for the current conditions.

Special Condition 5 of the current Illinois EPA Water Pollution Control Permit (Appendix A) specifies that upon completion, the site is to be covered with a five (5) foot thick clay and topsoil cap, graded to drain, and seeded and mulched to prevent erosion. The level of the dredged material placed near the perimeter dikes remains below the top of the dikes. In addition, the elevation of the northern and eastern perimeter dikes of the CDF has been increased by the placement of precast concrete blocks on the dike crest to potentially accommodate future cover material. Figure 3 shows a view of the blocks placed along the eastern perimeter dike, and the block dimensions are 4 feet high and 6 feet by 6 feet in length and width. The dredged material is presently managed so that the maximum height of the material in the vicinity of the dikes with the precast concrete blocks is two (2) feet below the crest of the dike. (The elevation of the crest of the dike is equivalent to the bottom of the blocks.) The precast concrete blocks are intended for the retention of cover and cap material, and the 2-foot freeboard, which is the difference in elevation between the top of the dredged material and the crest of the dike, is to prevent any runoff from the dredged material from entering Calumet Harbor along the perimeter of the CDF where the precast concrete blocks were placed.

The following statutory language provides relevant information regarding the above-mentioned management practices and the time period for depositing dredged material into the CDF:

Section 148 of the Water Resources Development Act (WRDA) of 1976 addressed management practices to extend the capacity and useful life of dredged material disposal areas:

> "The Secretary of the Army, acting through the Chief of Engineers, shall utilize and encourage the utilization of such management practices as he determines appropriate to extend the capacity and useful life of dredged material disposal areas such that the need for new dredged material disposal areas is kept to a minimum. Management practices authorized by this section shall include, but not be limited to, the construction of dikes, consolidation and dewatering of dredged material, and construction of drainage and outflow facilities."

In addition, Section 24 of the WRDA 1988 amended Section 123 of the River and Harbor Act of 1970 by adding the following new subsection:

> "(j) Period for Depositing Dredged Materials.--The Secretary of the Army, acting through the Chief of Engineers, is authorized to continue to deposit dredged materials into a contained spoil disposal facility constructed under this

> section until the Secretary determines that such facility is no longer needed for such purpose or that such facility is completely full."

Drying Pad

In the fall of 2014, the Chicago District began construction of a drying pad in the northwest portion of the CDF, which is exhibited in the general layout drawings in Appendix B. The purpose of this pad is to receive dredged material from Calumet Harbor, as this material is suitable for use outside the CDF or as cover material. After the Calumet Harbor dredged materials are placed on the drying pad, they will be left to dry over the course of several months. Once the Calumet Harbor material is dry, it will be removed from the pad and either stockpiled or beneficially used at a suitable location.

The drying pad was constructed by first leveling the CDF material with a slight southward slope for drainage, then covering it with a 10 ounce per square yard geotextile woven fabric that was subsequently overlain by several inches of bituminous concrete grindings. The geotextile and grindings provide stability and vertical separation between the dredged material that existed with the facility and the Calumet Harbor dredged materials placed on top. Horizontal separation between the drying pad and the dredged material in the remainder of the CDF will be maintained along the southern edge by the previously mentioned precast concrete blocks. Presently, the blocks have not been placed completely along the southern edge, and this portion of the drying pad construction is still in progress. The drying pad is being constructed to hold approximately 25,000 cubic yards (CY) of sediment while still allowing the sediment to dry.

General Plan for Grading and Drainage

Sediment dredged from the Calumet River is offloaded on the eastern side of the facility, whereas Calumet Harbor sediment is offloaded onto the drying pad in the northwest corner of the CDF. Since the dredged material is above the water level, it tends to mound during offloading operations to elevations that limit the capacity for further placement. In addition, due to the elevation differences between the lake and upland sides of the facility, drainage presently tends to flow towards the west and south (upland sides). As discussed earlier, there are drain pipes within the CDF cross-dike that allow the water to flow from the northern portion of the facility into the southern settling basin.

Shallow trenching methods (initially around one (1)-foot deep) are utilized in conjunction with regrading and mounding at the CDF site to facilitate drying and increase capacity. Employing these methods permits drainage from the west to the east and from the north to the south. The regrading and mounding permits the exposure of material at lower elevations for evaporative drying. By mounding the dredged material more on the western and northern sides of the facility that are adjacent to the land, but still

maintaining sufficient dike freeboard, greater capacity can be created along the perimeter of the facility adjacent to the water.

Activities that will typically occur each year following the placement of dredged material include the clearing of vegetation, initial dewatering of ponded areas, the construction of shallow trenches to facilitate the drying of the material, and the regrading and mounding of the material from the eastern to western side of the CDF site.

The construction of shallow trenches around the inside perimeter and the connection of pond areas within a CDF site is a procedure that has been used for many years to dewater CDFs. However, the Chicago Area CDF is difficult to access with heavy machinery either from the perimeter (due to the precast concrete blocks and steep slope) or inside the CDF (due to the low bearing capacity of the existing dredged material). The Chicago District utilizes low ground pressure equipment (less than 0.1 ton per square foot (TSF) ground pressure) in wet areas. Another alternative to low ground pressure equipment is the use of mats that can distribute the load beneath the equipment, as long as the mats achieve a less than 0.1 TSF ground pressure. The material within the CDF is capable of supporting heavier construction equipment when the upper, 6-inch layer of the material is dry.

In general, after the material is capable of supporting appropriate construction equipment, the material mounded on the eastern side of the CDF after placement is relocated to the low areas on the western side of the CDF. The material is sloped from east to west and from the north to south. Mounding in the interior of the CDF in certain localized areas helps facilitate the drying and management of the material during interim relocation procedures, as long as positive drainage is maintained. Mounding is not completed near the perimeter of the CDF where the mound crest would be higher than the CDF boundary, as this may allow material to migrate past the CDF perimeter. Mounding against the perimeter may also trap precipitation in a pocket that does not gravity drain to a trench.

Regrading the dredged material in the CDF is performed for several reasons. First, it helps dewater the material, ensures appropriate drainage, and facilitates the drying of the upper layer of the dredged material so it will be more compact and have a greater bearing capacity. Regrading also creates more space near the lake side of the CDF for the offloading and placement of additional dredged material. Lastly, regrading allows the space remaining in the facility in the CDF to be utilized in an efficient manner, and, eventually, the material in the CDF will need to be regraded to prepare for the cover layer and closure of the facility.

It is essential to note that the final grading and closure of the CDF will occur more than five (5) years into the future. As consequence, since this report is for the five (5)-year permit renewal application, it does not provide any information regarding the final grading contours or proposed design for the cover layer for the facility. This information will be provided in future correspondence.

Water Quality Monitoring Plan

The CDF water quality monitoring plan includes routine monitoring events and monitoring during dredging events. The water quality monitoring plan was modified in 1997 during the renewal of the Illinois EPA Water Pollution Control Permit to provide a more standardized, meaningful, and cost-effective data set. There have been subsequent slight modifications to the monitoring plan during the permit renewals in 2001, 2006, and 2011. The most recent version of the water quality monitoring plan was detailed in the Chicago District document cited in the Illinois EPA Water Pollution Control Permit entitled "Proposed Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, Illinois, January 2011." This document has also been included with the current permit in Appendix A. The sample locations, parameters, and schedule provide a standardized, meaningful, and cost-effective data set, and allow for quantitative comparisons between the monitoring locations over time and for comparisons between the data sets. The Chicago District proposes to use the same water quality monitoring plan for the current permit renewal application.

Monitoring Locations

Figure 4 shows the present locations for collecting water samples for routine monitoring events and for the monitoring during dredging events. In addition, during dredging events, the turbidity of the water in the vicinity of the dredging and rehandling operations is monitored at the locations in Figure 5. The turbidity is measured by analyzing the water samples for total suspended solids (TSS) and/or by taking field measurements using a nephelometer. The pre-1997 water quality monitoring locations are shown in Figures 6 and 7 for comparison.

There are currently fourteen (14) sample locations, not including the subsample locations for the near-dike composite samples. Water quality samples are collected from these locations for both routine monitoring events and for monitoring during dredging events. These locations are shown in Figure 4 and include the following: Three (3) individual CDF samples (CDF-001, CDF-002, and CDF-003) collected from the southern settling basin; three (3) near-dike composite samples (ND-COMP-001, ND-COMP-002, and ND-COMP-003), where each composite sample includes three (3) near-dike subsample locations, for a total of nine (9) near dike subsample locations; two (2) groundwater well samples (CH-18-81 and CH-19-81) that are collected from wells on the western side of the CDF adjacent to Iroquois Landing; three (3) background Calumet Harbor/Lake Michigan samples (BACK-001, BACK-002, and BACK-003); and three (3) Calumet River samples (RIV-001, RIV-002, and RIV-003).

Due to the age and condition of the groundwater wells adjacent to Iroquois Landing, the wells may be unreliable, so a minimum of one (1) of the two (2) wells is required to be sampled. In addition, filter cell influent and effluent samples (CH-00-02 and CH-00-03, respectively) are periodically collected whenever dredged material is placed into the CDF and effluent from the filter cells is discharged to the Calumet River. Furthermore, during dredging operations, a sediment grab sample is collected from the scow prior to the placement of the dredged material into the CDF, and, as mentioned above, turbidity

is monitored around the dredging and rehandling areas during dredging operations. The location of the filter cells is shown, but the filter cell and sediment samples are not identified in Figure 4.

Prior to 1997, the water quality samples were collected using a different monitoring schedule and alternate sampling locations were used, shown in Figures 6 and 7. Pre-1997 Location 1 was collected from within the CDF pond, similar to the CDF samples, CDF-001, CDF-002, and CDF-003 that are presently collected from the southern settling basin. The pre-1997 Locations 4(a) and 4(b) were collected from the Calumet River, similar to the samples presently acquired from the Calumet River locations, RIV-001, RIV-002, and RIV-003. The pre-1997 Locations 5, 6, and 7 are directly outside of the CDF in Lake Michigan, similar to the samples collected near the CDF dike at locations, ND-COMP-001, ND-COMP-002, and ND-COMP-003. The pre-1997 Locations 8(a) and 8(b) are further outside the CDF into Lake Michigan, similar to samples presently acquired at the background sample locations, BACK-001, BACK-002, and BACK-003. These pre-1997 data were only collected during dredging events that occurred in 1984, 1985, 1986, 1989, and 1994.

The groundwater monitoring wells CH-18-81, CH-19-81, and CH-20-81 shown in Figure 6 were sampled on a routine basis, with the sample frequency varying by parameter. Two (2) of these wells, CH-18-81 and CH-19-81, are the groundwater wells adjacent to Iroquois Landing described above that are currently monitored. The other dike monitoring wells (CH-04-83, CH-05-83, CH-07-84, CH-08-84, CH-09-84, CH-10-84 and CD-11-87) shown in Figure 6 were sampled on a routine basis before 1997, but have not been sampled since 1997.

Monitoring Parameters

The water quality monitoring parameters and required reporting limits for routine monitoring and monitoring during dredging events are given in Table 1.

Table 1: Water Quality Monitoring Parameters and Detection Limits

Parameters	Required Reporting Limits (mg/L, unless noted)
Parameters for Routine and During Dredging Monitoring	
Chromium (total)	0.005
Manganese (total)	0.005
Zinc (total)	0.005
Ammonia as Nitrogen	0.01
Total Kjeldahl Nitrogen (TKN)	0.2
Phosphorus (total)	0.005
Total Dissolved Solids (TDS)	1.0
Total Suspended Solids (TSS)	1.0
Temperature	± 0.1 °C
pH	± 0.01 units
Total PCB (Aroclors)[1]	0.1 µg/L
Additional Parameters: Only for Hydraulic Dredging	
Arsenic (total)	0.01
Barium (total)	0.1
Cadmium (total)	0.005
Copper (total)	0.01
Cyanide (total)	0.005
Lead (total)	0.005
Mercury (total)[2]	0.0002 µg/L
Nickel (total)	0.025
Oil & Grease	1.0
Dissolved Oxygen	± 0.1
Hardness	2.0

Notes:

1 The monitoring of Polychlorinated Biphenyl (PCB) Aroclors is only required when dredging the Chicago River and when the Chicago River material is placed in the CDF.

2 Low Level Mercury by U.S. EPA Method 1631

All past dredging and placement of the dredged material into the CDF has been performed using mechanical dredging equipment. Nevertheless, if the need arises to perform dredging operations using hydraulic equipment, the bottom part of Table 1 lists the additional water quality parameters the plan requires for hydraulic dredging operations. Sediment grab sample parameters for monitoring during dredging and required reporting limits are given in Table 2. Note that routine monitoring does not include the collection or analysis of a sediment sample.

Table 2: Sediment Grab Sample Parameters for Monitoring During Dredging

Sediment Parameter	Required Reporting Limit, mg/Kg unless otherwise noted
Arsenic (Total)	1
Barium (Total)	5
Cadmium (Total)	1
Chromium (Total)	1
Copper (Total)	2.5
Lead (Total)	5
Mercury (Total)	0.02
Manganese (Total)	5
Nickel (Total)	5
Zinc (Total)	2
Total Solids (%)	1%
Total Volatile Solids (%)	1%
Cyanide	0.2
Chemical Oxygen Demand	100
Ammonia Nitrogen	0.5
Oil & Grease	10
Total Phosphorus	1
Total Organic Carbon	100
Total PCB Aroclors[1]	0.05

Notes:

[1] The monitoring of Polychlorinated Biphenyl (PCB) Aroclors is only required when dredging the Chicago River and when the Chicago River material is placed in the CDF.

For mechanical dredging, the water quality monitoring plan requires the water samples to be analyzed for the parameters in the first part of Table 1 and requires the sediment grab sample to be analyzed for all the parameters in Table 2. As noted by these tables, the plan only requires water and sediment samples to be analyzed for total PCB Aroclors when the Chicago River is dredged and this dredged material is placed into the CDF. Table 3 gives a historical summary of past dredging and placement events that have occurred since the construction of the CDF, and, as shown in this table, the only dredging event where some material dredged from the Chicago River was placed into the CDF was the third dredging event performed in 1986.

Table 3: Historical Dredging and Placement Events for Chicago Area CDF

Event No.	Year of Placement Operation	Volume of Dredged Material	Location of Dredging	Location of Re-handling
1	Oct. – Dec. 1984	100,000 yd^3	Calumet River	NW corner of CDF
2	July – Sept. 1985	108,000 yd^3	Calumet River	NE corner of CDF
3	May – June 1986	62,000 yd^3	**Chicago* Harbor & Calumet River	N dike of CDF
4	April – June 1989	70,100 yd^3	Calumet River	NE of cross-dike in CDF
5	May 1991	3,100 yd^3	Calumet River	CDF
6	December 1994	62,000 yd^3	Calumet River	NE corner of CDF
7	Aug. 2000 – Apr. 2001	205,500 yd^3	Calumet River	N dike of CDF
8	Sept. – Dec. 2001	291,000 yd^3	Calumet Harbor & Calumet River Entrance Channel	E dike wall
9	Sept. – Dec. 2003	135,000 yd^3	Calumet River	E dike wall
10	Sept. – Dec. 2007	131,020 yd^3	Calumet Harbor	E dike wall
11	April 2008	186 yd^3	Calumet River	CDF
12	June 2009	600 yd^3	Calumet River	CDF
13	Oct. – Dec. 2009	167,404 yd^3	Calumet Harbor	E dike wall
14	Jun. – Jul. 2011	1,370 yd^3	Calumet Harbor	E dike wall
15	Sep. – Oct. 2011	56,086 yd^3	Calumet River	E dike wall
16	Nov. 2012 – Jul. 2013	57,160 yd^3	Calumet Harbor & Calumet River	E dike wall
17	Oct. 2014 – Jan. 2015	26,440 yd^3	Calumet Harbor	N dike wall for Harbor
		46,883 yd^3	Calumet River	E dike wall for River
18	Apr. 2015 – May 2015	25,260 yd^3	Calumet Harbor	E dike wall
	Total Dredged	1,549,109 yd^3		

*All Calumet except the 1986 dredging event included Chicago Harbor.

Monitoring Schedule

The greatest potential for adverse impacts to the water quality of Calumet Harbor and/or the Calumet River is during dredging events, so the water quality monitoring program is more comprehensive for dredging operations. There is a substantially lower potential for adverse impacts when no dredging occurs, so the monitoring schedule requires one routine monitoring event to be conducted during the year if there are no dredging events scheduled (non-dredging years). For years in which one or more dredging events are scheduled, no routine monitoring is conducted and the monitoring performed during dredging fulfills the requirement for water quality monitoring.

For dredging operations, monitoring is conducted in accordance with the following schedule: Water quality samples are collected on a twice-per-week schedule during the week prior to the commencement of dredging, and they are collected on a twice-per-week schedule during the week following the completion of dredging. During dredging operations, the samples are collected on a once-per-week schedule.

Sediment Data

Tables 4 and 5 provide a summary of the bulk sediment chemistry results from past and recent dredging events. The analytical results of metal parameters are listed in Table 4 and wet chemistry parameters are listed in Table 5. The data in these tables characterize and show the general trends for the sediment placed into the CDF during the last seventeen (17) dredging operations, with the exception of the 3,100 CY dredging event in May 1991 (Event #5 in Table 3) performed for KCBX. The results have been separated into historical data from 1984 to 2010 and recent data from 2011 to 2015. The last column of the table displays an overall maximum, mean, and minimum from all the combined dredging events. The overall mean value was calculated from the means of each individual sampling event. The number of sediment samples collected for each dredging event varied from 1 to 18 as shown in the bottom row of each table. The number of samples was dependent on the length of the dredging operations, because sediment samples are collected on a weekly basis.

Maintenance dredging of the Calumet Harbor and River is performed in areas where shoaling is present, so the sediment data shown in Tables 4 and 5 are representative of various locations along the length of the Federal navigation channel. Parameter concentrations in the sediment range from the low levels found in Calumet Harbor to the comparatively elevated levels found in the Calumet River, and the quality of the sediment near the entrance channel to the Calumet River typically falls in between these areas. Since samples are collected from the scow prior to the placement of the dredged material into the CDF, and scows can hold a large volume of roughly 1,000 CY of dredged material, there can be some uncertainty regarding the actual, precise dredging location from which the sediment in the sample was originally dredged. In other words, although Calumet Harbor may be listed as the dredging location in Tables 4 and 5, if the sediment in the sample was actually dredged from a location within the entrance channel to the Calumet River, the sample might have elevated parameter concentrations that are more representative of Calumet River sediment quality.

It can been observed from Tables 4 and 5 that there is considerable variation in the sediment parameter concentrations, even after differentiating the Calumet River and Calumet Harbor areas. As indicated above, there may be some variation due to the uncertainty of the actual dredging location, but the variations are mainly attributed to changes in the anthropogenic or natural sources of the contaminants in the sediment, as well as to the fate and transport mechanisms for the different parameters. Potential sources for the contaminants include urban runoff, combined storm water overflows, wastewater treatment plant effluent, land erosion, etc. Additional variation in the data is also introduced by the use of multiple laboratories, modifications in field collection techniques and/or equipment, and changes to analytical methods and instrumentation.

Table 4: Metals in Sediment Characteristics for Past and Recent Dredging Events

		Dredging Location (Year(s) of Operation)												
Sediment Parameters (Units)		River (1984)	River (1985)	Chicago Harbor / River[1] (1986)	River (1989)	River (1994)	River (2000-01)	Harbor / River Entrance (2001)	River (2003)	Harbor (2007)	River (2008)	River (2009)	Harbor (2009)	Historical Summary (1984-2009)
Arsenic (mg/kg)	Max	12	74	4.3	124	27	57.9	12.7	124	11	--	--	10	124
	Mean	5.2	19.1	2.2	54.4	20	17.4	8.8	46.9	7.4	8.8	44	8.8	20.3
	Min	0.4	<0.3	0.66	6.84	11	6.7	4.4	<10	4.6	--	--	7.1	<0.3
Barium (mg/kg)	Max	110	52	190	124	75	86	77	74	47	--	--	37	190
	Mean	46.3	27.8	66	71	65	<57	38	48.2	29.5	52	110	32	<53.6
	Min	23	8.4	28	30	57	32	13	30	19	--	--	27	8.4
Cadmium (mg/kg)	Max	5	2	5.1	15.8	4.8	6.2	15.5	2.7	1.3	--	--	1.3	15.8
	Mean	2.9	1.3	2.7	8.23	3.5	2.5	2.4	1.7	<1.03	<1.0	9.2	<1.05	<3.1
	Min	0.88	0.82	0.82	<0.50	2.7	0.2	0.3	0.88	<1.0	--	--	<0.9	0.2
Chromium (mg/kg)	Max	60	27	62	86.9	101	347	49	162	55	--	--	46	347
	Mean	34.7	19.2	24	62.3	61	68	25	52.4	25.6	20	110	35	44.8
	Min	23	12	3.0	20.9	31	19	1.6	24	14	--	--	30	1.6
Copper (mg/kg)	Max	100	44	82	87.4	131	118	68	502	49	--	--	39	502
	Mean	57.6	29.9	42	67.4	86	64	40	103.8	27.5	24	140	33	59.6
	Min	34	24	4.4	26.4	47	14	15	43	16	--	--	27	4.4
Iron (mg/kg)	Max	54,000	30,000	12,000	151,000	120,000	82,800	127,000	96,300	No Data			No Data	151,000
	Mean	40,323	18,909	8,100	54,043	76,475	38,388	38,044	49,582	No Data	No Data	No Data	No Data	40,483
	Min	22,350	13,000	5,400	16,100	37,400	14,800	12,700	27,900	No Data			No Data	5,400
Lead (mg/kg)	Max	520	130	250	276	639	367	161	393	140	--	--	93	1200
	Mean	297.3	88	140	179.4	350	179.7	77	178	59.2	56	1,200	71	240
	Min	50	50	18	35	119	8.8	33	84	29	--	--	56	8.8
Manganese (mg/kg)	Max	2,100	700	160	2,910	2,080	3,980	1,820	5,050	890	--	--	710	5050
	Mean	1,069	451.8	140	1,691	1,440	1,257	780	1,515	625	760	2,900	619	1104
	Min	600	390	130	344	881	394	476	717	360	--	--	500	130
Mercury (mg/kg)	Max	0.66	0.12	0.9	0.169	0.57	0.62	0.2	0.19	0.13	--	--	0.14	0.9
	Mean	0.157	0.07	0.57	0.09	0.39	<0.19	<0.12	0.15	0.097	0.027	0.32	0.10	<0.19
	Min	<0.01	0.04	0.11	0.022	0.23	<0.1	<0.1	<0.10	0.051	--	--	0.077	<0.01
Nickel (mg/kg)	Max	50	32	19	73.7	63	61	35	100	31	--	--	24	100
	Mean	27	24.3	14	56.8	41	43.4	23	40.5	19.7	46	68	22	35.5
	Min	15	19	8.6	33.6	23	28.4	12	25	13	--	--	18	8.6
Zinc (mg/kg)	Max	2,300	440	280	849	1,920	1,060	481	4,690	400	--	--	290	4,690
	Mean	1,108	270.5	170	423.5	1,051	511.9	221	942	172	180	4,000	203	771
	Min	280	180	61	80	282	54.3	82	283	95	--	--	150	54.3
# of Samples Collected		11	11	7	7	4	18	9	11	13	1	1	7	100

[1] Notes: The mean concentration was calculated using the detection limit when no concentrations were detected. Inclusion of the "<" symbol indicates at least one non-detect result was included in the calculation of the mean. All samples from Calumet Harbor and River except the 1986 dredging event included Chicago Harbor. Table 3 includes year of placement, volume of dredged material, and location of dredging and rehandling operations.

Table 4: Metals in Sediment Characteristics for Past and Recent Dredging Events (continued)

		Dredging Location (Year(s) of Operation)						
Sediment Parameters (Units)		Harbor (2011)	River (2011)	Harbor / River (2012-13)	Harbor / River (2014–15)	Harbor (2015)	Recent Summary 2011-2015	Overall Summary 1984-2015
Arsenic (mg/kg)	Max	--	23	12	29	6.7	29	124
	Mean	3.8	17	8.7	13.2	6.4	9.8	17.2
	Min	--	13	6.7	5.8	6.1	3.8	<0.3
Barium (mg/kg)	Max	--	81	70	78	26	81	190
	Mean	9.9	64	37.5	40.3	24	35.1	<48
	Min	--	47	20	20	22	9.9	8.4
Cadmium (mg/kg)	Max	--	2.3	1.2	2.4	0.57	2.4	15.8
	Mean	<1.0	<1.95	0.7	1.2	0.55	1.1	<2.5
	Min	--	<1.0	0.37	0.56	0.53	0.37	0.2
Chromium (mg/kg)	Max	--	210	34	64	23	210	347
	Mean	4.4	80	23.7	39.9	21.5	33.9	42
	Min	--	28	19	20	20	4.4	1.6
Copper (mg/kg)	Max	--	530	37	120	27	530	530
	Mean	3.0	180	29.7	50	24	57.3	59
	Min	--	53	21	21	21	3.0	3.0
Iron (mg/kg)	Max		No Data	No Data	No Data	No Data	No Data	No Data
	Mean	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	Min		No Data	No Data	No Data	No Data	No Data	No Data
Lead (mg/kg)	Max	--	310	140	270	37	310	1200
	Mean	8.7	210	74.7	112	36	88.2	195
	Min	--	79	28	37	34	8.7	8.7
Manganese (mg/kg)	Max	--	5500	1100	1,600	610	5500	5500
	Mean	270	2133	710	870	575	911.6	1047
	Min	--	1300	400	480	540	270	130
Mercury (mg/kg)	Max	--	0.41	0.21	0.38	0.097	0.41	0.9
	Mean	0.012	0.23	0.14	0.16	0.08	0.12	<0.17
	Min	--	0.11	<0.05	0.043	0.061	0.012	<0.01
Nickel (mg/kg)	Max	--	130	22	43	22	130	130
	Mean	5.2	55	18.8	27	20	25.1	32
	Min	--	35	13	15	18	5.2	5.2
Zinc (mg/kg)	Max	--	3500	370	1,000	120	3500	4,690
	Mean	60	1182	191	411	120	392.8	660
	Min	--	260	93	120	120	60	54.3
# of Samples Collected		1	6	6	7	2	22	122

[1] Notes: The mean concentration was calculated using the detection limit when no concentrations were detected. Inclusion of the "<" symbol indicates at least one non-detect result was included in the calculation of the mean. *All samples from Calumet Harbor and River except the 1986 dredging event included Chicago Harbor. Table 3 includes year of placement, volume of dredged material, and location of dredging and rehandling operations.

Table 5: Wet Chemistry Sediment Characteristics for Past and Recent Dredging Events

		Dredging Location (Year(s) of Operation)												
Sediment Parameters (Units)		River (1984)	River (1985)	Chicago Harbor / River[1] (1986)	River (1989)	River (1994)	River (2000-01)	Harbor / River Entrance (2001)	River (2003)	Harbor (2007)	River (2008)	River (2009)	Harbor (2009)	Historical Summary 1984-2009
	Max	63.2	73	74	66.8	65	86	62	No Data	66	--	--	76	86
Total Solids (%)	Mean	52	54.6	54	54.1	57	63.7	52	No Data	57.1	72	57	61	58
	Min	45.5	43	37	39.9	50.7	40	41	No Data	47	--	--	52	37
	Max	17	8.3	19	10.9	8.3	15.4	4.9	No Data	5.6	--	--	4.1	19
Total Volatile Solids (%)	Mean	11.1	7.2	9.3	6.34	7.2	5.4	3.6	No Data	3.85	13	7.1	3.4	7.0
	Min	5.1	2.7	2.4	3.8	6.2	2.8	2.4	No Data	2.6	--	--	2.6	2.4
	Max	5.1	0.56	0.54	2.8	1.4	2.1	<1	5.8	2.3	--	--	0.54	5.8
Cyanide (mg/kg)	Mean	<1.2	0.2	<0.23	<1.24	1.3	<0.79	<0.64	<1.9	<0.47	<0.23	<0.36	0.29	0.74
	Min	<0.14	0.08	<0.01	<0.15	1.2	<0.5	<0.5	<0.20	<0.22	--	--	0.17	0.01
	Max	290,000	73,000	52,000	962,000	200,000	134,000	107,000	282,000	240,000	--	--	110,000	962,000
Chemical Oxygen Demand (mg/kg)	Mean	135,309	55,046	39,000	172,500	136,000	81,170	76,689	176,936	112,000	180,000	100,000	83,286	112,328
	Min	65,000	27,000	21,000	11,500	94,000	6,130	39,500	99,300	53,000	--	--	62,000	6,130
	Max	240	110	240	141	293	255	244	253	470	--	--	220	470
Ammonia (as N) (mg/kg)	Mean	137.45	72.9	80	59.97	216	134	166	210	152	32	140	170	131
	Min	80	2.4	15	26.8	142	20	81	138	67	--	--	130	2.4
	Max	4,900	890	1500	1,220	9,850	2,970	1,310	1,430	No Data	--	--	No Data	9,850
TKN (mg/kg)	Mean	1,624	721.9	910	514.3	7,328	1,224	932	1,212	No Data	No Data	No Data	No Data	1808
	Min	670	81	360	156	4,200	541	627	713	No Data	--	--	No Data	81
	Max	15,000	4,400	6,500	99,500	1,640	5,780	3,350	6,580	790	--	--	800	99,500
Oil & Grease (mg/kg)	Mean	7,445	1,888	3,360	19,059	1,423	<1,394	1405	2714	338	2,200	13,000	486	4559
	Min	1,000	970	650	326	1,080	<20	258	1120	100	--	--	320	100
	Max	1,000	500	540	11.3	3,300	492	465	778	430	--	--	9.9	3,300
Phosphorus (total) (mg/kg)	Mean	513.6	307	360	15.8	1,118	252	295	511	290	160	730	<6.9	380
	Min	300	300	180	<0.10	227	8.9	208	350	190	--	--	3.4	0.1
	Max	19	1.2	12	39	7.3	4.1	<0.33	13	0.39	--	--	0.15	39
PCBs (mg/kg)	Mean	4.4	0.7	5.4	5.04	3.8	<0.79	<0.33	2	<0.155	0.179	4.8	<0.041	2.3
	Min	0.69	0.3	0.41	<0.25	0.8	<0.33	<0.33	<0.33	<0.075	--	--	<0.022	0.022
	Max	No Data	No Data	9.7	19.8	No Data	No Data	No Data	No Data	2.1	--	--	1.8	19.8
Total Organic Carbon (%)	Mean	No Data	No Data	5.8	9.8	No Data	No Data	No Data	No Data	1.2	1.7	7.1	1.6	4.5
	Min	No Data	No Data	0.9	2.4	No Data	No Data	No Data	No Data	0.8	--	--	1.4	0.80
# Samples Collected		11	11	7	7	4	18	9	11	13	1	1	7	100

[1] Notes: The mean concentration was calculated using the detection limit when no concentrations were detected. Inclusion of the "<" symbol indicates at least one non-detect result was included in the calculation of the mean. *All samples from Calumet Harbor and River except the 1986 dredging event included Chicago Harbor. Table 3 includes year of placement, volume of dredged material, and location of dredging and rehandling operations.

Table 5: Wet Chemistry Sediment Characteristics for Past and Recent Dredging Events (continued)

		Dredging Location (Year(s) of Operation)						
Sediment Parameters (Units)		Harbor (2011)	River (2011)	Harbor / River (2012-13)	Harbor / River (2014-15)	Harbor (2015)	Recent Summary 2011-2015	Overall Summary 1984-2015
	Max		60	81	76	61	85	86
Total Solids (%)	Mean	85	54	58.5	57	59	63	59
	Min		48	46	47	56	46	37
	Max		13	5	8	3.6	13	19
Total Volatile Solids (%)	Mean	1.0	9.9	4	4.6	3.2	4.5	6.3
	Min		5.8	3.1	2.5	2.7	1.0	1.0
	Max		2	1.2	1.1	<0.18	2	5.8
Cyanide (mg/kg)	Mean	0.12	1.42	<0.39	<0.44	<0.17	0.51	0.67
	Min		0.92	<0.16	<0.13	<0.16	0.12	0.01
	Max		320,000	110,000	190,000	85,000	320,000	962,000
Chemical Oxygen Demand (mg/kg)	Mean	110,000	233,333	67,667	131,143	79,000	124,229	115,828
	Min		130,000	44,000	65,000	73,000	44,000	6,130
	Max		297	224	282	46.6	297	470
Ammonia (as N) (mg/kg)	Mean	22.6	202	89	127	40.5	96	121
	Min		114	18.4	41.1	34.3	18.4	2.4
	Max		No Data	No Data	No Data	No Data	No Data	9,850
TKN (mg/kg)	Mean	No Data	No Data	No Data	No Data	No Data	No Data	1808
	Min		No Data	No Data	No Data	No Data	No Data	81
	Max		22,700	993	4,410	335	22,700	99,500
Oil & Grease (mg/kg)	Mean	43.1	5466	471	1,031	236	1449	3645
	Min		653	231	82.4	136	43	43
	Max		740	380	760	410	760	3,300
Phosphorus (total) (mg/kg)	Mean	6.5	515	216	489	405	326	364
	Min		320	<8.1	300	400	6.5	0.1
	Max		2.2	0.49	1.7	<0.089	2.2	39
PCBs (mg/kg)	Mean	0.02	<0.33	<0.25	<0.48	<0.0855	0.2	1.7
	Min		<0.028	0.084	<0.066	<0.082	0.02	0.02
	Max		4.5	1.6	3.3	1.4	4.5	19.8
Total Organic Carbon (%)	Mean	0.12	3.4	1.1	1.6	1.35	1.5	3.2
	Min		2.4	0.45	0.63	1.3	0.12	0.12
# Samples Collected		1	6	6	7	2	22	122

[1] Notes: The mean concentration was calculated using the detection limit when no concentrations were detected. Inclusion of the “<” symbol indicates at least one non-detect result was included in the calculation of the mean. *All samples from Calumet Harbor and River except the 1986 dredging event included Chicago Harbor. Table 3 includes year of placement, volume of dredged material, and location of dredging and rehandling operations.

Water Quality Data Analysis

As described earlier, the main purpose of this report is to comply with Special Condition 4 of the Illinois EPA Water Pollution Control Permit, No. 2011-EA-1347. This special condition requires the following:

1. Data from the beginning of the project to the time of the next permit renewal submission.
2. An analysis of these data showing trends for the parameters tested.
3. A separate analysis of the current data.
4. All data will be accounted for and correlated with locations currently used (i.e., BACK 1, 2, 3, ND 1, 2, 3, RIV 1, 2, 3, CDF 1, 2, 3, and CH 18, 19, etc.).

The analysis included an evaluation of the water quality monitoring data and a determination of trends. These analyses are discussed further in the following paragraphs.

Data

The water quality monitoring data from monitoring the Chicago Area CDF fall into two (2) distinct groups: 1984 to 1997 and 1997 to the present. These two (2) groups of data had different sampling frequencies and locations, some different parameters, and different reporting limits. Because of these differences, the value of information provided from a single comprehensive trend analysis of these data is somewhat questionable.

The number of samples collected before 1997 in Calumet Harbor, the Calumet River, and the CDF were often deficient in comparison post-1997 sample collection, and they were not collected on a regular basis (these locations were only monitored during dredging events before 1997). In addition, the pre-1997 data lacked an established background dataset, and, as described earlier, the number of samples and sample locations differed from the post-1997 sampling program. In general, the older, pre-1997 data have been previously submitted and these results are less meaningful, standardized, and representative of the current conditions. This older data also included a number of groundwater wells that have not been sampled since 1997. Since the old data from these wells was previously submitted and did not provide useful information, it was not included again with this current analysis.

A statistical analysis software program named ProUCL (Version 5.0.00) was utilized to perform the analyses. ProUCL was developed under the direction of the U.S. Environmental Protection Agency's (USEPA) Office of Research and Development (ORD) Technical Support Center (TSC). More information about ProUCL software and the statistical tests used for the current trend analysis is available at the following web site: http://www.epa.gov/land-research/proucl-software. The trend analyses were performed using the Theil-Sen test in the ProUCL 5.0 software program. This test is a nonparametric statistical test meant to identify trends in time series data. ProUCL has

an option that can be used to average multiple observations reported for the various sampling events, and this option was utilized for the trend analyses discussed in this report and the graphs shown in the appendices.

The results of the eight (8) water quality parameters listed in Table 1 were analyzed separately for the seven (7) different sampling environments. In particular, the water quality parameters included ammonia nitrogen, Total Kjeldahl Nitrogen (TKN), phosphorus, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), chromium, manganese, and zinc. The results for these parameters have been included in corresponding Appendices C through J for the different sampling environments. The monitoring locations were combined into background, near-dike, Calumet River, and CDF sampling environments. The three (3) groundwater wells were also considered to represent different sampling environments and were analyzed individually because the groundwater quality from the different wells is often quite variable. The pH and temperature measurements were not included with the trend analysis since there have generally not been substantial changes over time.

As discussed previously, for each monitoring location, three (3) samples were collected (Figure 4), but these sample locations were all treated as one (1) sampling environment. For example, BACK-001, BACK-002, and BACK-003 were all used to describe “background” (Calumet Harbor) because there should be no appreciable statistical difference between the water quality samples taken for a given monitoring location. However, the three (3) landing monitoring wells were treated as separate sampling points, because there are considerable differences between the well locations. The monitoring locations referred to in this discussion include: the background (BACK-001, BACK-002, BACK-003); near-dike (ND-COMP-001, ND-COMP-002, ND-COMP-003, Calumet River (RIV-001, RIV-002, RIV-003); CDF (CDF-001, CDF-002, CDF-003); and monitoring wells (MW 18 (CH-18-81); MW 19 (CH-19-81); MW 20 (CH-20-81)). As shown in Figure 7, prior to 1997, the background environment was represented by Station 8, the near-dike environment was represented by Stations 5, 6, and 7, the Calumet River environment was represented by Stations 4, 4A and 4B, and the CDF environment was represented by Station 1. The groundwater wells were monitored separately prior to 1997.

Environmental data include measurements of constituents at trace levels. Typically, concentrations below the reporting limit cannot be measured reliably; the un-measurable concentrations are presumed to fall between zero and the reporting limit. Such data sets are referred to as “left-censored,” since the lower (left) end of the dataset is truncated at the reporting limit. There are various ways to handle data below the reporting limit or “non-detectable.” The three (3) methods typically used for statistical analysis of data sets with non-detectable data are 1) zero is used for non-detectable concentrations; 2) one-half the detection limit is used for non-detectable concentrations; or 3) the detection limit is used for non-detectable concentrations (USACE WES, 1995). In this study, for statistical calculations, the reporting limit was used in place of data that were reported as non-detectable. No data substitution

methods are considered adequate when the data set is more than 80% censored (USACE WES, 1995).

The raw data, including laboratory documentation, have been reported previously in other publications (see references), so they were not included in this report. However, Appendices C through J include the graphs of the data used for the trend analyses, and the data were divided into “historical” (1984 to the present) and “current” (Water Year 2011 to the present) data. The current data are the water quality monitoring results from samples collected since the submission of the last permit application in January 2011. Tables have been included with the graphs that provide the general statistics and whether there was sufficient statistical evidence for a trend. If there was sufficient statistical evidence for a trend, the direction of the trend was identified. The concentrations were plotted versus the date serial number. A date serial number of one (1) corresponds to the date of 1 Jan. 1900, and subsequent date serial numbers indicate the number of days following that date. For reference, the first graph of each appendix provides both the actual dates and corresponding date serial numbers. Table 6 below provides a summary of the results that showed sufficient statistical evidence for a trend as well as the direction for the trend; increasing (+) or decreasing (-).

It is important to emphasize that the historical data represent data collected from 1984 to the present, over thirty (30) years of data. Different laboratories have been utilized over this time period, and the methods, techniques, and reporting limits for some of the parameters have changed over time. As a consequence, although the trend analysis results may indicate a decreasing trend in the concentration of a certain parameter, it may actually show a decreasing trend because of subsequent improvements in laboratory techniques, particularly when the improvements in the techniques resulted in the use of lower reporting limits. For example, in Appendix C, it can be observed that the analysis of the historical background data for ammonia nitrogen initially indicated that there was a decreasing trend in the concentration. However, the older, 1984-1985 data included a substantial number of sample results that were below the reporting limit, and the reporting limit for these data was comparatively high (0.5 mg/L). When these data were censored (removed) from the trend analysis, a subsequent background (censored) trend analysis revealed that there was actually insufficient evidence to identify a significant trend. The censoring of data was not performed for the other analyses, but the trend analysis results for the background ammonia nitrogen data show that the use of historical data can produce misleading results.

Table 6: Sampling Data Sets That Show a Time Trend

Parameter	Data Analysis[1]	Sampling location +/- indicates direction of trend
Ammonia	Historical	Background (-) Near-Dike (-) Calumet River (-) CDF (-) MW-18 (+) MW-19 (-) MW-20 (-)
	Current	MW-19 (+)
Total Kjeldahl Nitrogen	Historical	Background (-) Near-Dike (-) Calumet River (-) CDF (-) MW-19 (-) MW-20 (-)
	Current	None
Total Phosphorus	Historical	Background (-) Near-Dike (-) Calumet River (-) CDF (-) MW-19 (-)
	Current	Background (-) Near-Dike (-) MW-18 (-) MW-19 (+)
Total Dissolved Solids (TDS)	Historical	Calumet River (+) CDF (+) MW-19 (-) MW-20 (-)
	Current	Background (-) Near-Dike (-) CDF (-) MW-18 (-) MW-19 (+)
Total Suspended Solids (TSS)	Historical	CDF (+) MW-18 (-) MW-19 (-) MW-20 (+)
	Current	CDF (-)

Notes: [1] Historical refers to the data from 1984 to the present
Current refers to the data from Water Year 2011 to the present
Current data are results since the submission of the last permit application.

Table 6: Sampling Data Sets That Show a Time Trend (continued)

Parameter	Data Analysis[1]	Sampling location +/- indicates direction of trend
Chromium	Historical	Background (-) Near-Dike (-) Calumet River (-) CDF (-) MW-18 (-) MW-19 (-) MW 20 (-)
	Current	CDF (-)
Manganese	Historical	Background (-) Near-Dike (-) Calumet River (-) CDF (+) MW-18 (-) MW-19 (-) MW 20 (+)
	Current	Background (-) MW-18 (-)
Zinc	Historical	Background (-) Near-Dike (-) Calumet River (-) CDF (-) MW-18 (-) MW-19 (-)
	Current	Near-Dike (-) CDF (-) MW-18 (-)

Notes: [1] Historical refers to the data from 1984 to the present
Current refers to the data from Water Year 2011 to the present
Current data are results since the submission of the last permit application.

Furthermore, it can be observed in Table 6 that in comparison to the historical data, fewer time trends were identified for the current data. One potential reason fewer trends were identified using the current data is that there are simply less data available. However, as explained above for the background ammonia nitrogen, it should be noted that the water quality may not be significantly changing over time in the background, near-dike, and/or Calumet River sampling environments. Current data are generally more accurate and reliable and have lower reporting limits. Moreover, several of the parameters, such as nitrogen ammonia, TKN, phosphorus, chromium, and zinc, are often present at trace levels that are frequently below the reporting limit for samples collected from the background, near-dike, and Calumet River sampling locations.

Based on the trend analysis, the following preliminary conclusions can be drawn from the historical and current water quality monitoring data:

1. The historical data show a trend of decreasing concentrations for several parameters for the background, near-dike, Calumet River, and CDF sampling environments, including ammonia nitrogen, TKN, phosphorus, chromium, and zinc. In addition, historical manganese data reveal decreasing trends for the background, near-dike, and Calumet River sampling environments. Current data suggest a trend of decreasing concentrations of phosphorus and TDS in the background and near-dike sampling environments. These results suggest that there may have been reductions of non-point source runoff and other improvements in the water quality due to Clean Water Act (CWA) compliance or other changes that are unrelated to the CDF operation, but, as discussed previously, the older, historical data are suspect and may be misleading due to subsequent improvements in laboratory methods and techniques or other confounding factors. None of the historical or current data for the parameters showed statistical evidence of an increasing trend for the near-dike sampling environment, and this is an indication that the CDF is adequately containing the sediment and has not been the cause of short- or long-term water quality impacts to the adjacent Calumet Harbor and River.

2. The historical data from the Calumet River show an increasing trend for TDS, but this same trend was not identified in the analysis of the current data. In addition, the trend analysis did not identify an increasing trend in the Calumet River for any of the other parameters. There are number of potential reasons for parameter concentrations to be increasing in the Calumet River, such as from combined sewer overflows (CSOs), non-point source urban runoff, and storm sewers, but another potential source for adverse impacts could be from the inflow of contaminated groundwater. Groundwater quality issues at Iroquois Landing are well documented, and, as discussed earlier, Iroquois Landing was a landfill for municipal and steel mill solid wastes. It is important to recognize that the groundwater gradient has been estimated to flow from Iroquois Landing towards the CDF, and the trends identified in the monitoring wells do not appear to be related to CDF operations. Although a trend for increasing TDS concentrations was not identified by the analysis of the historical data from Monitoring Well 18, it can be observed from the historical graph of the TDS concentrations for this well (Appendix F) that starting in June 2011, the results from the groundwater samples showed comparatively high TDS levels, substantially higher than the TDS concentrations measured in the CDF. These results reveal that the TDS concentrations in the groundwater well closest to the Calumet River increased considerably starting in June 2011, but it is unknown whether there is a relationship between the increase of TDS concentrations in the groundwater and the increase of TDS levels in the Calumet River. It is important to emphasize that the variations and trends in TDS concentrations do not appear to be caused by or related to operations at the CDF. The trend analysis of the current data suggests the trend is for the TDS levels to be decreasing in Monitoring Well 18.

3. The amount of dredged material placed within the CDF has been increasing over time, and it can be observed from the cross-sectional drawings in Appendix B that the elevation of most of the material in the northern portion of the CDF, north of the cross-dike, is presently well above the Lake Michigan low water datum (LWD) (577.5

feet IGLD 1985). As a consequence, depending on the weather and site conditions, the water associated with the newly placed dredged material may largely infiltrate into the previously placed dredged material and/or evaporate, and the amount of water that flows by gravity to the southern settling pond is often comparatively small. Due to the filling of the CDF over time, the historical data were expected to show trends for increasing parameter concentrations, and, as expected, the analysis identified trends for increasing concentrations in the CDF for TDS, TSS, and manganese. However, the trend analysis of the current data did not identify any trends for increasing parameters in the CDF, and, to the contrary, the trend analysis of the current data identified several parameters, such as TDS, TSS, chromium, and zinc, that had trends for decreasing concentrations in the CDF. These decreasing trends may be attributed to the current conditions at the facility and the reductions in water flow to the southern settling basin, where the CDF samples are collected. Although the analysis of the historical data identified trends for increasing concentrations of TDS, TSS, and manganese within the CDF pond, no corresponding trends for these parameters were identified for the near-dike sampling environment. Even though conditions in the CDF have changed considerably, the trend analysis did not reveal evidence that CDF operations has caused impacts to the surrounding water quality of the adjacent Calumet Harbor and River.

4. The trend analysis of the historical data from Monitoring Wells 18, 19, and 20 identified a number of different trends. The analysis of the historical data identified a trend for increasing ammonia nitrogen concentrations in Monitoring Well 18, and trends for increasing TSS and manganese levels were identified for Monitoring Well 20. The analysis of the historical data also identified trends for the levels of all the parameters to be decreasing in Monitoring Well 19, and levels of TSS and all the metals were identified to be decreasing in Monitoring Well 18. Conversely, the trend analysis of the current data identified trends of increasing ammonia, phosphorus, and TDS concentrations in Monitoring Well 19. The trend analysis of the current data did not identify any parameters increasing in Monitoring Well 18, but phosphorus, TDS, manganese and zinc were identified as decreasing in this well. These trends do not appear to be consistent with or reflect the conditions in the CDF because the trends are usually inconsistent between the CDF and the various wells. Note that there were no current data for Monitoring Well 20 because, as explained in the proposed water quality monitoring report with the permit (Appendix A), this well was inadvertently buried and damaged during construction of a new fence around the perimeter of the IIPD property. Data have not been recorded from Monitoring Well 20 since 2008.

Conclusions

This report provides supplemental information regarding the operation of the CDF for the five (5)-year permit renewal application. The main purpose of the report was to comply with Special Condition 4 of the current permit (Appendix A), which requires the submission of analyses showing trends for the parameters tested, including analyses of both historical and current data.

Based on the trend analyses, which are detailed in the Appendices C through J, it can be concluded that there was a trend for the concentrations of several of the monitoring parameters to be decreasing over time in the background, near-dike, and Calumet River sampling environments. Although these results may be correlated to reductions of non-point source runoff and/or other improvements in the water quality associated with CWA compliance, it is important to recognize that the use of older, (approximately 30-year old) historical data can influence these analyses and lead to incorrect conclusions, particularly when a significant portion of the results are below the reporting limits. More recent data typically have lower reporting limits and are more accurate and reliable due to advancements in technology and laboratory methods.

The trend analysis of the historical Calumet River data identified an increasing trend for TDS concentrations, but this trend was not identified from the analysis of the current data, and no increasing trends in the Calumet River were identified for any other parameters. Potential sources for increasing parameter concentrations in the Calumet River include CSOs, non-point source urban runoff, storm sewers, and the inflow of contaminated groundwater. Groundwater issues at the adjacent Iroquois Landing are well documented, and the site was a former landfill for municipal and steel mill solid wastes. The groundwater gradient has been estimated to flow from Iroquois Landing towards the CDF, and trends identified in the monitoring wells do not appear to be related to CDF operations. The TDS levels in Monitoring Well 18, which is the well closest to the Calumet River, increased considerably in June 2011, but it is unknown if this increase is related to the trend identified for increasing TDS levels in the Calumet River. The elevated TDS concentrations do not appear to be caused by or related to operations at the CDF. The trend analysis of the historical data from Monitoring Wells 18, 19, and 20 identified a number of different trends for the different parameters. In general, the trends do not appear to be consistent with or reflect the conditions in the CDF and often conflict with the trends for the CDF pond.

The amount of dredged material placed within the CDF has gradually been increasing over time. Presently, it is common for the water associated with newly placed dredged material to primarily infiltrate into the previously placed dredged material and/or evaporate, and the amount of water that flows to the southern settling pond is often comparatively small. The analysis of the historical data identified trends for increasing concentrations for several parameters in the CDF, including TDS, TSS, and manganese, and this was expected due to the increasing amount of sediment placed into the facility. The current data did not identify any trends for increasing parameters in the CDF, and, to the contrary, the analysis identified several parameters, such as TDS, TSS, chromium, and zinc, that had trends for decreasing concentrations in the CDF. These decreasing trends may be attributed to the current conditions at the facility and the reductions in water flow to the southern settling basin.

Conditions in the CDF have changed considerably, but the trend analysis did not reveal evidence that the operations have caused short- or long-term water quality impacts to the surrounding water quality of the adjacent Calumet Harbor and River.

References

USACE, June 1984, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1983, Chicago District, Chicago, Illinois.

USACE, May 1985, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1984, Chicago District, Chicago, Illinois.

USACE, April 1985, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations , October 1984 to December 1984, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, February 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations July 1985 to September 1985, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, October 1986, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1986 to July 1986, Daily & Associates, Engineers, Inc. for Chicago District.

USACE, May 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1985, Chicago District, Chicago, Illinois.

USACE, June 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1986, Chicago District, Chicago, Illinois.

USACE, July 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1987, Chicago District, Chicago, Illinois.

USACE, December 1989, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1988, Chicago District, Chicago, Illinois.

USACE, December 1989, Water Quality Monitoring Chicago Area Confined Disposal Facility Final Report on Operations April 1989 Through June 1989, Randolph & Associates, Inc. for Chicago District.

USACE, June 1990, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1989, Chicago District, Chicago, Illinois.

USACE, June 1993, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1990, Chicago District, Chicago, Illinois.

USACE, March 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1991, Chicago District, Chicago, Illinois.

USACE, May 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report CY 1992, Chicago District, Chicago, Illinois.

USACE, Sep 1994, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1993 Calendar Year, Chicago District, Chicago, Illinois.

USACE, April 1995, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1994 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE Waterways Experiment Station (WES), July 1995, Environmental Effects of Dredging Technical Notes: Guidelines for Statistical Treatment of Less Than Detection Limit Data in Dredged Sediment Evaluations, WES Environmental Laboratory, Vicksburg, Mississippi.

USACE, November 1995, Report on Maintenance Dredging of Calumet River (12/2/94 through 12/31/94), Volume I, Chicago District, Chicago, Illinois.

USACE, August 1996, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1995 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE, March 1997, Chicago Area Confined Disposal Facility Monitoring Well Data Report 1996 Calendar Year, Environmental Engineering Section Chicago District, Chicago, Illinois.

USACE, August 1998, Final Supplemental Environmental Impact Statement for Chicago Area Confined Disposal Facility at Calumet Harbor, Chicago, Cook County, Illinois, CELRC-PD-S, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, June 2000, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 99 (October 98 to September 99), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, July 2001, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2000 (October 1999 to September 2000), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, June 2002, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2001 (October 2000 to September 2001), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, July 2002, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging July 2000 to April 2001, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, September 2002, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging September 2001 to December 2001, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, April 2003, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2002 (October 2001 to October 2002), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, January 2004, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2003 (October 2002 to October 2003), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, August 2004, Water Quality Monitoring Chicago Area Confined Disposal Facility Report on Dredging October 2003 to December 2003, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, December 2004, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Year (November 2003 to November 2004), U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, February 2006, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Water Year 2005, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, April 2006, Chicago Area Confined Disposal Facility Data Analysis, 1984 through 2005, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, April 2007, Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility for the Water Year 2006, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, March 2008, Report on Maintenance Dredging of the Calumet Harbor September 6, 2007 – December 11, 2007, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, May 2008, Report on Maintenance Dredging of the KCBX Terminals, Inc. South Ship Berth in the Calumet River, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, January 2010, Report on Maintenance Dredging of the DTE Energy (DTE Chicago Fuels Terminal, L.L.C) Ship Dock Area in the Calumet River, 10730 Burley Avenue, Chicago, Illinois May 19th Through June 16th 2009, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, June 2010, Report on Maintenance Dredging of Calumet Harbor, Water Quality Monitoring Year 2010, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, February 2012, Report on Maintenance Dredging of the U.S. Coast Guard Station in Calumet Harbor, Water Quality Monitoring Year 2011, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, March 2012, Report on Maintenance Dredging of the Calumet River, Water Quality Monitoring Year 2011, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, October 2012, Water Quality Monitoring Report for Routine Monitoring Event at Chicago Area Confined Disposal Facility for the Water Year 2012, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, March 2014, Maintenance Dredging Report for Calumet Harbor and River, Water Quality Monitoring Year 2013, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, January 2015, Water Quality Monitoring Report for Routine Monitoring Event at Chicago Area Confined Disposal Facility for Water Year 2014, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

USACE, January 2016, Maintenance Dredging Report for Calumet Harbor and River, Water Quality Monitoring Year 2013, U.S. Army Corps of Engineers, Chicago District, Chicago, Illinois.

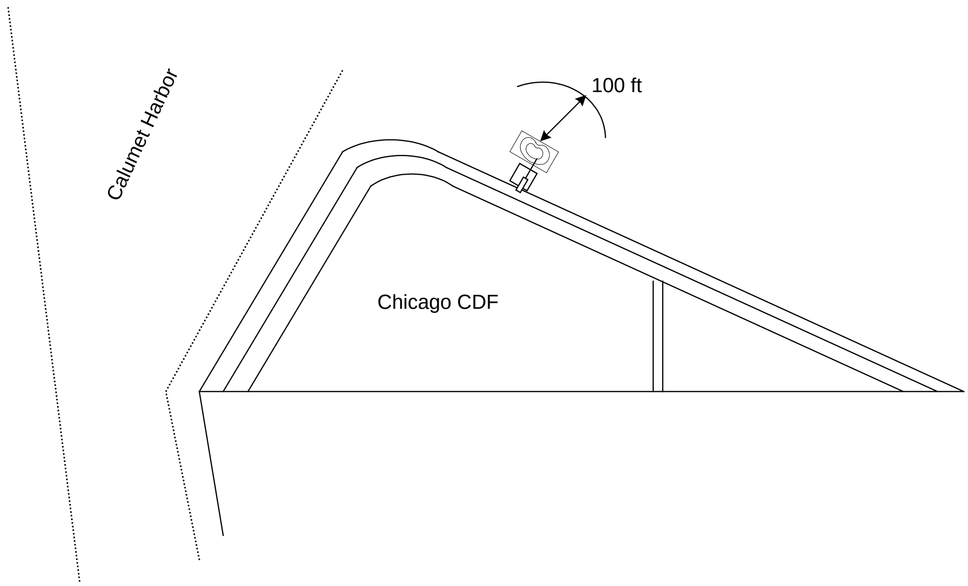
Figures

Figure 1: General Vicinity of Chicago Area Confined Disposal Facility (CDF)

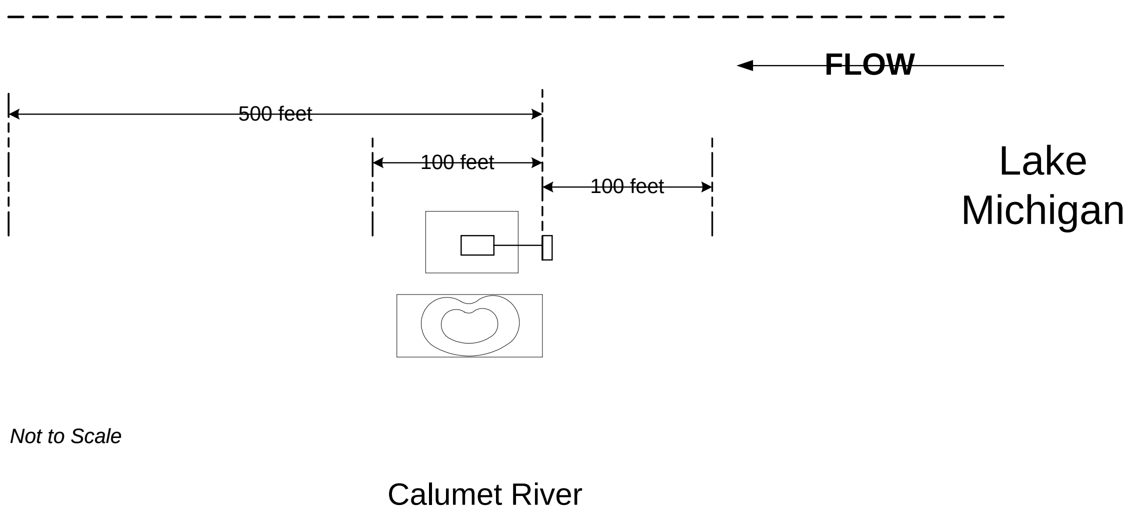
Figure 2: Chicago Area CDF Facility

Figure 3: Precast Concrete Blocks – Along Eastern Perimeter

Figure 4 Current Monitoring Locations



a. Rehandling area



b. Dredging operation

Figure 5: Dredging Operation Monitoring Locations

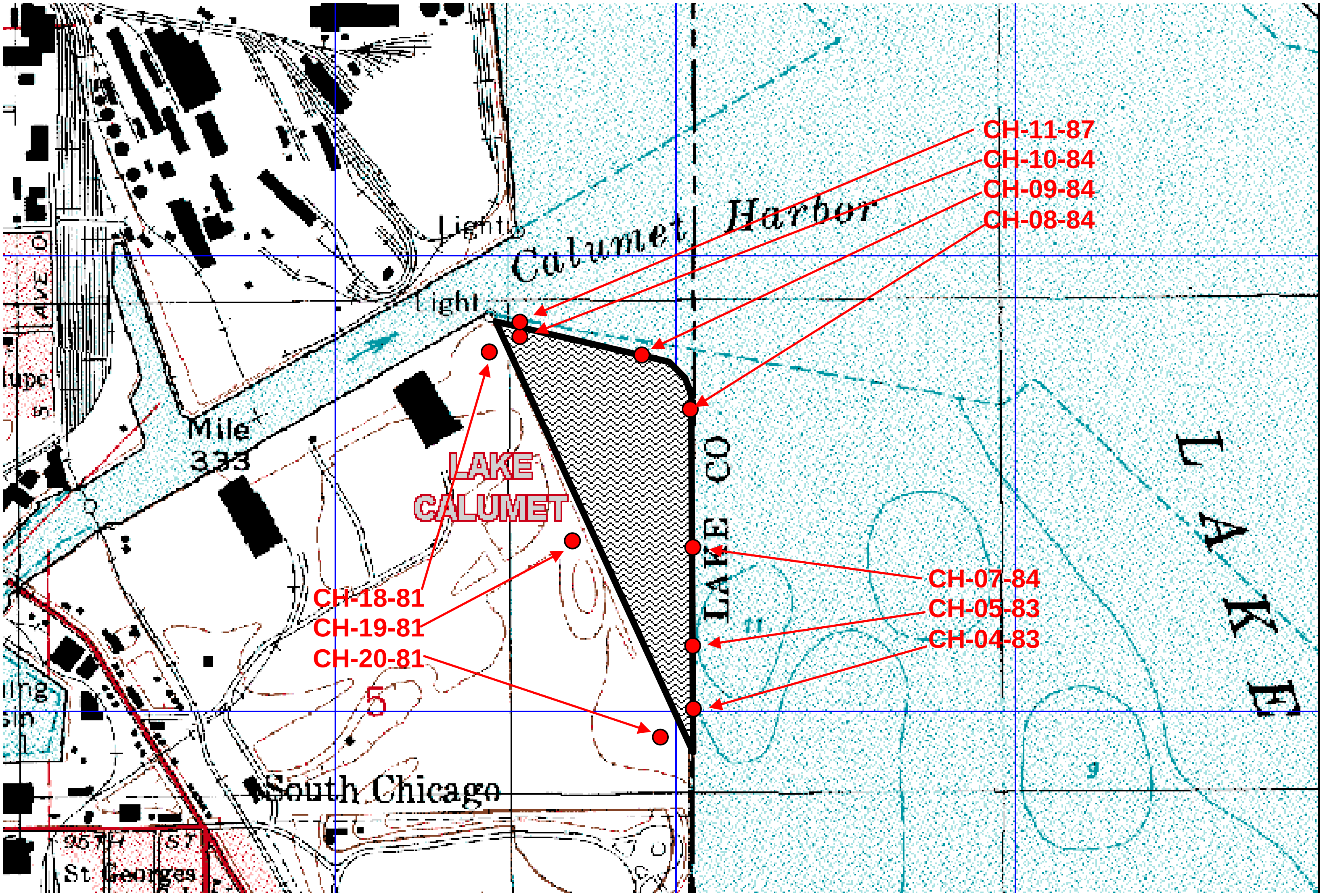


Figure 6: Past (Pre-1997) Well Monitoring Locations

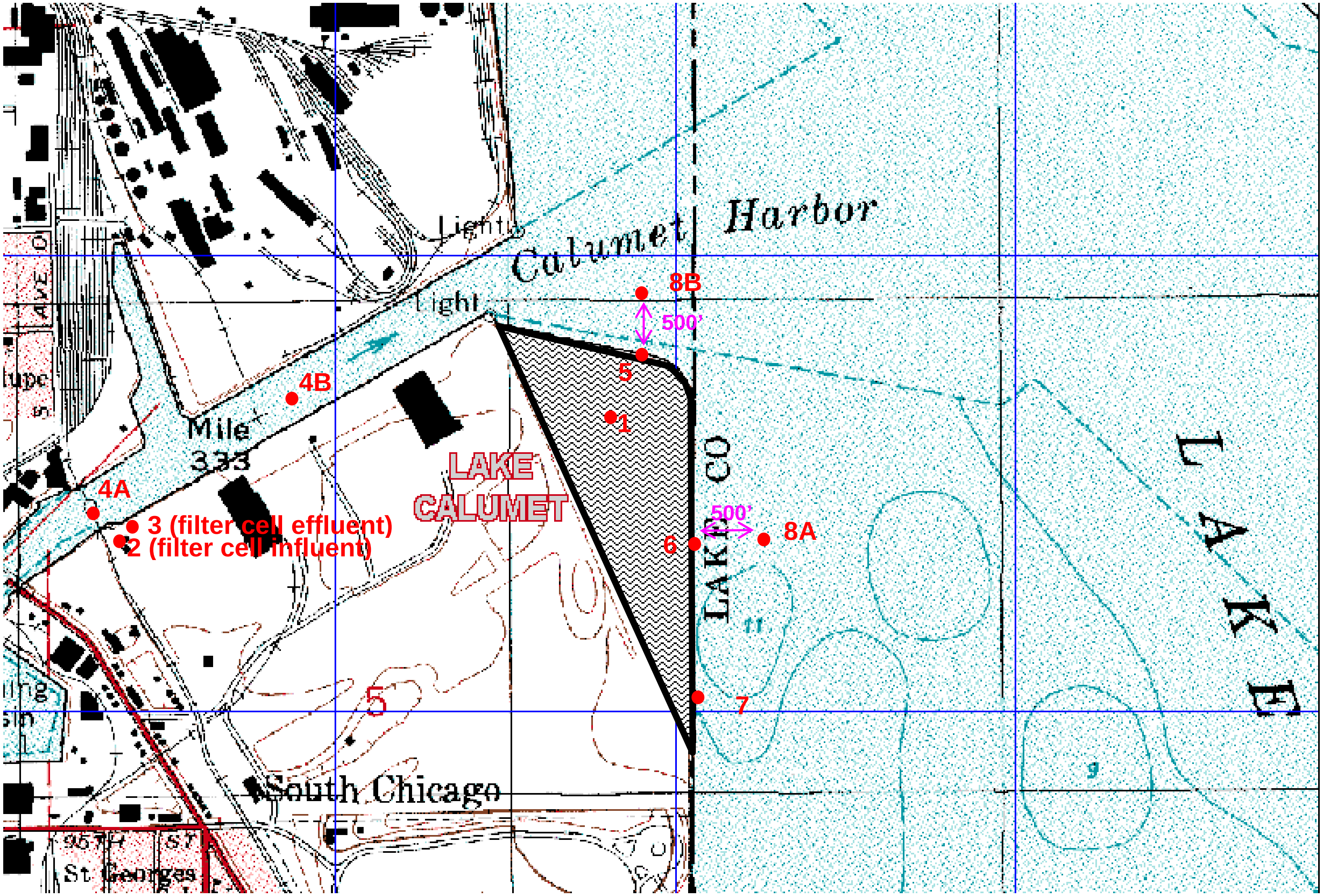


Figure 7: Past (Pre-1997) Dredging Event Monitoring Locations

Appendix A: Water Pollution Control Permit

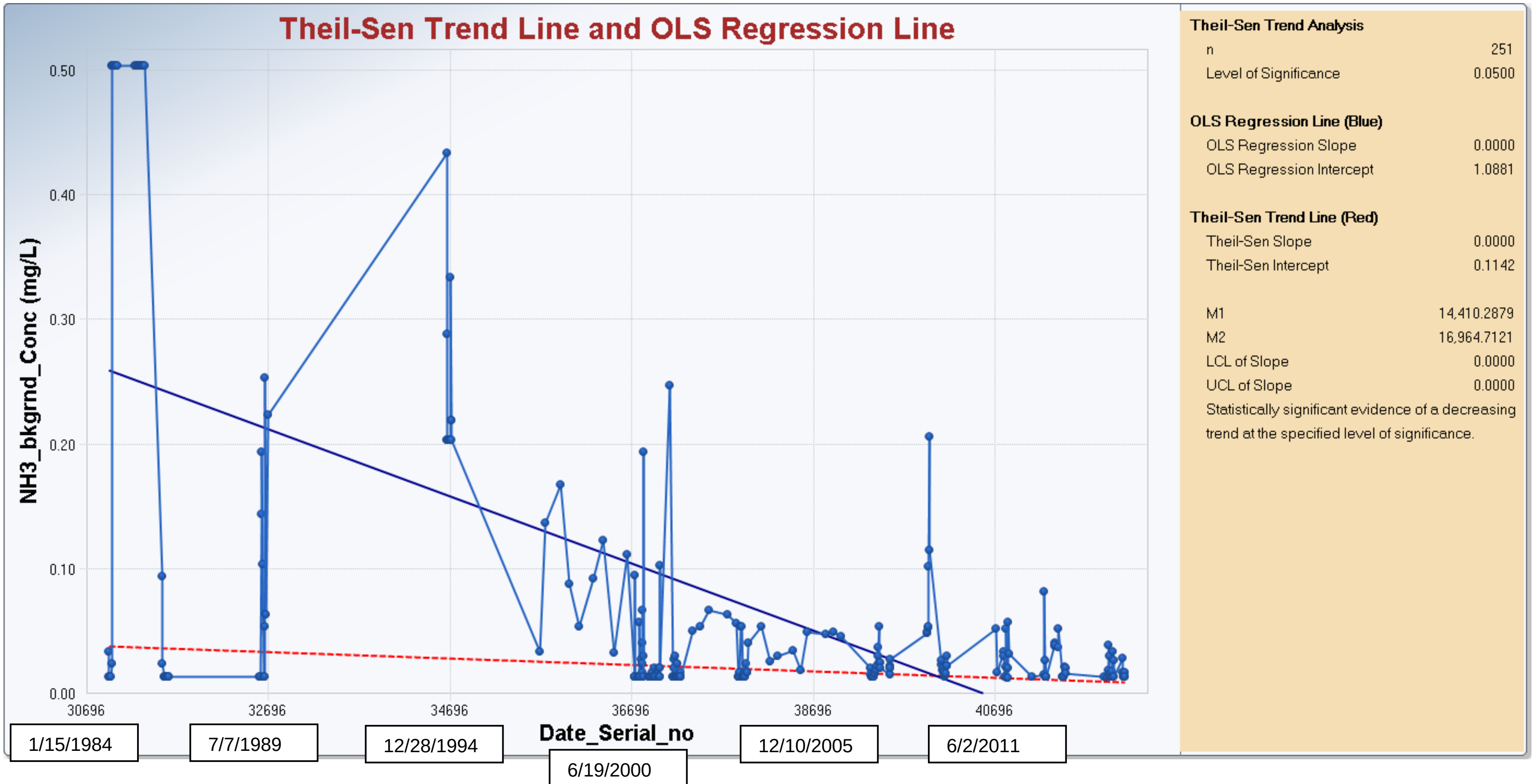
Appendix B: CDF General Layout Drawings

Appendix C: Ammonia Nitrogen Graphs

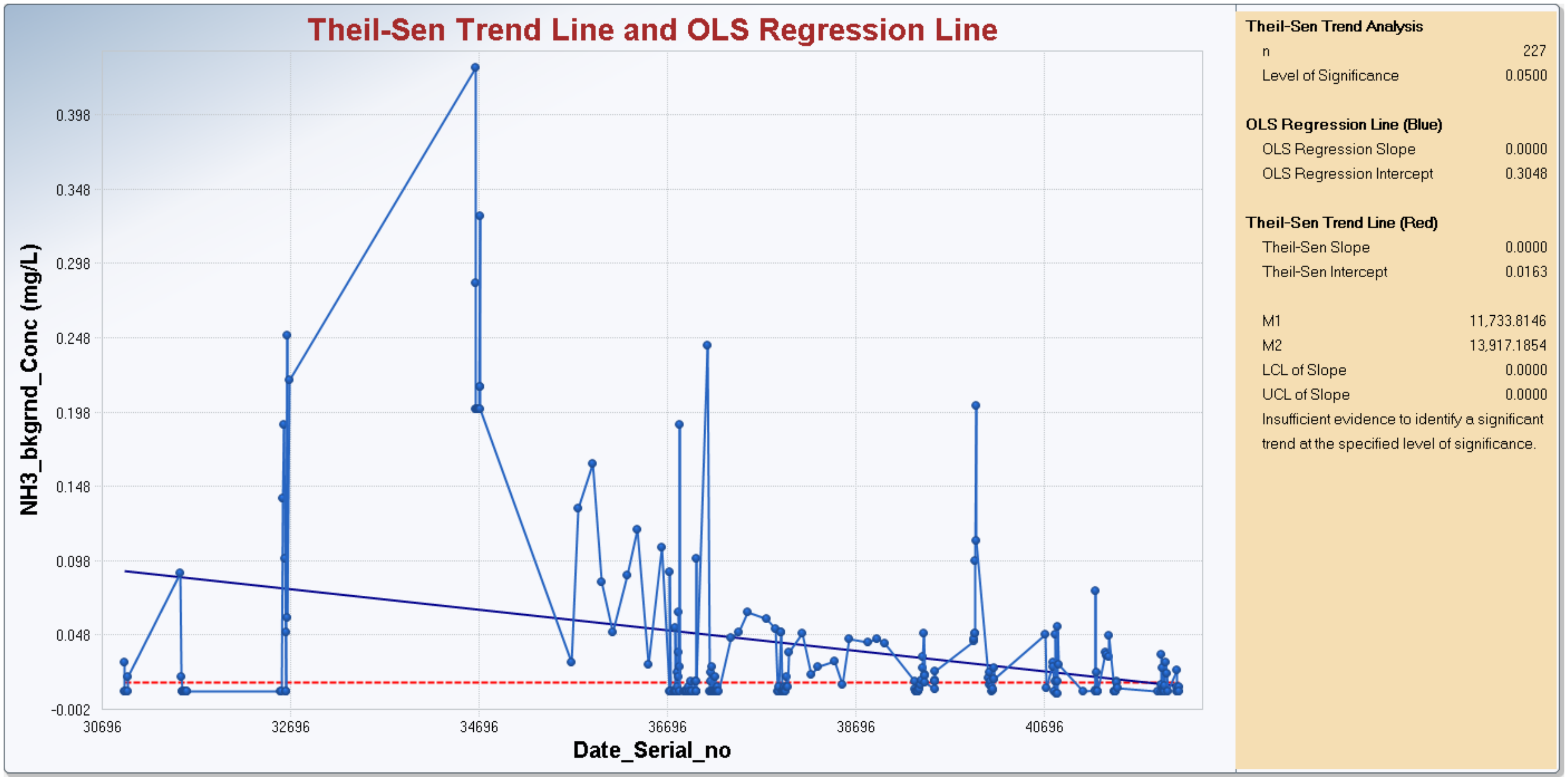
Historical Data

General Statistics - Ammonia Nitrogen								
Historical	Background	Background - Censored	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	643	619	750	634	622	260	263	186
Number of Values Reported (n)	643	619	750	634	622	260	263	186
Number of Values After Averaging	251	227	250	251	251	259	262	185
Number of Replicates	392	392	500	383	371	1	1	1
Minimum	0.0088	0.0088	0.00793	0.01	0.01	0.02	0.01	0.01
Maximum	0.5	0.43	0.597	2.0	4.467	4.9	19	2.9
Mean	0.0872	0.0436	0.0907	0.115	0.908	1.651	5.175	0.168
Geometric Mean	0.0309	0.023	0.0324	0.0481	0.359	1.275	4.044	0.0609
Median	0.018	0.0163	0.02	0.04	0.5	1.6	5	0.06
Standard Deviation	0.148	0.0652	0.151	0.194	1.018	0.968	3.001	0.28
Evidence of Trend Identified?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Direction of Trend (If Identified)	Decreasing	NA	Decreasing	Decreasing	Decreasing	Increasing	Decreasing	Decreasing

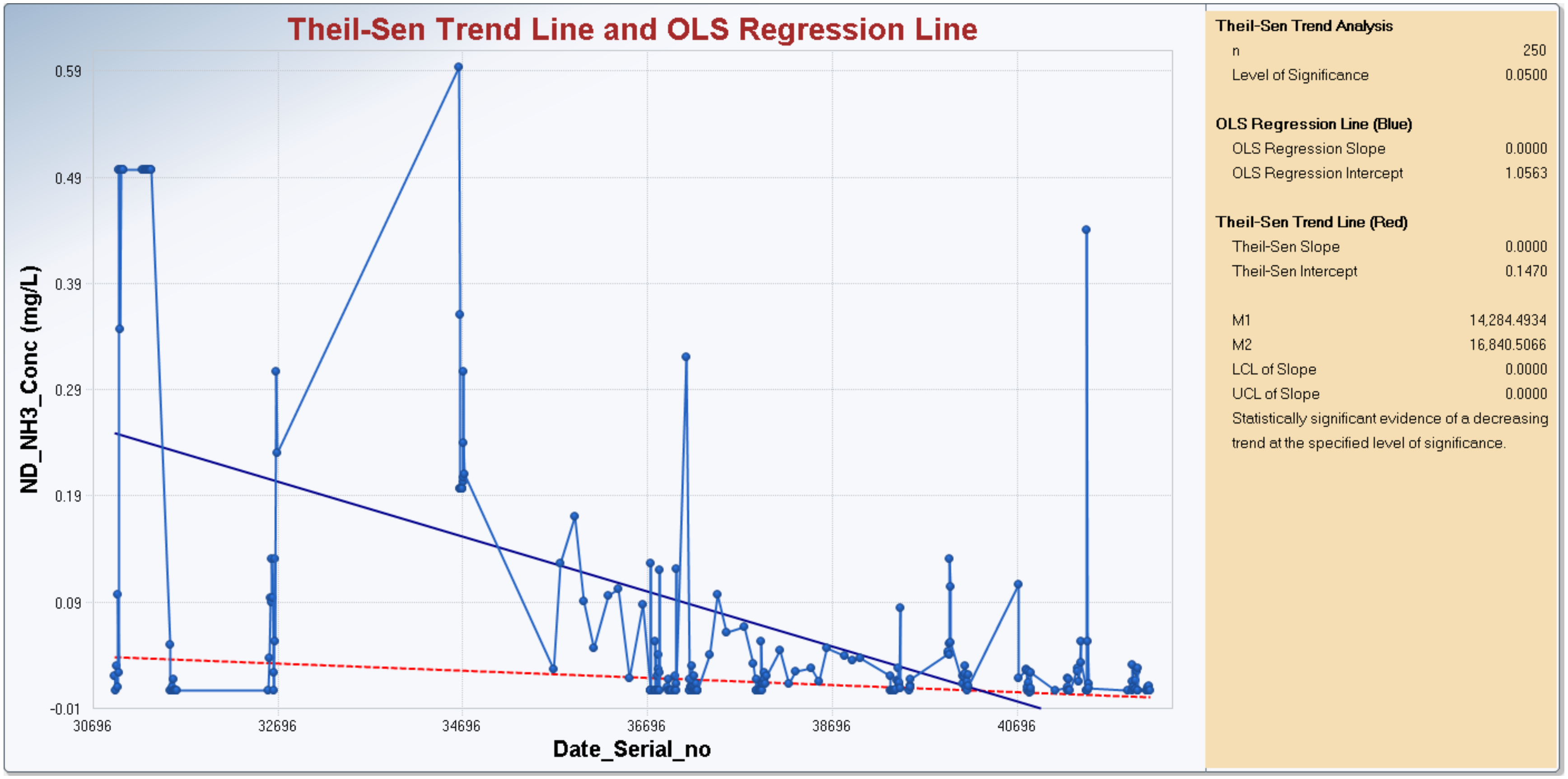
NA = Not Applicable



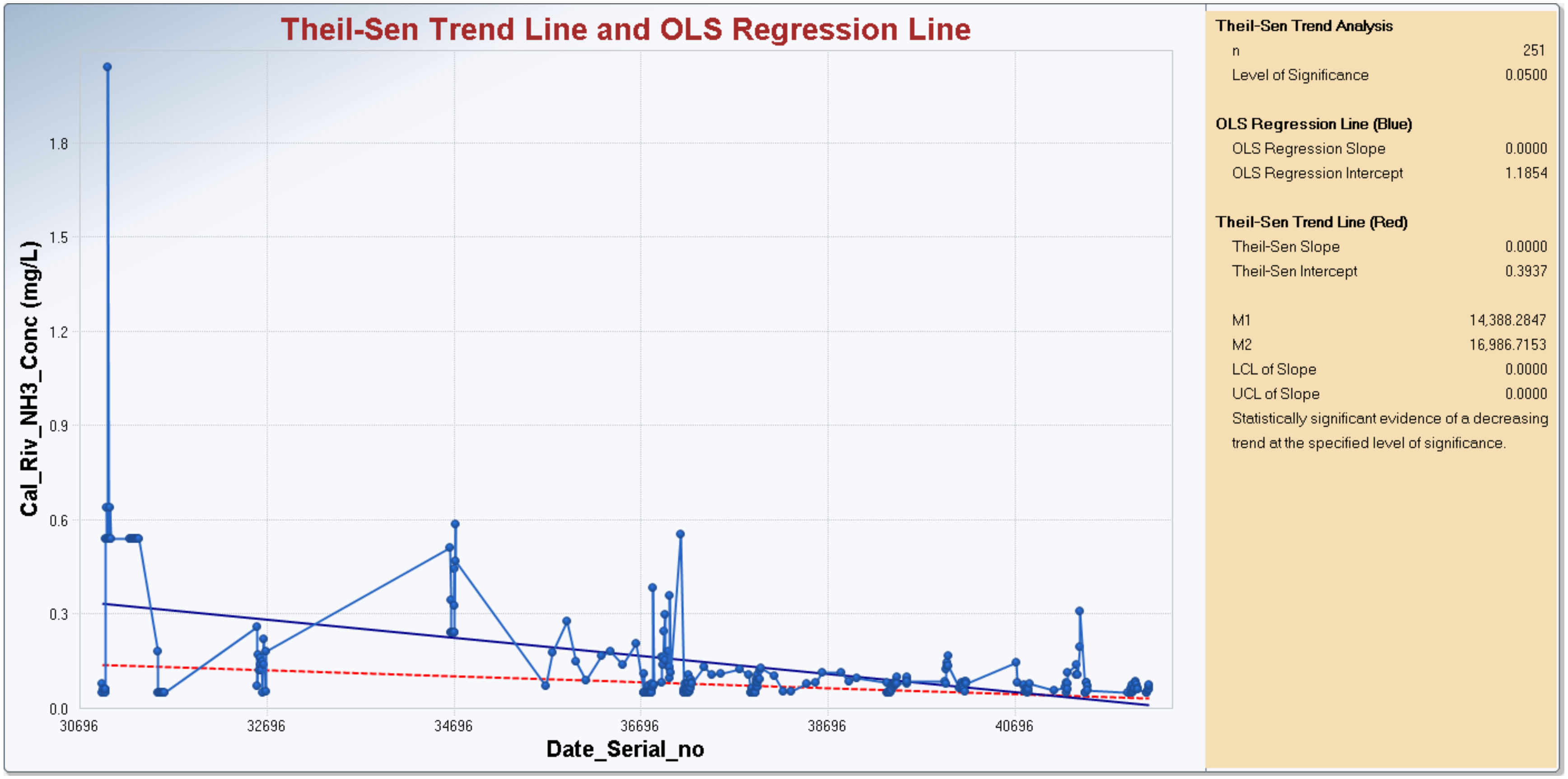
Ammonia Nitrogen – Background (uncensored)



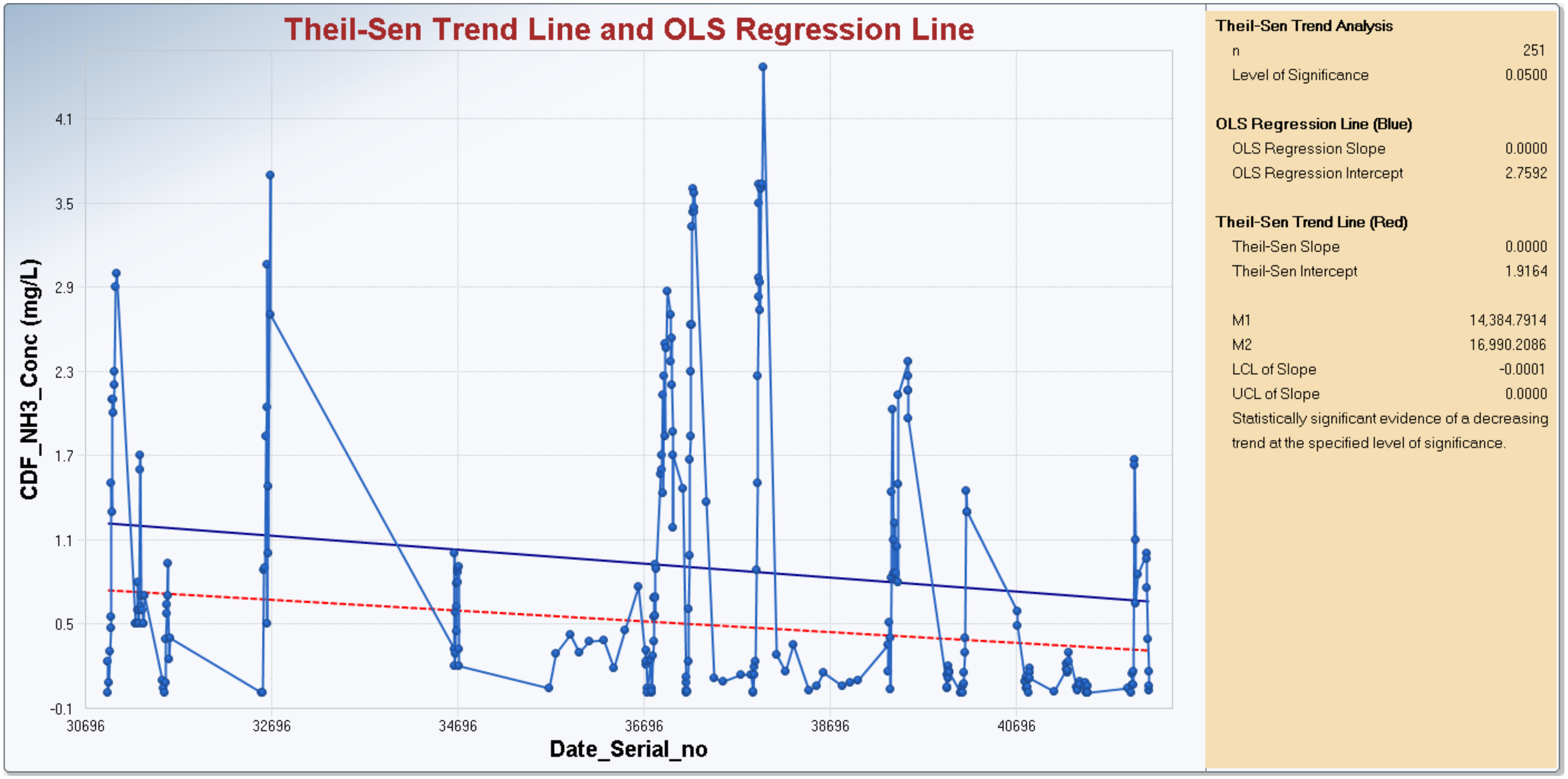
Ammonia Nitrogen – Background (censored)



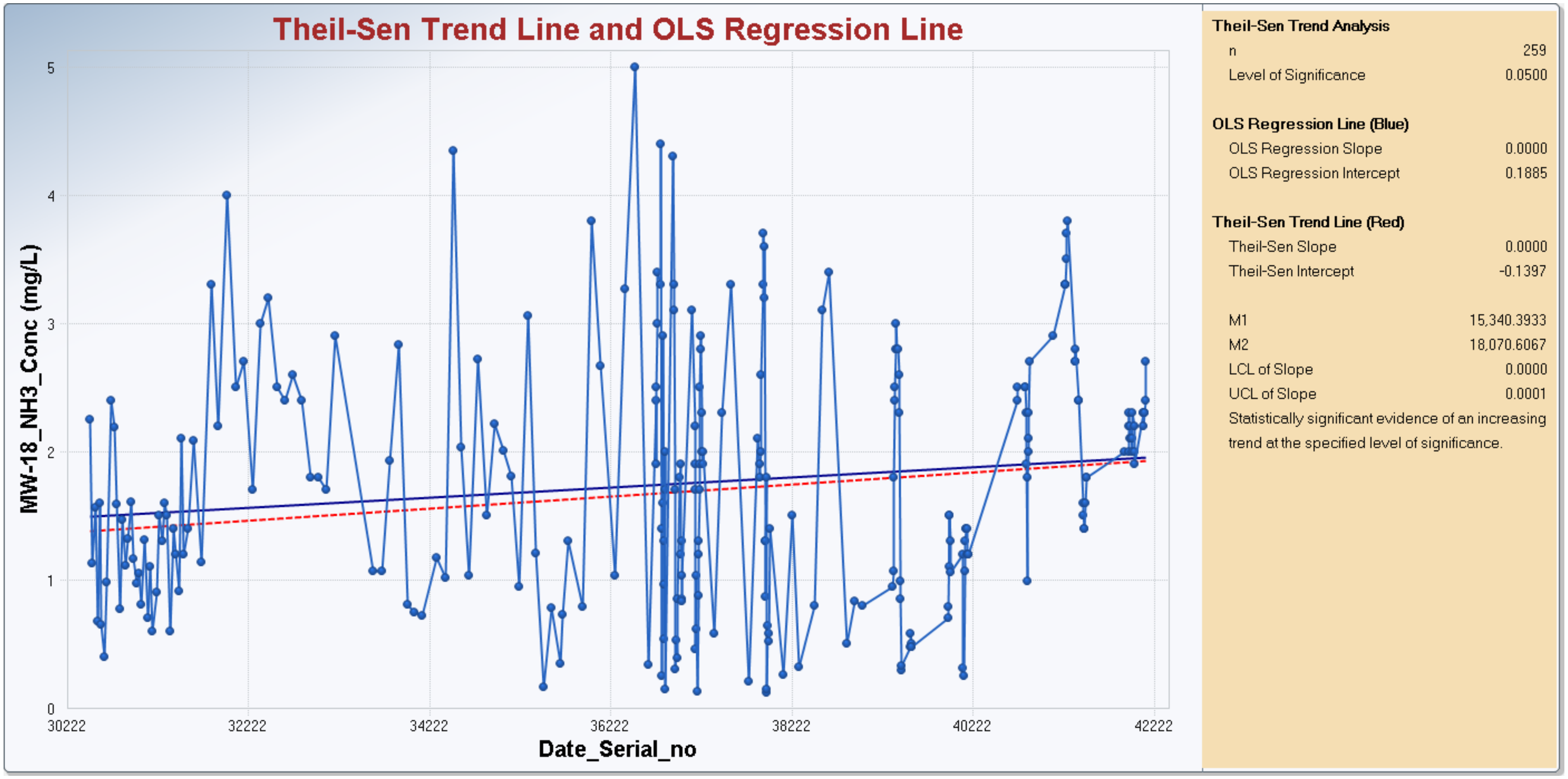
Ammonia Nitrogen – Near Dike



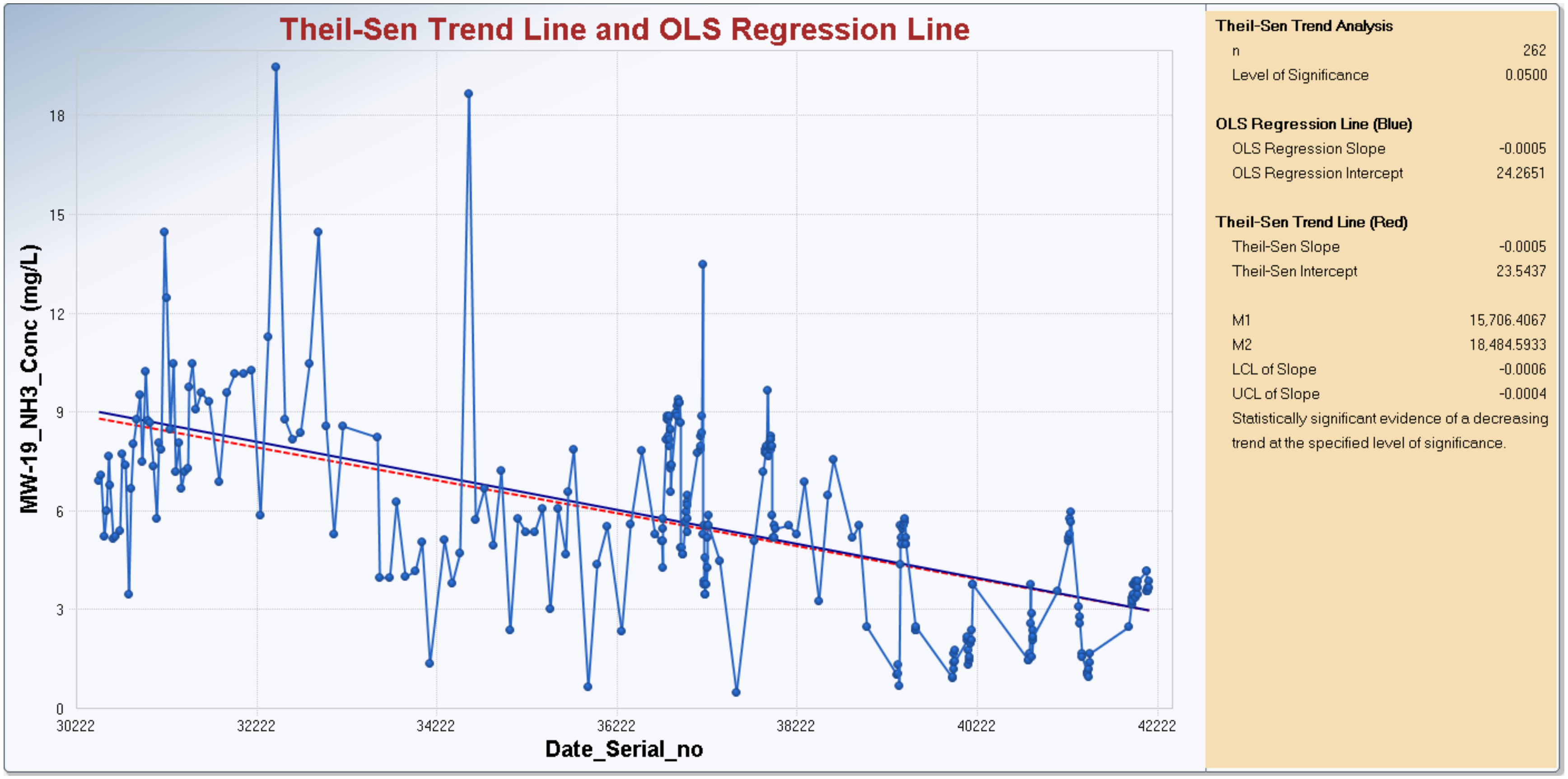
Ammonia Nitrogen – Calumet River



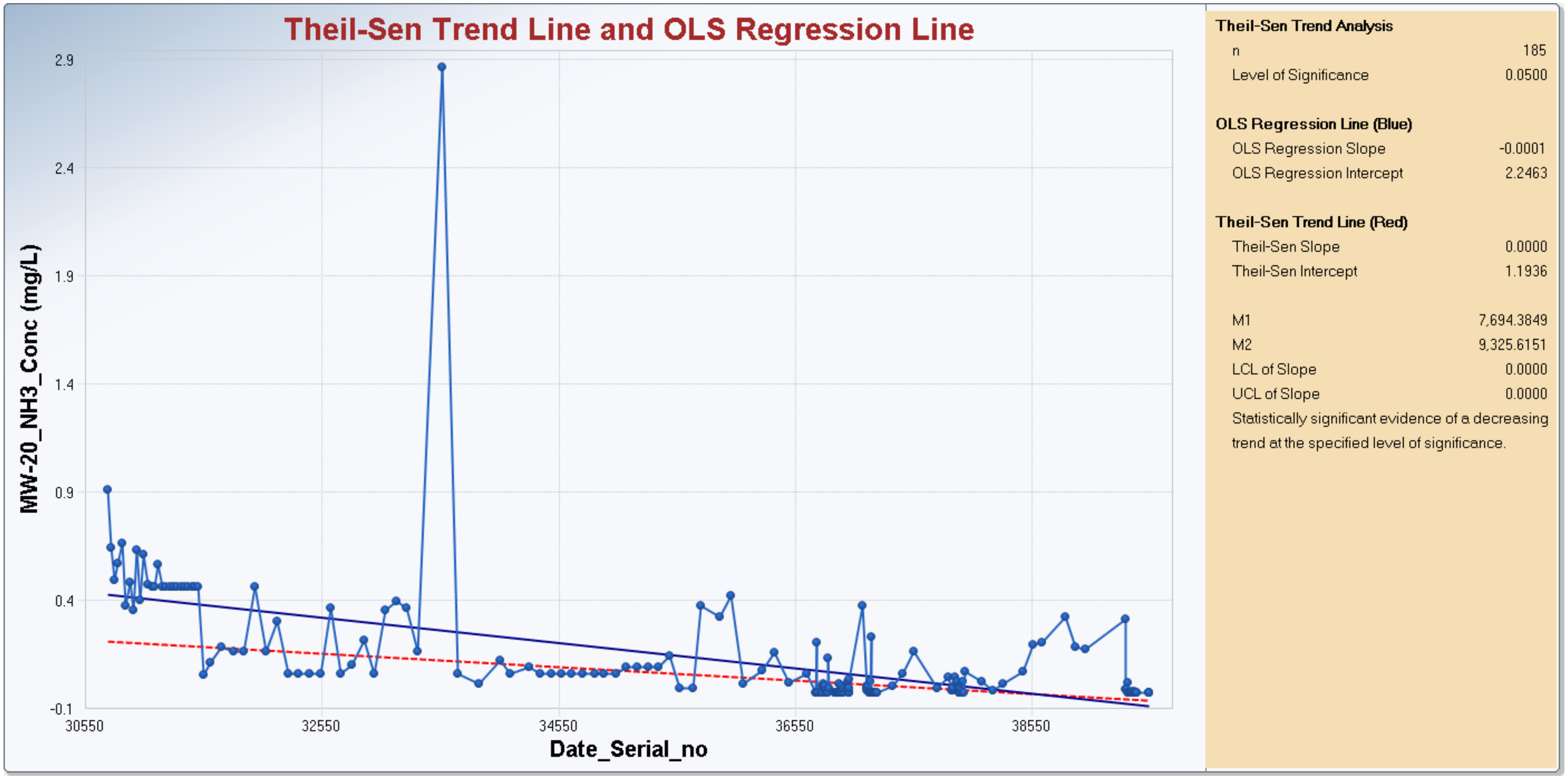
Ammonia Nitrogen – CDF



Ammonia Nitrogen – Monitoring Well 18



Ammonia Nitrogen – Monitoring Well 19



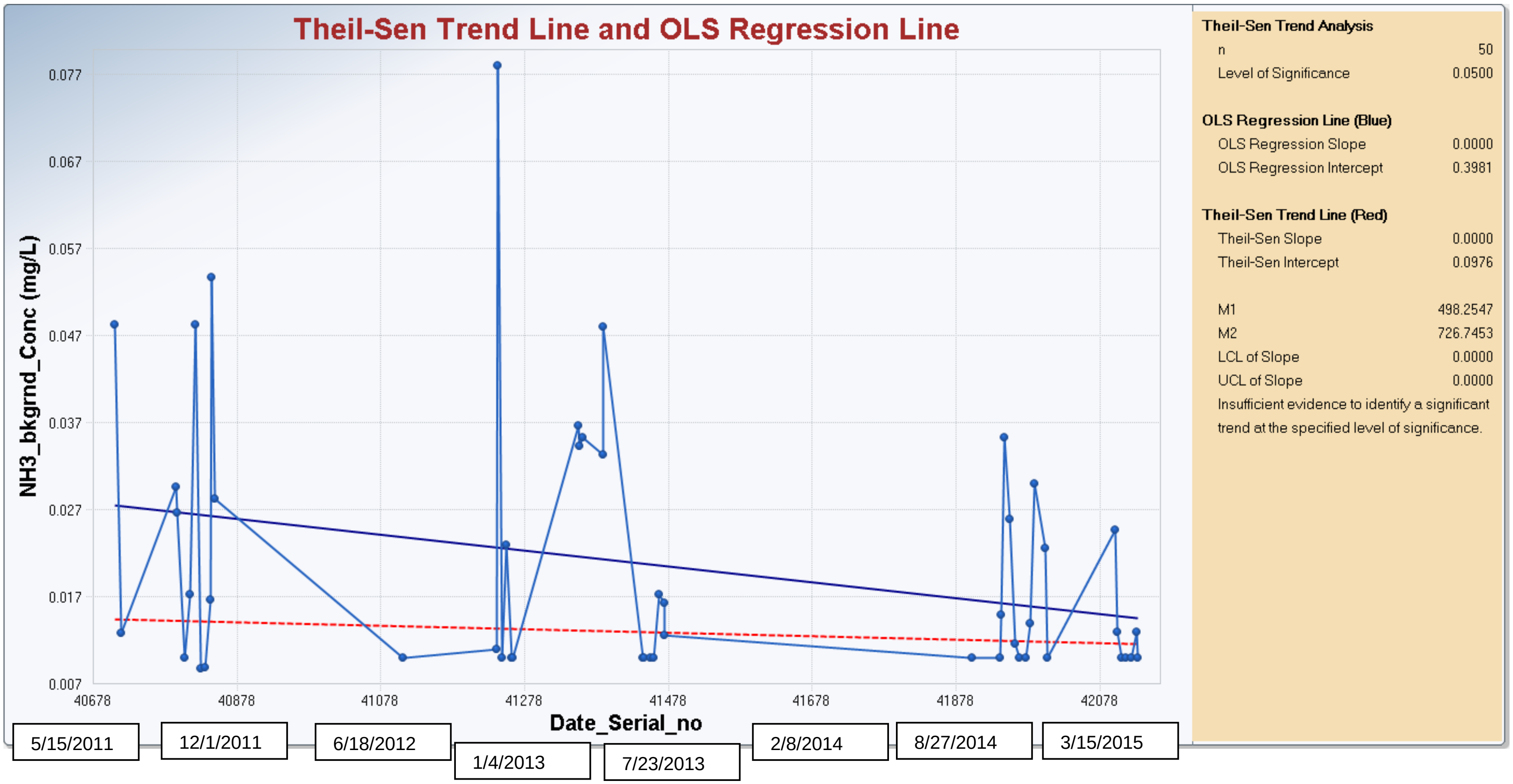
Ammonia Nitrogen – Monitoring Well 20

Ammonia Nitrogen Graphs

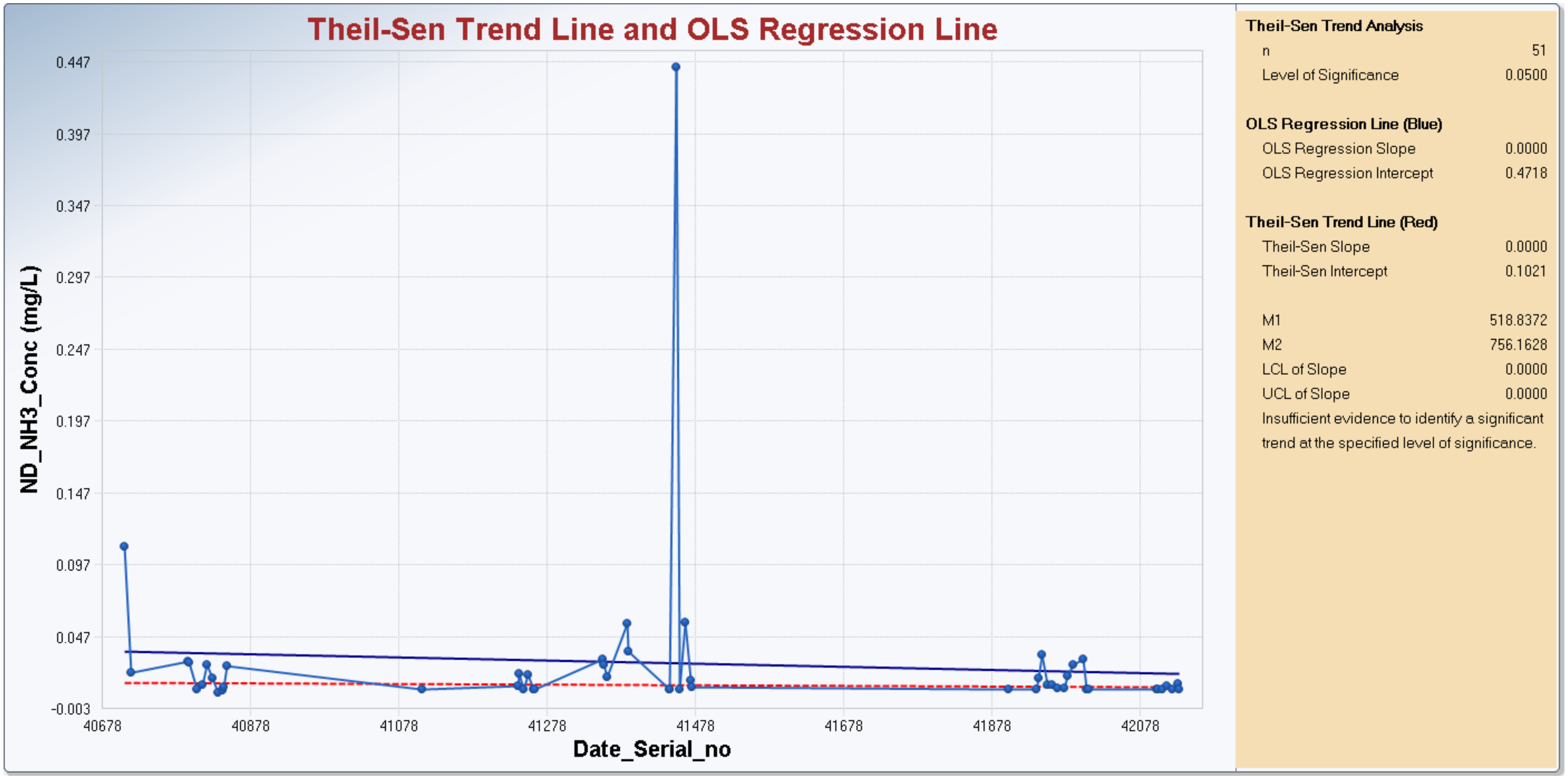
Current Data

General Statistics - Ammonia Nitrogen						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	150	151	153	147	51	49
Number of Values Reported (n)	150	151	153	147	51	49
Number of Values After Averaging	50	51	51	49	51	49
Number of Replicates	100	100	102	98	0	0
Minimum	0.0088	0.00793	0.01	0.01	0.89	0.47
Maximum	0.078	0.443	0.27	1.667	3.7	5.5
Mean	0.0206	0.0281	0.0366	0.276	2.21	2.602
Geometric Mean	0.0169	0.0172	0.0258	0.11	2.135	2.193
Median	0.013	0.013	0.023	0.109	2.2	2.9
Standard Deviation	0.0149	0.0617	0.0433	0.403	0.578	1.339
Evidence of Trend Identified?	No	No	No	No	No	Yes
Direction of Trend (If Identified)	NA	NA	NA	NA	NA	Increasing

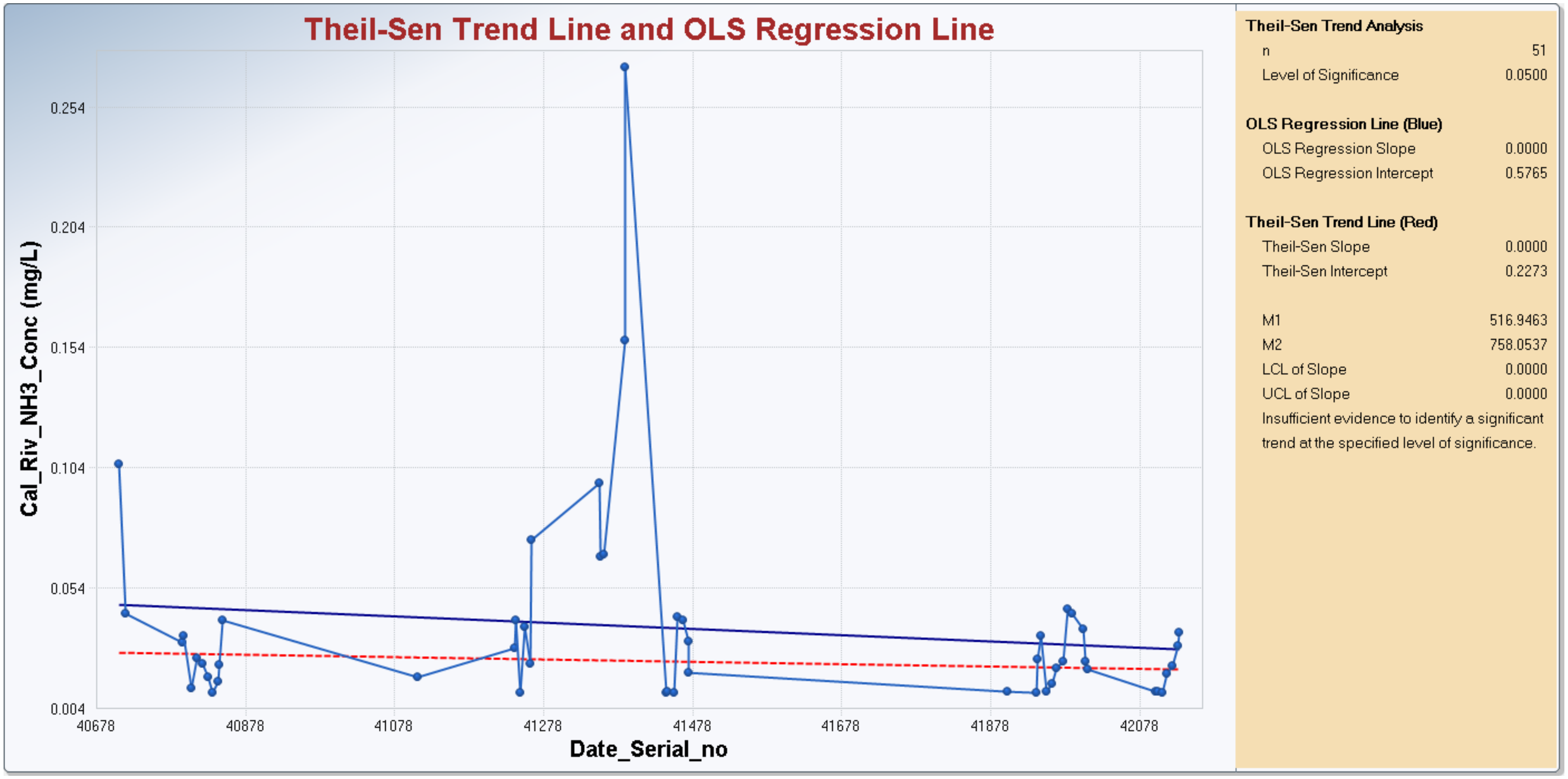
NA = Not Applicable



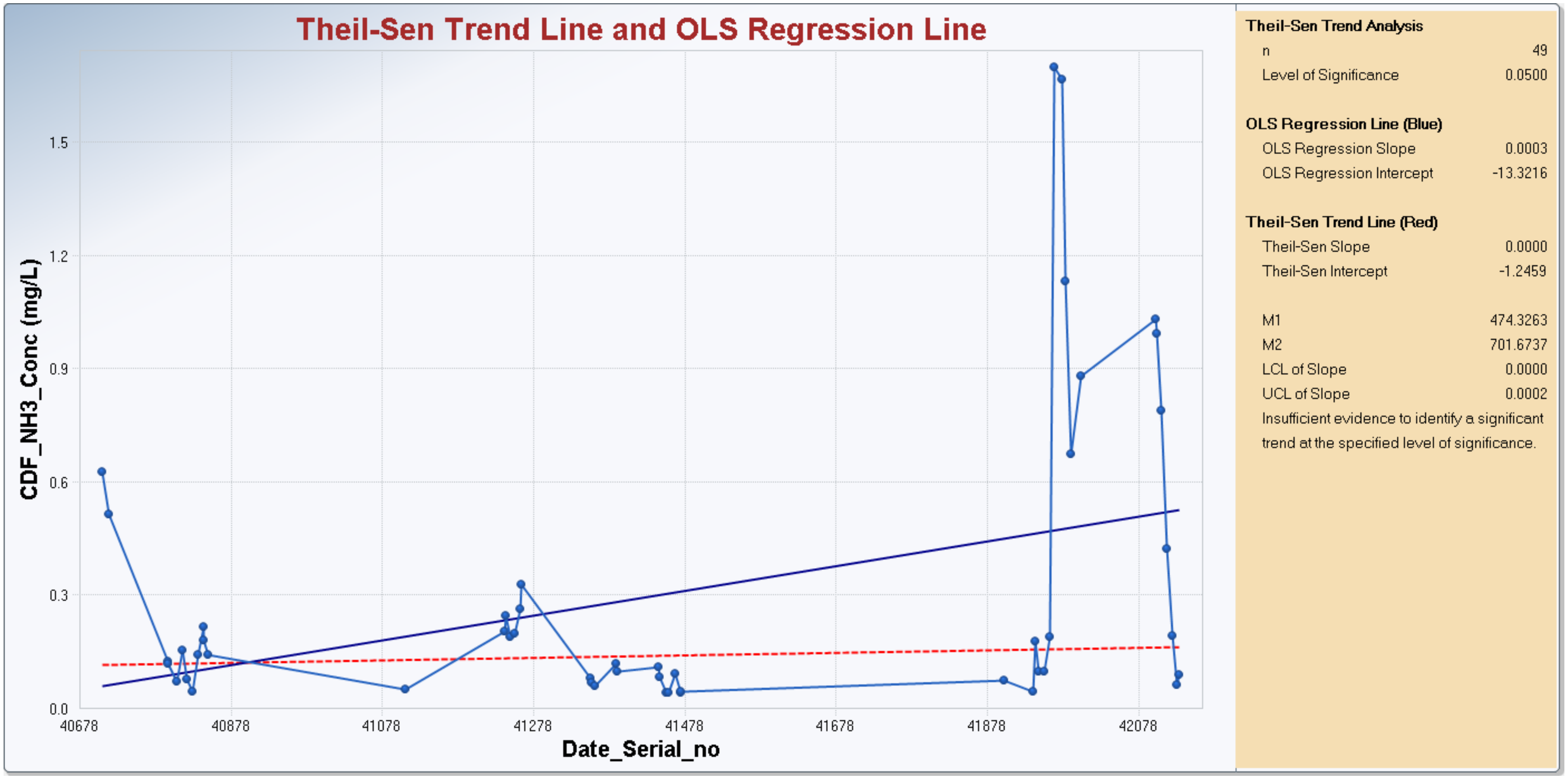
Ammonia Nitrogen – Background



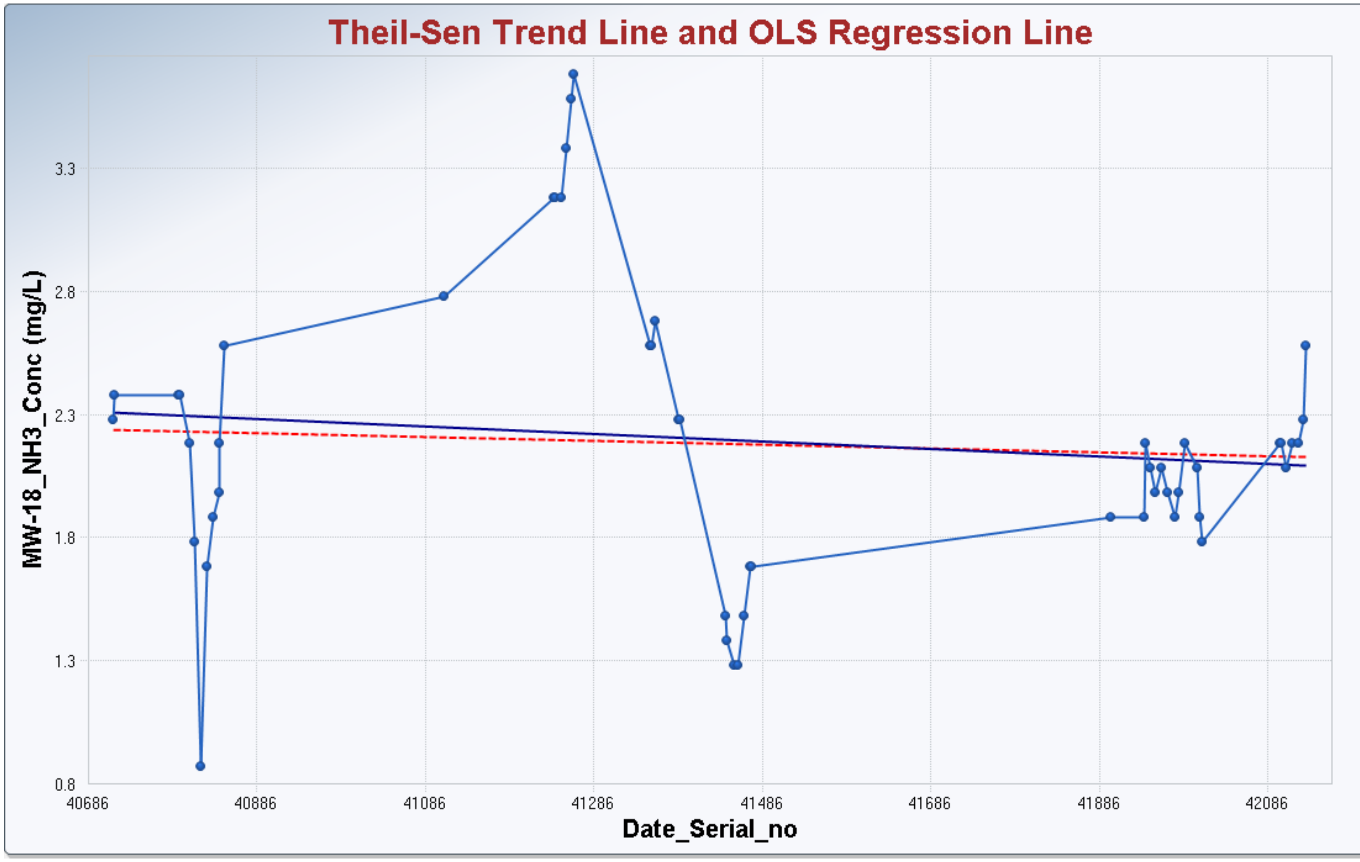
Ammonia Nitrogen – Near Dike



Ammonia Nitrogen – Calumet River



Ammonia Nitrogen – CDF



Theil-Sen Trend Analysis

n	51
Level of Significance	0.0500

OLS Regression Line (Blue)

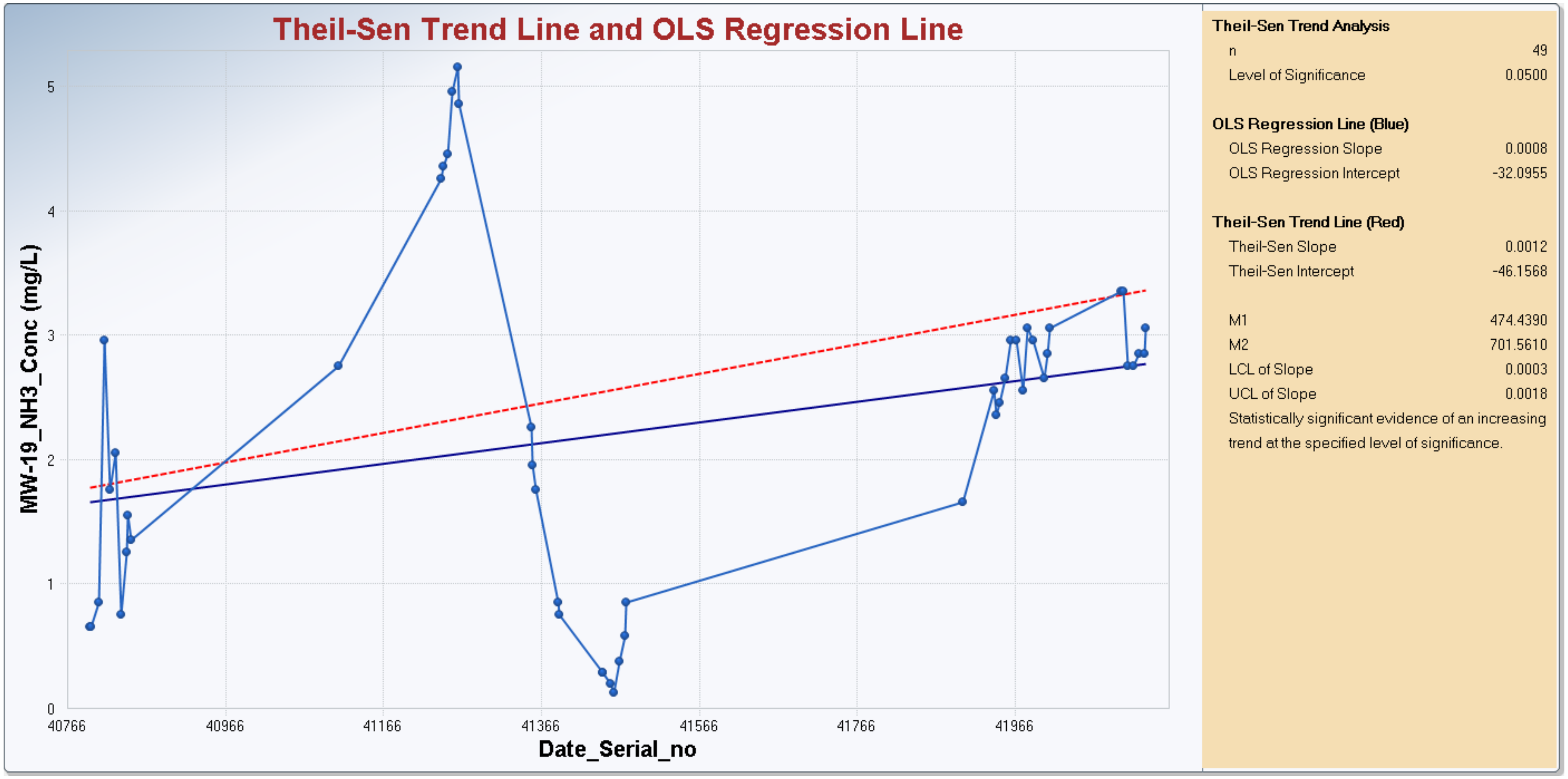
OLS Regression Slope	-0.0002
OLS Regression Intercept	8.6108

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0001
Theil-Sen Intercept	5.4736
M1	517.3666
M2	757.6334
LCL of Slope	-0.0004
UCL of Slope	0.0002

Insufficient evidence to identify a significant trend at the specified level of significance.

Ammonia Nitrogen – Monitoring Well 18



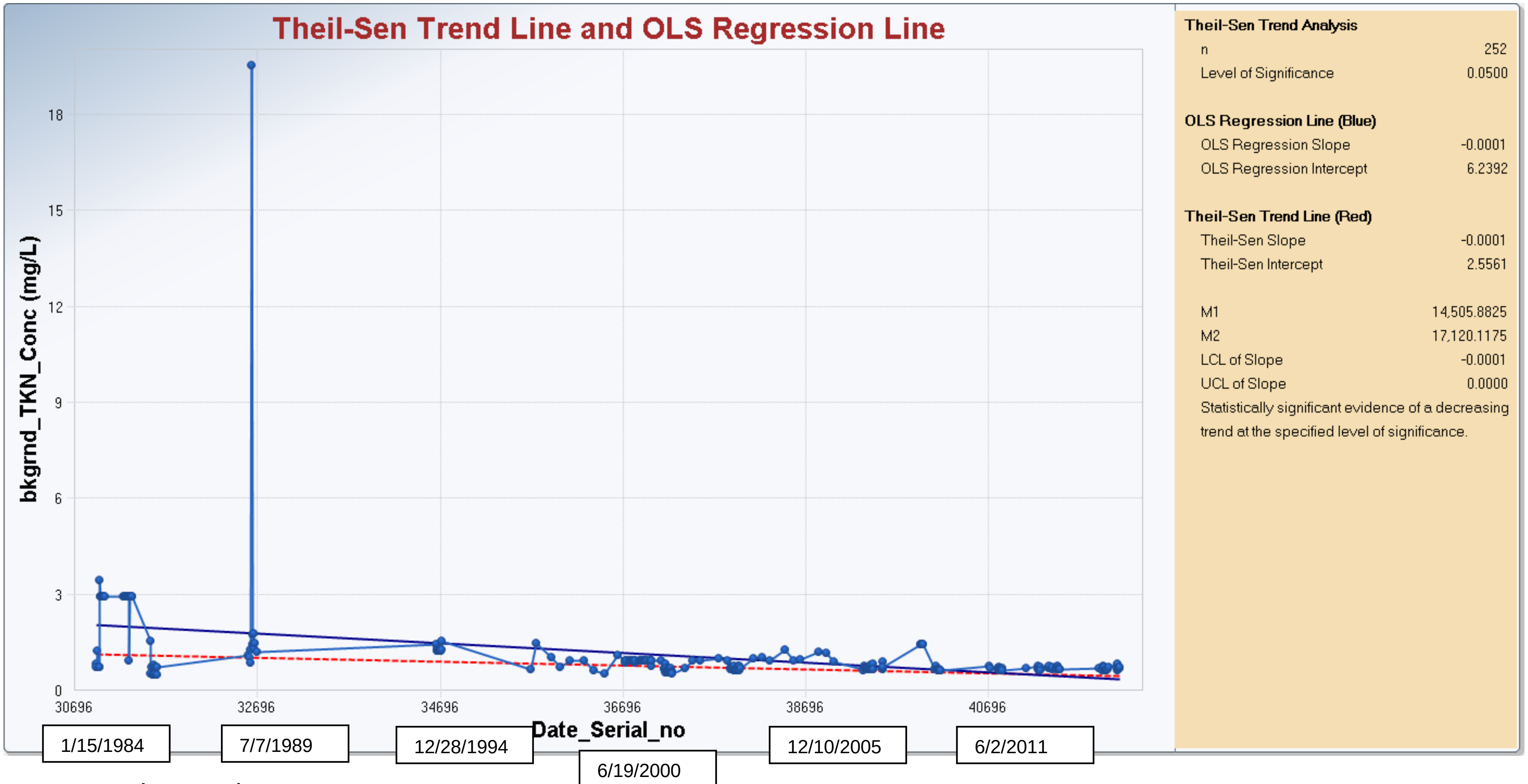
Ammonia Nitrogen – Monitoring Well 19

Appendix D: Total Kjeldahl Nitrogen (TKN) Graphs

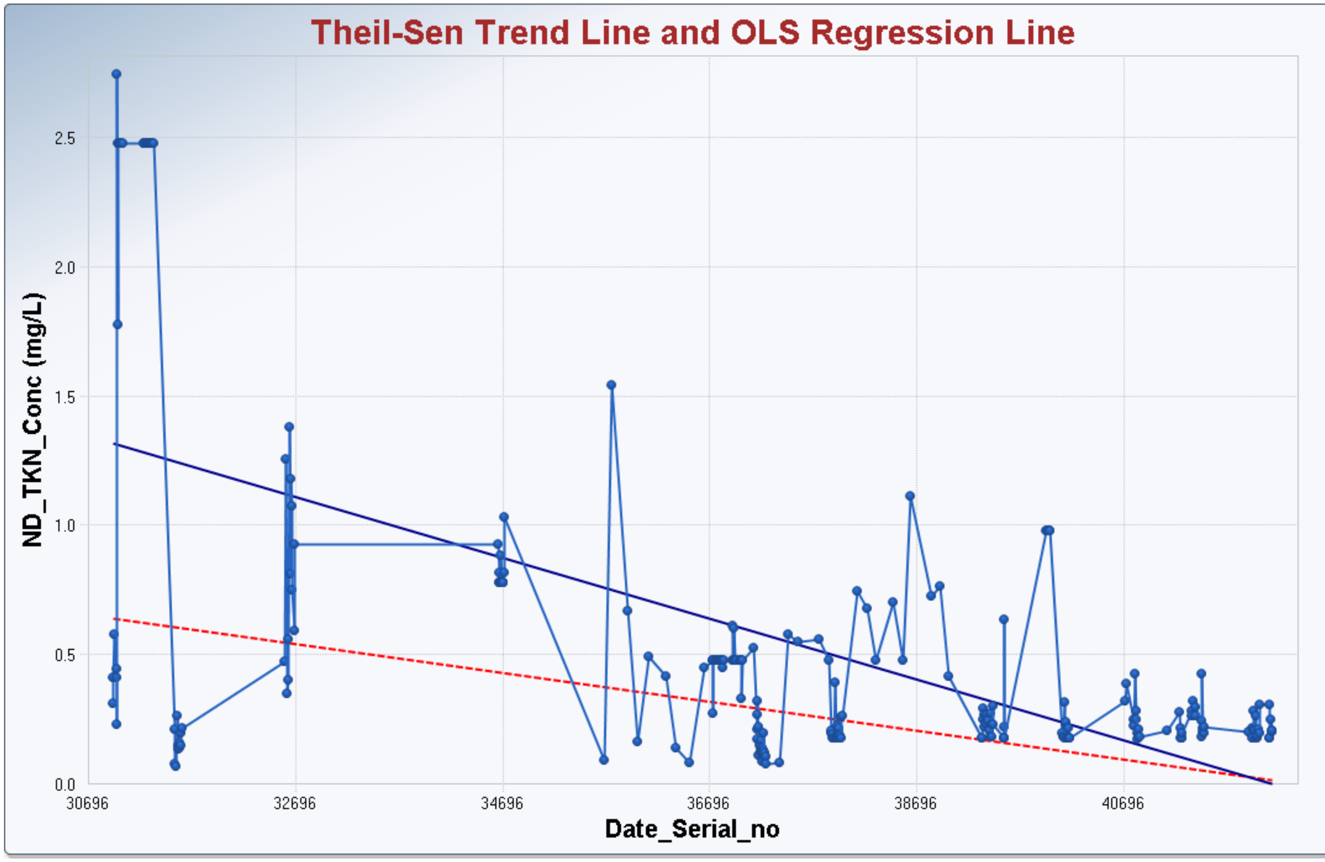
Historical Data

General Statistics - Total Kjeldahl Nitrogen							
Historical	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	643	750	634	621	247	250	172
Number of Values Reported (n)	643	750	634	622	247	250	172
Number of Values After Averaging	252	250	251	371	246	249	171
Number of Replicates	391	500	383	621	1	1	1
Minimum	0.05	0.09	0.1	251	0.1	0.27	0.061
Maximum	19.1	2.767	2.5	370	12	16	2.6
Mean	0.667	0.603	0.621	0.01	2.16	5.025	0.605
Geometric Mean	0.404	0.404	0.427	7.15	1.749	3.959	0.393
Median	0.317	0.31	0.367	1.831	2	4.9	0.5
Standard Deviation	1.34	0.668	0.665	1.443	1.517	2.957	0.646
Evidence of Trend Identified?	Yes	Yes	Yes	Yes	No	Yes	Yes
Direction of Trend (If Identified)	Decreasing	Decreasing	Decreasing	Decreasing	NA	Decreasing	Decreasing

NA = Not Applicable



TKN – Background



Theil-Sen Trend Analysis

n	250
Level of Significance	0.0500

OLS Regression Line (Blue)

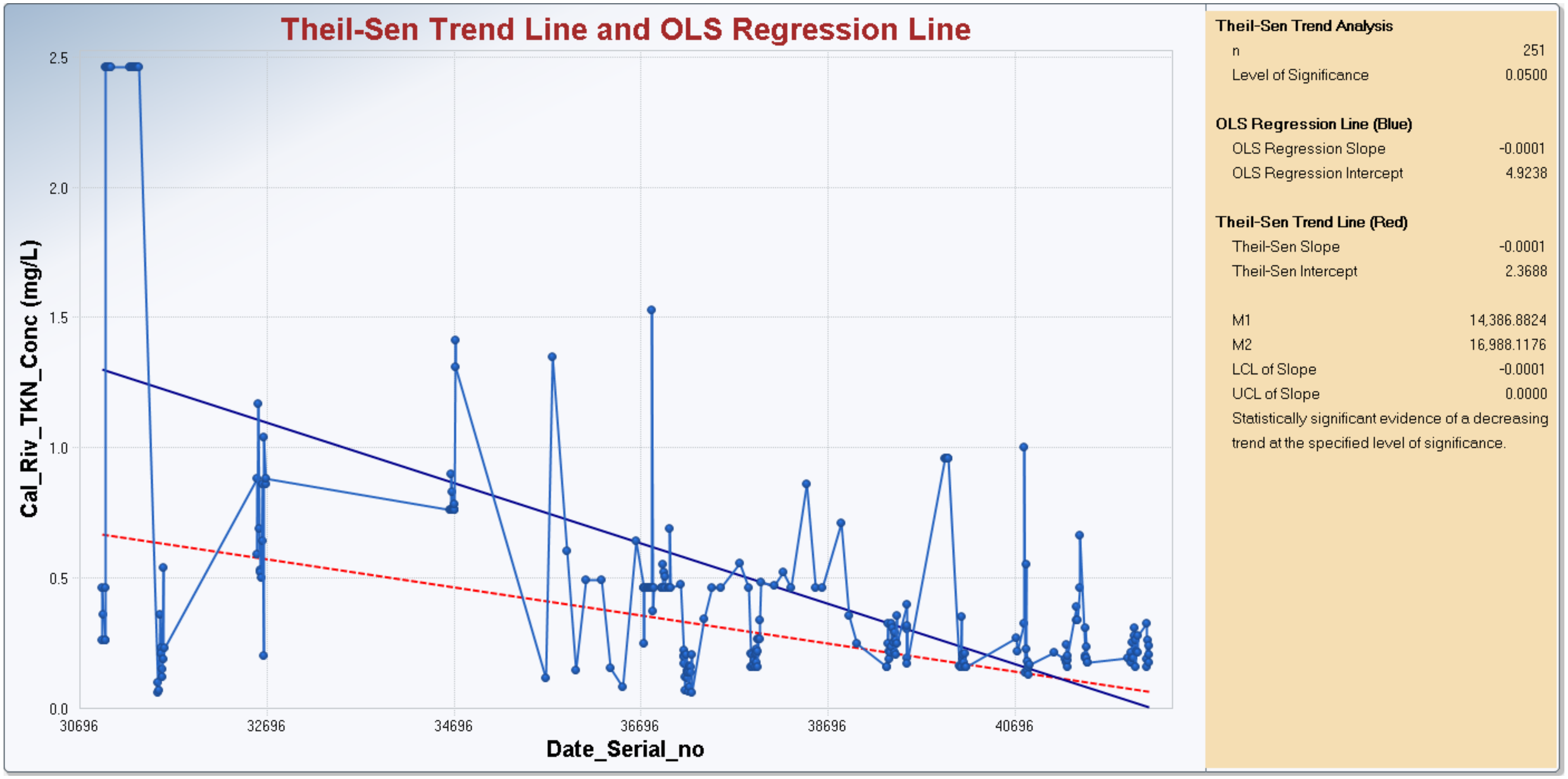
OLS Regression Slope	-0.0001
OLS Regression Intercept	4.9850

Theil-Sen Trend Line (Red)

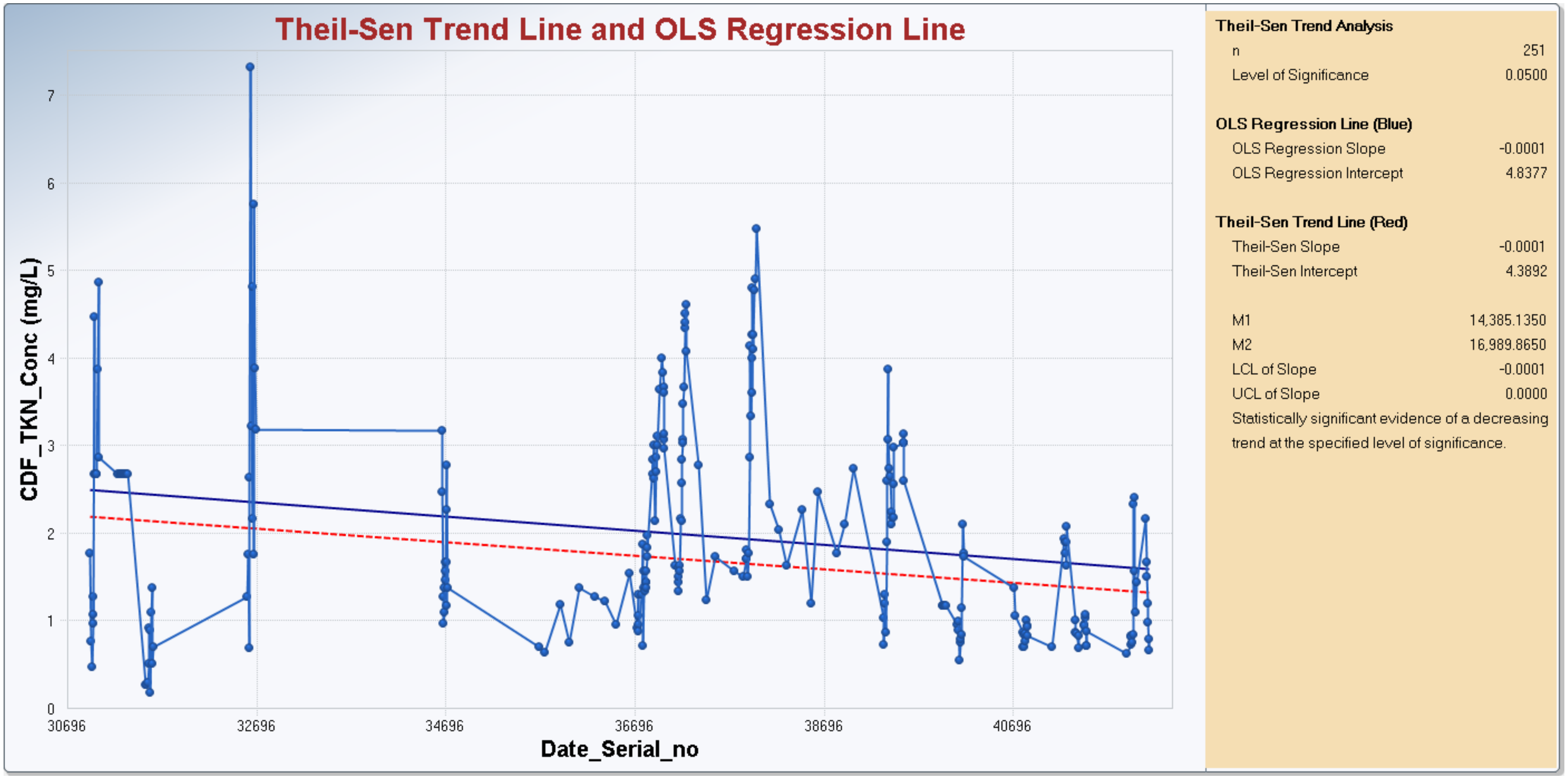
Theil-Sen Slope	-0.0001
Theil-Sen Intercept	2.3798
M1	14,269.7891
M2	16,855.2109
LCL of Slope	-0.0001
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

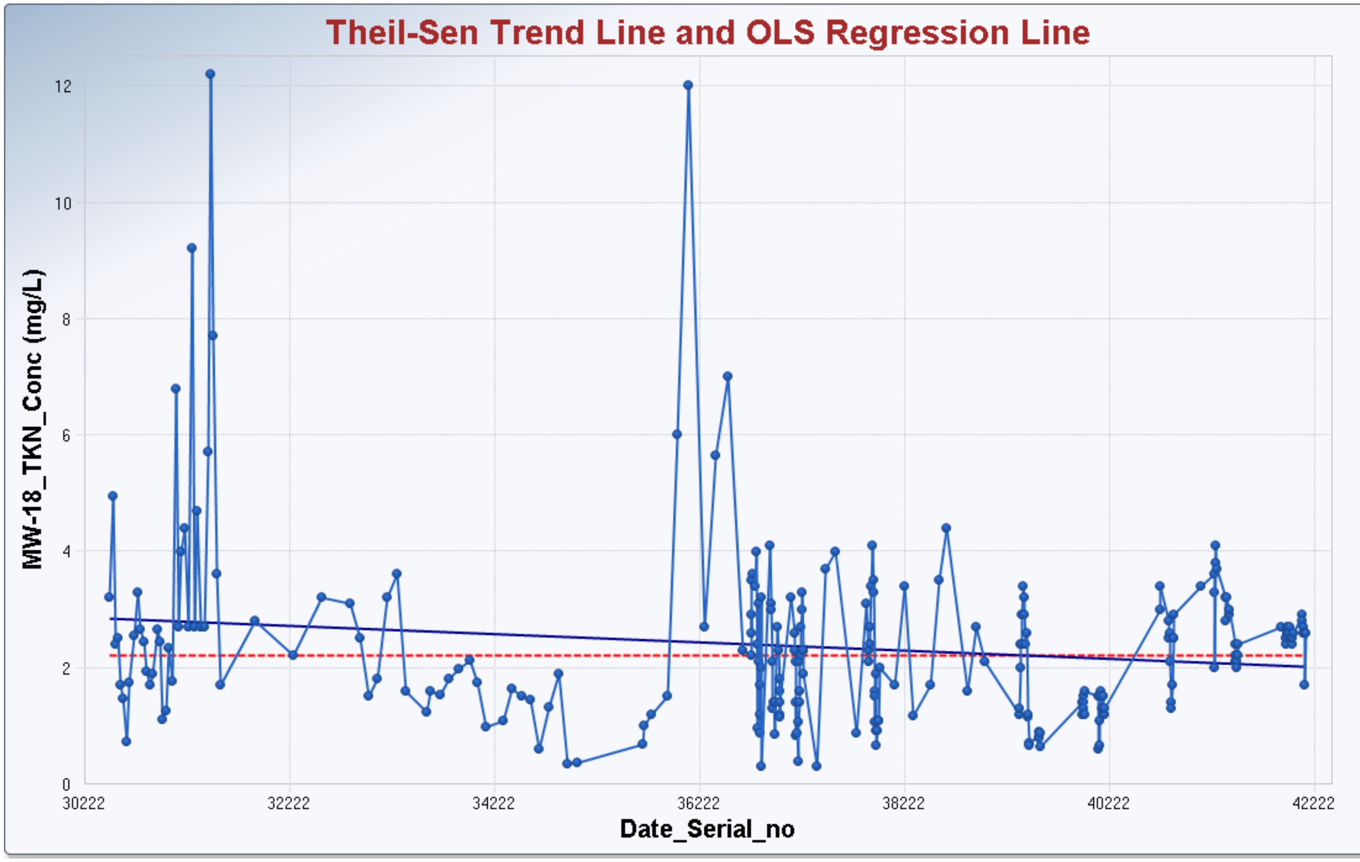
TKN – Near Dike



TKN – Calumet River


Theil-Sen Trend Line and OLS Regression Line
CDF_TKN_Conc (mg/L)
0
1
2
3
4
5
6
7
30696
32696
34696
36696
38696
40696
Date_Serial_no
Theil-Sen Trend Analysis
n 251
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope -0.0001
OLS Regression Intercept 4.8377
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0001
Theil-Sen Intercept 4.3892
M1 14,385.1350
M2 16,989.8650
LCL of Slope -0.0001
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

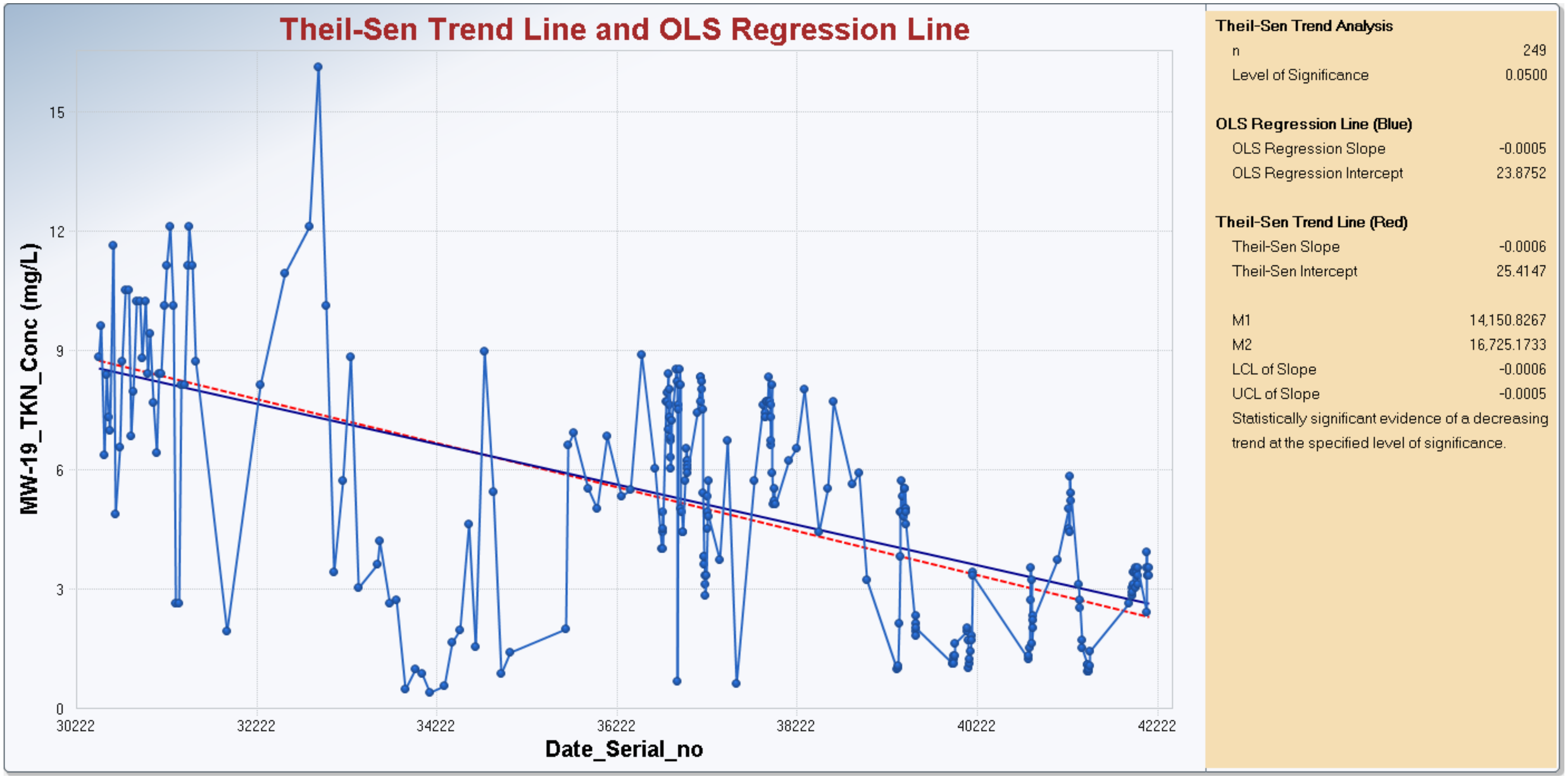
TKN – CDF



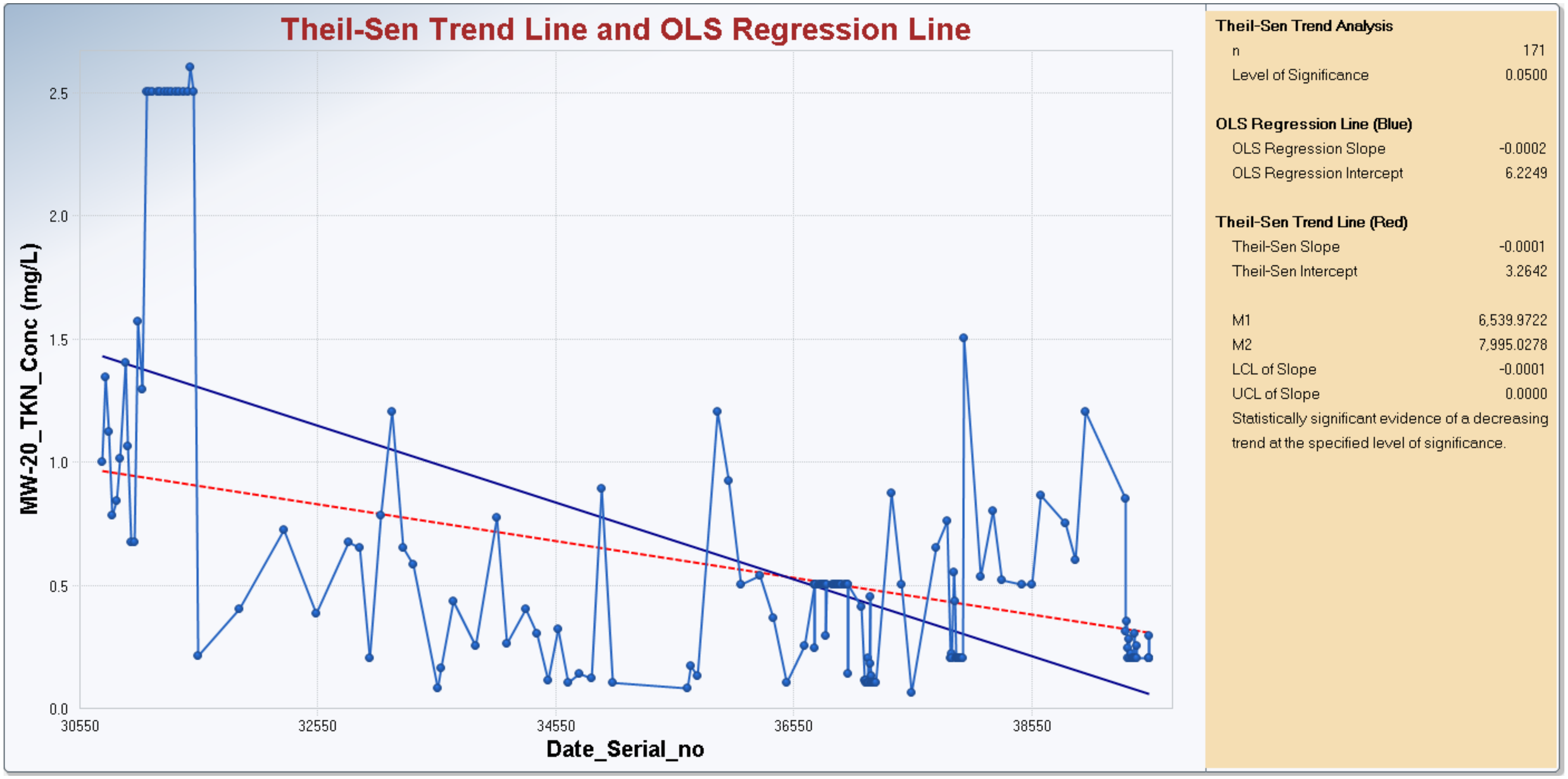
Theil-Sen Trend Analysis	
n	246
Level of Significance	0.0500
OLS Regression Line (Blue)	
OLS Regression Slope	-0.0001
OLS Regression Intercept	4.7852
Theil-Sen Trend Line (Red)	
Theil-Sen Slope	0.0000
Theil-Sen Intercept	2.0000
M1	13,803.8161
M2	16,331.1839
LCL of Slope	0.0000
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

TKN – Monitoring Well 18



TKN – Monitoring Well 19



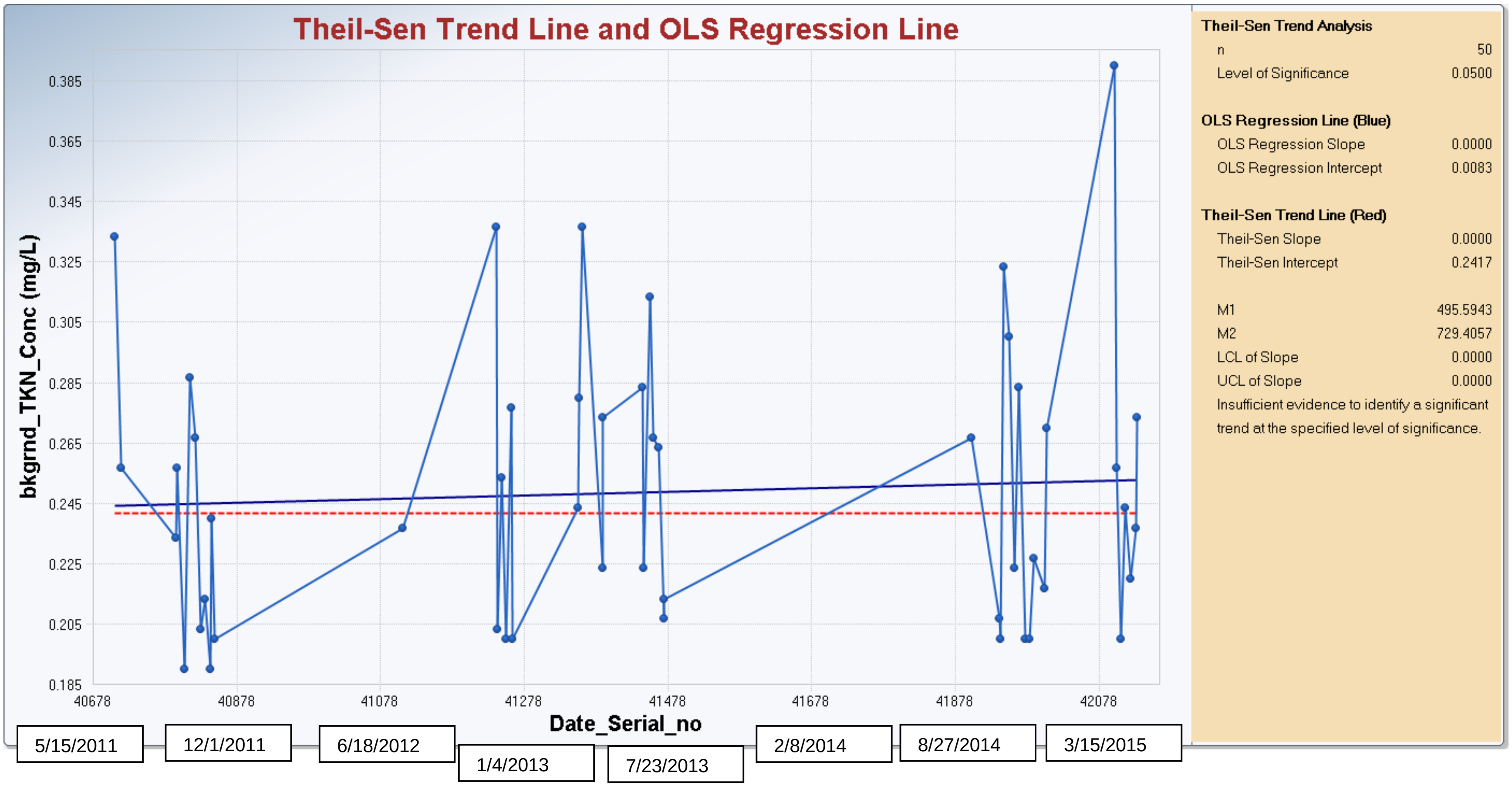
TKN – Monitoring Well 20

Total Kjeldahl Nitrogen (TKN) Graphs

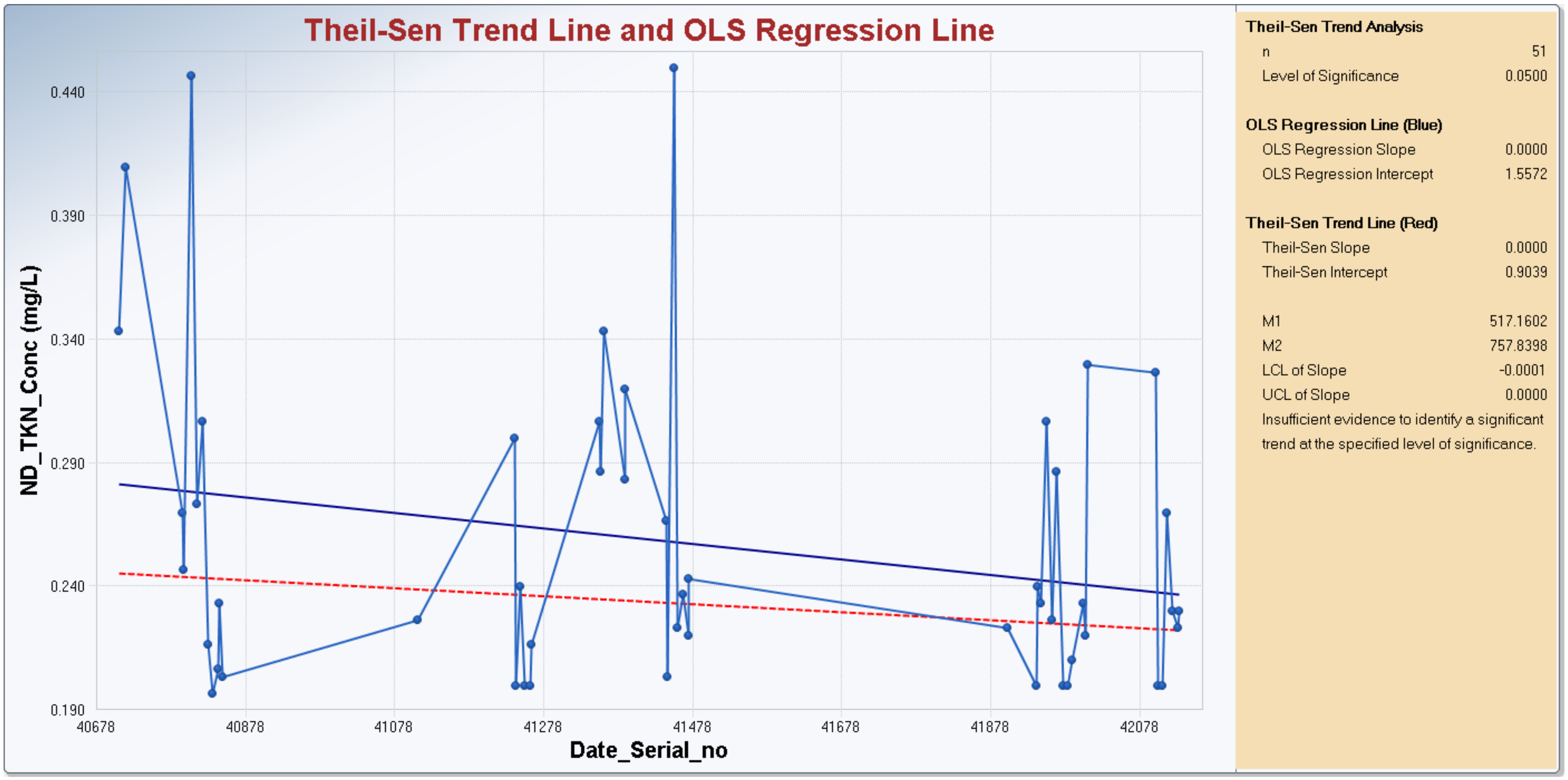
Current Data

General Statistics - Total Kjeldahl Nitrogen						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	150	151	153	147	51	49
Number of Values Reported (n)	150	151	153	147	51	49
Number of Values After Averaging	50	51	51	49	51	49
Number of Replicates	100	100	102	98	0	0
Minimum	0.19	0.197	0.167	0.46	1.1	0.8
Maximum	0.39	0.45	1.04	2.233	3.9	5.7
Mean	0.249	0.257	0.296	0.968	2.431	2.727
Geometric Mean	0.245	0.251	0.275	0.871	2.363	2.414
Median	0.242	0.233	0.253	0.77	2.4	2.9
Standard Deviation	0.0457	0.0623	0.147	0.49	0.563	1.233
Evidence of Trend Identified?	No	No	No	No	No	No
Direction of Trend (If Identified)	NA	NA	NA	NA	NA	NA

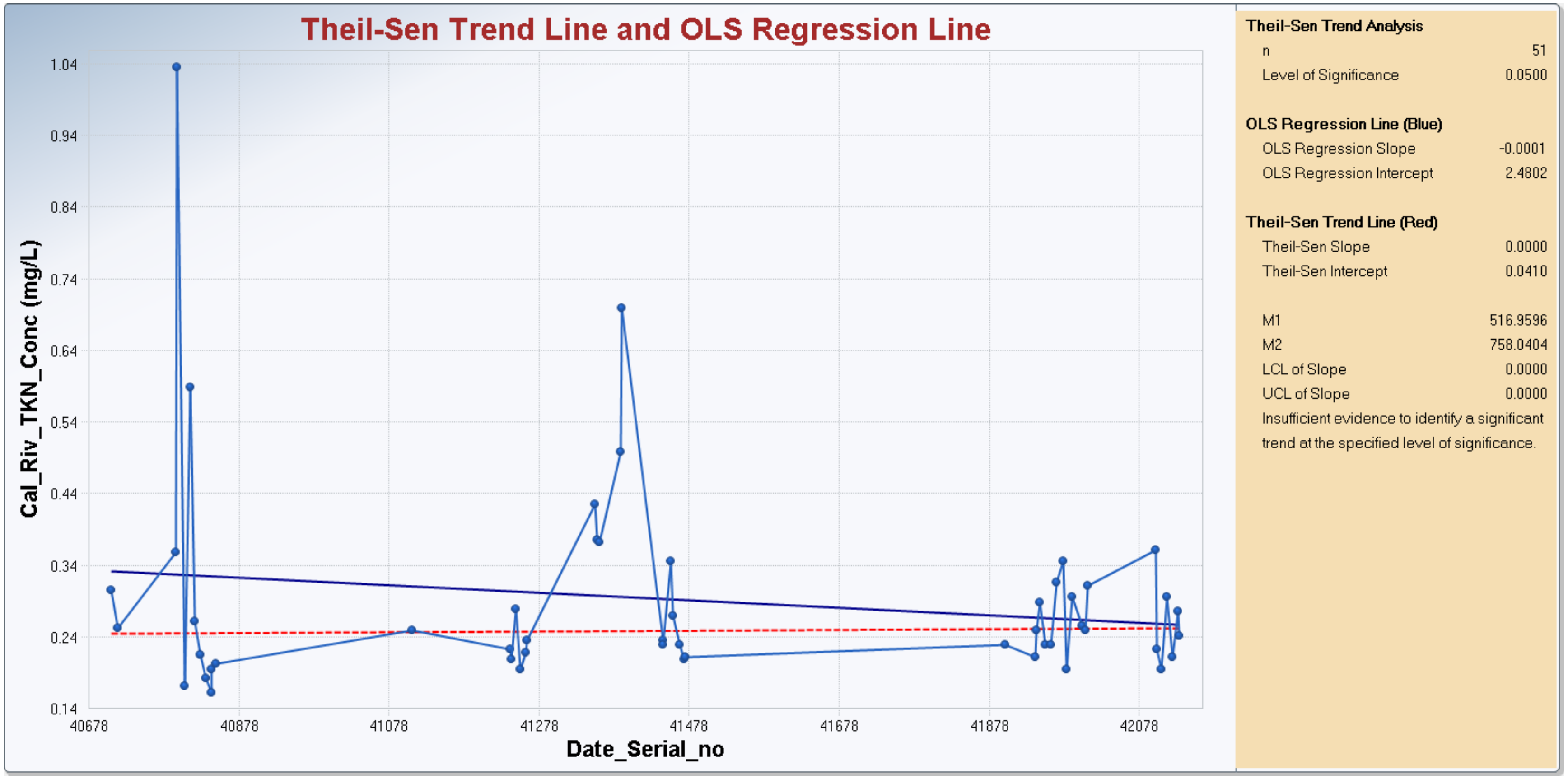
NA = Not Applicable



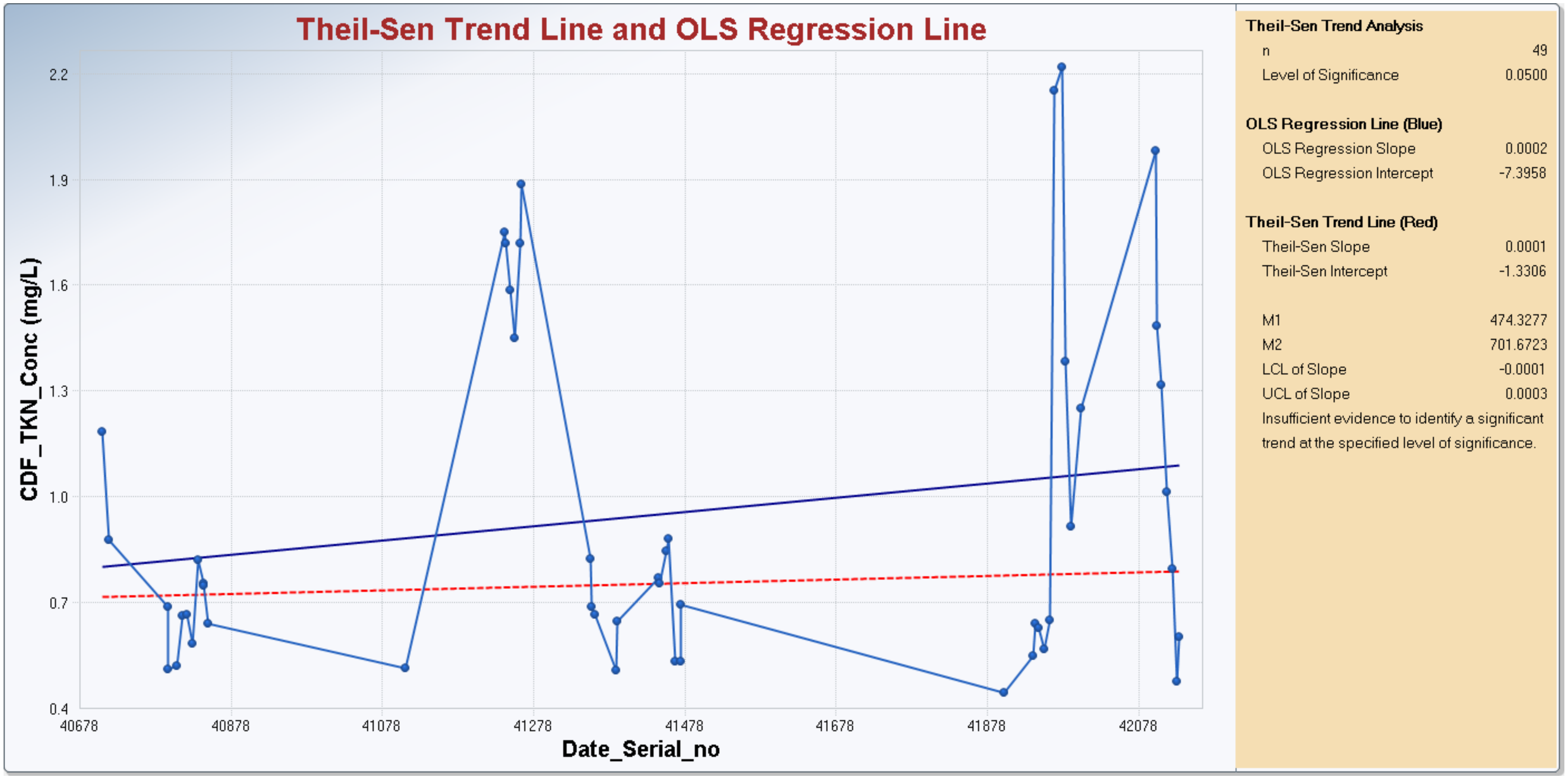
TKN – Background



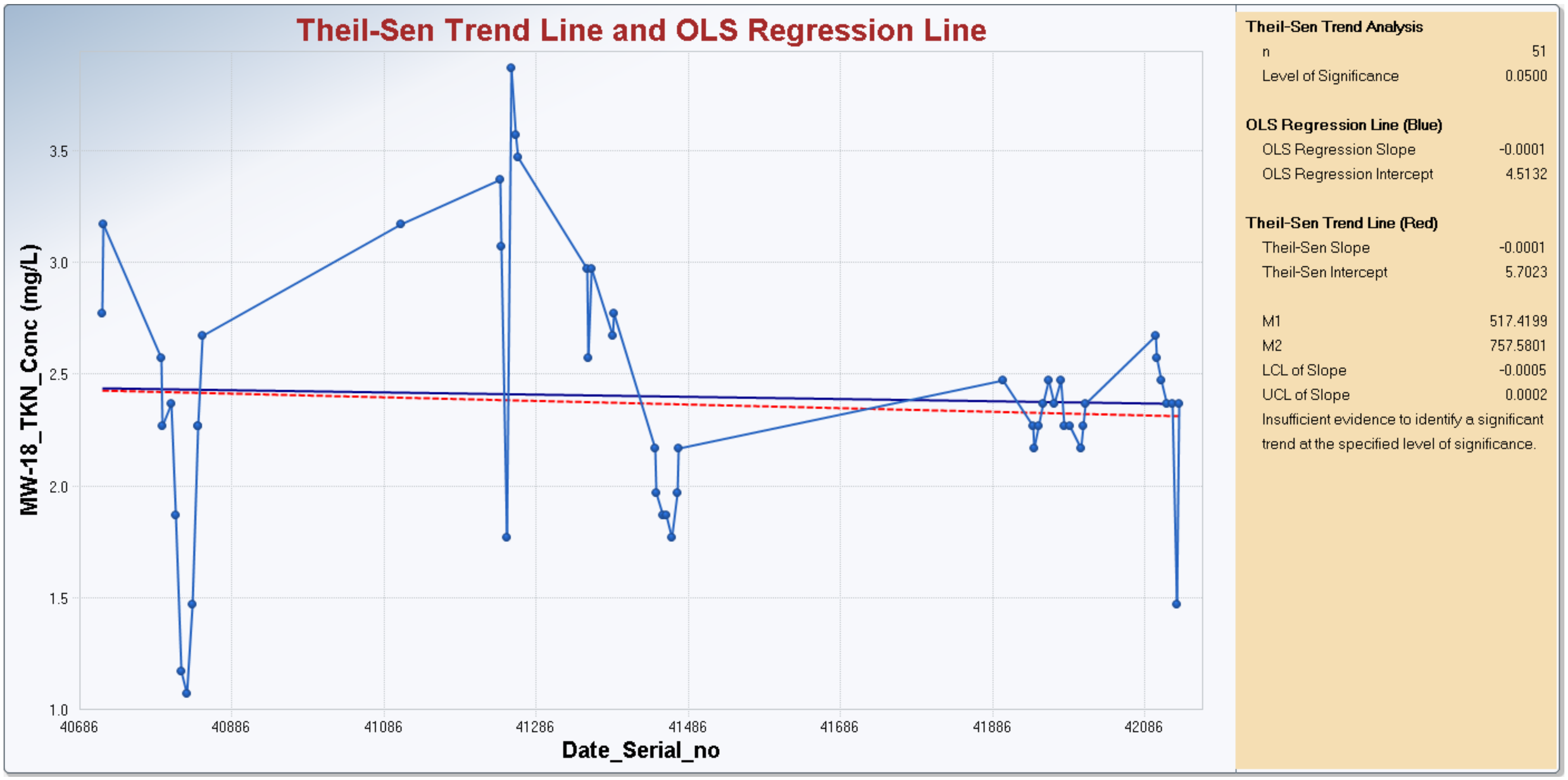
TKN – Near Dike



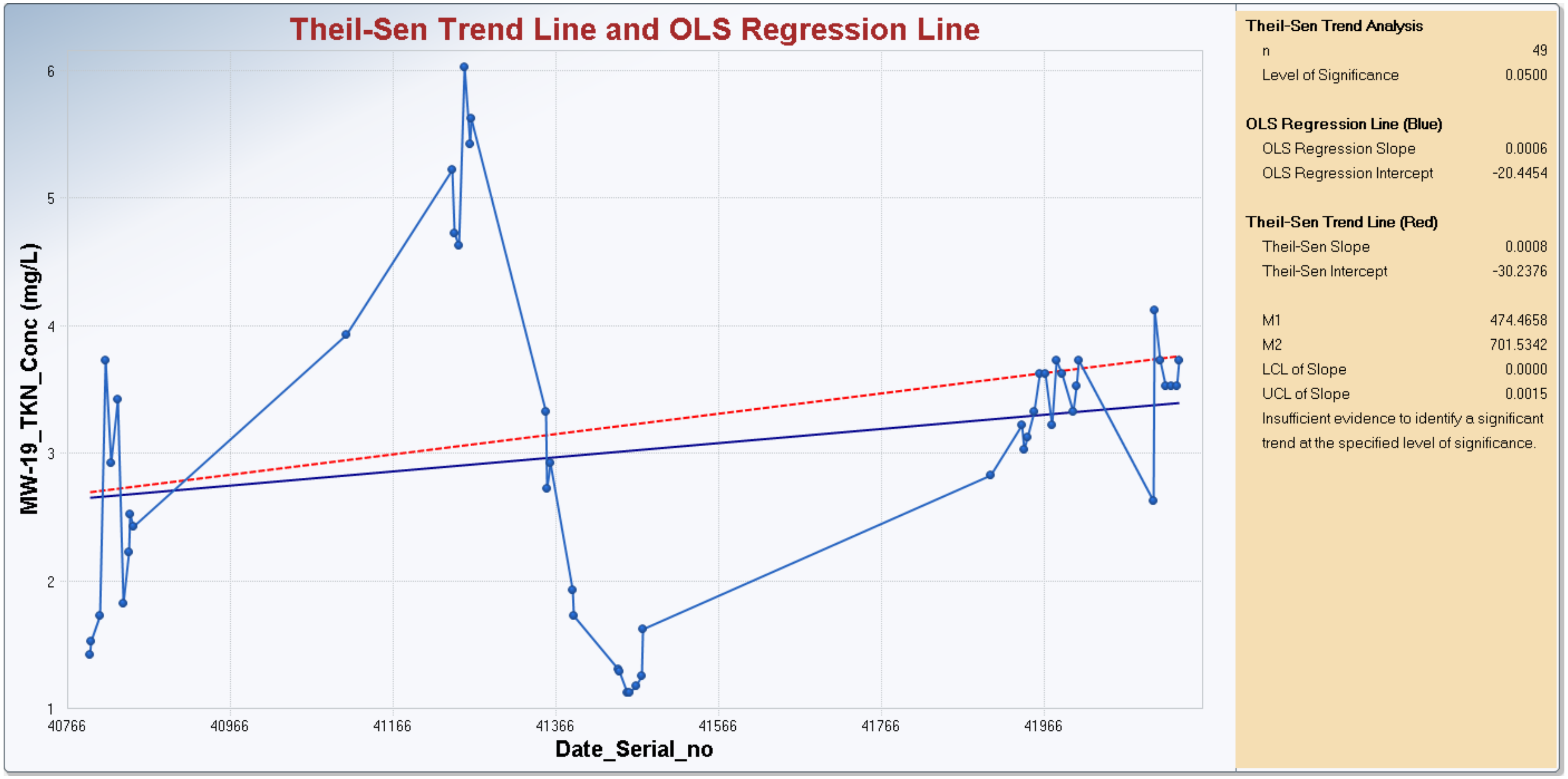
TKN – Calumet River


Theil-Sen Trend Line and OLS Regression Line
CDF_TKN_Conc (mg/L)
2.2
1.9
1.6
1.3
1.0
0.7
0.4
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 49
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0002
OLS Regression Intercept -7.3958
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0001
Theil-Sen Intercept -1.3306
M1 474.3277
M2 701.6723
LCL of Slope -0.0001
UCL of Slope 0.0003
Insufficient evidence to identify a significant
trend at the specified level of significance.

TKN – CDF



TKN – Monitoring Well 18



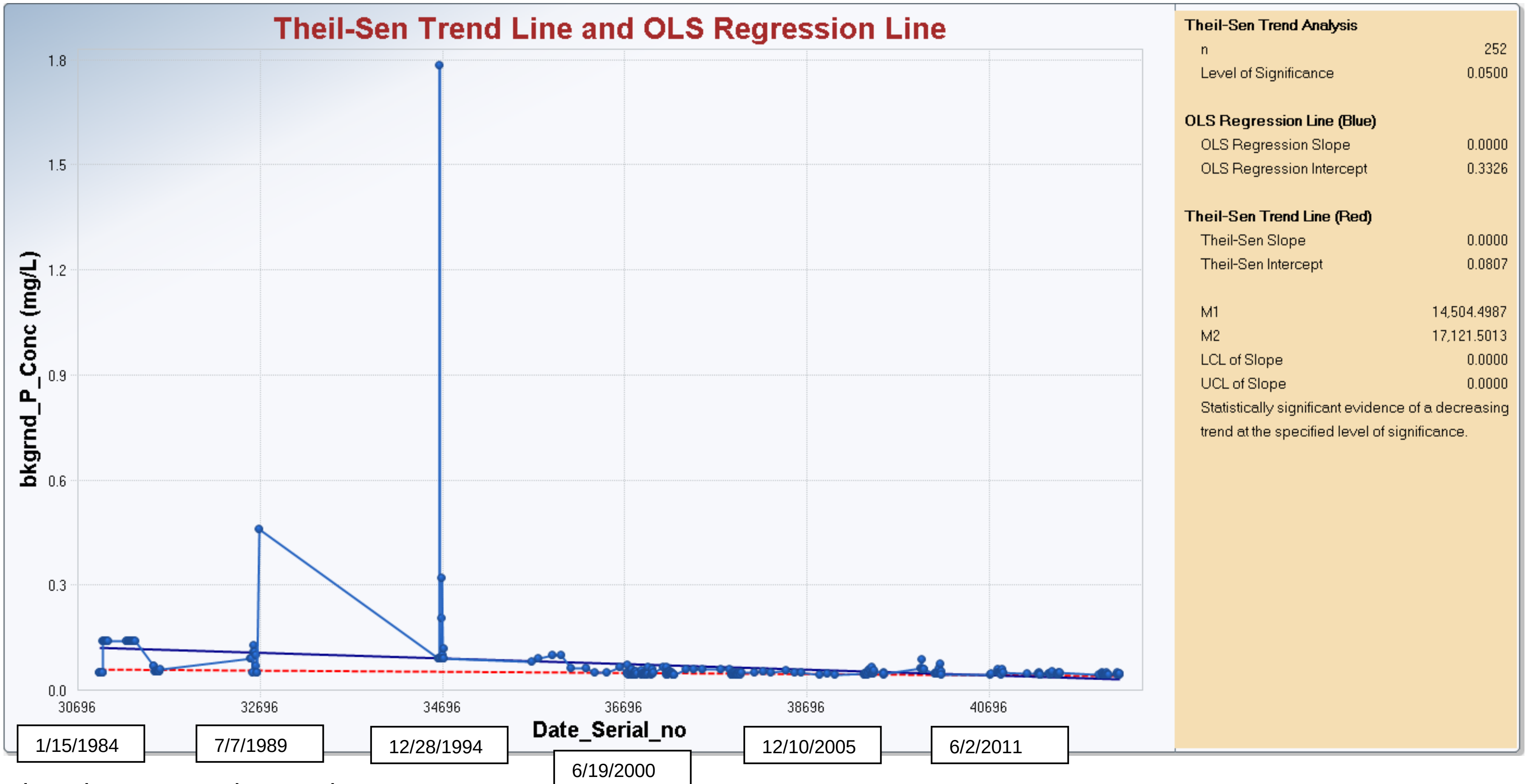
TKN – Monitoring Well 19

Appendix E: Phosphorus Graphs

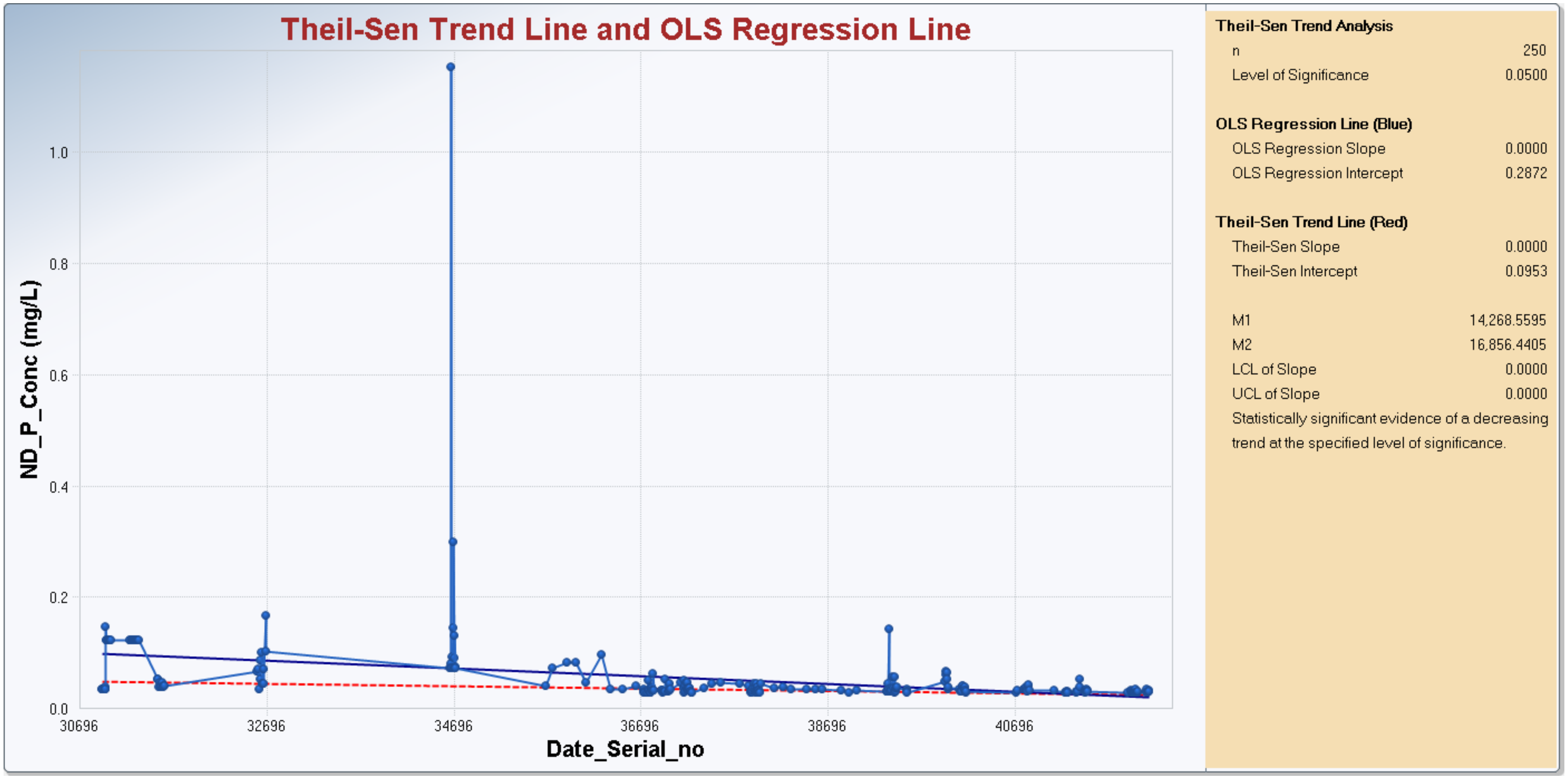
Historical Data

General Statistics - Phosphorus							
Historical	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	643	750	634	610	239	242	165
Number of Values Reported (n)	643	750	634	610	239	242	165
Number of Values After Averaging	252	250	251	239	238	241	164
Number of Replicates	391	500	383	371	1	1	1
Minimum	0.005	0.005	0.005	0.01	1.00E-04	1.00E-04	1.00E-04
Maximum	1.745	1.13	0.5	0.5	0.8	0.85	0.339
Mean	0.0335	0.0315	0.0305	0.0793	0.0614	0.0348	0.0428
Geometric Mean	0.0147	0.0158	0.0169	0.0601	0.0368	0.0151	0.031
Median	0.01	0.0117	0.0133	0.06	0.032	0.0138	0.03
Standard Deviation	0.116	0.0781	0.0483	0.0711	0.0983	0.0874	0.0415
Evidence of Trend Identified?	Yes	Yes	Yes	Yes	Yes	No	No
Direction of Trend (If Identified)	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	NA	NA

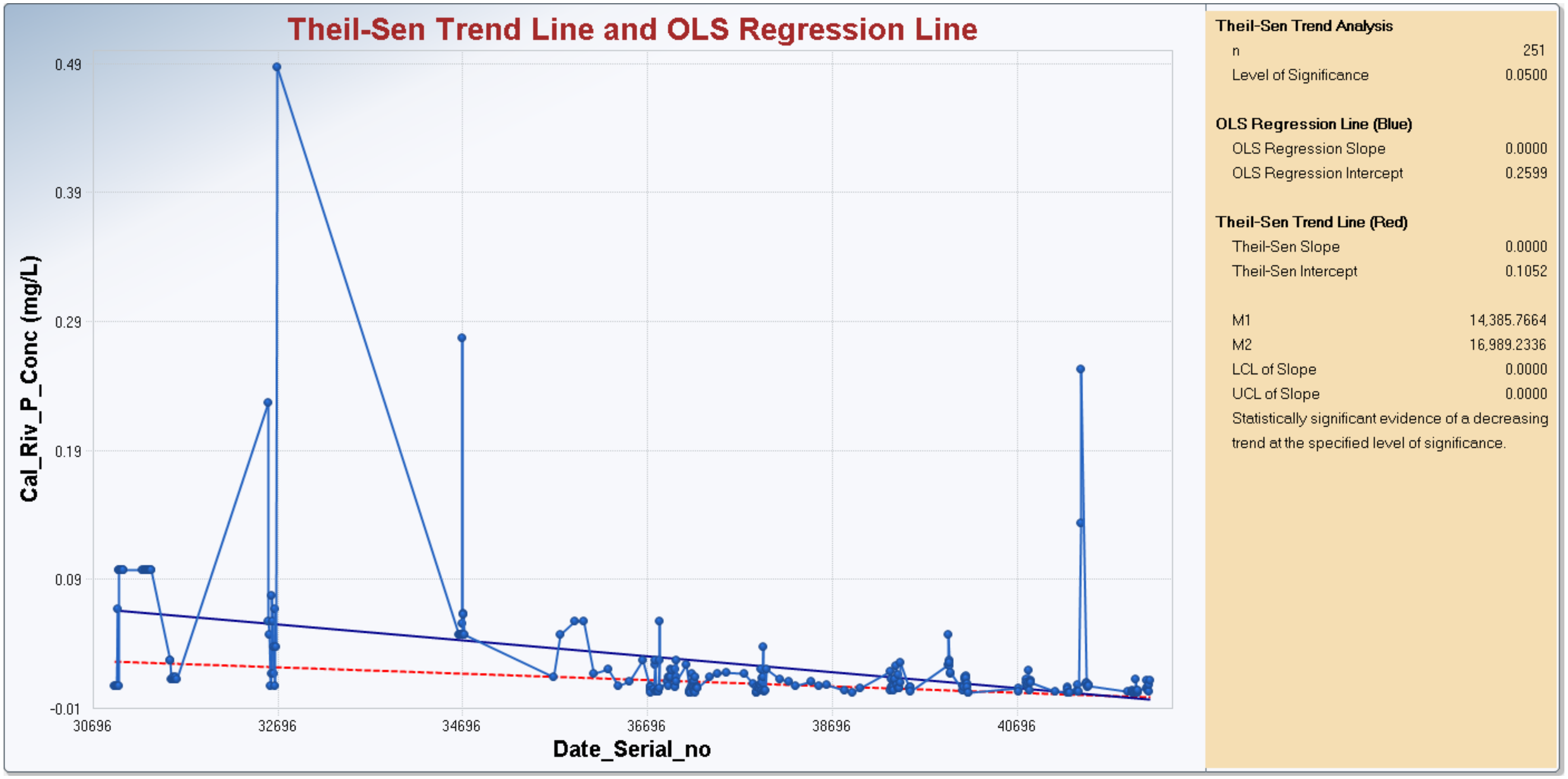
NA = Not Applicable



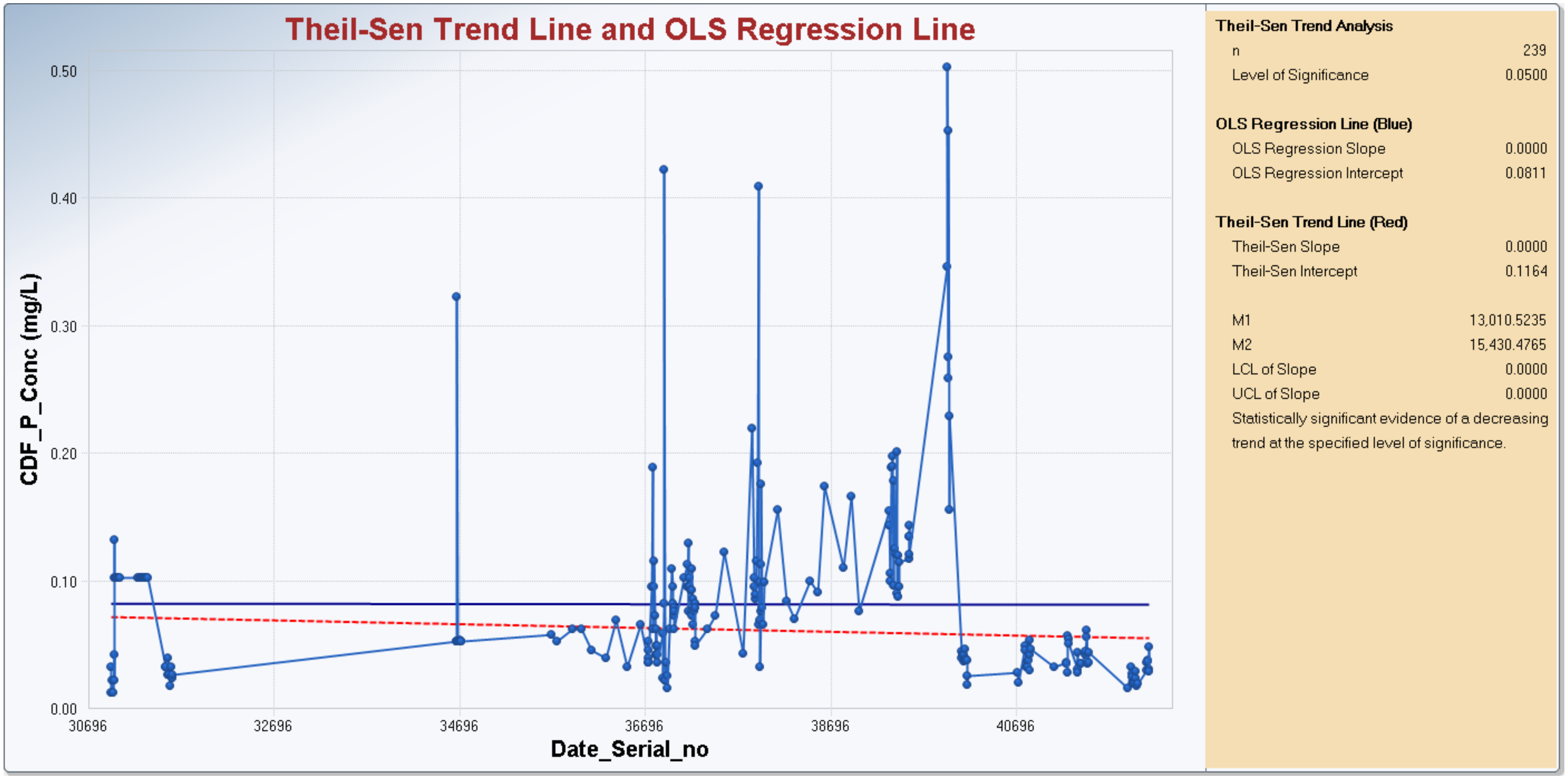
Phosphorus – Background



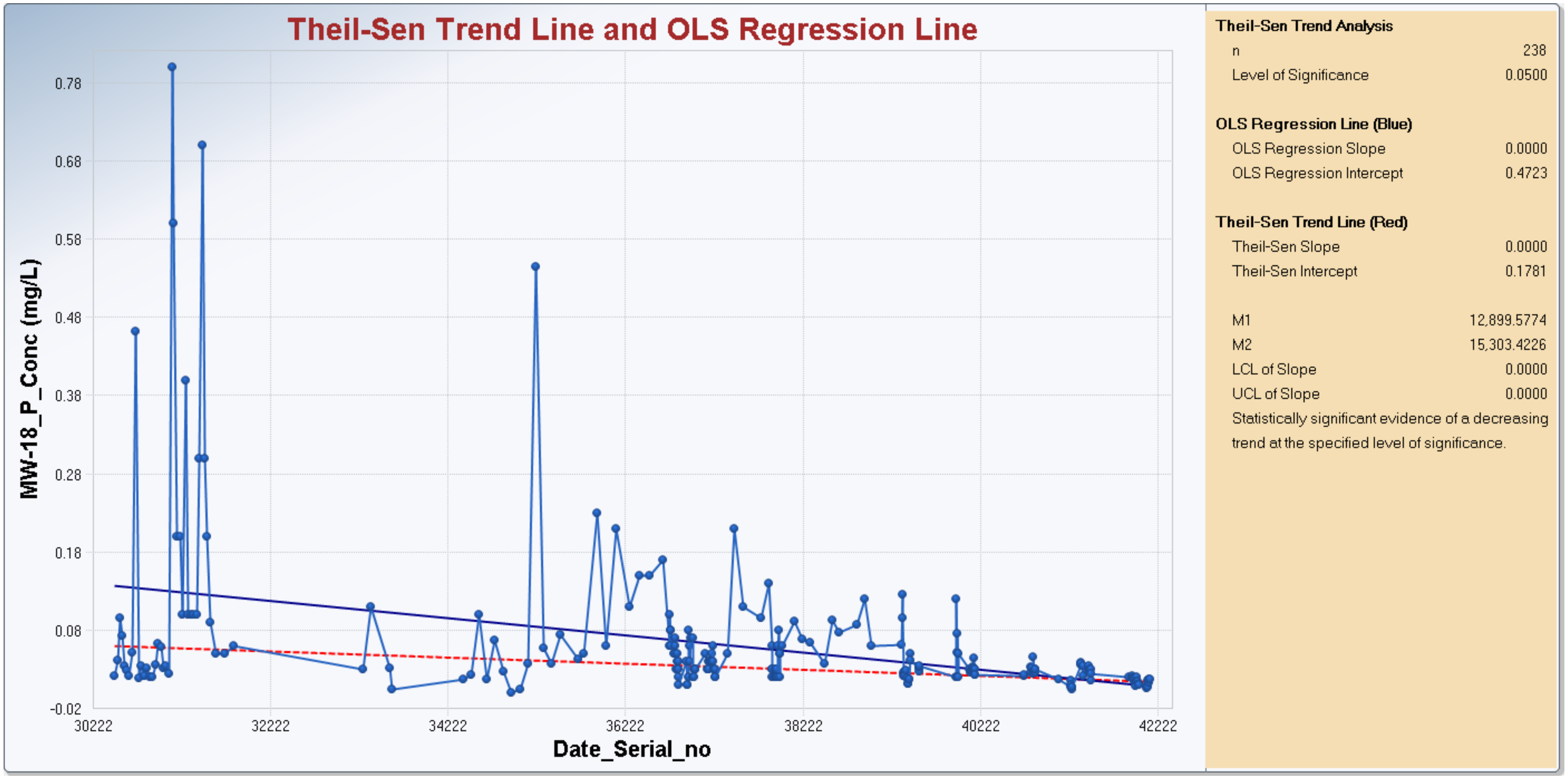
Phosphorus – Near Dike



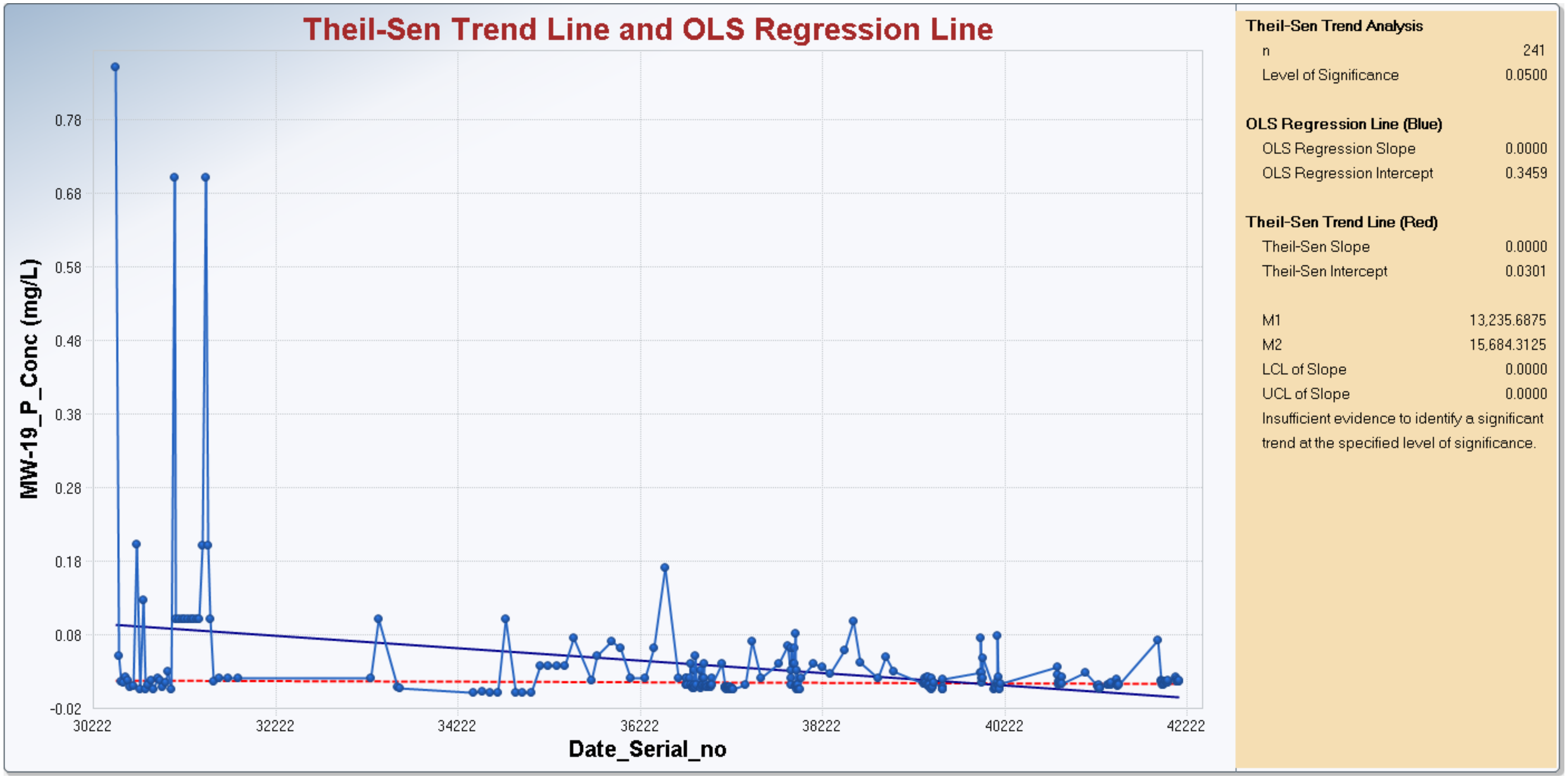
Phosphorus – Calumet River



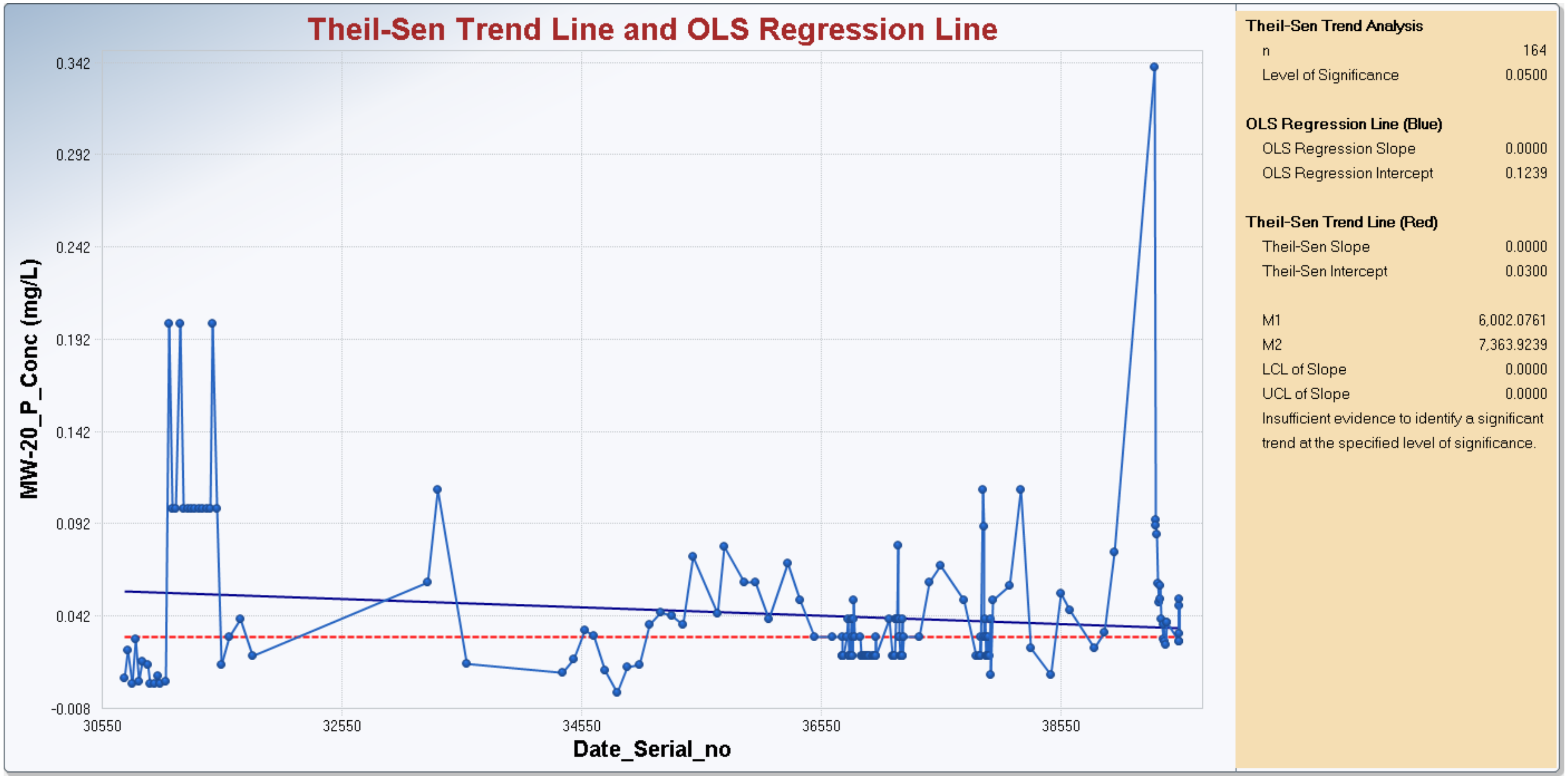
Phosphorus – CDF



Phosphorus – Monitoring Well 18



Phosphorus – Monitoring Well 19



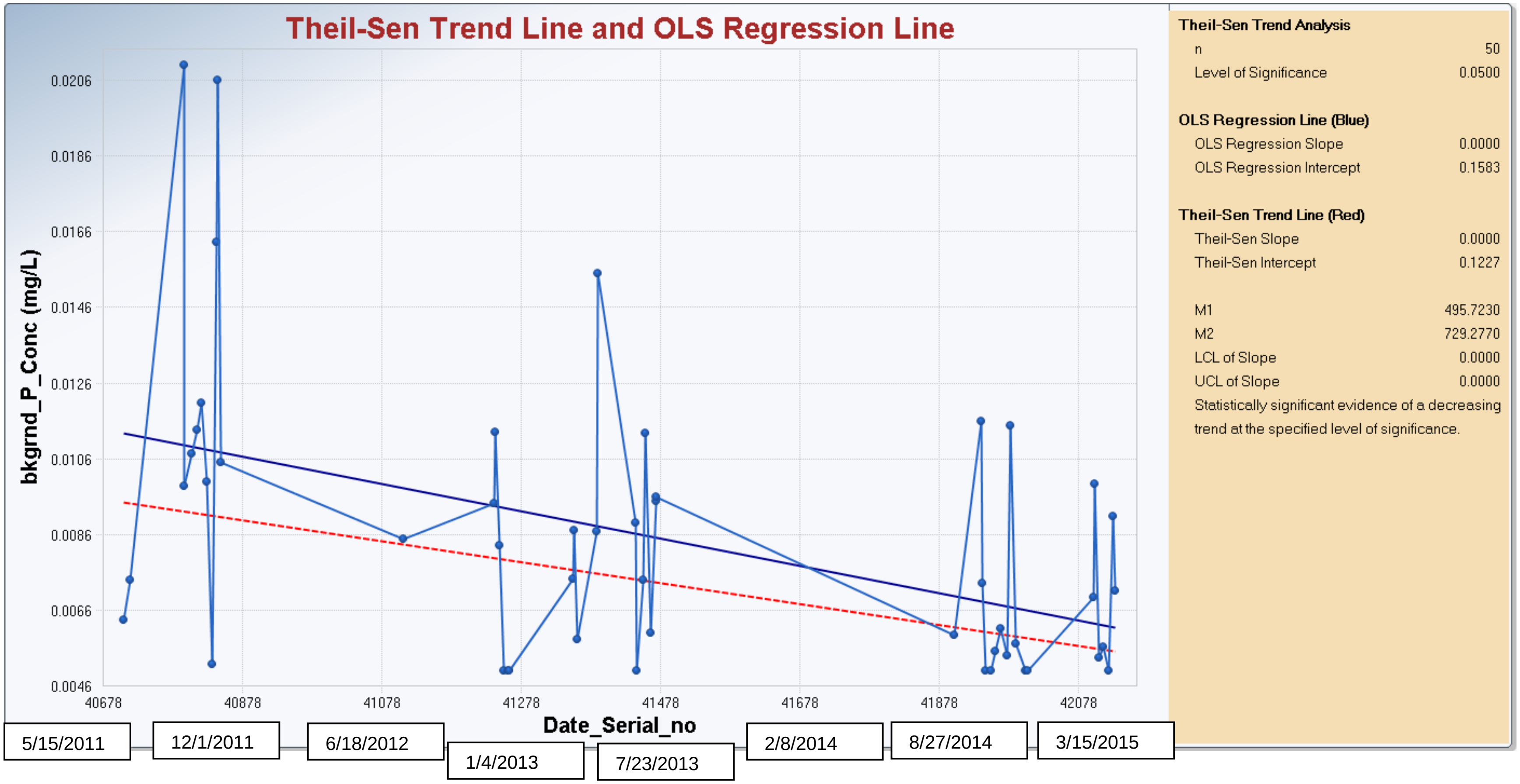
Phosphorus – Monitoring Well 20

Phosphorus Graphs

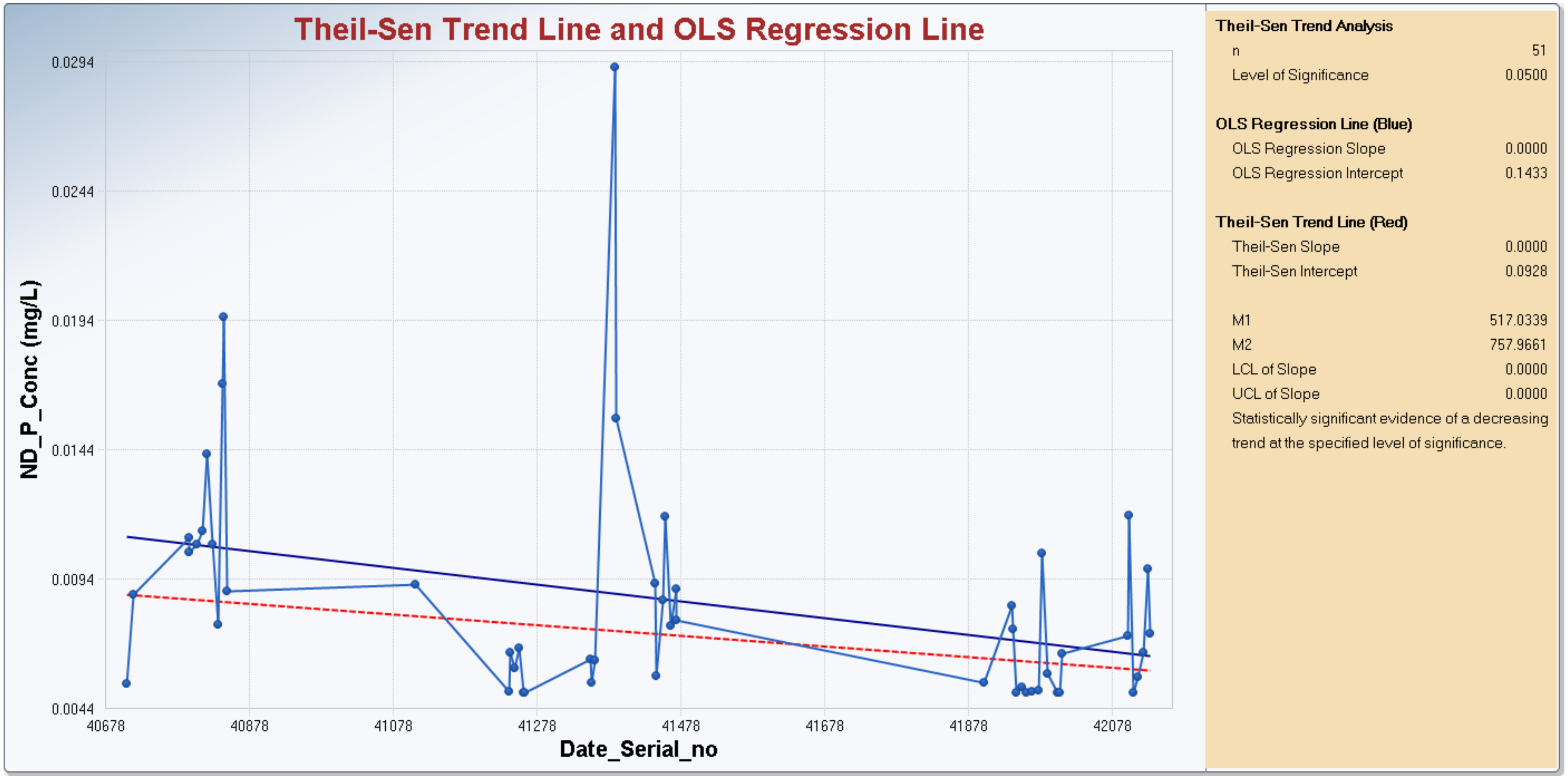
Current Data

General Statistics - Phosphorus						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	150	151	153	147	51	49
Number of Values Reported (n)	150	151	153	147	51	49
Number of Values After Averaging	50	51	51	49	51	49
Number of Replicates	100	100	102	98	0	0
Minimum	0.005	0.005	0.005	0.0135	0.005	0.0056
Maximum	0.021	0.0292	0.26	0.0586	0.0451	0.072
Mean	0.00851	0.0085	0.0163	0.0331	0.0209	0.0152
Geometric Mean	0.00787	0.00775	0.00937	0.0311	0.0184	0.0137
Median	0.00742	0.00727	0.00833	0.0326	0.0205	0.0131
Standard Deviation	0.00376	0.00443	0.0388	0.0112	0.00971	0.00976
Evidence of Trend Identified?	Yes	Yes	No	No	Yes	Yes
Direction of Trend (If Identified)	Decreasing	Decreasing	NA	NA	Decreasing	Increasing

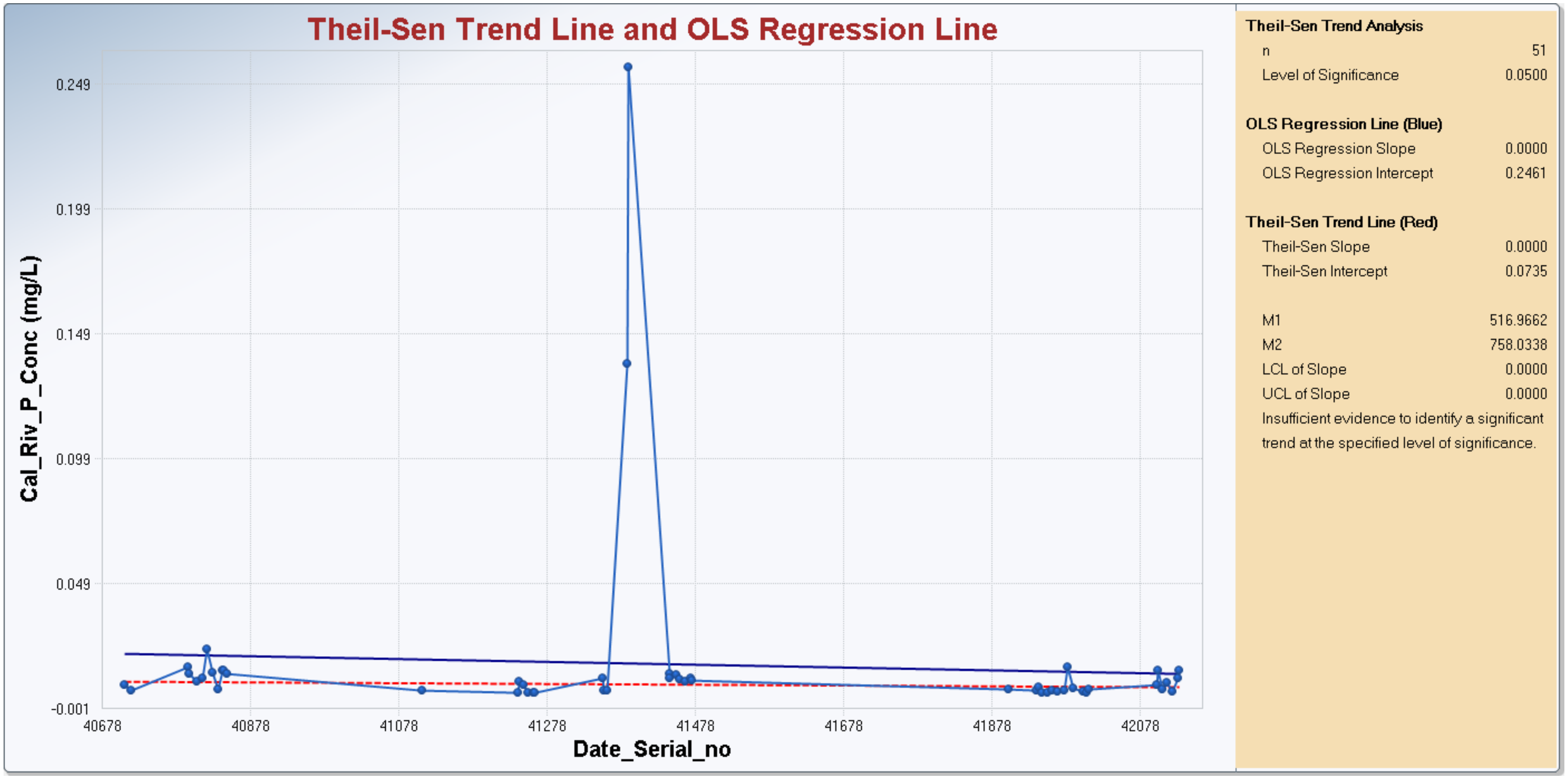
NA = Not Applicable



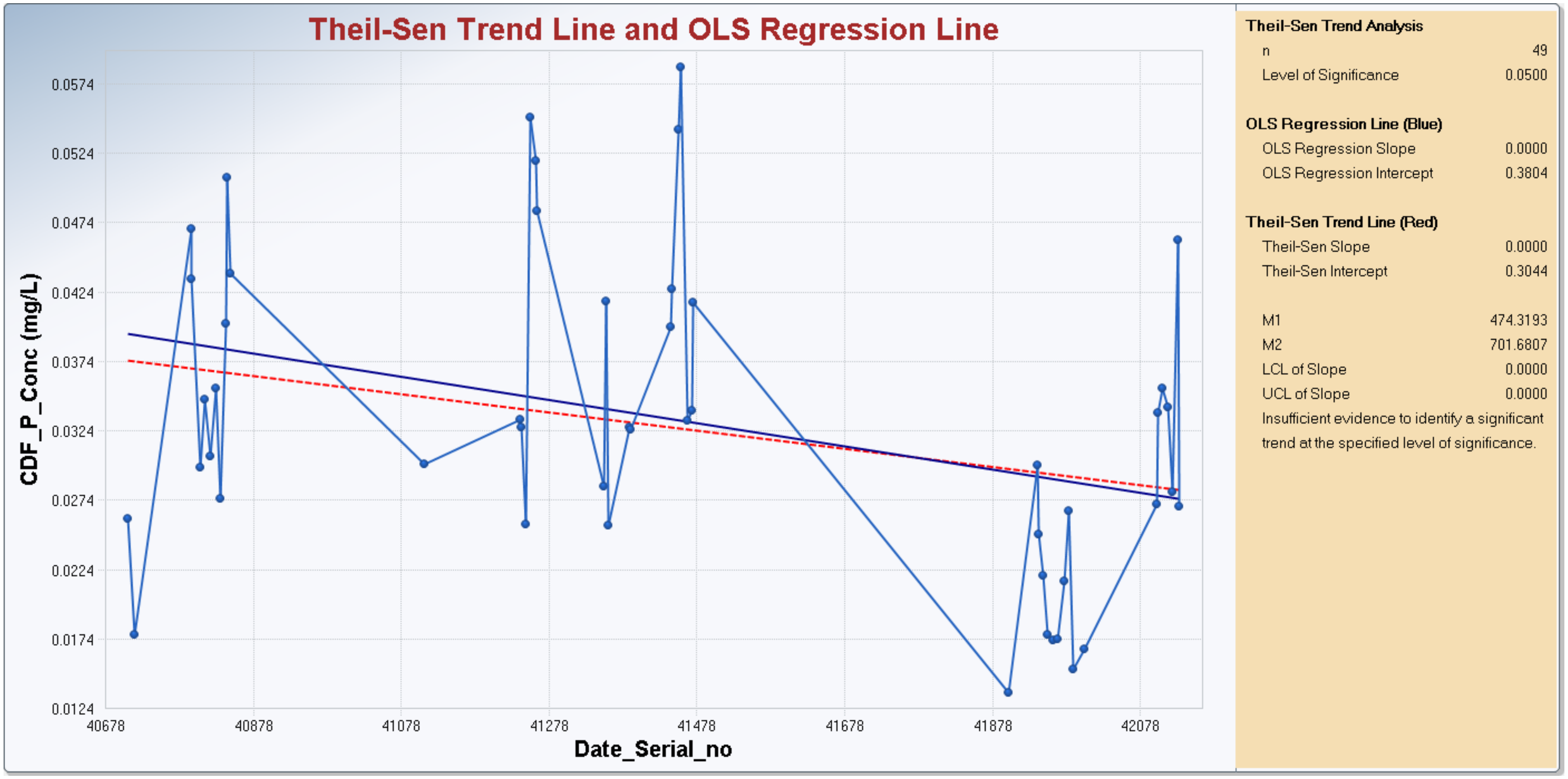
Phosphorus – Background



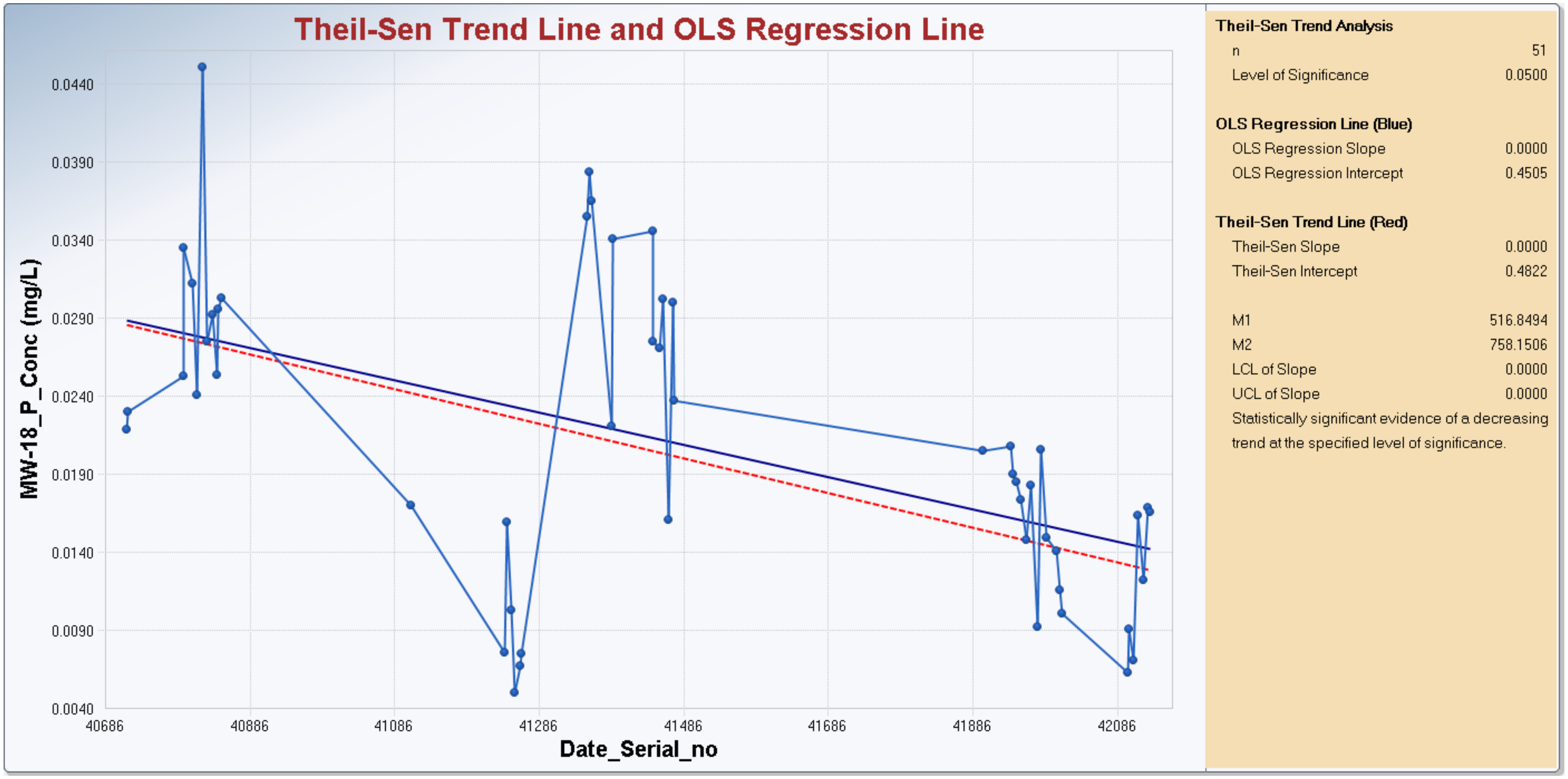
Phosphorus – Near Dike



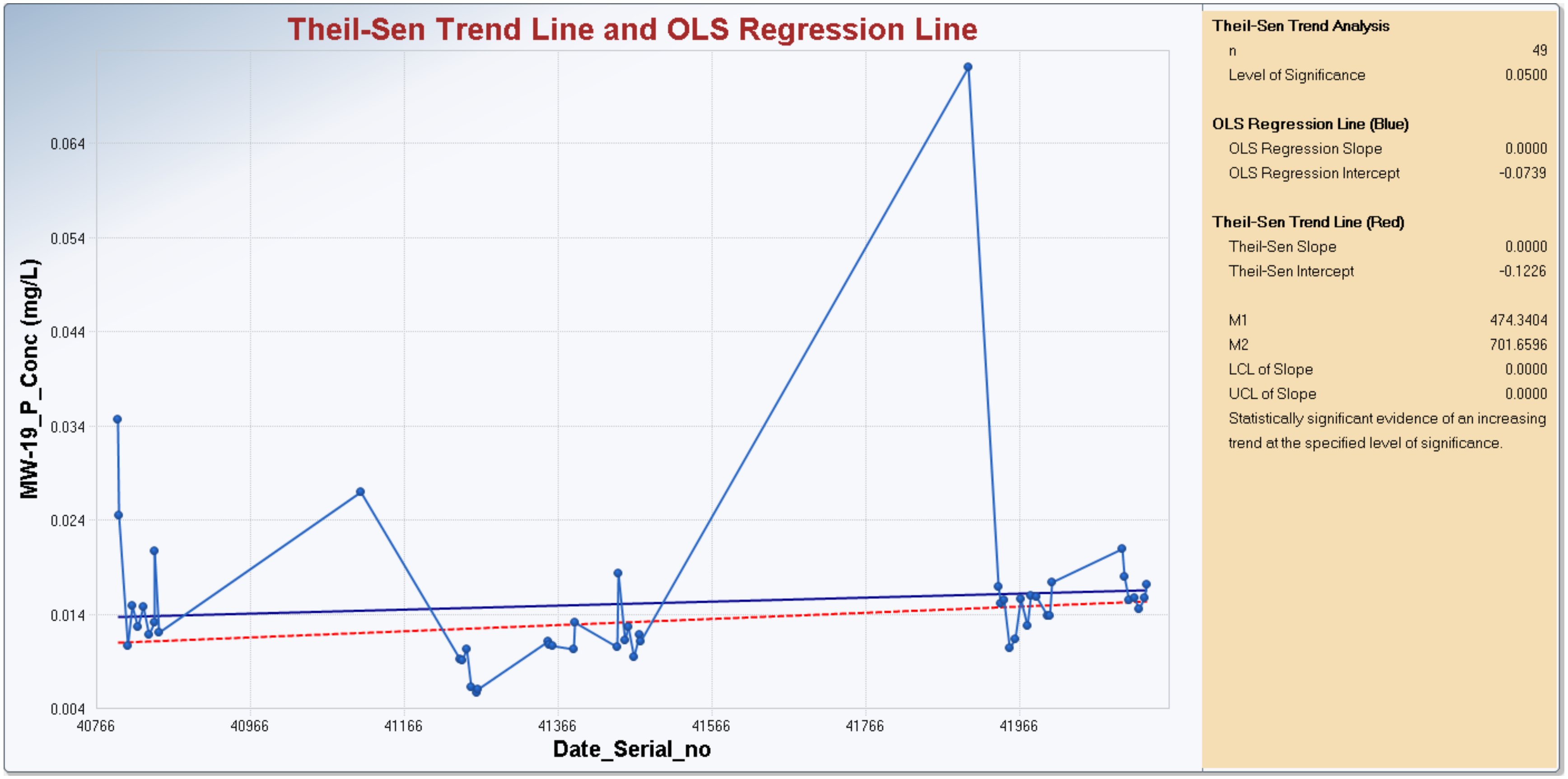
Phosphorus – Calumet River



Phosphorus – CDF



Phosphorus – Monitoring Well 18



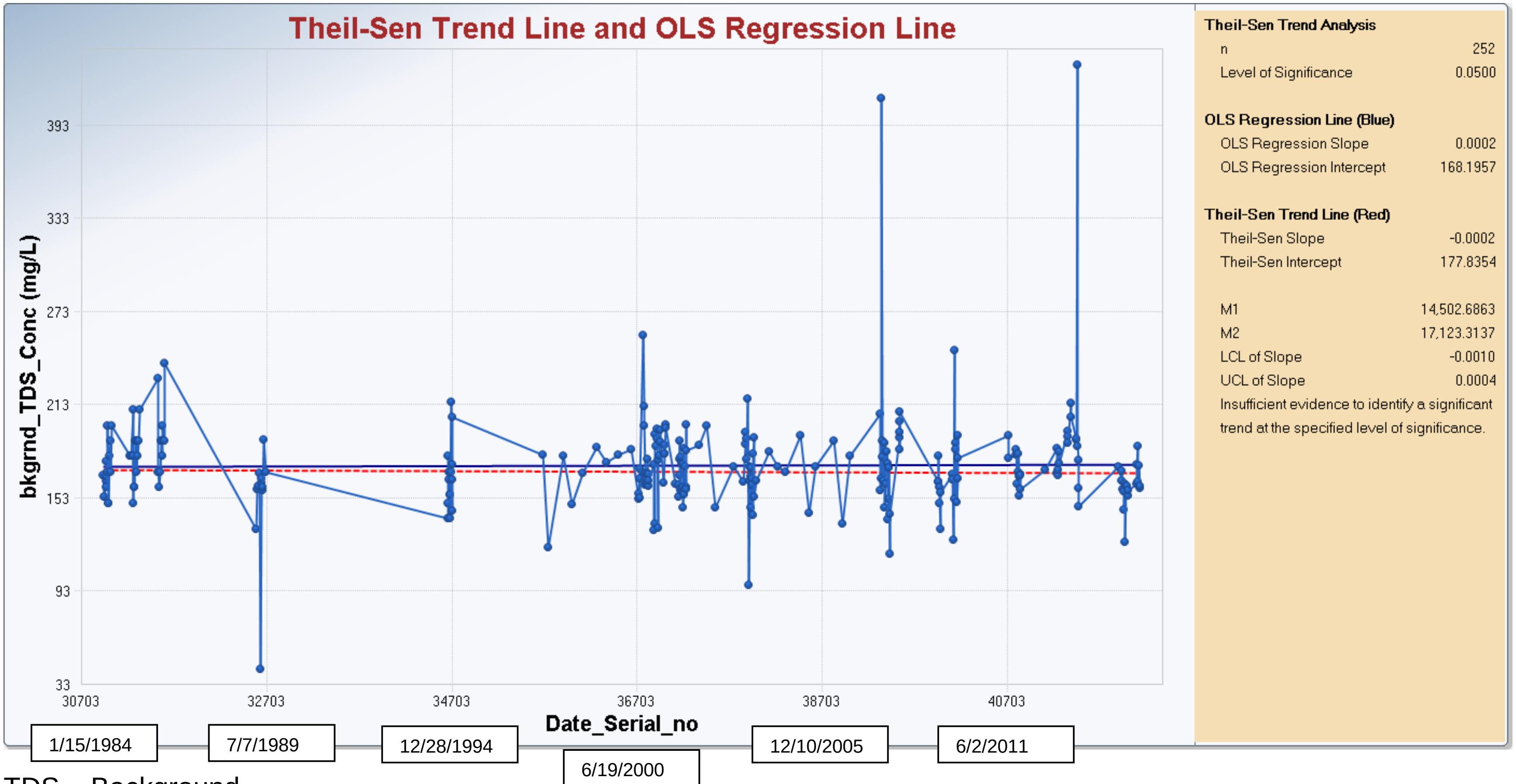
Phosphorus – Monitoring Well 19

Appendix F: Total Dissolved Solids (TDS) Graphs

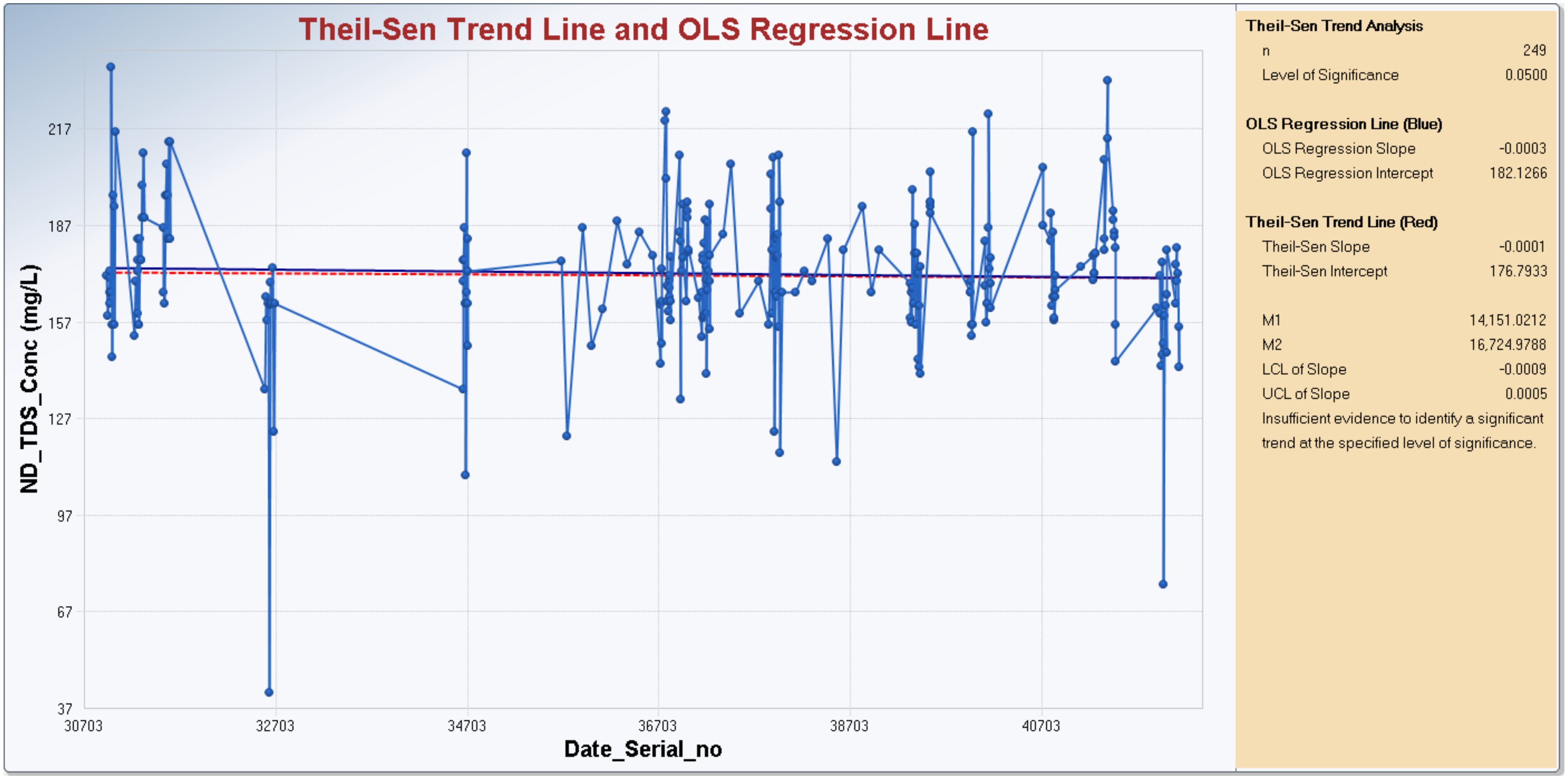
Historical Data

General Statistics - Total Dissolved Solids							
Historical	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	643	748	633	609	244	249	174
Number of Values Reported (n)	643	748	633	609	244	249	174
Number of Values After Averaging	252	249	250	238	243	248	173
Number of Replicates	391	499	383	371	1	1	1
Minimum	43	42.33	58	160	250	234	220
Maximum	432	236.7	387.3	903.3	19500	810	1876
Mean	174.1	172.5	201.8	376	1708	522.1	1005
Geometric Mean	171.6	170.8	197.1	351.3	973.4	518.3	937.6
Median	170	172	190	362.3	694	529	1100
Standard Deviation	31.54	22.39	45.71	144.4	2804	61.09	305
Evidence of Trend Identified?	No	No	Yes	Yes	No	Yes	Yes
Direction of Trend (If Identified)	NA	NA	Increasing	Increasing	NA	Decreasing	Decreasing

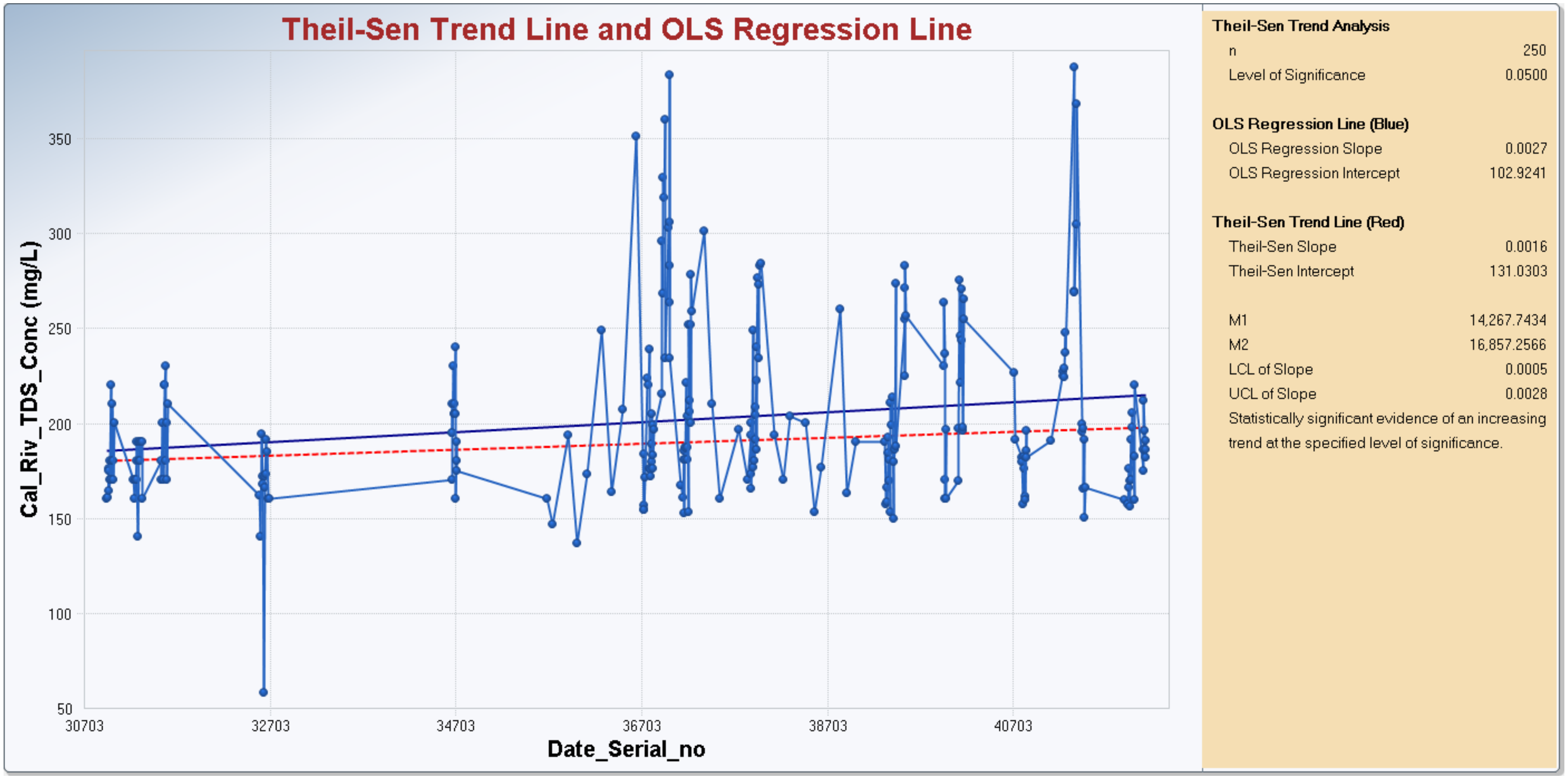
NA = Not Applicable



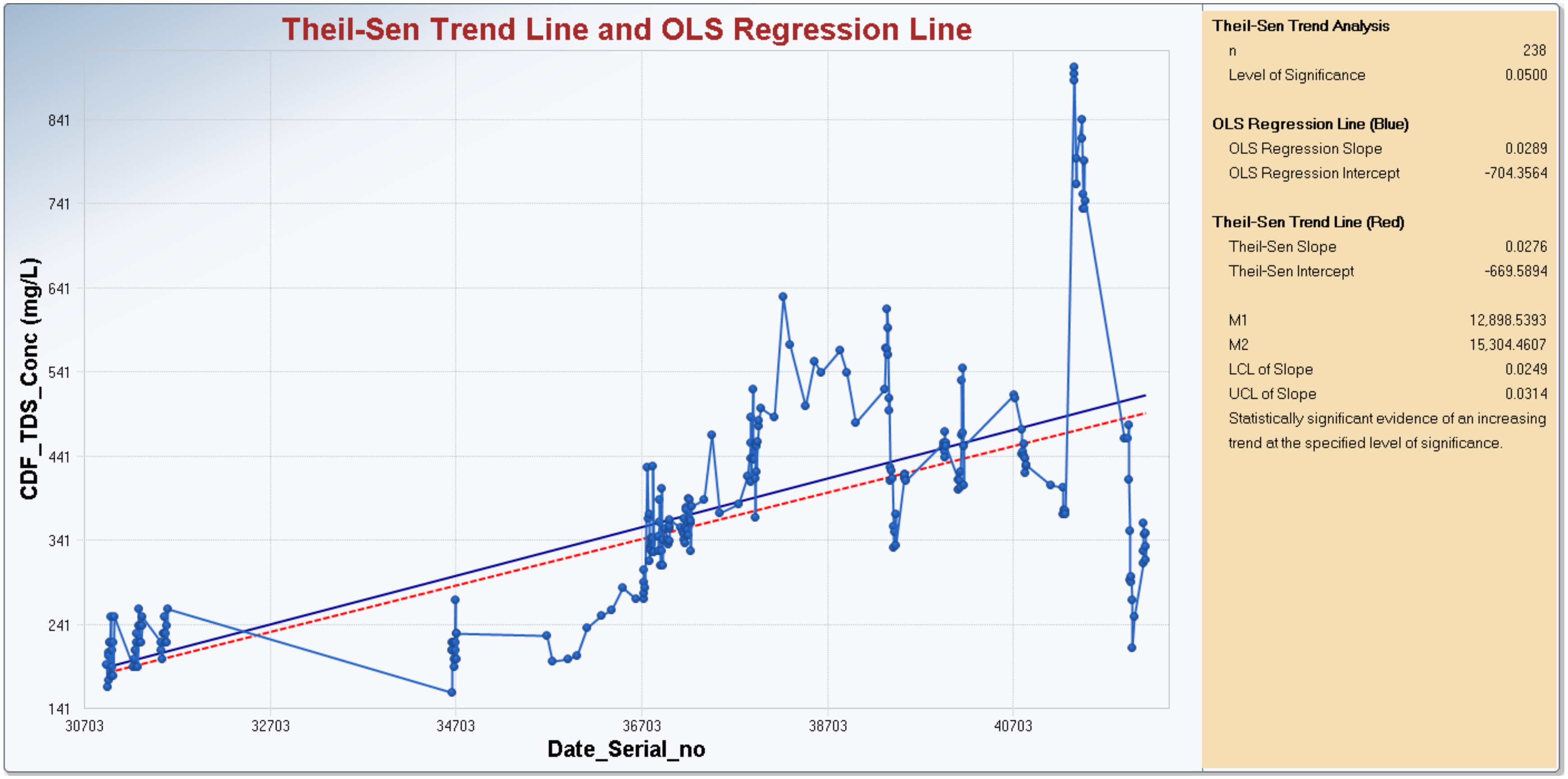
TDS – Background



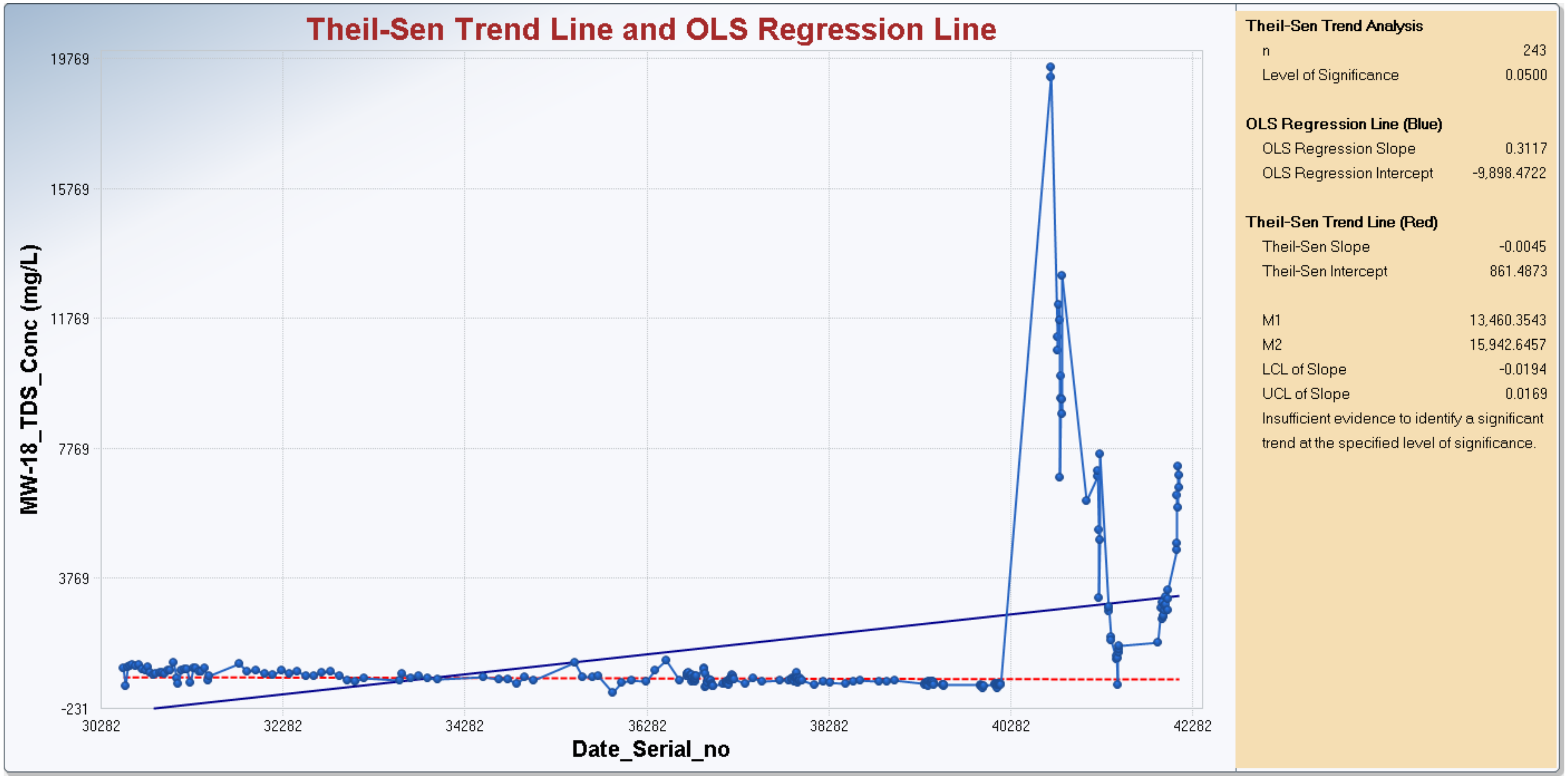
TDS – Near Dike



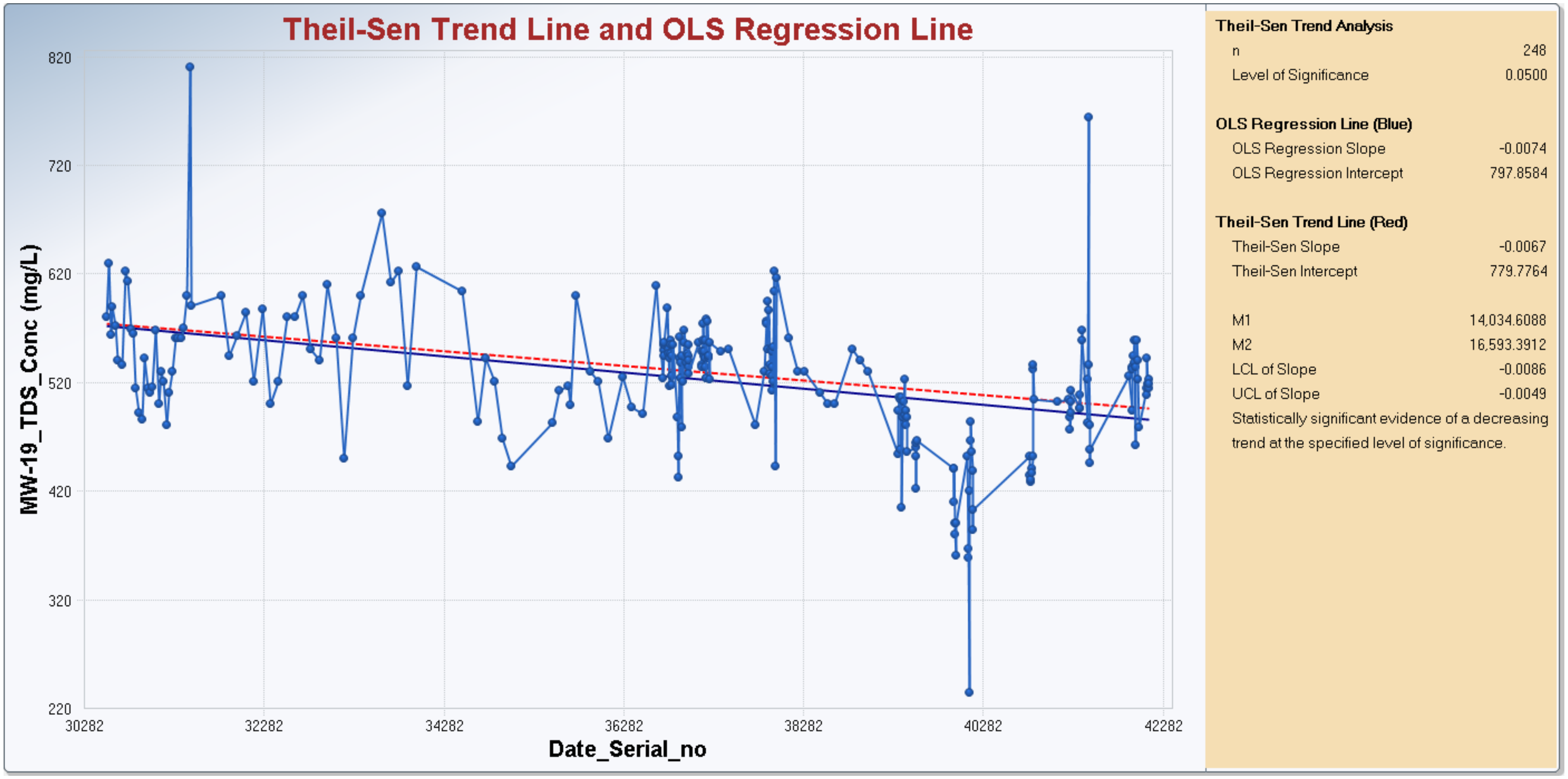
TDS – Calumet River


Theil-Sen Trend Line and OLS Regression Line
CDF_TDS_Conc (mg/L)
841
741
641
541
441
341
241
141
30703
32703
34703
36703
38703
40703
Date_Serial_no
Theil-Sen Trend Analysis
n 238
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0289
OLS Regression Intercept -704.3564
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0276
Theil-Sen Intercept -669.5894
M1 12,898.5393
M2 15,304.4607
LCL of Slope 0.0249
UCL of Slope 0.0314
Statistically significant evidence of an increasing trend at the specified level of significance.

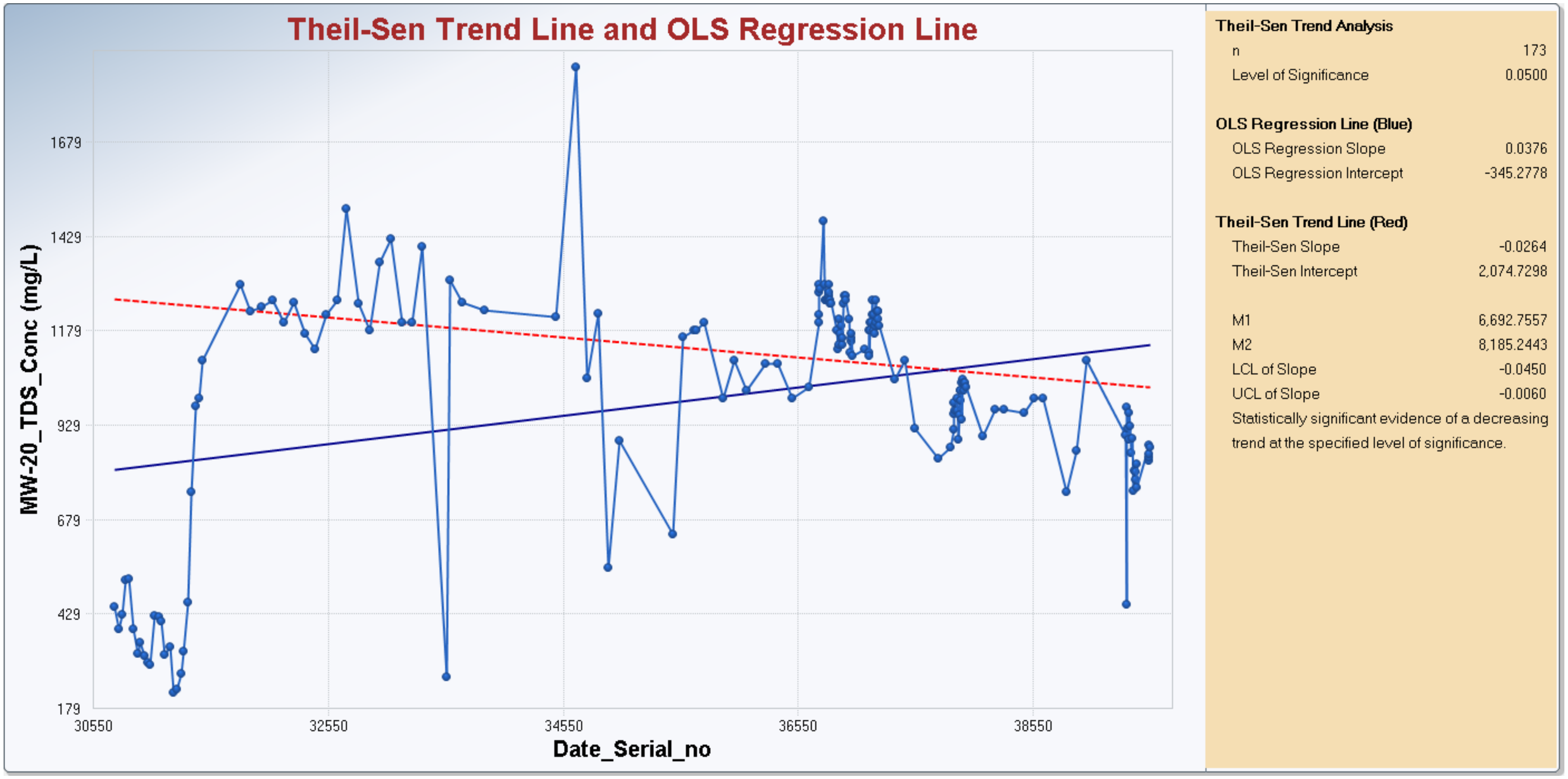
TDS – CDF



TDS – Monitoring Well 18



TDS – Monitoring Well 19



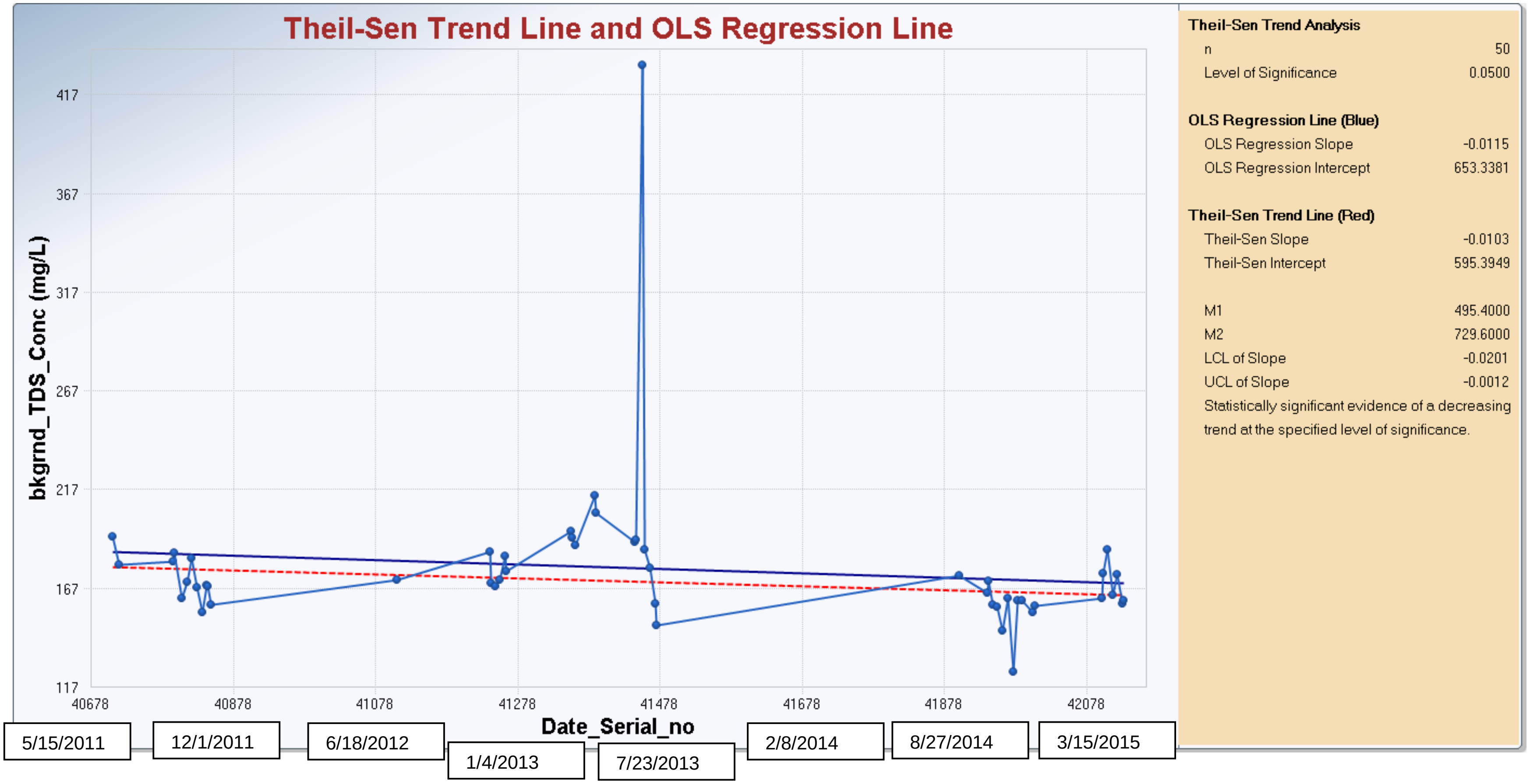
TDS – Monitoring Well 20

TDS Graphs

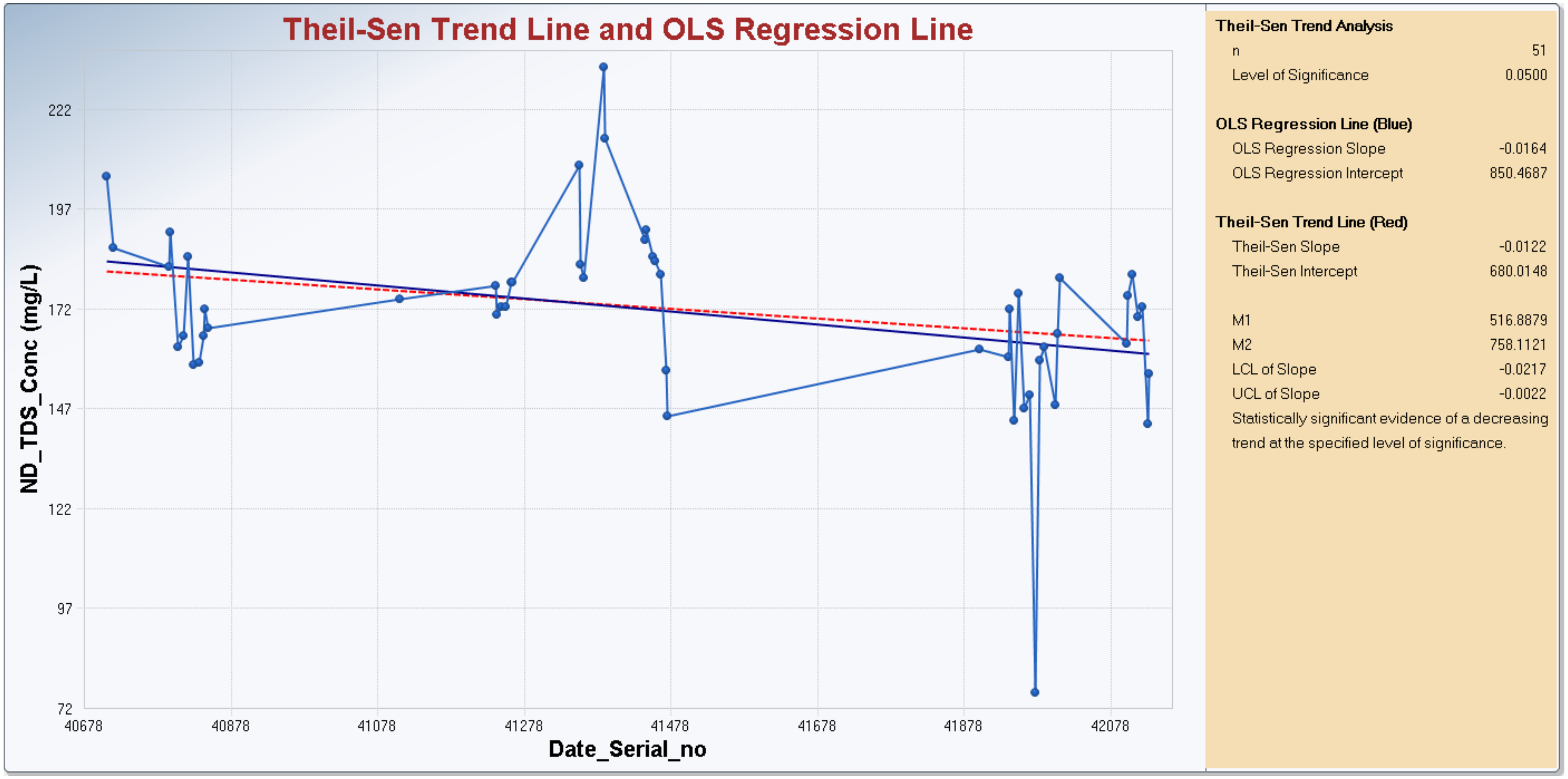
Current Data

General Statistics - Total Dissolved Solids						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	150	151	153	147	51	49
Number of Values Reported (n)	150	151	153	147	51	49
Number of Values After Averaging	50	51	51	49	51	49
Number of Replicates	100	100	102	98	0	0
Minimum	124.7	76	150	212.7	504	428
Maximum	432	232.7	387.30	903.3	19500	764
Mean	176.9	171.5	201.2	488	5564	508
Geometric Mean	174.2	169.7	196.7	454.3	4191	505.5
Median	170.3	172.7	190.7	430	3390	508
Standard Deviation	40.15	22.46	48.2	195.7	4328	52.72
Evidence of Trend Identified?	Yes	Yes	No	Yes	Yes	Yes
Direction of Trend (If Identified)	Decreasing	Decreasing	NA	Decreasing	Decreasing	Increasing

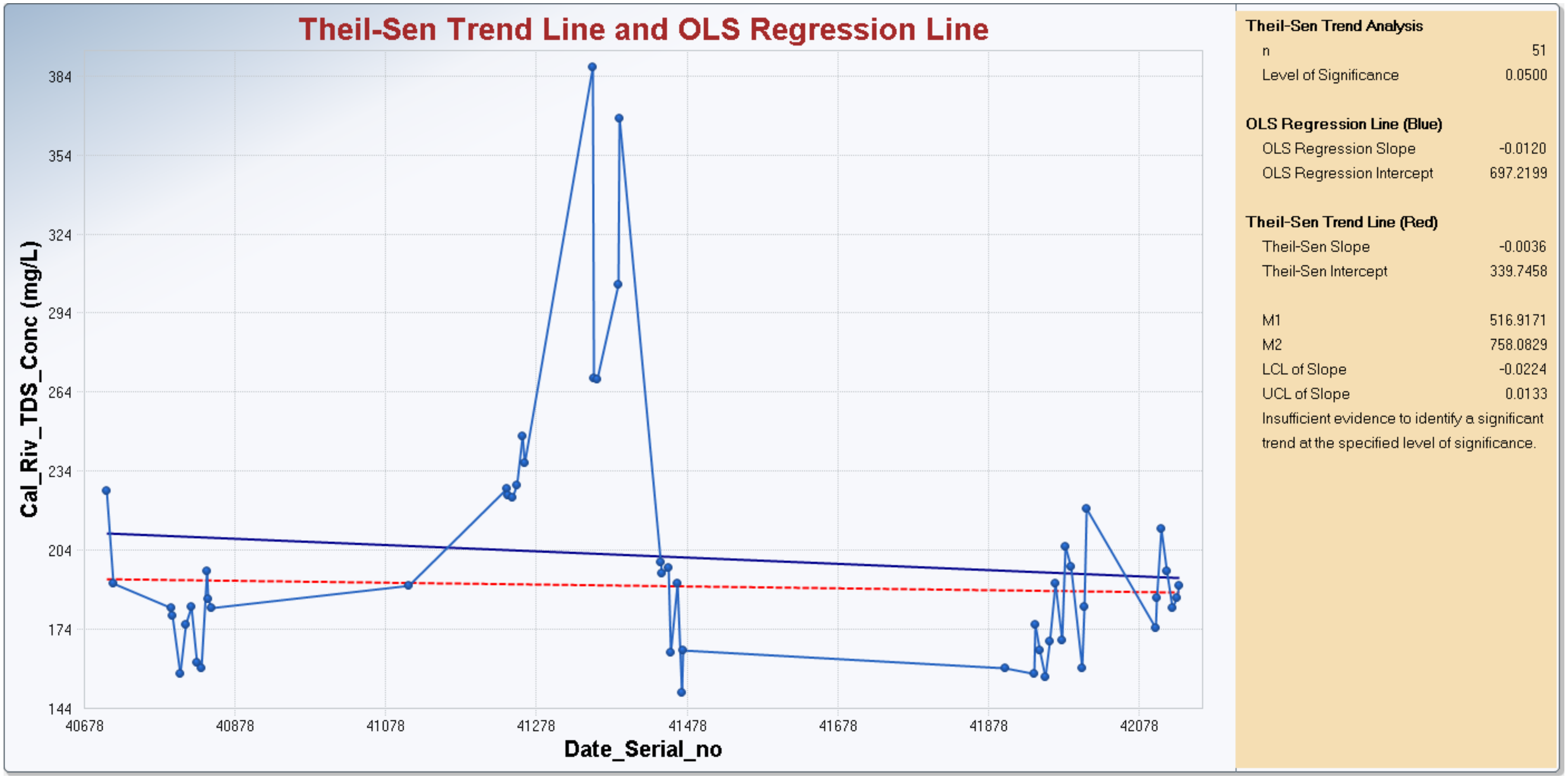
NA = Not Applicable



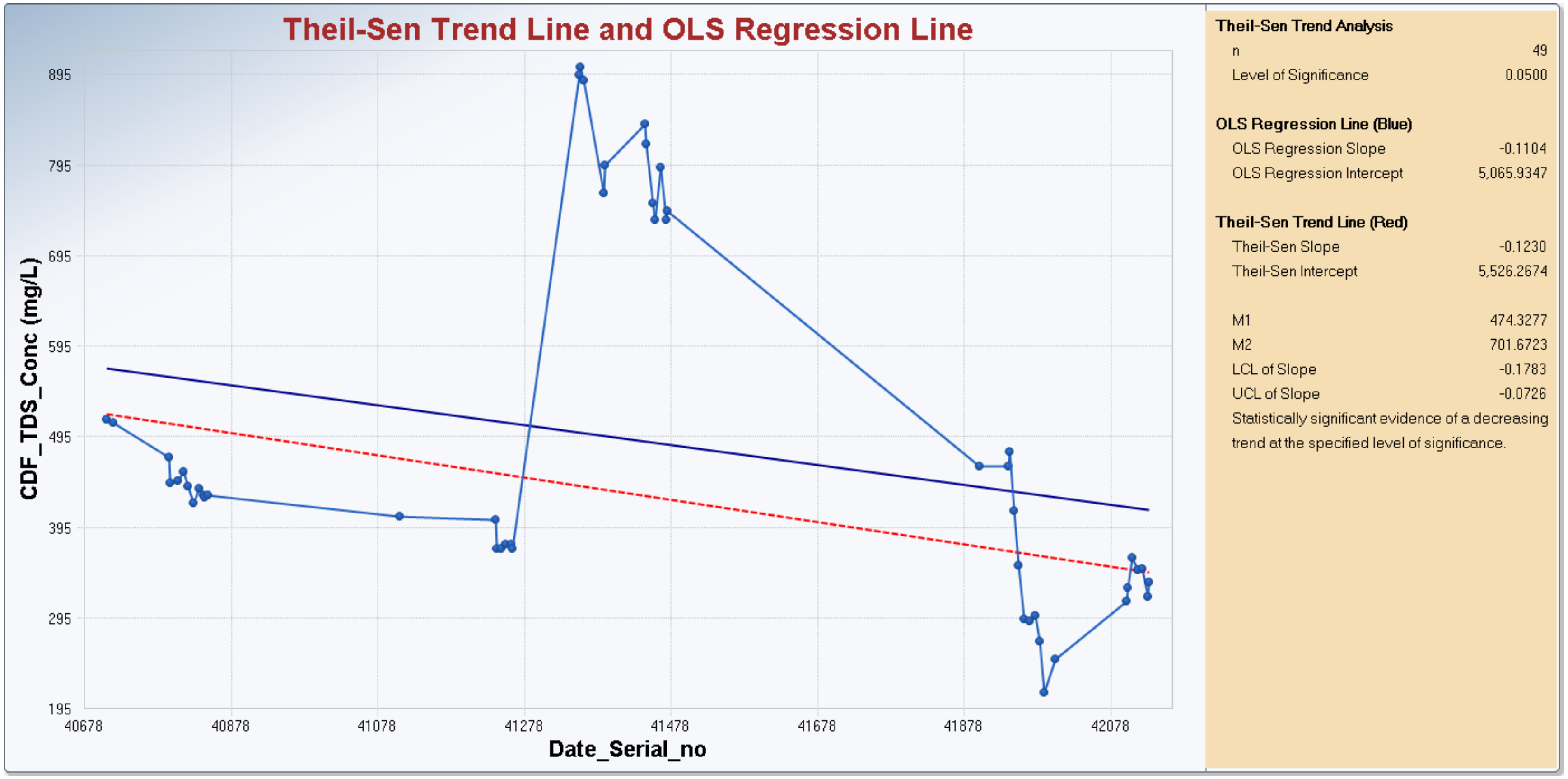
TDS – Background



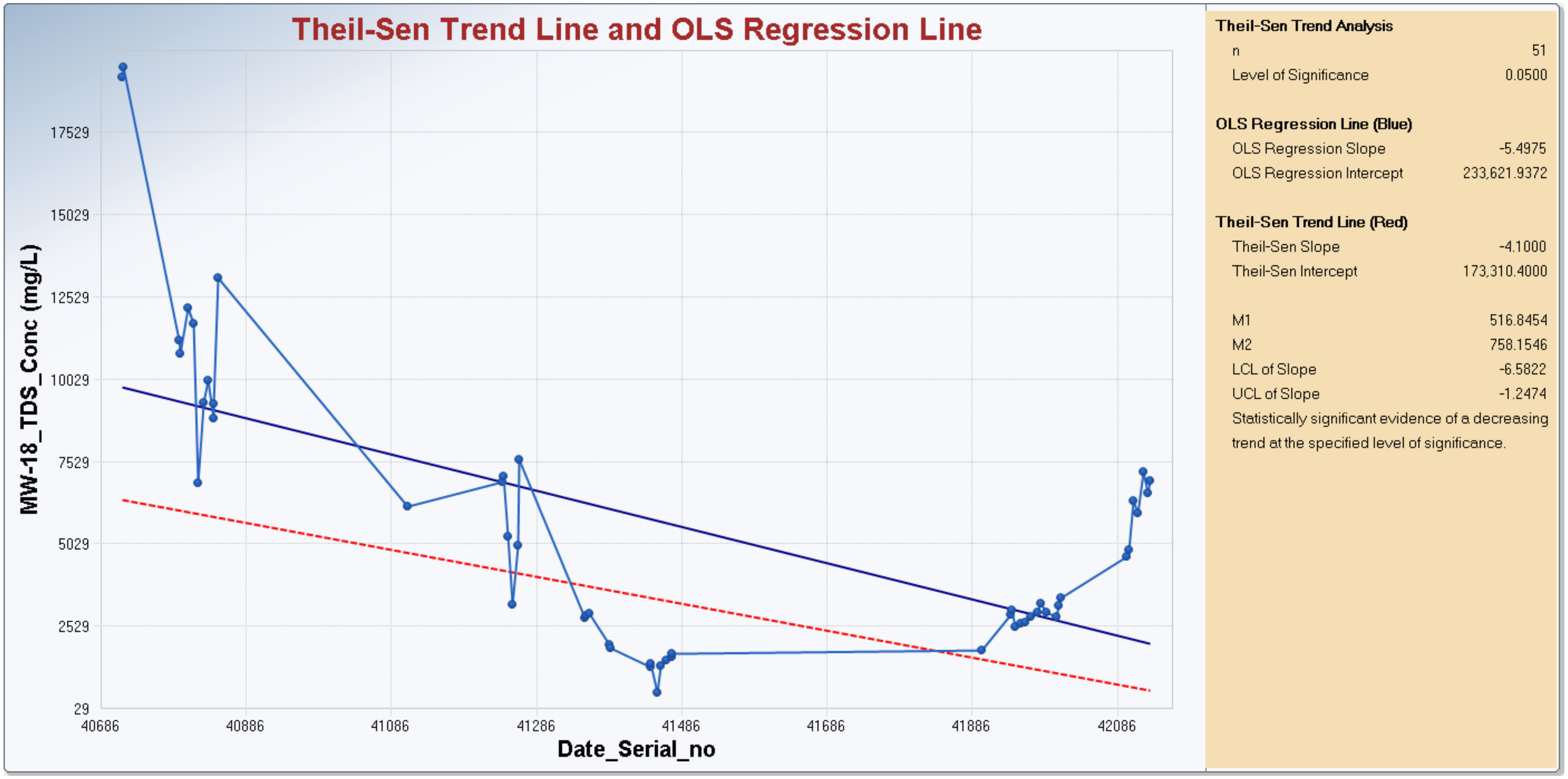
TDS – Near Dike



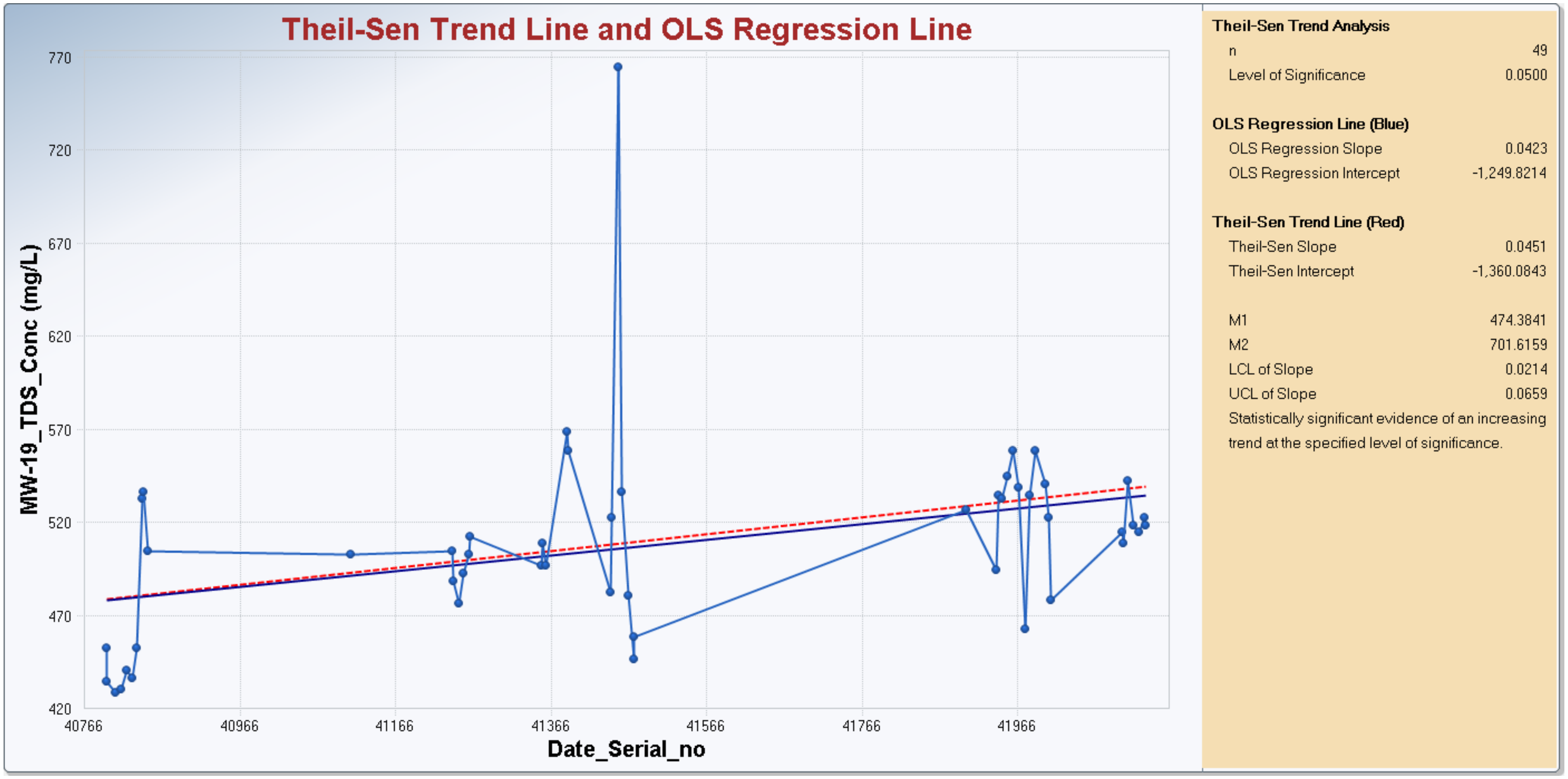
TDS – Calumet River


Theil-Sen Trend Line and OLS Regression Line
895
795
695
595
495
395
295
195
CDF_TDS_Conc (mg/L)
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 49
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope -0.1104
OLS Regression Intercept 5,065.9347
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.1230
Theil-Sen Intercept 5,526.2674
M1 474.3277
M2 701.6723
LCL of Slope -0.1783
UCL of Slope -0.0726
Statistically significant evidence of a decreasing trend at the specified level of significance.

TDS – CDF



TDS – Monitoring Well 18



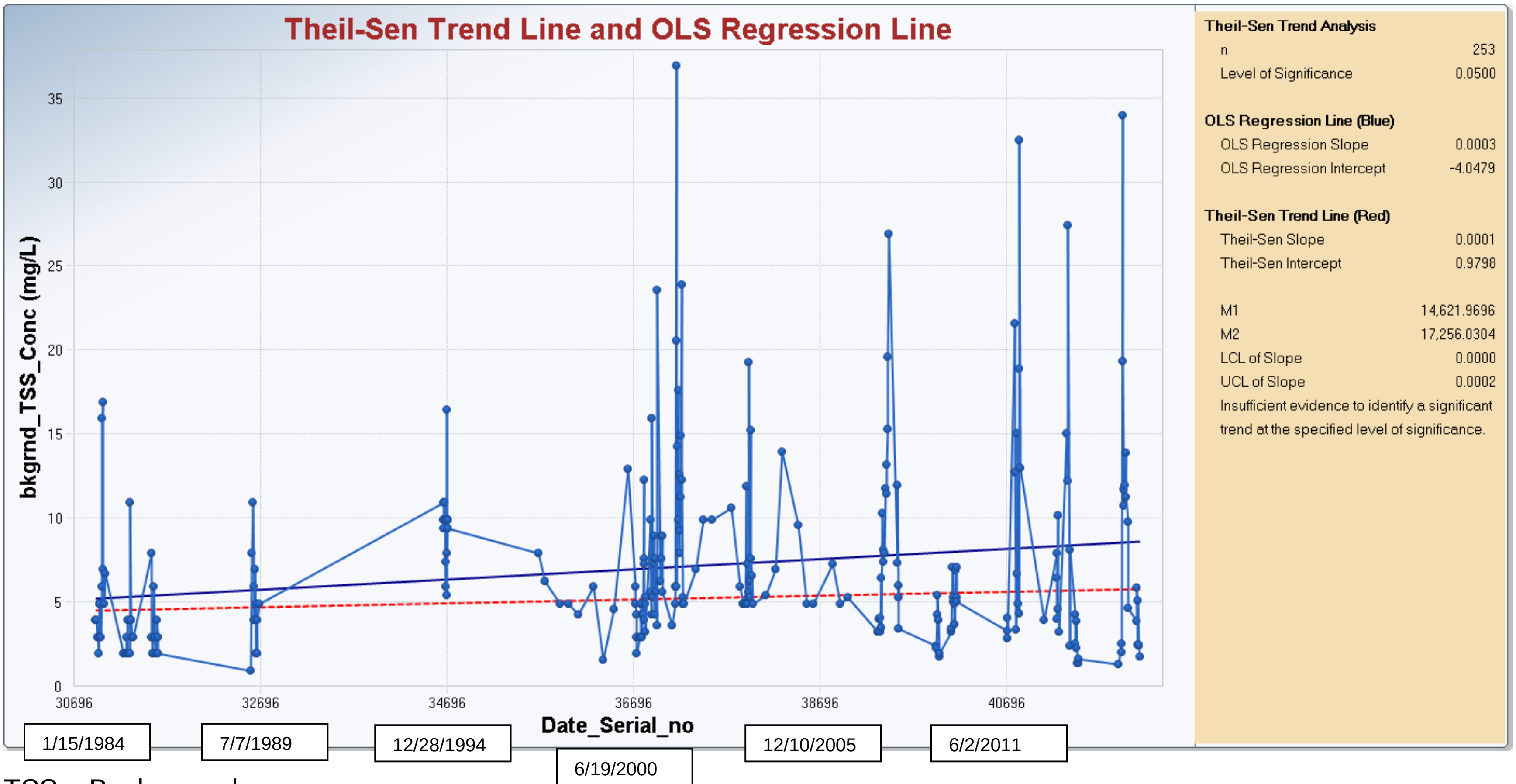
TDS – Monitoring Well 19

Appendix G: Total Suspended Solids (TSS) Graphs

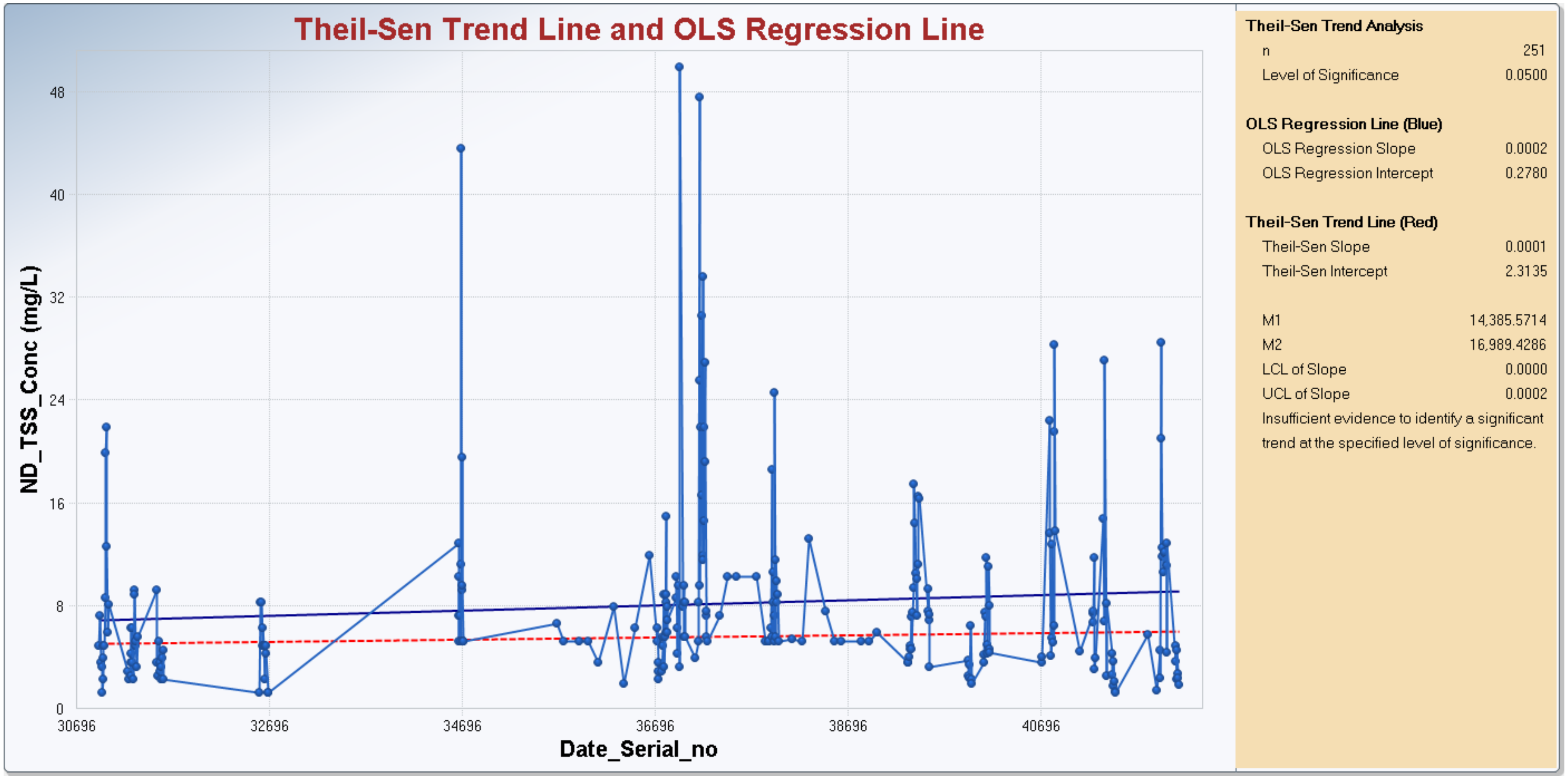
Historical Data

General Statistics - Total Suspended Solids							
Historical	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	646	754	637	625	260	263	188
Number of Values Reported (n)	646	754	637	625	260	263	188
Number of Values After Averaging	253	251	252	252	259	262	187
Number of Replicates	393	503	385	373	1	1	1
Minimum	1.00	1.00	1.83	1.00	1.00	1.00	1.00
Maximum	37	49.67	55.7	312	990	3960	1358
Mean	7.221	7.919	8.451	30.88	60.85	45.34	22.32
Geometric Mean	5.714	5.967	7.061	20.08	16.37	5.614	4.248
Median	5.333	5.333	7.317	19	12.2	4.25	4
Standard Deviation	5.638	7.168	5.812	35.91	152	276.9	140.6
Evidence of Trend Identified?	No	No	No	Yes	Yes	Yes	Yes
Direction of Trend (If Identified)	NA	NA	NA	Increasing	Decreasing	Decreasing	Increasing

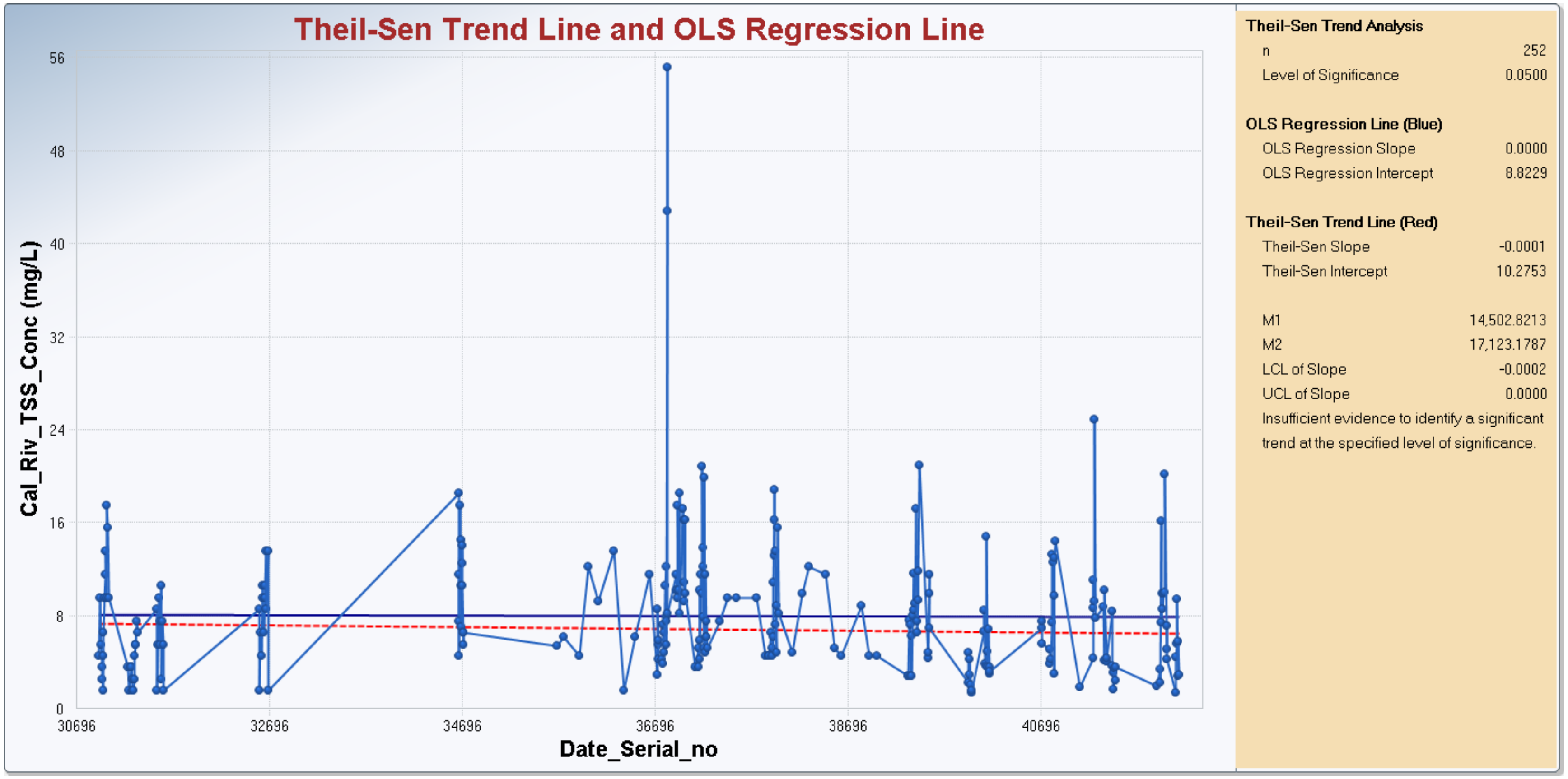
NA = Not Applicable



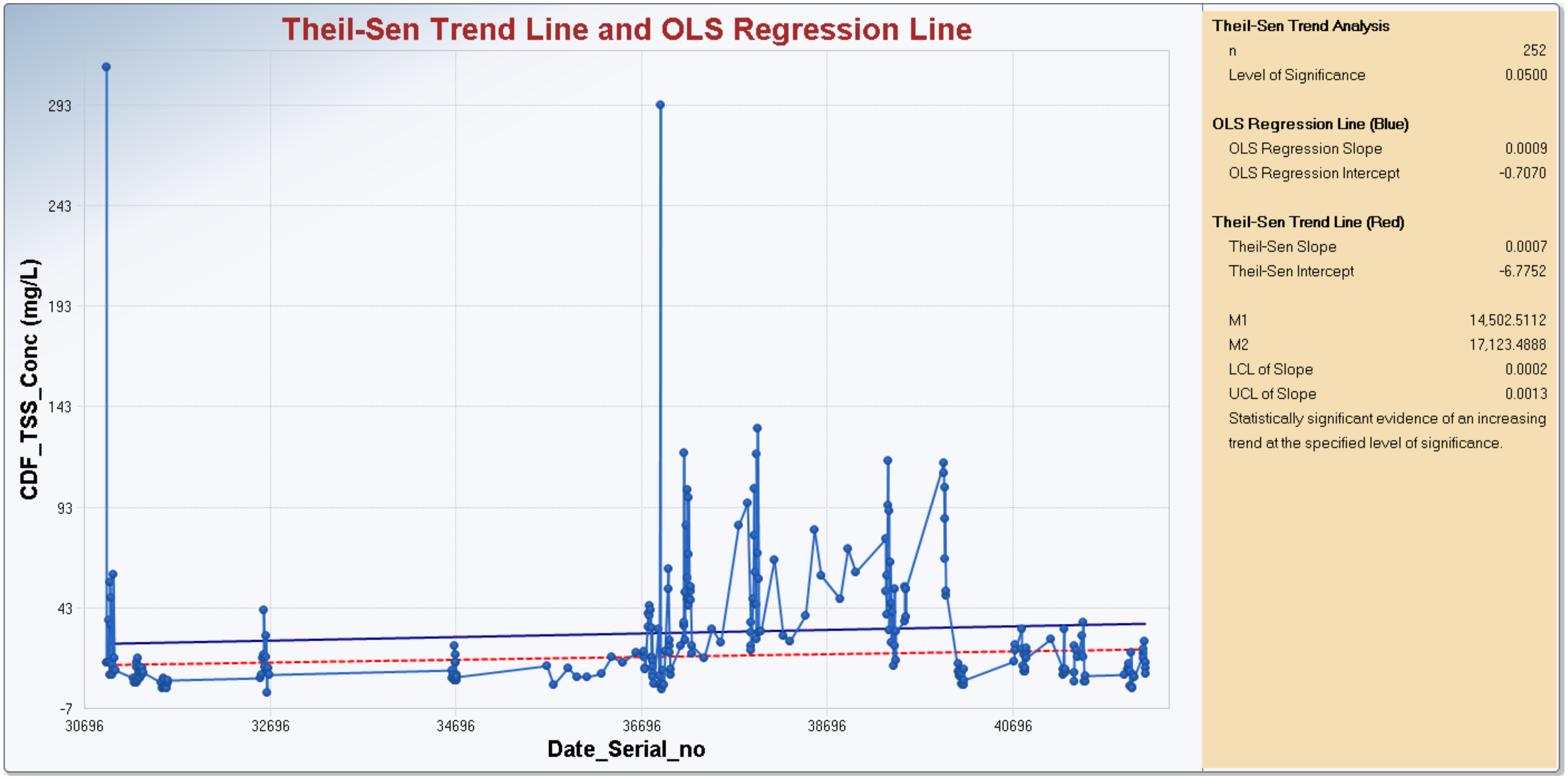
TSS – Background



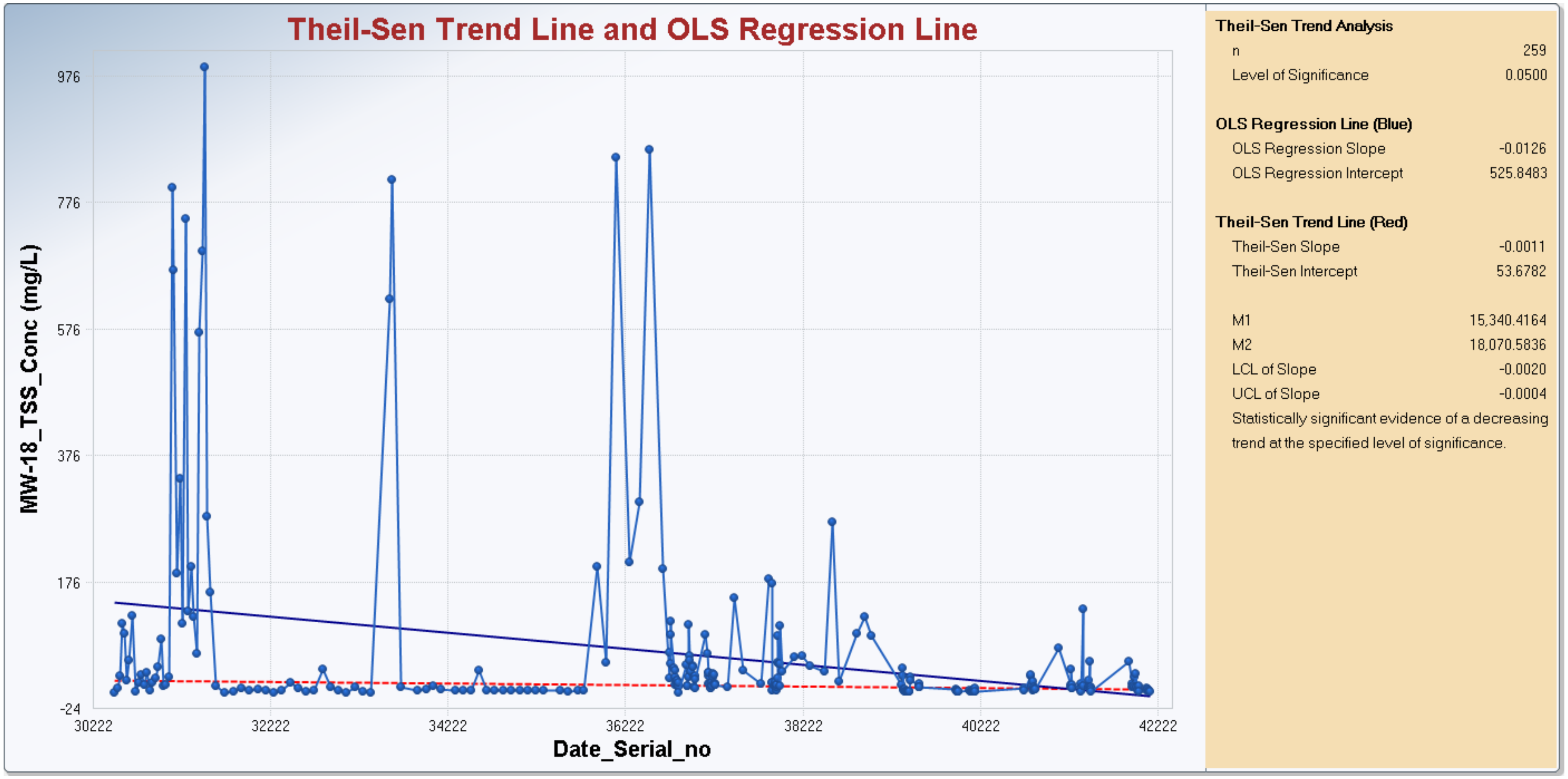
TSS – Near Dike



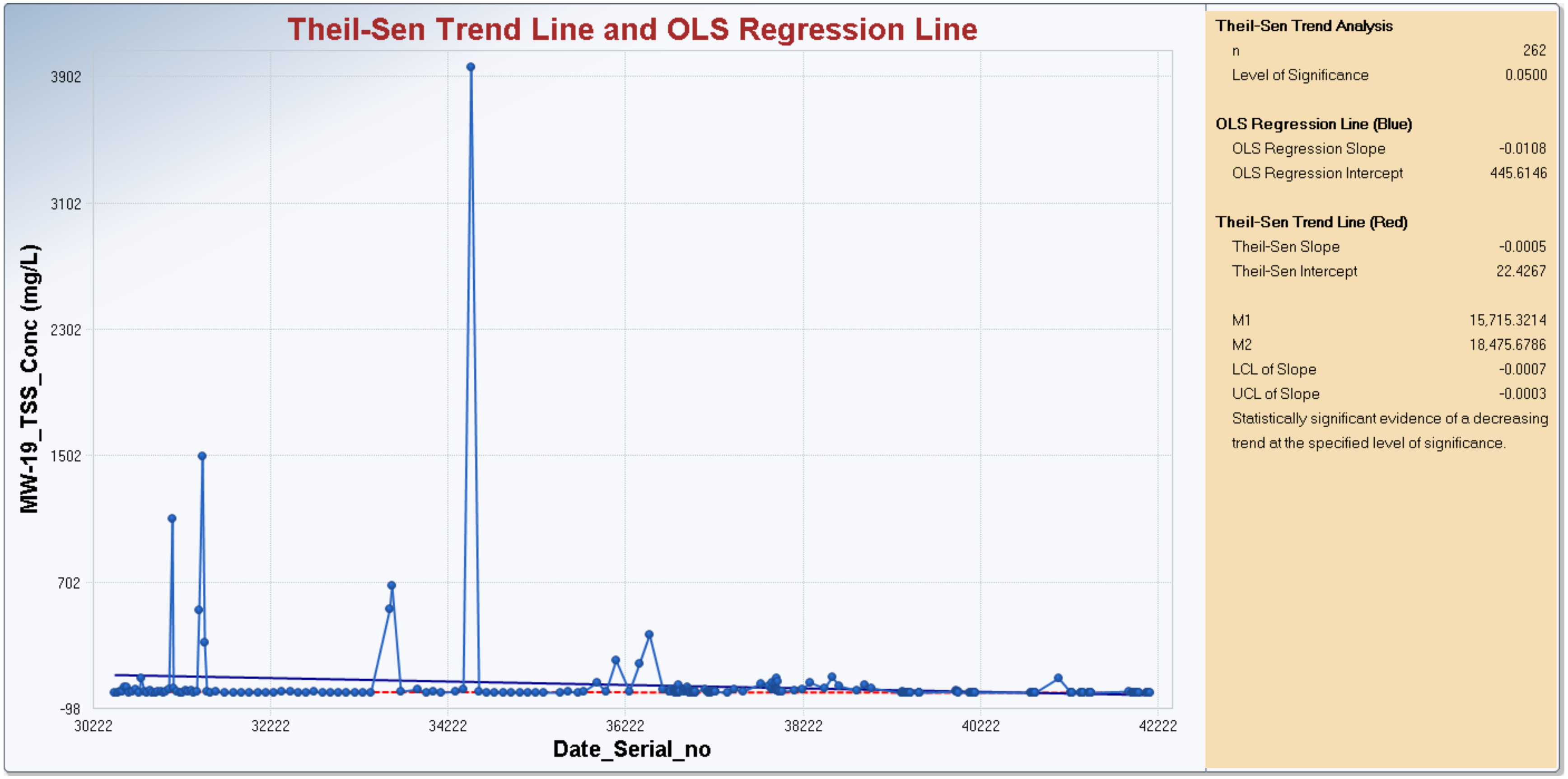
TSS – Calumet River


Theil-Sen Trend Line and OLS Regression Line
CDF_TSS_Conc (mg/L)
293
243
193
143
93
43
-7
30696
32696
34696
36696
38696
40696
Date_Serial_no
Theil-Sen Trend Analysis
n 252
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0009
OLS Regression Intercept -0.7070
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0007
Theil-Sen Intercept -6.7752
M1 14,502.5112
M2 17,123.4888
LCL of Slope 0.0002
UCL of Slope 0.0013
Statistically significant evidence of an increasing trend at the specified level of significance.

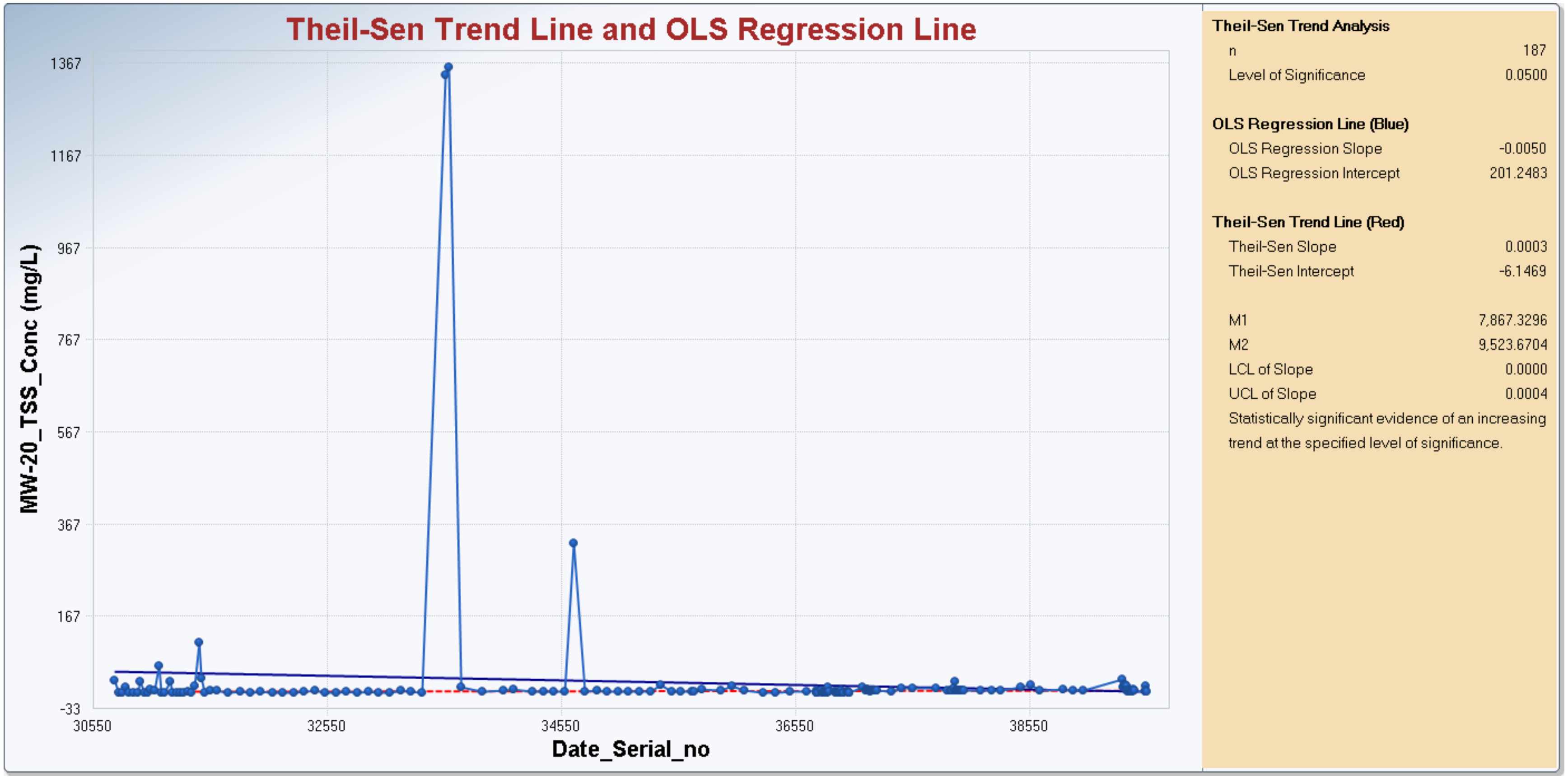
TSS – CDF



TSS – Monitoring Well 18



TSS – Monitoring Well 19



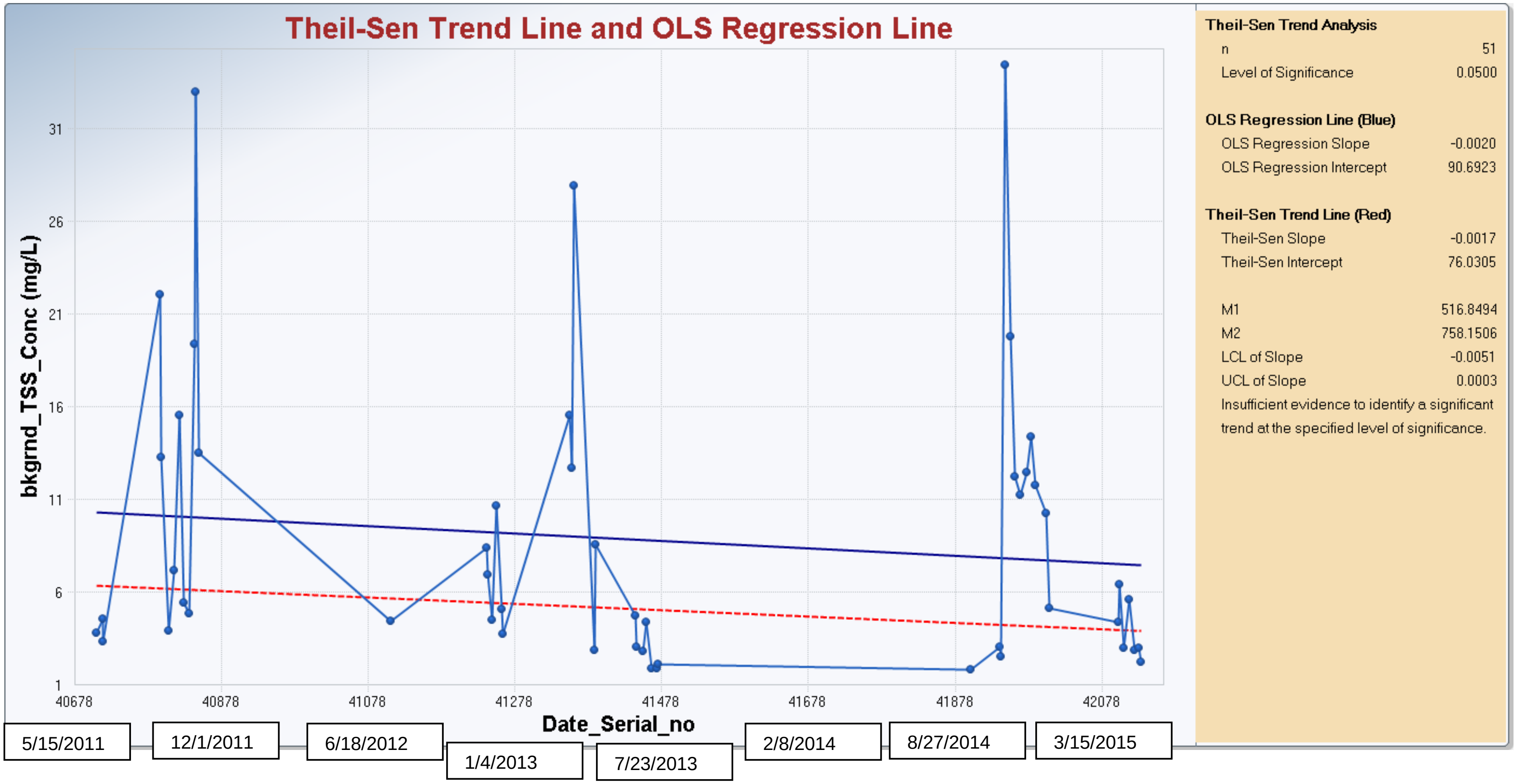
TSS – Monitoring Well 20

TSS Graphs

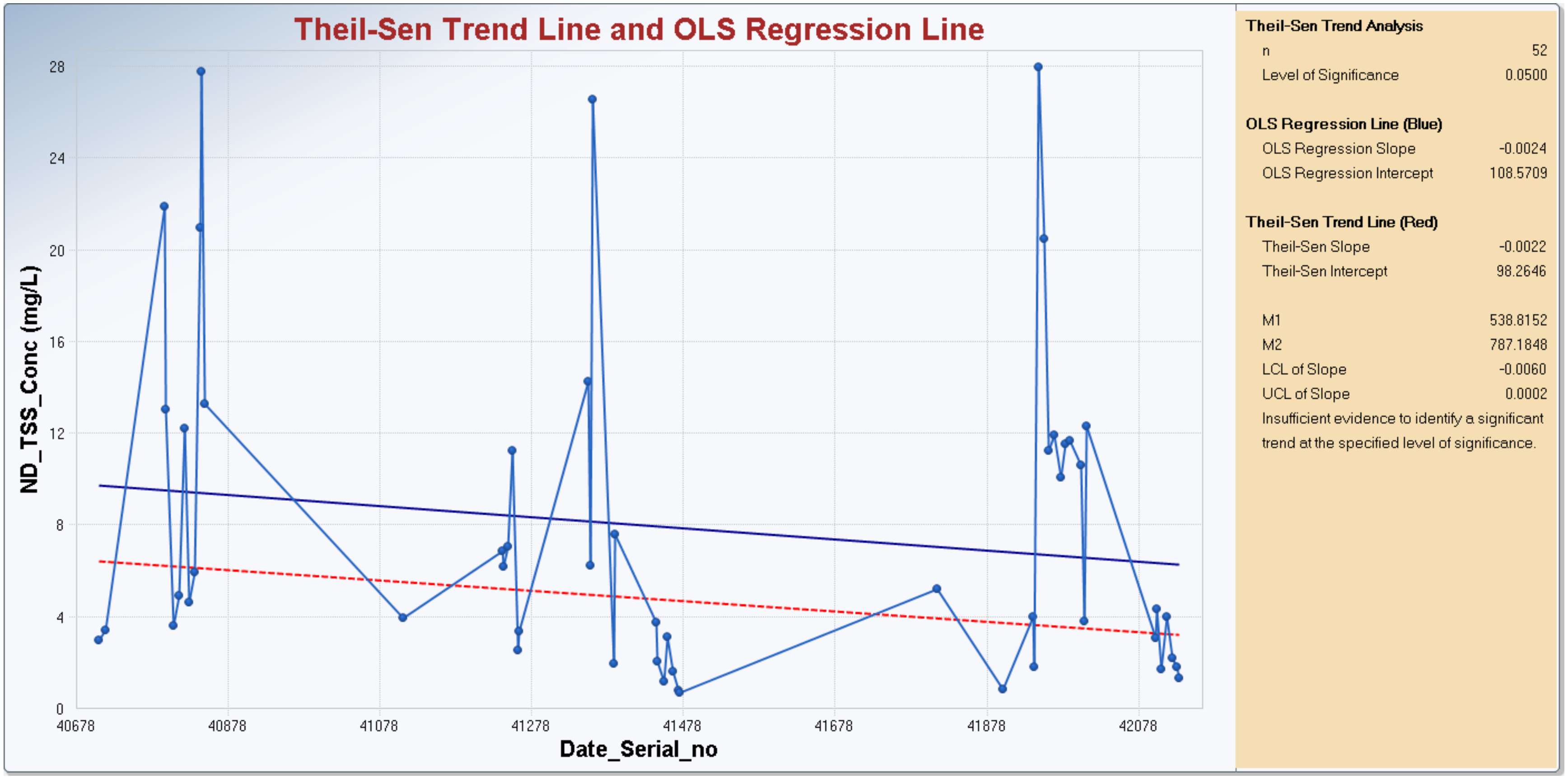
Current Data

General Statistics - Total Suspended Solids						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	153	154	156	150	51	49
Number of Values Reported (n)	153	154	156	150	51	49
Number of Values After Averaging	51	52	52	50	51	49
Number of Replicates	102	102	104	100	0	0
Minimum	1.40	1.00	1.87	3.33	2.40	1.00
Maximum	34.03	28.27	25.30	36.07	134	90.6
Mean	8.374	8.143	7.596	16.39	16.14	3.073
Geometric Mean	5.786	5.613	6.371	14.41	10.53	1.177
Median	4.7	5.083	6.183	14.88	9.6	1
Standard Deviation	7.809	7.229	4.767	7.832	21.58	12.85
Evidence of Trend Identified?	No	No	No	Yes	No	No
Direction of Trend (If Identified)	NA	NA	NA	Decreasing	NA	NA

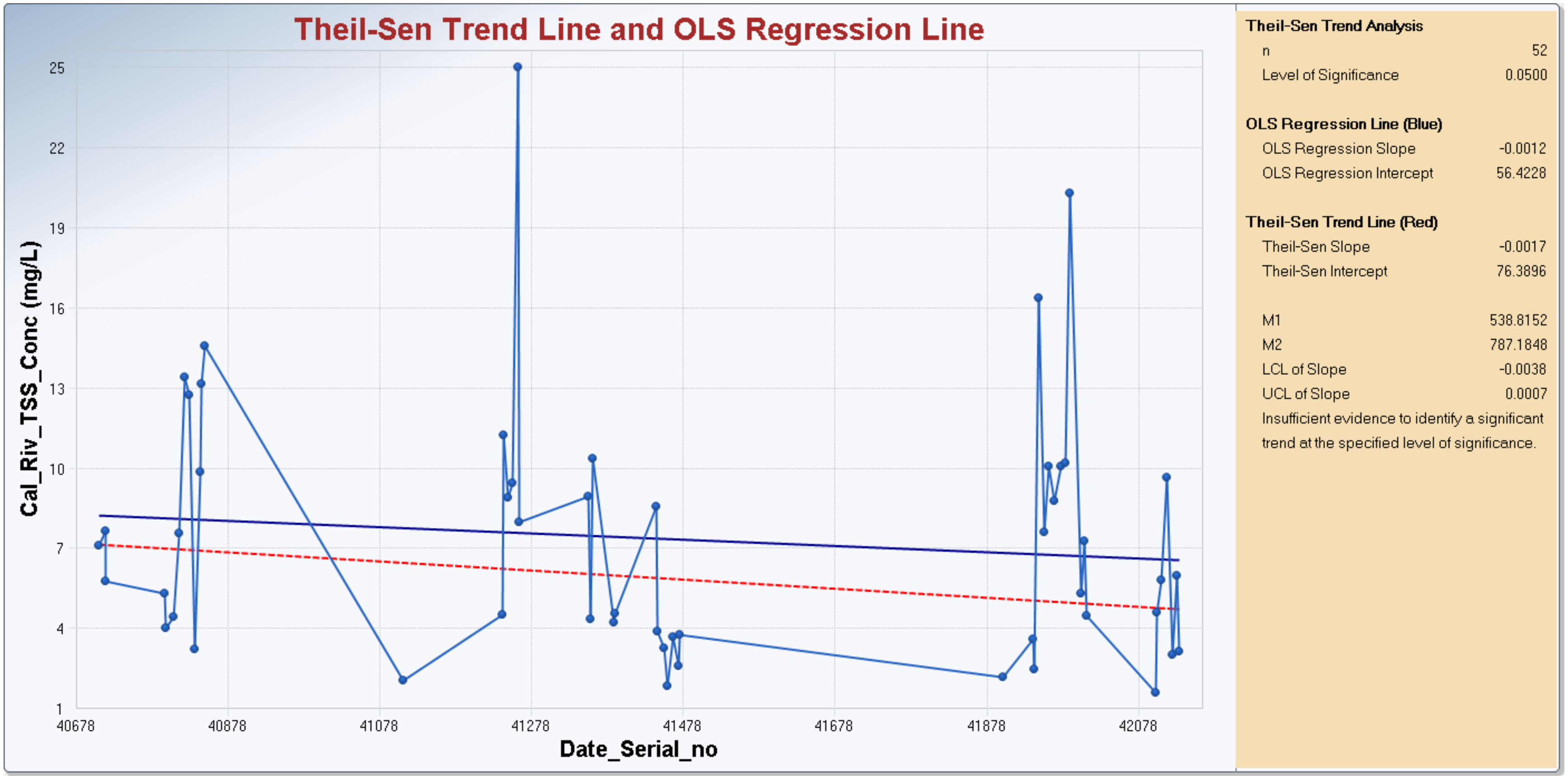
NA = Not Applicable



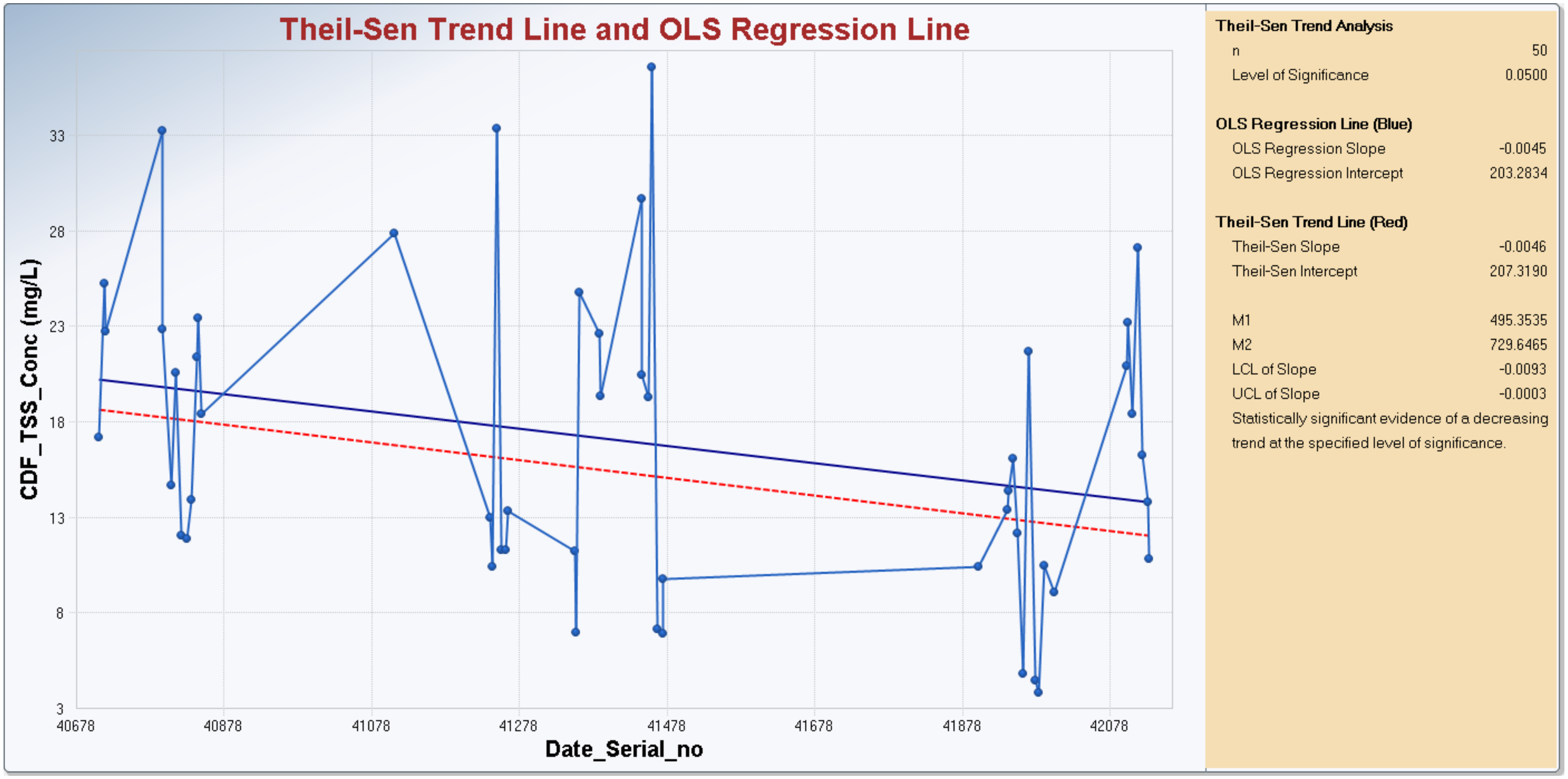
TSS – Background



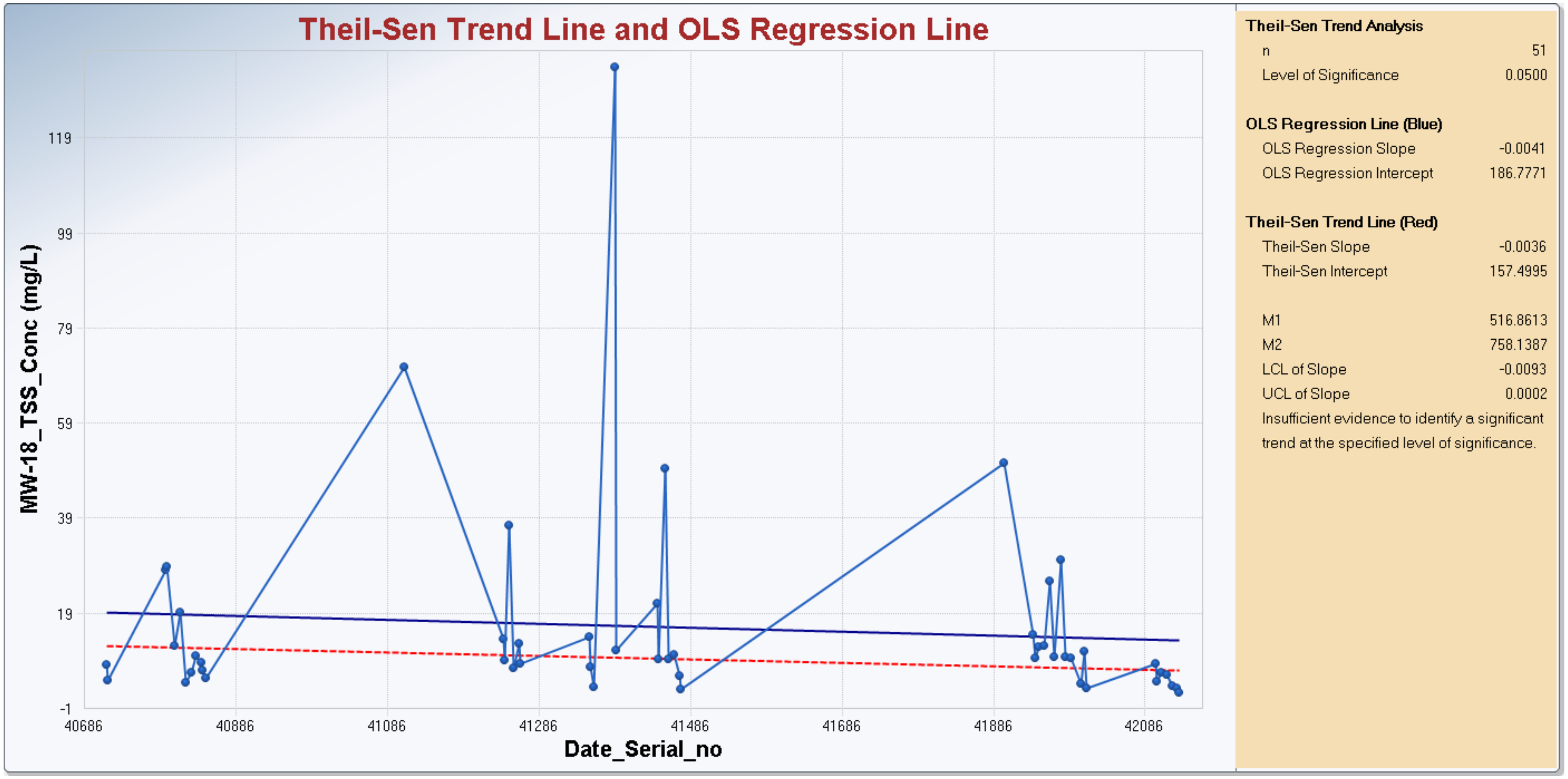
TSS – Near Dike



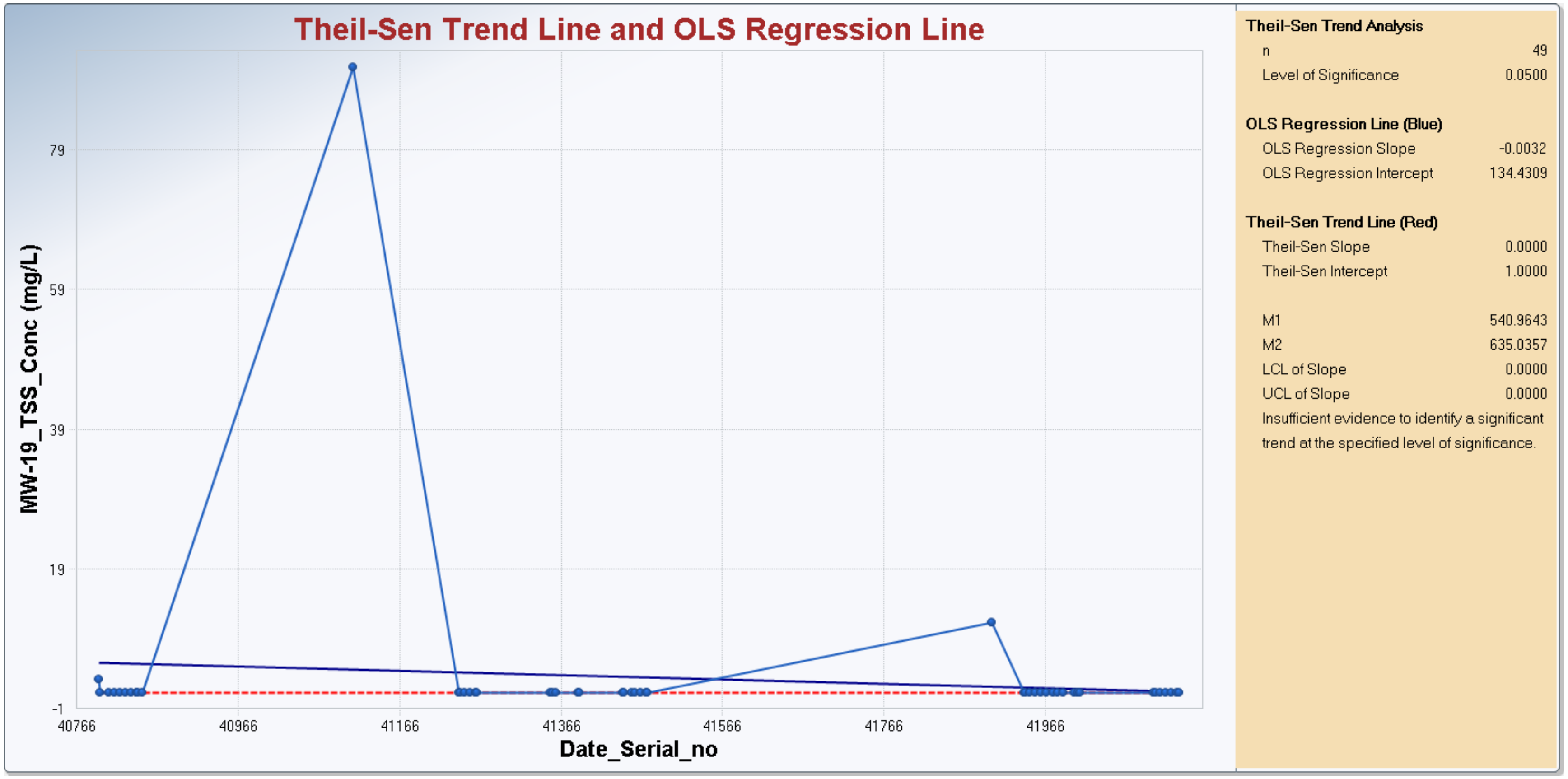
TSS – Calumet River


Theil-Sen Trend Line and OLS Regression Line
CDF_TSS_Conc (mg/L)
Date_Serial_no
3
8
13
18
23
28
33
40678
40878
41078
41278
41478
41678
41878
42078
Theil-Sen Trend Analysis
n 50
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope -0.0045
OLS Regression Intercept 203.2834
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0046
Theil-Sen Intercept 207.3190
M1 495.3535
M2 729.6465
LCL of Slope -0.0093
UCL of Slope -0.0003
Statistically significant evidence of a decreasing trend at the specified level of significance.

TSS – CDF



TSS – Monitoring Well 18



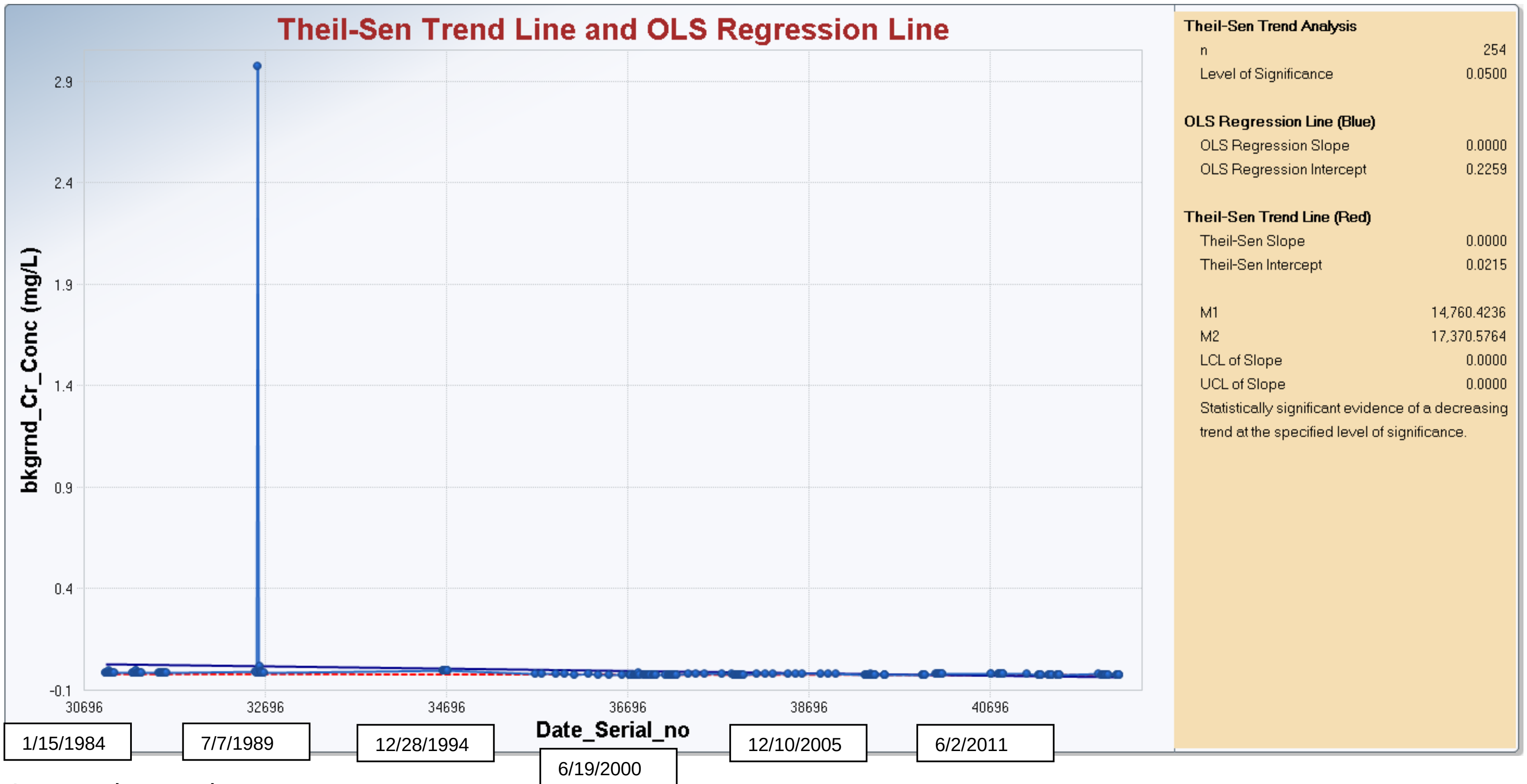
TSS – Monitoring Well 19

Appendix H: Chromium (Cr) Graphs

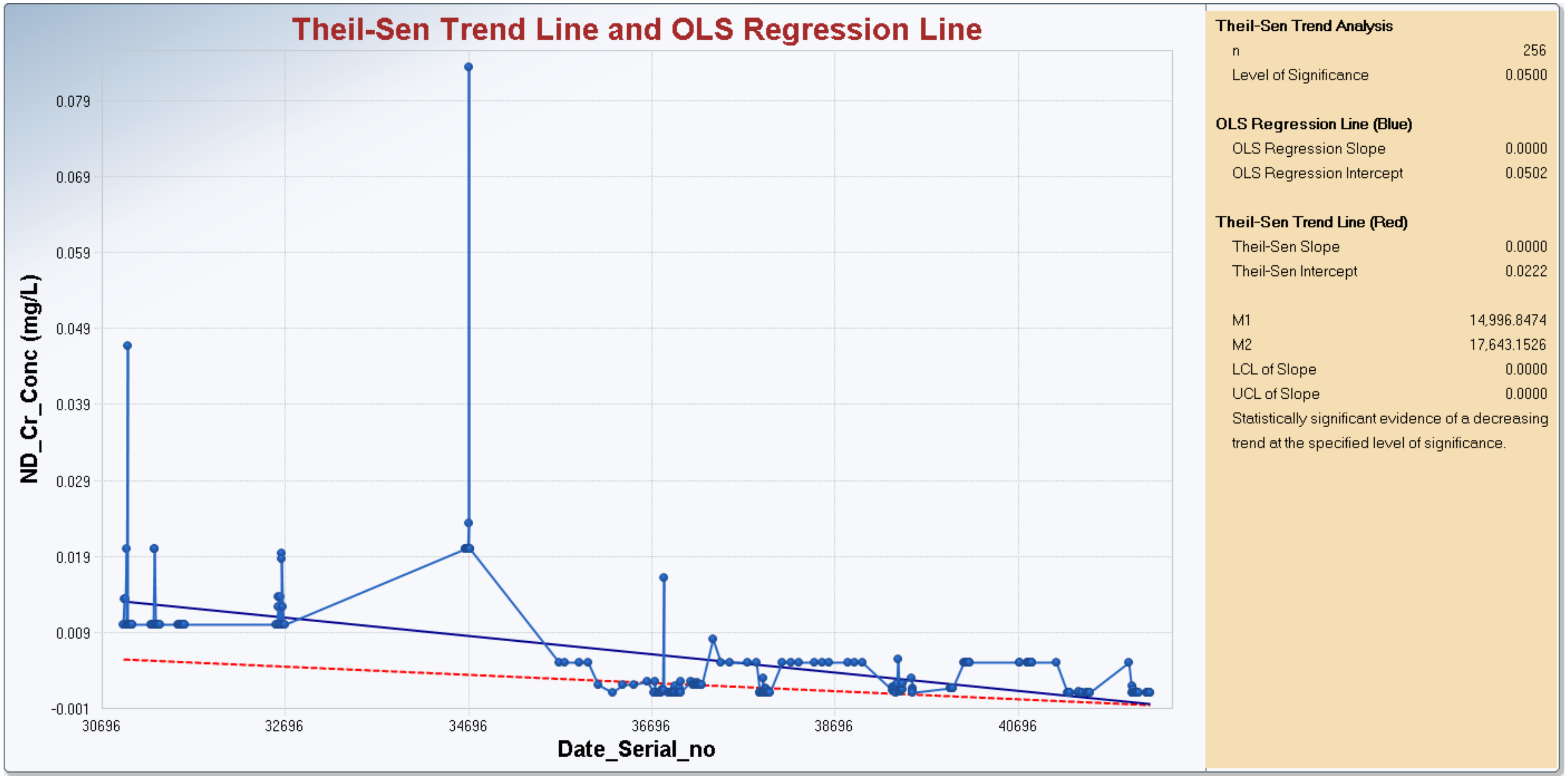
Historical Data

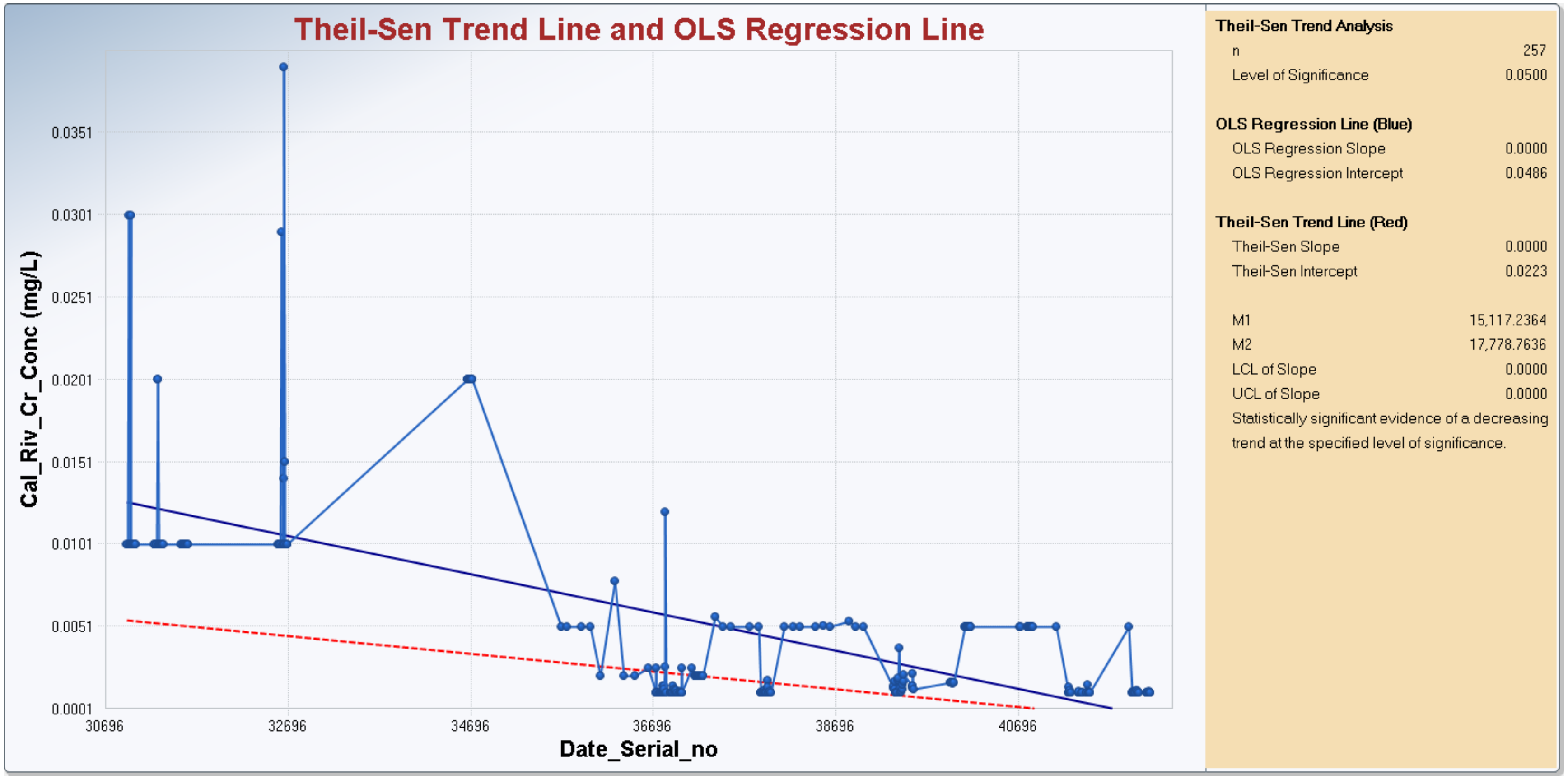
General Statistics - Chromium							
Historical	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	633	769	652	619	235	233	156
Number of Values Reported (n)	633	769	652	619	235	233	156
Number of Values After Averaging	254	256	257	242	234	232	155
Number of Replicates	379	513	395	377	1	1	1
Minimum	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Maximum	3.000	0.083	0.039	0.048	0.070	0.050	0.050
Mean	0.0169	0.00553	0.00532	0.00589	0.00885	0.00733	0.00968
Geometric Mean	0.00303	0.00302	0.003	0.00376	0.00395	0.0027	0.0035
Median	0.002	0.002	0.002	0.00449	0.0036	0.002	0.002
Standard Deviation	0.188	0.00777	0.00622	0.00647	0.0145	0.0141	0.0164
Evidence of Trend Identified?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Direction of Trend (If Identified)	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing

NA = Not Applicable

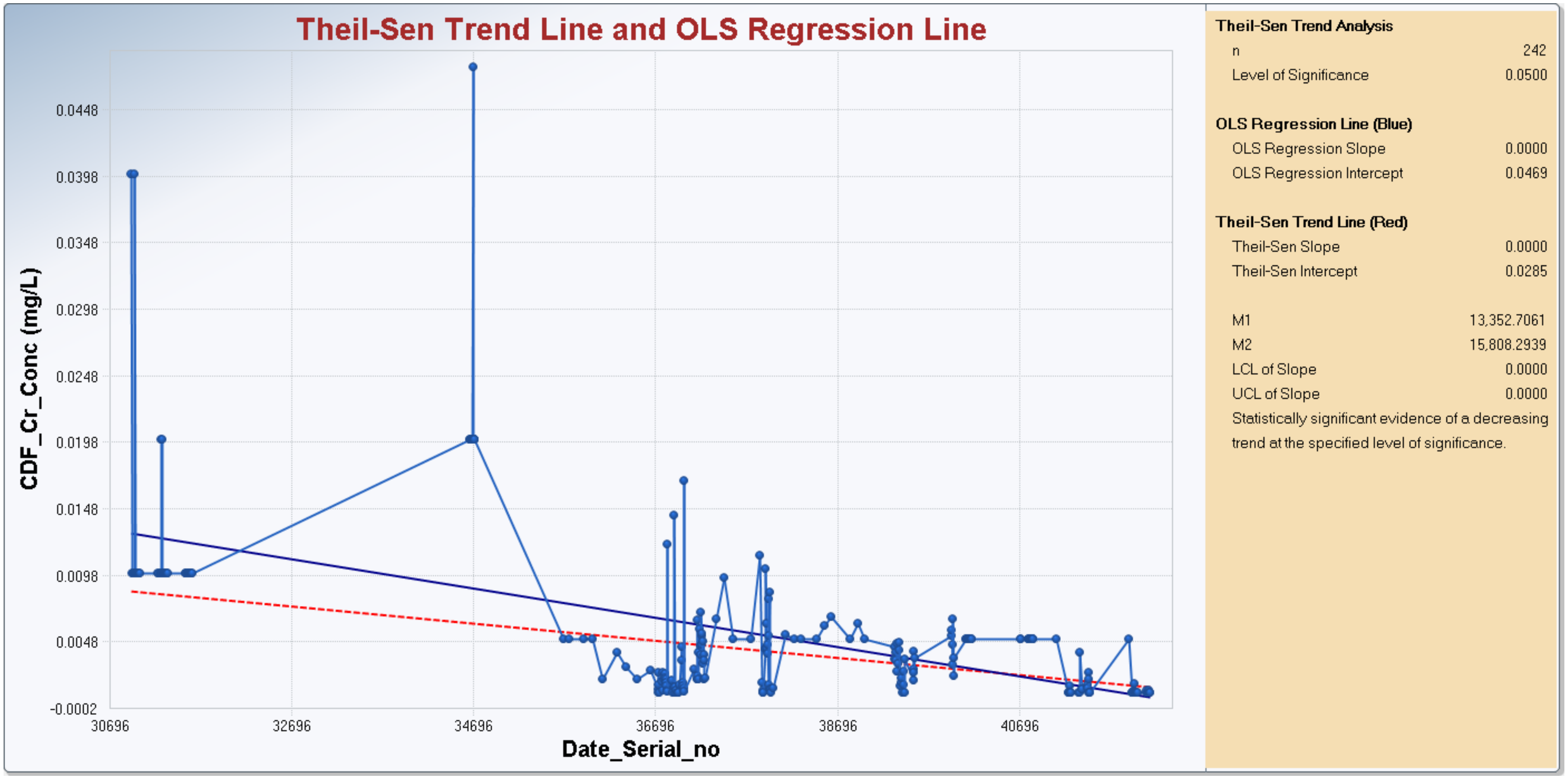


Cr – Background


Theil-Sen Trend Line and OLS Regression Line
ND_Cr_Conc (mg/L)
0.079
0.069
0.059
0.049
0.039
0.029
0.019
0.009
-0.001
30696
32696
34696
36696
38696
40696
Date_Serial_no
Theil-Sen Trend Analysis
n 256
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.0502
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0222
M1 14,996.8474
M2 17,643.1526
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.
Cr – Near Dike

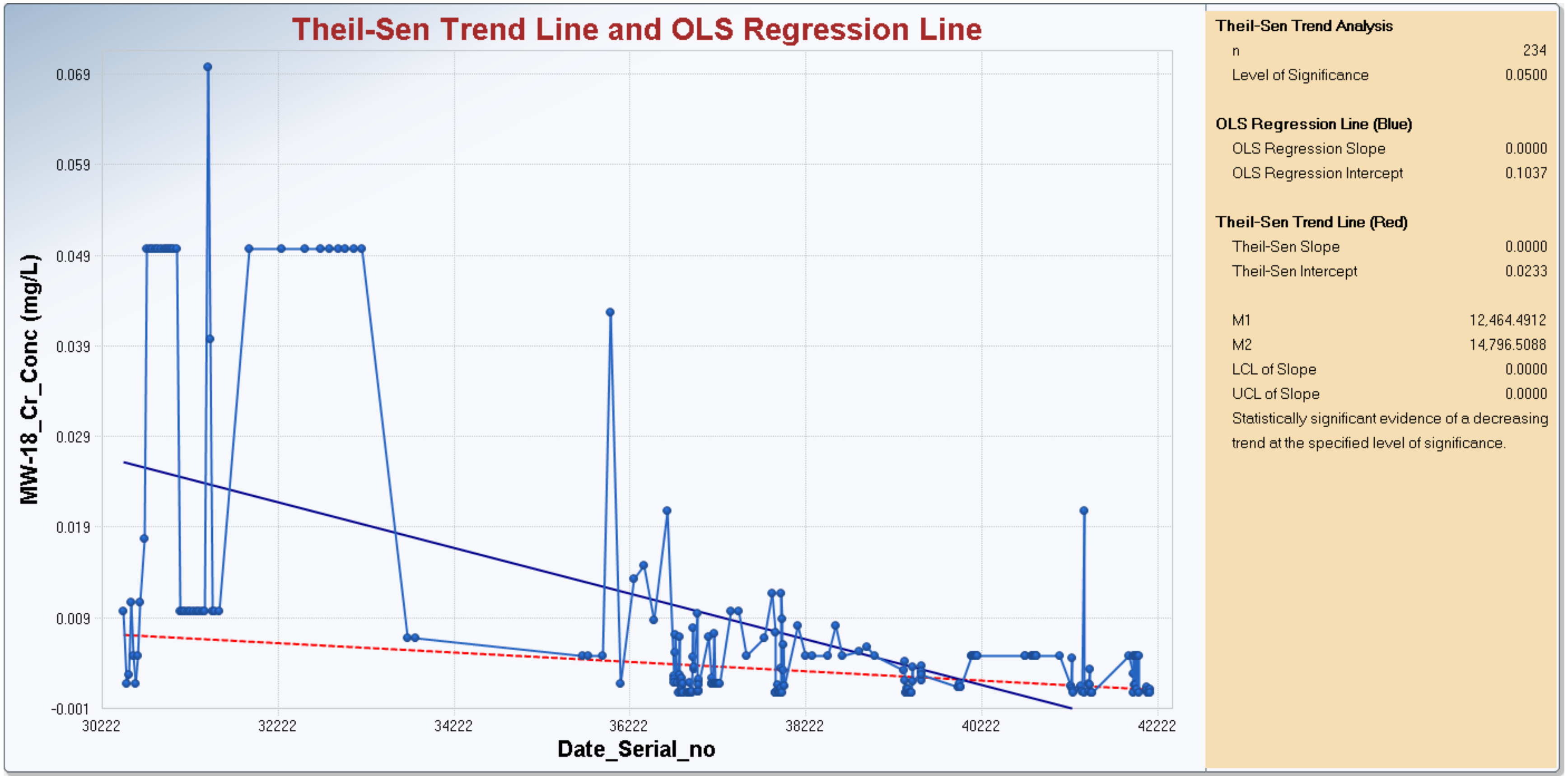


Cr – Calumet River

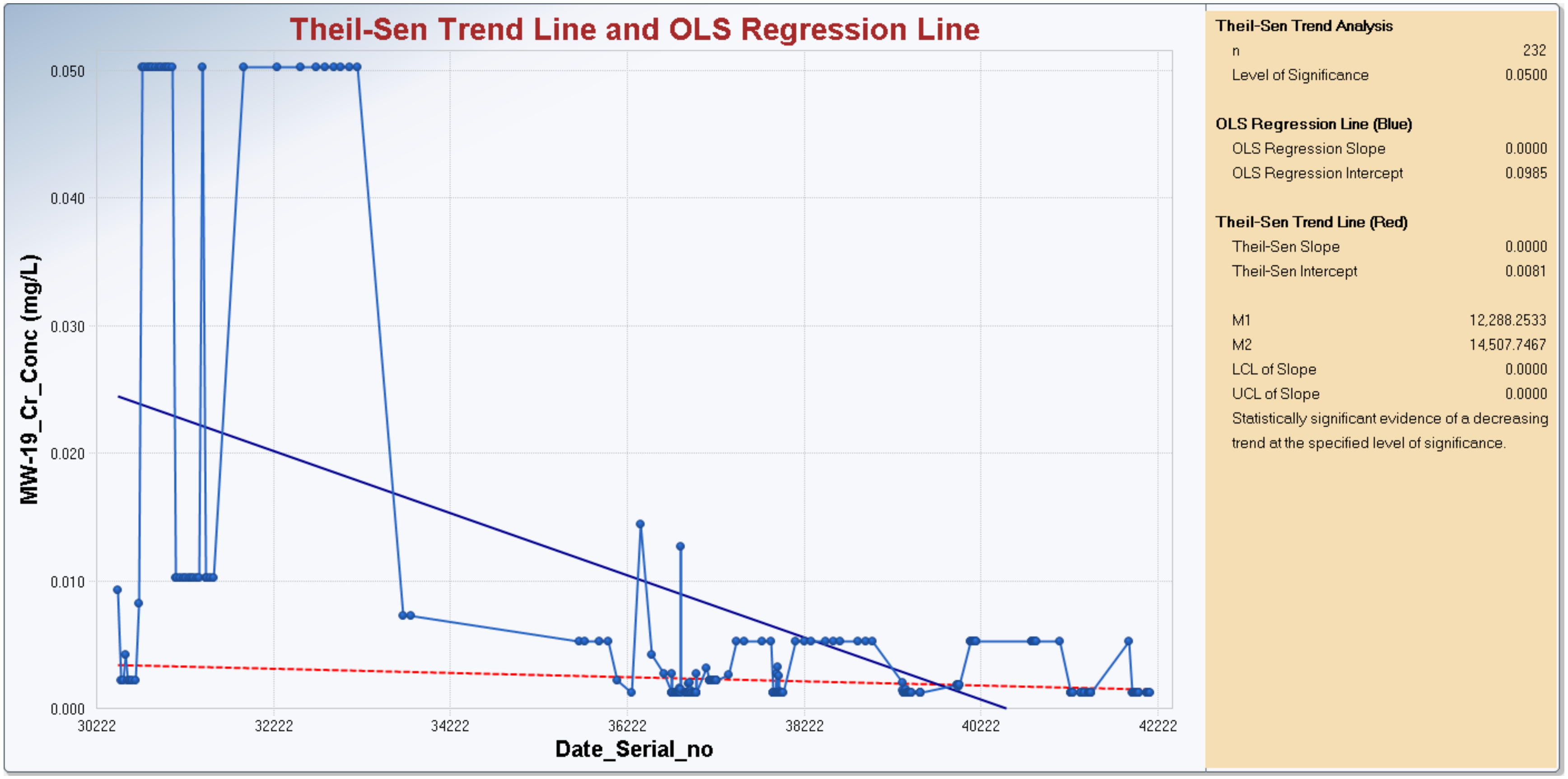


Theil-Sen Trend Line and OLS Regression Line
CDF_Cr_Conc (mg/L)
0.0448
0.0398
0.0348
0.0298
0.0248
0.0198
0.0148
0.0098
0.0048
-0.0002
30696
32696
34696
36696
38696
40696
Date_Serial_no
Theil-Sen Trend Analysis
n 242
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.0469
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0285
M1 13,352.7061
M2 15,808.2939
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

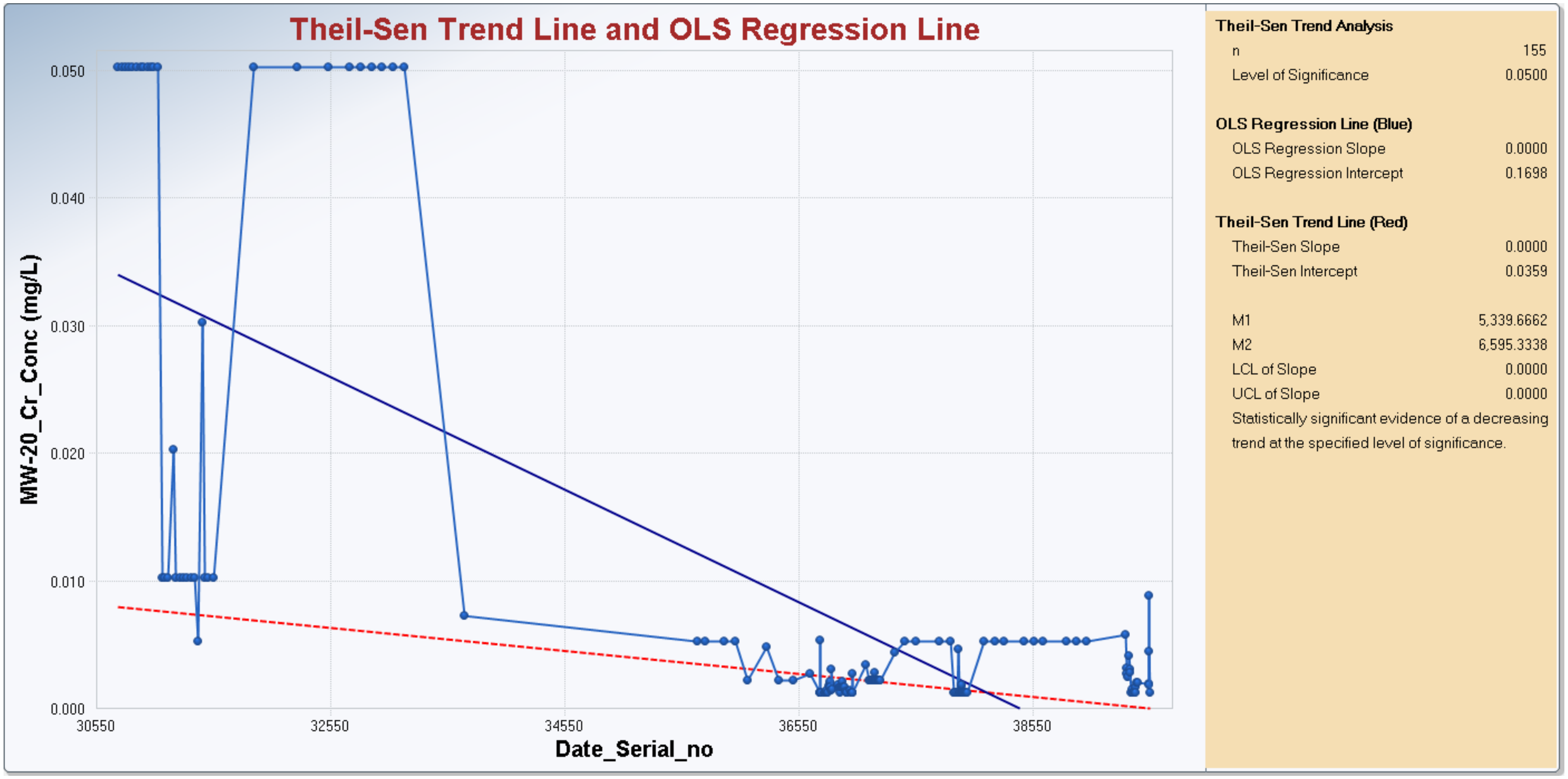
Cr – CDF



Cr – Monitoring Well 18



Cr – Monitoring Well 19



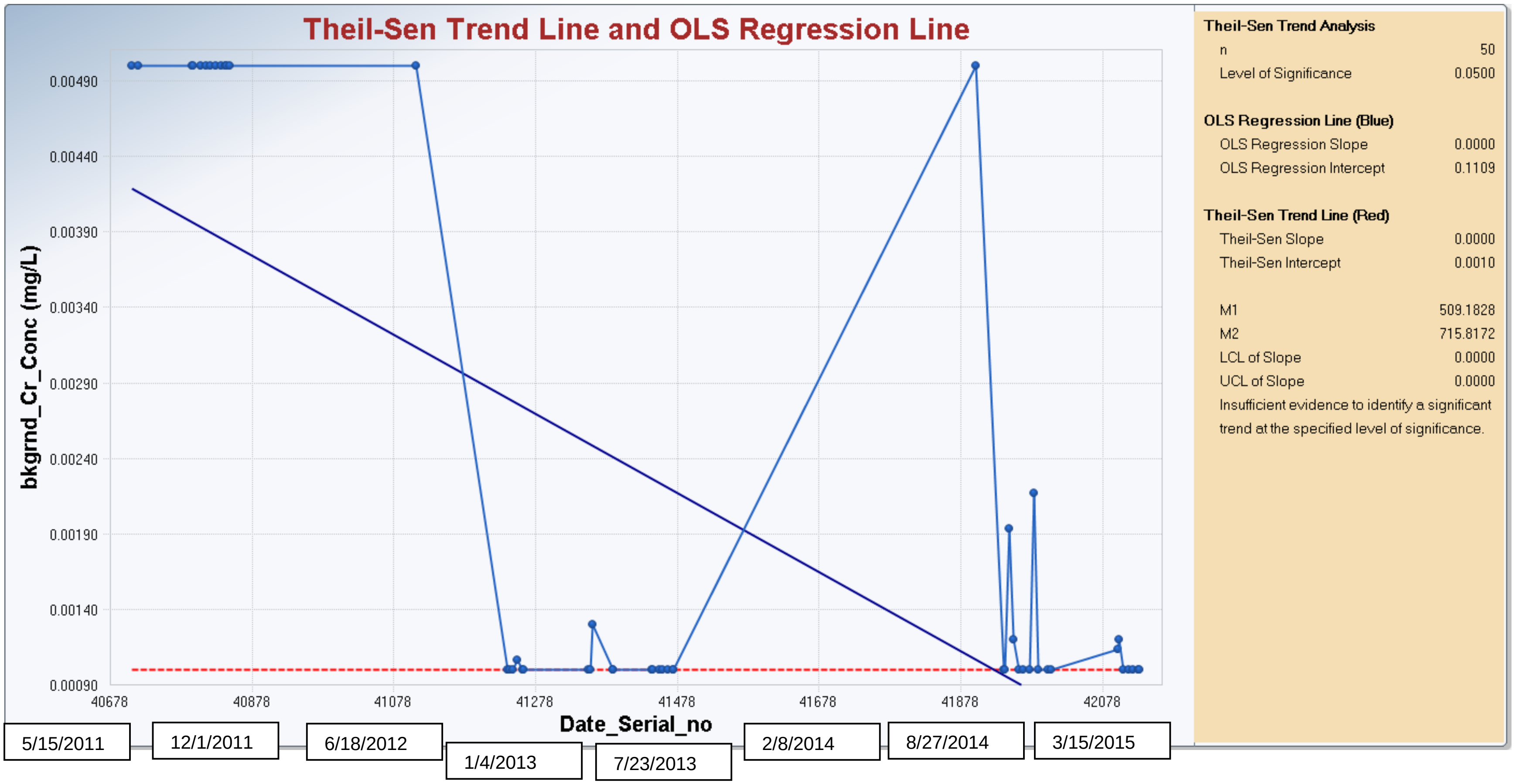
Cr – Monitoring Well 20

Cr Graphs

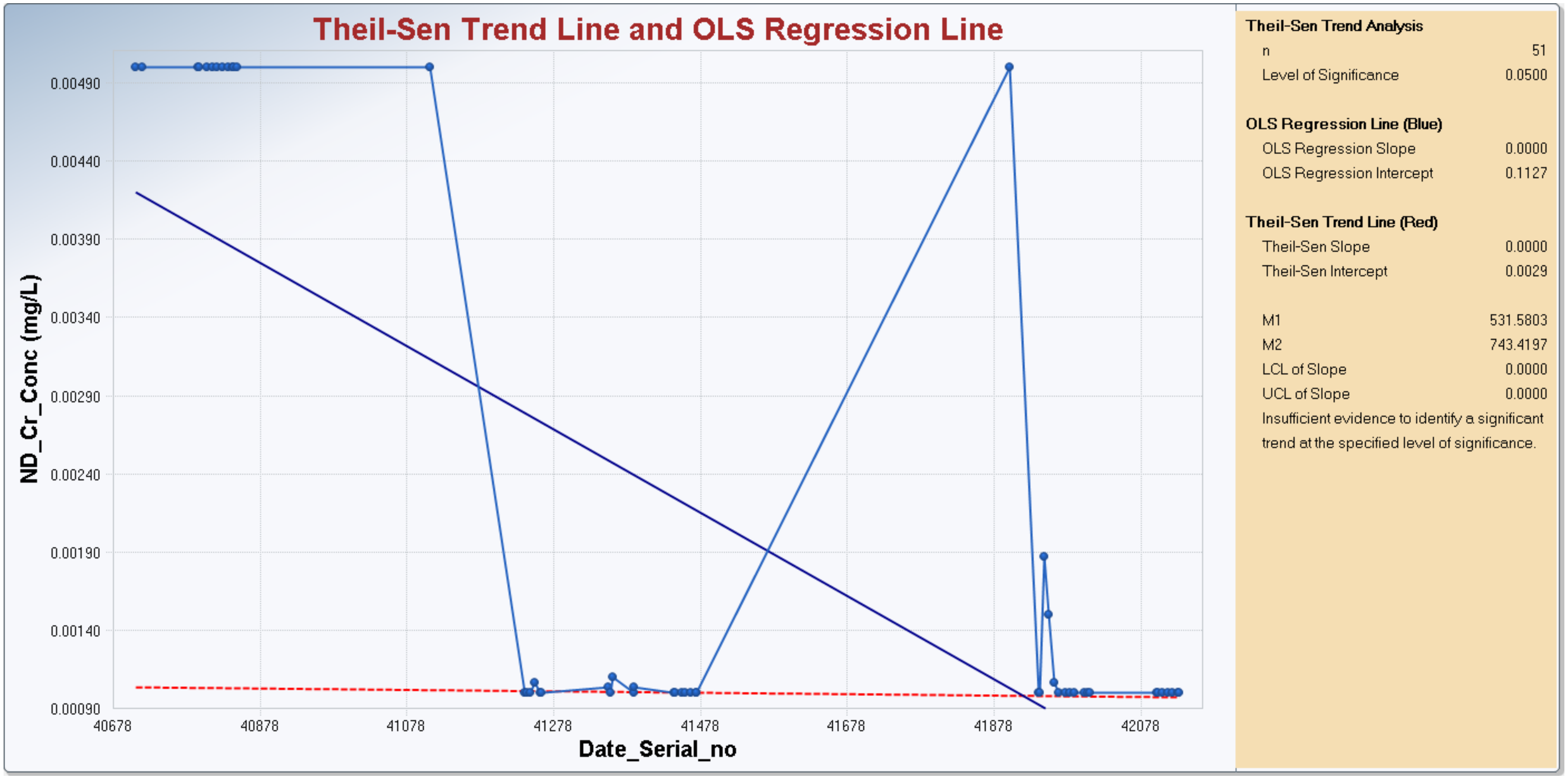
Current Data

General Statistics - Chromium						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	150	151	153	147	51	49
Number of Values Reported (n)	150	151	153	147	51	49
Number of Values After Averaging	50	51	51	49	51	49
Number of Replicates	100	100	102	98	0	0
Minimum	0.001	0.001	0.001	0.001	0.001	0.001
Maximum	0.005	0.005	0.005	0.005	0.021	0.005
Mean	0.00218	0.00213	0.00213	0.00232	0.0033	0.00198
Geometric Mean	0.00164	0.0016	0.00159	0.00177	0.00246	0.00148
Median	0.001	0.001	0.001	0.00113	0.0019	0.001
Standard Deviation	0.00179	0.00179	0.00179	0.00178	0.0031	0.00174
Evidence of Trend Identified?	No	No	No	Yes	No	No
Direction of Trend (If Identified)	NA	NA	NA	Decreasing	NA	NA

NA = Not Applicable

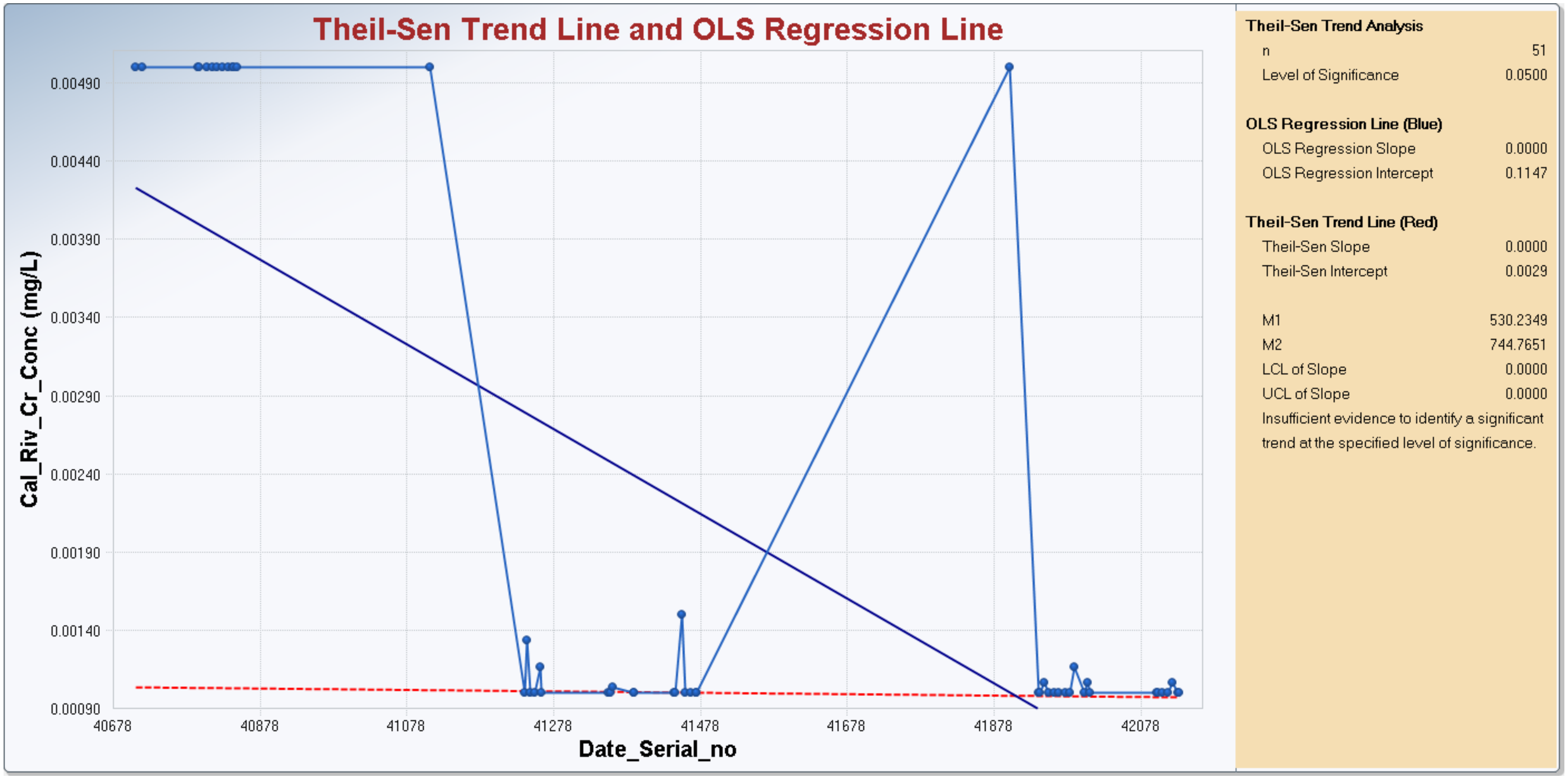


Cr – Background

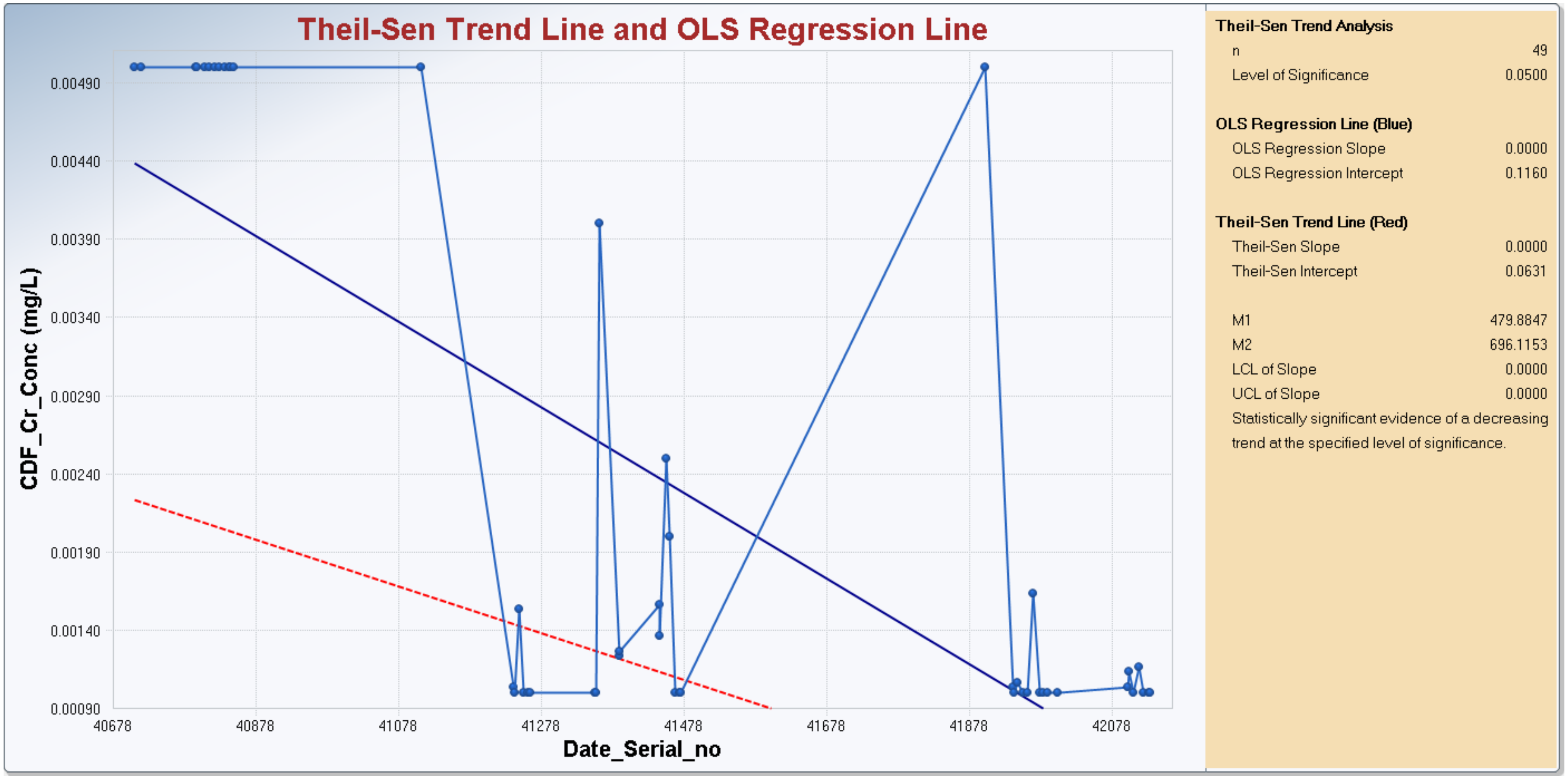


Theil-Sen Trend Line and OLS Regression Line
ND_Cr_Conc (mg/L)
0.00490
0.00440
0.00390
0.00340
0.00290
0.00240
0.00190
0.00140
0.00090
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 51
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.1127
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0029
M1 531.5803
M2 743.4197
LCL of Slope 0.0000
UCL of Slope 0.0000
Insufficient evidence to identify a significant
trend at the specified level of significance.

Cr – Near Dike

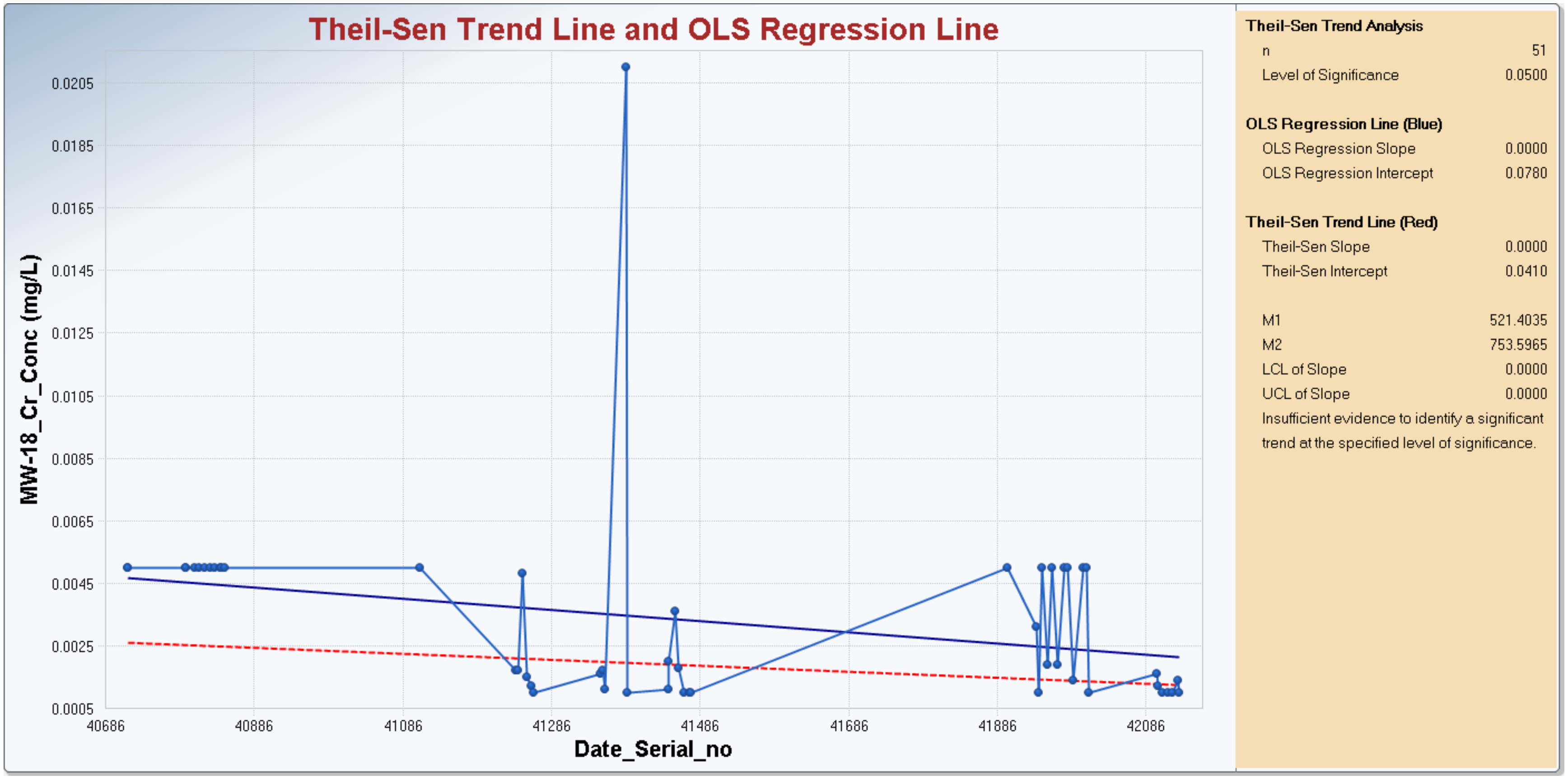


Cr – Calumet River

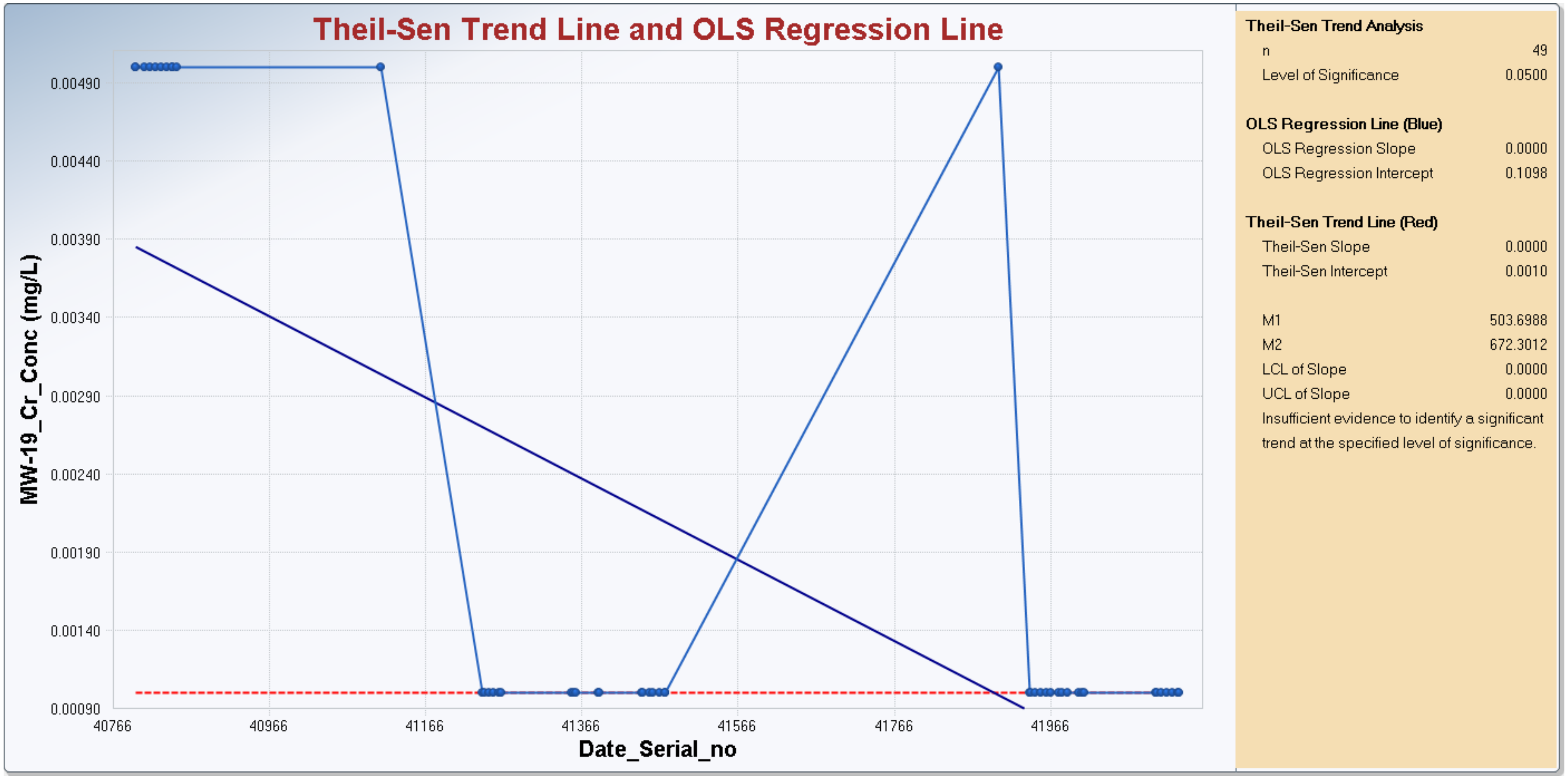


Theil-Sen Trend Line and OLS Regression Line
CDF_Cr_Conc (mg/L)
0.00490
0.00440
0.00390
0.00340
0.00290
0.00240
0.00190
0.00140
0.00090
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 49
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.1160
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0631
M1 479.8847
M2 696.1153
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

Cr – CDF



Cr – Monitoring Well 18



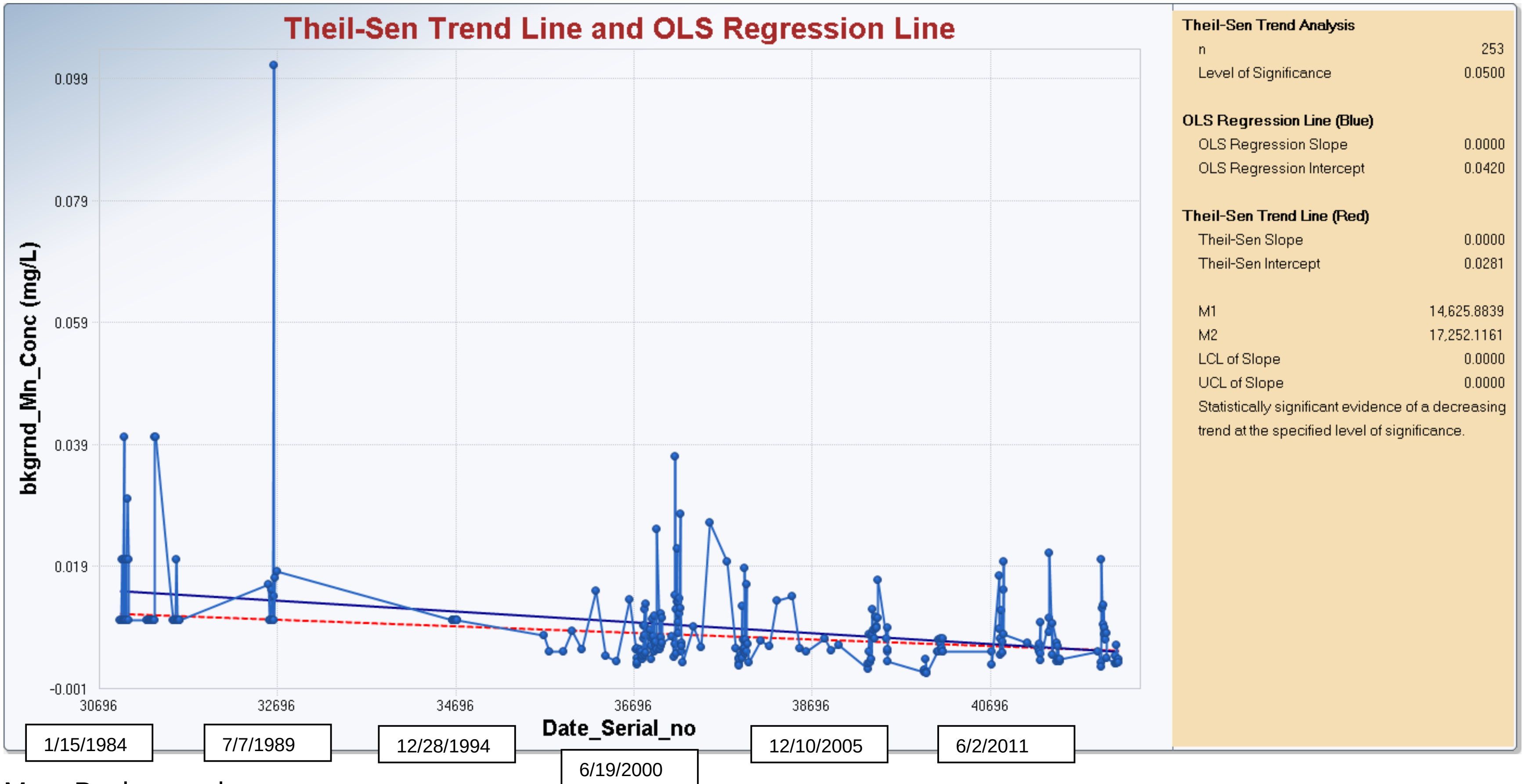
Cr – Monitoring Well 19

Appendix I: Manganese (Mn) Graphs

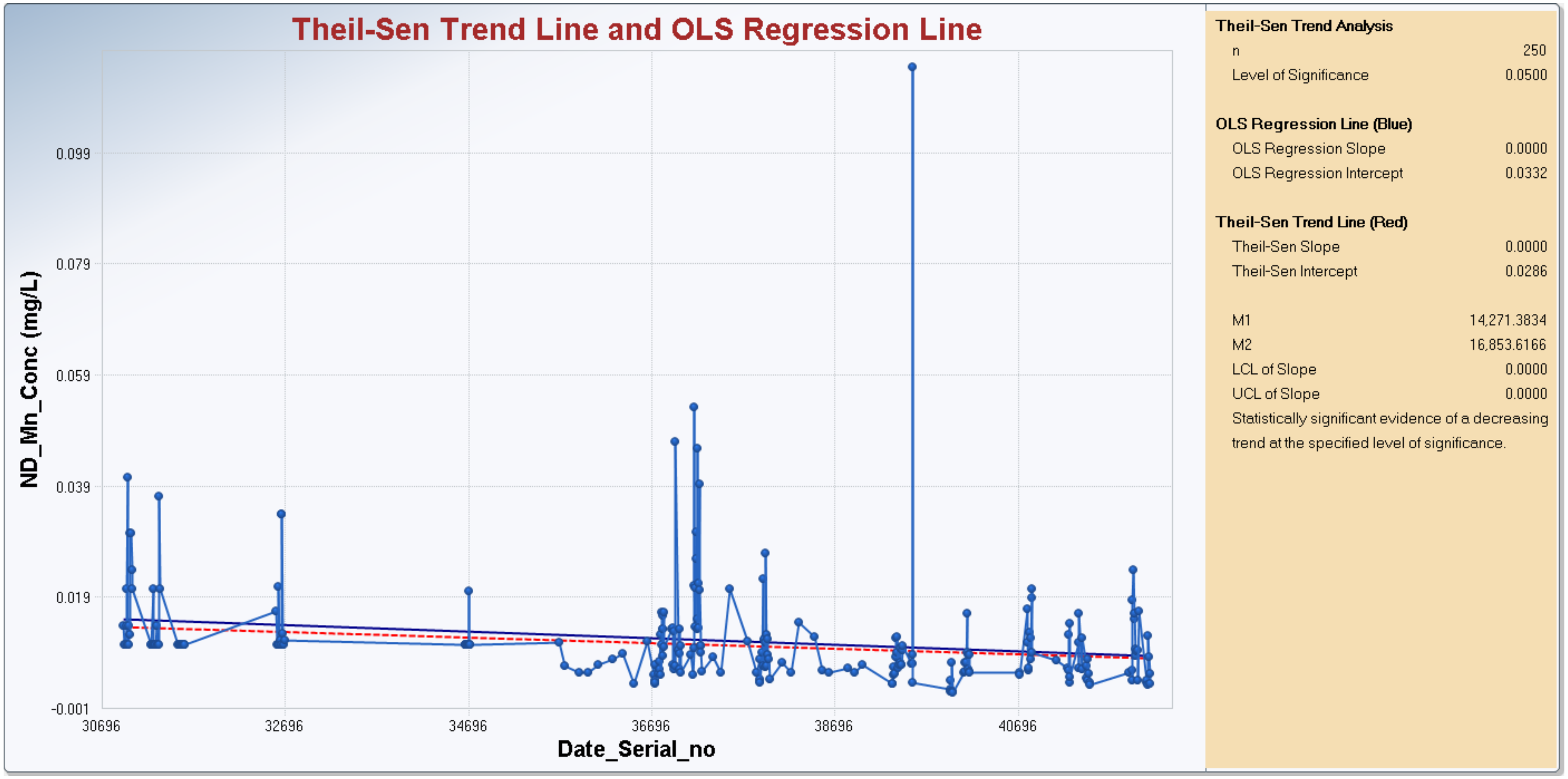
Historical Data

General Statistics - Manganese							
Historical	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	644	751	634	610	234	237	160
Number of Values Reported (n)	644	751	634	610	234	237	160
Number of Values After Averaging	253	250	251	239	233	236	159
Number of Replicates	391	501	383	371	1	1	1
Minimum	0.0014	0.0013	0.0017	0.0023	0.0050	0.0002	0.0020
Maximum	0.1010	0.1140	0.3600	2.1000	3.4000	2.4200	1.6000
Mean	0.00932	0.0109	0.0169	0.106	0.188	0.0874	0.103
Geometric Mean	0.0075	0.00868	0.0129	0.0682	0.0858	0.00953	0.0327
Median	0.0077	0.01	0.0114	0.0717	0.08	0.00892	0.0221
Standard Deviation	0.0085	0.0101	0.0247	0.153	0.342	0.328	0.224
Evidence of Trend Identified?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Direction of Trend (If Identified)	Decreasing	Decreasing	Decreasing	Increasing	Decreasing	Decreasing	Increasing

NA = Not Applicable

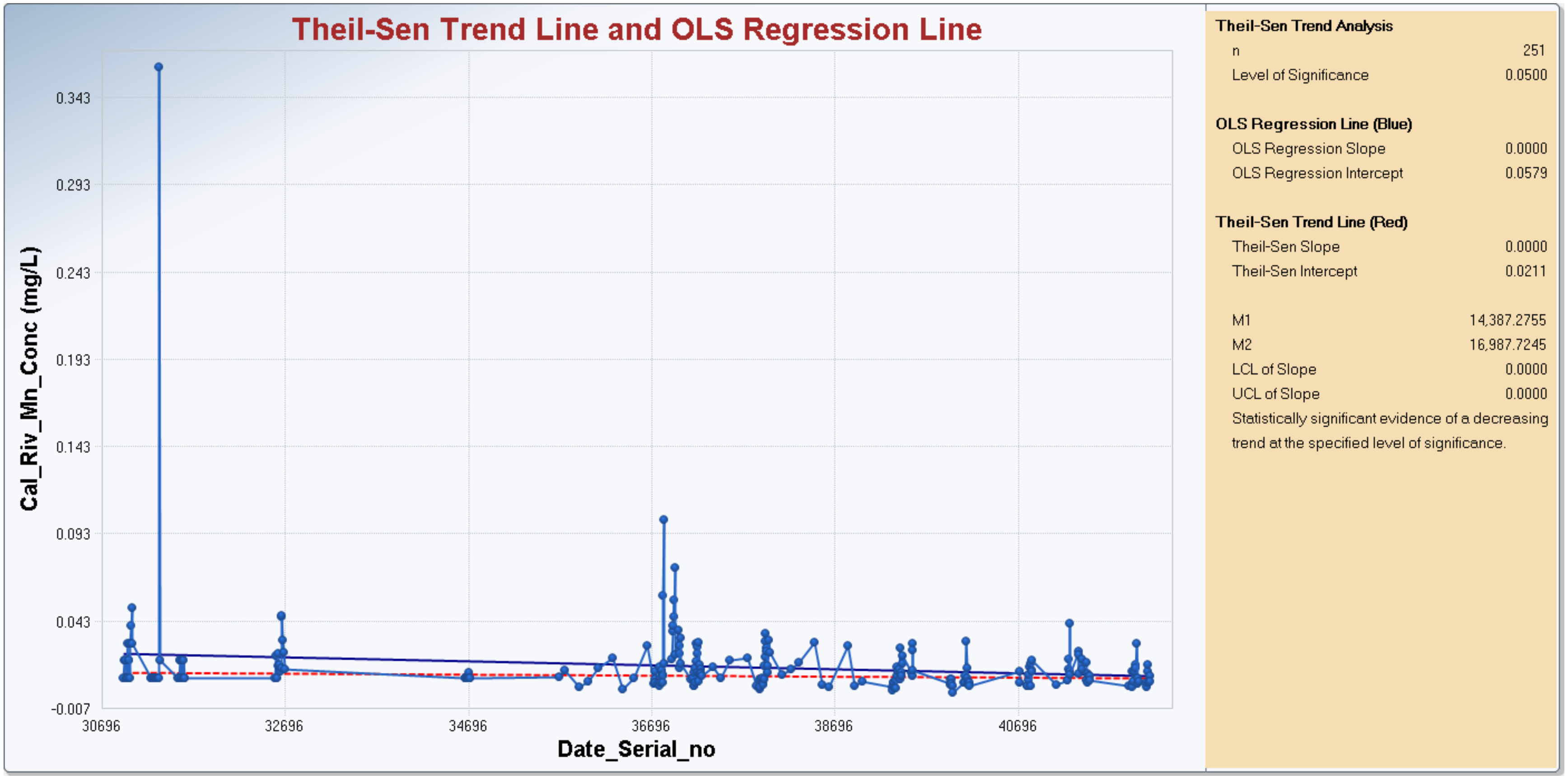


Mn – Background

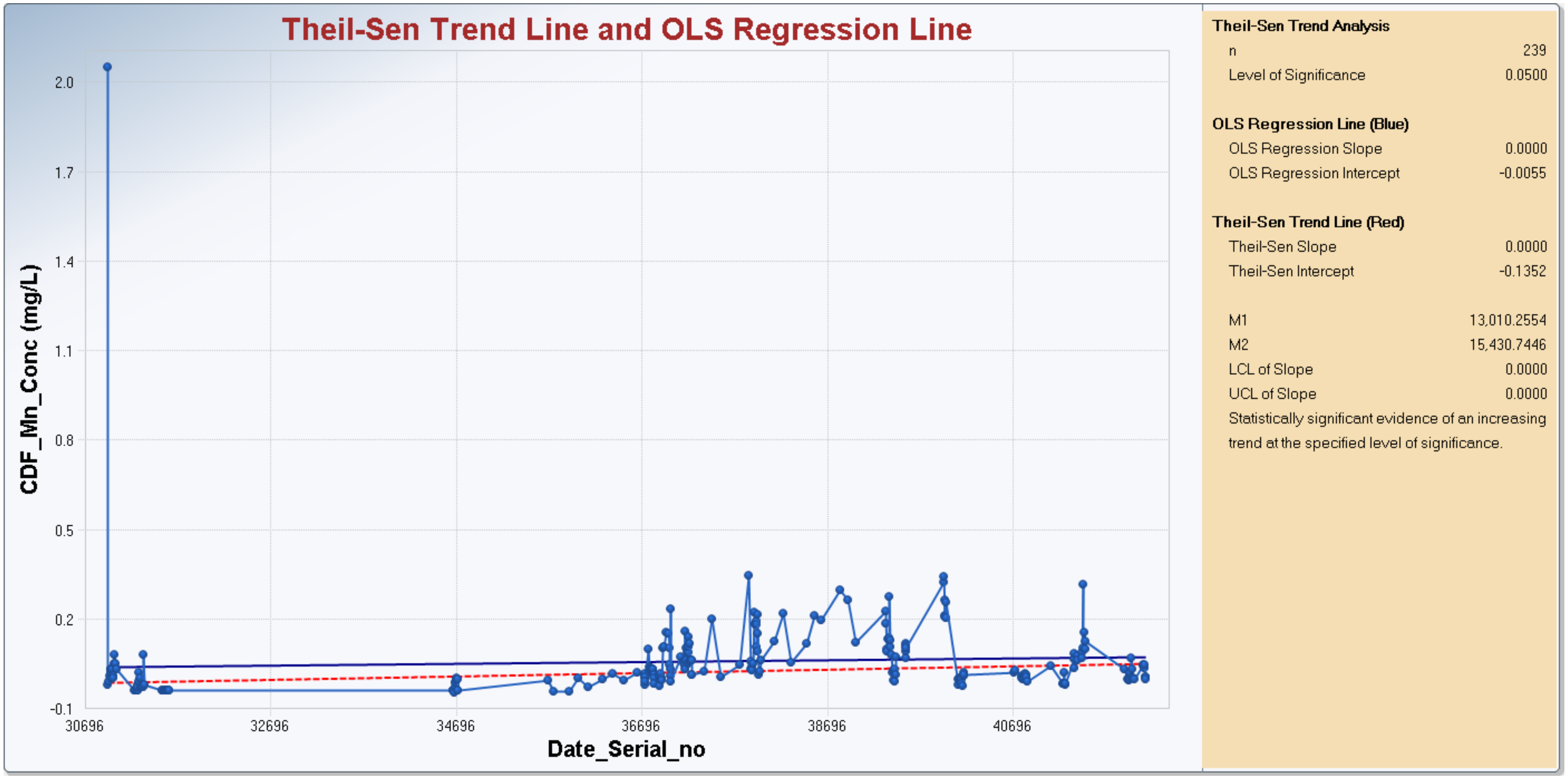


Theil-Sen Trend Line and OLS Regression Line
0.099
0.079
0.059
0.039
0.019
-0.001
ND_Mn_Conc (mg/L)
30696
32696
34696
36696
38696
40696
Date_Serial_no
Theil-Sen Trend Analysis
n 250
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.0332
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0286
M1 14,271.3834
M2 16,853.6166
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

Mn – Near Dike

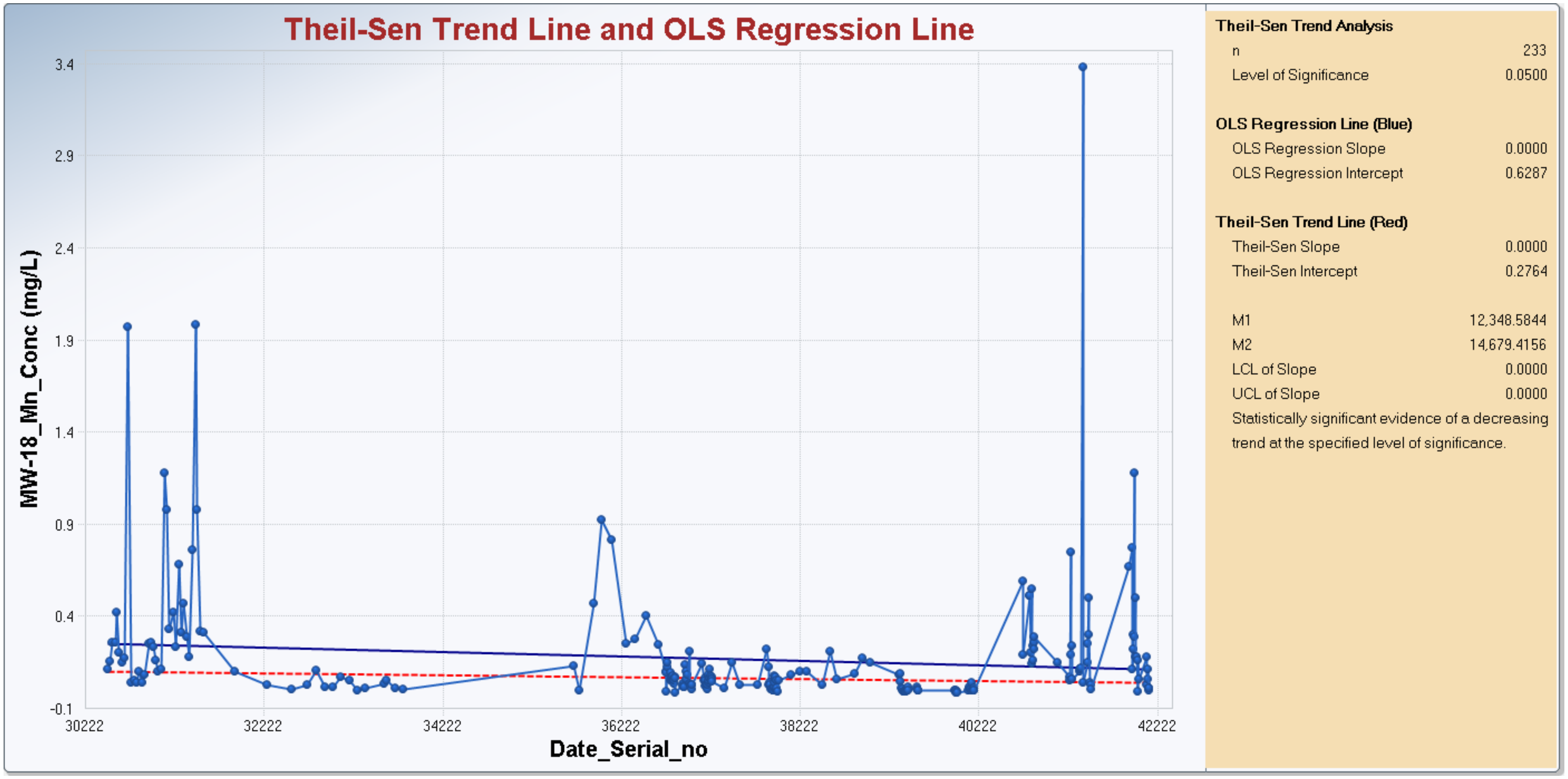


Mn – Calumet River

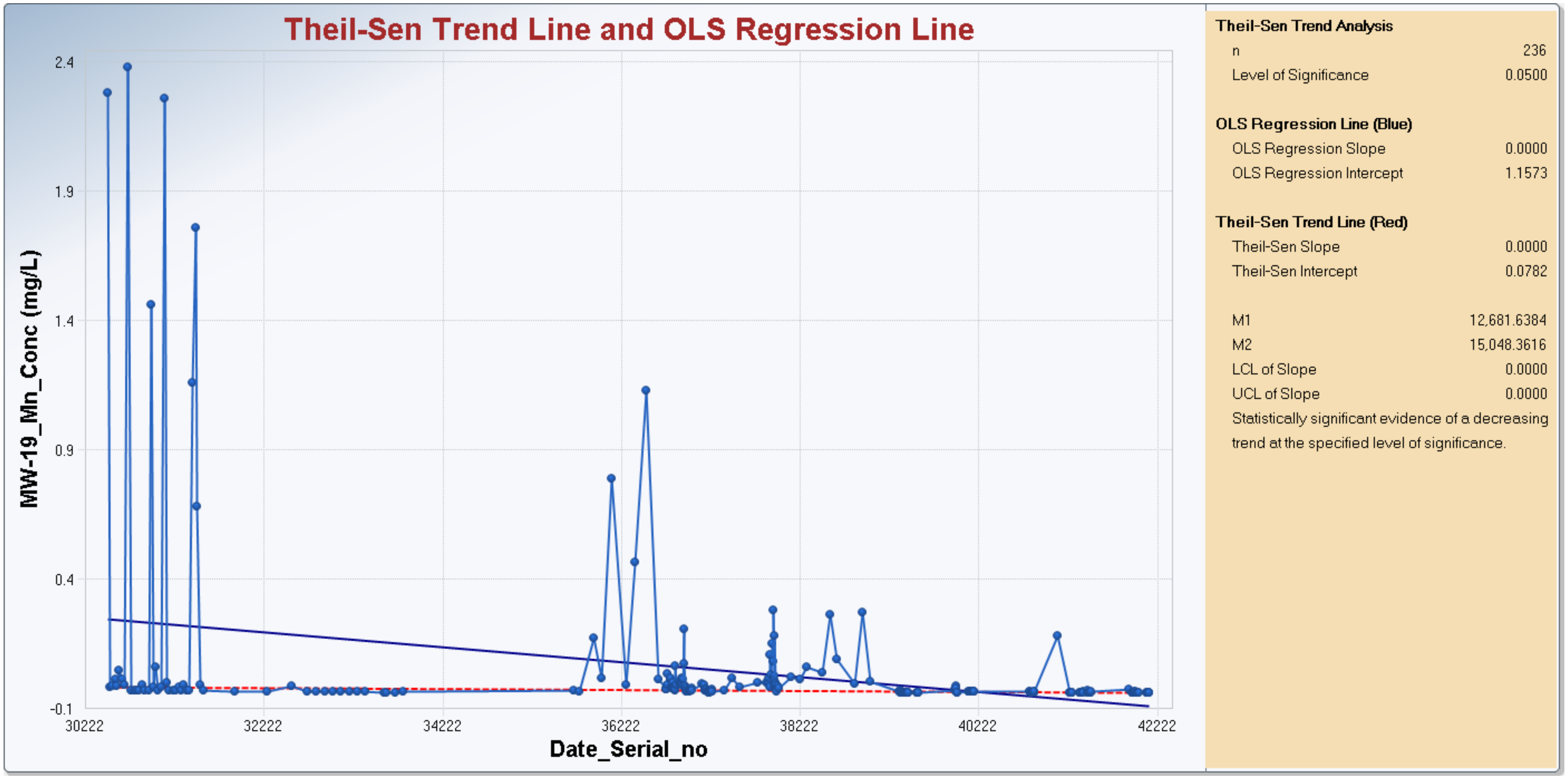


Theil-Sen Trend Line and OLS Regression Line
CDF_Mn_Conc (mg/L)
Date_Serial_no
2.0
1.7
1.4
1.1
0.8
0.5
0.2
-0.1
30696
32696
34696
36696
38696
40696
Theil-Sen Trend Analysis
n 239
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept -0.0055
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept -0.1352
M1 13,010.2554
M2 15,430.7446
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of an increasing trend at the specified level of significance.

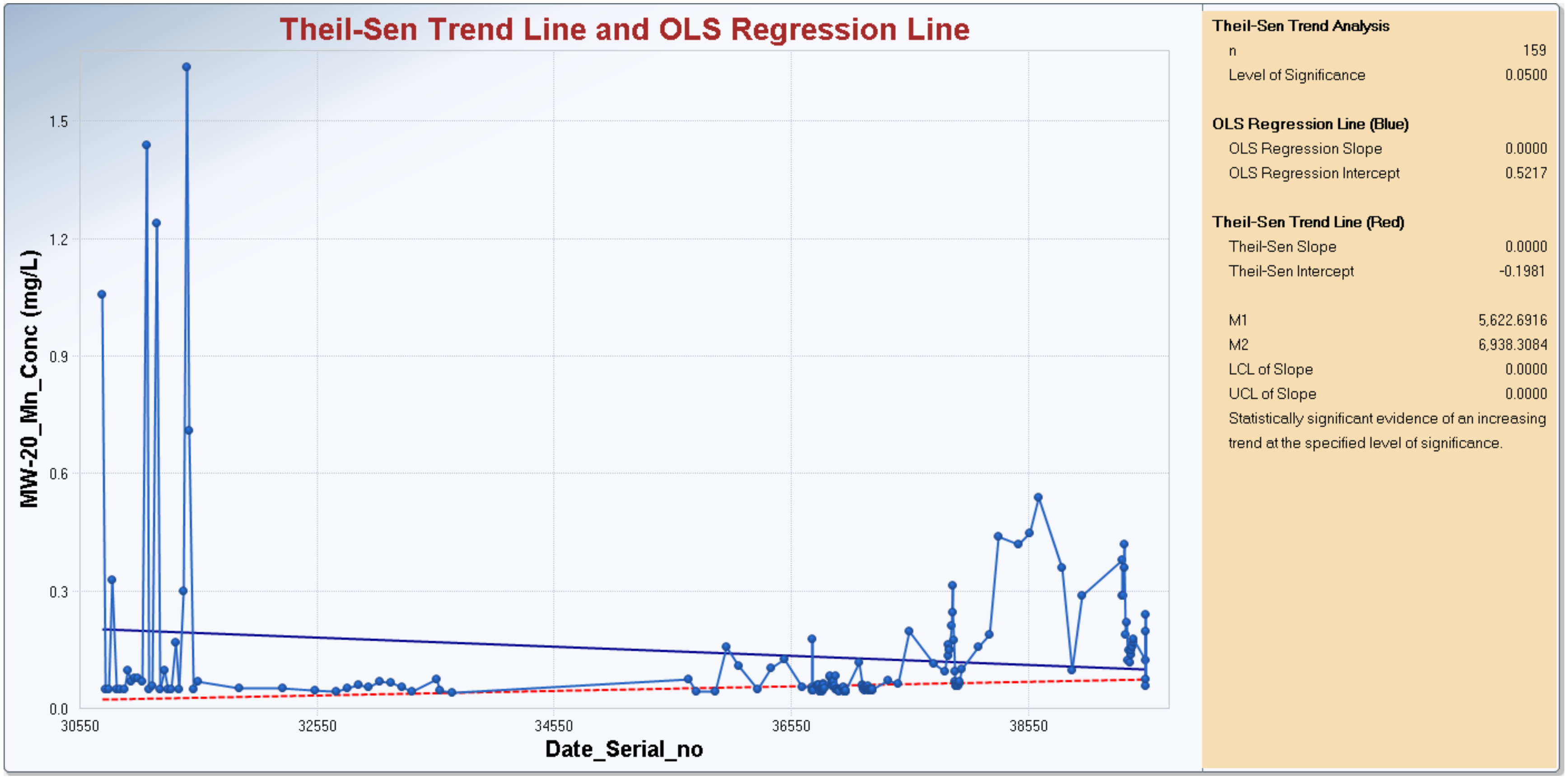
Mn – CDF



Mn – Monitoring Well 18



Mn – Monitoring Well 19



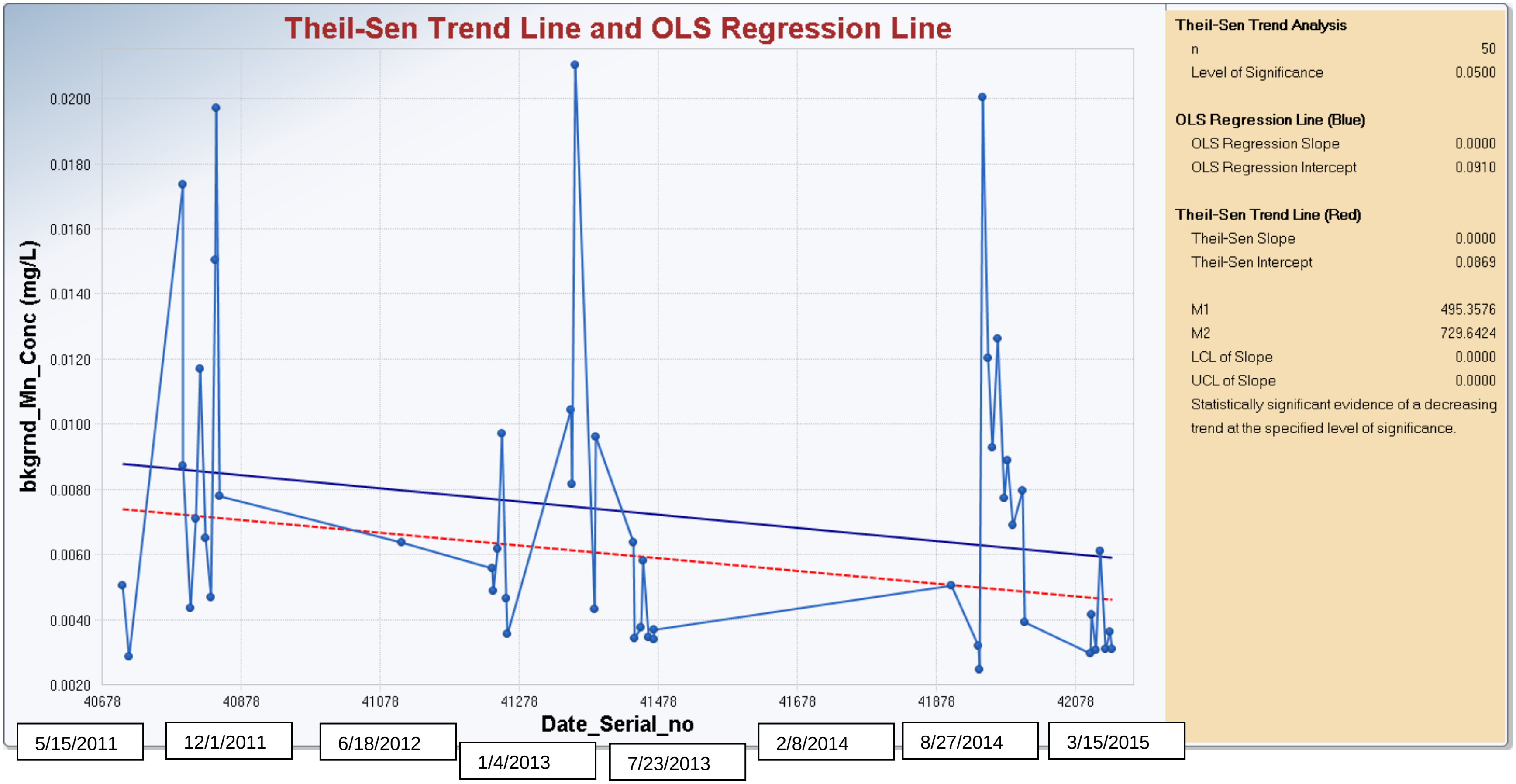
Mn – Monitoring Well 20

Mn Graphs

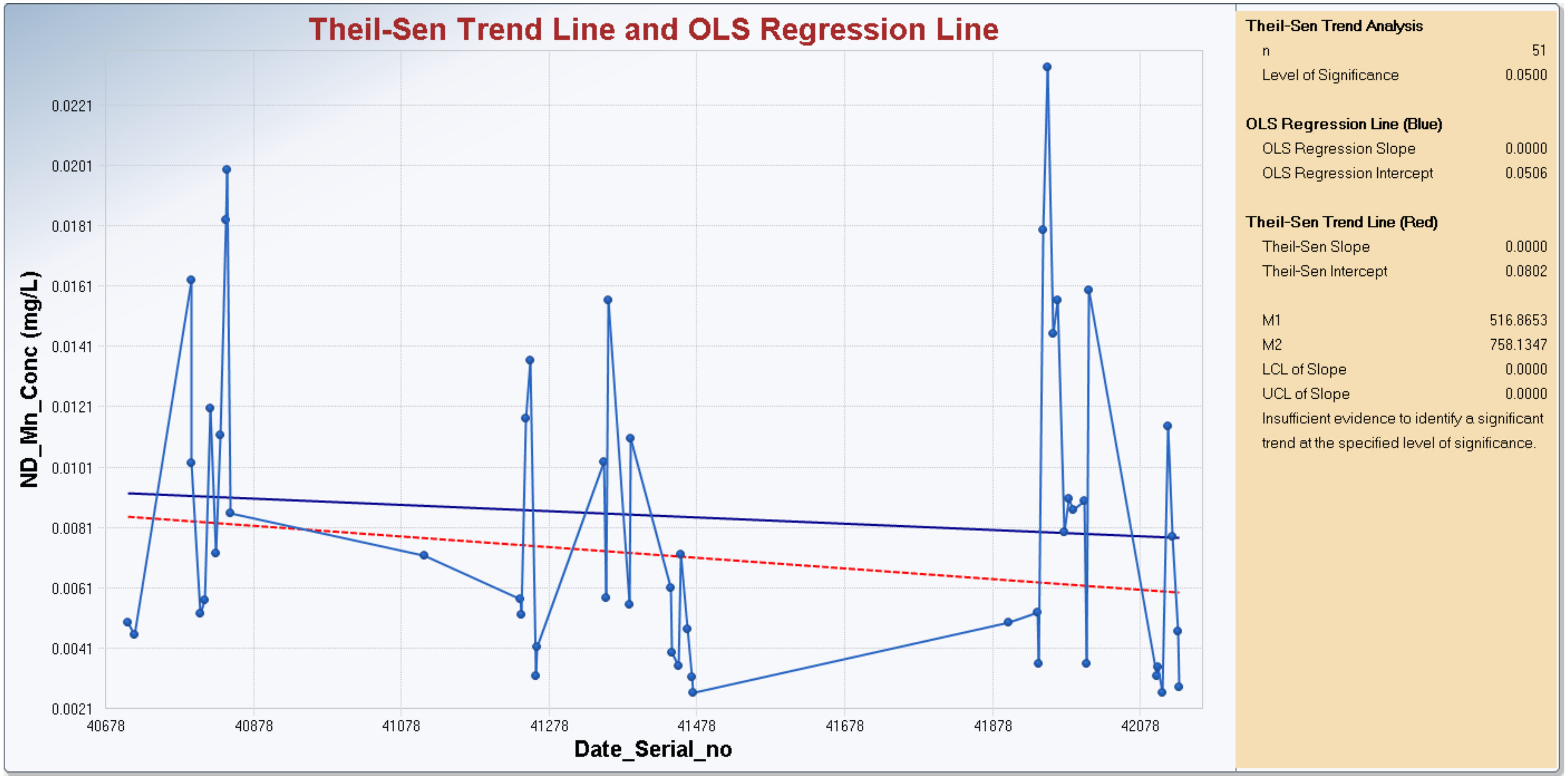
Current Data

General Statistics - Manganese						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	150	151	153	147	51	49
Number of Values Reported (n)	150	151	153	147	51	49
Number of Values After Averaging	50	51	51	49	51	49
Number of Replicates	100	100	102	98	0	0
Minimum	0.0024	0.0027	0.0049	0.0273	0.0110	0.0002
Maximum	0.0210	0.0234	0.0410	0.3630	3.4000	0.2200
Mean	0.0072	0.00848	0.013	0.0828	0.322	0.00629
Geometric Mean	0.00607	0.00712	0.0115	0.0703	0.177	0.00138
Median	0.00592	0.0072	0.012	0.0667	0.2	0.001
Standard Deviation	0.00468	0.00517	0.00697	0.0574	0.501	0.0312
Evidence of Trend Identified?	Yes	No	No	No	Yes	No
Direction of Trend (If Identified)	Decreasing	NA	NA	NA	Decreasing	NA

NA = Not Applicable

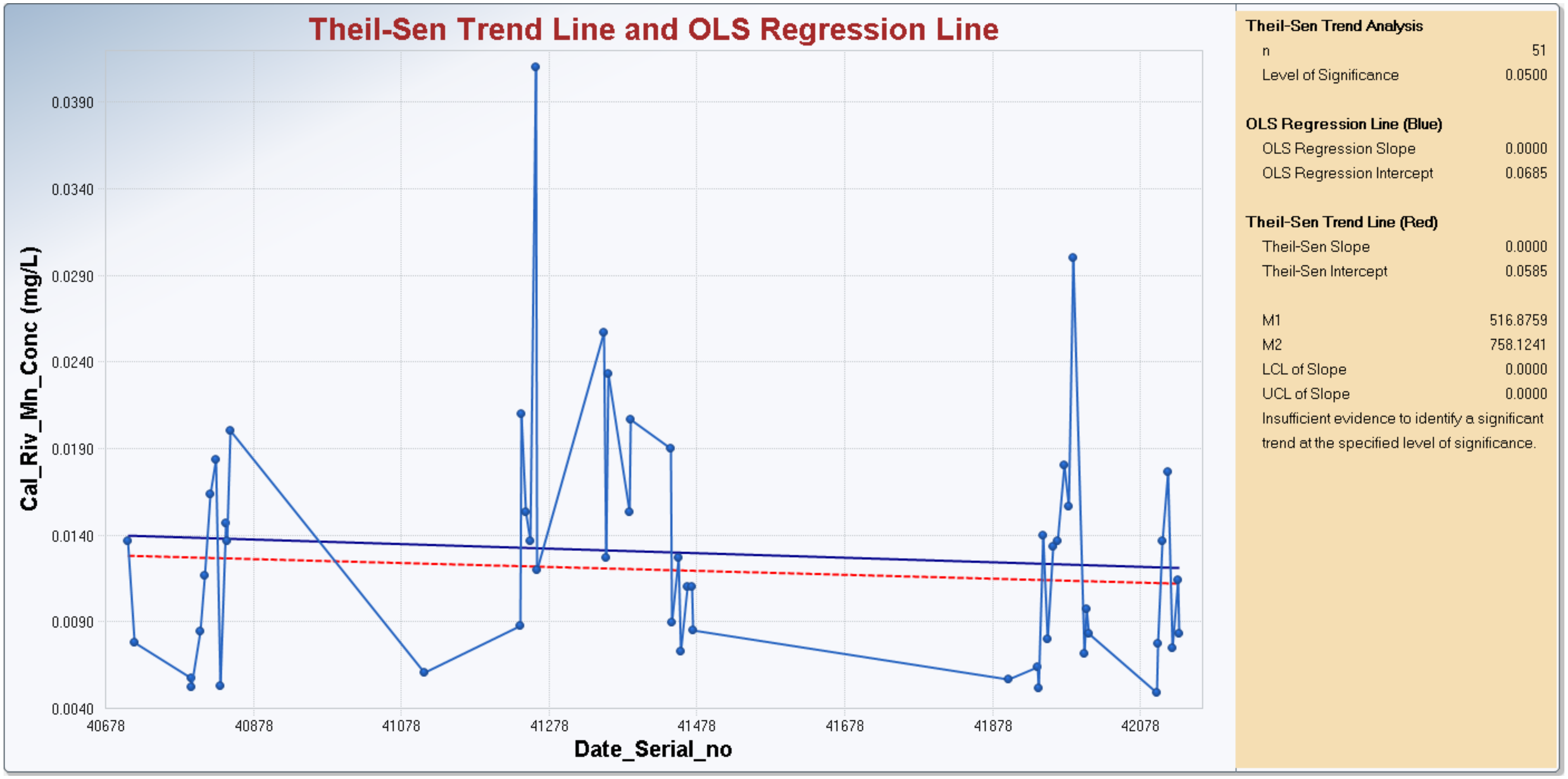


Mn – Background

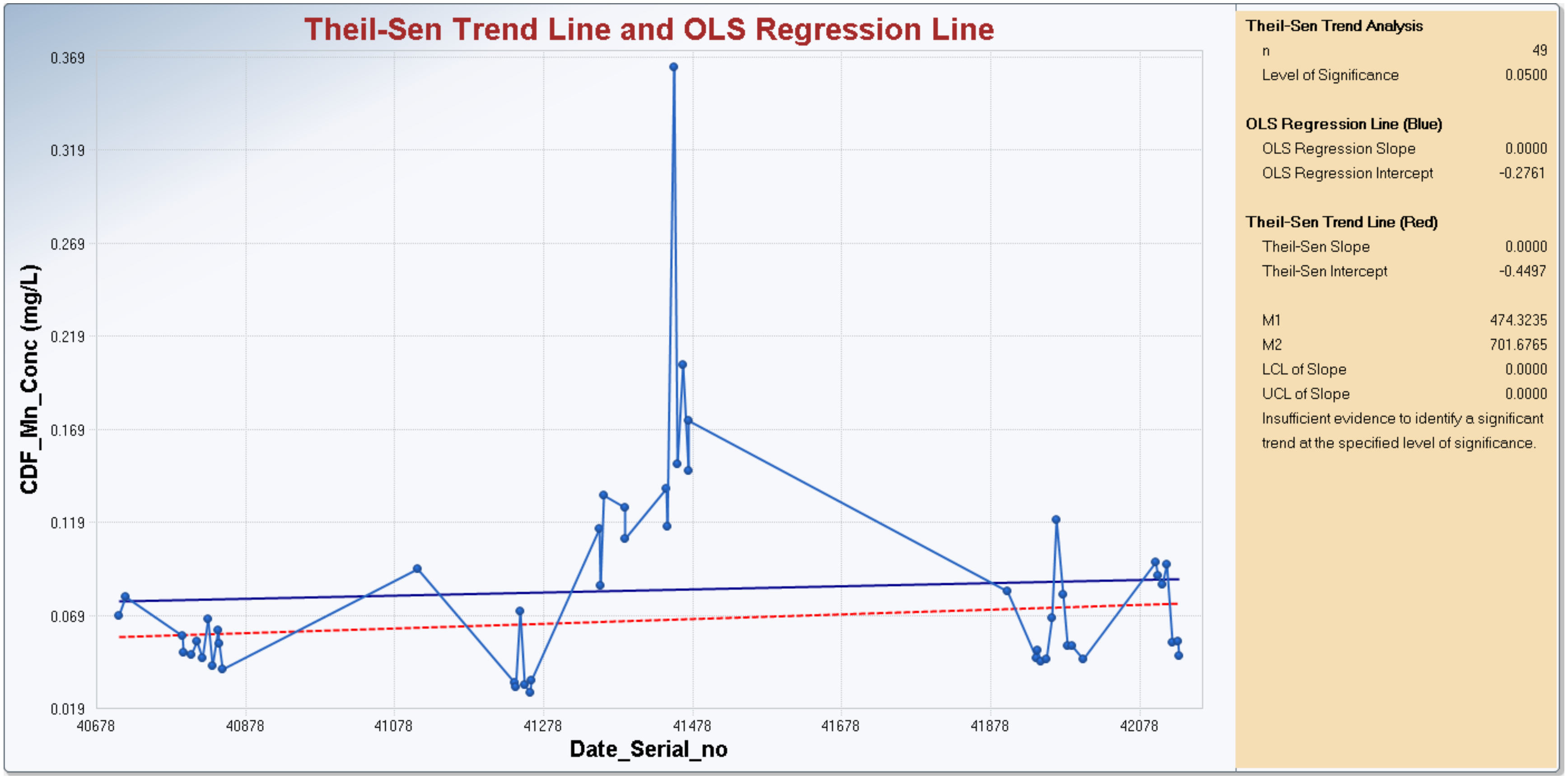


Theil-Sen Trend Line and OLS Regression Line
ND_Mn_Conc (mg/L)
0.0221
0.0201
0.0181
0.0161
0.0141
0.0121
0.0101
0.0081
0.0061
0.0041
0.0021
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 51
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.0506
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0802
M1 516.8653
M2 758.1347
LCL of Slope 0.0000
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.

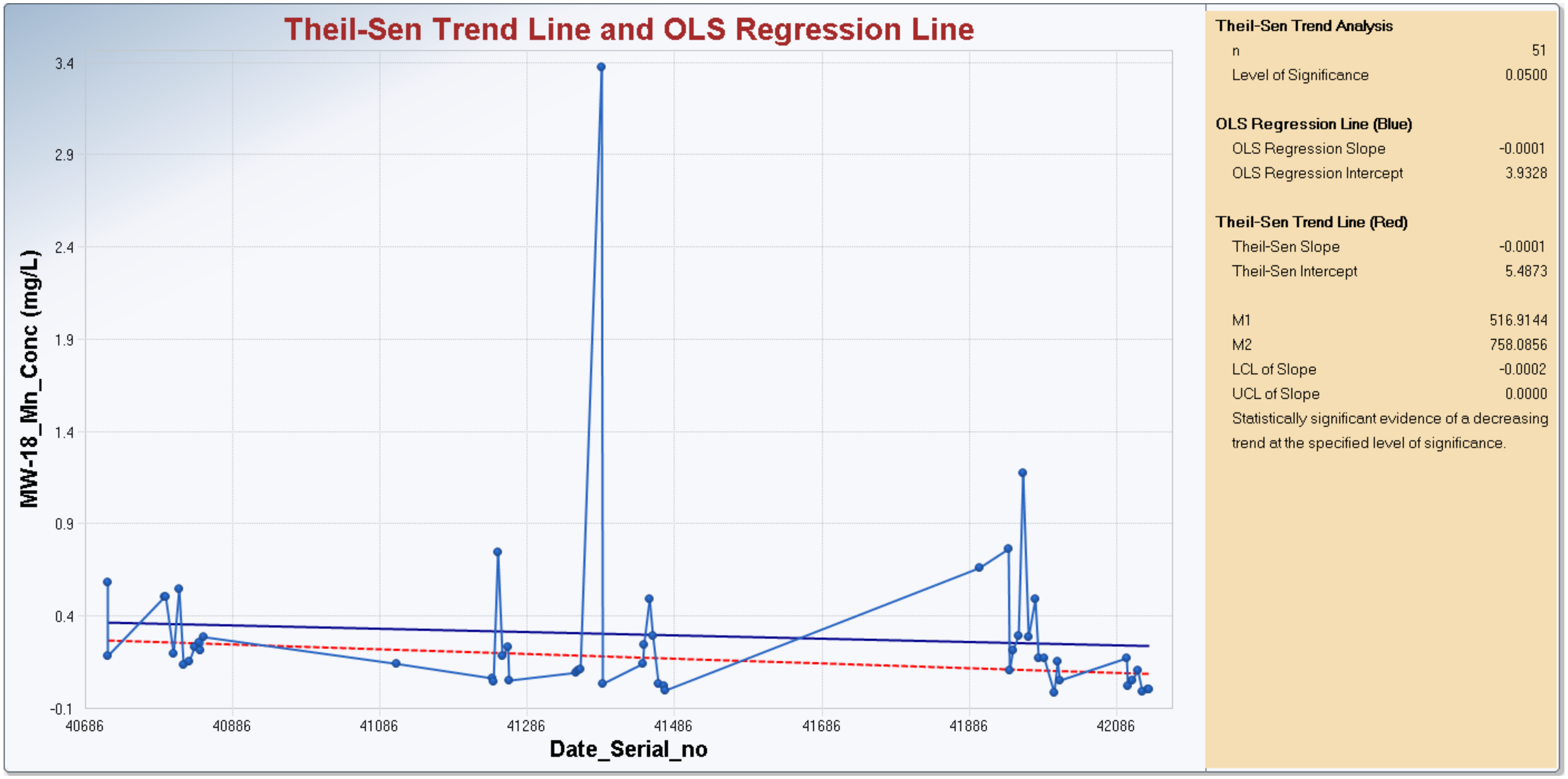
Mn – Near Dike



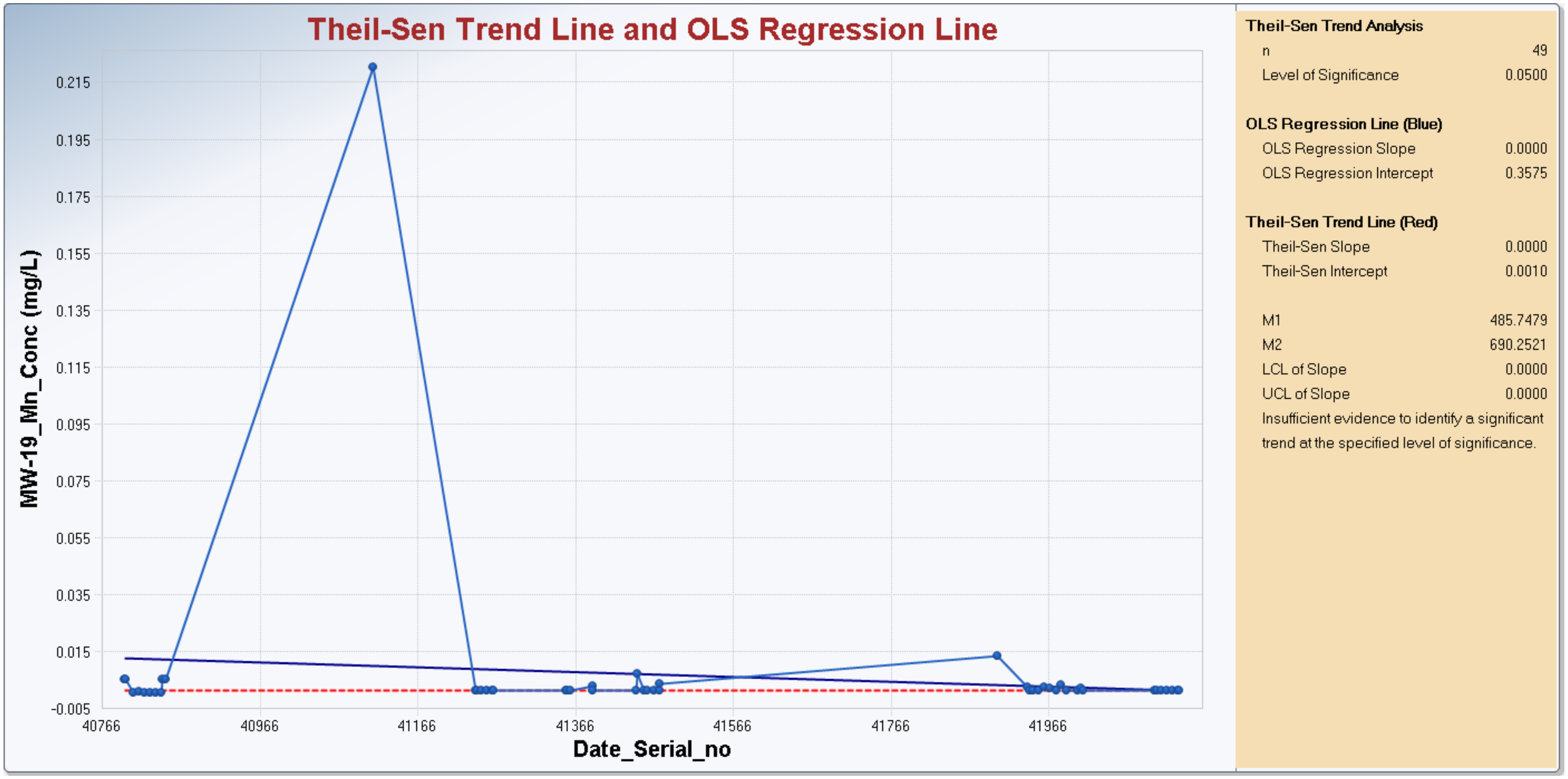
Mn – Calumet River


Theil-Sen Trend Line and OLS Regression Line
0.369
0.319
0.269
0.219
0.169
0.119
0.069
0.019
CDF_Mn_Conc (mg/L)
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 49
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept -0.2761
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept -0.4497
M1 474.3235
M2 701.6765
LCL of Slope 0.0000
UCL of Slope 0.0000
Insufficient evidence to identify a significant
trend at the specified level of significance.

Mn – CDF



Mn – Monitoring Well 18



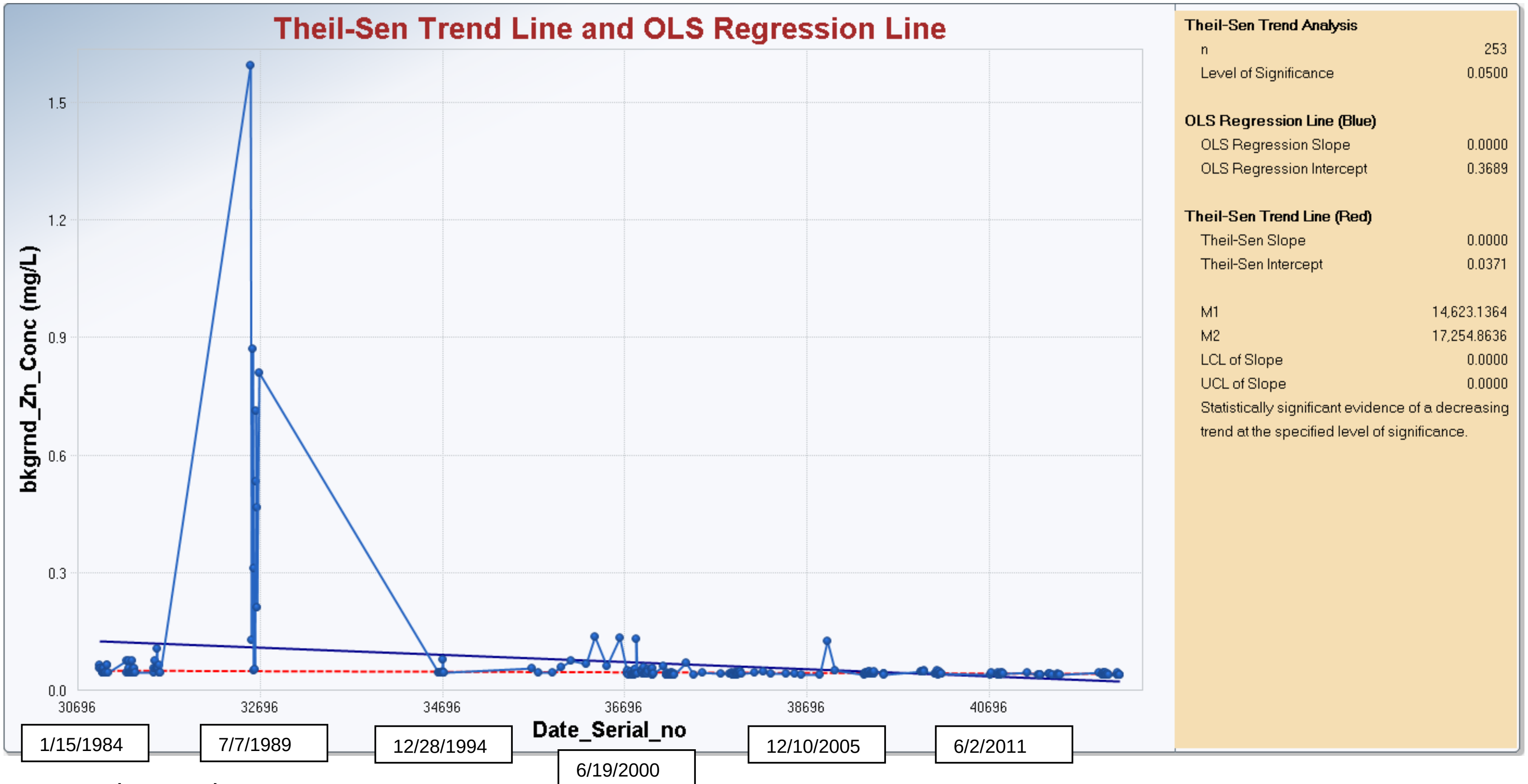
Mn – Monitoring Well 19

Appendix J: Zinc (Zn) Graphs

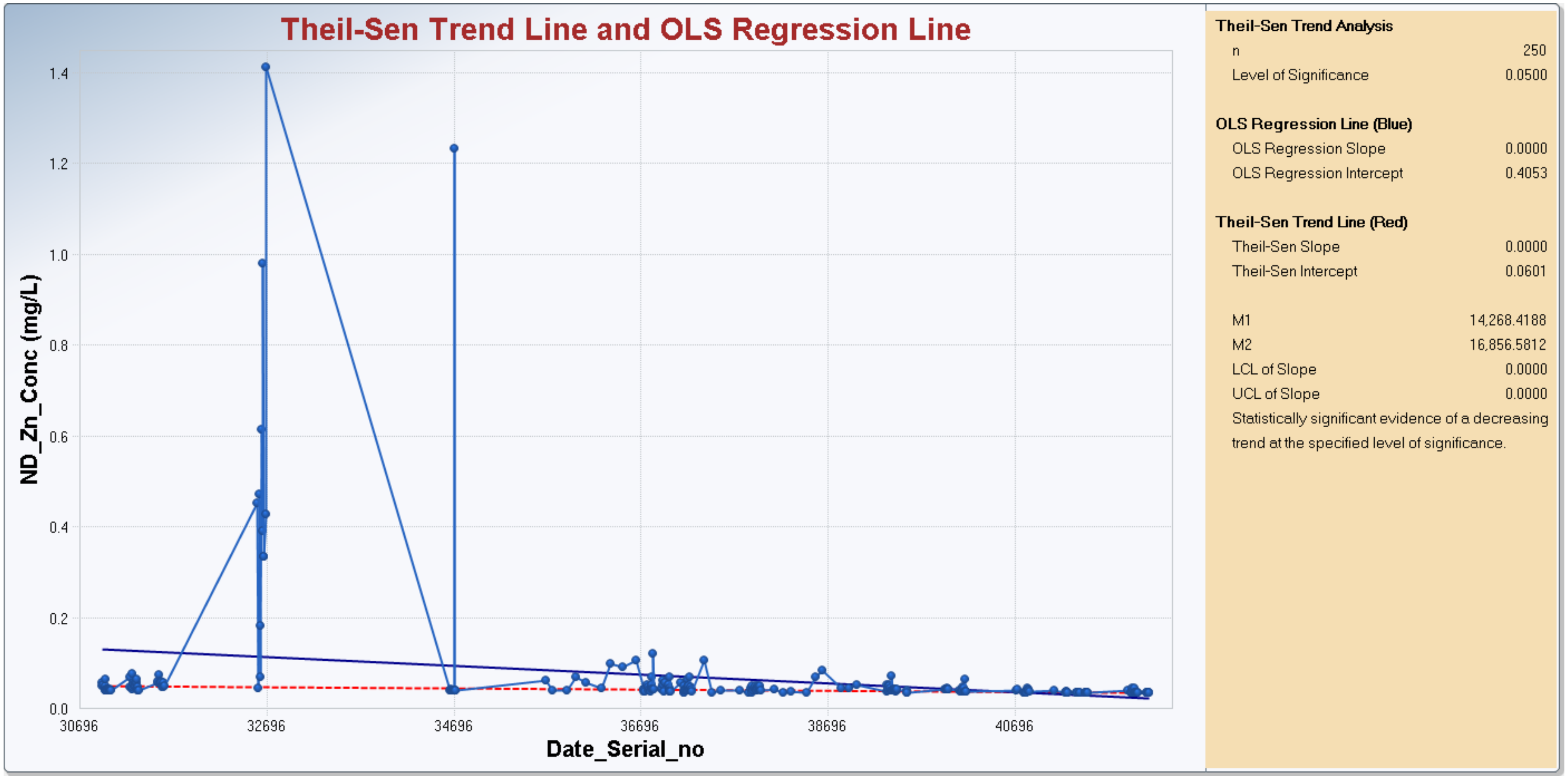
Historical Data

General Statistics - Zinc							
Historical	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19	MW-20
Number of Events	644	751	634	610	213	216	140
Number of Values Reported (n)	644	751	634	610	213	216	140
Number of Values After Averaging	253	250	251	239	212	215	139
Number of Replicates	391	501	383	371	1	1	1
Minimum	0.0045	0.0050	0.0048	0.0050	0.0010	0.0030	0.0010
Maximum	1.5600	1.3820	1.5000	0.2800	0.5580	0.6030	0.2520
Mean	0.033	0.0407	0.0368	0.0297	0.0333	0.0194	0.0229
Geometric Mean	0.011	0.0144	0.0126	0.0224	0.0184	0.0102	0.0152
Median	0.0097	0.0120	0.0100	0.0229	0.0160	0.0085	0.0141
Standard Deviation	0.134	0.144	0.144	0.0269	0.0589	0.0531	0.0315
Evidence of Trend Identified?	Yes	Yes	Yes	Yes	Yes	Yes	No
Direction of Trend (If Identified)	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	NA

NA = Not Applicable

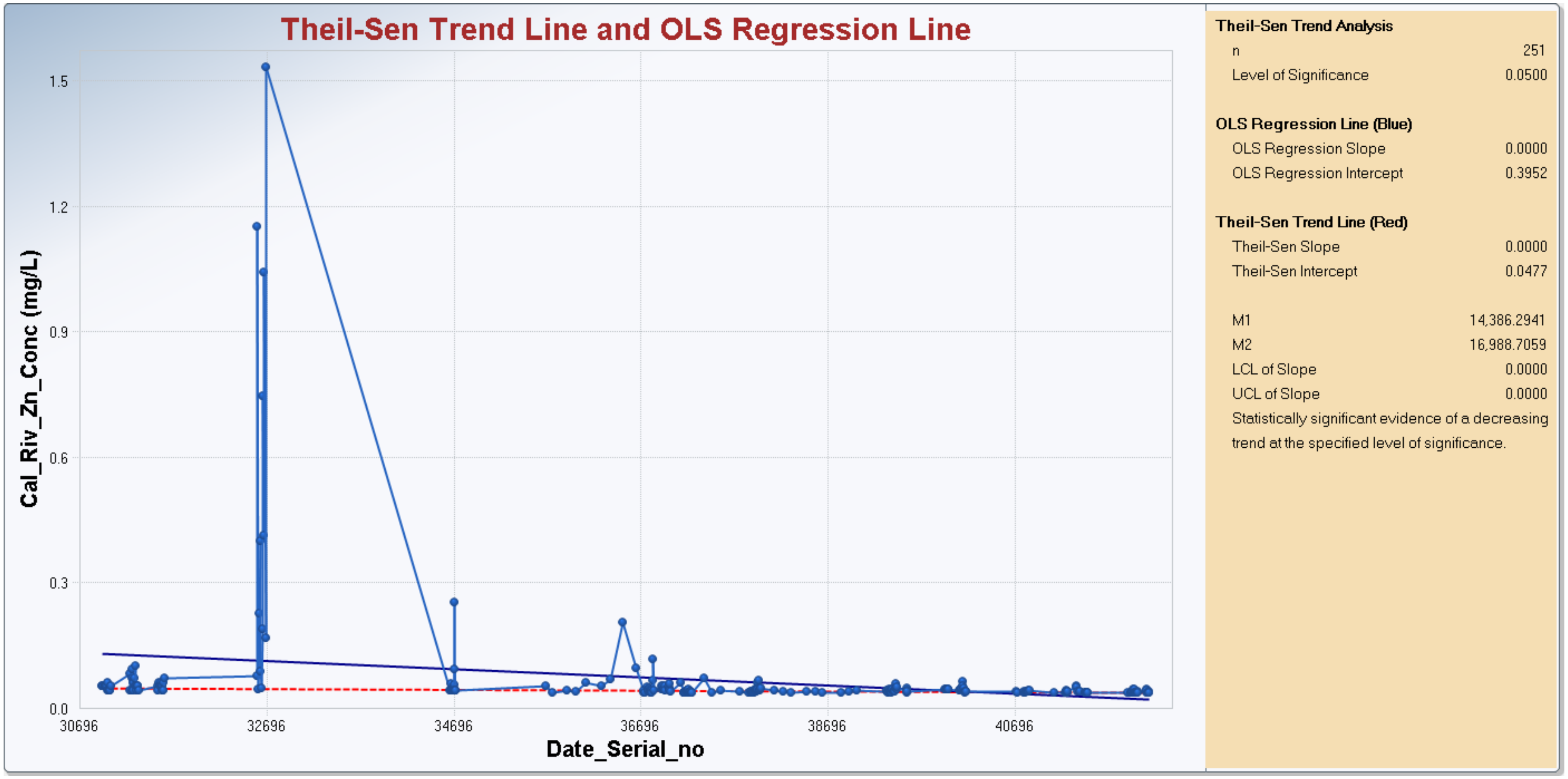


Zn – Background

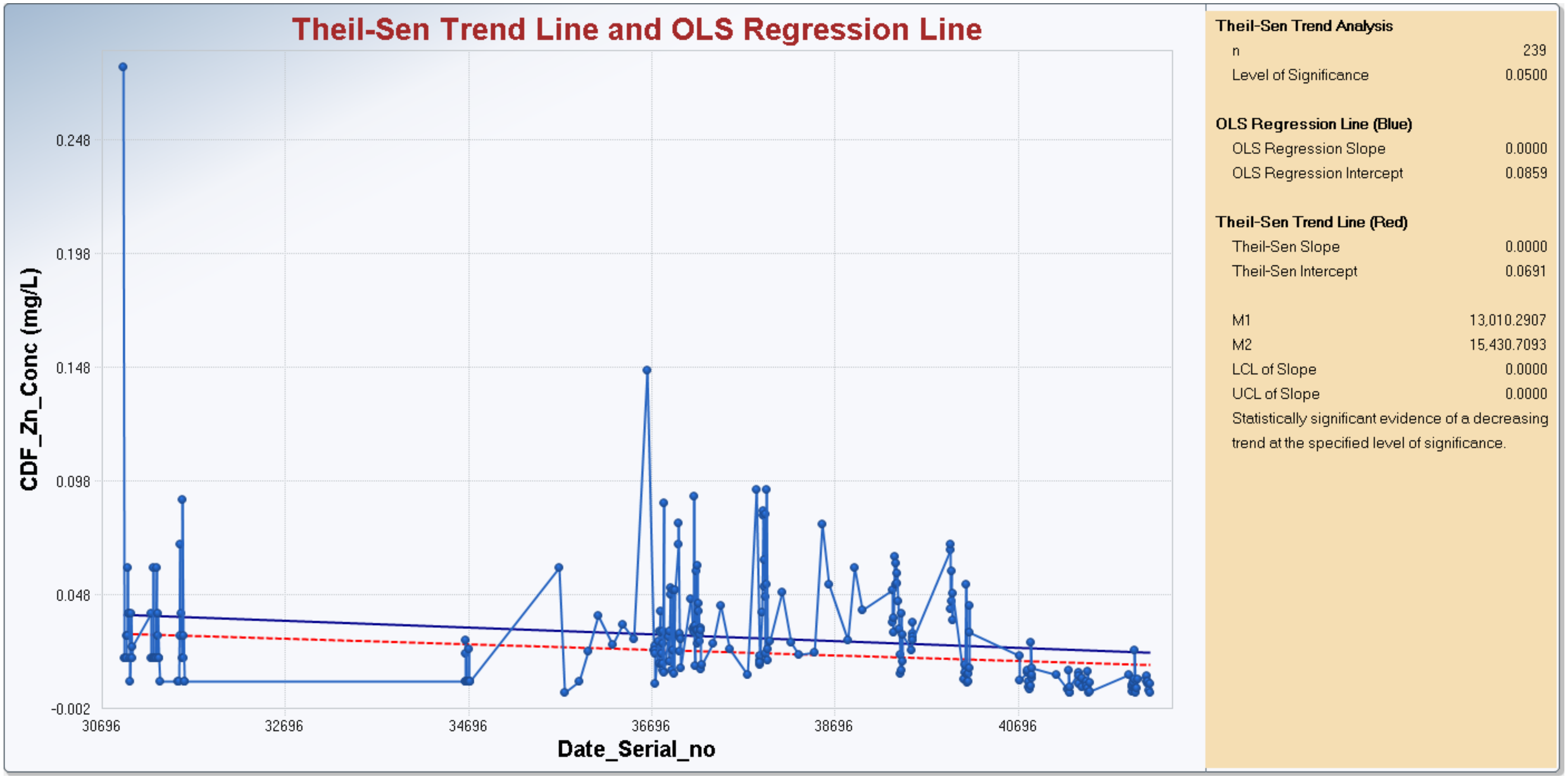


Theil-Sen Trend Line and OLS Regression Line
ND_Zn_Conc (mg/L)
Date_Serial_no
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
30696
32696
34696
36696
38696
40696
Theil-Sen Trend Analysis
n 250
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.4053
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0601
M1 14,268.4188
M2 16,856.5812
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

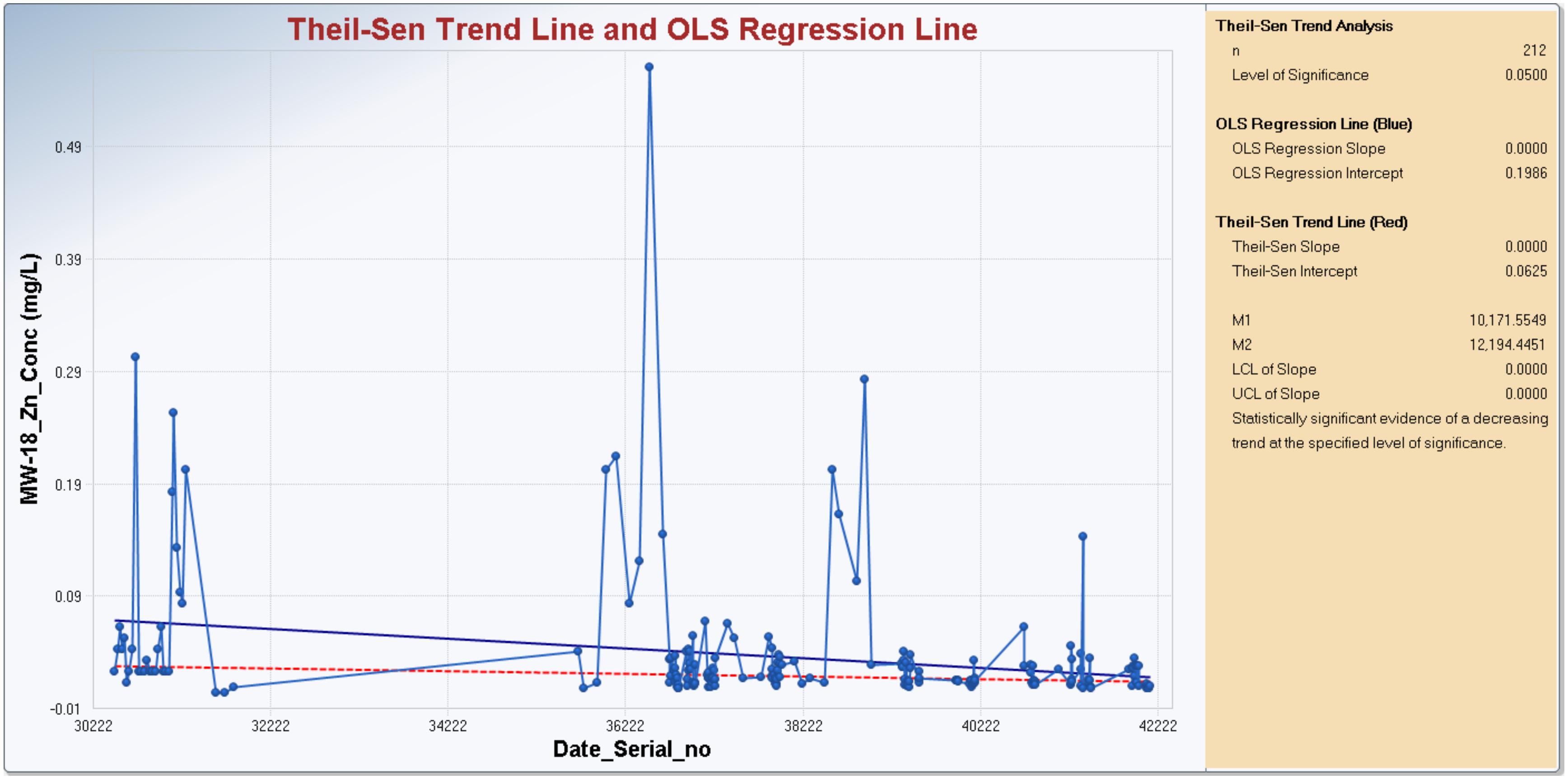
Zn – Near Dike



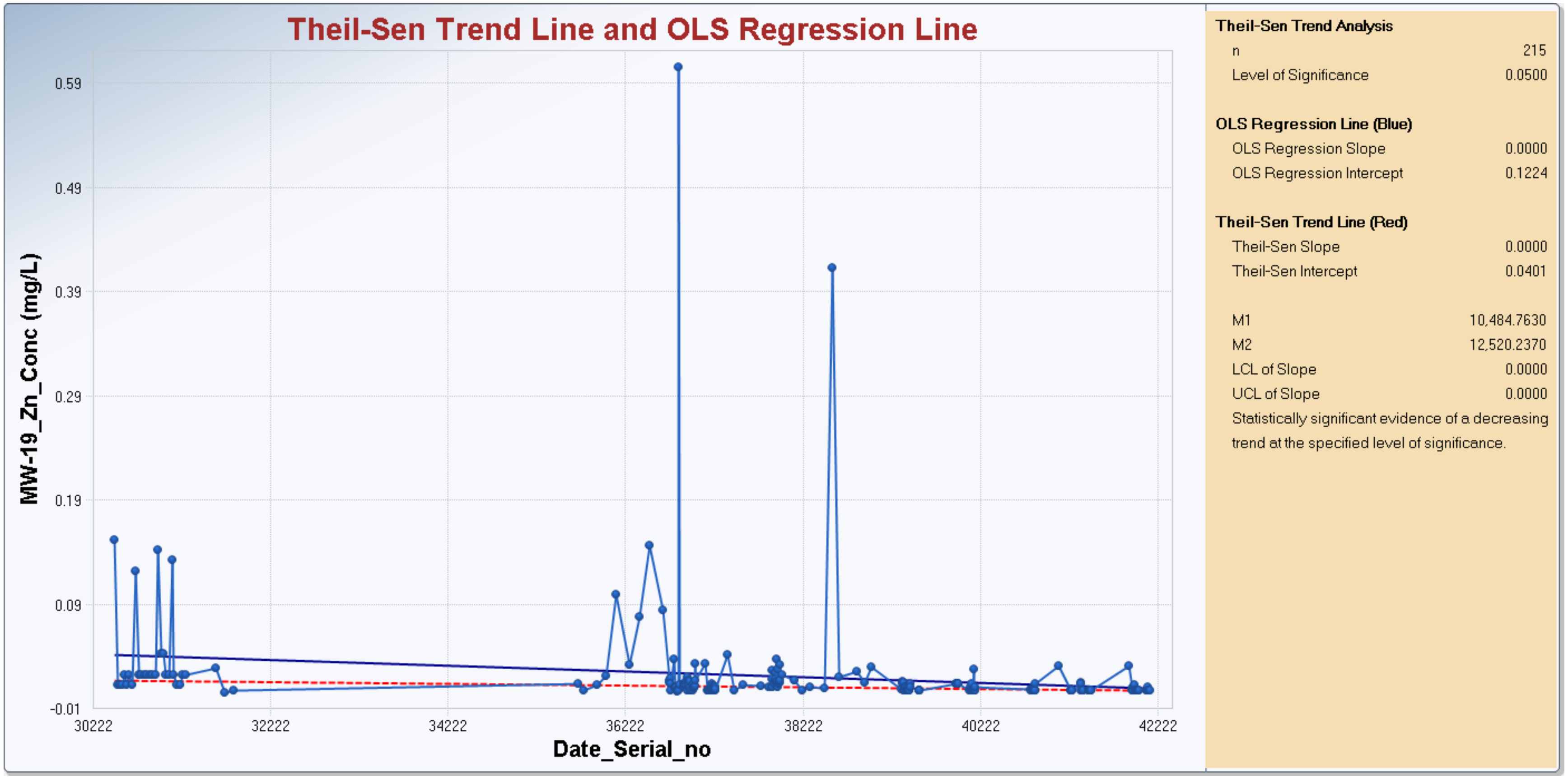
Zn – Calumet River


Theil-Sen Trend Line and OLS Regression Line
CDF_Zn_Conc (mg/L)
0.248
0.198
0.148
0.098
0.048
-0.002
30696
32696
34696
36696
38696
40696
Date_Serial_no
Theil-Sen Trend Analysis
n 239
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.0859
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0691
M1 13,010.2907
M2 15,430.7093
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

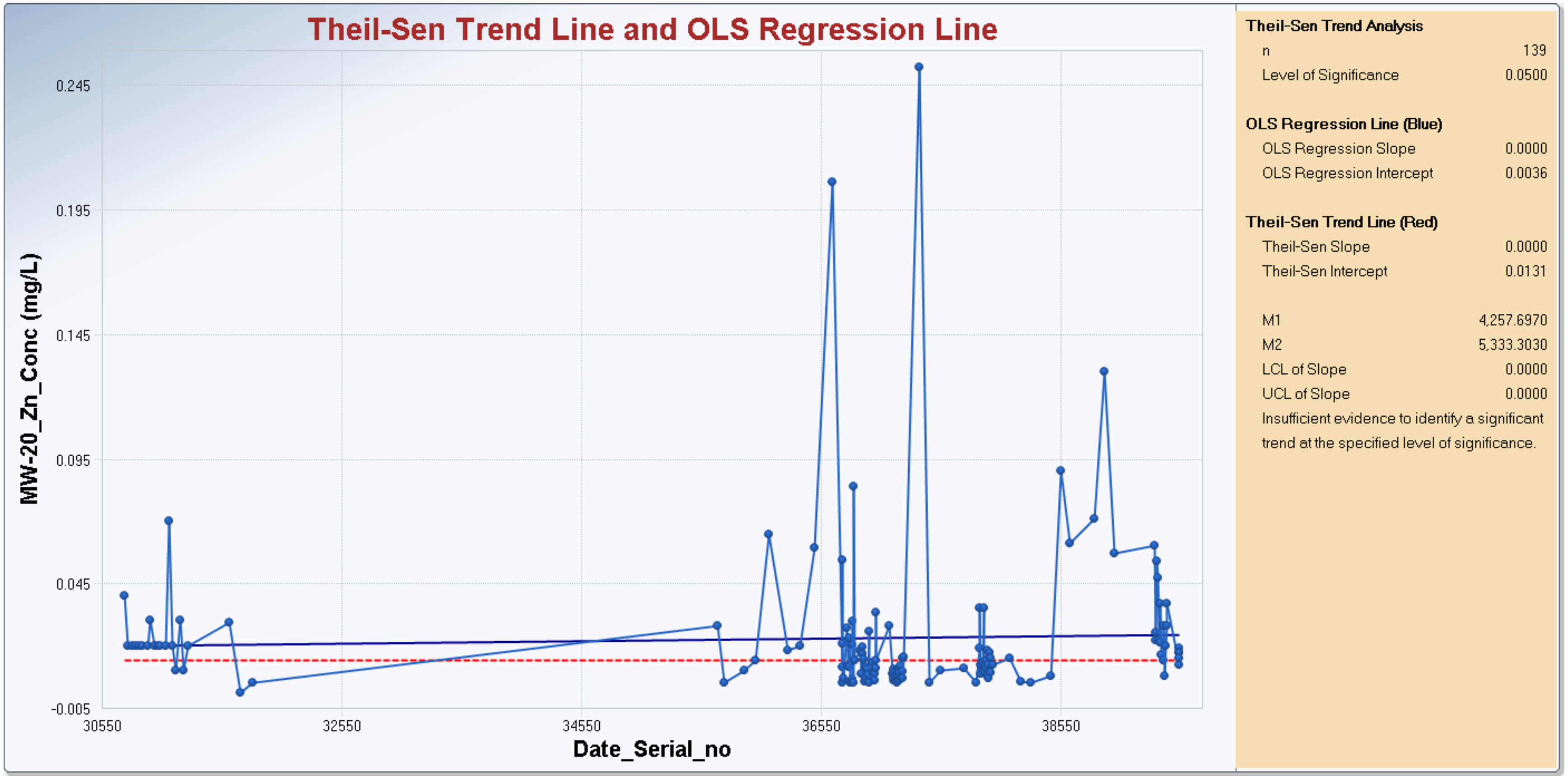
Zn – CDF



Zn – Monitoring Well 18



Zn – Monitoring Well 19



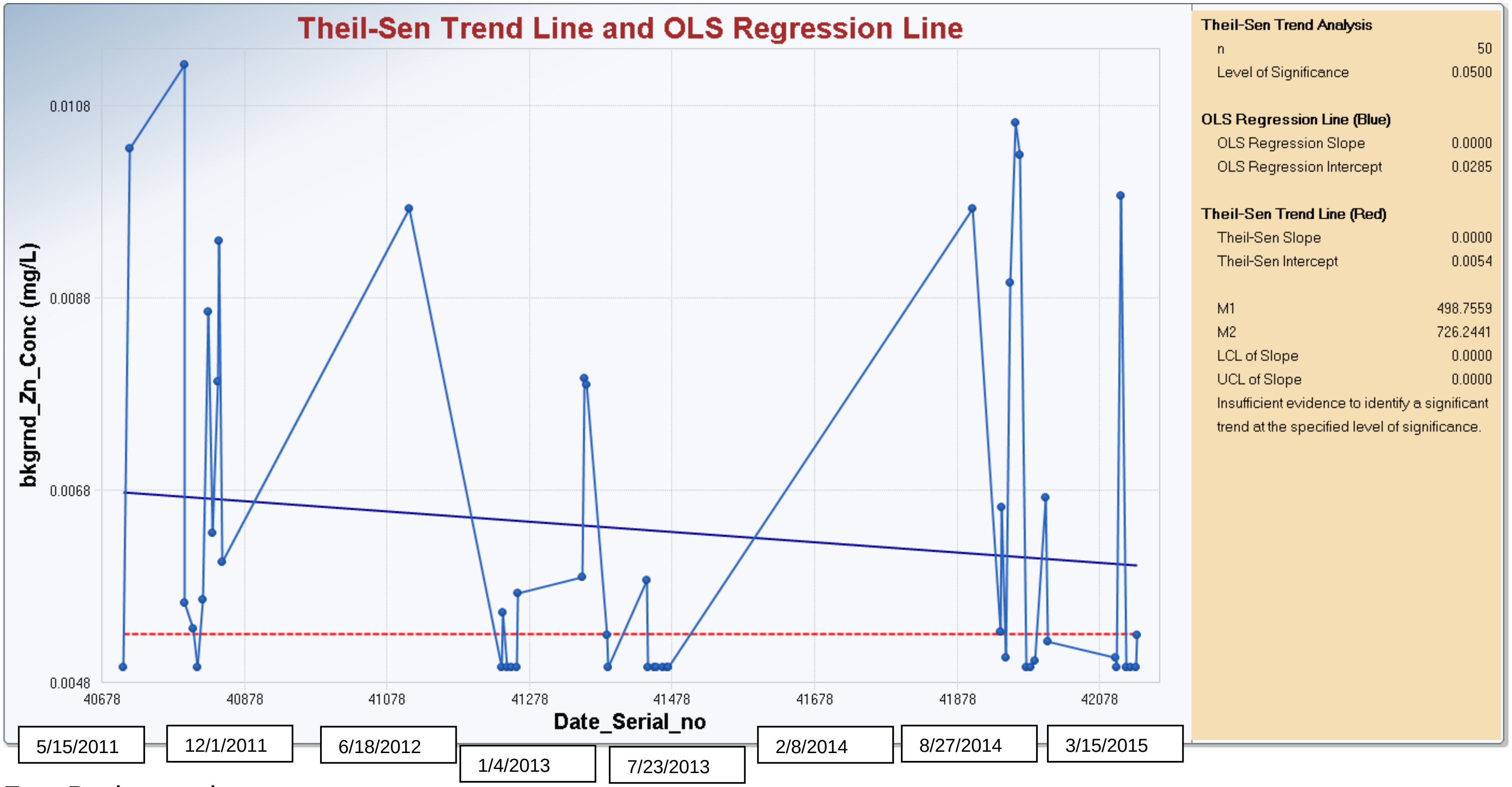
Zn – Monitoring Well 20

Zn Graphs

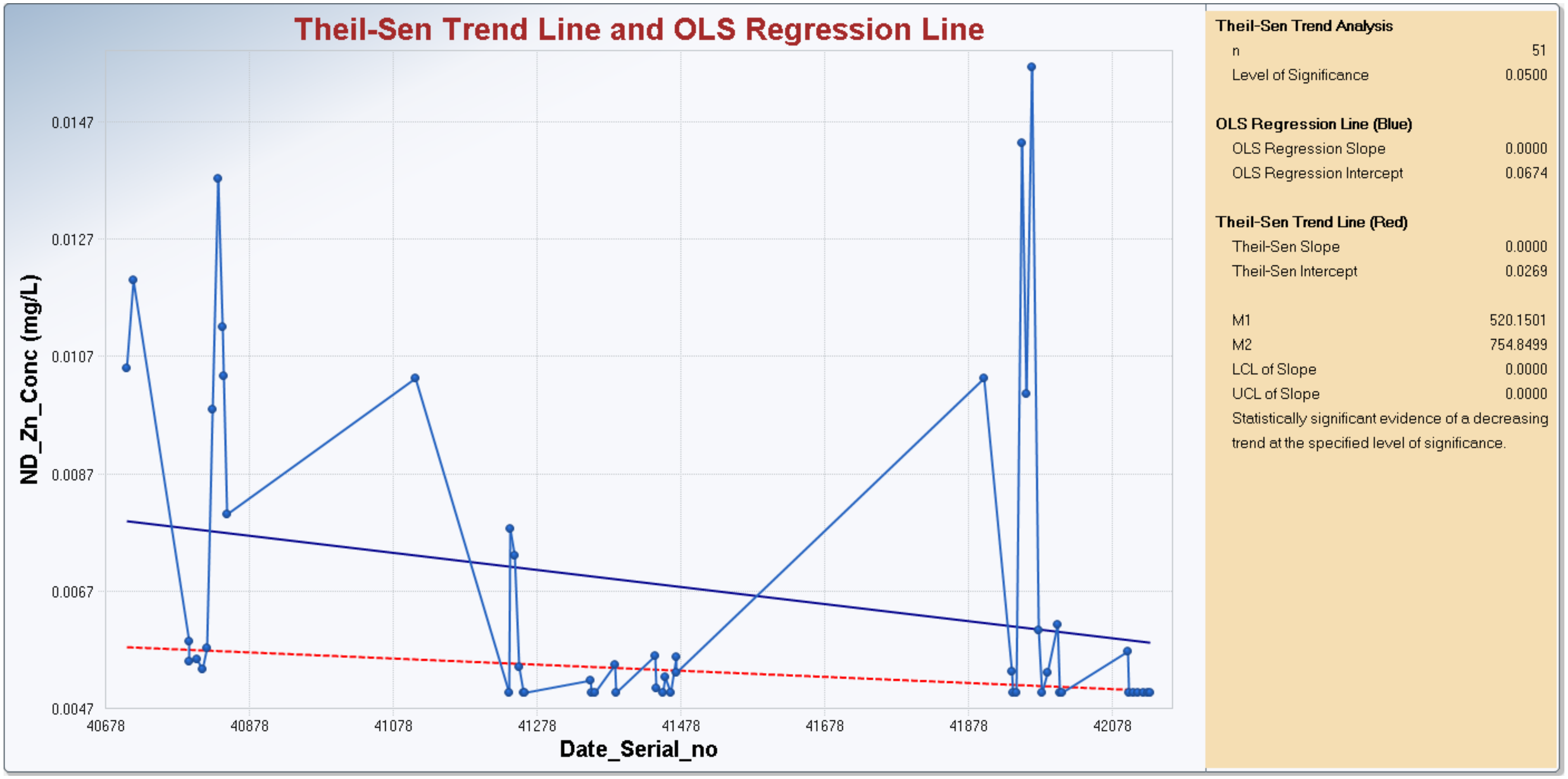
Current Data

General Statistics - Zinc						
Current	Background	Near-Dike	Calumet River	CDF	MW-18	MW-19
Number of Events	150	151	153	147	51	49
Number of Values Reported (n)	150	151	153	147	51	49
Number of Values After Averaging	50	51	51	49	51	49
Number of Replicates	100	100	102	98	0	0
Minimum	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Maximum	0.0113	0.0157	0.0217	0.0270	0.1400	0.0290
Mean	0.00641	0.0068	0.00726	0.0102	0.019	0.00675
Geometric Mean	0.00617	0.00637	0.00676	0.00931	0.0137	0.00597
Median	0.00535	0.00540	0.00597	0.00940	0.012	0.005
Standard Deviation	0.00196	0.00282	0.00334	0.00466	0.0208	0.00503
Evidence of Trend Identified?	No	Yes	No	Yes	Yes	No
Direction of Trend (If Identified)	NA	Decreasing	NA	Decreasing	Decreasing	NA

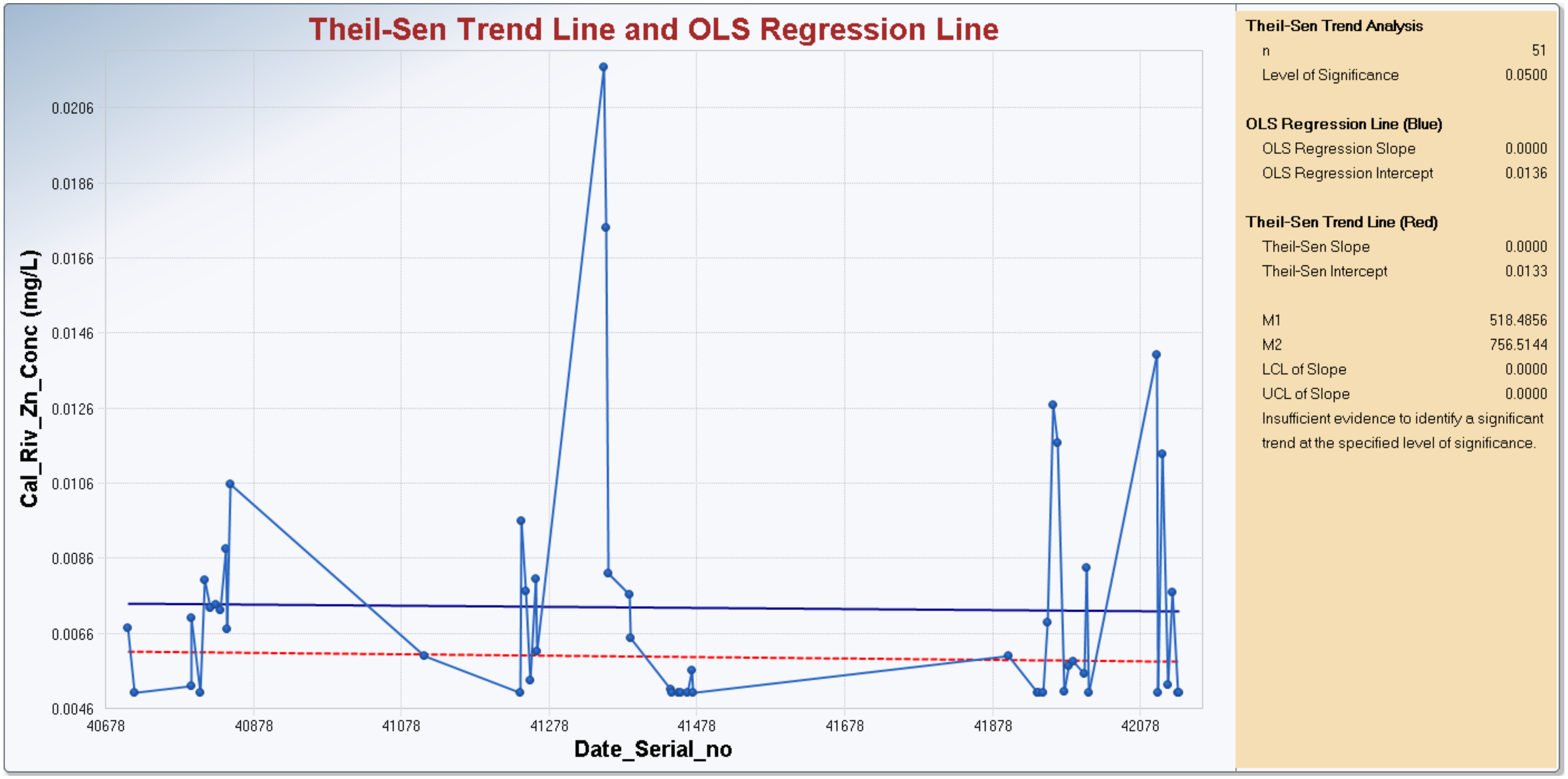
NA = Not Applicable



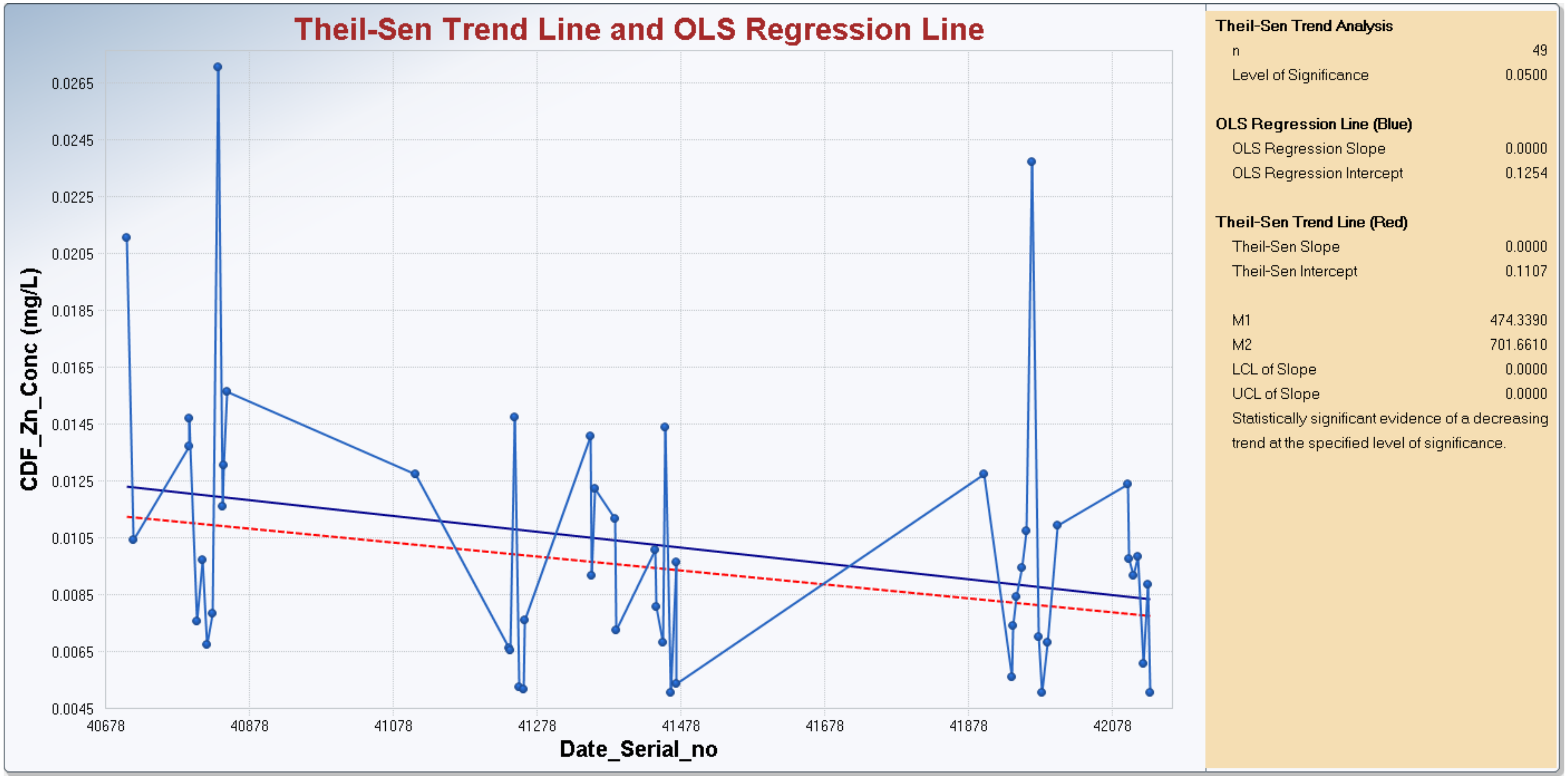
Zn – Background


Theil-Sen Trend Line and OLS Regression Line
ND_Zn_Conc (mg/L)
0.0147
0.0127
0.0107
0.0087
0.0067
0.0047
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 51
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.0674
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0269
M1 520.1501
M2 754.8499
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

Zn – Near Dike

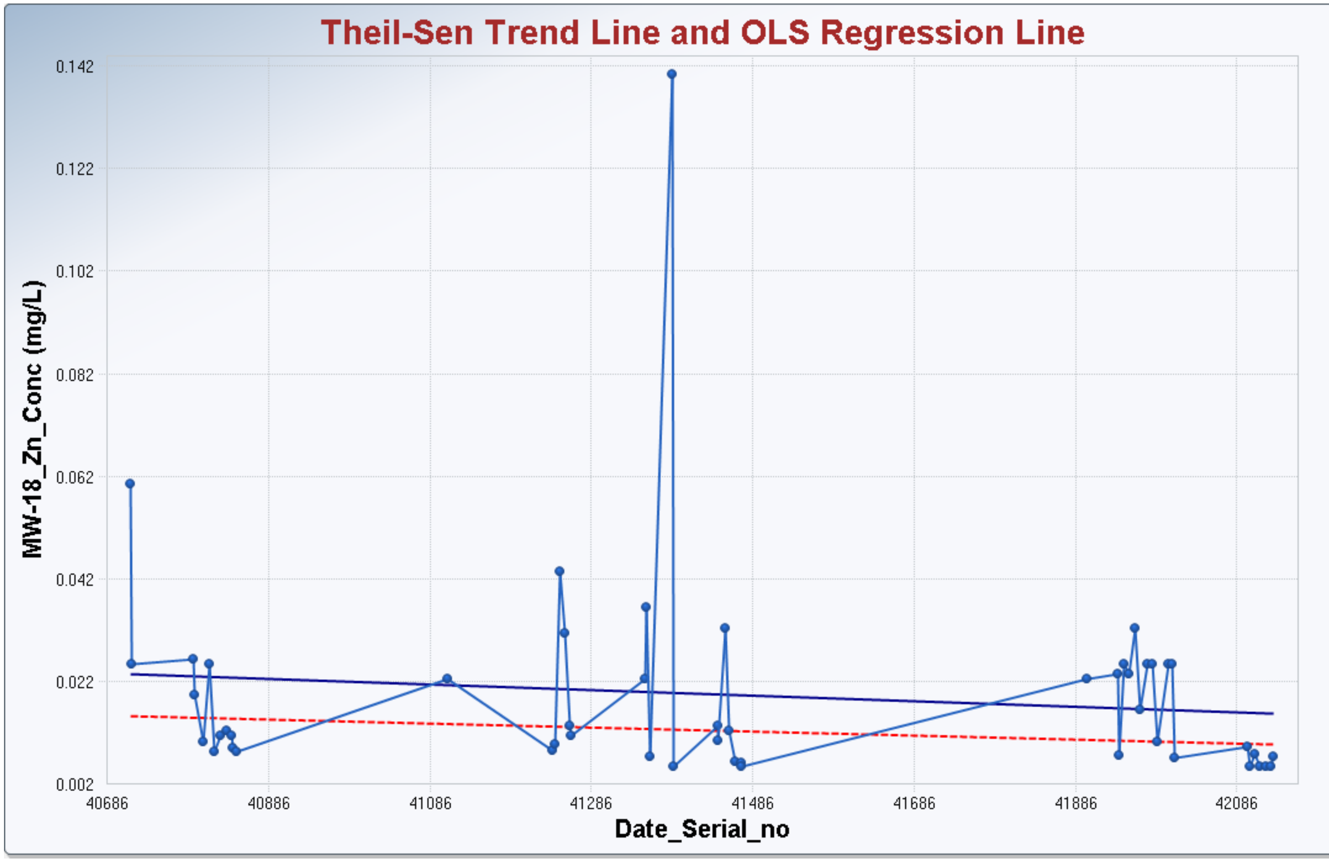


Zn – Calumet River



Theil-Sen Trend Line and OLS Regression Line
CDF_Zn_Conc (mg/L)
0.0265
0.0245
0.0225
0.0205
0.0185
0.0165
0.0145
0.0125
0.0105
0.0085
0.0065
0.0045
40678
40878
41078
41278
41478
41678
41878
42078
Date_Serial_no
Theil-Sen Trend Analysis
n 49
Level of Significance 0.0500
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.1254
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.1107
M1 474.3390
M2 701.6610
LCL of Slope 0.0000
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.

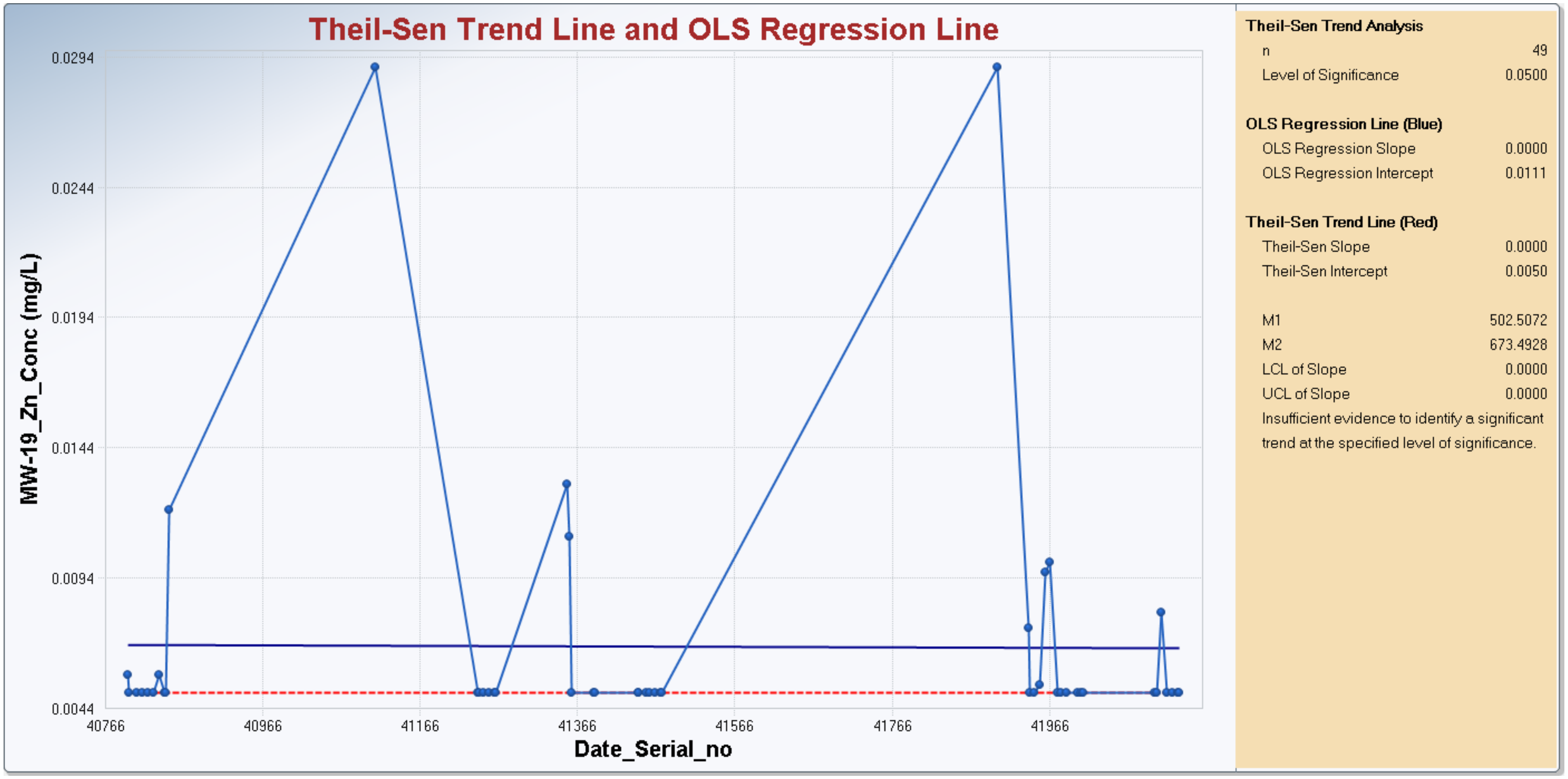
Zn – CDF



Theil-Sen Trend Analysis	
n	51
Level of Significance	0.0500
OLS Regression Line (Blue)	
OLS Regression Slope	0.0000
OLS Regression Intercept	0.2392
Theil-Sen Trend Line (Red)	
Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.1782
M1	517.1802
M2	757.8198
LCL of Slope	0.0000
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Zn – Monitoring Well 18



Zn – Monitoring Well 19