# *2009 Annual Water Monitoring Report*

## *South Dakota Department of Environment and Natural Resources, Solid Waste Permit 06-18A*

## *Big Stone Plant*
## *Big Stone City, South Dakota*

***Prepared for***

OTTER TAIL POWER COMPANY

***April 2010***

BARR

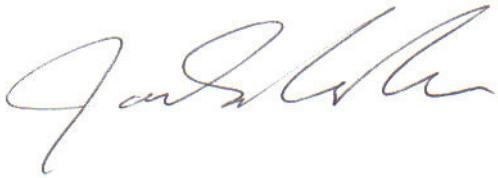
***4700 West 77th*** Street
Minneapolis, MN 55435-4803
Phone: (952) 832-2600
Fax: (952) 832-2601

# Big Stone Plant
# 2009 Annual Water Monitoring Report

## Signature of Environmental Professional

I certify that this report was prepared by me or under my direct supervision and that I am a geologist possessing academic training and professional experience in the field of hydrogeology. A statement of qualifications is included as Appendix A of this report.

Respectfully Submitted,



James S. Aiken, B.S., M.S.
Barr Engineering Company

Date: April 27, 2010

# Executive Summary

This report presents the results of water monitoring for 2009 at the Big Stone Plant (Facility). The purpose of monitoring at the Facility is to document water quality data collected from uppermost saturated portions of the subsurface. The monitoring network at the Facility addresses two hydraulically distinct areas at the Facility: the Ash Disposal Area (ADA) and the Brine Pond Area. Process water ponds and deeper aquifer wells are monitored voluntarily at the discretion of Otter Tail Power. Monitoring of these ponds/wells is not required by the Facility permit.

The most recent significant change has included the operation of the New Brine Pond (NBP) next to the Existing Brine Pond (EBP) and located south of the Cooling Pond (Figure 1). Both ponds are constructed with a high density polyethylene liner system and are located within the approximate footprint of an older brine pond. The old brine pond was closed in the 1998. Seven 'BCX'-series monitoring wells were installed in the Brine Pond Area during 2007 to monitor both the new and existing brine ponds. The NBP was filled for the first time in October 2007 and baseline monitoring of these wells was completed during early 2008.

Overall, water quality results for 2009 were similar to previous events. Statistical evaluation of the data indicates that there was no evidence of a release from the ADA. Nitrite-nitrate levels are statistically elevated downgradient of the ADA but these are likely due to the agricultural land use surrounding the Facility. Upgradient HX-series wells continue to exhibit background concentrations that are above water quality standards including sulfate and other general parameters.

Water quality results from the SX-series wells located downgradient from the EBP continue to show lingering effects from releases related to the old brine pond. However, there is some indication that concentrations are leveling off in the wells located nearest to the old pond. Previous investigations (Barr, 1990) have indicated that there are no groundwater receptors downgradient from the pond and transport model results have shown that off-site impacts to surface water are unlikely.

In general, BC wells located along the downgradient perimeter of the EBP exhibit higher overall concentrations than upgradient wells. These downgradient wells are located nearest the active portions of the old brine pond.

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# 1.0 Introduction/Summary

This report summarizes the groundwater data collected in accordance with South Dakota Department of Environment and Natural Resources (SD DENR) rules and Solid Waste Facility Permit 06-18 for the Big Stone Plant (Facility, Figure 1) during 2009. Annual reports are submitted by May 1 each year in accordance with ARSD 74:27:13:22 (11) and with approval of SDDENR.

The Facility is located in portions of the SW1/4 and the SW1/4 NW1/4 of Section 7, T121N, R46W, and a portion of the SW1/4 SE1/4, a portion of the SW1/4, and portion of the NW1/4 of Section 12, T121N, R47W, all in Grant County. The total permitted area is 216 acres, of which total active disposal occurs over approximately 23.1 acres.

# 2.0 Description of Disposal Areas and Monitoring Networks

The Facility layout is shown on Figure 1. The permit for the Facility applies to a restricted use facility, the Ash Disposal Area, the new and existing brine concentrator ponds ("Brine Ponds"), and the lime sludge ponds.

## 2.1 Disposal Areas

### 2.1.1 Restricted Use Facility and Lime Sludge Ponds

The Restricted Use Facility and Lime Sludge Ponds accept only inert materials and do not require groundwater monitoring under the permit. These areas do not have a monitoring network and are not shown on Figure 1.

### 2.1.2 Ash Disposal Area

The Ash Disposal Area (ADA) is an ash monofill located between the Cooling Pond and Evaporation/Holding Pond areas (Figure 1). The goal of monitoring at the ADA wells is detection monitoring. The wells and the Ash Runoff Pond are monitored three times annually for the parameters listed in Table 1.

The ADA is monitored by the HX-series well nests. The monitored well nests consist of downgradient H1OX and H1I as well as upgradient Wells H2OX, H2I, H3OX, H3I, H4OX, and H4I. A deeper well (HXD) is also nested at each location. However, the deeper wells were dropped from the network in 1995 because tritium sample data indicated that these wells are not connected hydraulically to surface recharge. These deeper wells are therefore not useful for detecting evidence of a release for the Facility.

The ADA also includes the Ash Runoff Pond which collects contact storm water runoff from the Ash Monofill. The runoff is directed toward the Ash Runoff Pond located north of the ADA as shown on Figure 1. The purpose of monitoring the Ash Runoff Pond is not defined as detection monitoring in the Facility permit, but the samples collected are useful in evaluating potential source concentrations for general comparison to groundwater quality.

### 2.1.3 Brine Ponds

The Brine Pond Area is located south of the Cooling Pond as shown on Figure 1. It consists of two newer brine ponds that were constructed within the footprint of an older, pond. The older original brine pond was a 12-acre pond that was originally constructed with a compacted native clay liner that was exposed to frost, desiccation, and plant rooting for an extended period of time. A previous study (Barr, 1990) indicated that the former pond had resulted in some seepage of the pond contents to groundwater. Groundwater monitoring was initiated at that time and found that there was evidence of a release moving slowly in the clay soils toward the Whetstone River. A containment fate and transport model predicted that concentrations would be below applicable standards at the Whetstone River due to natural processes including dispersion.

The Existing Brine Pond (EBP) was constructed in 1998. In September 2005, a broken weld in the EBP's pond liner was detected during routine operations. The liner was repaired and the release was contained by the underdrain system and discharged to the Cooling Pond. SDDENR issued a No Further Action letter on January 4, 2006 (SDDENR, 2006) stating that there was no risk to the human health or further risk to the environment.

In August 2009, six small tears (ranging in size from a pinhole to 2") were discovered in the liner of the EBP. During the repair of these small tears it was also discovered that the liner seal boots surrounding the pipes of the EBP had worked loose. The necessary repairs were made. The SD DENR was notified of the situation at that time and assigned the file number 2009.134 to the occurrence. The SD DENR issued a No Further Action letter on March 18, 2010 concerning this incident.

The New Brine Pond (NBP) was constructed in 2007. Both active ponds were constructed with a liner of high density polyethylene (HDPE). The liner for the existing pond was placed over a compacted native clay while the new pond has a composite liner system composed of HDPE over a two foot compacted clay layer. The ponds also have underdrain systems that are designed to relieve hydrostatic pressure under the liner.

The goal of monitoring in the Brine Pond Area is twofold:

1. Provide detection monitoring for the EBP and NBP so that a potential future release can be rapidly addressed.

2. Provide corrective action monitoring to evaluate improvements in water quality following closure of the old pond and subsequent installation of the liner and underdrain systems for the newer ponds.

The monitoring network for the Brine Pond Area is shown on Figure 2. It consists of two SX-series well nests (each nest includes a cluster of three wells) and the new BCX-series wells, installed during the spring/summer of 2007.

Wells S1, S2, and S3 are located immediately downgradient of the EBP. Wells S4, S5, and S6 are located further downgradient and are situated in a natural topographic depression that slopes toward the Whetstone River. The wells are monitored three times annually for the parameters listed in Table 1.

Wells BC1, BC2, BC3, BC4, and BC101 are located around the perimeter of the EBP. Wells BC1 and BC101 are nested shallow and deep wells, respectively, and they are located upgradient of the EBP. Wells BC5 and BC6 are located downgradient of the NBP, on the southern berm.

### 2.1.4 Other Monitoring

Surface water monitoring of the Cooling, Evaporation, and Holding Ponds is included in the sampling program at the Facility. There is no compliance threshold established for monitoring these ponds. Because the ponds are subject to significant annual evaporation, there is a tendency for the ponds to concentrate naturally-occurring ions. Therefore, periodic increases in major ions are expected. In addition, diffusion of these ions into the clay soil is anticipated over time as part of routine plant operations. Because the normal pond elevations are generally higher than the surrounding groundwater elevations, it is possible that wells near the pond (e.g., the BC-X and HX-series) may eventually be influenced by the pond water chemistry.

## 2.2 Statistical Evaluation

Statistical analysis and data management services were provided by Barr Engineering Co. using DUMPStat software by Discerning Systems, Inc. (2006). Statistical methods for each area and well grouping are summarized in Table 1. A Statement of Qualifications and discussion of statistical methods is included in Appendix A.

## 2.3 Monitoring and Analytical Services

Groundwater monitoring events for the existing monitoring network were conducted on April 22-23, July 16-17, and October 21-23 of 2009. Standard sampling methods were used in collection of the samples and were consistent with previous years. Samples were shipped to Era Laboratories, Inc. located in Duluth, Minnesota for analysis of permit-required parameters. A statement of qualifications for ERA Laboratories is included in Appendix A. Field data sheets, laboratory analytical reports are included in Appendix B. Well construction data are shown in Table 2.

## 2.4 Changes in Monitoring Program

No changes were made to the monitoring program in 2009. A review of recent modifications to the program includes the following:

- Well 1 was dropped from the monitoring program in 2008 with approval from SD DENR.
- Wells 10, 11, and 12 and the Cooling, Evaporation, and Holding Ponds are not a permit-required part of monitoring, but are sampled at the discretion of Otter Tail Power to provide background water quality data from lower aquifer units.
- Baseline monitoring for the BC-X series wells was completed in January of 2008
- Total metals were required for Baseline monitoring but were discontinued upon completion of baseline monitoring found no significant difference in metals concentrations (Barr 2008a).
- Permit-required laboratory measurements for pH, specific conductance and temperature are not included in statistical analysis. However, field-measured values for pH and specific conductance are used because they are more representative than lab measured values for these parameters. Also, because field measured temperature data are extremely sensitive to seasonal fluctuations; these values are not used in statistical calculations.

# 3.0 Geology and Hydrogeology

## 3.1 Physical Setting

The site is located west of Big Stone Lake and slightly northwest of Big Stone City in Grant County, South Dakota. The area is within the Coteau des Prairie plateau of the Central Lowlands physiographic province. Topography is gently rolling to flat with drainage toward the south and east.

## 3.2 Geology

The surficial geology is composed of Late Wisconsin Des Moines Lobe glacial till. The glacial till is clayey with generally low permeability, although locally higher permeability sand and silt seams are present within the clay. Underlying units consist of Cretaceous-aged sedimentary rocks deposited in terrestrial alluvial, tidal, and deeper marine shale environments. Precambrian granite outcrops to the south of Big Stone City and is likely present under the sedimentary rocks at the Facility. Because the Des Moines Lobe and earlier glacial tills eroded bedrock materials of similar provenance, the matrix of the glacial till carries many of the same geochemical characteristics of the bedrock source material. Chemical interaction of groundwater with the geologic matrix results in unique but spatially variable chemical signatures depending on flow characteristics and localized matrix composition.

## 3.3 Hydrogeologic Conceptual Model

Regional discharge is toward the Minnesota River/Big Stone Lake located east of the Facility and the Whetstone River to the south. Regional groundwater flow at the Facility is generally from the northwest to the south or southeast toward these discharge areas, depending on location at the Facility. As shown on Figure 2, the large pond areas likely exhibit a large influence on flow directions.

The flow conditions shown on Figure 2 are highly interpretive because the low permeability and differential saturation of the clay typically results in localized flow variations. Overall, groundwater flows from areas of higher hydraulic head (upgradient and recharge areas) to areas of lower hydraulic head (downgradient and discharge areas).

Groundwater moves relatively slowly in the clay till and the overall potential for horizontal migration is relatively low. As shown on Figure 3, groundwater levels show very little correlation with average monthly rainfall indicating that most precipitation results in runoff rather than infiltration.

Very slow downward vertical migration through the clay till is possible over millennia. However, based on the tritium analysis of the HX-series wells, vertical migration rates are on the order of decades per foot. Monitoring of groundwater in these deeper zones was discontinued because release detection is ineffective in zones where there is virtually no groundwater movement.

## 3.4 Ambient Groundwater Conditions

Ambient groundwater conditions in the vicinity of the Facility were established in previous reports and during more than 35 years of monitoring. The results show that the available groundwater is highly mineralized and possesses sulfate concentrations over the South Dakota water quality standard for sulfate of 500 ppm (where TDS concentration is less than 10,000 ppm). Similarly, ambient water quality is elevated with respect to other general chemistry parameters. The results also have shown that considerable spatial variation in water quality exists between wells.

# 4.0 Monitoring Results

The results of 2009 monitoring are discussed below. Graphical summaries and tabulated data for detection monitoring (Ash Disposal Area – HX-series wells and Ash Runoff Pond), assessment monitoring (Brine Pond Area – SX-series and BCX-series wells) and general monitoring (Wells 10, 11, 12 and Cooling, Evaporation and Holding Ponds) are included in Appendix C, D and E, respectively.

## 4.1 Water Levels

Water level elevations are shown in Table 3 for each of the monitoring wells. The average pond elevations from 2009 are also provided for reference. Field data is included in Appendix B. Figure 3 shows a hydrograph for all wells. In general, water levels were consistent with 2008 and previous years (Barr 2009). Pond elevations are somewhat higher than the monitoring wells. All water levels are higher than surface water levels at the Big Stone River and Whetstone River. This implies that overall flow continues to be from northwest to east and south.

Average monthly precipitation is graphed along the bottom of Figure 3 (units are on right y-axis). Peaks in monthly average precipitation do not appear to result in corresponding increases in groundwater elevations. This suggests that the surficial groundwater flow system responds slowly to precipitation and that infiltration rates through the clay are relatively low.

## 4.2 Water Quality Data – Ash Disposal Area

### 4.2.1 HX-Series Wells

Intrawell (Shewhart-CUSUM) control charts for the H-series wells are included in Appendix C. Background data is updated through 2007. Significant-only results are shown on Figure 4. Note that no water quality data was obtained from upgradient well H2I in 2009 due to insufficient sample volume.

#### *SSIs – Downgradient Wells*

SSIs were verified for the following well/parameter combinations in downgradient wells as shown on Figure 4.

- H1OX: Nitrate-nitrite
- H1I: Hardness

The nitrate-nitrite SSI is likely due to surrounding agricultural land use. The SSI for hardness is also observed in all the upgradient wells, as discussed below, and does therefore not indicate a potential release from the ADA.

***SSIs – Upgradient Wells***

Apparent SSIs were noted in several wells upgradient of the ADA as shown in Appendix C. Because these wells are upgradient from the ADA, none of these SSIs indicate a potential release from the ADA. Therefore, these results are not shown on Figure 4.

- H20X
  - Hardness

- H3I
  - Boron (CUSUM only)
  - Chloride (CUSUM only)
  - Hardness
  - Potassium (CUSUM only)
  - Sodium (CUSUM only)
  - Sulfate (CUSUM only)
  - Total Alkalinity

- H3OX
  - Hardness

- H4I
  - Hardness (CUSUM only)

- H4OX
  - Chloride (CUSUM only)
  - Hardness (CUSUM only)
  - Sodium (CUSUM only)
  - Sulfate

***General Trends***

Sulfate concentrations are elevated above the South Dakota water quality standard of 500 mg/L in samples from upgradient wells. The upward trends in sulfate are similar to many of the general parameters. The presence of these trends and the magnitude of the upgradient concentrations indicate that upward trends in sulfate are expected to continue in downgradient Well H1-I as the upgradient concentrations move slowly through the clay to the south of the ADA. Upward trends for chloride, boron, sodium, and hardness were also noted in one or more upgradient wells.

In general, the concentrations of major ions and metals are generally lower in the downgradient wells than in the upgradient HX-series wells.

### 4.2.2 Ash Runoff Pond

***General Trends***

Trends for Ash Runoff Pond samples are evaluated using Sen's trend tests (ASTM 2005). Based on the results shown in Appendix C, significant increasing trends have been noted for boron, chloride, field conductivity, hardness, potassium, strontium, and sulfate.

## 4.3 Water Quality Data – Brine Concentrator Sludge Pond

### 4.3.1 SX-Series Wells

In 2009, the following parameters were verified at concentrations above the Intrawell Prediction Limits (IPL) in the SX series wells:

- S1
  – Hardness
- S2
  – Hardness
- S3
  –Chloride
  –Sulfate
- S4
  – Sodium
- S5
  – Chloride (the verification result for this event was flagged as an outlier)

The relatively few parameters that exhibit concentrations above the IPL indicate that concentrations within the aquifer are stabilizing and that the engineering changes at the EBP may be improving water quality. In general, the deeper wells (S3, S5 and S6), located further downgradient have not yet shown evidence of significant impact. IPL plots for the SX-series wells are included in Appendix D.

Well S5 is typically dry but was sampled during the spring monitoring event. Due to the paucity of sampling events (2 in last 10 years), the inferred increasing trends plotted using DUMPStat are likely premature pending confirmation with data from future sampling events.

***General Trends***

Historically, statistically significant upward trends are present for multiple major ions in every well except for S5 and S6. In general, major ion trends are more gradual in the furthest downgradient well nest (S4, S5, S6) than in the wells closest to the EBP (S1, S2, S3). In addition, major ion concentrations are generally one to two orders of magnitude higher in Wells S1 and S2 than in the other wells (deeper Well S3 and further downgradient Wells S4, S5 and S6).

Sulfate is a relatively conservative ion and forms a major portion of the cumulative ion load in downgradient groundwater. As discussed in the 2007 and 2008 reports, and as observed again in 2009, sulfate trends in the SX-series wells follow a similar pattern as described above, with significantly higher concentrations observed in Wells S1 and S2. Sulfate concentrations in S1 in the spring and summer of 2009, however, were significantly lower than historical concentrations and the concentration observed in the fall of 2009.

Detected metals concentrations (arsenic, boron and strontium) are also generally 2 to 10 times higher in Wells S1, S2 and S3 than in S4, S5 and S6.

The following significant increasing trends in metals concentrations were observed in Wells S1, S2 and S3:

- S1 – boron, manganese, and strontium
- S2 – arsenic, boron, manganese and strontium
- S3 – arsenic, manganese, and strontium

The following significant increasing trends in metals concentrations were observed in Wells S4 and S5:

- S4 – boron and strontium
- S5 – strontium

No statistically significant increasing trends for metals were observed in Well S6, although chloride and sulfate have trended slightly upward over the last four years.

### 4.3.2 BC-X Series Wells –

Baseline data for the BC-X series wells was completed in January of 2008. Data summary tables and IPL plots for the BCX-series wells are included in Appendix D. A detailed summary and

evaluation of the baseline data is included in the Baseline Monitoring report (Barr, 2008). The background data for the BC-X wells was set to include the first eight sampling events through 2008. The background will remain fixed to data through 2008 for comparison of data collected during 2010, and then will be updated each year to include the data up to two years prior to the sampling year in accordance with ASTM (2005).

In 2009, no parameters were verified at concentrations above the Intrawell Prediction Limits (IPL) in any of the BCX series wells. The nitrate-nitrite SSI at BC5 was not verified upon resampling in 2009. Chloride at BC1 was above the IPL in April 2009, but was not verified as an SSI during subsequent sampling events.

#### *General Trends*

In general, upgradient Wells BC1, BC101 and downgradient Well BC6 exhibit significantly lower concentrations of metals and major ions than perimeter downgradient Wells BC2, BC3, BC4 and BC5. These perimeter downgradient wells appear to show continuing residual effects from the old brine pond releases. However, these concentrations are stable or decreasing and have likely been significantly diluted by over 15 years of recharge and groundwater flux through the area.

## 4.4 Water Quality Data – Other Monitoring

### 4.4.1 Well 1

Well 1 was removed from the sampling network after the first quarter (Spring 2008) sampling event. The SD DENR gave permission for the removal of Well 1 from the sampling network in an email dated May 20, 2008 from Gary Haag. Well 1 will not be sampled in the future.

Wells 10, 11, and 12 continue to be monitored but are not included in the permit required statistical analysis and reporting. Well 12 was not sampled in Summer or Fall of 2009 because the pump was not working.

### 4.4.2 Process Water Ponds (Cooling, Evaporation, and Holding Ponds)

Water quality data from the ponds is shown in Appendix E but are not included in permit required statistical analysis and reporting. Overall, water quality remained consistent with previous years. Concentrations of some parameters continue to fluctuate due to long-term concentration effects of evaporation as discussed in Section 2.1.4.

# 5.0 Summary and Recommendations

Overall, groundwater quality remained relatively stable in 2009 with minor variations when compared to 2008 monitoring results. SSIs were verified for the following well/parameter combinations in the downgradient Wells H1OX and H1as shown on Figure 4.

- H1OX: Nitrate-nitrite
- H1I: Hardness

The nitrite-nitrate in H1OX is likely due to agricultural land use. The SSI for hardness is also observed in all the upgradient wells, and therefore does not appear to indicate a potential release from the ADA.

The SX-series wells that are used to monitor the EBP appear to continue to show increasing trends for major ions and metals, but the increases appear to be leveling off compared to previous years. The BCX-series wells did not show any significant increases above background concentrations during 2009.

The following repairs and/or improvements should be considered for 2010:

- Repair or replace the pump in Well 12

# 6.0 References


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# Tables

## Table 1
### Summary of Big Stone Monitoring Network, Parameters and Frequency

| Site | Parameter List | Statistical Test | Well Depth | Diameter (Inches) | Well Elevation | Sample Equipment | Dedicated? | Pump Rate (ml/min) | Goes Dry? |
|---|---|---|---|---|---|---|---|---|---|
| ***General Monitoring*** | | | | | | | | | |
| Well 10 | A | Intrawell | 57 | 4 | 1098.70 | Keck | No | 3,000 | No |
| Well 11 | A | Prediction Limit | 127 | 4 | 1104.00 | Other Pump | Yes | 36,000 | No |
| Well 12 | A | (IPL) | 113 | 4 | 1071.89 | Other Pump | Yes | 20,000 | No |
| Cooling Pond | A | | N/A | N/A | N/A | Grab | N/A | N/A | No |
| Evaporation Pond | A | Time Series | N/A | N/A | N/A | Grab | N/A | N/A | No |
| Holding Pond | A | | N/A | N/A | N/A | Grab | N/A | N/A | No |
| ***Brine Pond Area Detection/Assessment Monitoring*** | | | | | | | | | |
| BC1 (Upgradient) | B | | 16 | 2 | 1118.46 | Bailer | Yes | N/A | No |
| BC101 (Upgradient | B | | 37 | 2 | 1118.70 | Bailer | Yes | N/A | Yes |
| BC2 | B | | 30 | 2 | 1115.28 | Bailer | Yes | N/A | No |
| BC3 | B | | 33 | 2 | 1114.42 | Bailer | Yes | N/A | Yes |
| BC4 | B | | 32 | 2 | 1113.86 | Bailer | Yes | N/A | Yes |
| BC5 | B | Intrawell | 35 | 2 | 1122.59 | Bailer | Yes | N/A | No |
| BC6 | B | Prediction Limit | 31 | 2 | 1121.58 | Bailer | Yes | N/A | No |
| S1 | B | (IPL) | 30 | 2 | 1102.17 | Bailer | Yes | N/A | Yes |
| S2 | B | | 40.5 | 2 | 1102.39 | Bailer | Yes | N/A | Yes |
| S3 | B | | 60 | 2 | 1102.65 | Bailer | Yes | N/A | No |
| S4 | B | | 25.4 | 2 | 1090.57 | Bailer | Yes | N/A | Yes |
| S5 | B | | 44.3 | 2 | 1091.40 | Bailer | Yes | N/A | Yes |
| S6 | B | | 59.7 | 2 | 1090.71 | Bailer | Yes | N/A | No |
| ***Ash Disposal Area Detection Monitoring*** | | | | | | | | | |
| H1OX | C | Intrawell | 30 | 2 | 1115.89 | Bailer | Yes | N/A | Yes |
| H1I | C | (Shewart- | 58.5 | 2 | 1115.81 | Keck | No | 1500 | No |
| H2OX (Upgradient) | C | CUSUM) | 30 | 2 | 1103.91 | Bailer | Yes | N/A | Yes |
| H2I (Upgradient) | C | Control Charts | 60.5 | 2 | 1103.91 | Bailer | Yes | N/A | Yes |
| H3OX (Upgradient) | C | | 20.5 | 2 | 1095.19 | Bailer | Yes | N/A | Yes |
| H3I (Upgradient) | C | | 52.5 | 2 | 1095.17 | Whale | No | 2000 | No |
| H4OX (Upgradient) | C | | 25.5 | 2 | 1108.22 | Whale | No | 2500 | No |
| H4I (Upgradient) | C | | 58.5 | 2 | 1108.61 | Keck | No | 2000 | Yes |
| Ash Runoff Pond | C | Time Series | N/A | N/A | N/A | Grab | N/A | N/A | No |

All Wells and Ponds Sampled in Spring (April 22-23), Summer (July 16-17), and Fall (October 21-23) 2009.

| List A | List B[1,2] | | List C[2] | |
|---|---|---|---|---|
| Field pH | Field pH | **Arsenic** | Field pH | **Arsenic** |
| Field Temperature | Field Temperature | **Boron** | Field Temperature | **Barium** |
| Field Conductivity (@25C) | Field Conductivity (@25C) | **Cadmium** | Field Conductivity (@25C) | **Boron** |
| | | **Lead** | | **Cadmium** |
| | | **Manganese** | | **Chromium** |
| Total Alkalinity | Total Alkalinity | **Strontium** | Total Alkalinity | **Copper** |
| Chloride | Chloride | | Chloride | **Lead** |
| Hardness as CaCO3 | Hardness as CaCO3 | | Hardness as CaCO3 | **Manganese** |
| Nitrate - Nitrite as N | Nitrate - Nitrite as N | | Nitrate - Nitrite as N | **Mercury** |
| Potassium - total | Potassium - total | | Potassium - total | **Selenium** |
| Sodium - total | Sodium - total | | Sodium - total | **Silver** |
| Sulfate | Sulfate | | Sulfate | **Strontium** |
| | | | | **Vanadium** |
| | | | | **Zinc** |

[1] BC-series wells analyzed for both total and dissolved metals through Spring 2008 event.

[2] Ashrunoff pond samples are analyzed for Total Metals.

All other wells are analyzed for dissolved metals only.

**Table 2**
**Well Construction Summary**
**Big Stone Facility**

| Well ID | Measuring Point Elevation (ft.,MSL)[1] | Surface Elevation (ft.,MSL)[1] | Top of Screen (ft. bgs)[2] | Top of Screen Elevation (ft.MSL)[1] | Bottom of Screen (ft. bgs)[2] | Base of Screen Elevation (ft.MSL)[1] | As Built Total Depth (ft. bgs)[2] | Elevation of Bottom of Well (ft. MSL)[1] | Length of Screen (ft) |
|---|---|---|---|---|---|---|---|---|---|
| ***General Monitoring[3]*** | | | | | | | | | |
| Well 10 | 1098.70 | 1096.6 | - | - | - | - | 57 | 1039.6 | - |
| Well 11 | 1104.00 | 1101.9 | - | - | - | - | 127 | 974.9 | - |
| Well 12 | 1071.89 | 1069.7 | - | - | - | - | 113 | 956.7 | - |
| ***Brine Pond Area Detection/Assessment Monitoring*** | | | | | | | | | |
| BC-1 | 1118.46 | 1116.6 | 6.0 | 1110.6 | 16.0 | 1100.6 | 16 | 1100.6 | 10 |
| BC-101 | 1118.70 | 1116.6 | 27.0 | 1089.6 | 37.0 | 1079.6 | 37 | 1079.6 | 10 |
| BC-2 | 1115.28 | 1112.9 | 20.0 | 1092.9 | 30.0 | 1082.9 | 30 | 1082.9 | 10 |
| BC-3 | 1114.42 | 1112.5 | 23.0 | 1089.5 | 33.0 | 1079.5 | 33 | 1079.5 | 10 |
| BC-4 | 1113.86 | 1111.1 | 22.0 | 1089.1 | 32.0 | 1079.1 | 32 | 1079.1 | 10 |
| BC-5 | 1122.59 | 1119.1 | 23.5 | 1095.6 | 33.5 | 1085.6 | 35 | 1084.1 | 10 |
| BC-6 | 1121.58 | 1118.8 | 21.0 | 1097.8 | 31.5 | 1087.3 | 31 | 1087.8 | 10 |
| S-1 | 1102.17 | 1090.5 | 23.5 | 1078.7 | 33.7 | 1068.5 | 30 | 1060.5 | 7 |
| S-2 | 1102.39 | 1090.5 | 34.2 | 1068.2 | 44.2 | 1058.2 | 40.5 | 1050.0 | 7 |
| S-3 | 1102.65 | 1090.5 | 53.7 | 1049.0 | 63.7 | 1039.0 | 60 | 1030.5 | 7 |
| S-4 | 1090.57 | 1088.3 | 18.6 | 1072.0 | 28.6 | 1062.0 | 25.4 | 1062.9 | 7 |
| S-5 | 1091.40 | 1088.3 | 37.6 | 1053.8 | 47.8 | 1043.6 | 44.3 | 1044.0 | 7 |
| S-6 | 1090.71 | 1088.3 | 50.6 | 1040.1 | 63.2 | 1027.5 | 59.7 | 1028.6 | 7 |
| ***Ash Disposal Area Detection Monitoring*** | | | | | | | | | |
| H1OX | 1115.89 | 1113.3 | 25.0 | 1088.3 | 30.0 | 1083.3 | 30 | 1083.3 | 5 |
| H1INT | 1115.81 | 1113.3 | 53.0 | 1060.3 | 58.0 | 1055.3 | 58.5 | 1054.8 | 5 |
| H2OX | 1103.91 | 1101.4 | 25.0 | 1076.4 | 30.0 | 1071.4 | 30 | 1071.4 | 5 |
| H2INT | 1103.91 | 1101.4 | 55.0 | 1046.4 | 60.0 | 1041.4 | 60.5 | 1040.9 | 5 |
| H3OX | 1095.19 | 1092.9 | 15.0 | 1077.9 | 20.0 | 1072.9 | 20.5 | 1072.4 | 5 |
| H3INT | 1095.17 | 1092.9 | 47.0 | 1045.9 | 52.0 | 1040.9 | 52.5 | 1040.4 | 5 |
| H4OX | 1108.22 | 1106.0 | 20.0 | 1086.0 | 25.0 | 1081.0 | 25.5 | 1080.5 | 5 |
| H4INT | 1108.61 | 1106.0 | 53.0 | 1053.0 | 58.0 | 1048.0 | 58.5 | 1047.5 | 5 |

[1] FT. MSL - Feet above mean sea level.

[2] FT. BGS = Feet below ground surface. Static levels were measured relative prior to completion of the wells and final survey.

[3] Screen length and depth is not known at Wells 1, 10, 11, and 12

**Notes:**
BCX-series wells installed in April-May (BC-1 through BC-6) and August (BC5,6, and 101) 2007. All wells surveyed in September 2007
BC-5 was resurveyed in November 2007
SX-series well data is from Barr (1990).
All wells are constructed of 2 inch diameter PVC

# Table 3
## 2009 Water Level Data
## Big Stone Facility

| Well/Location | Top of Riser Elevation[1] | Depth To Water Measured (ft) | | | Water Level Elevation[1] | | |
|---|---|---|---|---|---|---|---|
| | | 4/23/2009 | 7/16/2009 | 10/21/2009 | 4/23/2009 | 7/16/2009 | 10/21/2009 |
| ***HX-Series Wells*** | | | | | | | |
| H1-Int | 1115.81 | 21.61 | 27.14 | 26.02 | 1094.20 | 1088.67 | 1089.79 |
| H1-Ox | 1115.86 | 21.49 | 26.16 | 25.51 | 1094.37 | 1089.70 | 1090.35 |
| H2-Int | 1103.91 | 61.74 | 61.38 | 61.21 | 1042.17 | 1042.53 | 1042.70 |
| H2-Ox | 1103.91 | 5.17 | 9.10 | 5.83 | 1098.74 | 1094.81 | 1098.08 |
| H3-Int | 1095.17 | 28.14 | 28.32 | 28.37 | 1067.03 | 1066.85 | 1066.80 |
| H3-Ox | 1095.19 | 7.64 | 8.46 | 6.71 | 1087.55 | 1086.73 | 1088.48 |
| H4-Int | 1108.61 | 16.37 | 18.97 | 17.03 | 1092.24 | 1089.64 | 1091.58 |
| H4-Ox | 1108.22 | 15.76 | 18.35 | 16.59 | 1092.46 | 1089.87 | 1091.63 |
| ***SX-Series Wells*** | | | | | | | |
| S-1 | 1102.17 | 8.35 | 12.66 | 6.80 | 1093.82 | 1089.51 | 1095.37 |
| S-2 | 1102.39 | 11.05 | 15.07 | 9.46 | 1091.34 | 1087.32 | 1092.93 |
| S-3 | 1102.65 | 45.35 | 45.69 | 45.52 | 1057.30 | 1056.96 | 1057.13 |
| S-4 | 1090.57 | 9.00 | 14.83 | 8.29 | 1081.57 | 1075.74 | 1082.28 |
| S-5 | 1091.40 | 45.54 | 45.89 | 45.80 | 1045.86 | 1045.51 | 1045.60 |
| S-6 | 1090.71 | 47.21 | 47.40 | 47.23 | 1043.50 | 1043.31 | 1043.48 |
| ***Water Wells*** | | | | | | | |
| WELL #10 | 1098.70 | 15.45 | 18.00 | 13.96 | 1083.25 | 1080.70 | 1084.74 |
| WELL #11 | 1104.00 | 98.35 | 98.53 | 97.85 | 1005.65 | 1005.47 | 1006.15 |
| WELL #12 | 1071.89 | 65.82 | 66.67 | 65.64 | 1006.07 | 1005.22 | 1006.25 |
| ***BC-Series Wells*** | | | | | | | |
| BC-1 | 1118.46 | 4.46 | 5.80 | 2.00 | 1114.00 | 1112.66 | 1116.46 |
| BC-2 | 1115.28 | 17.35 | 18.18 | 17.49 | 1097.93 | 1097.10 | 1097.79 |
| BC-3 | 1114.42 | 19.87 | 22.01 | 20.47 | 1094.55 | 1092.41 | 1093.95 |
| BC-4 | 1113.86 | 20.15 | 20.23 | 18.67 | 1093.71 | 1093.63 | 1095.19 |
| BC-5 | 1122.59 | 25.38 | 27.94 | 26.34 | 1097.21 | 1094.65 | 1096.25 |
| BC-6 | 1121.58 | 21.78 | 23.14 | 21.14 | 1099.80 | 1098.44 | 1100.44 |
| BC-101 | 1118.70 | 6.55 | 8.21 | 4.50 | 1112.15 | 1110.49 | 1114.20 |
| ***Surface Water Ponds (2009 Annual Average)*** | | | | | | | |
| Cooling Pond | N/A | N/A | N/A | N/A | 1119 | | |
| Evaporation Pond | N/A | N/A | N/A | N/A | 1104 | | |
| Holding Pond | N/A | N/A | N/A | N/A | 1102 | | |

[1] In Feet above mean sea level. Pond survey dated April 27, 2009 by Otter Tail Power.

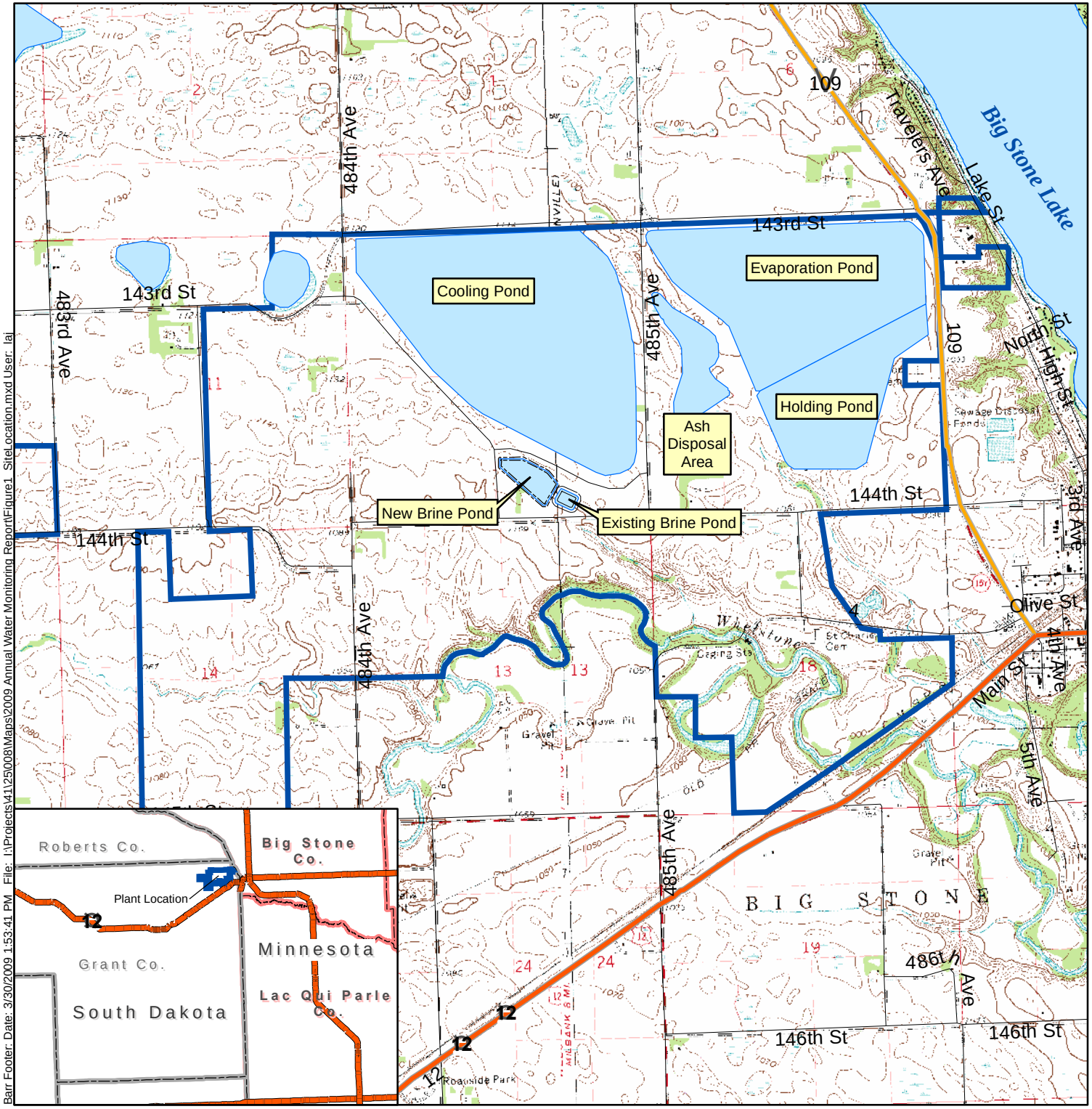
Wells surveyed Sept 2007 except BC-5 surveyed November 2007 by Otter Tail Power

**Notes:**

NI - No data collected because well was not installed at the time of the referenced event

-- Denotes field where no elevation calculated due to dry well.

# Figures




## Legend

- Existing Brine Pond
- New Brine Pond
- Local Road
- State Highway
- U.S. Highway
- Interstate Highway
- Property Boundary
- Lakes, Ponds, & Reservoirs
- South Dakota Counties
- Minnesota Counties
- MN - SD State Line

Feet
2,000 0 2,000

Meters
500 0 500

BARR

Figure 1

Site Location
Big Stone Plant
Big Stone City, SD

Otter Tail Power

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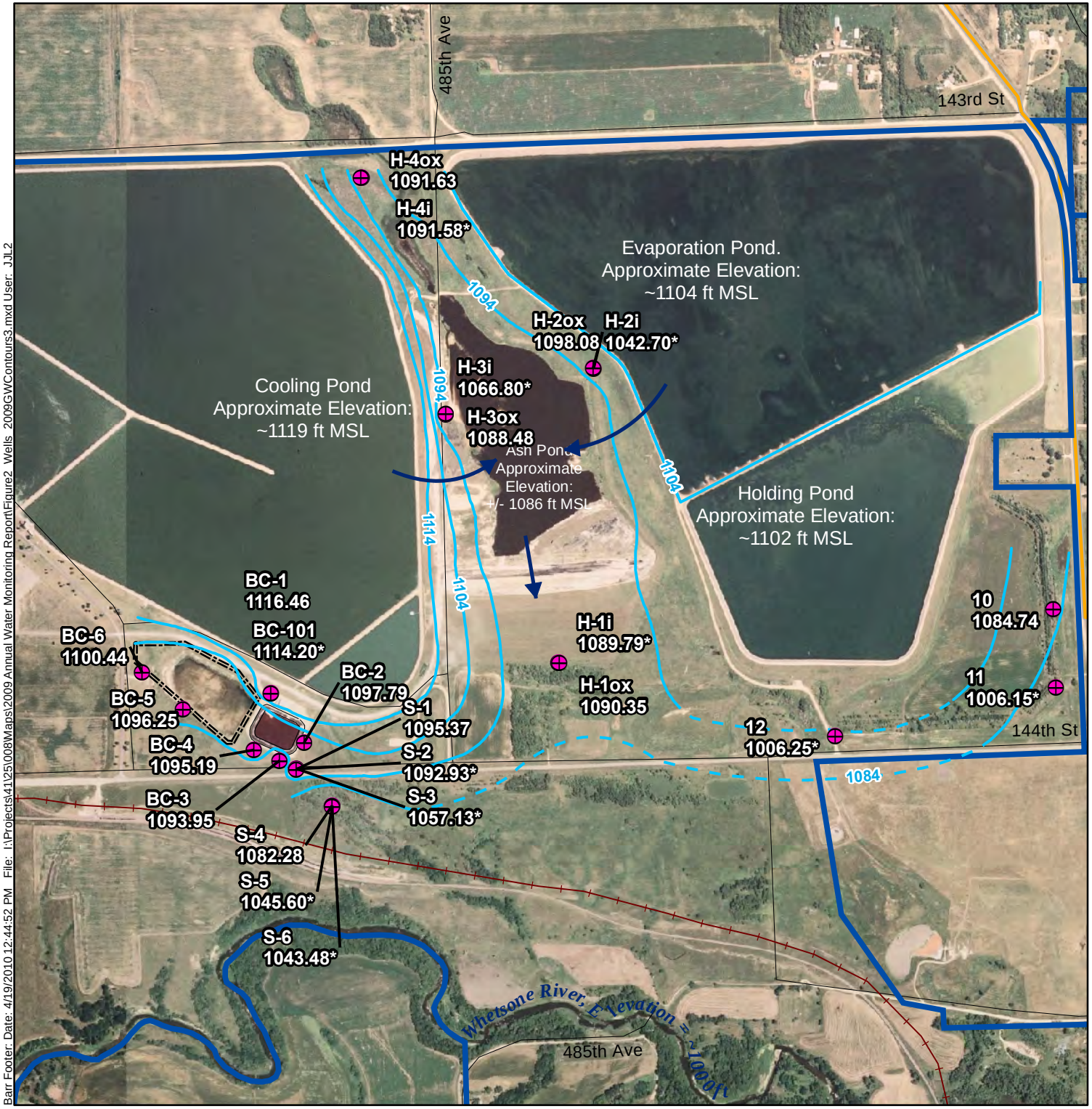



## Legend

- Monitoring Wells
- Groundwater Elevation Contour
- Existing Brine Pond
- New Brine Pond
- Rail Line
- Local Road
- State Highway
- U.S. Highway
- Property Boundary
- Direction of Groundwater Flow

* Groundwater Elevation not contoured for deep wells

N

Meters
200 0 200 400

Feet
1,000 0 1,000

BARR

Figure 2

MONITORING WELLS AND GROUNDWATER ELEVATION CONTOURS: OCTOBER 2009
Big Stone Plant
Big Stone City, SD

Otter Tail Power

Barr Footer: Date: 4/19/2010 12:44:52 PM File: I:\Projects\41\25\008\Maps\2009 Annual Water Monitoring Report\Figure2_Wells_2009GWContours3.mxd User: JJL2

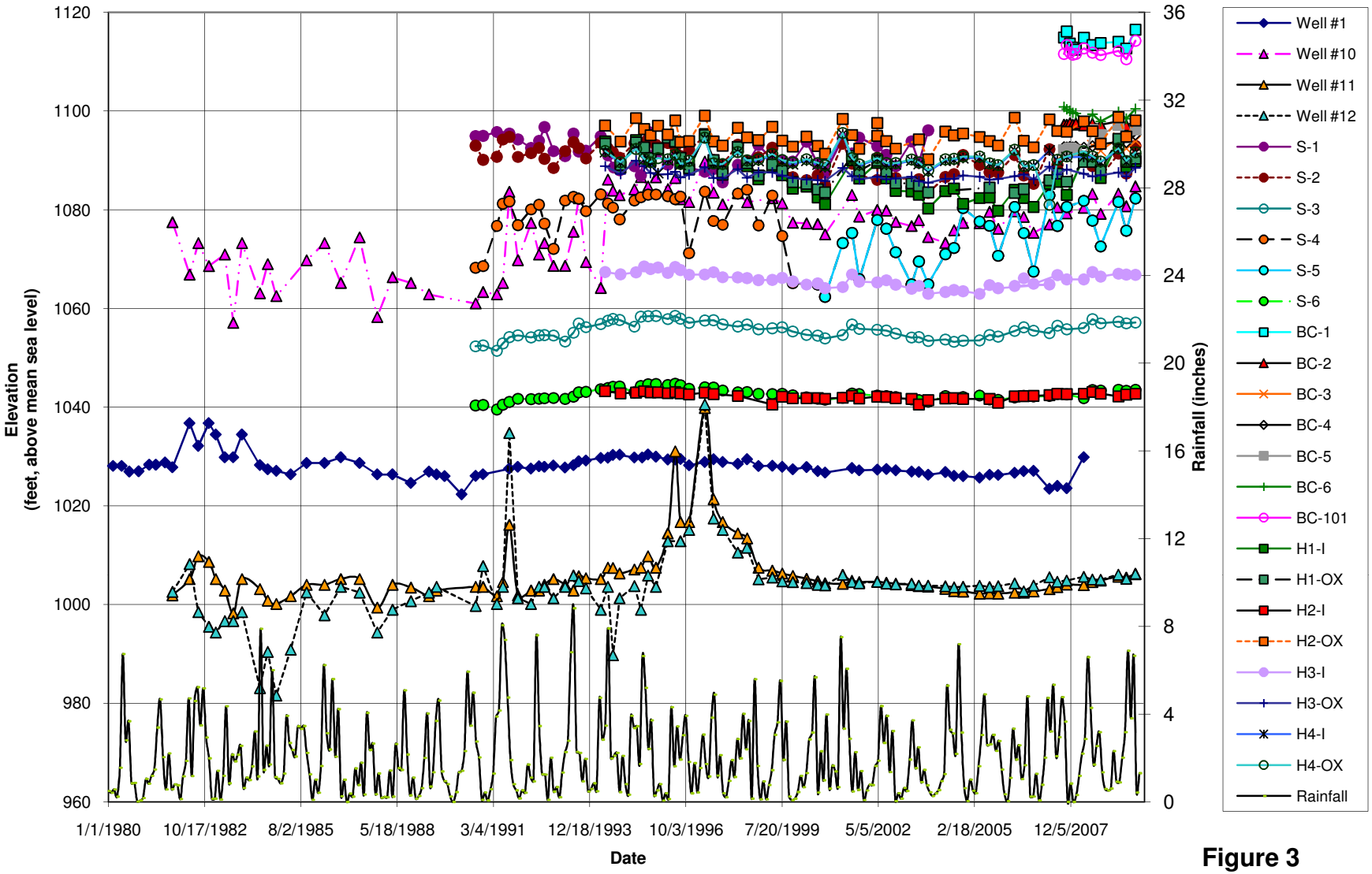
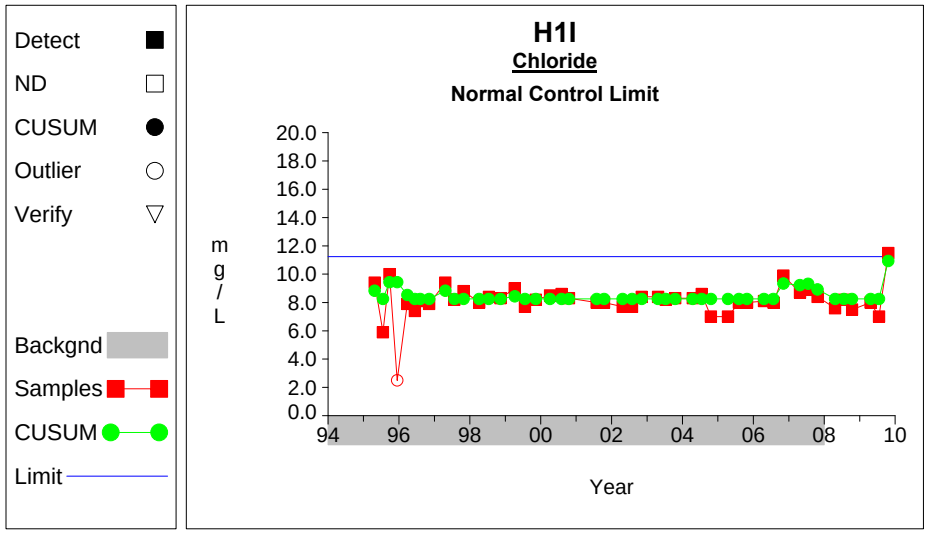
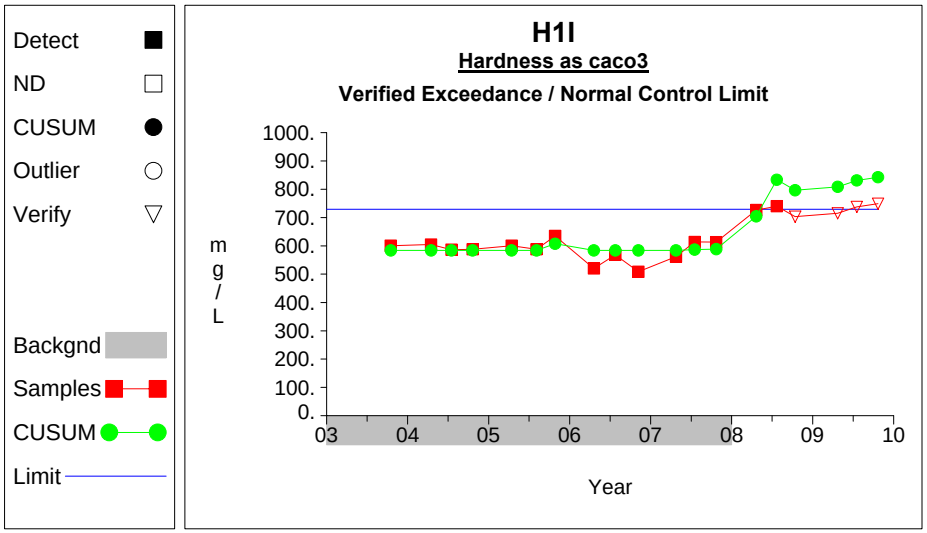



**Figure 3**
**Historical Well and Precipitation Hydrograph**

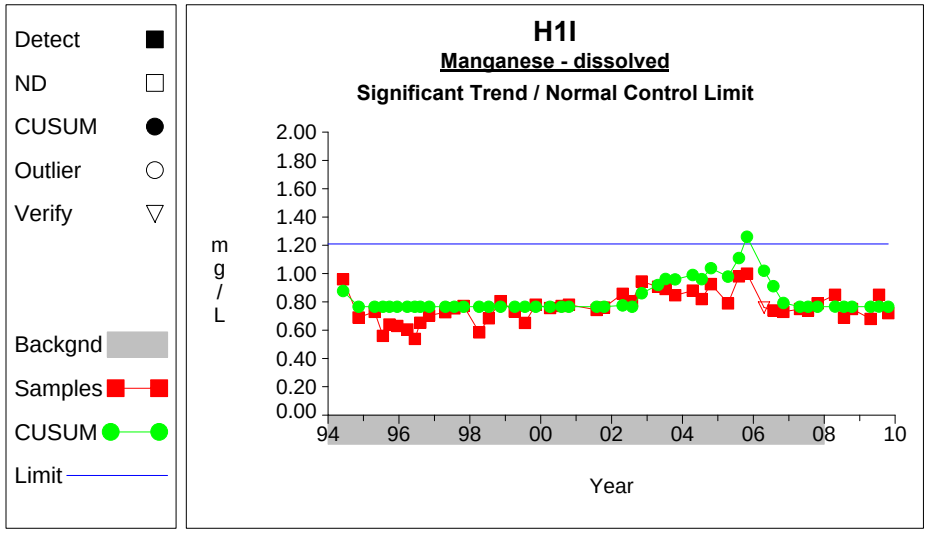
# Figure 4 - HX Well Charts



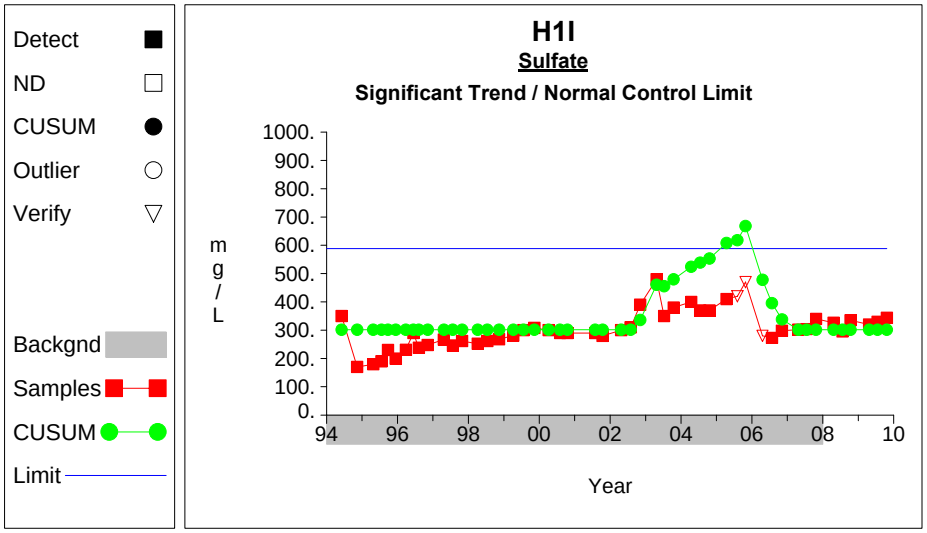

Graph 5




Graph 11

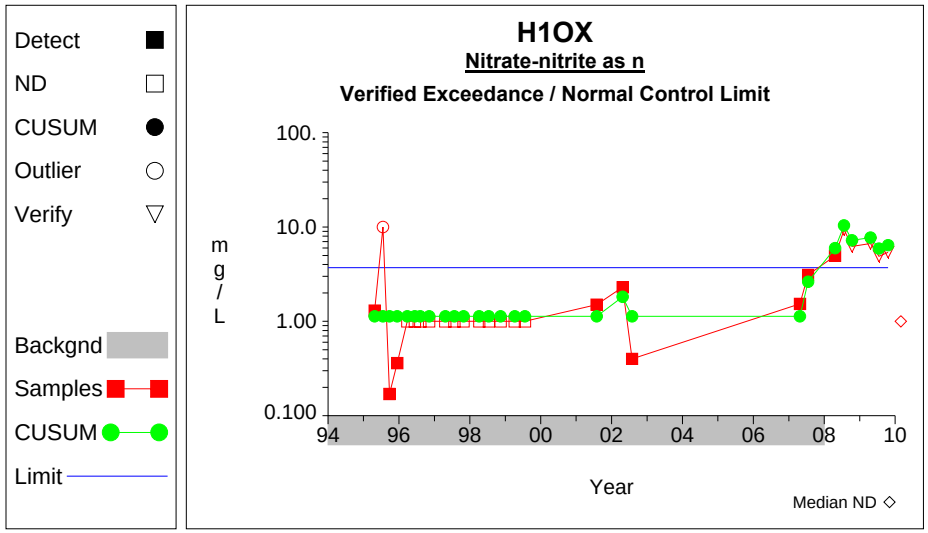



Graph 14




Graph 21

# Figure 4 - HX Well Charts




**Graph 40**

# Appendix A

## Statistical Methods and
## Barr Engineering Co. Statement of Qualifications

# Appendix A.1
# Barr Engineering Qualifications

## Company Information

Barr provides a wide range of engineering and scientific consulting services. Barr traces its origins to the early 1900s, and was incorporated as an employee-owned firm in 1966. Our company, which is based in Minneapolis, has gained the confidence of clients throughout the upper Midwest and the nation, serving private industry, mining, energy, first nations, law firms, and all levels of government.

Barr has branch offices in Bismarck, North Dakota, Duluth and Hibbing, Minnesota; Jefferson City, Missouri; Ann Arbor, Michigan, and Calgary Alberta. Drawing upon skills in more than two dozen technical areas, our staff is able to form multidisciplinary teams to meet those needs in the areas of:

- Solid and hazardous waste management and site remediation
- Water resources management
- Environmental management
- Air quality
- Process and materials handling
- Facilities and infrastructure engineering
- Information technology

Barr employs approximately 450 engineers, scientists, and support staff in the following disciplines:

| Engineering/Design | Science | Support Services |
|---|---|---|
| Agricultural | Atmospheric Science | Accounting |
| Architectural | Biology | Computer Science |
| Chemical | Biochemistry | Drafting/Graphics |
| Civil | Chemistry | Field Operations |
| Electrical | Data QA/QC | Laboratory Operations |
| Environmental | Forestry | Library Science |
| Geologic | Geochemistry | Information Management |
| Geotechnical | Geology | Public Relations |
| Hydraulic | Geophysics | Surveying |
| Hydrologic | Hydrogeology | Technical Writing |
| Mining | Industrial Hygiene | Word Processing |
| Mechanical | | Expert testimony |
| Structural | Public Health | |
| Water Resources | Statistics | |
| | Soil Science | |
| | Toxicology | |

Barr uses a project team approach that matches our expertise with the unique requirements of each project. Overall responsibility for each project is maintained by an officer of the company. Barr uses computer and data processing systems to manage and monitor budgets, staff workloads, and billings for all projects.

Quality control on each project is the responsibility of every member of the project team. Reports, designs, and specifications are prepared to meet the client's requirements. Barr's quality assurance program includes:

- Obtaining clear and complete understanding of the client's needs
- Communication among team members and with the client as work progresses
- Peer review as the work progresses
- Evaluation of completed documents for technical accuracy and cost-effectiveness

## Qualifications and Experience – Hydrogeologic Site Evaluations

Barr conducts hydrogeologic site characterization for a wide variety of clients involved in site response, clean up, permitting and facility operations. Clients include cities, attorneys, developers, and private and public parties that own or operate or are seeking to permit facilities that require subsurface evaluation and assessment of groundwater quality.

Barr has specialized in the investigation and design of remedial actions for contaminated sites since the early 1970s. Our company has completed hundreds of site investigations, feasibility studies, and remedial action designs. This experience includes work on most of the larger contaminated sites in the Midwest as well as numerous smaller sites.

Many projects are initiated by clients who are seeking to clean up or permit a new or existing facility. In many cases a hydrogeologic site characterization is required by statute, rule or consent decree. Other projects are initiated by clients who suspect that contamination may be present on a site. Still other projects are in response to orders from regulatory agencies. Many of these projects involve a state voluntary cleanup program. Barr works for clients in both the public and private sectors, and clients range from major industries to state and federal agencies.

Barr has worked on a variety of properties, including:

- Steel and coke manufacturing
- Wood treating
- Petroleum refining
- Manufacturing (paint waste/spent solvents)
- Coal gasification
- Mining and mineral processing
- Petroleum product storage (above and below ground)
- Metal plating
- Scrapyards
- Landfills
- Fly and bottom ash
- Permitted and nonpermitted waste disposal facilities

Barr staff is familiar with a wide range of industrial practices and we provide environmental and waste management consulting to many industries. The resumes of the specific Barr staff who worked on this site characterization are included in the following pages.

**Experience**

Jim Aiken is a hydrogeologist with more than 18 years of experience in both field investigation and project management. Jim's experience covers a unique breadth and depth of knowledge, including environmental investigation and remediation, brownfields redevelopment, solid-waste investigation and permitting, environmental review, water supply and engineering support for the power industry, facility compliance, environmental management, and expert testimony and legal support.

His project work includes:

**Environmental Investigation and Remediation**

- Serving as senior scientist for environmental investigation and remediation projects for Barr and several other consulting firms. Projects included:

  - Authored multiple Phase I site assessments and Phase II field investigations for several transmission relay tower sites in southern Minnesota.
  - Managing and performing Phase I environmental site assessments for eight compost-yard-waste facilities, as well as assistance with purchase agreement documents and exhibits.
  - Assisting in negotiations and modifications to a voluntary response action plan (RAP) for a former dump-turned ball field that saved the client more than $1.5 million relative to the initial RAP prepared by a previous consultant.
  - Performing a Phase I assessments and Phase II investigation for existing and proposed transmission tower sites. Obtained "no association" letters for the client from the MPCA.
  - Managing the Phase I assessment and Phase II investigation of a former methamphetamine-lab property.
  - Conducting a pre-purchase assessment for a former missile site located in Dakota County, Minnesota.
  - Directing emergency response, brownfield investigation and coordinating forensic contamination study and expert testimony for criminal prosecution at a brownfield site in Jordan, Minnesota.
  - Managing brownfield investigation, remediation, and successful redevelopment of a former gun range and gravel mine in Chanhassen, Minnesota.
  - Conducting a Phase I environmental site assessment and natural resource evaluation for a 260-acre property in Kandiyohi County, Minnesota, that including a 15-acre unpermitted landfill, gravel quarries, and a former railyard.
  - Performing a Phase I property assessment and a Phase II site investigation for a former landfill site in Hackensack, Minnesota.

- Serving as project manager for a subsurface investigation related to an EPA brownfields demonstration pilot in Des Moines, Iowa.

- Serving as project manager for remedial investigation of six former manufactured gas plant (MGP) sites in Iowa.
- Managing the groundwater and geologic investigations for seven former MGP sites in Iowa.
- Conducted high-resolution field mapping of a coarse fluvial aquifer using ground-penetrating radar (GPR) to identify preferential pathways for contaminant migration.
- Constructed a full three-dimensional, finite-difference flow model (MODFLOW) of an outwash aquifer near Stoughton, Wisconsin. The model was linked with a particle-tracking code (PATH3D) to identify sedimentary facies that are associated with preferential contaminant movement.
- Analyzed recovery data for volatile organic compounds and conducted field investigations to optimize pumping-well efficiency at a Superfund site in Minnesota.
- Performed a subsurface investigation to isolate areas of widespread and nonuniform PCB contamination at a former scrap-metal-recycling facility.
- Installed monitoring wells and performed aquifer testing of a low-permeability aquifer at an Oregon site with petroleum distillates in soils and groundwater.
- Investigated and managed response actions at more than 30 petroleum tank and spill sites in Minnesota and Wisconsin. Examples of his work include:
  - Closing out the site of a free-product release in Cambridge, Minnesota.
  - Served as site manager for remedial investigation of extensive diesel contamination at a fuel-oil transfer station in Madison, Wisconsin.
  - Coordinated claims reimbursement under the Petroleum Environmental Cleanup Fund Act (PECFA) for a retail gasoline stores in Eau Claire, River Falls, Somerset, Ladysmith, Waupaca, and Superior, Wisconsin.
  - Completed expedited site investigations and implemented remedial actions at ten gas- and diesel-contaminated sites in Minnesota as part of a regional merger of two petroleum companies.
  - Directed removal and arranged for incineration of approximately 1,200 cubic yards of diesel-contaminated soil from a former fuel-oil storage facility.
  - Assessed distribution of gasoline and diesel in soils observed in trenches and borings at a bulk-storage facility and an active refinery.
  - Designed and tested a pilot soil-vapor-extraction system for a petroleum-contaminated site in Oregon.
- Managed field investigation of creosote-contaminated demolition fill in Golden Valley, Minnesota.
- Conducted ground penetrating radar survey that identified a source area for chlorinated solvent contamination at a site in Mound, Minnesota.
- Participated in a quick response investigation and removal of buried drums discovered during the development of a property in Golden Valley, Minnesota.

- Conducted Phase I and Phase II environmental assessments for property transfers in Minnesota and Wisconsin.

### Solid-Waste Investigation and Permitting

- Serving as principal scientist for solid-waste investigation and permitting projects including:
  - Conducting Phase I, II, and III hydrogeologic investigations and Phase IV work plans for two municipal solid waste (MSW) landfill expansion projects located near Minneapolis, Minnesota.
  - Preparing annual groundwater monitoring reports, database management, and statistical evaluation for three facilities in North Dakota and South Dakota—a total of twelve separate waste-management units.
  - Revising a landfill leachate management plan and providing annual report preparation for a combustor-ash landfill in Sherburne County, Minnesota.
  - Conducting monitoring and hydrogeologic evaluation and statistical analysis for of a 40-acre industrial landfill expansion in Missouri.
  - Preparing an investigation work plan and technical specifications for the continued development of an existing solid-waste facility in Minnesota.
  - Performing field and project management of a streamlined hydrogeological investigation for a landfill expansion that accelerated the completion timeline for the study by more than six months.
  - Providing expert testimony on environmental due diligence and remote-sensing data interpretation for determining past waste disposal activities adjacent to a permitted solid-waste facility.
  - Assessing the suitability of clay-borrow materials for use in landfill-liner construction.
  - Conducting a solid-waste-permitting investigation for the continued development of an existing facility in Minnesota.
  - Calculating synthetic liner and landfill-berm seepage estimates for technical performance evaluation and regulatory review.
  - Conducting a comprehensive multi-site groundwater/surface-water monitoring program for eight coal-ash management units at five separate facilities in Iowa.
- Implementing an integrated geophysical and subsurface boring program to identify areas of leachate accumulation for a landfill in Missouri.
- Successfully obtaining closure of a RCRA facility in Nevada, Missouri.
- Developing a RCRA monitoring assessment program at a former incinerator in Missouri.
- Performing RCRA facility investigation and closure activities at a petroleum-contaminated site in Oregon.
- Coordinated closure/postclosure groundwater monitoring program for two ash landfills in Michigan.

- Performed a hydrogeologic investigation and geophysical mapping for two fly-ash landfill expansions in Michigan.
- Investigated process water quality and groundwater issues near an ash pond in Muscatine, Iowa.
- Developed baseline and postclosure monitoring plans for two industrial-waste landfills in Minnesota.
- Conducted groundwater and geophysical survey to determine limits of sludge ash landfill in Eagan, Minnesota.
- Performed geotechnical testing, construction observation, and documentation of all aspects of landfill construction for six landfills in Wisconsin.
- Modeled transient changes in hydraulic head at a tailings pond near Hibbing, Minnesota, using MODFLOW. The purpose of the simulation was to predict settlement of fine-grained tailing particles to increase pond capacity.
- Tested and installed monitoring devices during landfill liner construction at two sanitary landfills in Wisconsin.
- Managed site characterization and groundwater monitoring plan for a landfill in Cottage Grove, Minnesota.
- Performed hydrogeologic evaluation and managed a field investigation of a landfill and former sewage lagoons in Rochester, Minnesota.

**Environmental Review**

- Serving as senior project manager for multiple site assessment and development projects. Work included:
  - Preparing site permit applications for two nuclear power plant uprate expansions.
  - Conducting comprehensive groundwater evaluation and managing environmental impact statement (EIS) study and siting evaluation for a proposed solid-waste facility in Washington County, Minnesota.
  - Providing detailed research and authoring portions of environmental assessment worksheet (EAW) and EIS documents as a regulatory contractor. Also wrote technical resource documents for private clients and a landfill advisory committee.
  - Preparing EAW and scoping EIS documents for a landfill expansion in Burnsville, Minnesota.
  - Providing a preliminary groundwater/surface-exposure assessment for a proposed commercial hunting preserve in central Minnesota.

**Land-Use Planning**

- Completing an aggregate-resource investigation to estimate mine-worthy quantities of sand and gravel for a site near Jordan, Minnesota.
- Performing an aggregate-resource investigation and mine-development plan for a property in Sibley County, Minnesota.

**Environmental Management**

- Serving as senior scientist for environmental management projects including:
  - Conducting a field audit and developing portions of a revised RCRA facility assessment for a manufacturing plant in Missouri.
  - Conducting spill-prevention-plan compliance review, development, revisions, and integrated recommendations into an ISO 14000-compatible format.
  - Developing spill-prevention-control and countermeasure (SPCC) plans for three waste-to-energy facilities in Minnesota.
  - Assisting in negotiations and review of zoning requirements for a proposed electrical substation on property owned by the city of Hackensack, Minnesota.

**Water-Supply Studies**

- Developing water-supply alternatives for a proposed 500-MW combined-cycle power plant in southwestern Iowa.
- Performing a water-supply and geochemical evaluation for a 750-MW plant and coal-ash-disposal facility near Muscatine, Iowa, that included well installation, groundwater modeling, and a comprehensive well identification, mapping, and well-abandonment program.
- Completing preliminary site selection and water-supply evaluation for a combined-cycle power plant near Appleton, Wisconsin.

**Education**

M.S., Geology (Emphasis: Glacial Geology and Hydrogeology), University of Wisconsin at Madison, 1993

B.S., Geology, University of Wisconsin at Madison, 1986

**Registration**

Registered Professional Geologist: MN, WI, MO, IL

**Certification**

PECFA—Registered Consultant: WI

**Memberships**

Carver County Water Environment and Natural Resources Committee

MPCA Stormwater Steering Committee—Industrial Stormwater Working Group

ASTM International Standards Subcommittee on Soil and Rock

Minnesota Groundwater Association

**Presentations/ Publications**

"The Lexington Manor debacle—a costly transition from former gun range to residential subdivision." Presented at the 2005 MPCA Air, Water, and Waste Conference, 2005.

“Assessment of Leachate quality—implications for solid waste management planning” by T.R. Johnson, J.S. Aiken, and J. Cetrullo. Presented by Deborah MacDonald at the 2005 MPCA Air, Water, and Waste Conference, 2005.

“A new method for mapping hydraulic conductivity using sonic methods in fractured bedrock geologic settings.” Presented at the 2005 Air, Water, and Waste Conference sponsored by the Minnesota Pollution Control Agency (MPCA), 2005.

“Site-specific groundwater flow model for evaluation of landfill liner design and comparison to IWEM results” with J.R. McCain and M. Lynn. Presented during the 2004 MPCA Air, Water, and Waste Conference, 2004.

“Sedimentology and hydrogeology of two braided stream deposits” by M.P. Anderson, J.S. Aiken, E.K. Webb and D.M. Mickelson, (in press) Journal of Sedimentology special issue on sedimentology and hydrogeology, June 1999.

“A three-dimensional characterization of coarse outwash used for modeling contaminant movement.” Presented at the North-Central Section Geological Society of America’s 1994 Annual Meeting, Kalamazoo, Michigan, 1994.

“Current approaches to joint hydrogeological and sedimentological research.” Presented at the Geological Society of America’s Annual Meeting, Symposium on Sedimentologic and Stratigraphic Framework of Groundwater Resources Investigations, Boston, Massachusetts, 1993.

“Estimating hydraulic conductivity of outwash deposits using sedimentary facies architecture.” Presented at the American Water Resources Association, Wisconsin Section Sixteenth Annual Meeting, LaCrosse, Wisconsin, 1992.

“Use of process simulation models to estimate the heterogeneity of hydraulic conductivity.” Presented at the American Water Resources Association, Wisconsin Section Fifteenth Annual Meeting, Oshkosh, Wisconsin, March 1991.

“Preliminary characterization of a hydrogeologic facies model for an outwash sand and gravel deposit in Wisconsin.” Presented at the Midwest Symposium of Research in Hydrogeology, Northern Illinois University, Dekalb, Illinois, October, 1991.

202527

# Appendix A.2 Statistical Analysis Methods

This appendix describes the statistical tests used and supporting rationale for their application.

### A.1 Tests of Normality

Tests of normality are performed automatically by DUMPStat using ASTM D 6312 Standard methods. The Shapiro-Wilk test is applied to *n* background measurements using either the multiple group or single group method versions of the test. If normality is rejected, the measurements are log-transformed and the test repeated. If the subsequent results are greater than the level of significance for the G test statistic (0.01), then distribution statistics cannot be calculated and non-parametric methods are used.

### A.2 Outliers

No monitoring data from a current event can be considered an outlier unless verification resampling indicates that it was a false positive. Outliers are mainly a consideration in calculation of mean and standard deviation of the background data distribution. This helps prevent negative or positive bias in setting statistical limits. For this project, DUMPStat has been set to screen outliers from background using the method of Dixon if greater than 25% of the values are detected. An outlier is determined if it is both indicated by the Dixon test and it is ten times the median value for the remaining distribution.

Outliers are shown on the graphical output but are not used in calculations to determine a statistically significant increase or SSI. If a future measurement is found to be an outlier (due to verification resampling) it is removed from the database to prevent it from artificially inflating control limits.

### A.3 Updating Background

Intrawell methods use historical data from each well to establish a statistical control thresholds based on previous background data. Confirmed releases and verified outliers are screened from the background to prevent bias in future statistical comparisons. Outlier values that were refuted by resampling are “replaced” in the background dataset with the verification sample value. This is done by deactivating them from statistical calculations within DUMPStat. The values will still continue to be shown on the graphs using a different symbol. Confirmed releases are handled on a well-by-well basis, but generally a release would freeze the background at the time that the verified SSI appears within the historical data set. This level may also be determined by a combination of Sen’s Trend testing, visual identification of slope inflection, and/or site information that reliably establishes the date of release.

Because each area has a slightly different history and monitoring goals, updating of the background varies for different well groups as described in each of the following summaries.

### A.4 HX-Series Wells Statistical Tests (Intrawell Control Charts)

These wells monitor the ADA and are used for detection monitoring. Variation in permeability and water quality at the Facility indicate intrawell (same-well) statistical comparisons are the preferred method of analysis.

Sen's trend testing has indicated increasing trends for several parameters in some of the wells, including the furthest upgradient well nest H4X. Standard statistical protocols (EPA, 1992) suggest that intrawell tests not be used where increasing trends related to a release from the facility may mask a potential SSI.

However, this method is appropriate for these wells because the upward trends observed in the HX-series wells are mainly found in wells that are upgradient of the ADA. Therefore, trends for these parameters observed in downgradient wells (H1-Ox and H1-I) are not related to the ADA. This overprint of ambient conditions on downgradient wells is referred to as a 'superimposed' effect in this report to refer to upgradient or ambient groundwater conditions. These changing upgradient conditions are part of the background data that must be used to characterize water quality conditions each location.

The use of intrawell methods under these circumstances is described in ASTM (2006). The superimposed background is also similar to adjustments for seasonal effects discussed by Gibbons (2001).

The specific intrawell method used is the Shewhart-CUSUM control charts. These charts combine two different statistical tests in comparing the historical distribution of the background events at each well with the current monitoring data. Both short-term (Shewhart Limit or SCL) and long-term gradual trends (CUSUM) limits are used to detect a change in the sample distribution. Sen's trend tests are also performed. If a well/parameter exceeds the control limits during two consecutive events it is considered an SSI. If the SSI appears due the ADA, and is above water quality standards, appropriate additional actions will be required to assess the source of the change in groundwater quality. Such additional actions may include quantitative geochemical evaluation of potential sources, additional wells, and/or ash leachate testing.

Background data are updated every year with a two year lag behind the monitoring year (e.g. 2007 results are compared to background through 2005). This method is consistent with ASTM 6312 guidance.

### A.5 SX-Series and BCX-Series Statistical Tests

These wells monitor the Brine Pond Area. Groundwater monitoring for the SX-series wells is used corrective action monitoring for the old closed brine pond. The purpose of monitoring for these wells is not to detect a release but to document extent of the

previous release and improvements in water quality resulting from the BCSP pond improvement and containment systems. The BCX-Series wells are primarily used for detection monitoring and also for monitoring past corrective action monitoring near the EBP.

For the SX-series and BCX-series wells, the threshold limit used for comparison is a statistical baseline unique to each location. Since no fixed value has yet been established (data are still trending upward for the SX-series wells and BCX-series wells were first sampled in 2007), the intrawell prediction limit (IPL) method (ASTM, 2006) and Sen's trend testing are used to observe improvements in groundwater and establish thresholds for future detection monitoring. Background data are updated continuously including the monitoring year for these wells. Once eight events are achieved, the BCX-series wells will be updated every year with a two-year lag similar to the HX-series wells described above.

### A.6 Surface Water Pond Evaluation

As described above, the ADA includes the Ash Runoff Pond and is a permitted unit. The Ash Runoff Pond data are not used for compliance monitoring. These data are evaluated using time series graphs with Sen's trend testing to observe long term changes in water quality. These changes are likely related to concentration of ions due to evaporation and possibly due to natural variability in coal and related residues.

The Evaporation, Cooling, and Holding Pond data are not solid waste disposal areas and not sampled for compliance monitoring. The pond data is evaluated with time series graphs. Because pond water quality is expected to vary depending on numerous process factors, statistical tests are not used to evaluate these data. Background for these wells is updated continuously through the monitoring year.

# Qualification Statement

## COMPANY BACKGROUND

Era Laboratories incorporated in 1977 and has provided its clients with analytical laboratory services since that time. The laboratory performs compliance monitoring for Safe Drinking Water Act, Clean Water Act (NPDES) and RCRA programs, as well as chemical and biological testing for product evaluation, environmental monitoring and research support.

## CERTIFICATIONS

Era Laboratories, Inc. currently hold laboratory accreditation from the Minnesota Department of Health, The Wisconsin Department of Natural Resources, and the North Dakota State Department of Health.

## STAFF

Era Laboratories, Inc. currently employs 18 individuals, all of whom work at, or out of, the home office in Duluth.

| Name | Status | Education | Env Lab Experience | Years at Era Labs | Position |
|---|---|---|---|---|---|
| Susan D. Magnuson | FT | BBA, UMD | 30 | 30 | President |
| Robert D. Magnuson | FT | BA Chem, UMD | 38 | 32 | Lab Dir |
| James T. Taraldsen | FT | BS Bio, UWS | 24 | 18 | Lab Mgr |
| Joseph R. Dierkes | FT | BS Bio, UMD | 20 | 9 | Proj Mgr |
| Kevin Donahue | FT | BS Env Chem, GSU | 24 | 3 | Proj Mgr |
| Laura Lubahn | FT | BS Earth Sci, Northland | 24 | 1 | Proj Mgr |
| Laura M. Flood | FT | BA Nat Science, CSS | 18 | 15 | Client Service |
| Angela Kissel | FT | BS Field Bio, St. Cloud | 3 | 2 | Analyst |
| Janell Virnig | FT | BS Bio, UWS | 2 | 2 | Analyst |
| Abhilasha Shrestha | FT | BS BIO, UMD | 1 | 1 | Analyst |
| Phillip Defoe | FT | HS | 1 | 1 | Lab Tech |
| Anna Hafdahl | PT | UMD Student | 1 | 1 | Lab Tech |
| Bishal Thapa | FT | BS Biomed Sci, St.Cloud | 1 | 1 | Lab Tech |
| Annette L. Panfil | PT | Secretarial Certificate | 13 | 13 | Secretary |
| Charles E. Prudhomme | on call | BA Geography UMD | 17 | 17 | Field Services |
| Peggy E. Donahue | PT | BS Sci, Herzing College | 17 | 6 | Accounting |
| Gail Prudhomme | PT | HS | 3 | 3 | Shipping |
| Connie Amborn | PT | HS | 4 | 4 | Receiving |

RESUMES OF KEY PERSONNEL

Susan D. Magnuson is President and Business Manager. Ms. Magnuson is a graduate of the University of Minnesota, Duluth, with a Bachelor of Business Administration degree. She is in charge of all business and financial operations.

Robert D. Magnuson is Vice President and Laboratory Director. Mr. Magnuson received a Bachelors Degree in Chemistry from the University of Minnesota, Duluth in 1969 and began working in an environmental lab in 1971. From 1977 to present, Mr. Magnuson has served as Laboratory Director of Era Laboratories, Inc.

James E. Taraldsen is the Laboratory Manager. Mr. Taraldsen received a Bachelor of Science degree with a Major in Biology and a Minor in Chemistry from the University of Wisconsin, Superior in 1985. He began employment with Era in 1991. His previous experience included protocol development for acute and chronic toxicity tests, as well as Toxicity Identification Evaluations (TIEs), for the Environmental Protection Agency (USEPA). He also served as Laboratory Supervisor at Mid-State Associates. Mr. Taraldsen is responsible for performing and overseeing inorganic and organic analyses, and toxicological studies at Era.

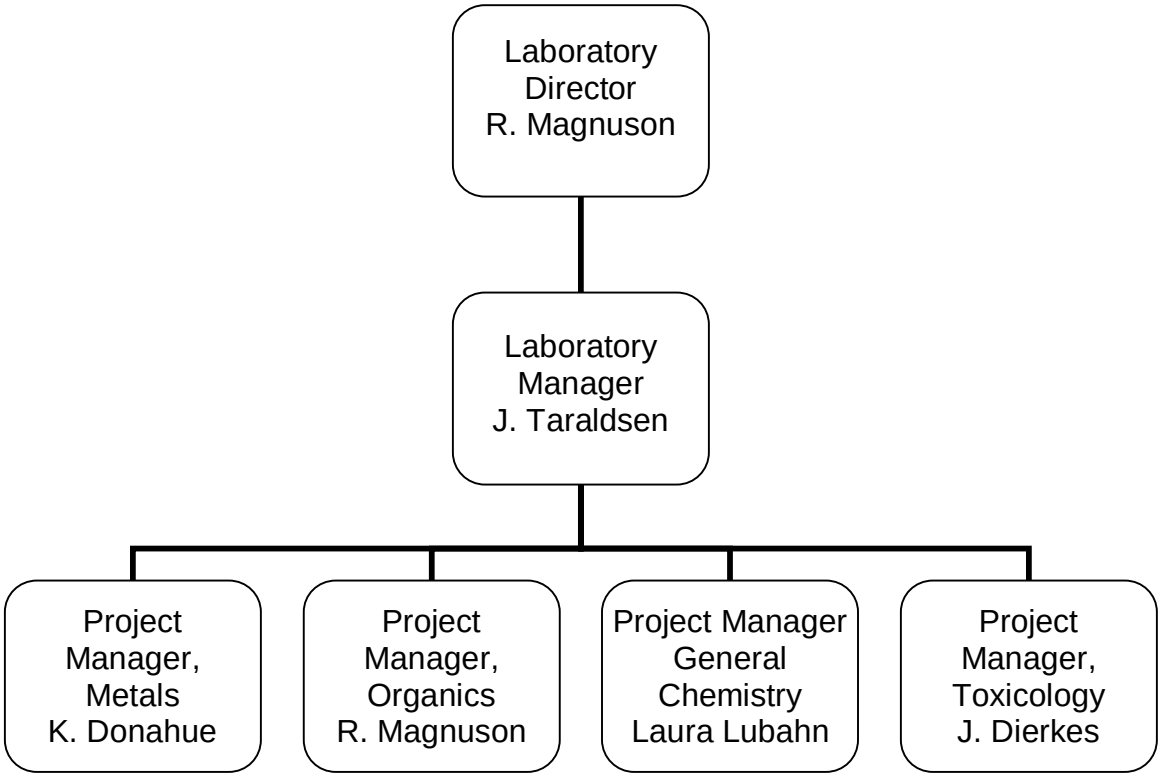
Joseph R. Dierkes is the Project Manager for Toxicology. Mr. Dierkes received a Bachelor of Science degree with a Major in Biology and a Minor in Chemistry from the University of Minnesota, Duluth in 1989. He began employment with Era in 2000. His previous experience includes laboratory and guidance document development for acute and chronic TIEs with aqueous and sediment samples for the USEPA. He also served as Supervisory Biologist and Operations Manager at AScI Corporation where he was responsible for conducting, reporting, and managing effluent and sediment associated environmental studies. Mr. Dierkes is responsible for performing and overseeing toxicological studies at Era, which includes routine chemical analysis along with the biological studies.

Kevin Donahue is the Project Manager for Metals Analysis and is Safety Coordinator. Mr. Donahue received a Bachelor of Science degree from Governors' State College in University Park, Illinois with a major in environmental Chemistry. His previous professional experience includes 3 years with Chem Clear (which later became later Clean Harbors), 8 years as a Senior Analyst with RMT labs, 6 years as a Senior Analyst with Enchem (which became part of Pace Analytical) , and 5 years with Northeast Technical Services. He came to work for Era Labs in 2007.

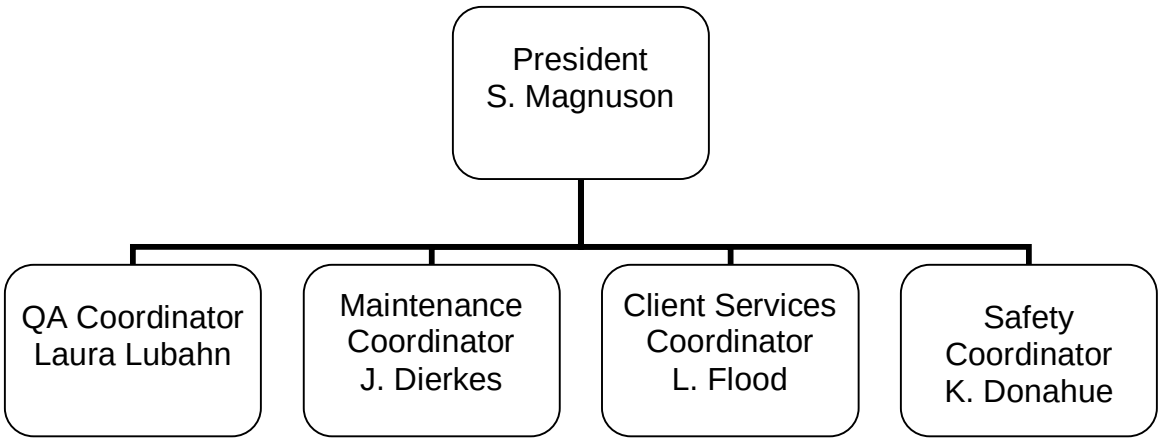
Laura M. Lubahn is the Project Manager for General Chemistry and Microbiology. She received a Bachelors of Arts degree with a major in Earth Sciences from Northland College in Ashland, Wisconsin. Her previous experience includes 4 years as Technical Administrator for Berkley Products, 6 years as an Environmental Scientist at Keystone-Block Transportation, 3 years as Health and Safety Supervisor and Field Supervisor at Edward Armstrong and Sons, 3 years as Compliance Officer and field sampling at J&D Services, and 8 years with Northeast Technical Services as an Analyst, Project Manager, and Health and Safety Coordinator. Ms. Lubahn came to work for Era Labs in 2009.

Laura M. Flood is Era's Client Service Coordinator. Ms. Flood received a Bachelor of Arts degree with a Major in Natural Sciences from the College of St. Scholastica in 1991. She began her employment with Era in 1994. Ms. Flood's previous experience included laboratory analysis for organic chemicals at the USEPA. Ms Flood is responsible for coordinating sample receipt, testing, and reporting of all samples. She is also responsible for management of Era's LIMS system.

## Organization Chart – Analytical Staff




## Organization Chart – Management and Support Staff



## GROUNDWATER MONITORING EXPERIENCE

The following is a list of Groundwater Monitoring projects Era Laboratories has worked on within the past 5 years:

City of Superior – Moccasin Mike Landfill (open)

City of Superior – Wisconsin Point Landfill (closed)

Falkirk Mining/NACRC – Groundwater Monitoring

Kimmes – 2 Demolition Landfills

Minnesota Power – Taconite Harbor Ash Disposal Site

New Page – Hazardous Waste Site

New Page – Industrial Groundwater

Otter Tail Power – Big Stone

Otter Tail Power – Coyote Station

Otter Tail Power – Hoot Lake

Otter Tail Power – VIC Site

Red Lake Reservation – Ponemah Landfill

Red Lake Reservation – Red Lake Landfill

Red Lake Reservation – Redby Landfill

Red Lake Reservation – Shell Lake Landfill

Sokaogon Chippewa – Reservation Groundwater

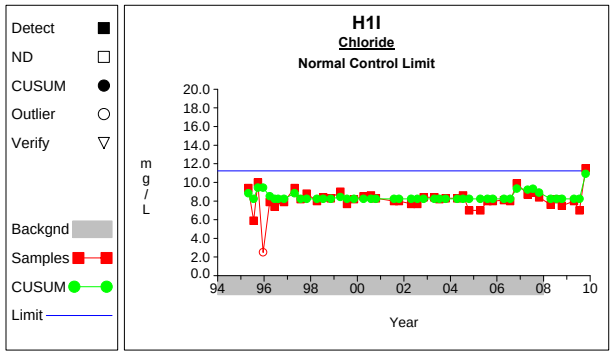
# Appendix B

## Laboratory Reports and Field Data (on CD-ROM)

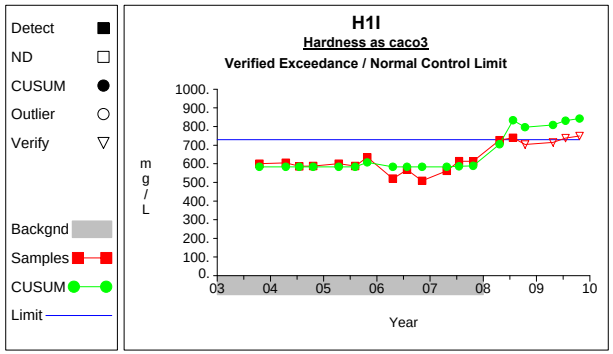
# Appendix C

## Statistical Results and Data Summary
## Ash Disposal Area
## (HX-Series Wells and Ash Runoff Pond)

# Intra-Well Control Charts




Graph 5

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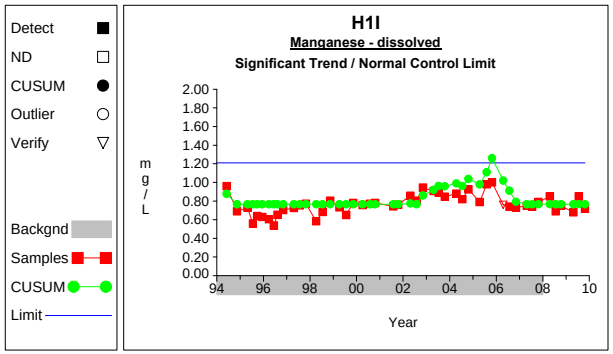


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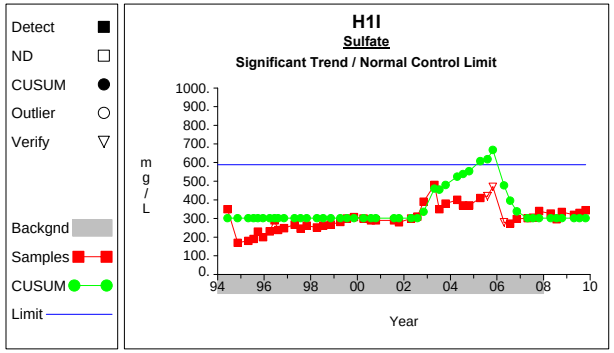


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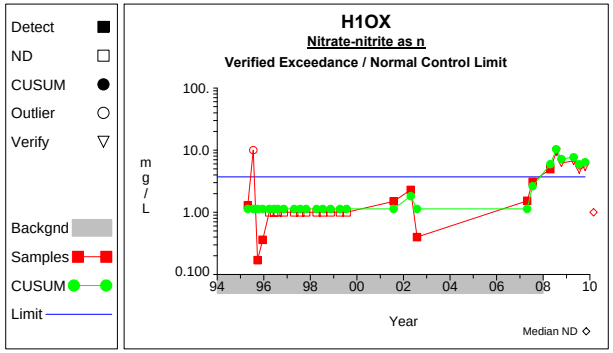


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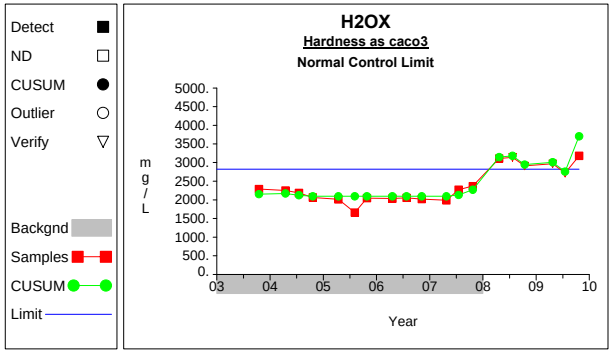


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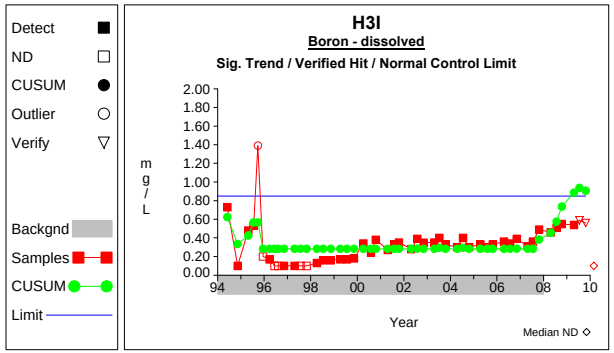


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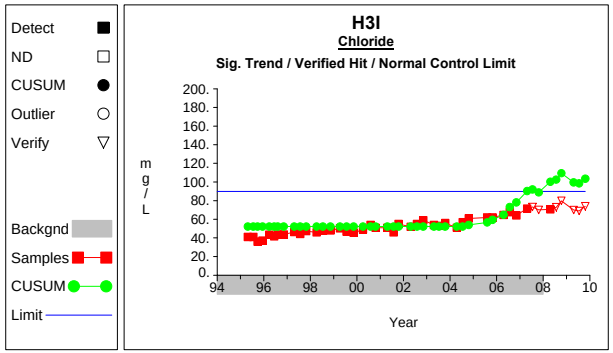
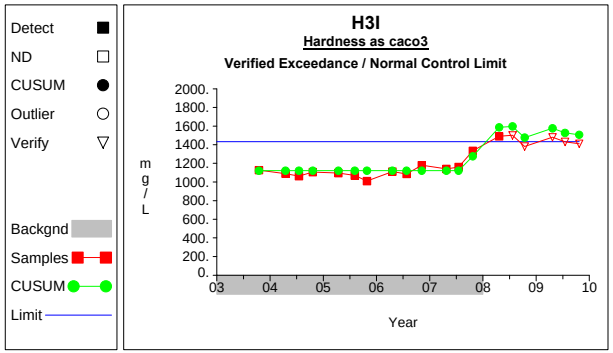
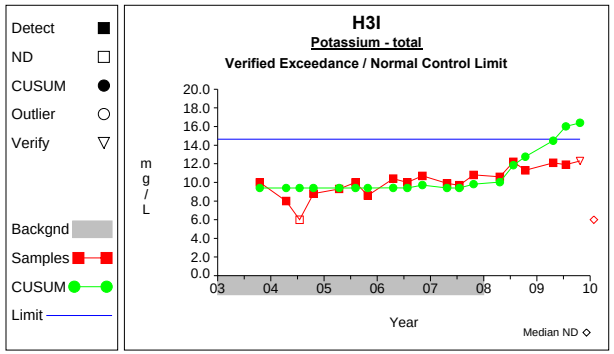



Graph 101

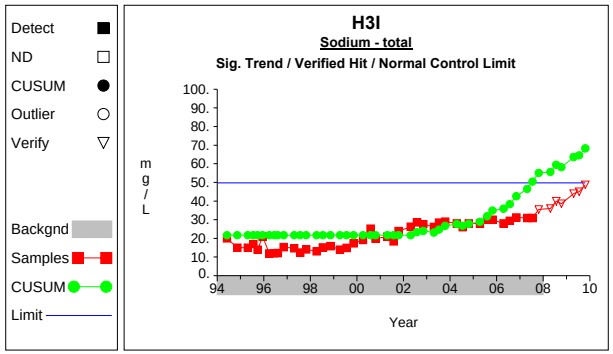



Graph 107

# Intra-Well Control Charts




Graph 112

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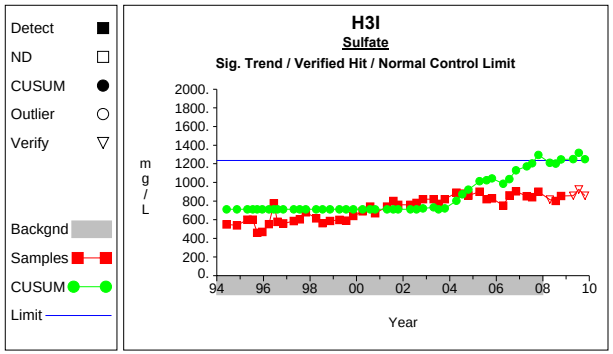


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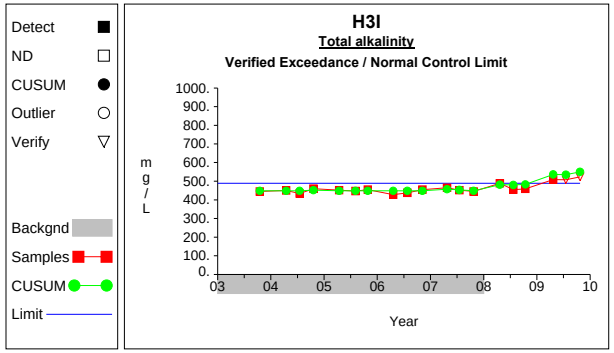


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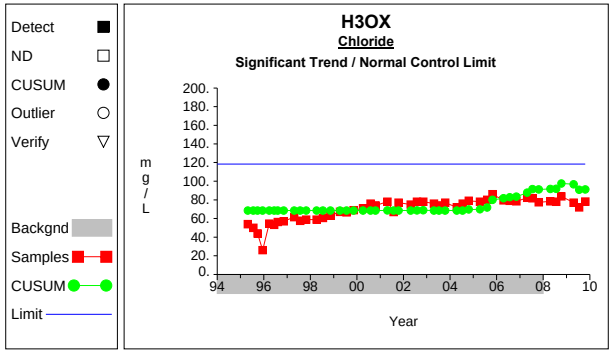


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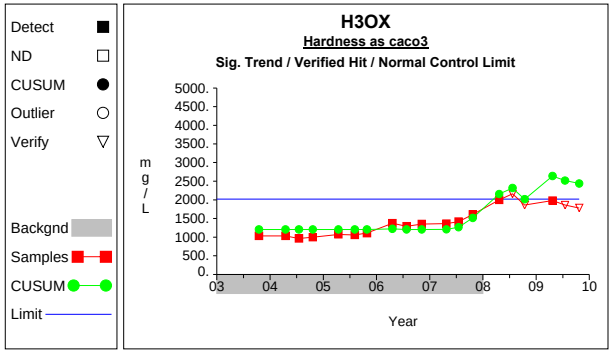
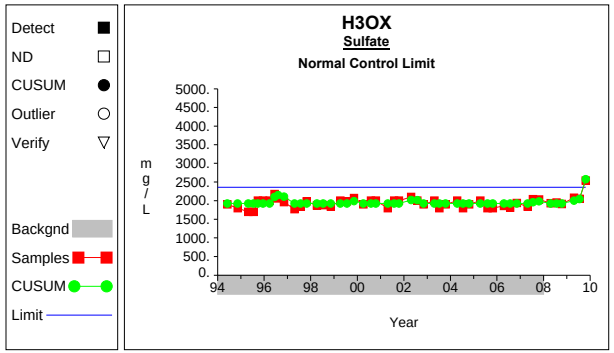



Graph 131

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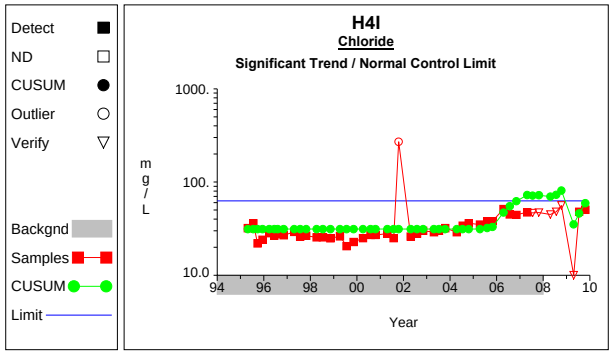


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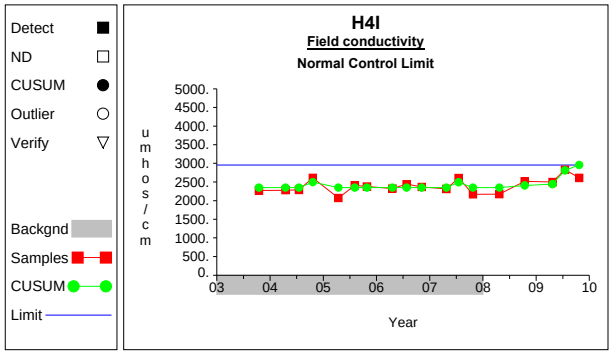
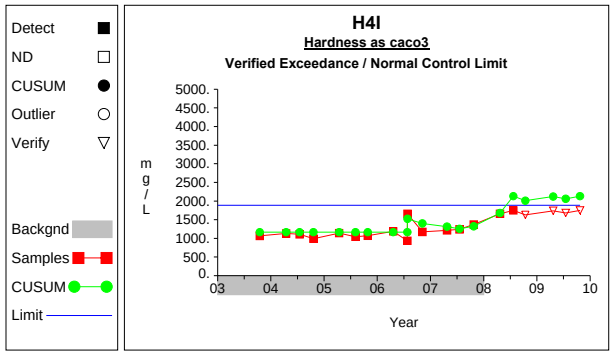
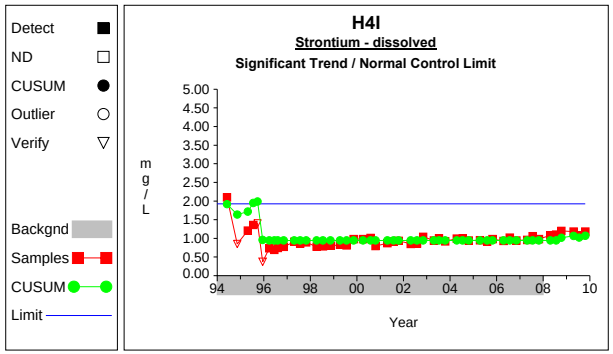



Graph 152

# Intra-Well Control Charts




Graph 155

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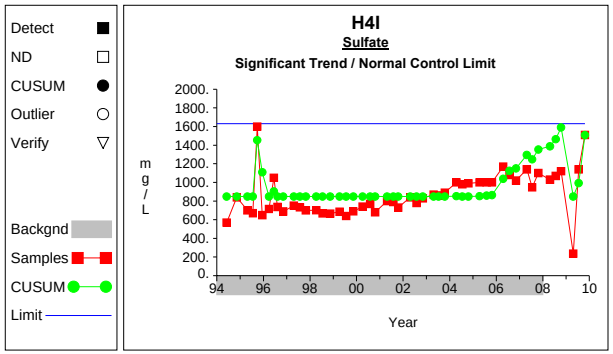


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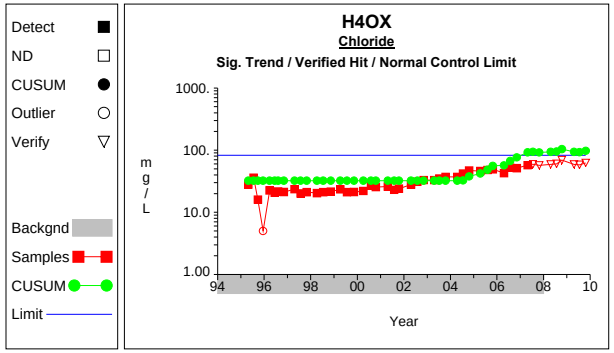


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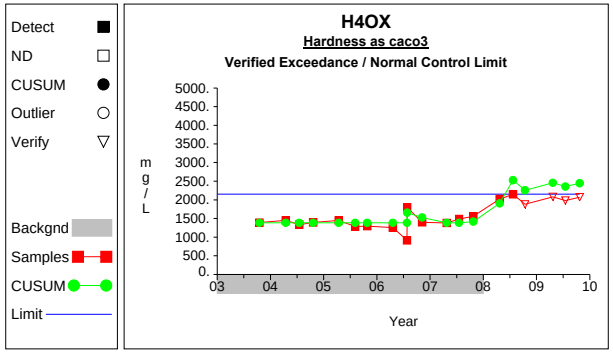


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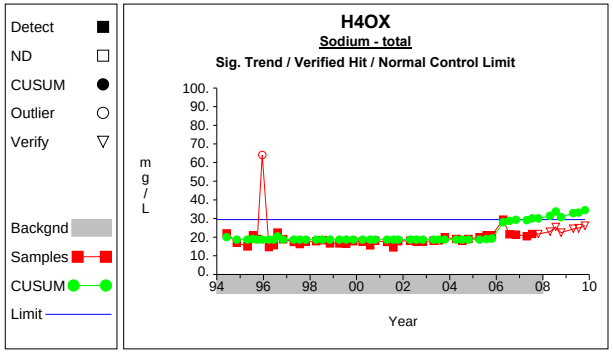


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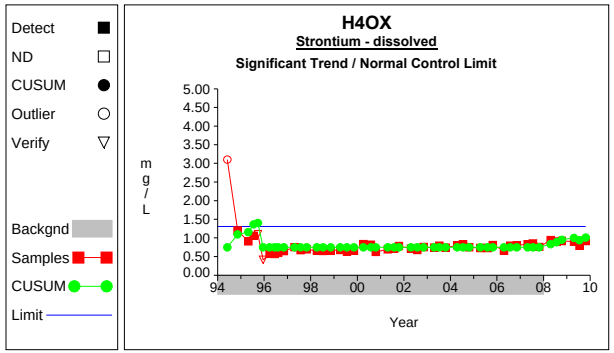


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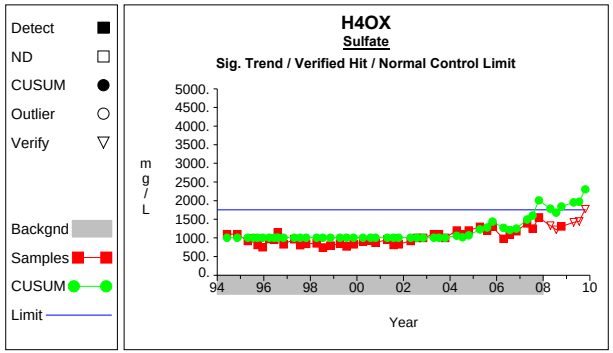



Graph 189

# Table 1

## Analytical Data Summary for H1I

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | .0060 |
| Barium - dissolved | mg/L | .0200 | .0200 | .0200 |
| Boron - dissolved | mg/L | .1400 | 1.0500 | .1000 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 8.0000 | 7.0000 | 11.5000 |
| Chromium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Copper - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Field conductivity | umhos/cm | 1225.0000 | 1373.0000 | 1270.0000 |
| Field ph | s.u. | 6.8400 | 6.7000 | 7.0200 |
| Field temperature | degrees C | 15.5000 | 16.3100 | 10.8000 |
| Hardness as caco3 | mg/L | 715.0000 | 738.0000 | 749.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | .6800 | .8500 | .7200 |
| Mercury - dissolved | mg/L | <.0000 | <.0000 | <.0000 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.0100 | <.0100 |
| Potassium - total | mg/L | 6.0000 | 5.7000 | 6.0000 |
| Selenium - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Silver - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Sodium - total | mg/L | 12.9000 | 12.9000 | 12.8000 |
| Strontium - dissolved | mg/L | .6000 | .5600 | .5900 |
| Sulfate | mg/L | 320.0000 | 330.0000 | 344.0000 |
| Total alkalinity | mg/L | 386.0000 | 404.0000 | 415.0000 |
| Vanadium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Zinc - dissolved | mg/L | <.0050 | <.0050 | .0070 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 2

## Analytical Data Summary for H1OX

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Barium - dissolved | mg/L | .0500 | .0500 | .0500 |
| Boron - dissolved | mg/L | 4.1000 | 4.2200 | 4.2900 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 3.3000 | 2.0000 | 4.2200 |
| Chromium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Copper - dissolved | mg/L | <.0010 | .0010 | .0010 |
| Field conductivity | umhos/cm | 1940.0000 | 1920.0000 | 1730.0000 |
| Field ph | s.u. | 6.8500 | 6.8800 | 6.9300 |
| Field temperature | degrees C | 10.2900 | 9.9700 | 9.7700 |
| Hardness as caco3 | mg/L | 1390.0000 | 1050.0000 | 1100.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | <.0100 | <.0100 | <.0100 |
| Mercury - dissolved | mg/L | <.0000 | <.0000 | <.0000 |
| Nitrate-nitrite as n | mg/L | 6.7000 | 4.9000 | 5.4000 |
| Potassium - total | mg/L | 3.1000 | 3.0000 | 2.7000 |
| Selenium - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Silver - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Sodium - total | mg/L | 39.0000 | 50.6000 | 39.6000 |
| Strontium - dissolved | mg/L | .4900 | .3700 | .4100 |
| Sulfate | mg/L | 369.0000 | 200.0000 | 229.0000 |
| Total alkalinity | mg/L | 905.0000 | 796.0000 | 883.0000 |
| Vanadium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Zinc - dissolved | mg/L | <.0050 | <.0050 | <.0050 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 3

## Analytical Data Summary for H2I

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | | | |
| Barium - dissolved | mg/L | | | |
| Boron - dissolved | mg/L | | | |
| Cadmium - dissolved | mg/L | | | |
| Chloride | mg/L | | | |
| Chromium - dissolved | mg/L | | | |
| Copper - dissolved | mg/L | | | |
| Field conductivity | umhos/cm | | | |
| Field ph | s.u. | | | |
| Field temperature | degrees C | | | |
| Hardness as caco3 | mg/L | | | |
| Lead - dissolved | mg/L | | | |
| Manganese - dissolved | mg/L | | | |
| Mercury - dissolved | mg/L | | | |
| Nitrate-nitrite as n | mg/L | | | |
| Potassium - total | mg/L | | | |
| Selenium - dissolved | mg/L | | | |
| Silver - dissolved | mg/L | | | |
| Sodium - total | mg/L | | | |
| Strontium - dissolved | mg/L | | | |
| Sulfate | mg/L | | | |
| Total alkalinity | mg/L | | | |
| Vanadium - dissolved | mg/L | | | |
| Zinc - dissolved | mg/L | | | |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 4

## Analytical Data Summary for H2OX

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Barium - dissolved | mg/L | <.0100 | <.0100 | <.0100 |
| Boron - dissolved | mg/L | .3200 | .2800 | .3200 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | <20.0000 | 2.0000 | 3.4100 |
| Chromium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Copper - dissolved | mg/L | .0040 | .0040 | .0030 |
| Field conductivity | umhos/cm | 4240.0000 | 4690.0000 | 4180.0000 |
| Field ph | s.u. | 6.5500 | 6.6400 | 6.8700 |
| Field temperature | degrees C | 9.9400 | 9.0900 | 8.2900 |
| Hardness as caco3 | mg/L | 2970.0000 | 2720.0000 | 3180.0000 |
| Lead - dissolved | mg/L | <.0050 | .0060 | <.0050 |
| Manganese - dissolved | mg/L | .0300 | <.0100 | .5700 |
| Mercury - dissolved | mg/L | <.0000 | <.0000 | <.0000 |
| Nitrate-nitrite as n | mg/L | .7500 | 1.8000 | 2.0000 |
| Potassium - total | mg/L | 15.4000 | 13.6000 | 15.5000 |
| Selenium - dissolved | mg/L | .0320 | .0270 | .0090 |
| Silver - dissolved | mg/L | .0010 | .0030 | <.0010 |
| Sodium - total | mg/L | 117.0000 | 113.0000 | 93.3000 |
| Strontium - dissolved | mg/L | 2.5900 | 2.4300 | 2.7500 |
| Sulfate | mg/L | 2770.0000 | 2710.0000 | 2790.0000 |
| Total alkalinity | mg/L | 461.0000 | 470.0000 | 518.0000 |
| Vanadium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Zinc - dissolved | mg/L | <.0050 | <.0050 | <.0050 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 5

## Analytical Data Summary for H3I

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Barium - dissolved | mg/L | .0300 | .0300 | .0300 |
| Boron - dissolved | mg/L | .5400 | .5900 | .5600 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 70.0000 | 69.0000 | 74.0000 |
| Chromium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Copper - dissolved | mg/L | <.0010 | .0010 | <.0010 |
| Field conductivity | umhos/cm | 2260.0000 | 2550.0000 | 2360.0000 |
| Field ph | s.u. | 6.5800 | 6.5300 | 6.7600 |
| Field temperature | degrees C | 14.1300 | 12.2100 | 11.5300 |
| Hardness as caco3 | mg/L | 1480.0000 | 1430.0000 | 1410.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | .1000 | .0800 | .0800 |
| Mercury - dissolved | mg/L | <.0000 | <.0000 | <.0000 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.0100 | <.0100 |
| Potassium - total | mg/L | 12.1000 | 11.9000 | 12.3000 |
| Selenium - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Silver - dissolved | mg/L | .0010 | <.0010 | <.0010 |
| Sodium - total | mg/L | 44.0000 | 45.0000 | 48.7000 |
| Strontium - dissolved | mg/L | .9200 | .8100 | .9200 |
| Sulfate | mg/L | 858.0000 | 925.0000 | 857.0000 |
| Total alkalinity | mg/L | 509.0000 | 508.0000 | 523.0000 |
| Vanadium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Zinc - dissolved | mg/L | <.0050 | <.0050 | <.0050 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 6

## Analytical Data Summary for H3OX

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Barium - dissolved | mg/L | .0100 | .0100 | .0100 |
| Boron - dissolved | mg/L | 13.1000 | 12.0000 | 14.0000 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 77.0000 | 72.0000 | 78.1000 |
| Chromium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Copper - dissolved | mg/L | .0050 | .0030 | .0040 |
| Field conductivity | umhos/cm | 4210.0000 | 4620.0000 | 4270.0000 |
| Field ph | s.u. | 7.0100 | 6.8600 | 7.0300 |
| Field temperature | degrees C | 9.1600 | 10.5800 | 11.5900 |
| Hardness as caco3 | mg/L | 1980.0000 | 1860.0000 | 1780.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | <.0100 | <.0100 | <.0100 |
| Mercury - dissolved | mg/L | <.0000 | <.0000 | <.0000 |
| Nitrate-nitrite as n | mg/L | .0700 | .0700 | .1000 |
| Potassium - total | mg/L | 6.4000 | 7.5000 | 6.7000 |
| Selenium - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Silver - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Sodium - total | mg/L | 475.0000 | 93.0000 | 477.0000 |
| Strontium - dissolved | mg/L | 1.0600 | .9500 | 1.0300 |
| Sulfate | mg/L | 2080.0000 | 2050.0000 | 2540.0000 |
| Total alkalinity | mg/L | 678.0000 | 686.0000 | 675.0000 |
| Vanadium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Zinc - dissolved | mg/L | <.0050 | <.0050 | <.0050 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 7

## Analytical Data Summary for H4I

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Barium - dissolved | mg/L | .0100 | .0100 | .0100 |
| Boron - dissolved | mg/L | .1600 | .1600 | .1600 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 10.0000 | 48.0000 | 50.4000 |
| Chromium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Copper - dissolved | mg/L | <.0010 | .0020 | <.0010 |
| Field conductivity | umhos/cm | 2500.0000 | 2830.0000 | 2610.0000 |
| Field ph | s.u. | 6.8100 | 6.9000 | 6.9600 |
| Field temperature | degrees C | 9.5900 | 9.1600 | 8.3800 |
| Hardness as caco3 | mg/L | 1740.0000 | 1680.0000 | 1750.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | .3400 | .2900 | .2700 |
| Mercury - dissolved | mg/L | <.0000 | <.0000 | <.0000 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.0100 | <.0100 |
| Potassium - total | mg/L | 12.6000 | 12.0000 | 13.2000 |
| Selenium - dissolved | mg/L | .0050 | <.0030 | <.0030 |
| Silver - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Sodium - total | mg/L | 31.0000 | 30.1000 | 33.6000 |
| Strontium - dissolved | mg/L | 1.1800 | 1.0800 | 1.1800 |
| Sulfate | mg/L | 236.0000 | 1140.0000 | 1510.0000 |
| Total alkalinity | mg/L | 439.0000 | 438.0000 | 419.0000 |
| Vanadium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Zinc - dissolved | mg/L | .0090 | .0290 | .0120 |

* - The displayed value is the arithmetic mean of multiple database matches.

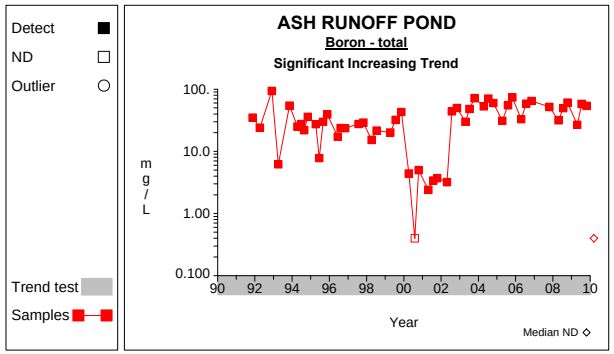
# Table 8

## Analytical Data Summary for H4OX

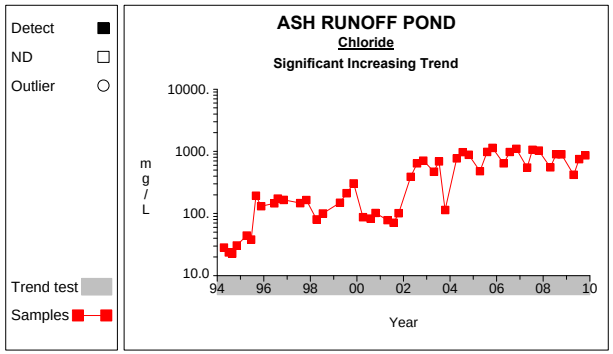
| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Barium - dissolved | mg/L | .0100 | .0100 | .0100 |
| Boron - dissolved | mg/L | .1900 | .1900 | .2200 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 59.0000 | 58.0000 | 62.4000 |
| Chromium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Copper - dissolved | mg/L | <.0010 | <.0010 | .0010 |
| Field conductivity | umhos/cm | 2820.0000 | 3180.0000 | 2940.0000 |
| Field ph | s.u. | 6.7000 | 6.7900 | 6.8800 |
| Field temperature | degrees C | 17.3400 | 9.2300 | 8.5200 |
| Hardness as caco3 | mg/L | 2080.0000 | 1980.0000 | 2070.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | .0200 | .0100 | .0100 |
| Mercury - dissolved | mg/L | .0001 | <.0000 | <.0000 |
| Nitrate-nitrite as n | mg/L | .1700 | .1700 | .1400 |
| Potassium - total | mg/L | 5.8000 | 6.1000 | 6.2000 |
| Selenium - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Silver - dissolved | mg/L | .0020 | <.0010 | <.0010 |
| Sodium - total | mg/L | 24.5000 | 24.8000 | 26.1000 |
| Strontium - dissolved | mg/L | .9000 | .7900 | .9200 |
| Sulfate | mg/L | 1420.0000 | 1440.0000 | 1770.0000 |
| Total alkalinity | mg/L | 487.0000 | 506.0000 | 493.0000 |
| Vanadium - dissolved | mg/L | <.0020 | <.0020 | <.0020 |
| Zinc - dissolved | mg/L | <.0050 | <.0050 | <.0050 |

* - The displayed value is the arithmetic mean of multiple database matches.

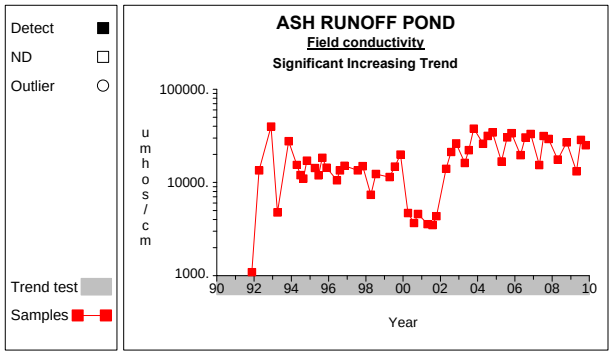
# Time Series



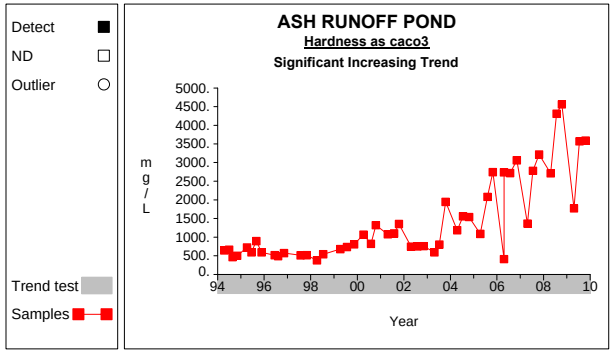

Graph 3



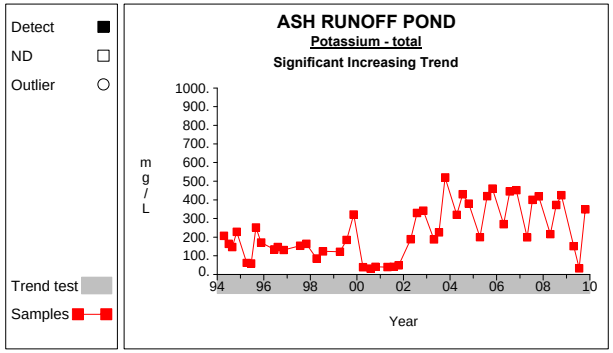

Graph 5



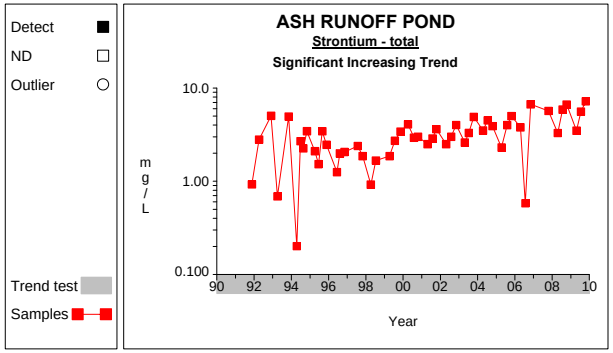

Graph 8



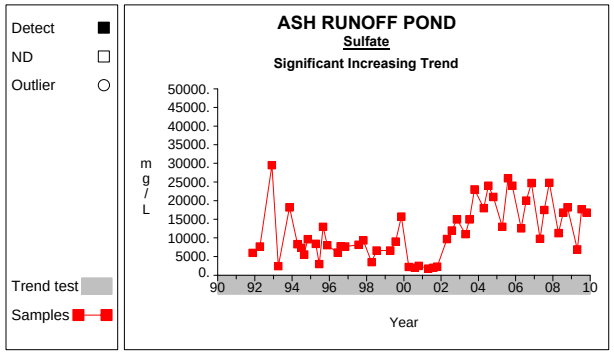

Graph 11



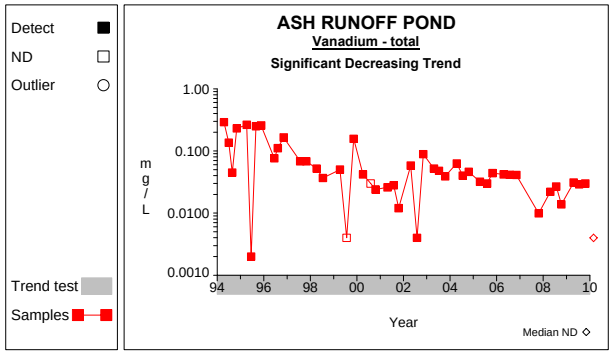

Graph 16




Graph 20




Graph 21




Graph 23

# Table 1

## Analytical Data Summary for ASH RUNOFF POND

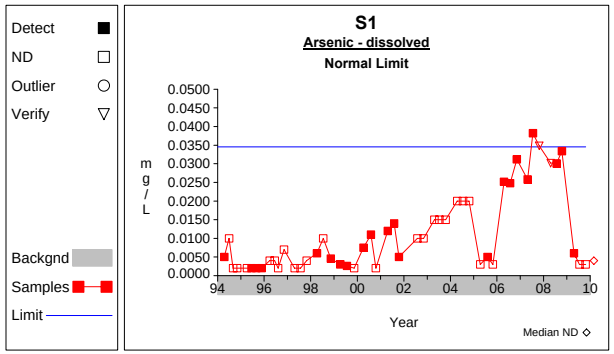
| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - total | mg/L | .0180 | .0410 | .0400 |
| Barium - total | mg/L | .0800 | .1100 | .0900 |
| Boron - total | mg/L | 26.7000 | 58.0000 | 54.0000 |
| Cadmium - total | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 420.0000 | 750.0000 | 864.0000 |
| Chromium - total | mg/L | .0040 | <.0020 | .0030 |
| Copper - total | mg/L | .0020 | .0020 | <.0010 |
| Field conductivity | umhos/cm | 13160.0000 | 28600.0000 | 25100.0000 |
| Field ph | s.u. | 9.0400 | 9.3100 | 9.0300 |
| Field temperature | degrees C | 13.0800 | 20.1600 | 6.5000 |
| Hardness as caco3 | mg/L | 1770.0000 | 3570.0000 | 3590.0000 |
| Lead - total | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - total | mg/L | .2000 | .2000 | .2100 |
| Mercury - total | mg/L | .0001 | .0001 | .0001 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.1000 | .0200 |
| Potassium - total | mg/L | 152.0000 | 32.8000 | 349.0000 |
| Selenium - total | mg/L | .0150 | .0180 | .0190 |
| Silver - total | mg/L | <.0010 | <.0010 | <.0010 |
| Sodium - total | mg/L | 2920.0000 | 6800.0000 | 6900.0000 |
| Strontium - total | mg/L | 3.4900 | 5.5900 | 7.2000 |
| Sulfate | mg/L | 6890.0000 | 17700.0000 | 16800.0000 |
| Total alkalinity | mg/L | 276.0000 | 507.0000 | 491.0000 |
| Vanadium - total | mg/L | .0310 | .0290 | .0300 |
| Zinc - total | mg/L | .0090 | .0150 | .0130 |

* - The displayed value is the arithmetic mean of multiple database matches.

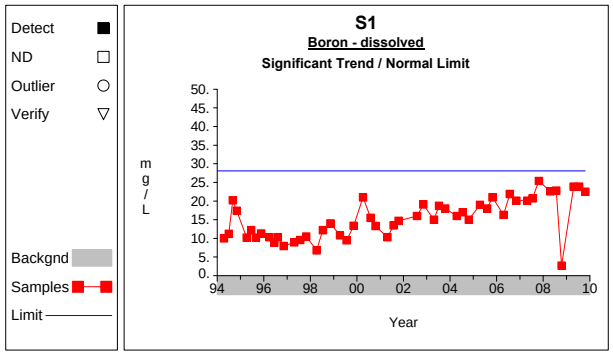
# Appendix D

## Statistical Results and Data Summary
## Brine Pond Area
## (SX-Series and BCX-Series Wells)

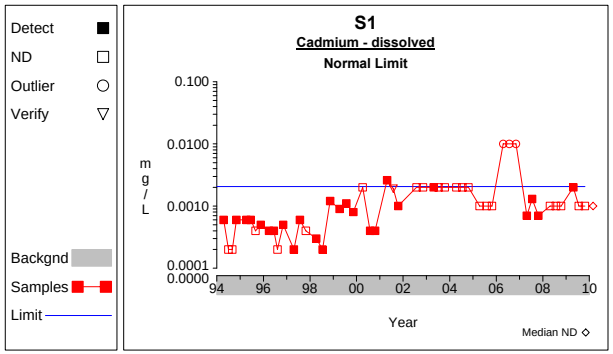
# Intra-Well Prediction Limits



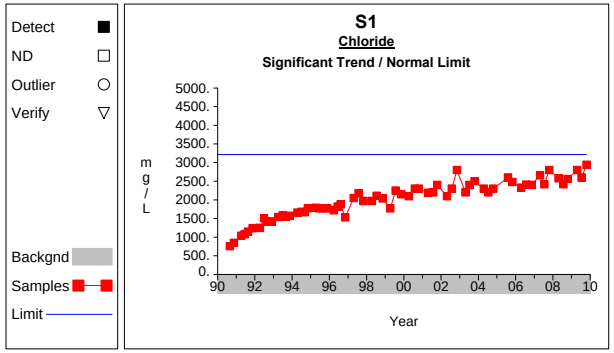

Graph 1



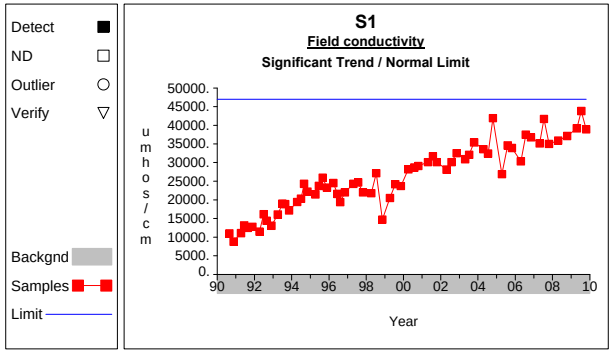

Graph 2



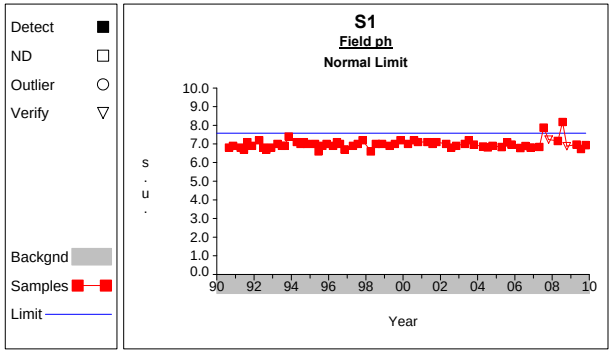

Graph 3



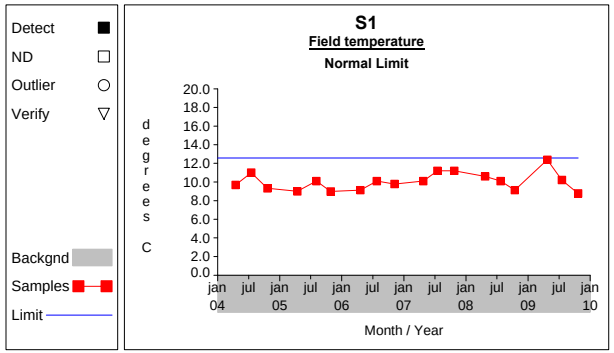

Graph 4



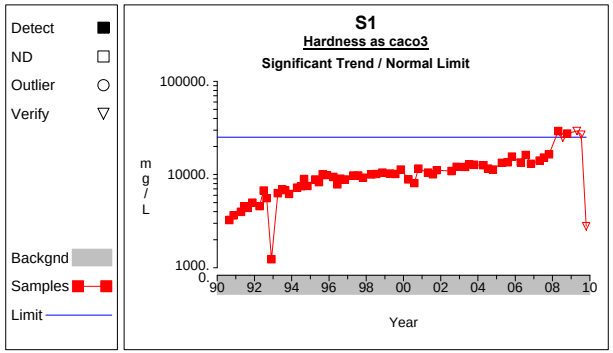

Graph 5



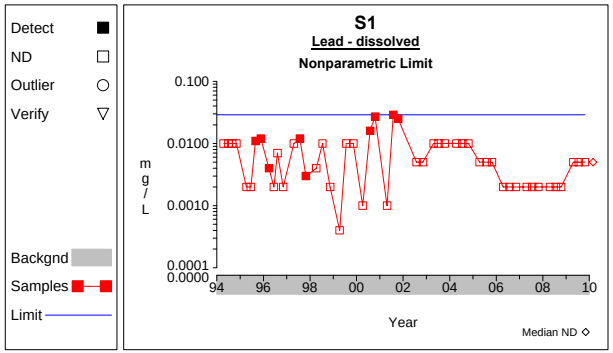

Graph 6




Graph 7

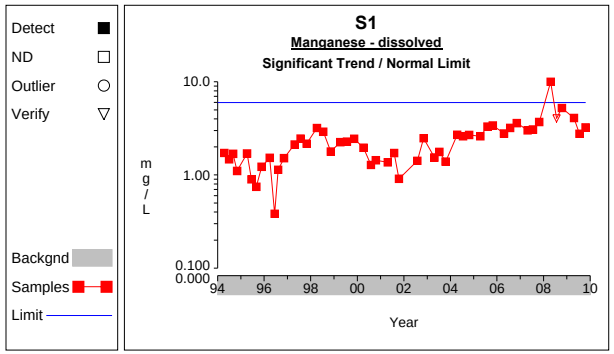



Graph 8

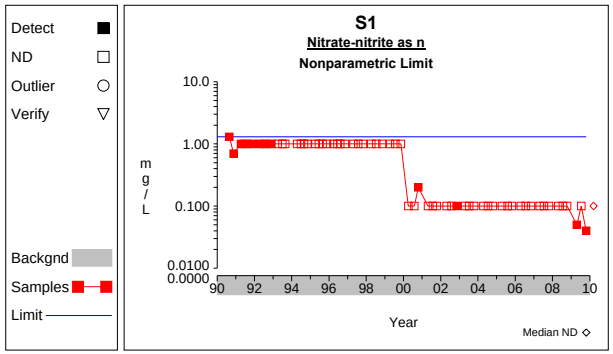



Graph 9

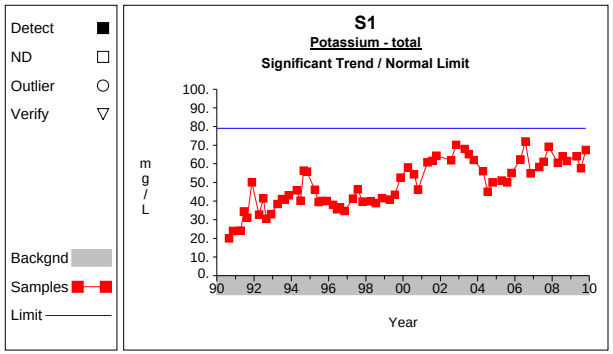
# Intra-Well Prediction Limits



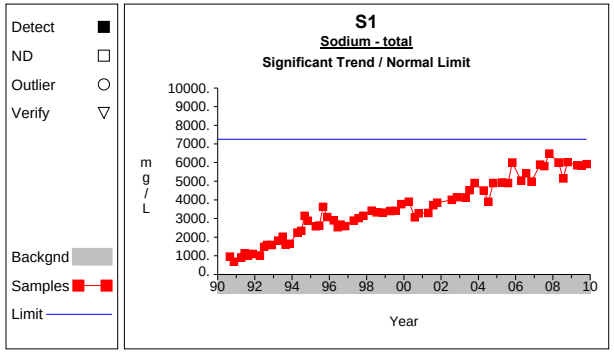

Graph 10



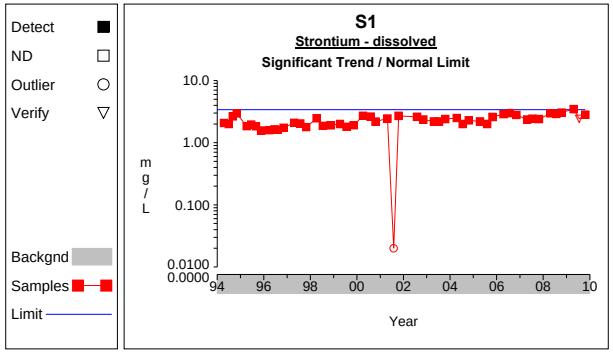

Graph 11



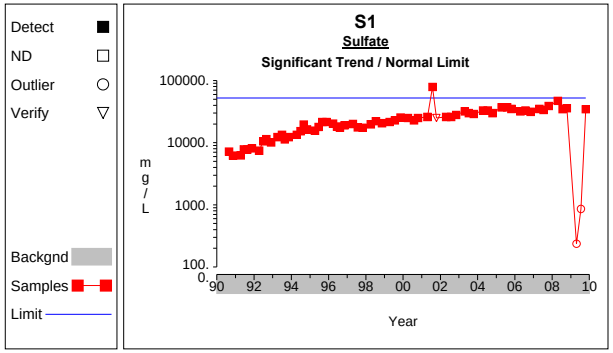

Graph 12



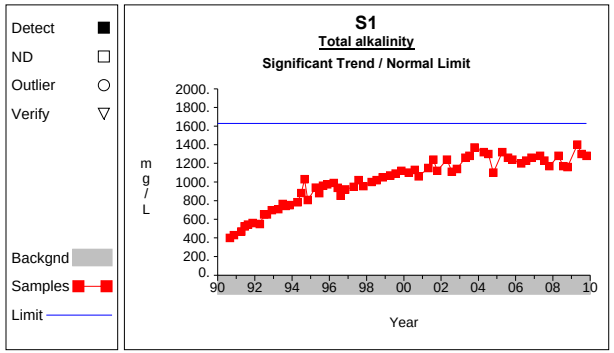

Graph 13



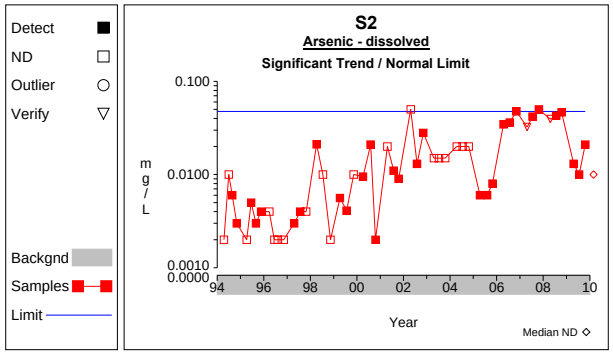

Graph 14



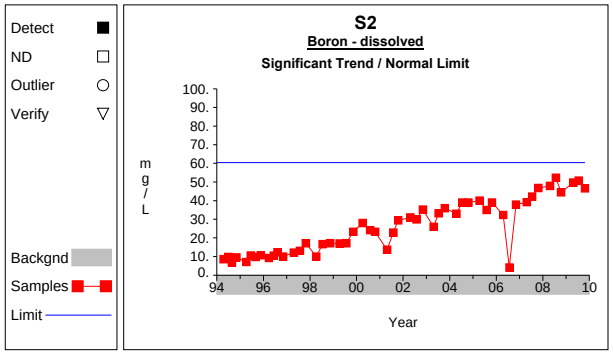

Graph 15




Graph 16

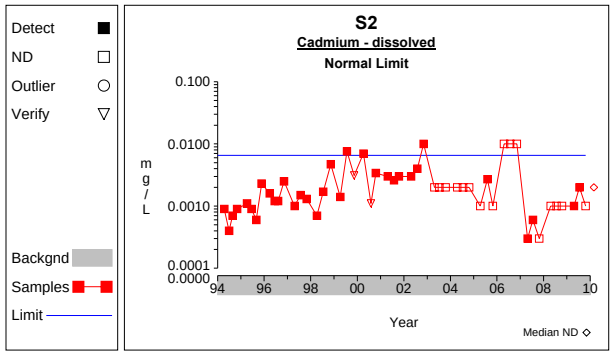



Graph 17

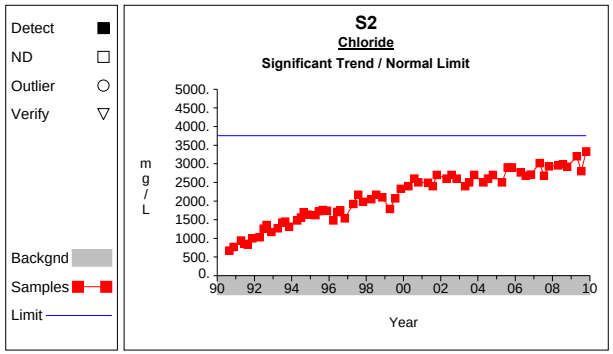



Graph 18

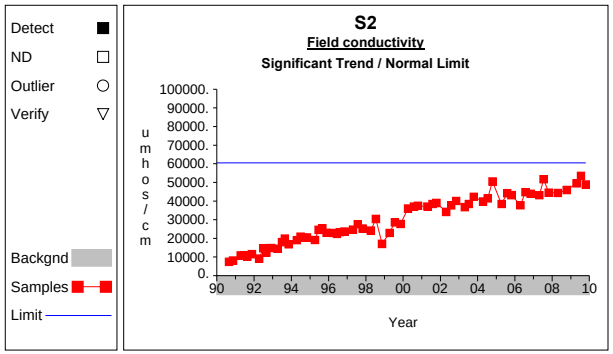
# Intra-Well Prediction Limits



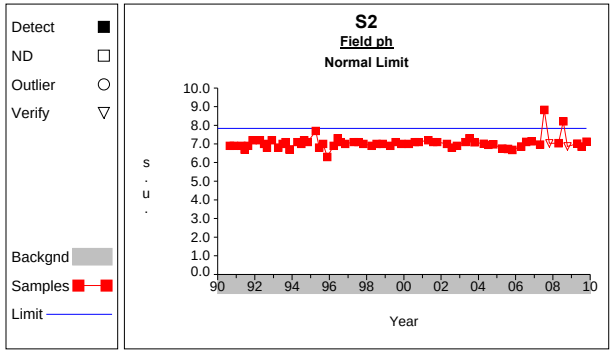

Graph 19



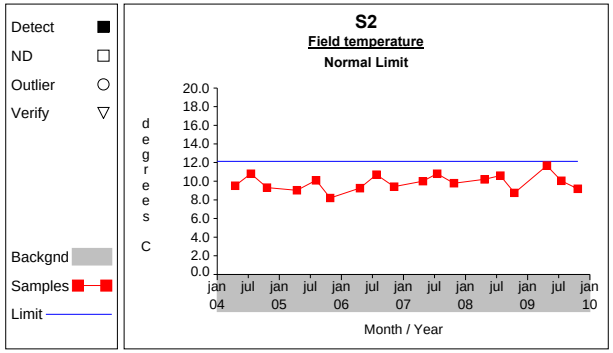

Graph 20



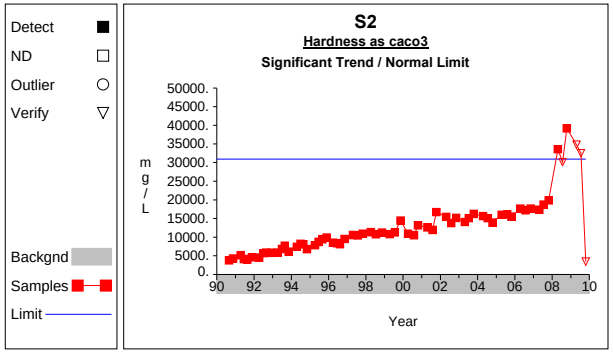

Graph 21



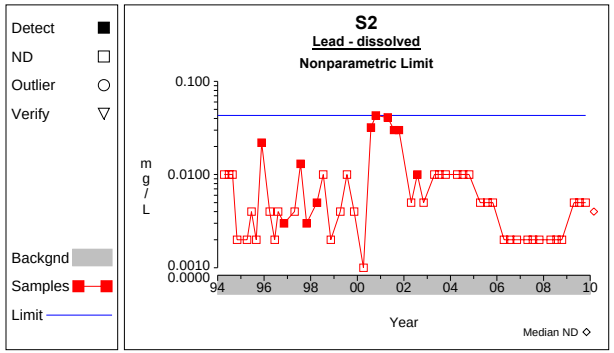

Graph 22



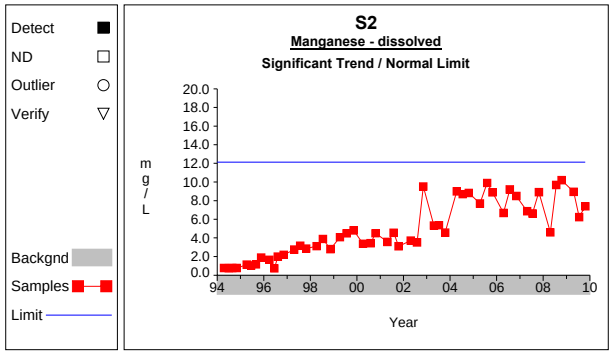

Graph 23



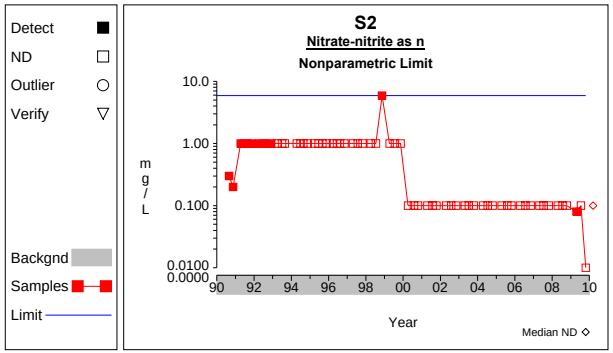

Graph 24




Graph 25

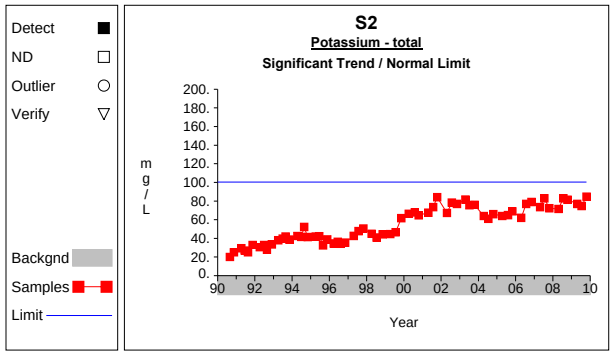



Graph 26

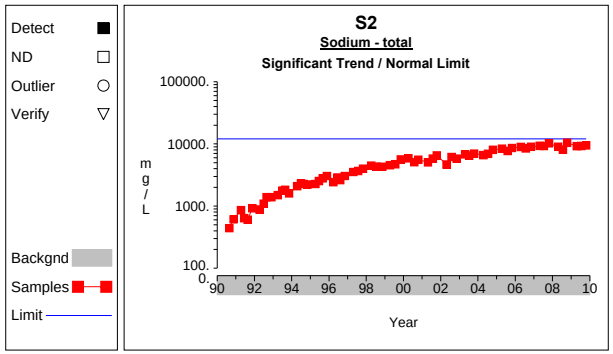



Graph 27

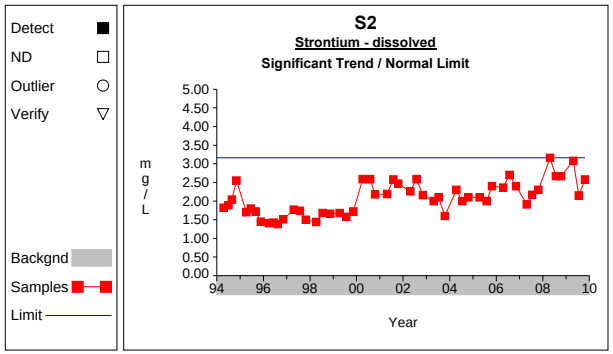
# Intra-Well Prediction Limits



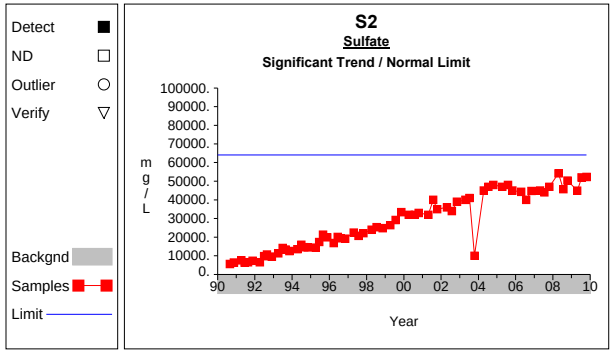

Graph 28



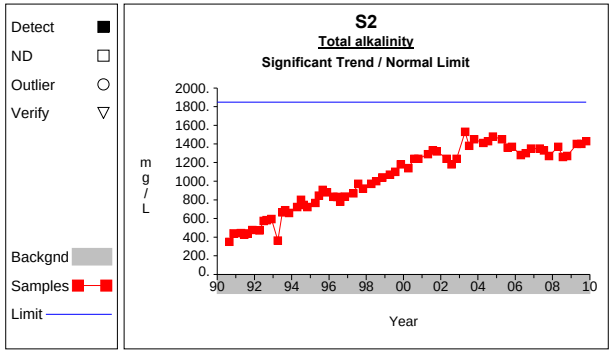

Graph 29



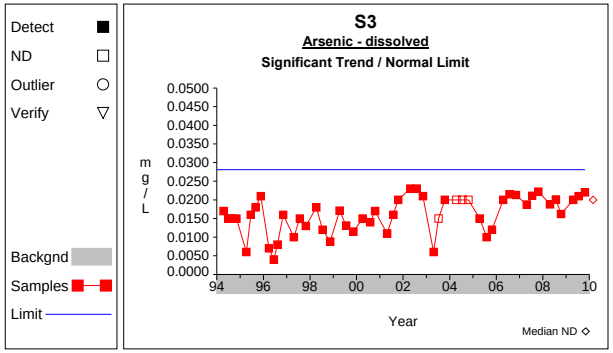

Graph 30



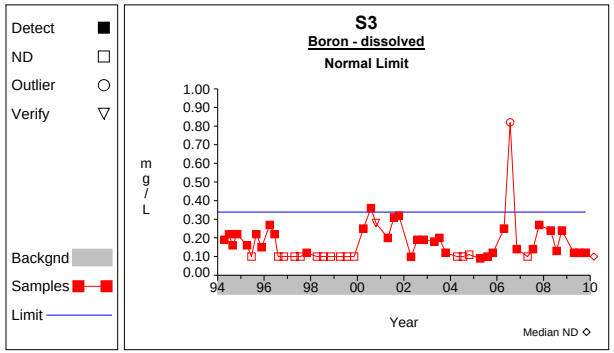

Graph 31



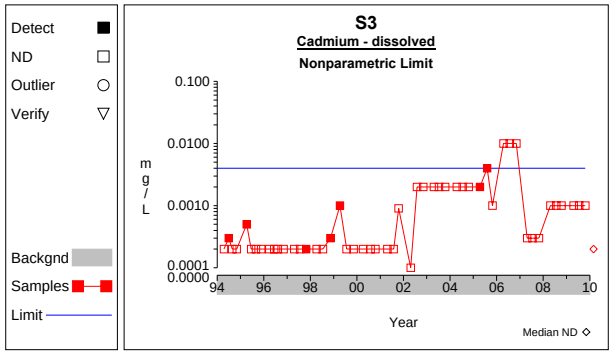

Graph 32



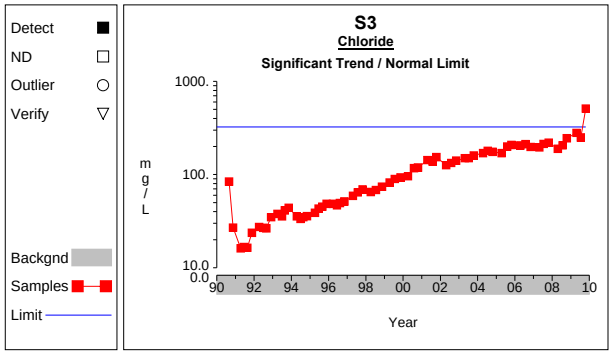

Graph 33




Graph 34

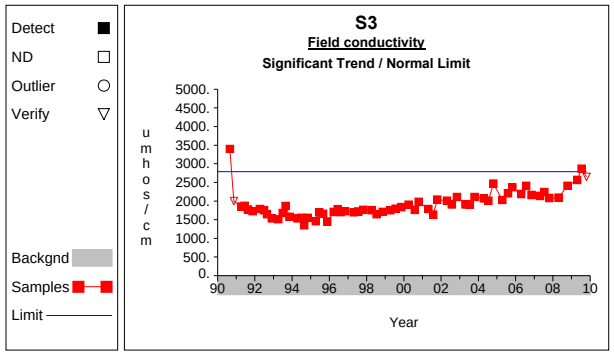



Graph 35

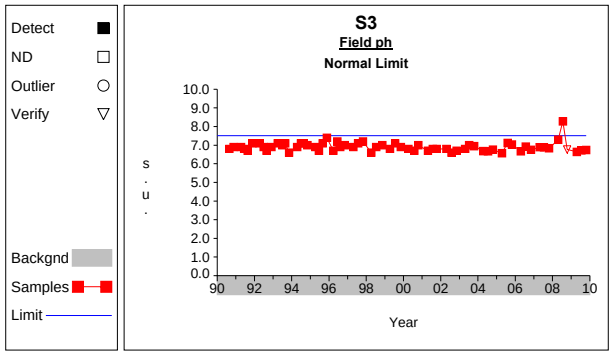



Graph 36

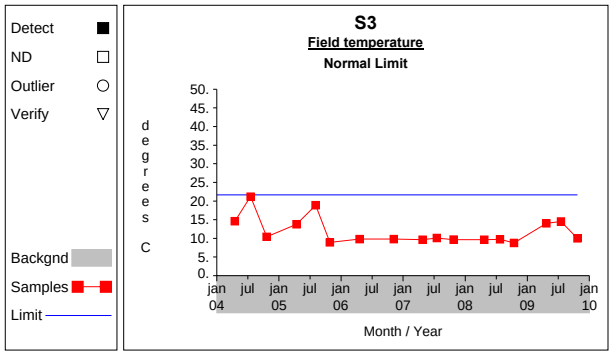
# Intra-Well Prediction Limits



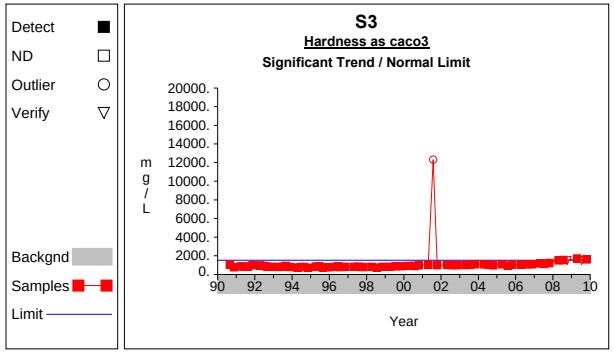

Graph 37



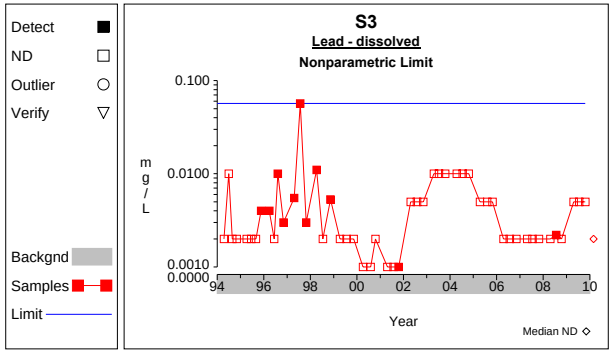

Graph 38



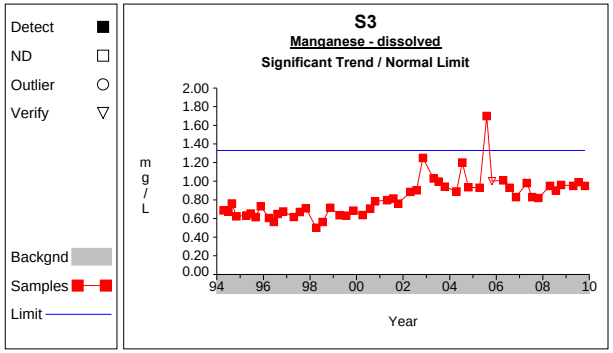

Graph 39



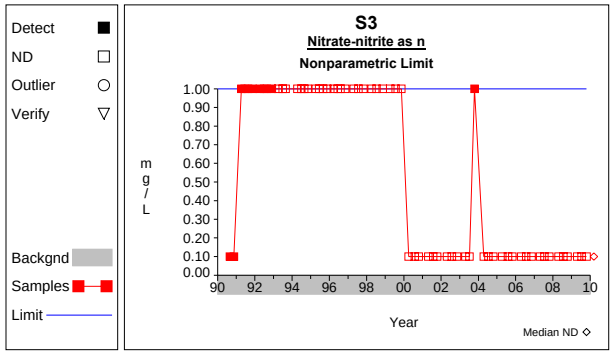

Graph 40



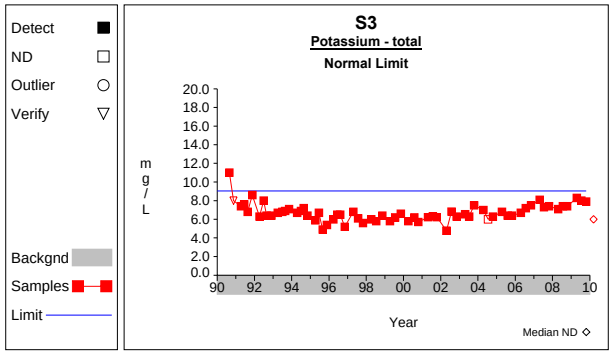

Graph 41



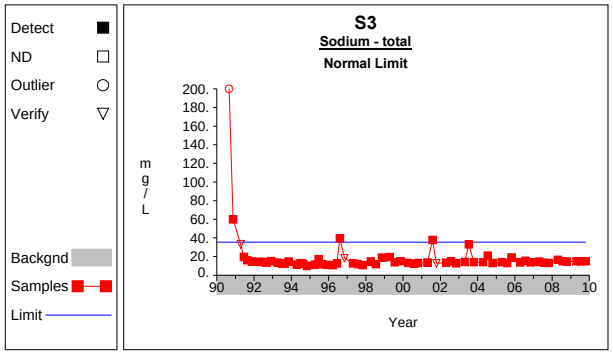

Graph 42




Graph 43

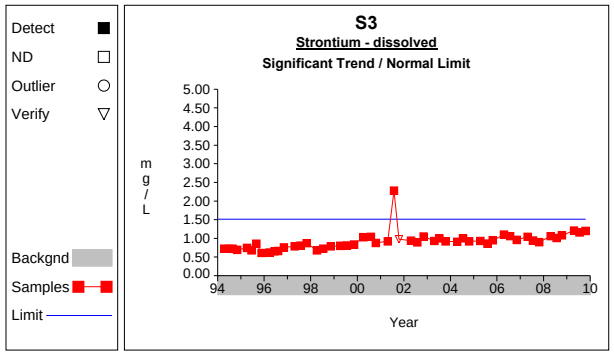



Graph 44

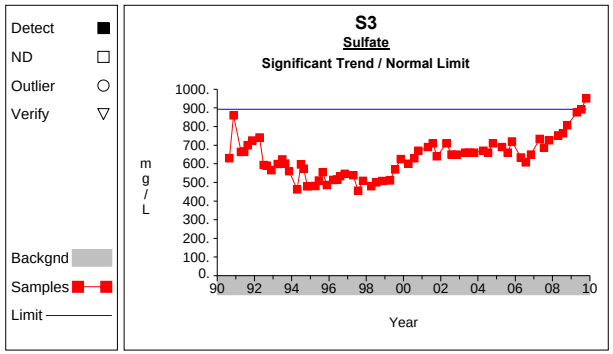



Graph 45

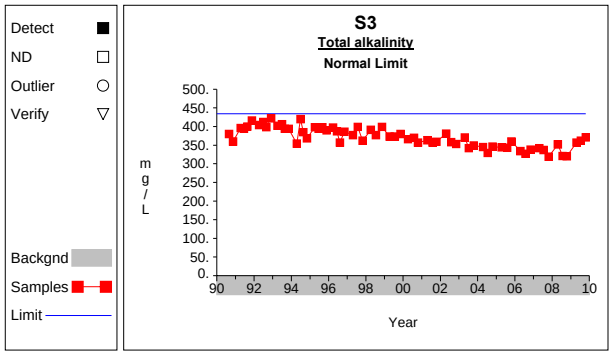
# Intra-Well Prediction Limits



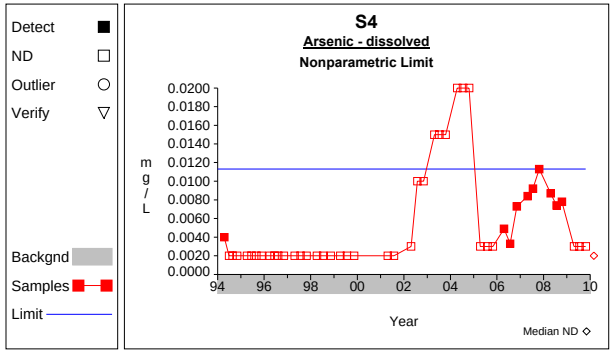

Graph 46



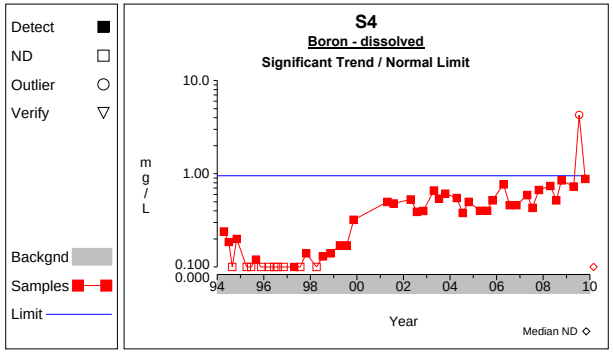

Graph 47



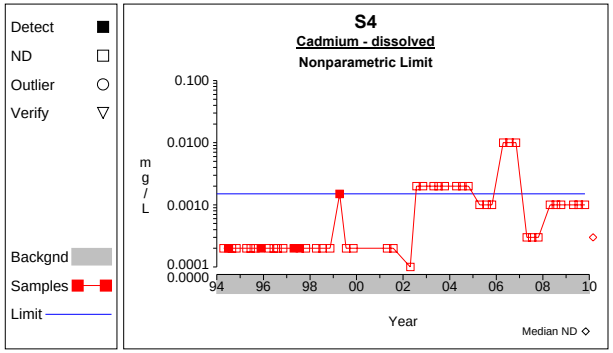

Graph 48



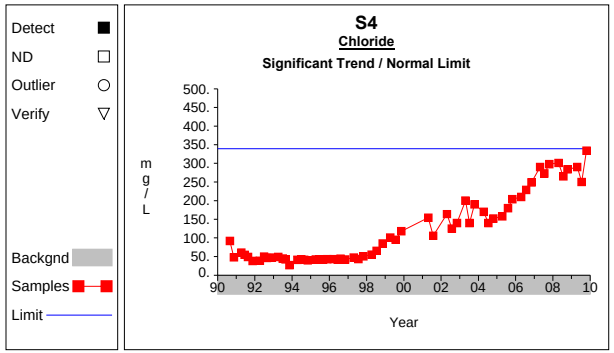

Graph 49



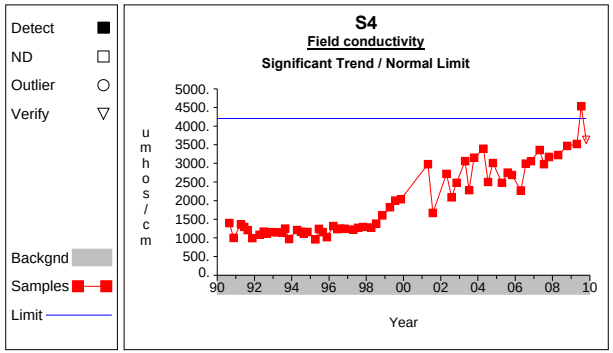

Graph 50



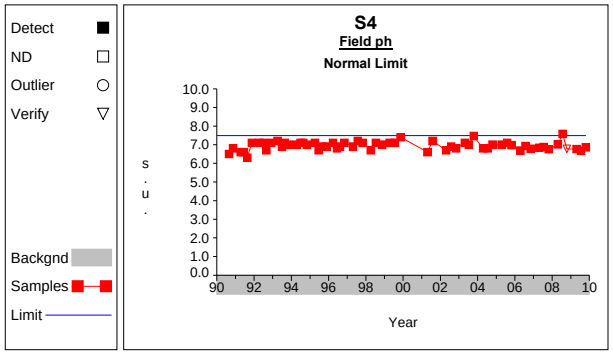

Graph 51




Graph 52

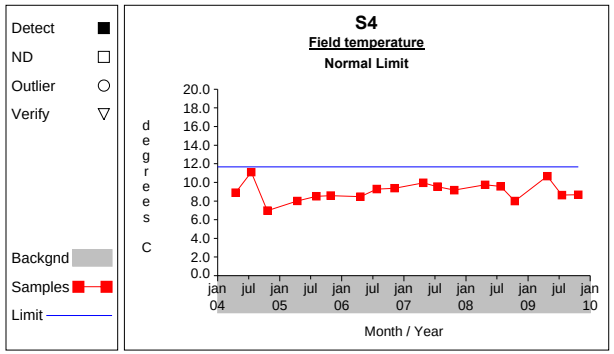



Graph 53

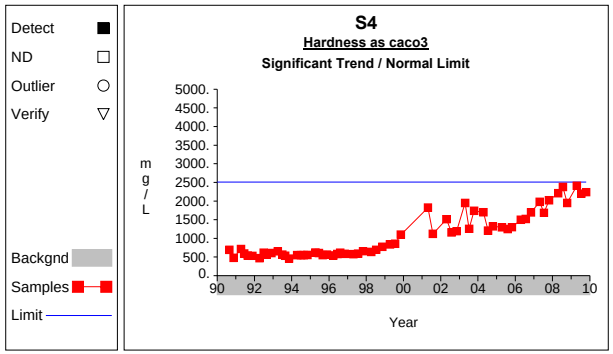



Graph 54

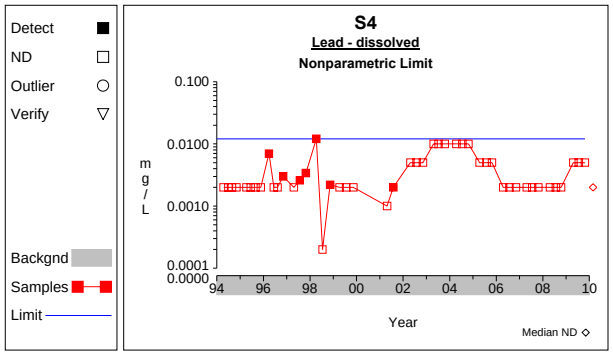
# Intra-Well Prediction Limits



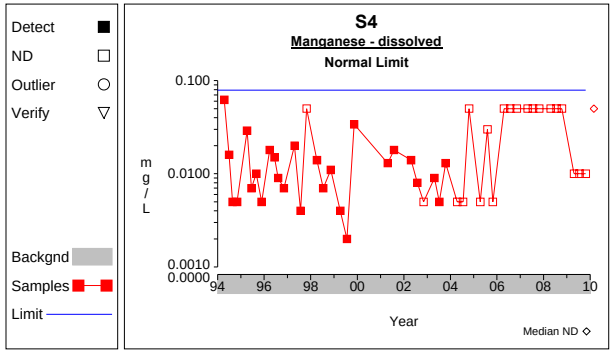

Graph 55



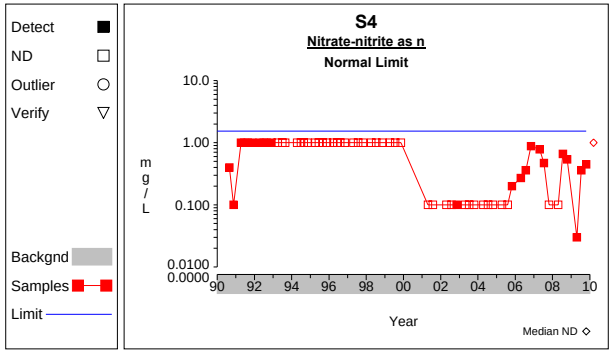

Graph 56



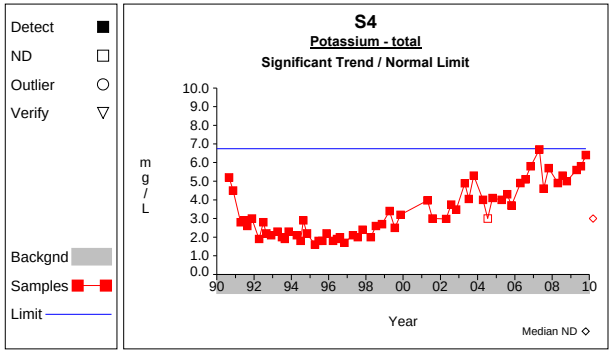

Graph 57



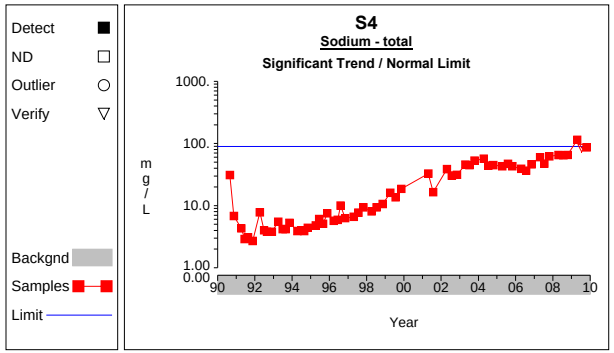

Graph 58



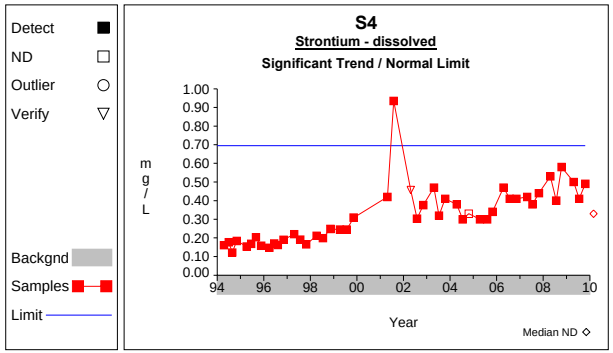

Graph 59



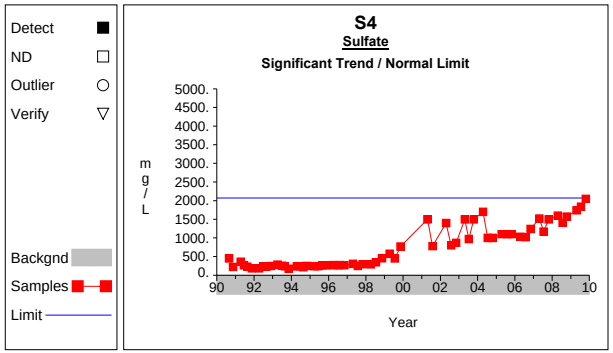

Graph 60




Graph 61

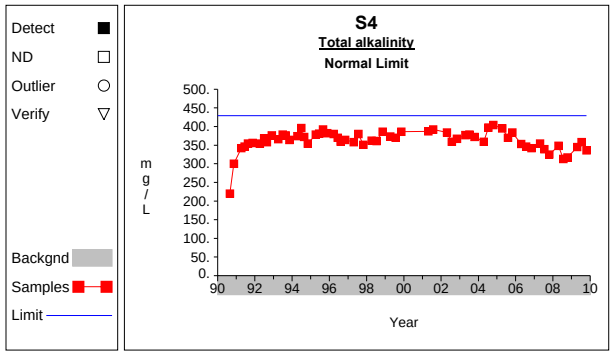



Graph 62

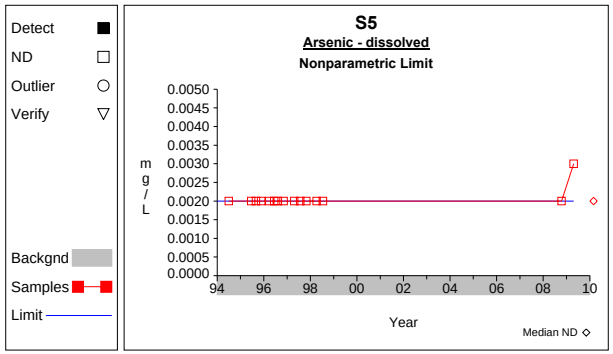



Graph 63

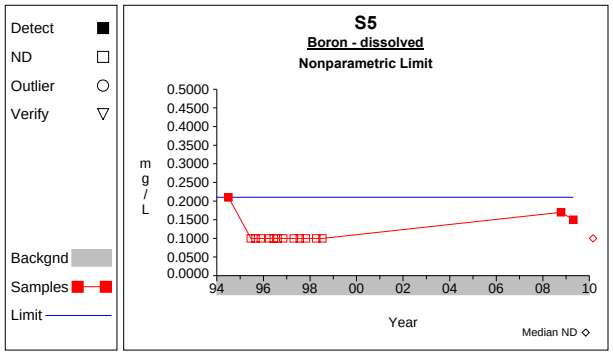
# Intra-Well Prediction Limits



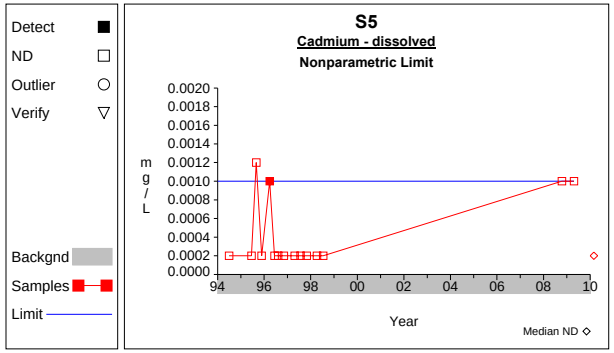

Graph 64



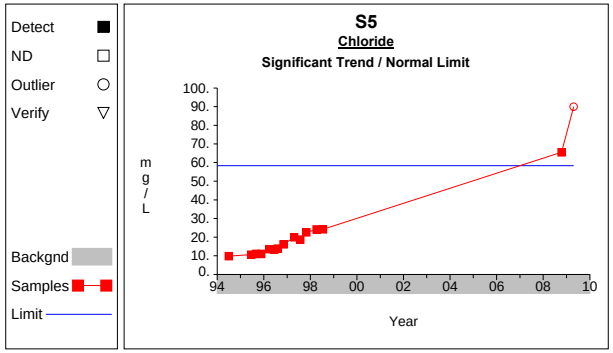

Graph 65



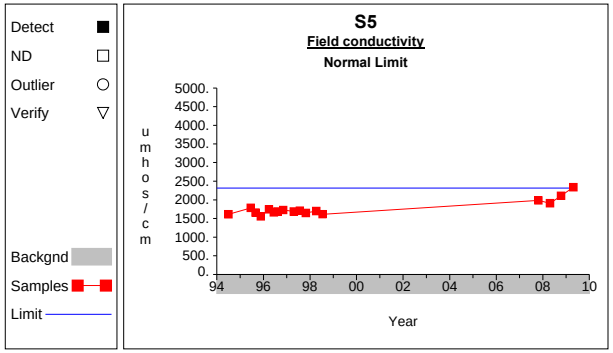

Graph 66



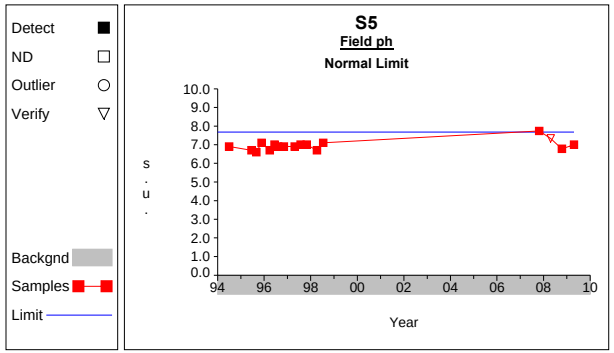

Graph 67



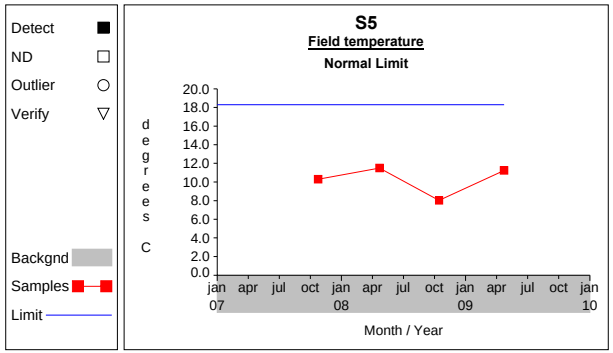

Graph 68



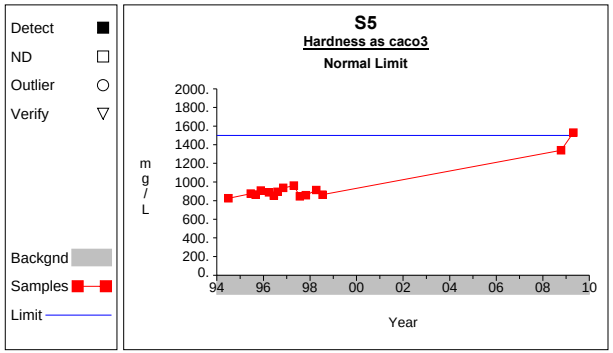

Graph 69




Graph 70

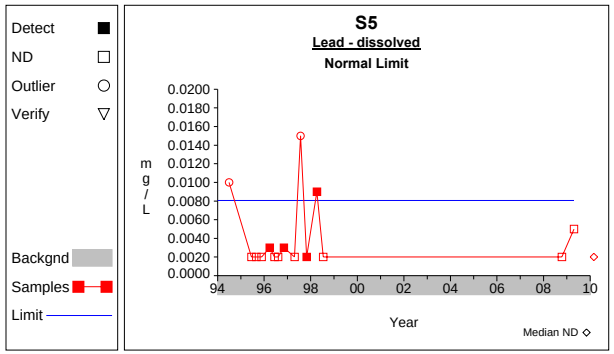



Graph 71

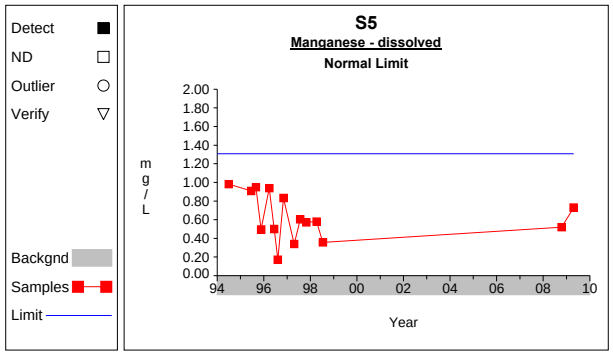



Graph 72

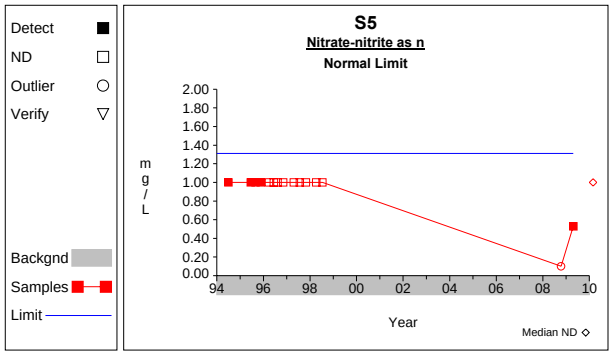
# Intra-Well Prediction Limits



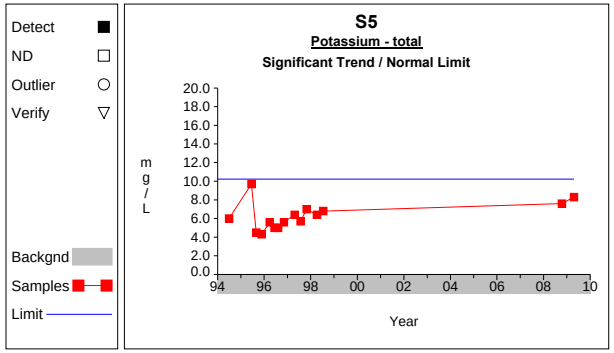

Graph 73



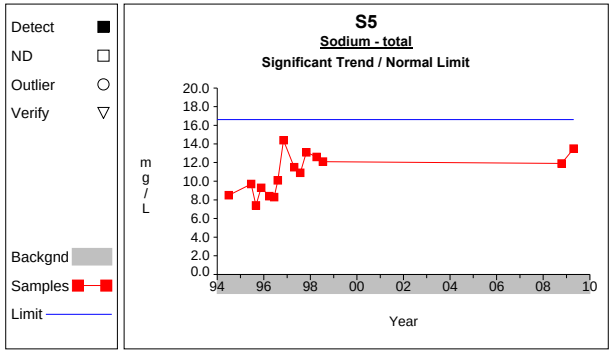

Graph 74



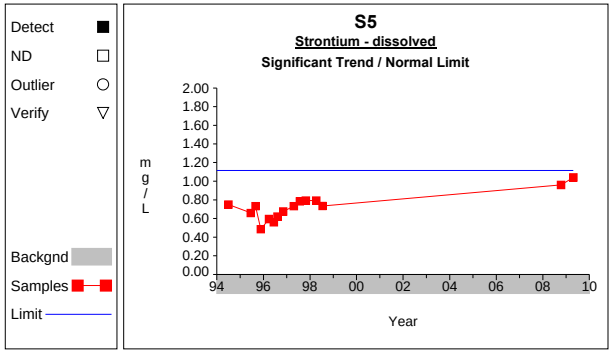

Graph 75



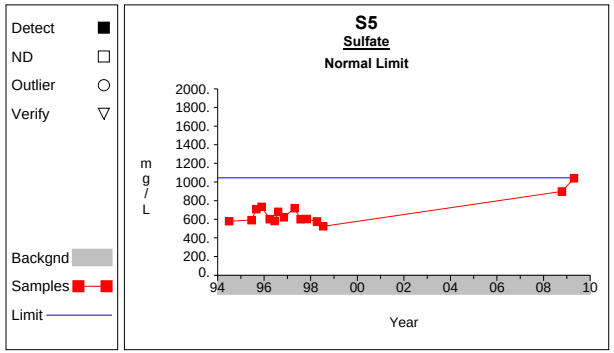

Graph 76



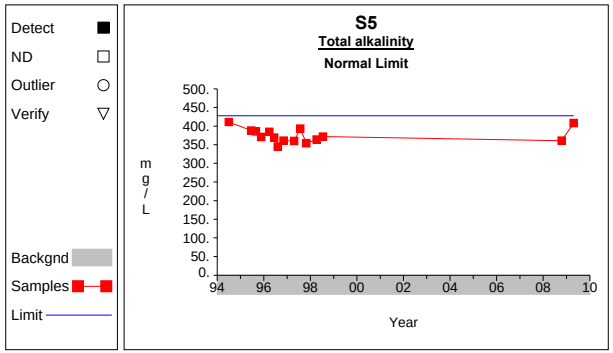

Graph 77



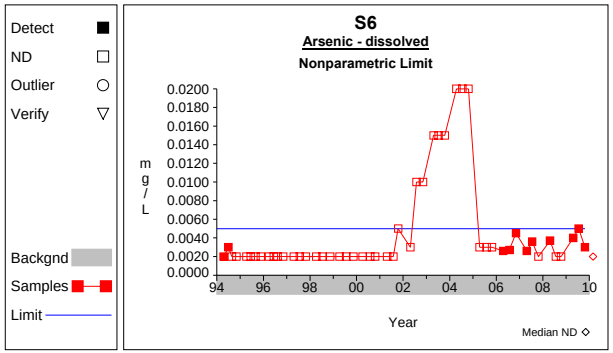

Graph 78




Graph 79

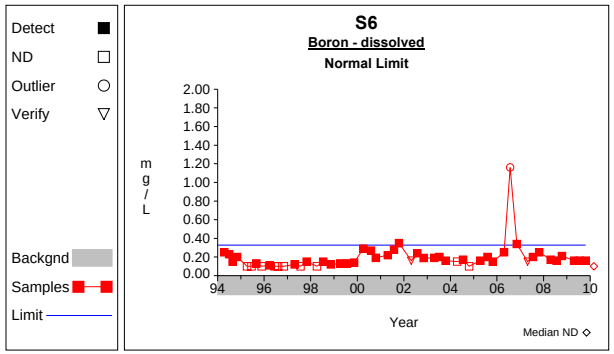



Graph 80

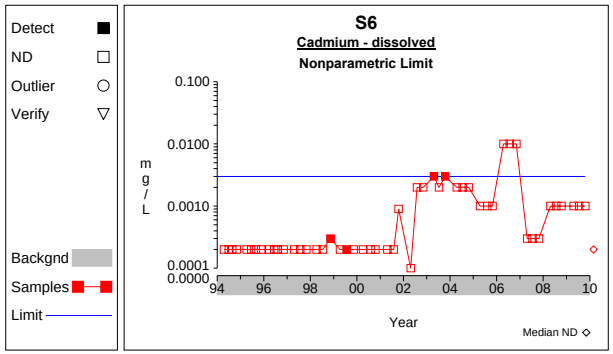



Graph 81

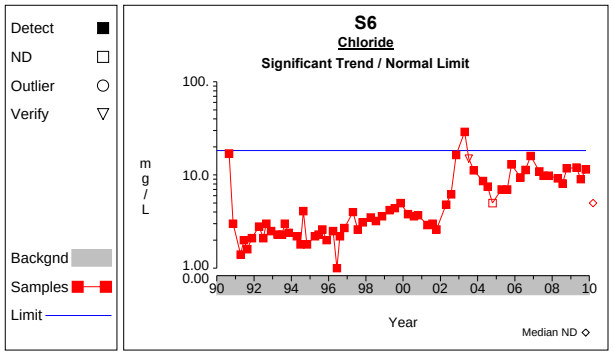
# Intra-Well Prediction Limits



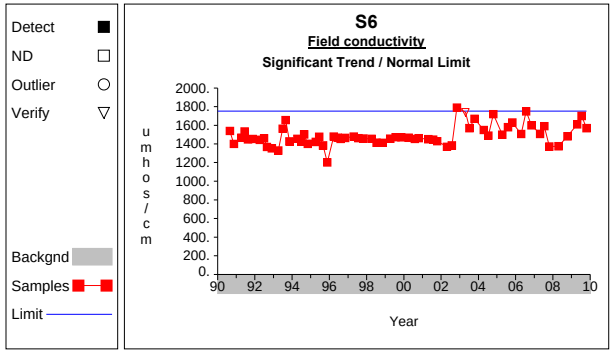

Graph 82



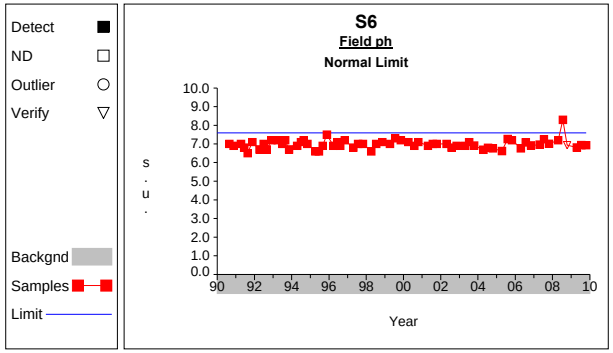

Graph 83



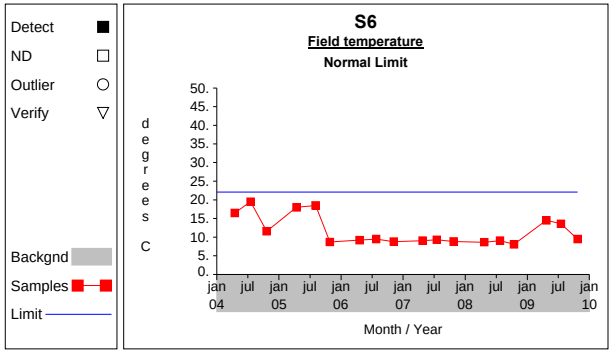

Graph 84



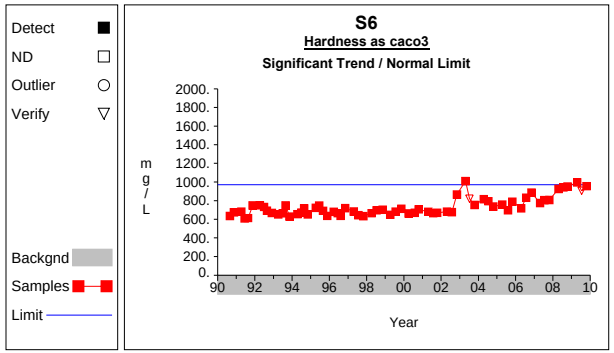

Graph 85



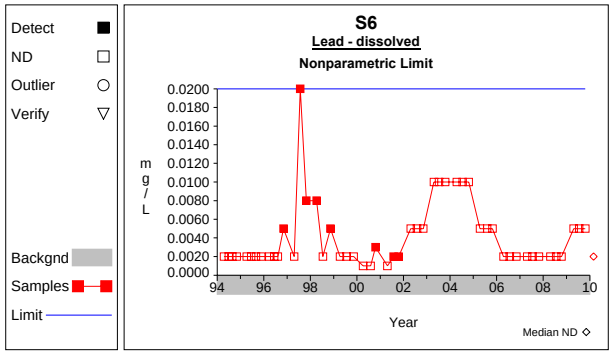

Graph 86



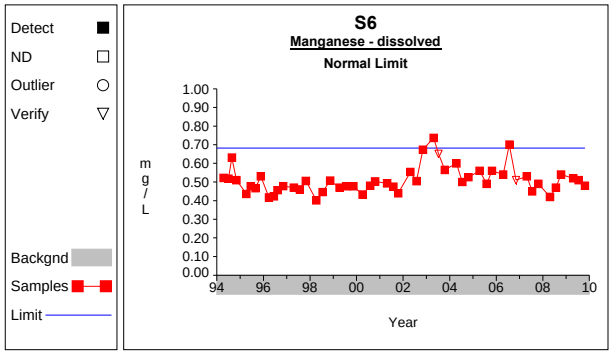

Graph 87




Graph 88

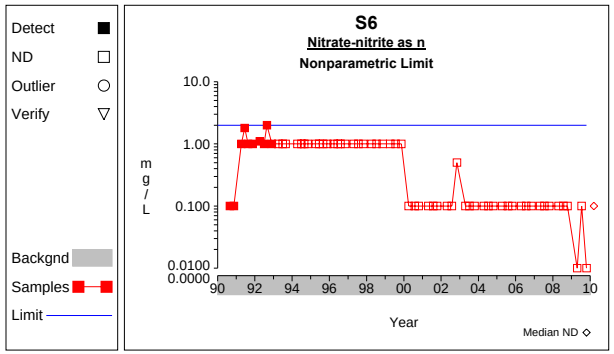



Graph 89

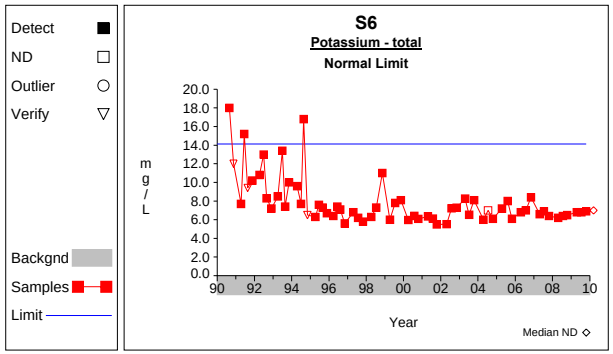



Graph 90

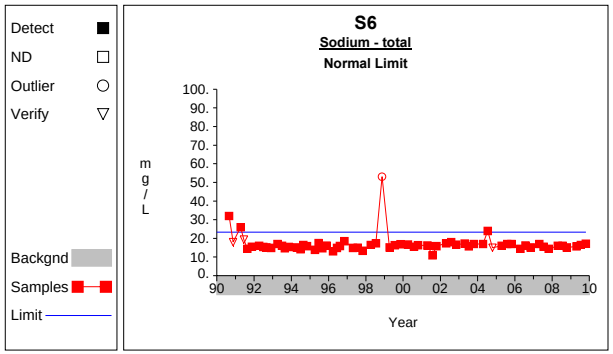
# Intra-Well Prediction Limits



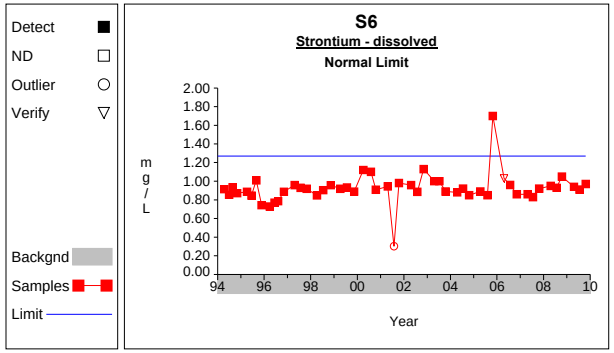

Graph 91



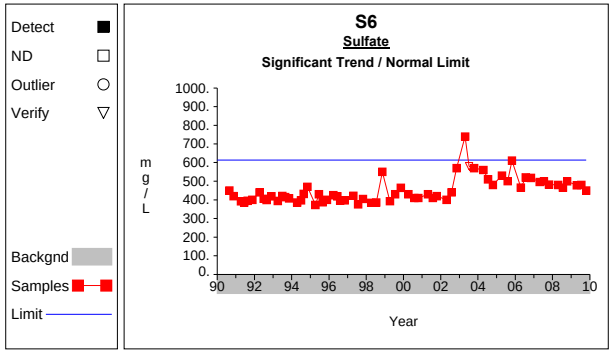

Graph 92



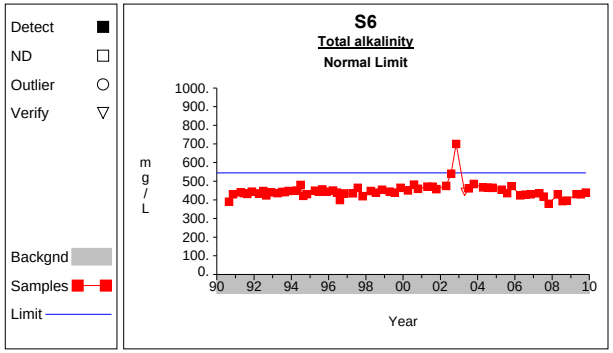

Graph 93




Graph 94




Graph 95




Graph 96

# Table 1

## Analytical Data Summary for S1

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | .0060 | <.0030 | <.0030 |
| Boron - dissolved | mg/L | 23.9000 | 23.9000 | 22.5000 |
| Cadmium - dissolved | mg/L | .0020 | <.0010 | <.0010 |
| Chloride | mg/L | 2800.0000 | 2600.0000 | 2940.0000 |
| Field conductivity | umhos/cm | 39200.0000 | 43800.0000 | 38900.0000 |
| Field ph | s.u. | 6.9700 | 6.7300 | 6.9400 |
| Field temperature | degrees C | 12.3900 | 10.2100 | 8.7700 |
| Hardness as caco3 | mg/L | 29400.0000 | 26800.0000 | 2790.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | 4.0900 | 2.7700 | 3.2300 |
| Nitrate-nitrite as n | mg/L | .0500 | <.1000 | .0400 |
| Potassium - total | mg/L | 64.0000 | 57.6000 | 67.4000 |
| Sodium - total | mg/L | 5850.0000 | 5840.0000 | 5920.0000 |
| Strontium - dissolved | mg/L | 3.4700 | 2.4200 | 2.8200 |
| Sulfate | mg/L | 236.0000 | 860.0000 | 34500.0000 |
| Total alkalinity | mg/L | 1400.0000 | 1300.0000 | 1280.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 2

## Analytical Data Summary for S2

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | .0130 | .0100 | .0210 |
| Boron - dissolved | mg/L | 49.7000 | 50.7000 | 46.6000 |
| Cadmium - dissolved | mg/L | .0010 | .0020 | <.0010 |
| Chloride | mg/L | 3200.0000 | 2800.0000 | 3330.0000 |
| Field conductivity | umhos/cm | 49500.0000 | 53500.0000 | 48900.0000 |
| Field ph | s.u. | 7.0200 | 6.8600 | 7.1200 |
| Field temperature | degrees C | 11.6700 | 10.0500 | 9.1800 |
| Hardness as caco3 | mg/L | 34800.0000 | 32500.0000 | 3450.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | 8.9400 | 6.2400 | 7.3900 |
| Nitrate-nitrite as n | mg/L | .0800 | <.1000 | <.0100 |
| Potassium - total | mg/L | 77.0000 | 74.7000 | 84.8000 |
| Sodium - total | mg/L | 9190.0000 | 9250.0000 | 9500.0000 |
| Strontium - dissolved | mg/L | 3.0800 | 2.1500 | 2.5800 |
| Sulfate | mg/L | 44900.0000 | 52000.0000 | 52300.0000 |
| Total alkalinity | mg/L | 1400.0000 | 1400.0000 | 1430.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 3

## Analytical Data Summary for S3

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | .0200 | .0210 | .0220 |
| Boron - dissolved | mg/L | .1200 | .1200 | .1200 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 280.0000 | 250.0000 | 510.0000 |
| Field conductivity | umhos/cm | 2570.0000 | 2870.0000 | 2650.0000 |
| Field ph | s.u. | 6.6400 | 6.7200 | 6.7400 |
| Field temperature | degrees C | 14.0200 | 14.5200 | 10.0000 |
| Hardness as caco3 | mg/L | 1710.0000 | 1500.0000 | 1620.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | .9500 | .9900 | .9500 |
| Nitrate-nitrite as n | mg/L | <.1000 | <.1000 | <.1000 |
| Potassium - total | mg/L | 8.3000 | 8.0000 | 7.9000 |
| Sodium - total | mg/L | 14.9000 | 14.9000 | 14.9000 |
| Strontium - dissolved | mg/L | 1.2100 | 1.1600 | 1.2000 |
| Sulfate | mg/L | 876.0000 | 892.0000 | 951.0000 |
| Total alkalinity | mg/L | 357.0000 | 362.0000 | 371.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 4

## Analytical Data Summary for S4

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Boron - dissolved | mg/L | .7300 | 4.2800 | .8800 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 290.0000 | 250.0000 | 334.0000 |
| Field conductivity | umhos/cm | 3520.0000 | 4530.0000 | 3630.0000 |
| Field ph | s.u. | 6.7700 | 6.6800 | 6.8600 |
| Field temperature | degrees C | 10.6800 | 8.6400 | 8.6800 |
| Hardness as caco3 | mg/L | 2410.0000 | 2200.0000 | 2240.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | <.0100 | <.0100 | <.0100 |
| Nitrate-nitrite as n | mg/L | .0300 | .3600 | .4500 |
| Potassium - total | mg/L | 5.6000 | 5.8000 | 6.4000 |
| Sodium - total | mg/L | 115.0000 | 84.3000 | 86.5000 |
| Strontium - dissolved | mg/L | .5000 | .4100 | .4900 |
| Sulfate | mg/L | 1740.0000 | 1840.0000 | 2050.0000 |
| Total alkalinity | mg/L | 345.0000 | 358.0000 | 336.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 5

## Analytical Data Summary for S5

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | | |
| Boron - dissolved | mg/L | .1500 | | |
| Cadmium - dissolved | mg/L | <.0010 | | |
| Chloride | mg/L | 90.0000 | | |
| Field conductivity | umhos/cm | 2340.0000 | | |
| Field ph | s.u. | 7.0000 | | |
| Field temperature | degrees C | 11.2500 | | |
| Hardness as caco3 | mg/L | 1530.0000 | | |
| Lead - dissolved | mg/L | <.0050 | | |
| Manganese - dissolved | mg/L | .7300 | | |
| Nitrate-nitrite as n | mg/L | .5300 | | |
| Potassium - total | mg/L | 8.3000 | | |
| Sodium - total | mg/L | 13.5000 | | |
| Strontium - dissolved | mg/L | 1.0400 | | |
| Sulfate | mg/L | 1040.0000 | | |
| Total alkalinity | mg/L | 408.0000 | | |

* - The displayed value is the arithmetic mean of multiple database matches.

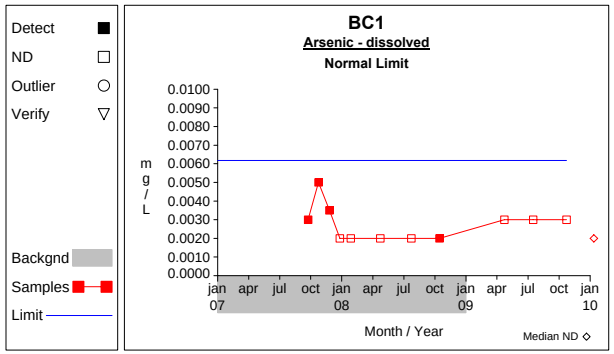
# Table 6

## Analytical Data Summary for S6

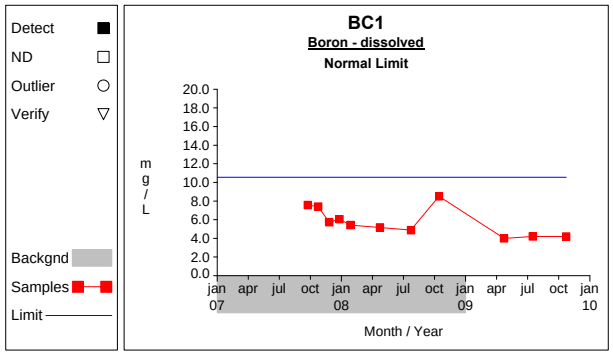
| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | .0040 | .0050 | .0030 |
| Boron - dissolved | mg/L | .1600 | .1600 | .1600 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 12.0000 | 9.0000 | 11.5000 |
| Field conductivity | umhos/cm | 1610.0000 | 1700.0000 | 1570.0000 |
| Field ph | s.u. | 6.8100 | 6.9400 | 6.9300 |
| Field temperature | degrees C | 14.5200 | 13.6100 | 9.4900 |
| Hardness as caco3 | mg/L | 996.0000 | 906.0000 | 955.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | .5200 | .5100 | .4800 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.1000 | <.0100 |
| Potassium - total | mg/L | 6.8000 | 6.8000 | 6.9000 |
| Sodium - total | mg/L | 15.7000 | 16.5000 | 17.1000 |
| Strontium - dissolved | mg/L | .9400 | .9100 | .9700 |
| Sulfate | mg/L | 478.0000 | 480.0000 | 450.0000 |
| Total alkalinity | mg/L | 431.0000 | 430.0000 | 439.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

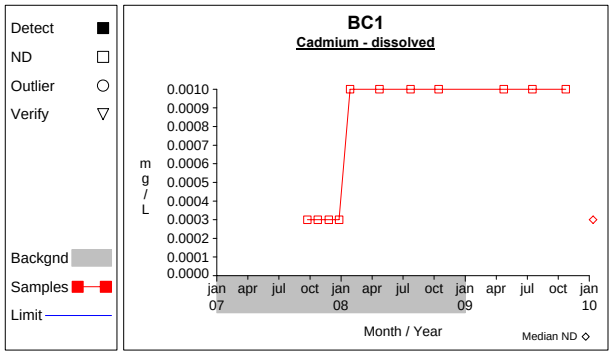
# Intra-Well Prediction Limits



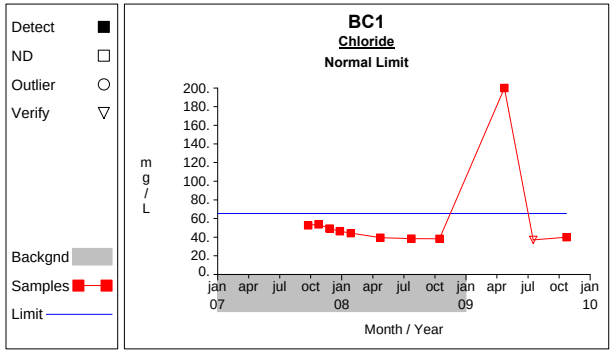

Graph 1



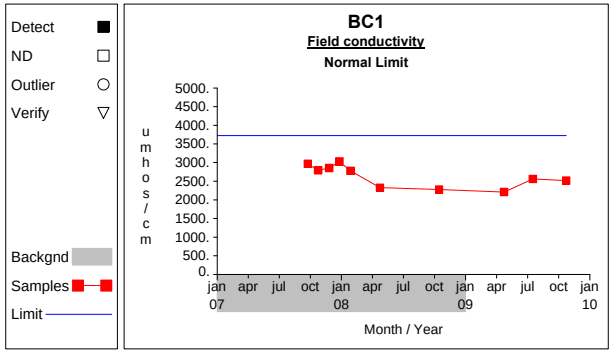

Graph 2



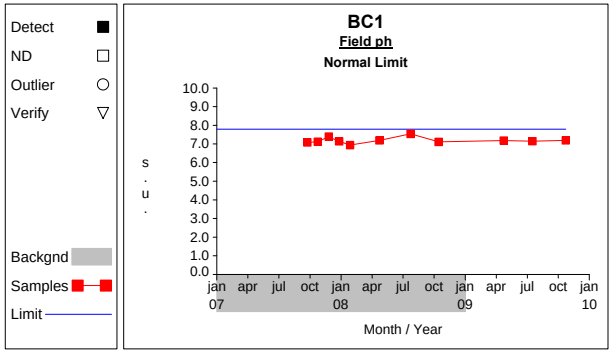

Graph 3



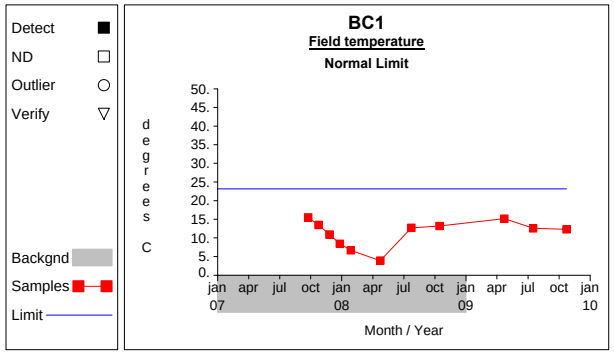

Graph 4



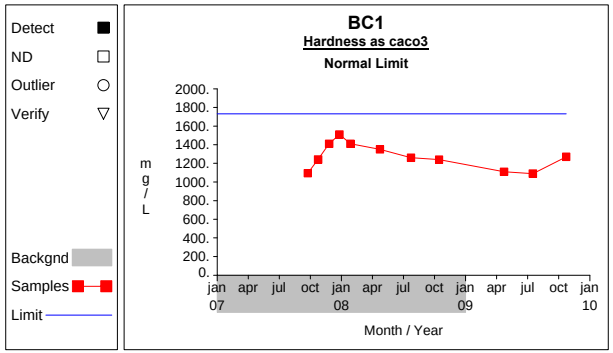

Graph 5



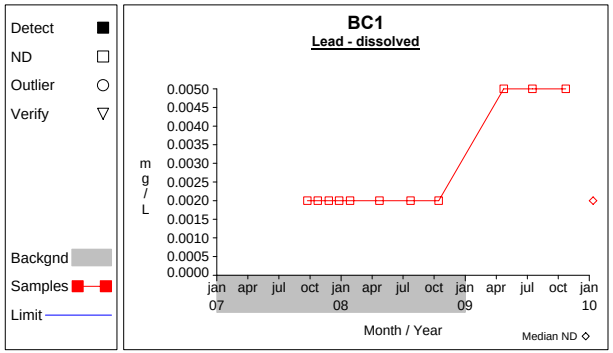

Graph 6




Graph 7

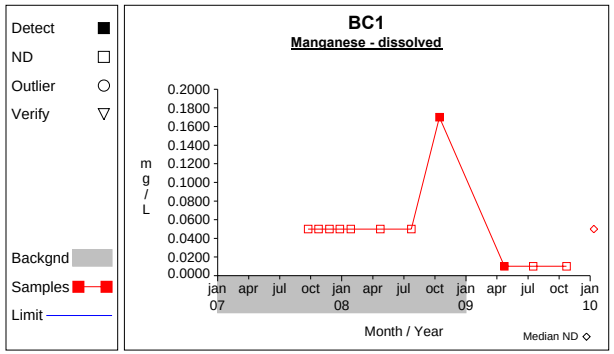



Graph 8

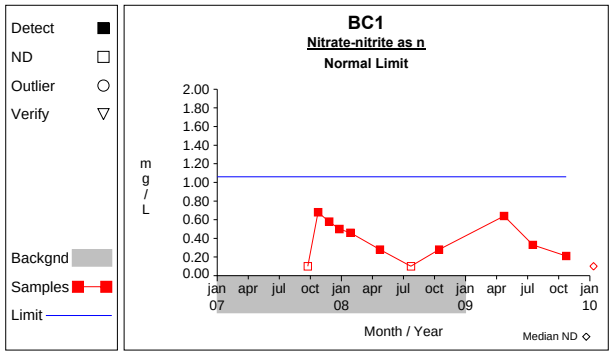



Graph 9

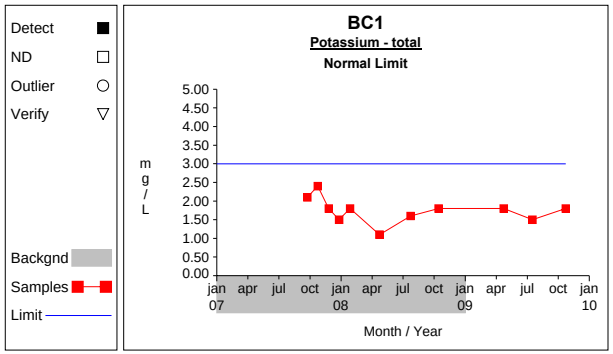
# Intra-Well Prediction Limits



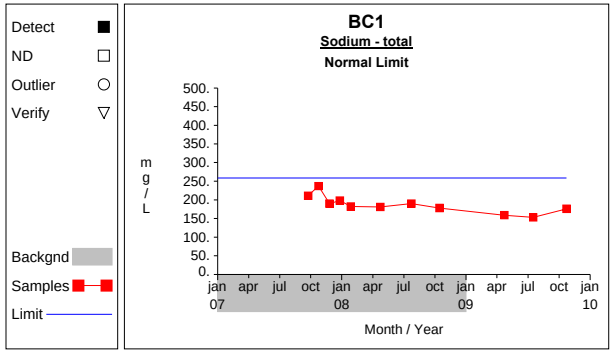

Graph 10



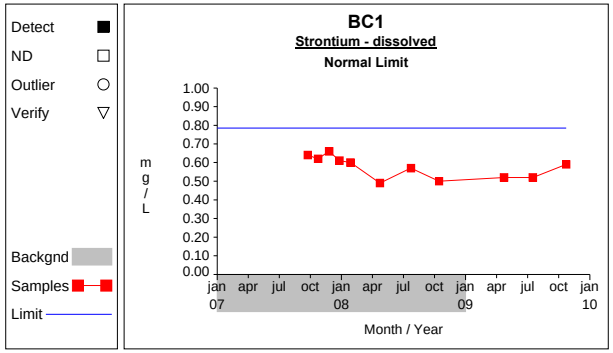

Graph 11



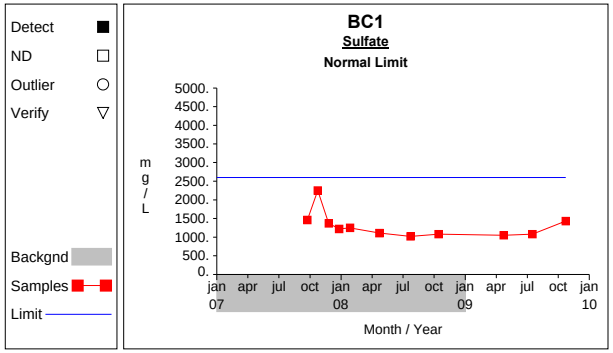

Graph 12



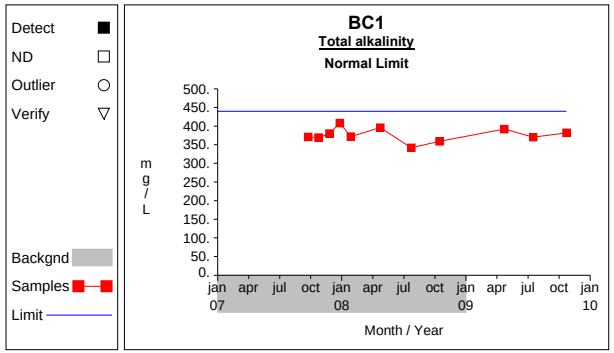

Graph 13



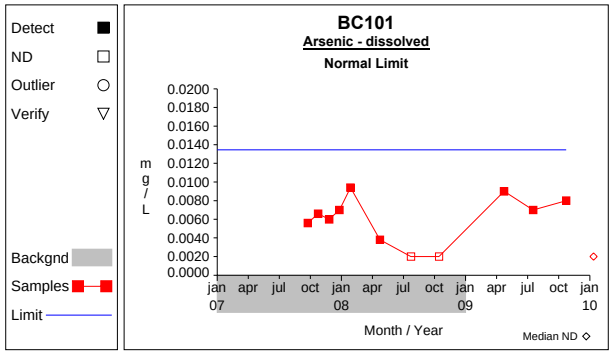

Graph 14



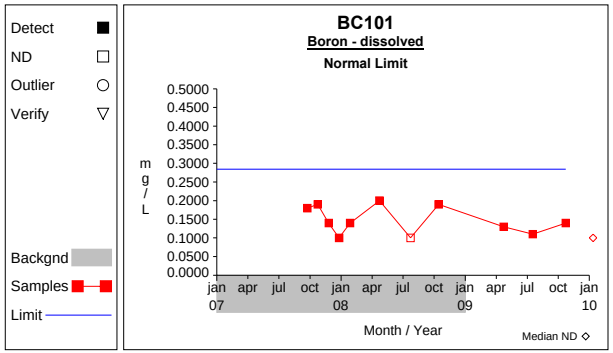

Graph 15




Graph 16

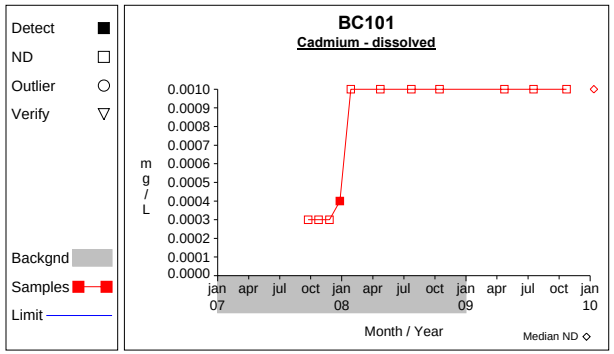



Graph 17

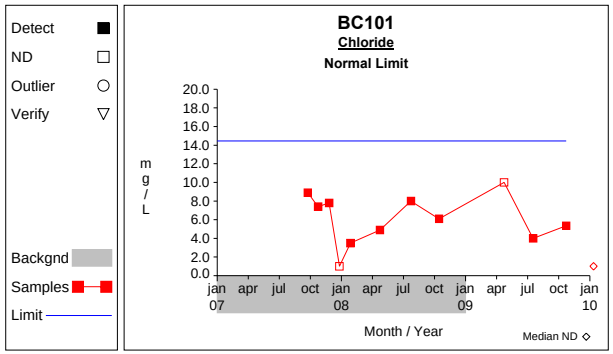



Graph 18

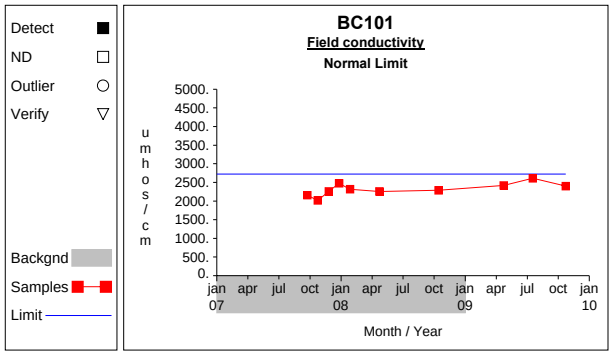
# Intra-Well Prediction Limits



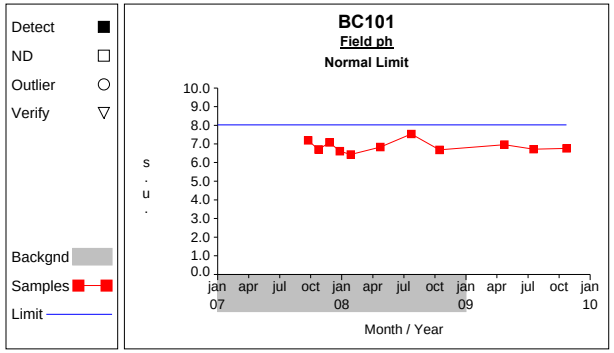

Graph 19



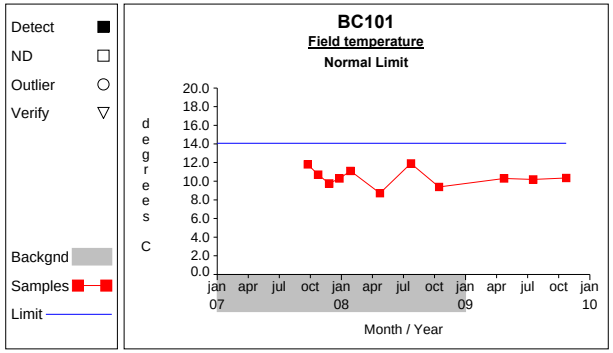

Graph 20



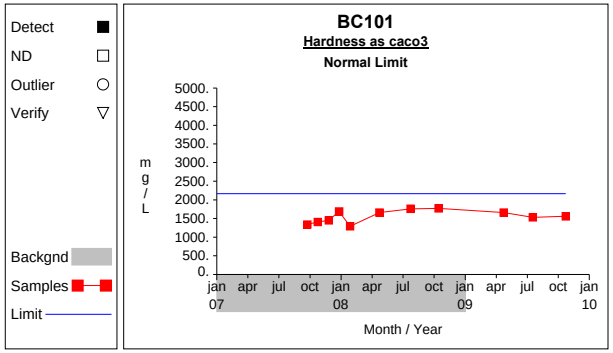

Graph 21



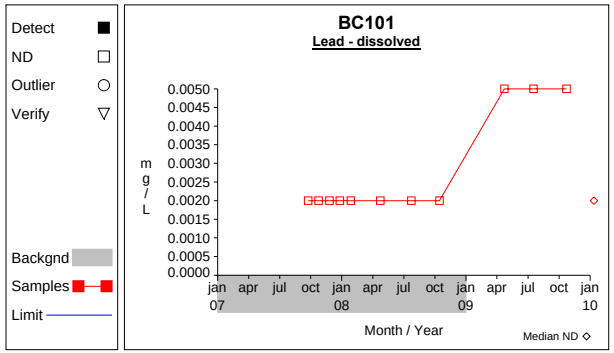

Graph 22



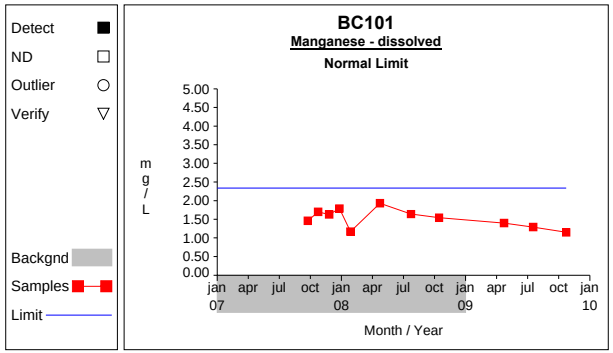

Graph 23



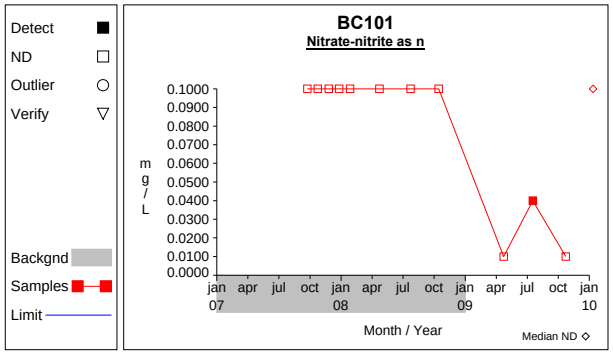

Graph 24




Graph 25

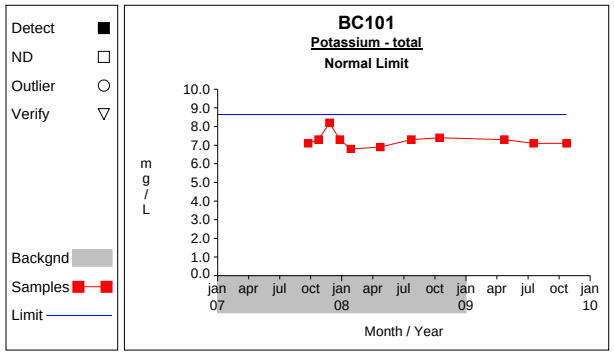



Graph 26

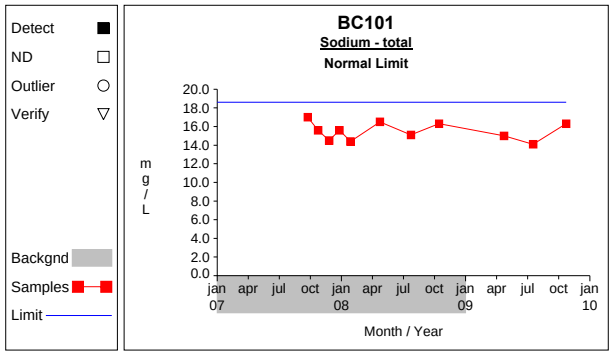



Graph 27

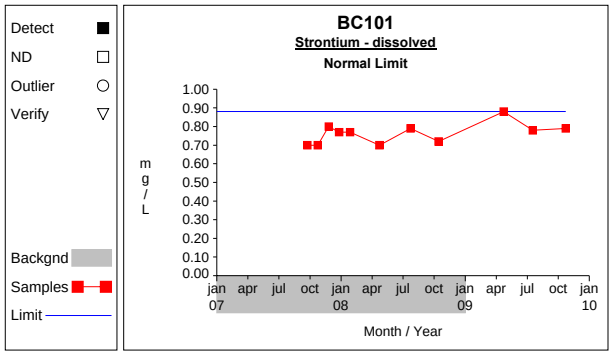
# Intra-Well Prediction Limits



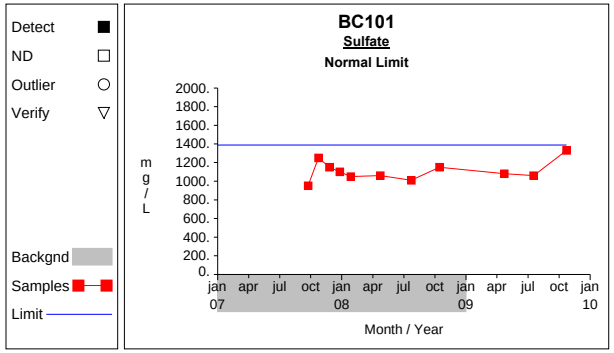

Graph 28



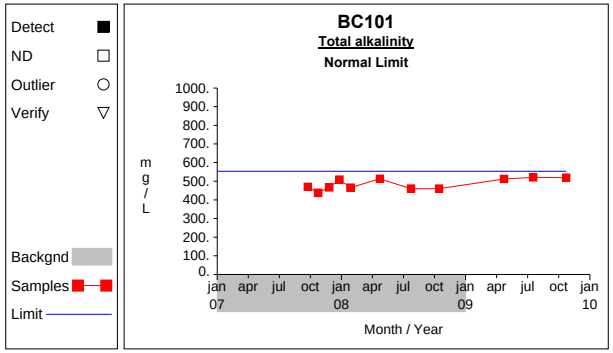

Graph 29



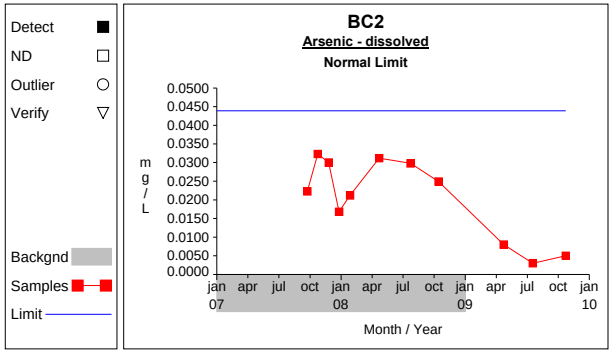

Graph 30



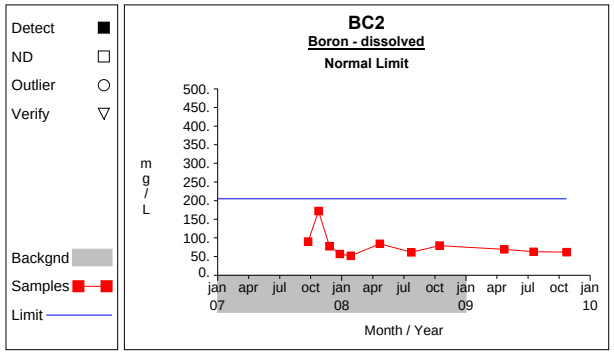

Graph 31



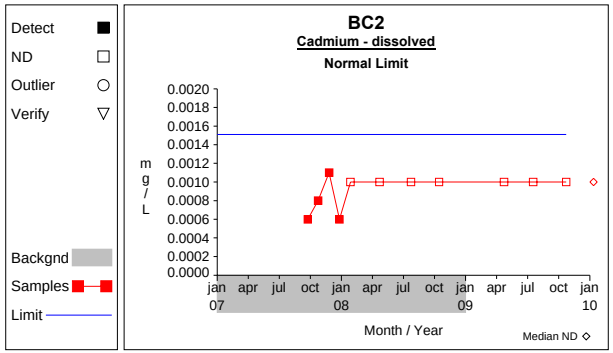

Graph 32



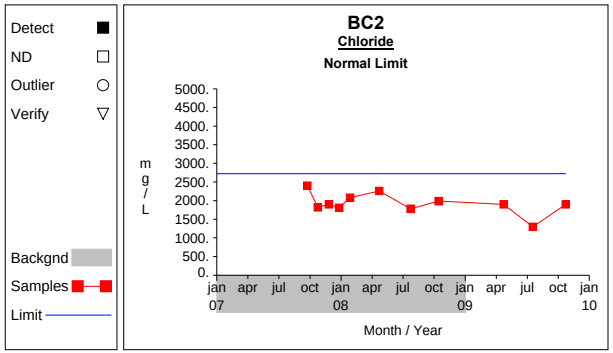

Graph 33




Graph 34

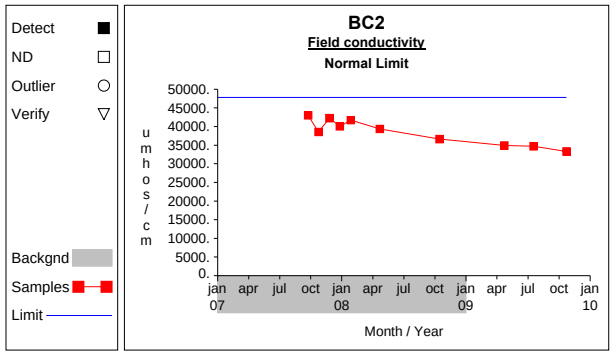



Graph 35

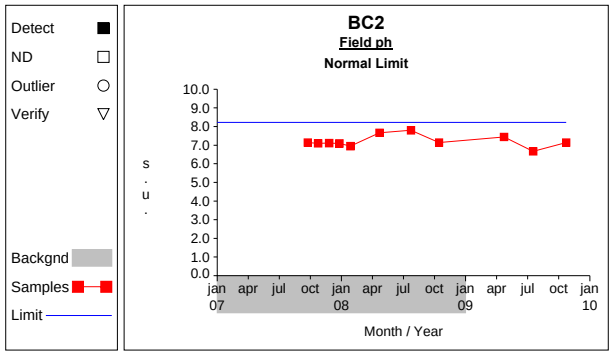



Graph 36

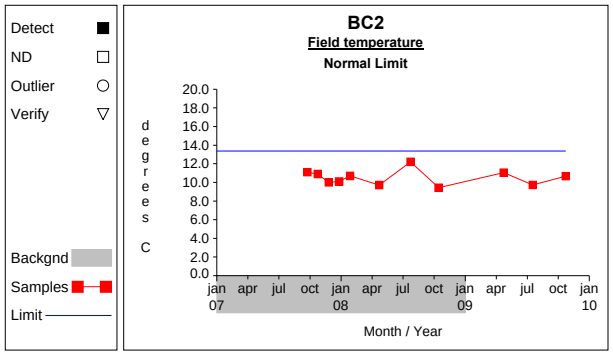
# Intra-Well Prediction Limits



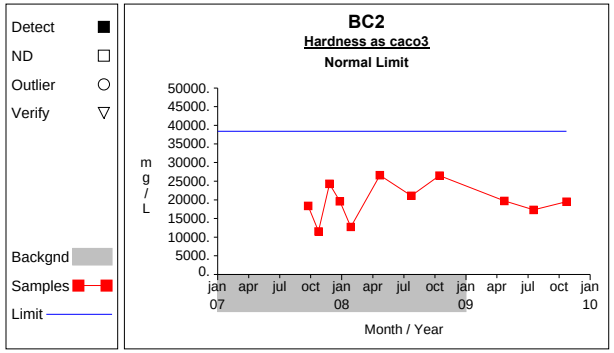

Graph 37



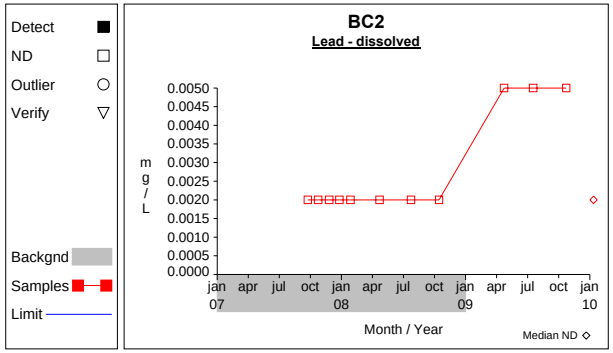

Graph 38



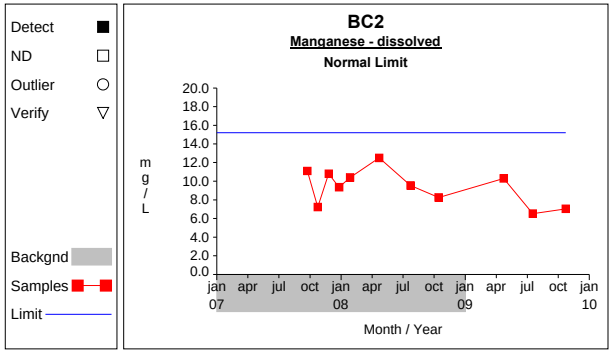

Graph 39



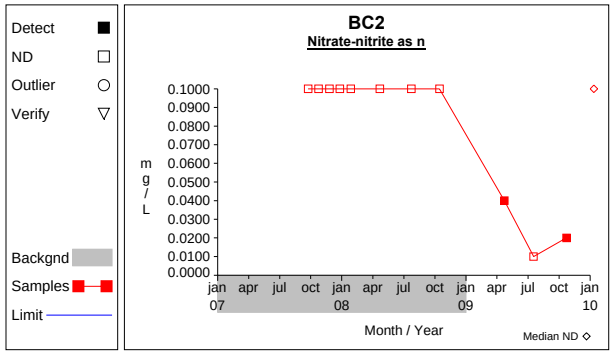

Graph 40



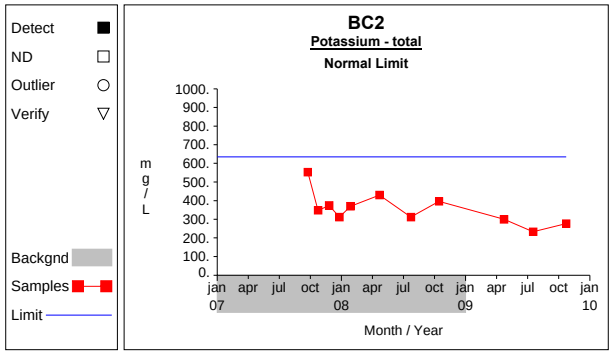

Graph 41



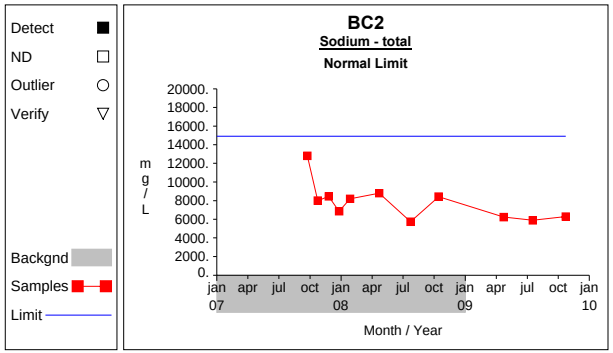

Graph 42




Graph 43

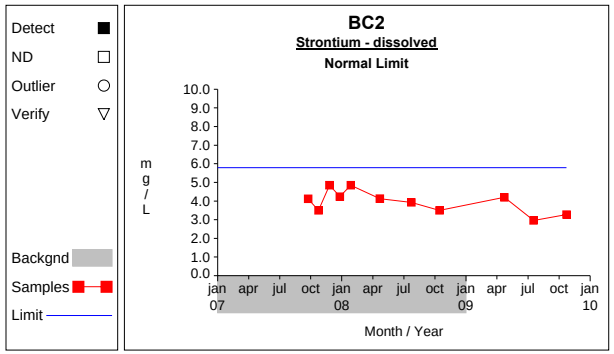



Graph 44

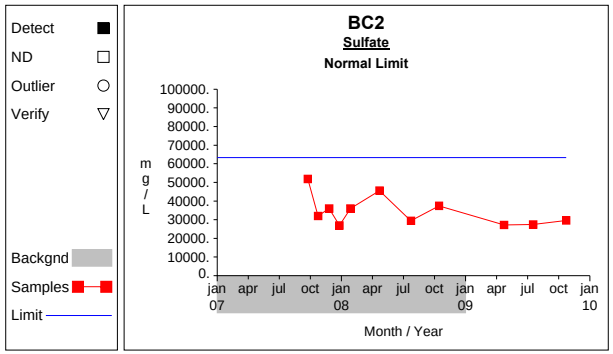



Graph 45

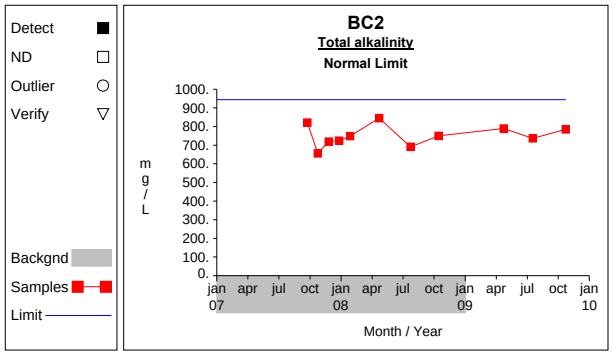
# Intra-Well Prediction Limits



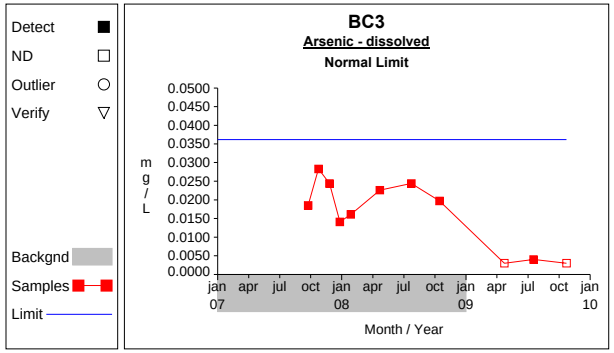

Graph 46



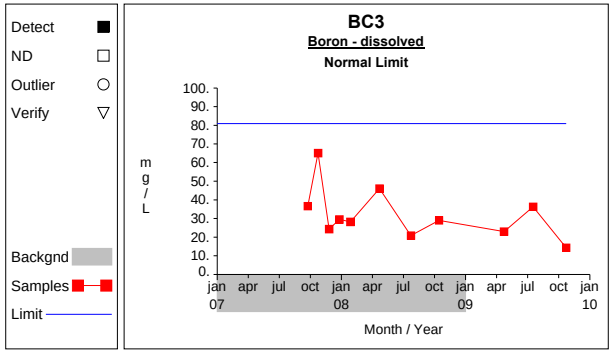

Graph 47



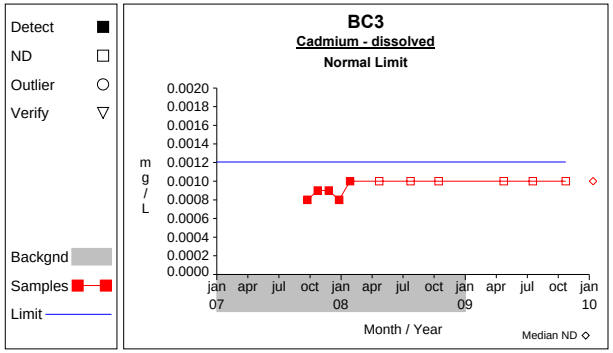

Graph 48



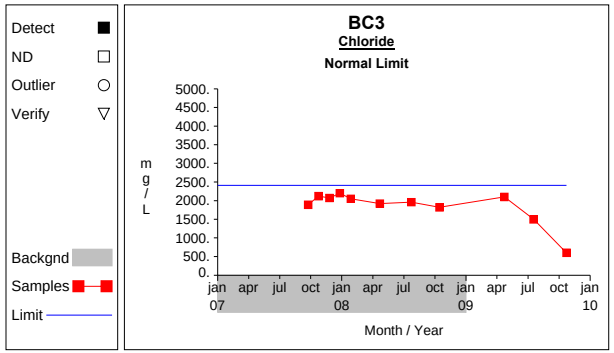

Graph 49



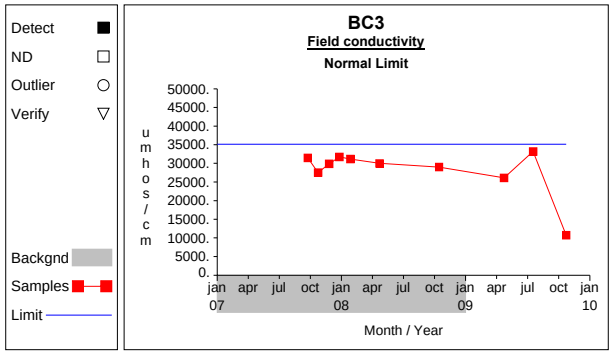

Graph 50



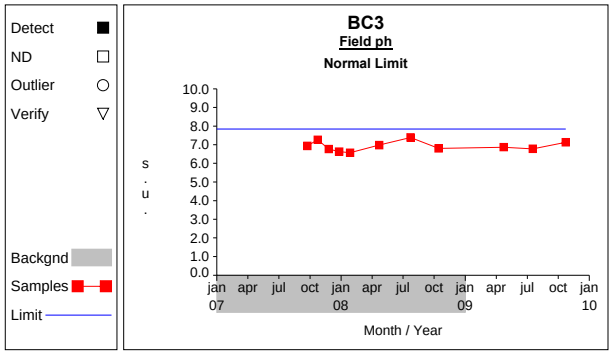

Graph 51




Graph 52

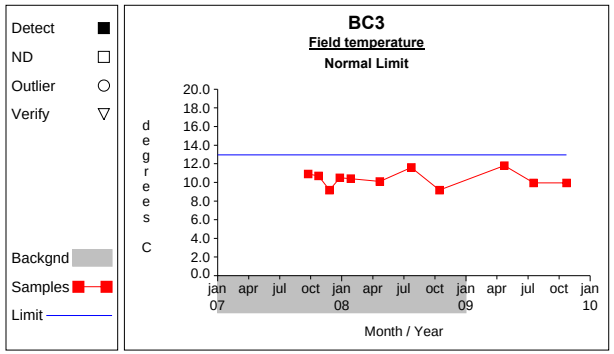



Graph 53

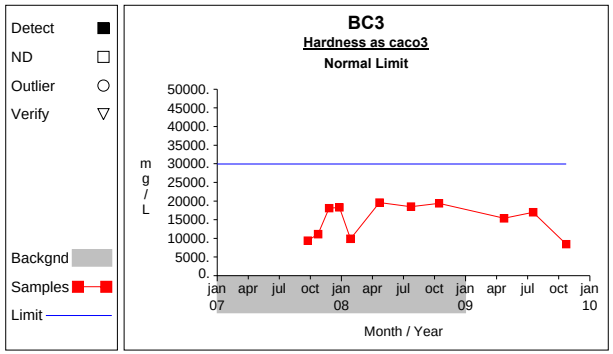



Graph 54

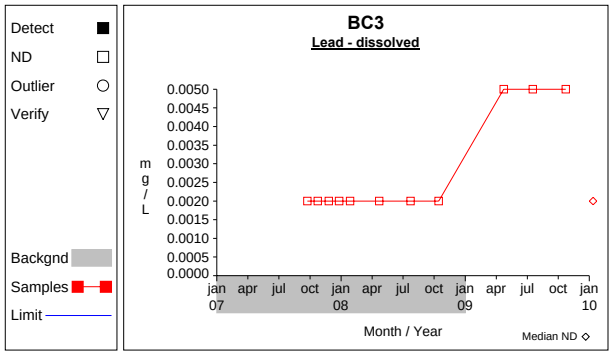
# Intra-Well Prediction Limits



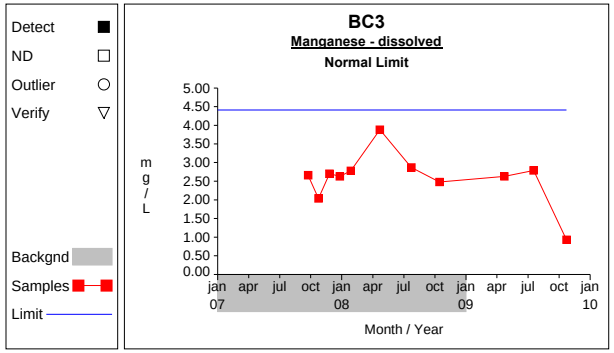

Graph 55



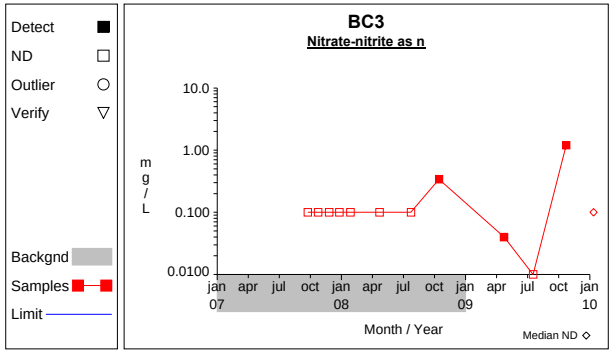

Graph 56



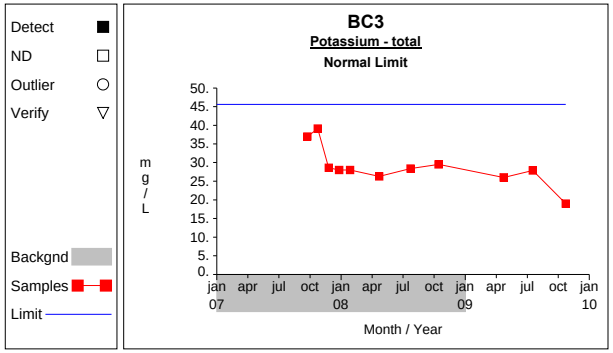

Graph 57



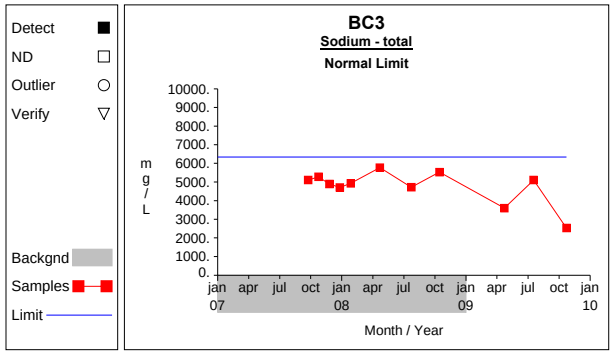

Graph 58



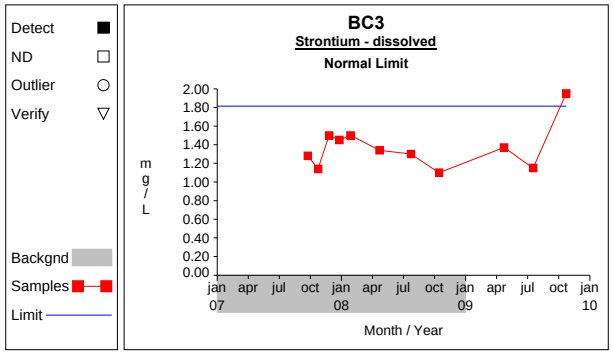

Graph 59



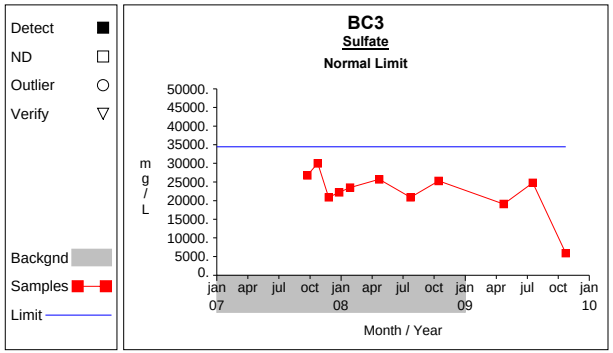

Graph 60




Graph 61

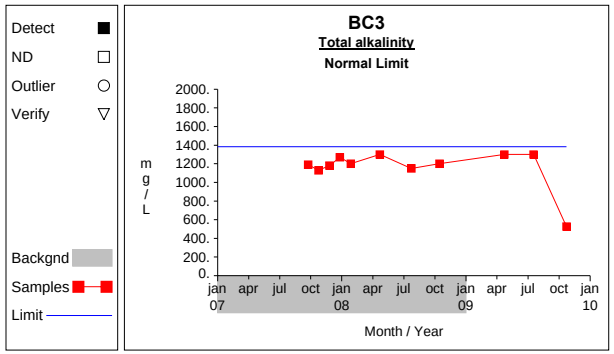



Graph 62

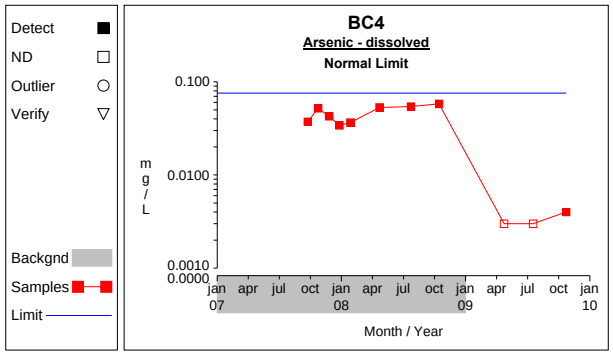



Graph 63

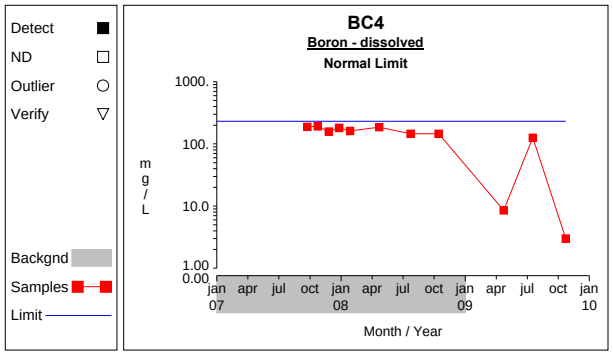
# Intra-Well Prediction Limits



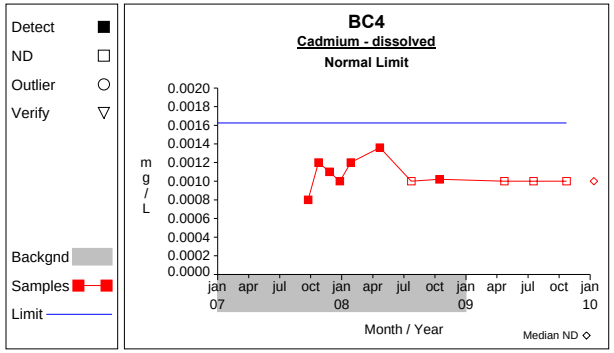

Graph 64



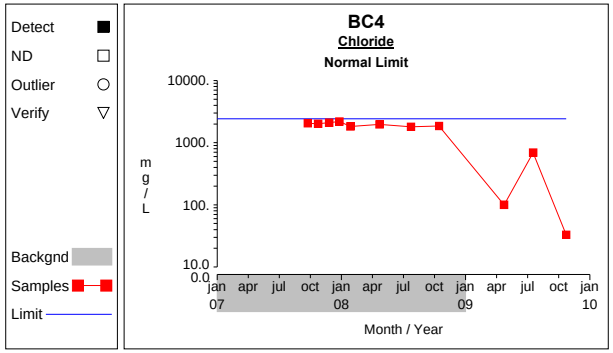

Graph 65



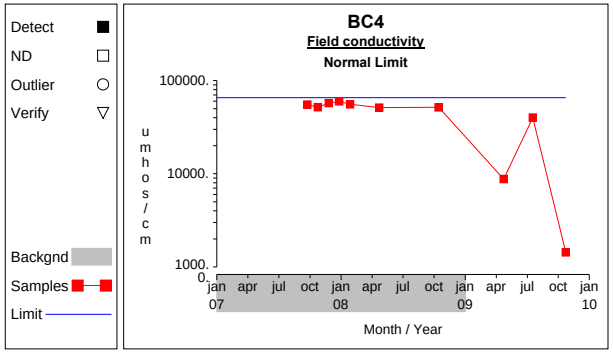

Graph 66



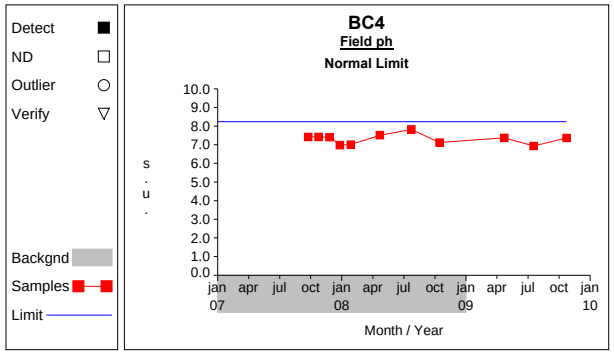

Graph 67



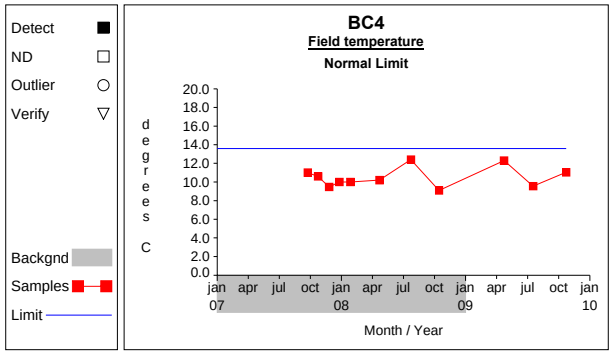

Graph 68



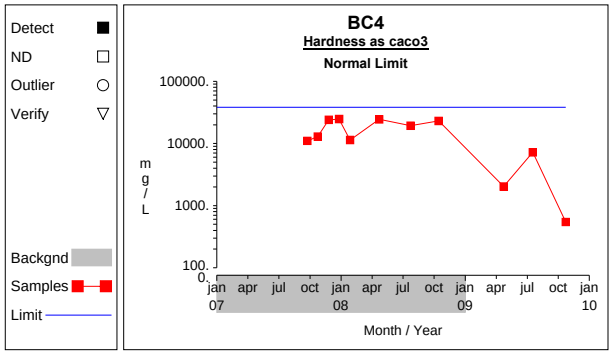

Graph 69




Graph 70

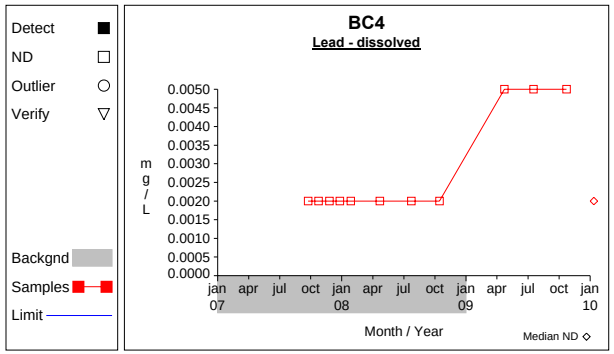



Graph 71

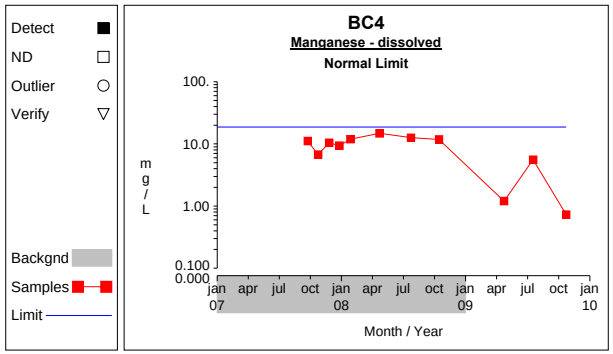



Graph 72

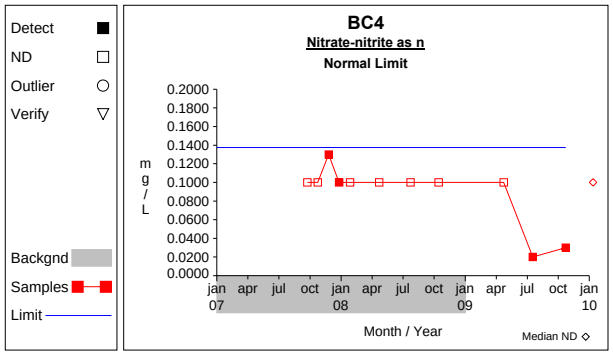
# Intra-Well Prediction Limits



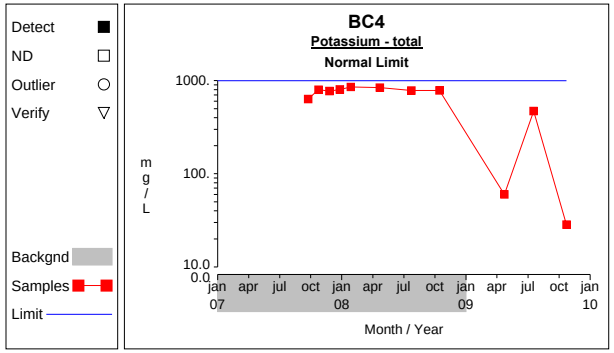

Graph 73



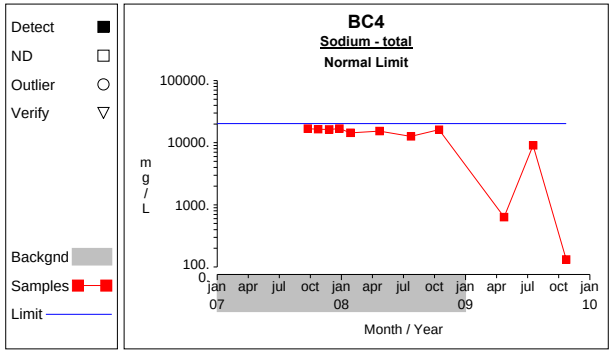

Graph 74



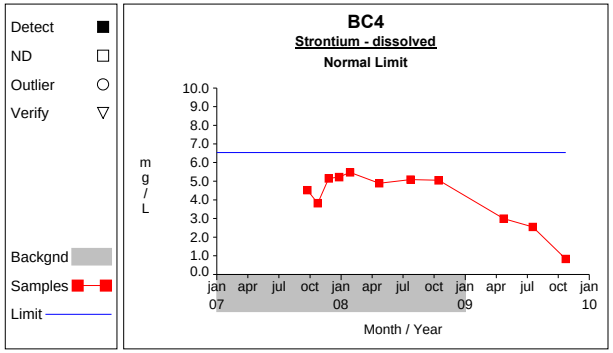

Graph 75



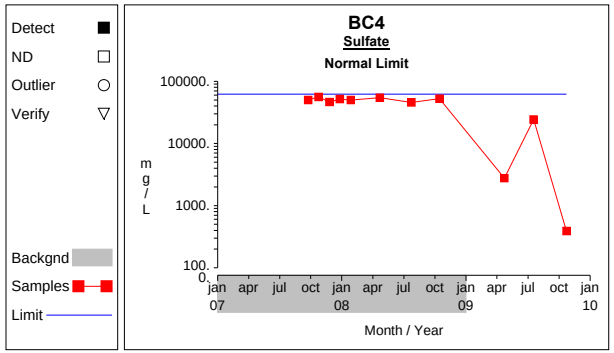

Graph 76



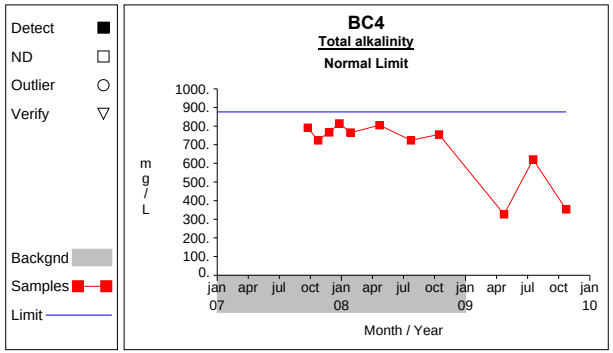

Graph 77



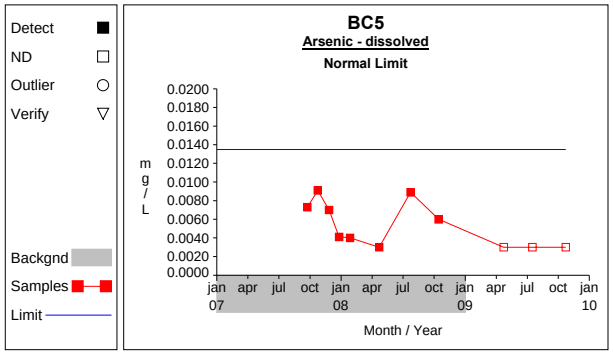

Graph 78




Graph 79

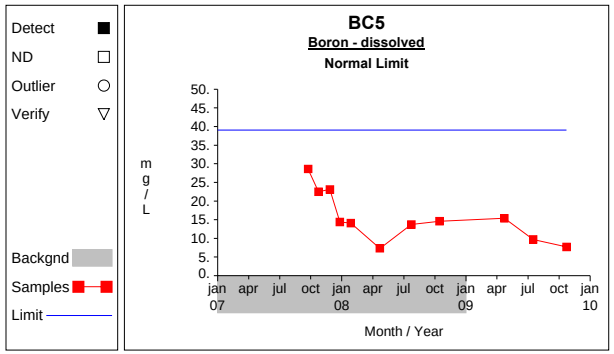



Graph 80

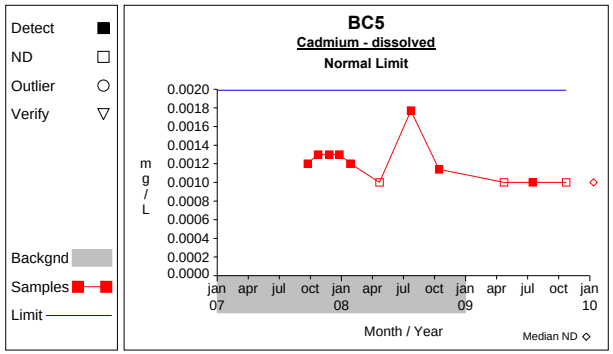



Graph 81

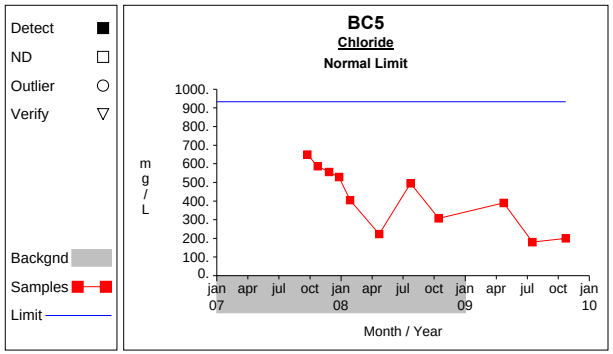
# Intra-Well Prediction Limits



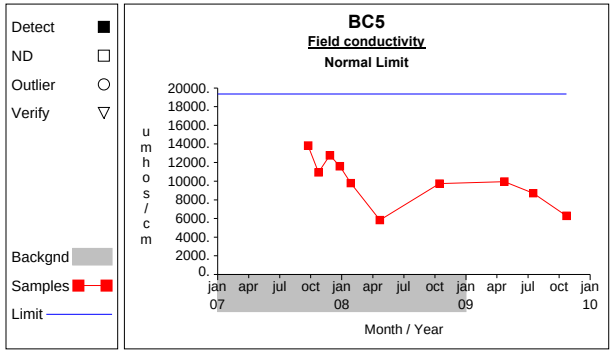

Graph 82



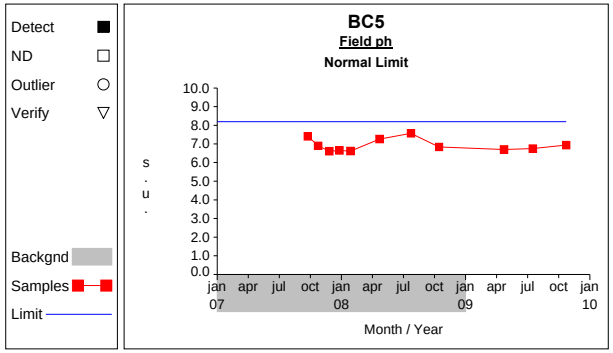

Graph 83



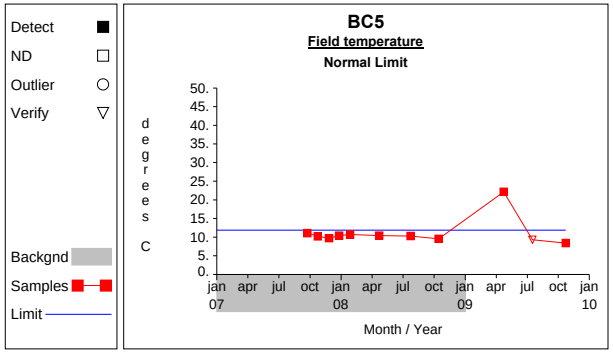

Graph 84



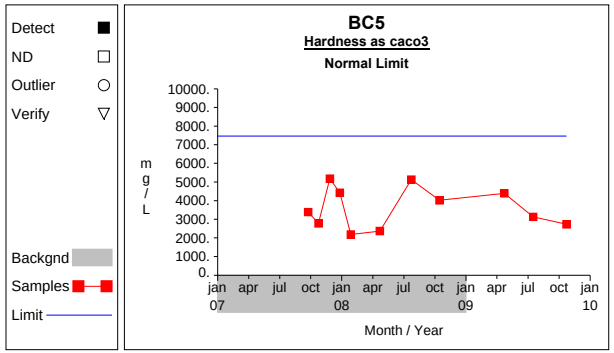

Graph 85



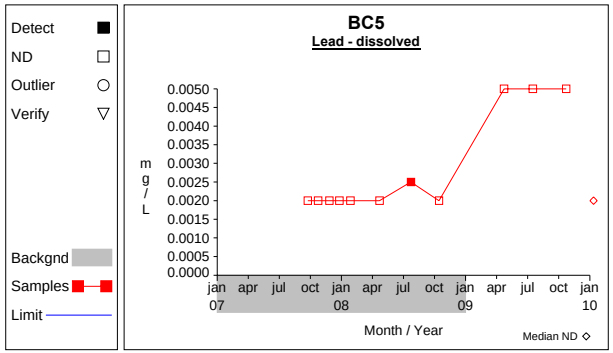

Graph 86



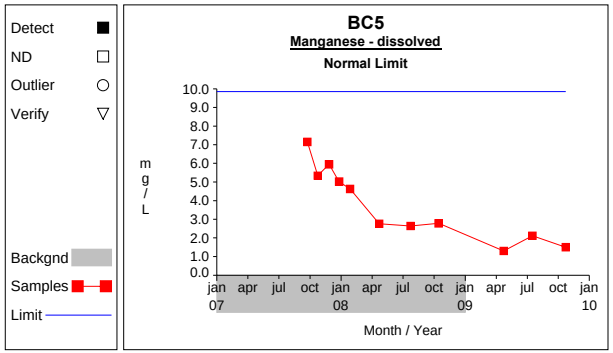

Graph 87




Graph 88

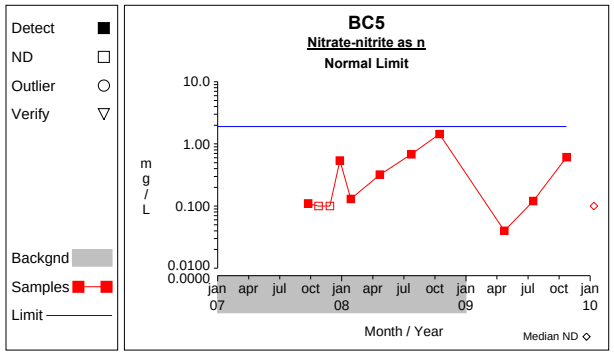



Graph 89

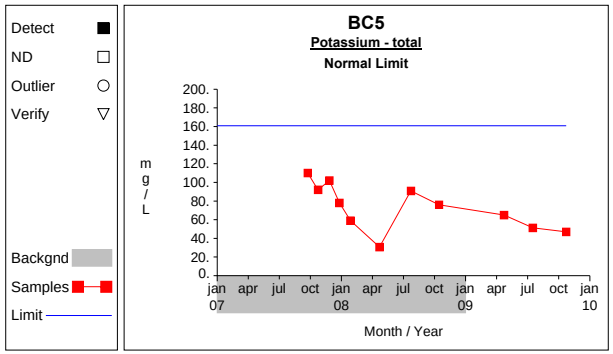



Graph 90

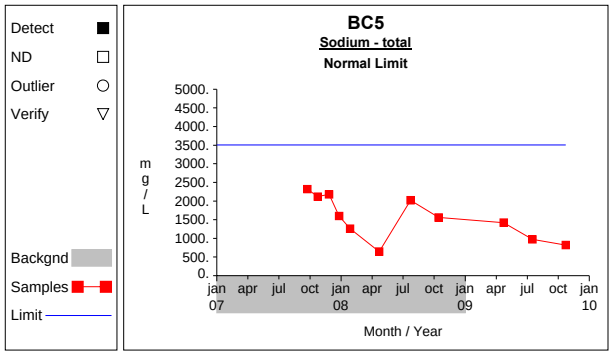
# Intra-Well Prediction Limits



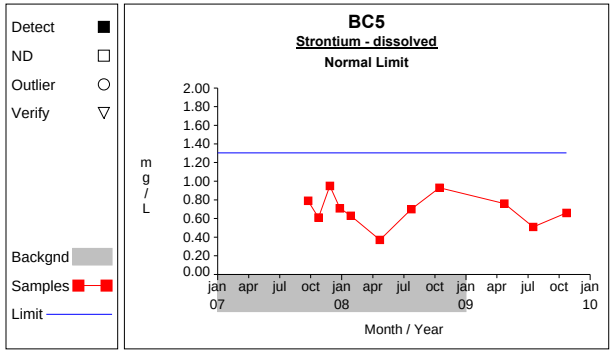

Graph 91



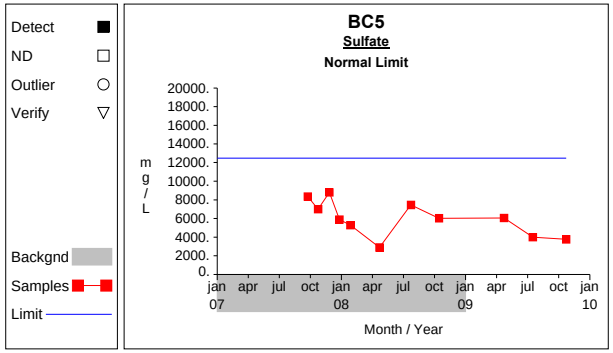

Graph 92



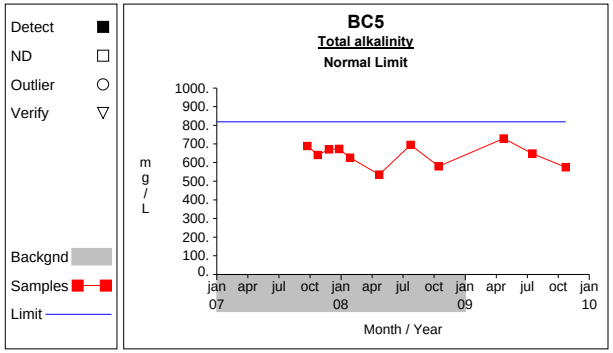

Graph 93



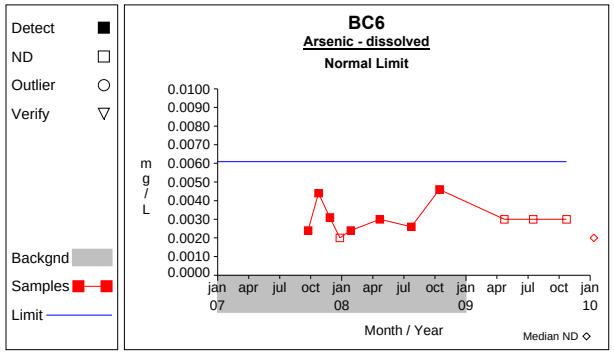

Graph 94



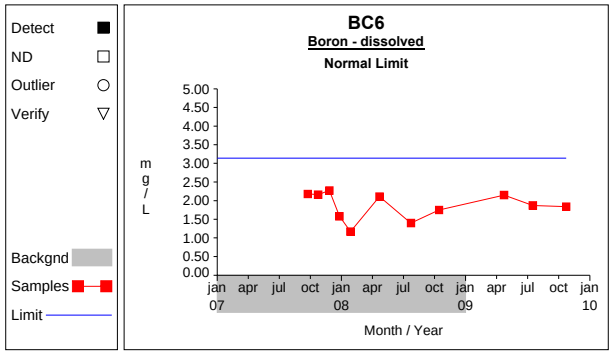

Graph 95



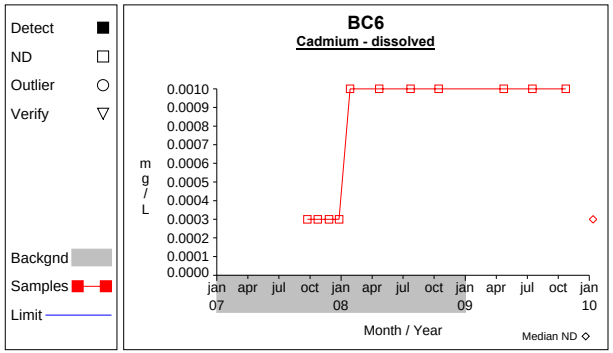

Graph 96




Graph 97

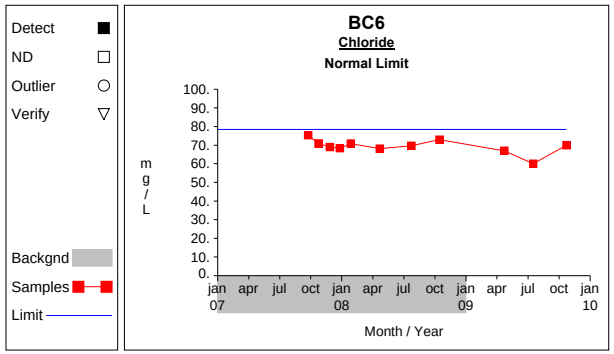



Graph 98

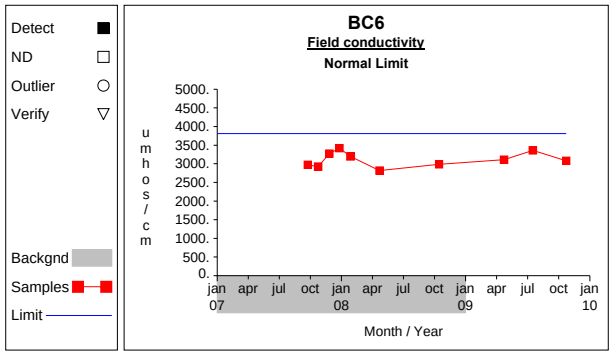



Graph 99

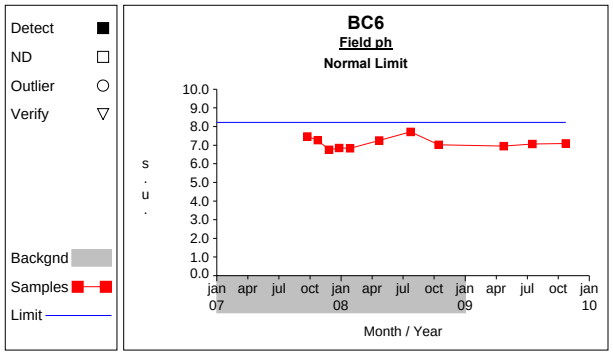
# Intra-Well Prediction Limits



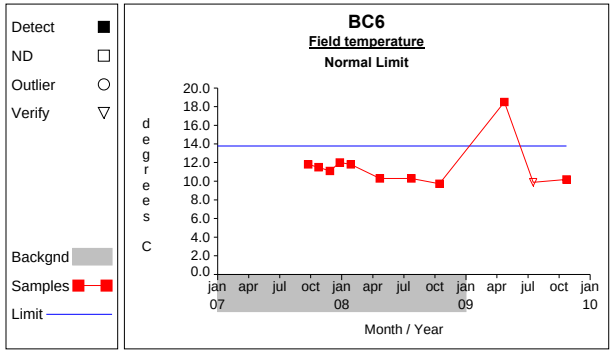

Graph 100



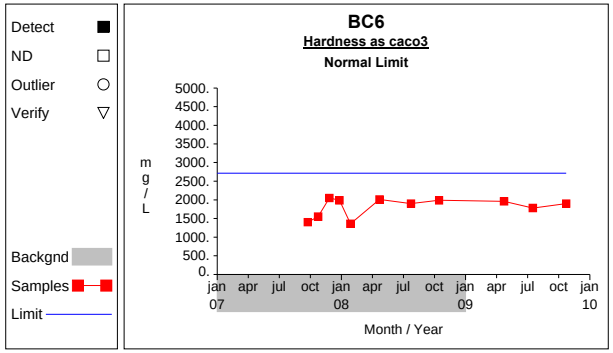

Graph 101



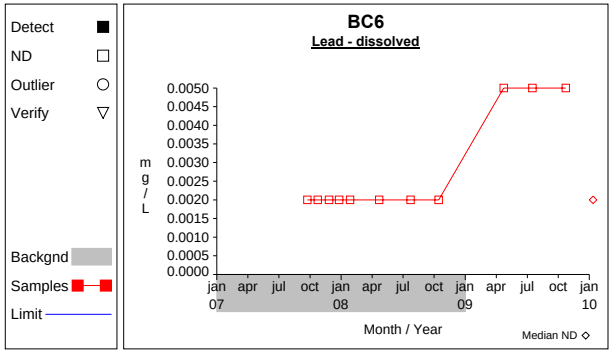

Graph 102



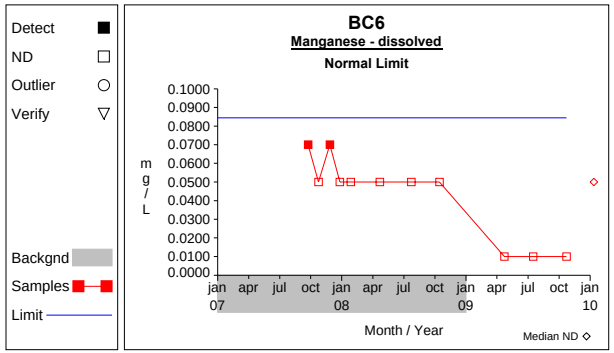

Graph 103



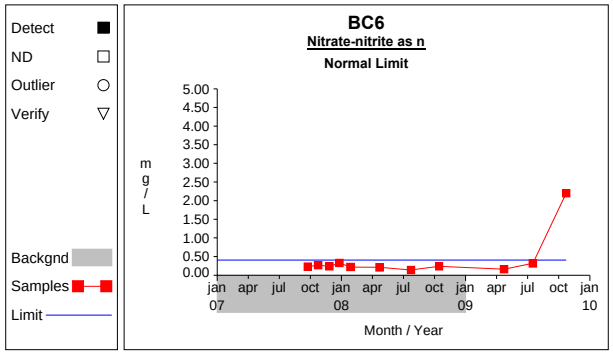

Graph 104



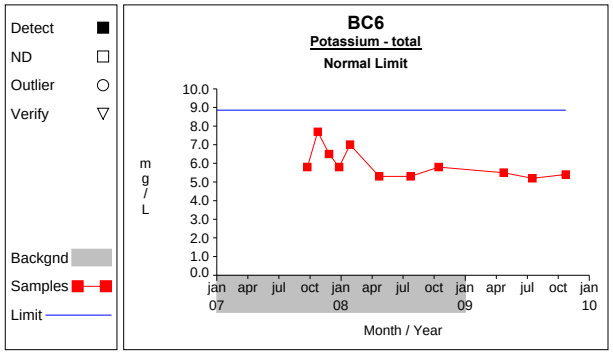

Graph 105




Graph 106

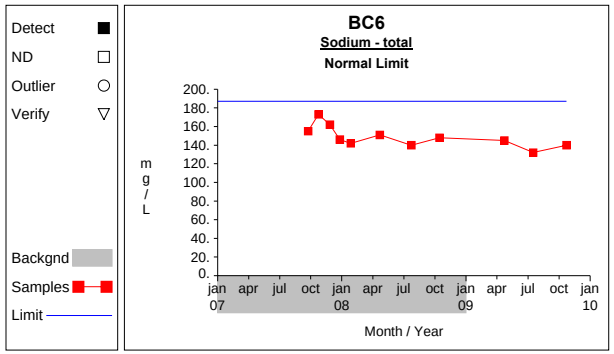



Graph 107

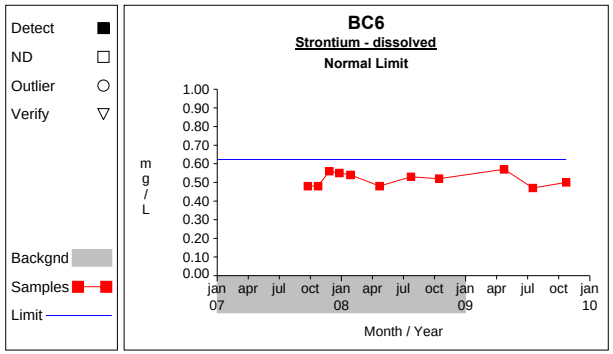



Graph 108

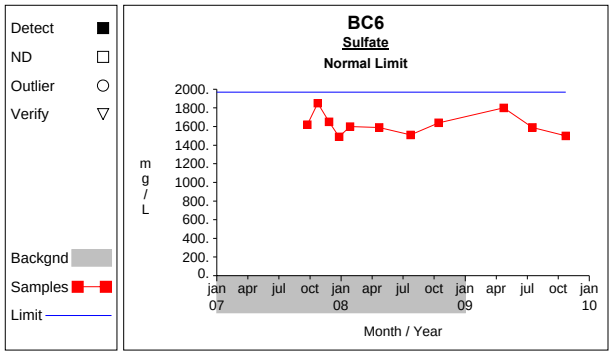
# Intra-Well Prediction Limits



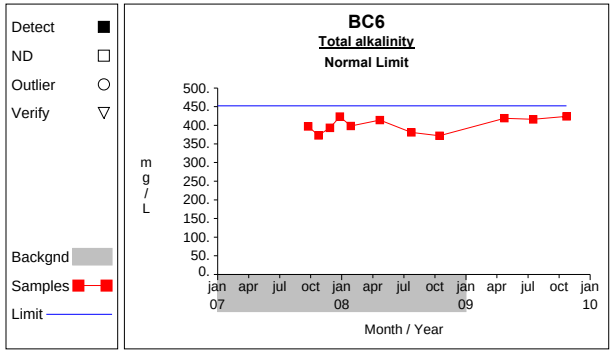

Graph 109




Graph 110




Graph 111




Graph 112

# Table 1

## Analytical Data Summary for BC1

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Boron - dissolved | mg/L | 4.0000 | 4.2100 | 4.2000 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 200.0000 | 37.0000 | 40.0000 |
| Field conductivity | umhos/cm | 2210.0000 | 2560.0000 | 2520.0000 |
| Field ph | s.u. | 7.1800 | 7.1500 | 7.1900 |
| Field temperature | degrees C | 15.1600 | 12.5800 | 12.3000 |
| Hardness as caco3 | mg/L | 1110.0000 | 1090.0000 | 1270.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | .0100 | <.0100 | <.0100 |
| Nitrate-nitrite as n | mg/L | .6400 | .3300 | .2100 |
| Potassium - total | mg/L | 1.8000 | 1.5000 | 1.8000 |
| Sodium - total | mg/L | 159.0000 | 153.0000 | 176.0000 |
| Strontium - dissolved | mg/L | .5200 | .5200 | .5900 |
| Sulfate | mg/L | 1050.0000 | 1080.0000 | 1430.0000 |
| Total alkalinity | mg/L | 392.0000 | 370.0000 | 382.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 2

## Analytical Data Summary for BC101

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | .0090 | .0070 | .0080 |
| Boron - dissolved | mg/L | .1300 | .1100 | .1400 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | <10.0000 | 4.0000 | 5.3500 |
| Field conductivity | umhos/cm | 2420.0000 | 2610.0000 | 2400.0000 |
| Field ph | s.u. | 6.9600 | 6.7200 | 6.7600 |
| Field temperature | degrees C | 10.3000 | 10.1900 | 10.3500 |
| Hardness as caco3 | mg/L | 1660.0000 | 1530.0000 | 1560.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | 1.4000 | 1.2900 | 1.1500 |
| Nitrate-nitrite as n | mg/L | <.0100 | .0400 | <.0100 |
| Potassium - total | mg/L | 7.3000 | 7.1000 | 7.1000 |
| Sodium - total | mg/L | 15.0000 | 14.1000 | 16.3000 |
| Strontium - dissolved | mg/L | .8800 | .7800 | .7900 |
| Sulfate | mg/L | 1080.0000 | 1060.0000 | 1330.0000 |
| Total alkalinity | mg/L | 512.0000 | 521.0000 | 519.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 3

## Analytical Data Summary for BC2

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | .0080 | .0030 | .0050 |
| Boron - dissolved | mg/L | 69.4000 | 63.0000 | 61.9000 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 1900.0000 | 1300.0000 | 1900.0000 |
| Field conductivity | umhos/cm | 34900.0000 | 34700.0000 | 33300.0000 |
| Field ph | s.u. | 7.4400 | 6.6700 | 7.1400 |
| Field temperature | degrees C | 11.0500 | 9.7300 | 10.6700 |
| Hardness as caco3 | mg/L | 19700.0000 | 17300.0000 | 19500.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | 10.3000 | 6.5200 | 7.0400 |
| Nitrate-nitrite as n | mg/L | .0400 | <.0100 | .0200 |
| Potassium - total | mg/L | 300.0000 | 233.0000 | 277.0000 |
| Sodium - total | mg/L | 6240.0000 | 5900.0000 | 6290.0000 |
| Strontium - dissolved | mg/L | 4.2000 | 2.9600 | 3.2800 |
| Sulfate | mg/L | 27200.0000 | 27400.0000 | 29600.0000 |
| Total alkalinity | mg/L | 789.0000 | 736.0000 | 785.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 4

## Analytical Data Summary for BC3

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | .0040 | <.0030 |
| Boron - dissolved | mg/L | 23.0000 | 36.3000 | 14.3000 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 2100.0000 | 1500.0000 | 600.0000 |
| Field conductivity | umhos/cm | 26100.0000 | 33200.0000 | 10730.0000 |
| Field ph | s.u. | 6.8700 | 6.7800 | 7.1300 |
| Field temperature | degrees C | 11.8000 | 9.9400 | 9.9500 |
| Hardness as caco3 | mg/L | 15400.0000 | 17000.0000 | 8450.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | 2.6300 | 2.7900 | .9300 |
| Nitrate-nitrite as n | mg/L | .0400 | <.0100 | 1.2000 |
| Potassium - total | mg/L | 26.0000 | 27.9000 | 19.0000 |
| Sodium - total | mg/L | 3600.0000 | 5110.0000 | 2530.0000 |
| Strontium - dissolved | mg/L | 1.3700 | 1.1500 | 1.9500 |
| Sulfate | mg/L | 19100.0000 | 24800.0000 | 5900.0000 |
| Total alkalinity | mg/L | 1300.0000 | 1300.0000 | 527.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 5

## Analytical Data Summary for BC4

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | .0040 |
| Boron - dissolved | mg/L | 8.5000 | 126.0000 | 3.0000 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 100.0000 | 690.0000 | 33.0000 |
| Field conductivity | umhos/cm | 8760.0000 | 40100.0000 | 1438.0000 |
| Field ph | s.u. | 7.3700 | 6.9300 | 7.3600 |
| Field temperature | degrees C | 12.3000 | 9.5600 | 11.0400 |
| Hardness as caco3 | mg/L | 2030.0000 | 7220.0000 | 545.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | 1.2000 | 5.5700 | .7300 |
| Nitrate-nitrite as n | mg/L | <.1000 | .0200 | .0300 |
| Potassium - total | mg/L | 60.0000 | 470.0000 | 28.4000 |
| Sodium - total | mg/L | 634.0000 | 9050.0000 | 132.0000 |
| Strontium - dissolved | mg/L | 2.9900 | 2.5500 | .8300 |
| Sulfate | mg/L | 2770.0000 | 24300.0000 | 390.0000 |
| Total alkalinity | mg/L | 327.0000 | 621.0000 | 353.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 6

## Analytical Data Summary for BC5

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Boron - dissolved | mg/L | 15.4000 | 9.7000 | 7.7100 |
| Cadmium - dissolved | mg/L | <.0010 | .0010 | <.0010 |
| Chloride | mg/L | 390.0000 | 180.0000 | 200.0000 |
| Field conductivity | umhos/cm | 9960.0000 | 8720.0000 | 6280.0000 |
| Field ph | s.u. | 6.7000 | 6.7500 | 6.9400 |
| Field temperature | degrees C | 22.1600 | 9.2900 | 8.4200 |
| Hardness as caco3 | mg/L | 4390.0000 | 3130.0000 | 2730.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | 1.3000 | 2.1200 | 1.5000 |
| Nitrate-nitrite as n | mg/L | .0400 | .1200 | .6100 |
| Potassium - total | mg/L | 65.0000 | 51.3000 | 47.0000 |
| Sodium - total | mg/L | 1420.0000 | 973.0000 | 820.0000 |
| Strontium - dissolved | mg/L | .7600 | .5100 | .6600 |
| Sulfate | mg/L | 6060.0000 | 4000.0000 | 3770.0000 |
| Total alkalinity | mg/L | 729.0000 | 648.0000 | 575.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 7

## Analytical Data Summary for BC6

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Arsenic - dissolved | mg/L | <.0030 | <.0030 | <.0030 |
| Boron - dissolved | mg/L | 2.1500 | 1.8700 | 1.8400 |
| Cadmium - dissolved | mg/L | <.0010 | <.0010 | <.0010 |
| Chloride | mg/L | 67.0000 | 60.0000 | 70.0000 |
| Field conductivity | umhos/cm | 3110.0000 | 3360.0000 | 3080.0000 |
| Field ph | s.u. | 6.9500 | 7.0600 | 7.0900 |
| Field temperature | degrees C | 18.5000 | 9.8900 | 10.1900 |
| Hardness as caco3 | mg/L | 1960.0000 | 1780.0000 | 1900.0000 |
| Lead - dissolved | mg/L | <.0050 | <.0050 | <.0050 |
| Manganese - dissolved | mg/L | <.0100 | <.0100 | <.0100 |
| Nitrate-nitrite as n | mg/L | .1600 | .3200 | 2.2000 |
| Potassium - total | mg/L | 5.5000 | 5.2000 | 5.4000 |
| Sodium - total | mg/L | 145.0000 | 132.0000 | 140.0000 |
| Strontium - dissolved | mg/L | .5700 | .4700 | .5000 |
| Sulfate | mg/L | 1800.0000 | 1590.0000 | 1500.0000 |
| Total alkalinity | mg/L | 419.0000 | 416.0000 | 424.0000 |

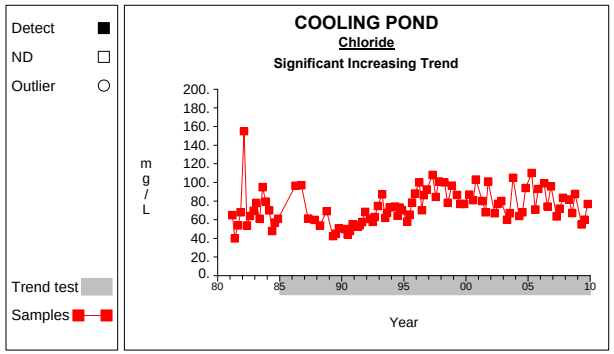
* - The displayed value is the arithmetic mean of multiple database matches.

# Appendix E

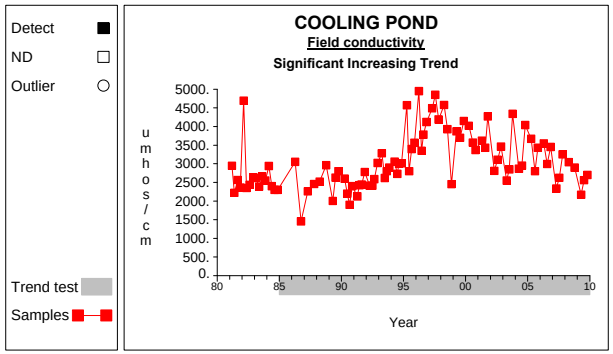
## Cooling, Evaporation, Holding Ponds and

## Wells 10, 11, 12

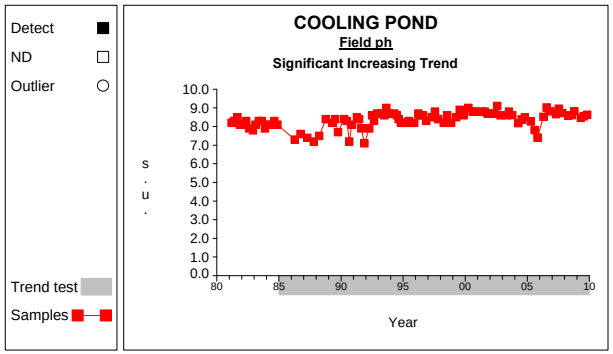
# Time Series



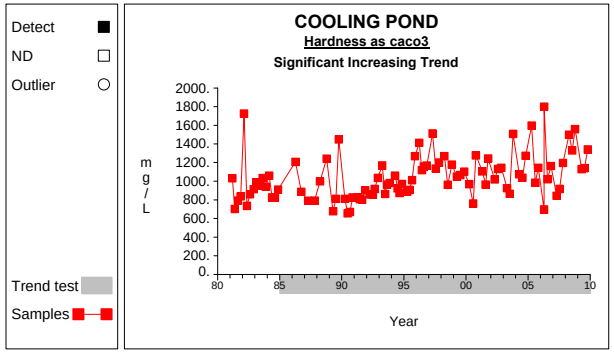

Graph 1



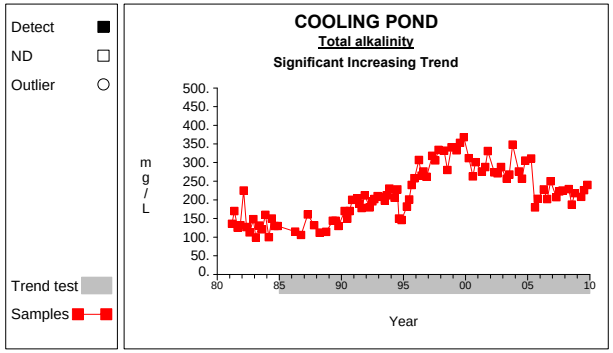

Graph 2



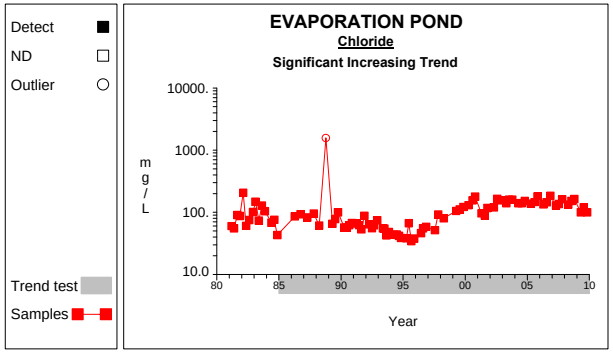

Graph 3



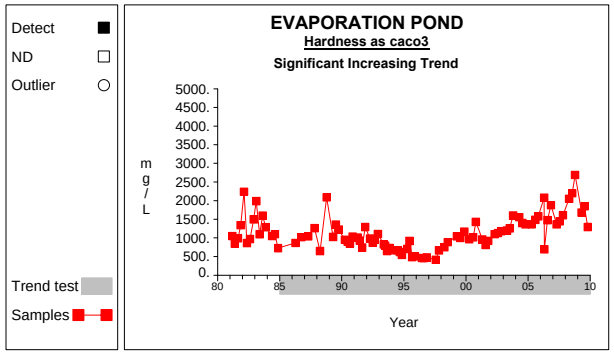

Graph 5



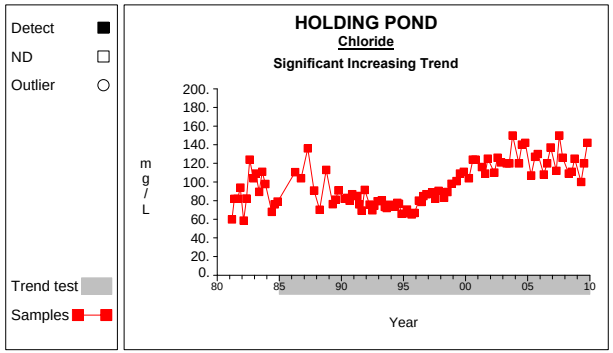

Graph 10



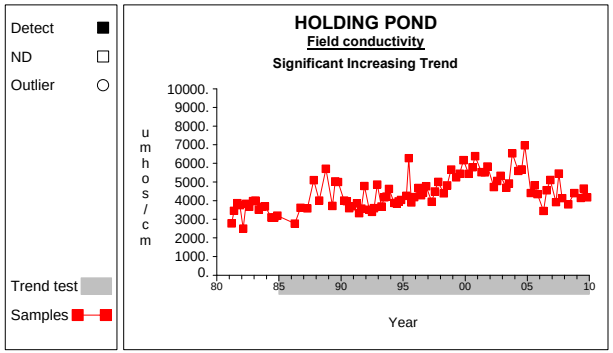

Graph 11




Graph 15

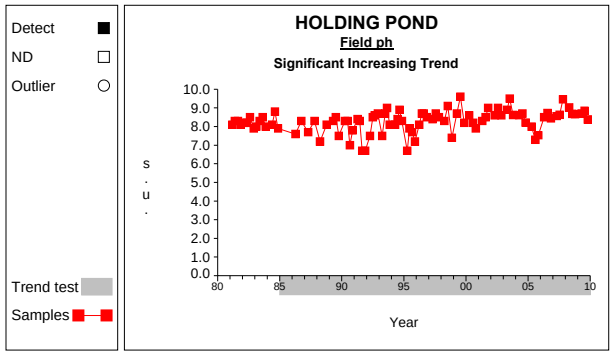



Graph 21

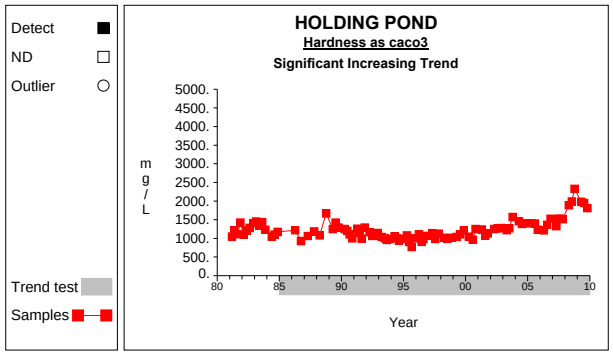



Graph 22

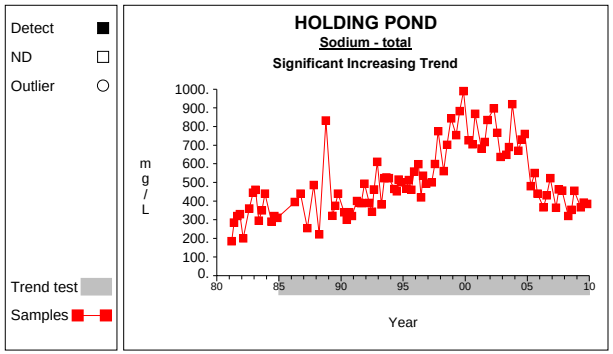
# Time Series



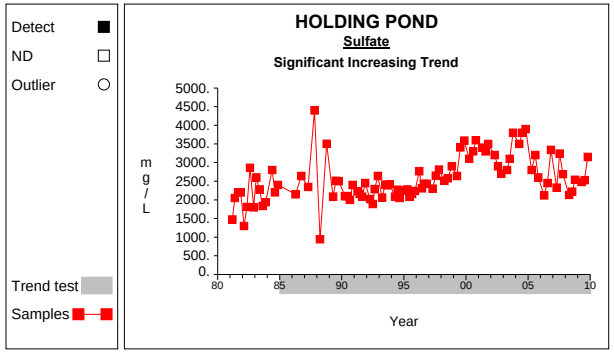

Graph 23



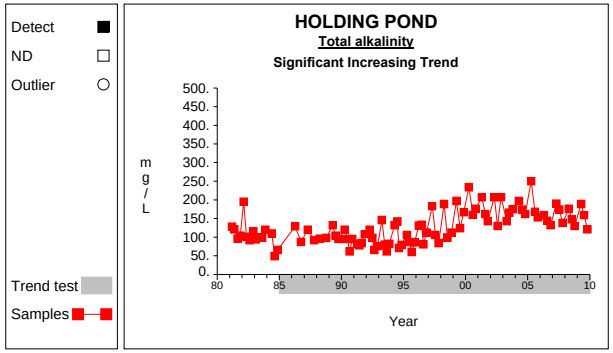

Graph 25




Graph 28




Graph 29




Graph 30

# Table 1

## Analytical Data Summary for COOLING POND

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Chloride | mg/L | 55.0000 | 60.0000 | 76.9000 |
| Field conductivity | umhos/cm | 2170.0000 | 2560.0000 | 2700.0000 |
| Field ph | s.u. | 8.4600 | 8.5500 | 8.6300 |
| Field temperature | degrees C | 20.2000 | 22.1000 | 16.7800 |
| Hardness as caco3 | mg/L | 1130.0000 | 1140.0000 | 1340.0000 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.0100 | <.0100 |
| Potassium - total | mg/L | 26.0000 | 24.8000 | 31.9000 |
| Sodium - total | mg/L | 130.0000 | 140.0000 | 178.0000 |
| Sulfate | mg/L | 1070.0000 | 1140.0000 | 1320.0000 |
| Total alkalinity | mg/L | 208.0000 | 226.0000 | 240.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 2

## Analytical Data Summary for EVAPORATION POND

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Chloride | mg/L | 100.0000 | 120.0000 | 100.0000 |
| Field conductivity | umhos/cm | 3850.0000 | 4800.0000 | 4180.0000 |
| Field ph | s.u. | 8.5100 | 8.5700 | 8.1700 |
| Field temperature | degrees C | 14.2700 | 19.4900 | 5.0400 |
| Hardness as caco3 | mg/L | 1680.0000 | 1850.0000 | 1290.0000 |
| Nitrate-nitrite as n | mg/L | <.0100 | .0500 | <.0100 |
| Potassium - total | mg/L | 41.0000 | 52.3000 | 50.0000 |
| Sodium - total | mg/L | 363.0000 | 526.0000 | 422.0000 |
| Sulfate | mg/L | 2280.0000 | 2680.0000 | 3020.0000 |
| Total alkalinity | mg/L | 157.0000 | 68.0000 | 99.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

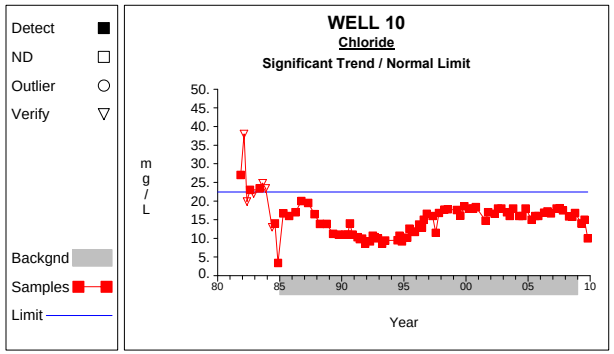
# Table 3

## Analytical Data Summary for HOLDING POND

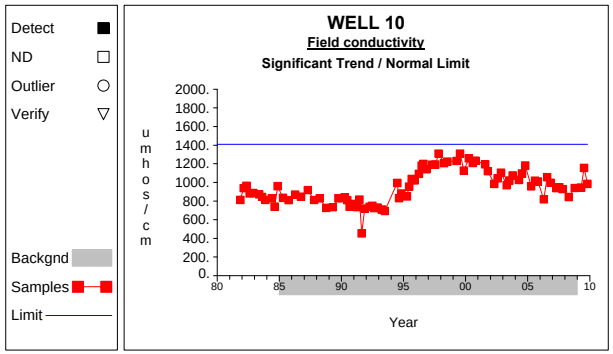
| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Chloride | mg/L | 100.0000 | 120.0000 | 142.0000 |
| Field conductivity | umhos/cm | 4140.0000 | 4650.0000 | 4180.0000 |
| Field ph | s.u. | 8.7000 | 8.8400 | 8.3800 |
| Field temperature | degrees C | 13.8300 | 20.2400 | 5.3100 |
| Hardness as caco3 | mg/L | 1980.0000 | 1950.0000 | 1810.0000 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.0100 | .0600 |
| Potassium - total | mg/L | 48.0000 | 483.0000 | 51.0000 |
| Sodium - total | mg/L | 366.0000 | 392.0000 | 385.0000 |
| Sulfate | mg/L | 2480.0000 | 2530.0000 | 3150.0000 |
| Total alkalinity | mg/L | 189.0000 | 159.0000 | 121.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

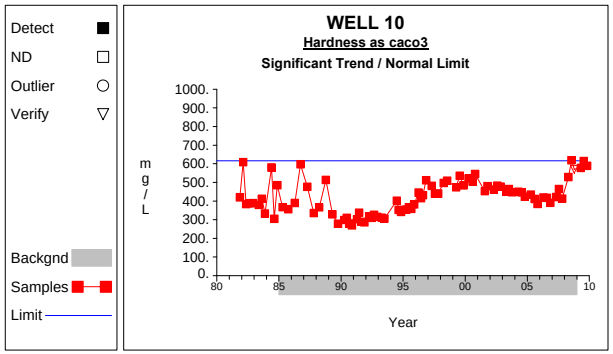
# Intra-Well Prediction Limits



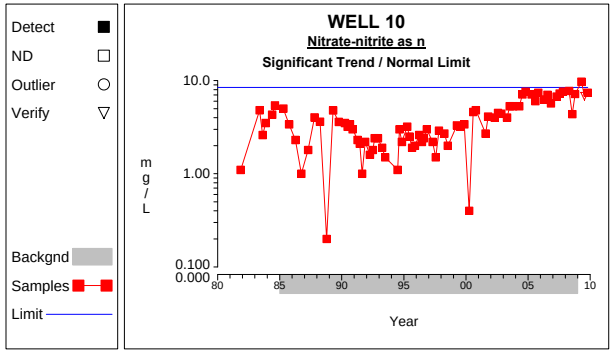

Graph 1



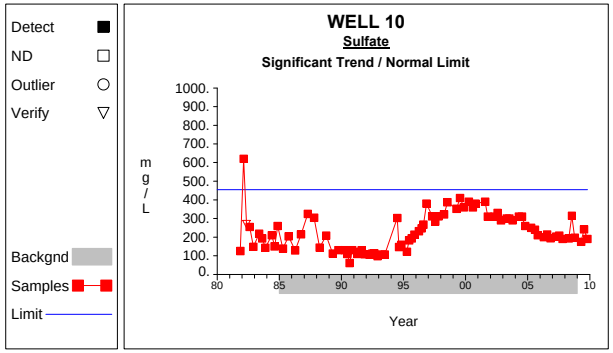

Graph 2



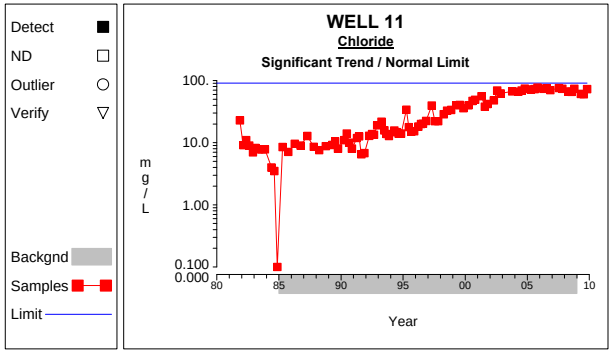

Graph 5



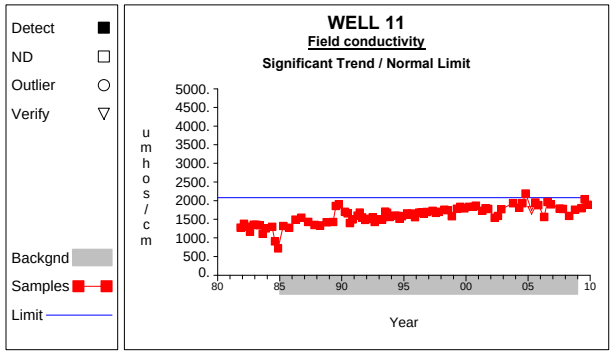

Graph 6



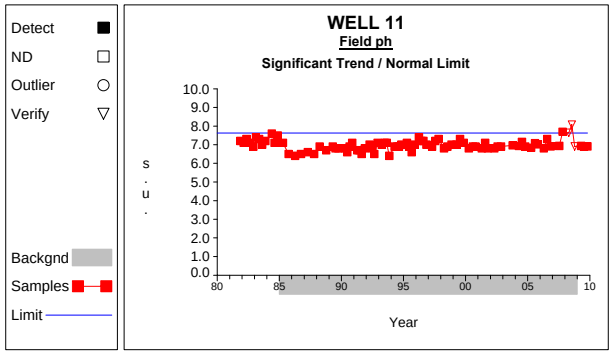

Graph 9



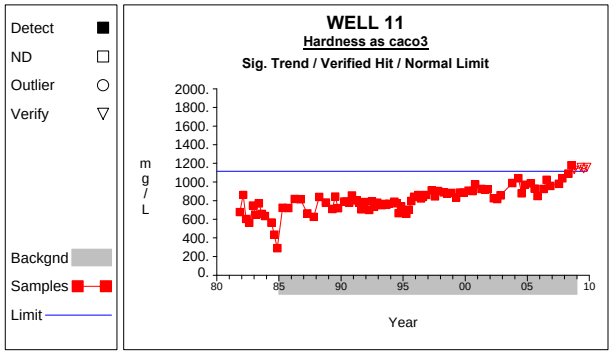

Graph 11




Graph 12

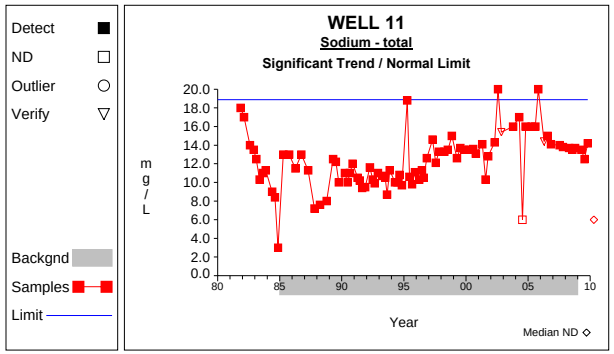



Graph 13

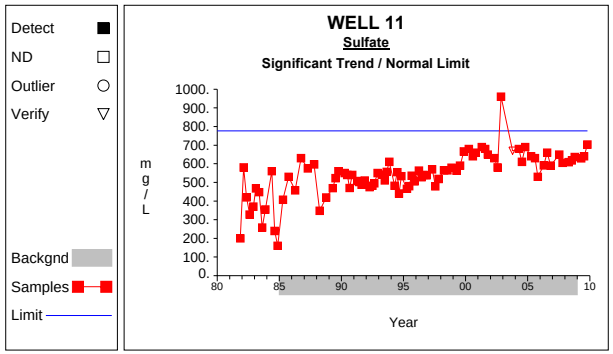



Graph 15

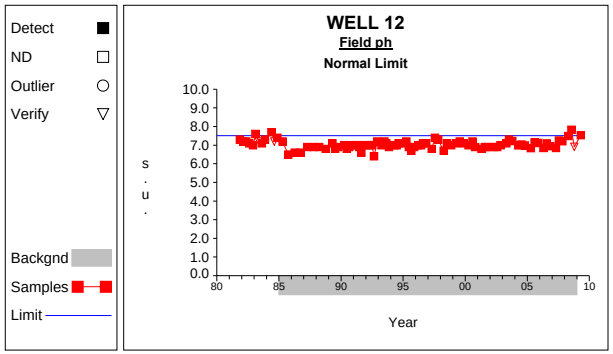
# Intra-Well Prediction Limits



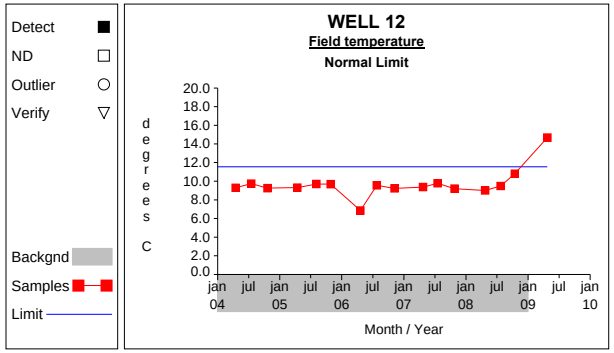

Graph 18



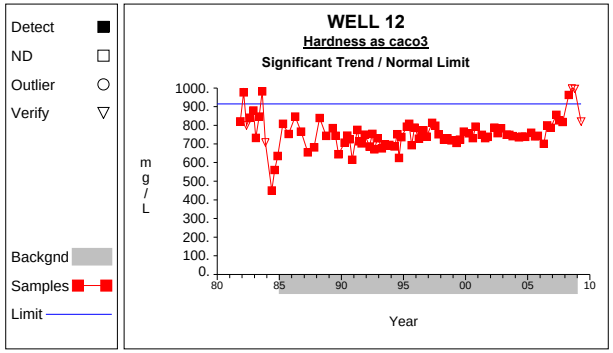

Graph 19




Graph 23




Graph 24




Graph 25

# Table 1

## Analytical Data Summary for WELL 10

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Chloride | mg/L | 14.0000 | 15.0000 | 10.0000 |
| Field conductivity | umhos/cm | 944.0000 | 1156.0000 | 984.0000 |
| Field ph | s.u. | 7.1000 | 6.9300 | 7.2000 |
| Field temperature | degrees C | 11.7100 | 11.0100 | 9.7000 |
| Hardness as caco3 | mg/L | 578.0000 | 615.0000 | 589.0000 |
| Nitrate-nitrite as n | mg/L | 9.7000 | 6.8000 | 7.4000 |
| Potassium - total | mg/L | 2.8000 | 2.7000 | 2.7000 |
| Sodium - total | mg/L | 4.6000 | 10.7000 | 6.0000 |
| Sulfate | mg/L | 175.0000 | 242.0000 | 190.0000 |
| Total alkalinity | mg/L | 316.0000 | 312.0000 | 323.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 2

## Analytical Data Summary for WELL 11

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Chloride | mg/L | 61.0000 | 60.0000 | 73.0000 |
| Field conductivity | umhos/cm | 1800.0000 | 2040.0000 | 1890.0000 |
| Field ph | s.u. | 6.9400 | 6.9000 | 6.9100 |
| Field temperature | degrees C | 9.8100 | 9.9300 | 9.5000 |
| Hardness as caco3 | mg/L | 1160.0000 | 1140.0000 | 1160.0000 |
| Nitrate-nitrite as n | mg/L | <.0100 | <.1000 | .0300 |
| Potassium - total | mg/L | 8.4000 | 9.0000 | 9.1000 |
| Sodium - total | mg/L | 13.5000 | 12.5000 | 14.2000 |
| Sulfate | mg/L | 629.0000 | 640.0000 | 703.0000 |
| Total alkalinity | mg/L | 384.0000 | 381.0000 | 389.0000 |

* - The displayed value is the arithmetic mean of multiple database matches.

# Table 3

## Analytical Data Summary for WELL 12

| Constituents | Units | 4/22/2009<br>4/23/2009 | 7/16/2009<br>7/17/2009 | 10/21/2009<br>10/23/2009 |
|---|---|---|---|---|
| Chloride | mg/L | 3.4000 | | |
| Field conductivity | umhos/cm | 1422.0000 | | |
| Field ph | s.u. | 7.5300 | | |
| Field temperature | degrees C | 14.6800 | | |
| Hardness as caco3 | mg/L | 820.0000 | | |
| Nitrate-nitrite as n | mg/L | <.0100 | | |
| Potassium - total | mg/L | 7.3000 | | |
| Sodium - total | mg/L | 20.0000 | | |
| Sulfate | mg/L | 461.0000 | | |
| Total alkalinity | mg/L | 398.0000 | | |

* - The displayed value is the arithmetic mean of multiple database matches.