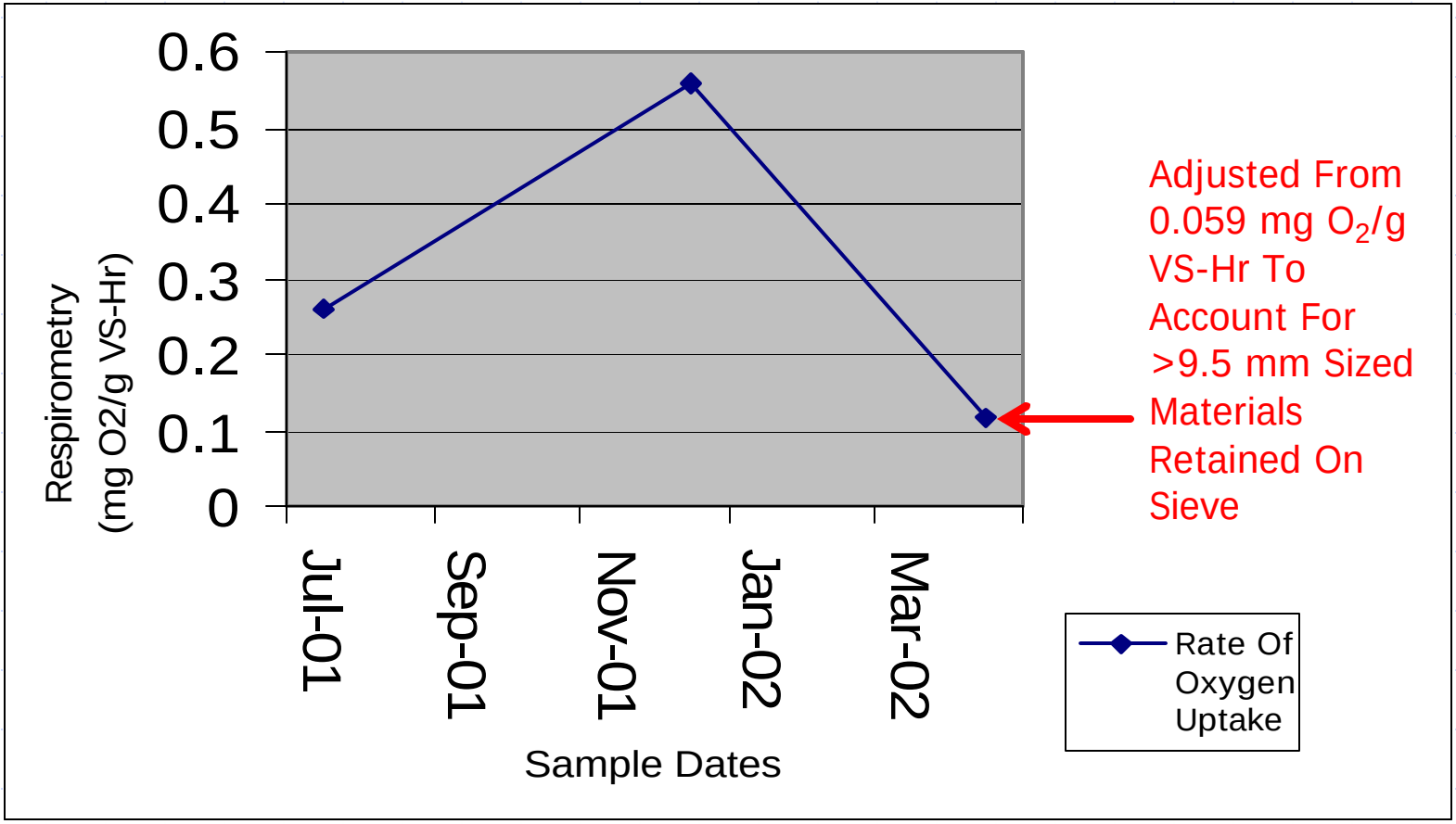
SOLIDS DATA

- **Tennessee Tech University is processing samples and analyzing them for volatile solids, cellulose, hemi-cellulose, lignin, and BMP.**
- **Samples are being split and processed by two different methods**
  - **Wiley Mill (method as outlined by Dr Mort Barlaz)**
  - **Proposed Method by Dr Lenly Weathers**
- **Results for VS, cellulose/lignin, and BMP rate changes per sampling period will be published within the next 12 to 24 months**

OXYGEN UPTAKE FOR MSW SAMPLES MEASURED VIA RESPIROMETRY

- **Tests performed by the University of Georgia (Dr K C Das)**
- **Iannotti method (1993 Compost Science & Utilization) for respirometry**
- **Method requires only sieving through 9.5mm sieve. MSW samples with high soil content can form large clods and enmesh waste within soil. Large clods will not pass sieving procedure. Therefore, MSW samples must be processed before use of this method.**

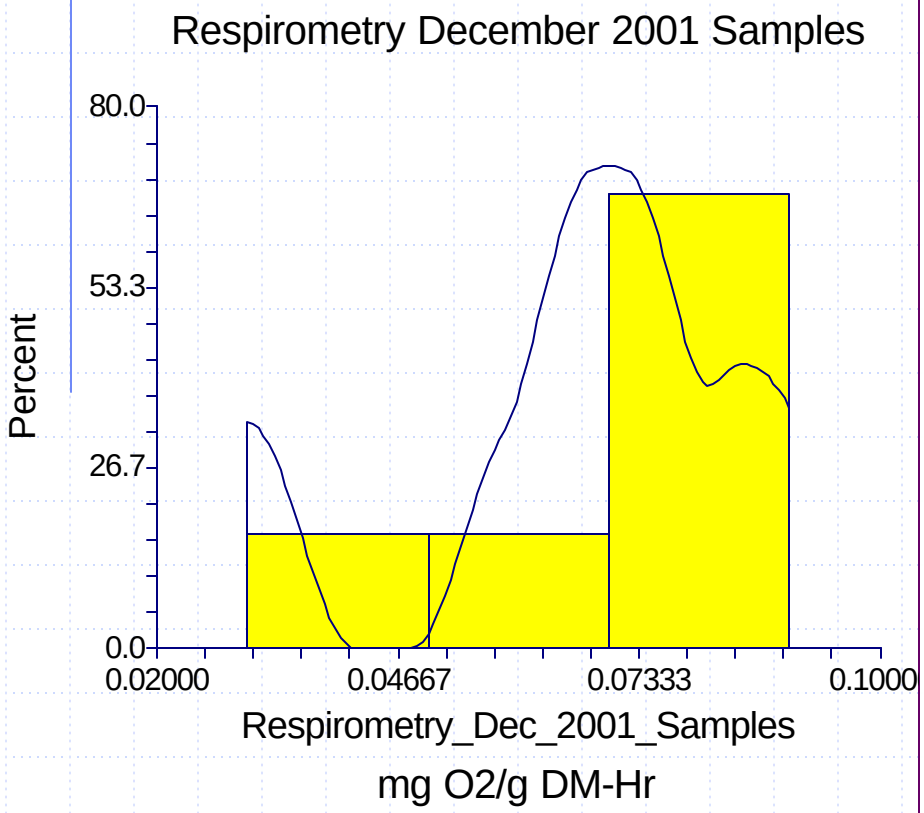
TRENDS FOR OXYGEN UPTAKE FOR MSW SAMPLES MEASURED VIA RESPIROMETRY

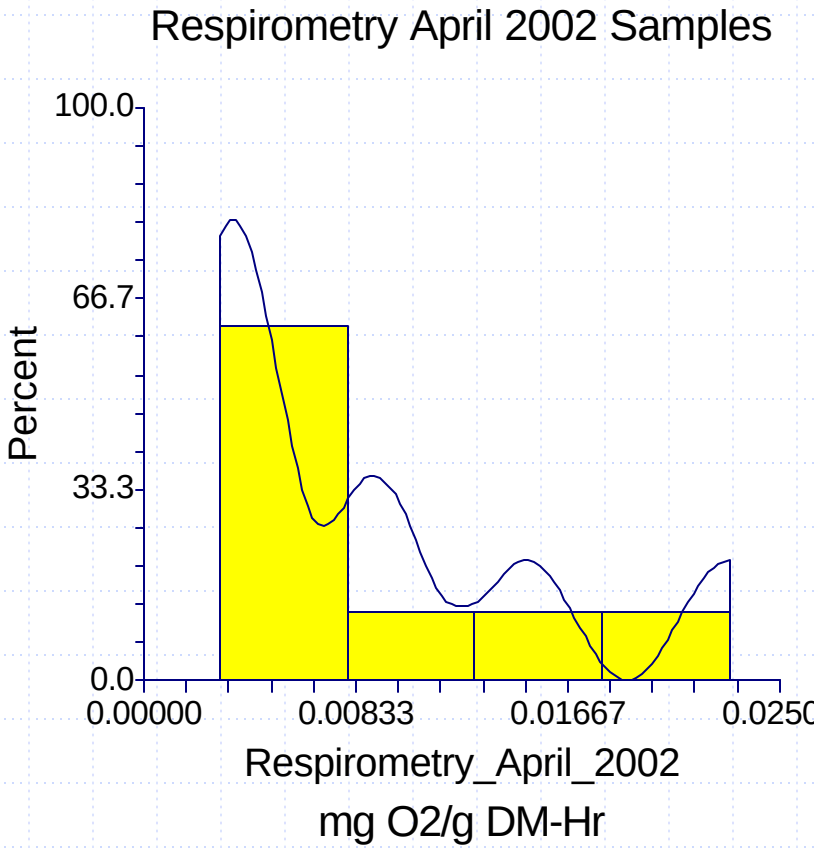


From December 2001 to April 2002:

3.38 E -3 mg O_2/g VS-Hr rate drop per day and 79% reduction in O_2 uptake

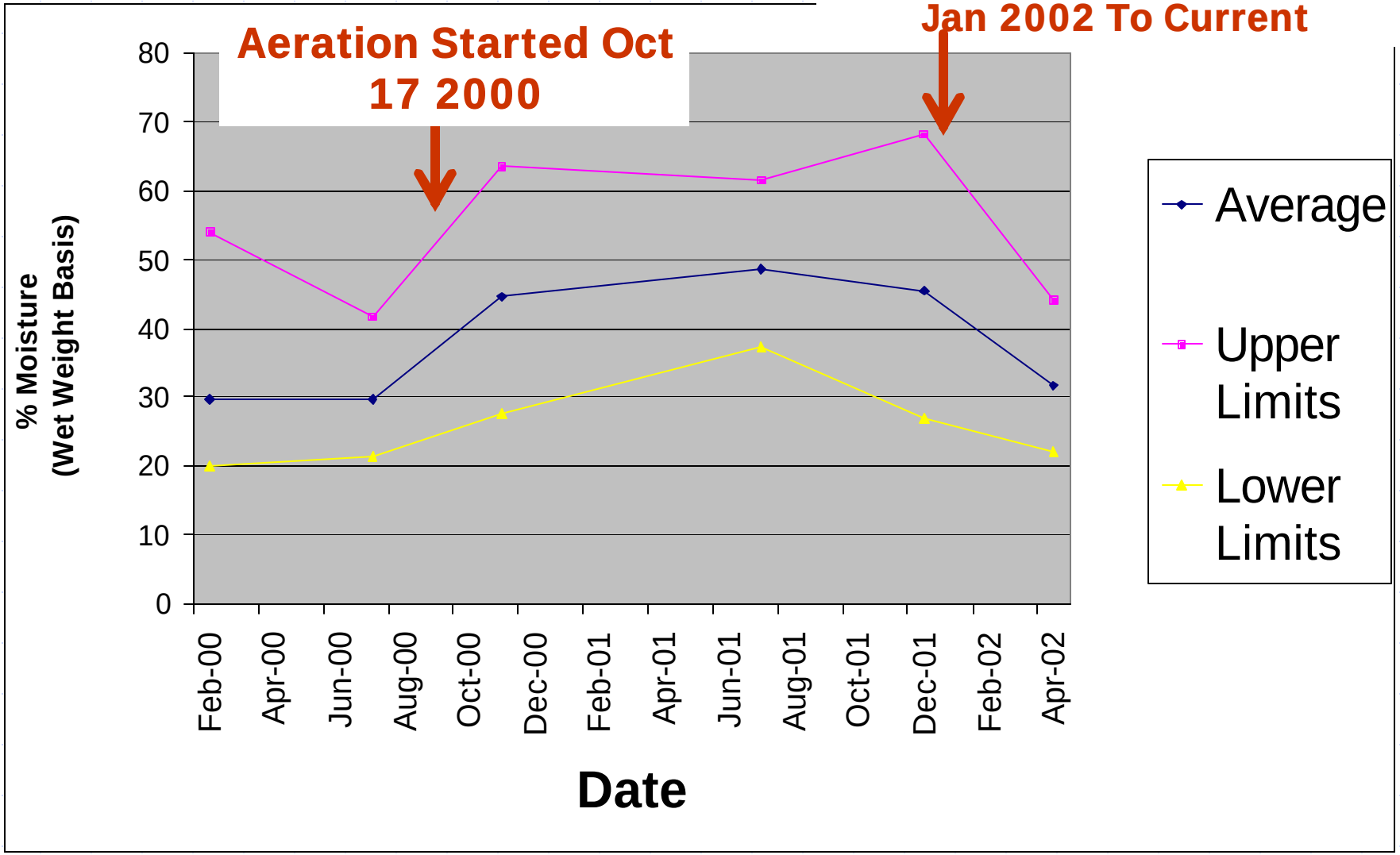
OXYGEN UPDATE OF SOLID WASTE SAMPLES MEASURED VIA RESPIROMETRY





Significant Difference In Samples Sets At Type I Error Of 5%

WILLIAMSON COUNTY BIOREACTOR WASTE MOISTURE CONTENT

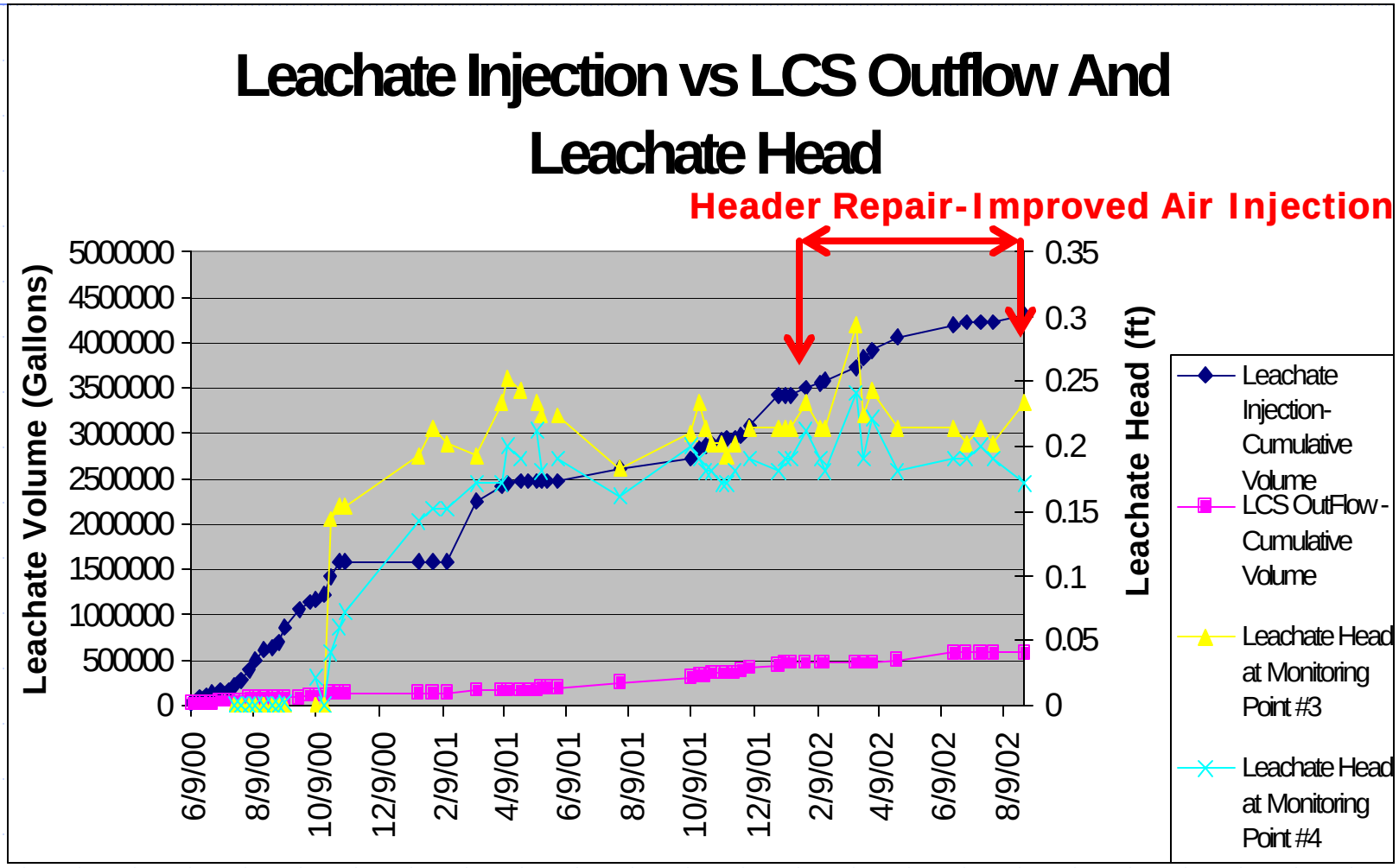


TREND DATA FOR LEACHATE

- **Leachate samples are taken concurrently with solids sampling events for full characterization analysis (including transition metals, volatile and semi-volatile organics, aromatic compounds, N-based compounds, ortho-P, chlorides, alkalinity, TDS, TSS)**

- **Bi-weekly field analysis of leachate includes, conductivity, DO, ORP, pH, and temperature of both injection leachate at the mix tank and leachate from the LCS of the bioreactor (at the southeast manhole)**

LEACHATE INJECTION VS LCS OUTFLOW AND HEAD-ON-LINER MEASUREMENTS

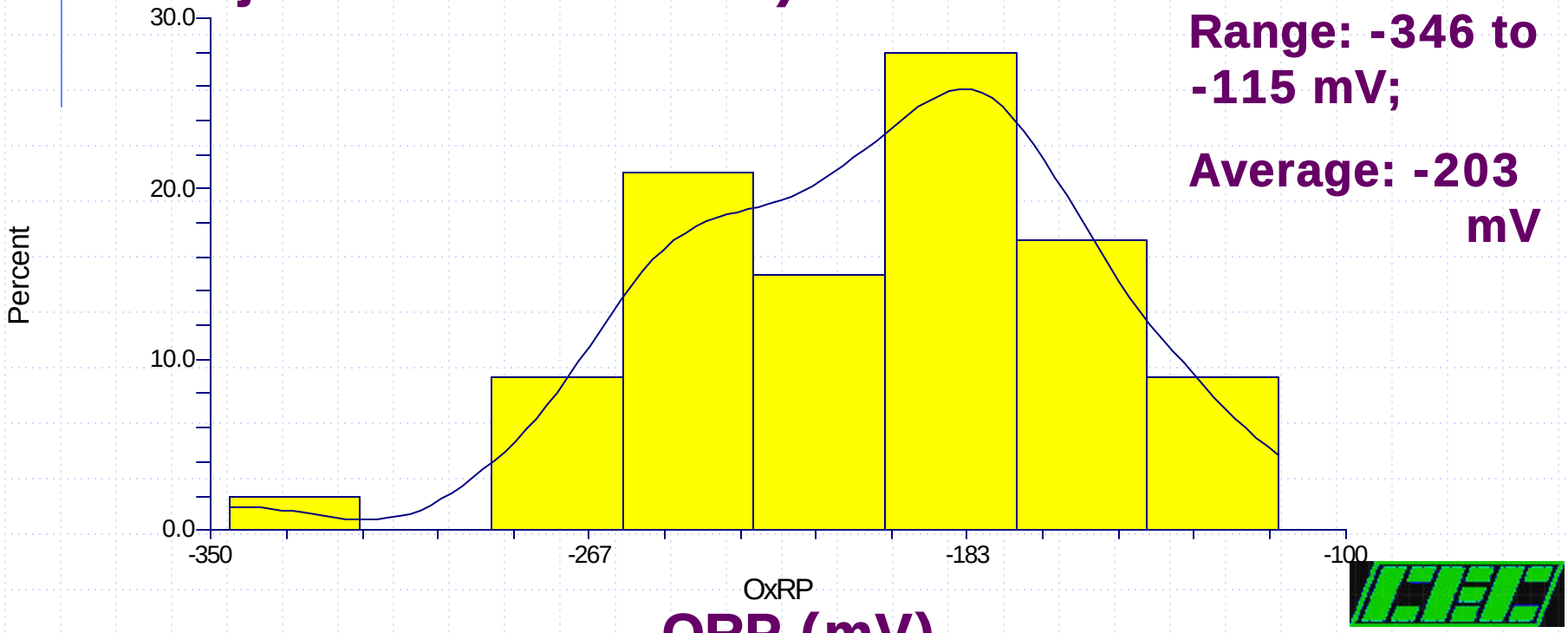


OXIDATION REDUCTION POTENTIAL

- **Bi-Weekly analysis of ORP taken from *in-situ* leachate (via monitoring wells)**
- **Leachate ORP is analyzed with both blowers on and with blowers off to examine influence of compressed air injection on the system environment**
- **ORP data from wells covers 10 weeks of sample measurements. Measurements will continue over the next 12 to 24 months**

OXIDATION REDUCTION POTENTIAL

- **Data set below includes ORP measurements taken when the blowers were off or when the blowers were on but the air header system static pressure measured less than 4.5 psig (indicative of major air header leaks)**

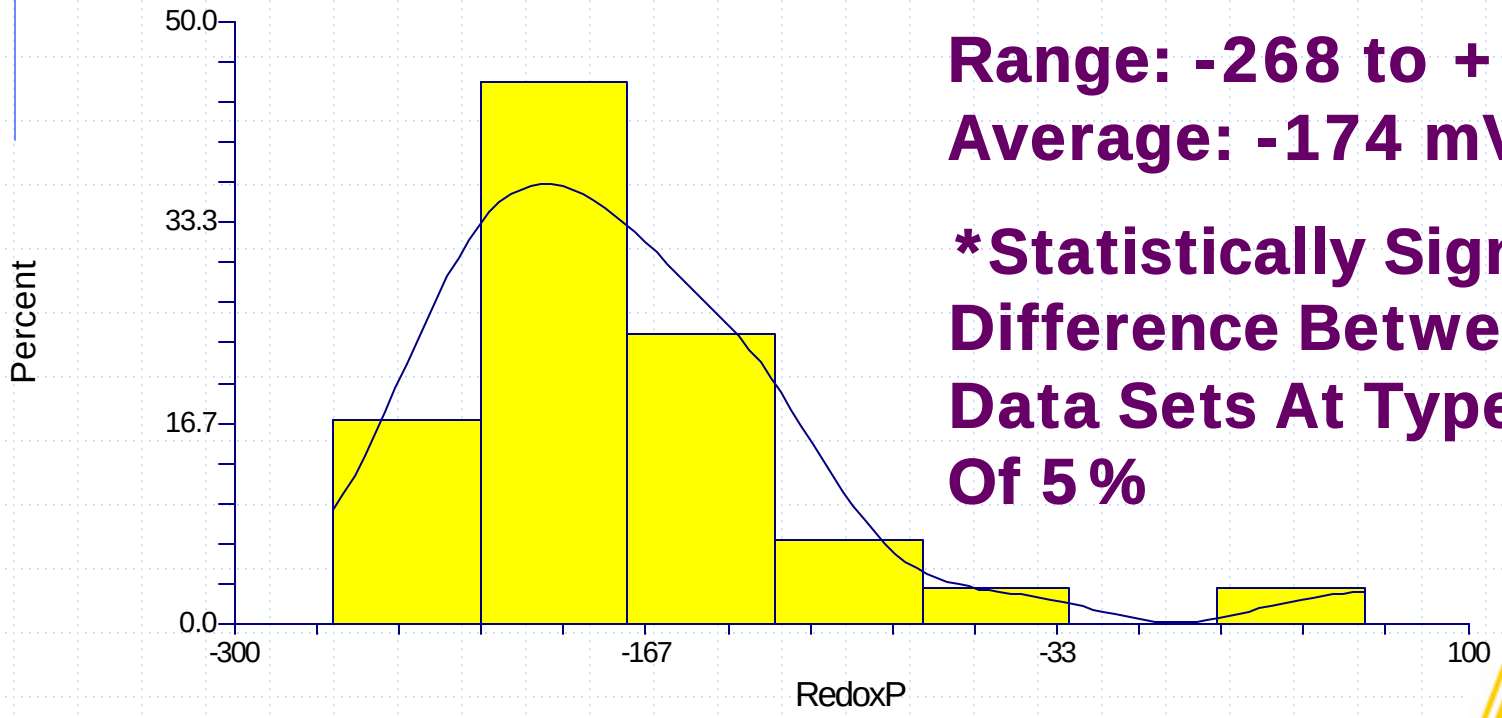


Range: -346 to -115 mV;

Average: -203 mV

OXIDATION REDUCTION POTENTIAL

Data set below includes readings taken when blowers were on and air header system static backpressure readings exceeded 4.5 psig (indicative of minimal air header pipe leaks)

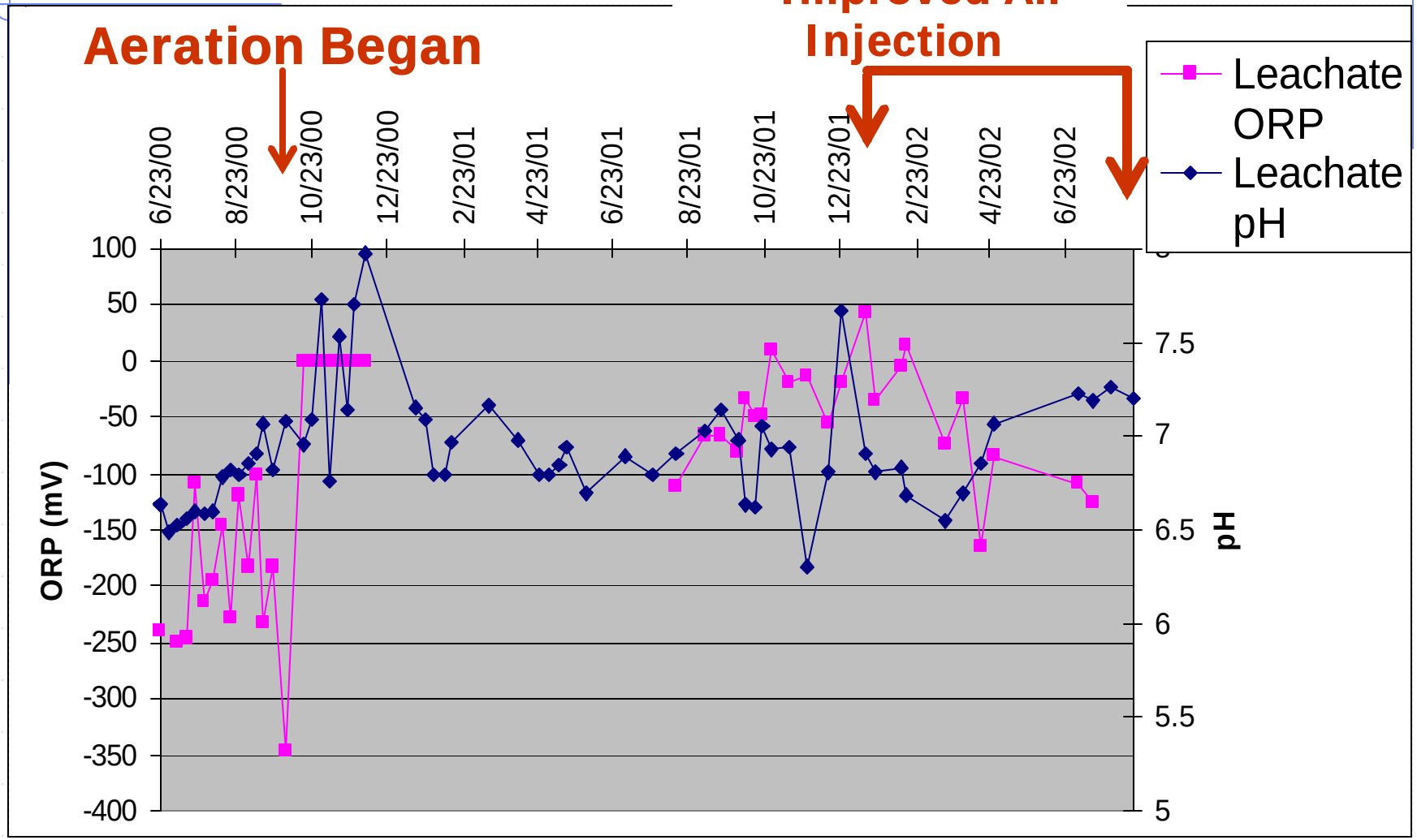


ORP (mV)

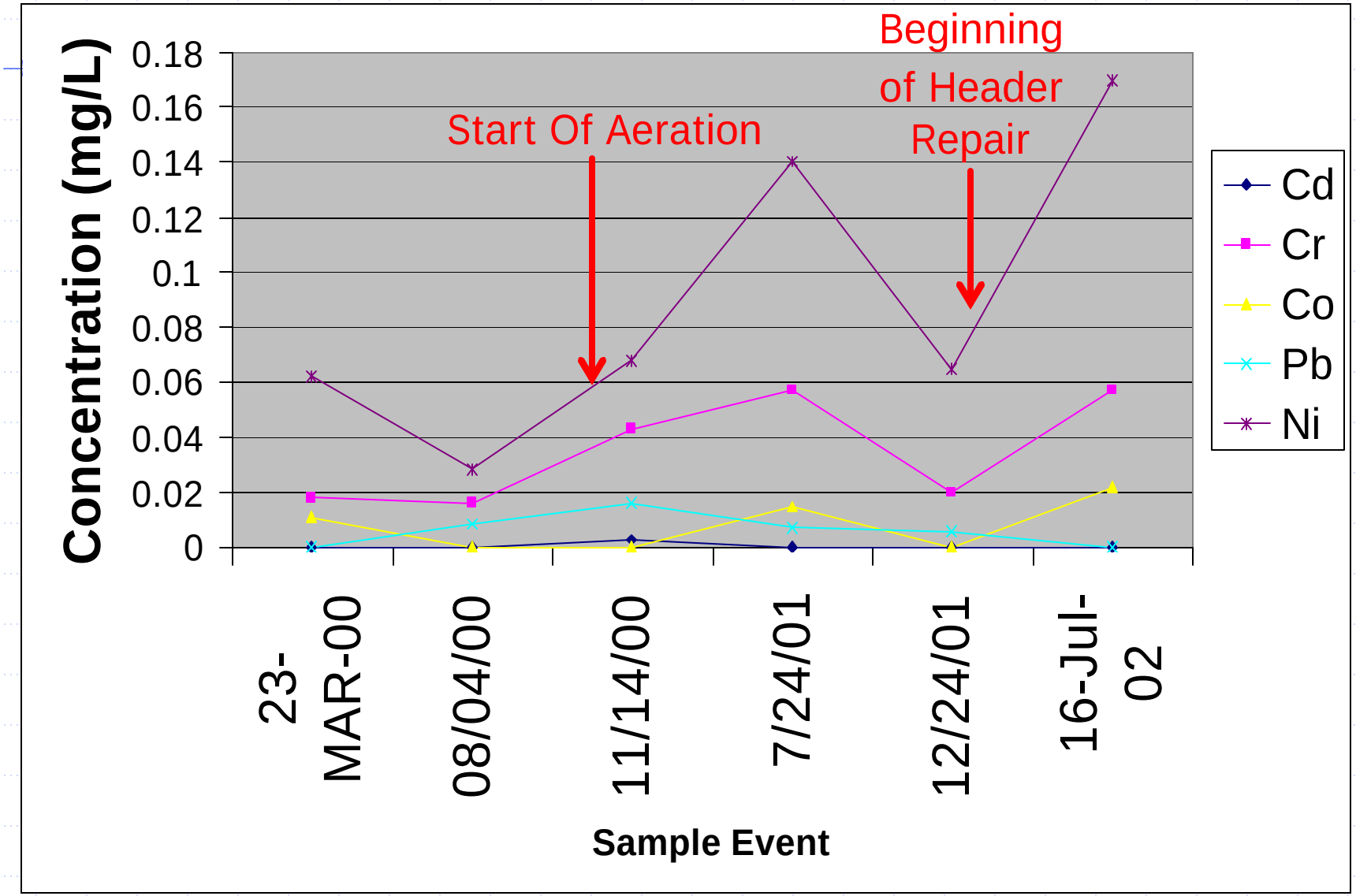
Range: -268 to +66 mV;
Average: -174 mV

***Statistically Significant Difference Between ORP Data Sets At Type I Error Of 5%**

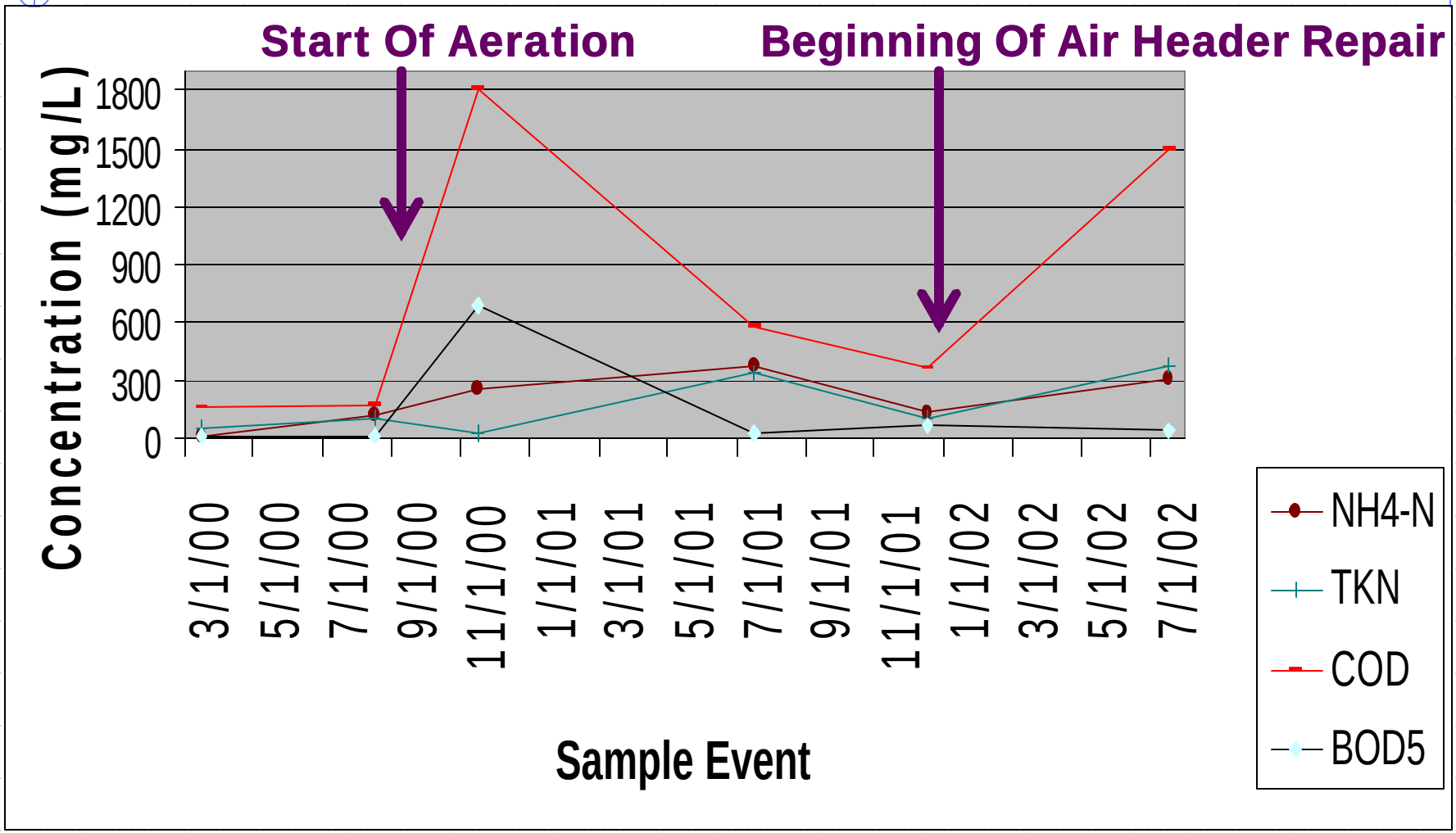
TREND IN LEACHATE pH AND ORP FROM BIOREACTOR LCS



METALS IN BIOREACTOR LCS LEACHATE

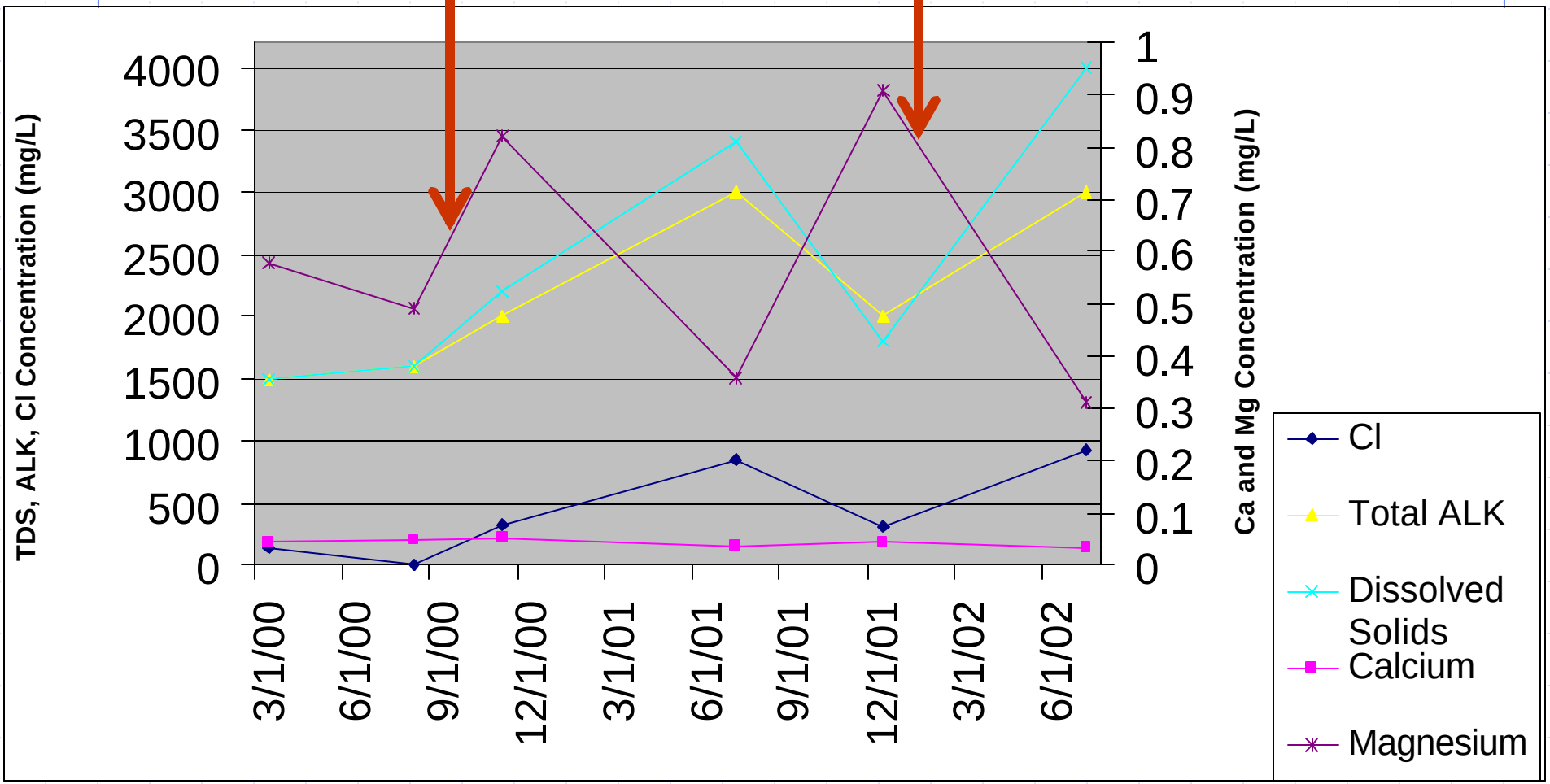


BIOREACTOR LCS LEACHATE QUALITY TRENDS

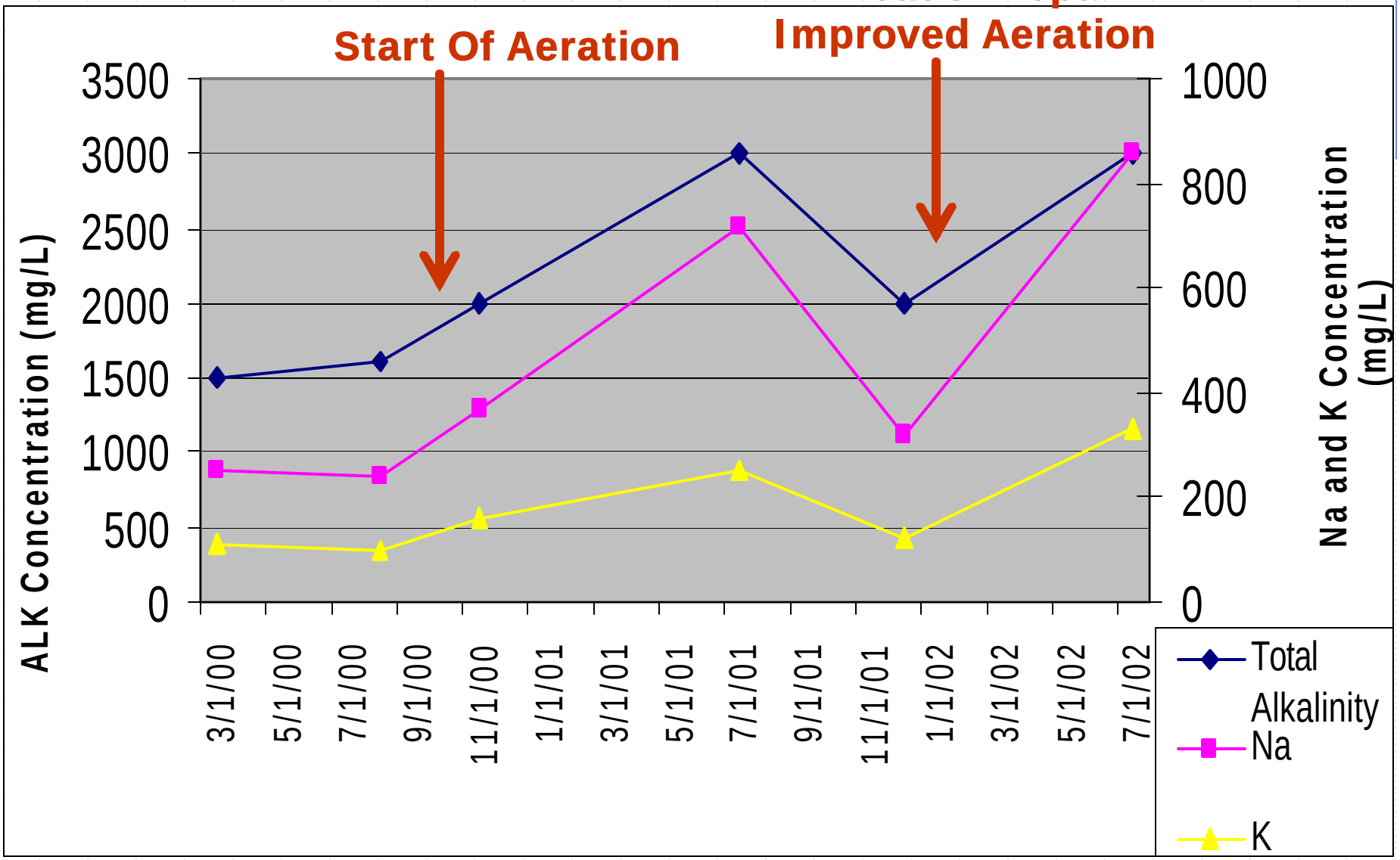


SURFACE LYSIMETERS IN CAP SYSTEM

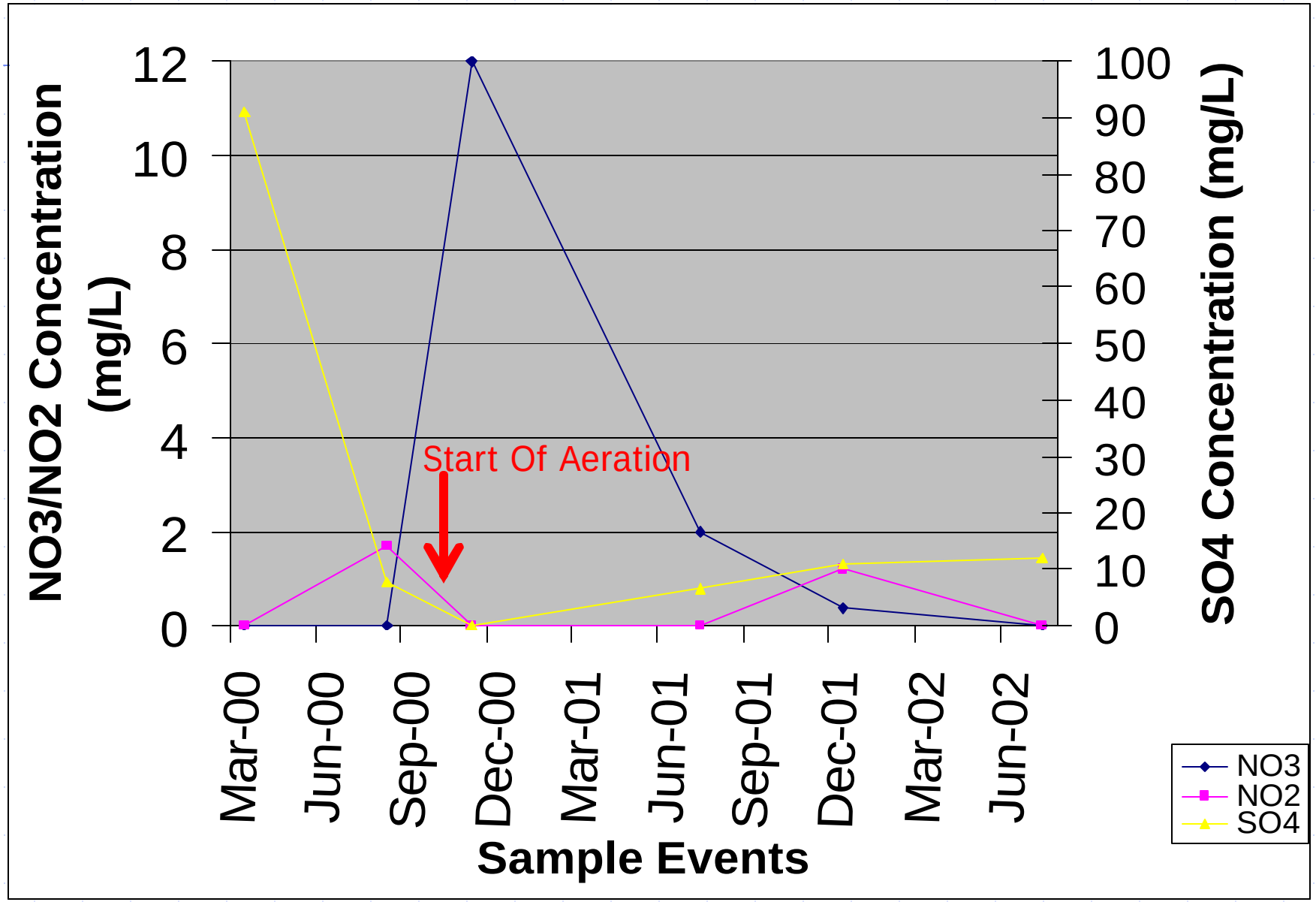
BIOREACTOR LCS LEACHATE QUALITY TRENDS



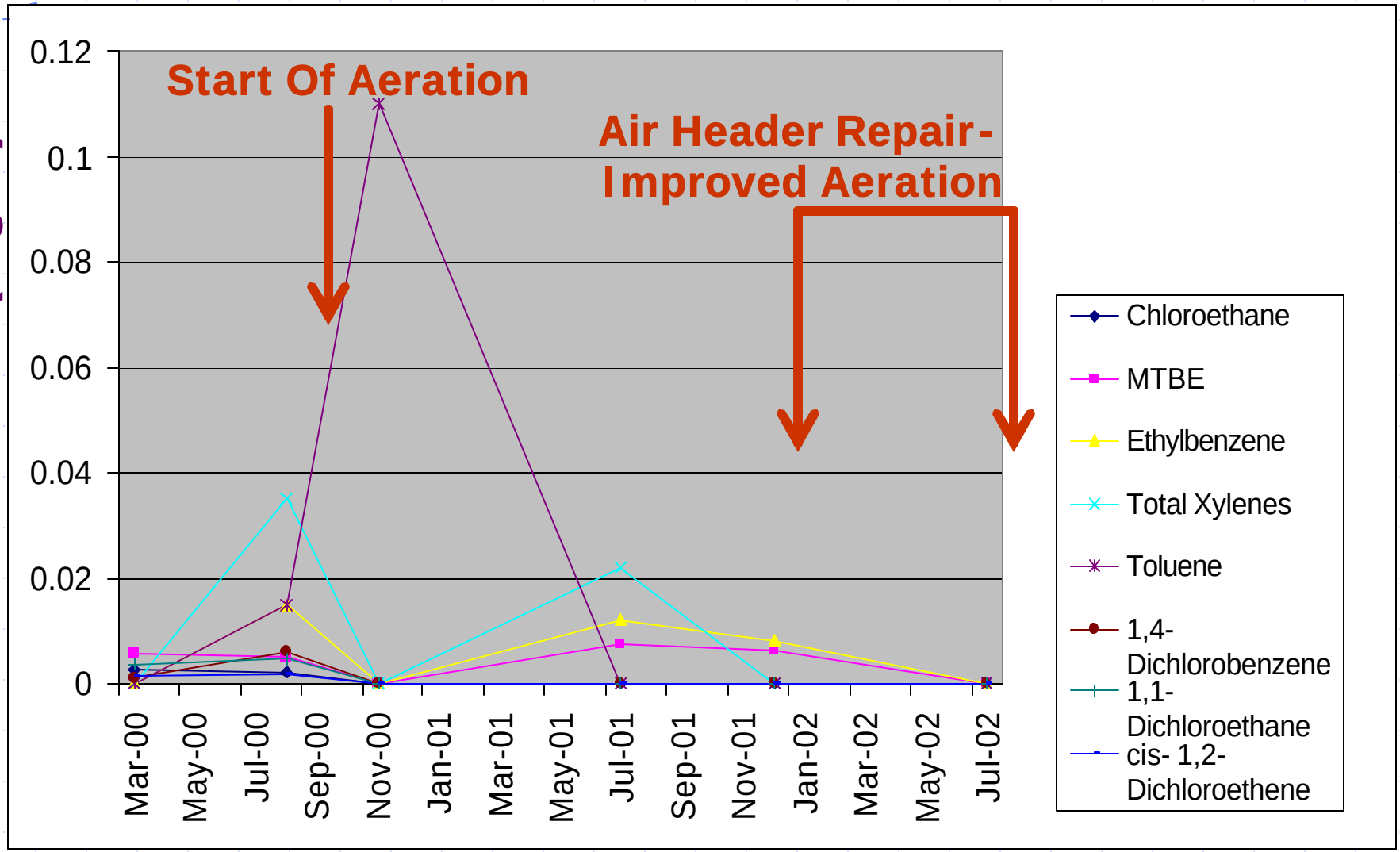
BIOREACTOR LCS LEACHATE QUALITY TRENDS



BIOREACTOR LCS LEACHATE QUALITY TRENDS



LEACHATE TRENDS – AROMATICS AND VOCs



OPERATIONAL PROBLEMS AND TROUBLESHOOTING

- **PROBLEM: Thermocouples**
  - **Sealing Connections**
  - **Shielded Wire**
  - **Accidental Severing of Lines**
  - **Wires wrapped around piping**
- **SOLUTION:**
  - **Replacement of wire; use of shielded wire**
  - **Shrink-Wrap Connections or replace with outdoor connectors (watertight)**
  - **Remove wires from around piping**

PRECIPITATE AND CORROSION AT THERMOCOUPLE CONNECTOR

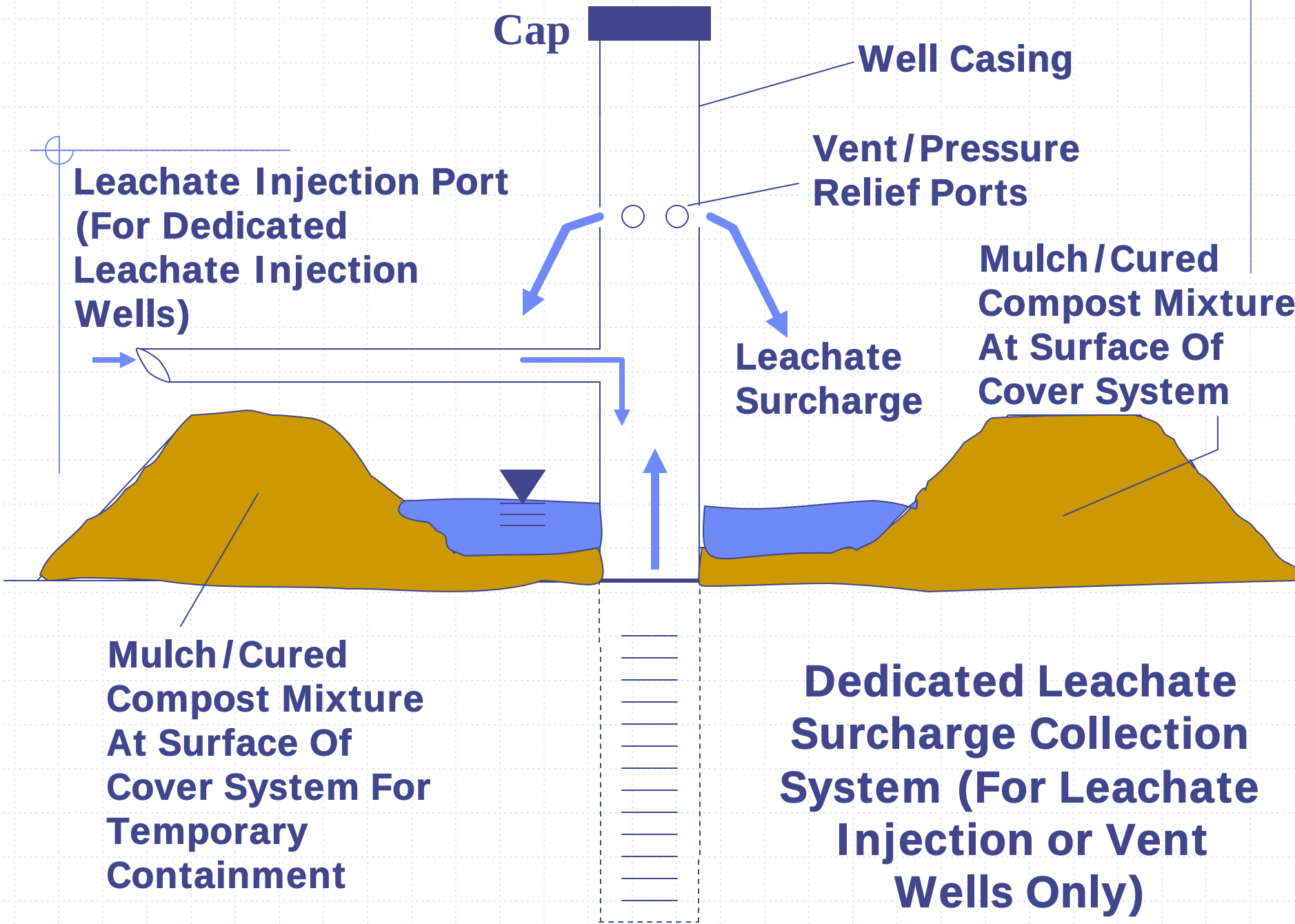
OPERATIONAL PROBLEMS AND TROUBLESHOOTING

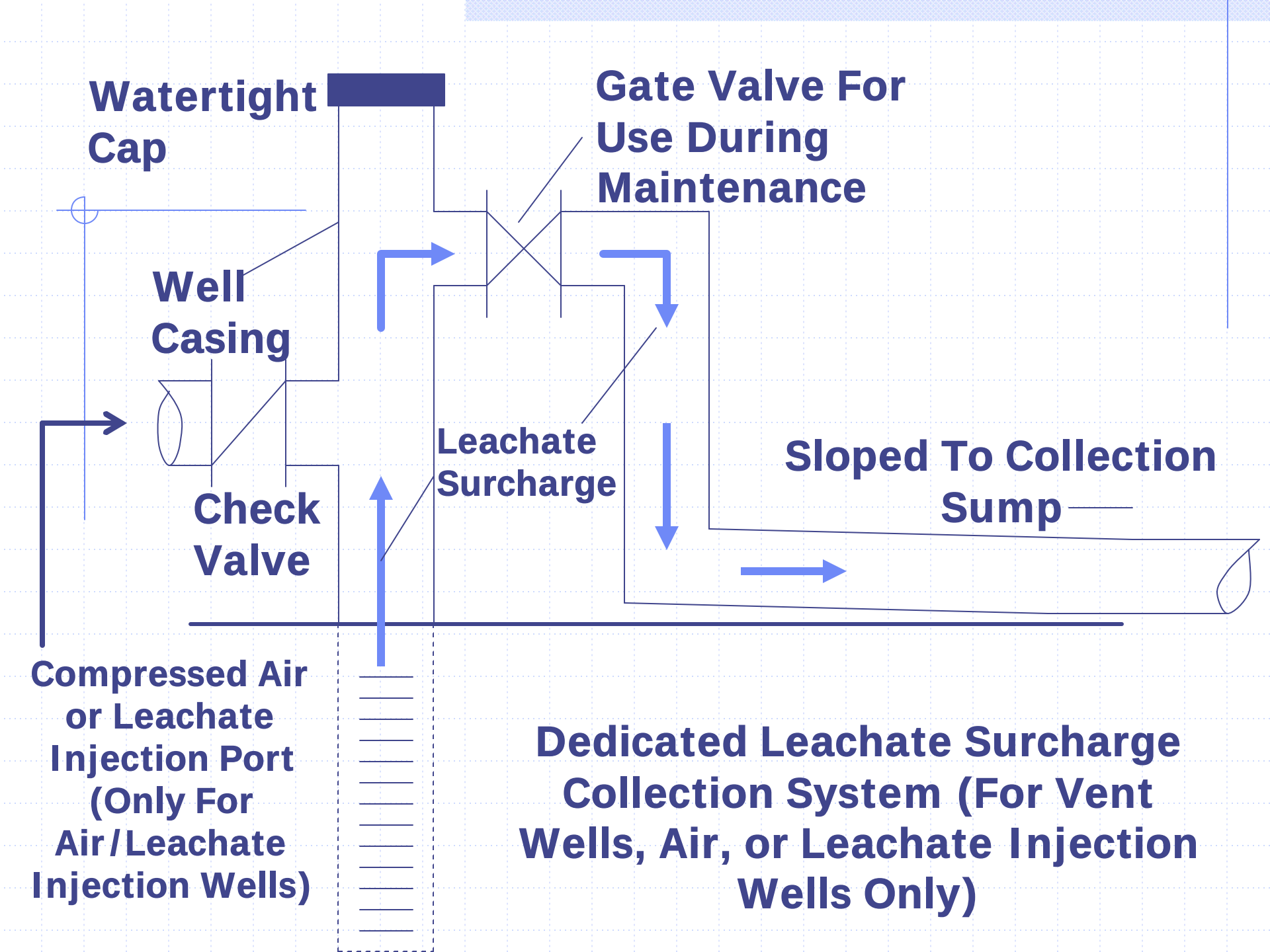
- **PROBLEM: Backflow/Surcharging of leachate from injection wells (including leachate backflow into air pipes when blowers are off)**

- **SOLUTION: Throttle valves at well heads; build mulch berms to contain surcharge and prevent it from leaving site as stormwater; periodic dosing (McCreanor, 1998); check valves on air lines to prevent leachate backflow**

LEACHATE BACKFLOW/SURCHARGE

LEACHATE BACKFLOW/SURCHARGE


Cap
Well Casing
Vent/Pressure Relief Ports
Leachate Injection Port (For Dedicated Leachate Injection Wells)
Leachate Surcharge
Mulch/Cured Compost Mixture At Surface Of Cover System
Mulch/Cured Compost Mixture At Surface Of Cover System For Temporary Containment
Dedicated Leachate Surcharge Collection System (For Leachate Injection or Vent Wells Only)


Watertight Cap
Gate Valve For Use During Maintenance
Well Casing
Leachate Surcharge
Sloped To Collection Sump
Check Valve
Compressed Air or Leachate Injection Port (Only For Air/Leachate Injection Wells)
Dedicated Leachate Surcharge Collection System (For Vent Wells, Air, or Leachate Injection Wells Only)

OPERATIONAL PROBLEMS AND TROUBLESHOOTING

- **PROBLEM: Maintaining air header pressure due to pipe leaks at cracks and due to inadequate sealing at joints**
- **SOLUTION: Replaced cracked pipe and all leaking joints; future alternate plan is to replace PVC with HDPE pipe with butt-fused joints**
- **PROBLEM: Noise from blowers (neighbor complaints)**
- **SOLUTION: Vibration dampeners on outlet air header pipes; mufflers on blower intakes; carpeted structure around blowers**

OPERATIONAL PROBLEMS AND TROUBLESHOOTING

- **PROBLEM: Excessive air backpressures at air injection wells. The primary reason may relate to the method of construction for the injection wells. Secondary reasons may include the variability in waste densities, the amount of soil fill in a given area, moisture saturation.**

- **SOLUTION: Examine measured backpressures in the field comparing air backpressures at the originally constructed wells vs. newly constructed wells (constructed using auguring techniques and granular backfill for the annular space). Internal examination of wells with down-hole camera.**

WILLIAMSON COUNTY SUMMARY

- **To date, mixed redox conditions exist during full operation. It appears that truly aerobic areas may be most likely confined to radial zones immediately located around air injection wells (however, this is not always the case). <u>There is a need to better define this area of influence.</u>**

- **Initial drops in % CH_4 when blowers are first started up appears to be due to <u>dilution</u> of landfill gases with the compressed air. Need a sustained operating period of minimal air header leaks to observe long-term gas characterization with sustained high influx of air.**

WILLIAMSON COUNTY SUMMARY

- **Anoxic areas where reduction of alternate electron receptors takes place most likely dominates the bioreactor system when the blowers are on**

- **Even though % CH_4 is significantly dampened, microenvironments of fermentation are obviously still present during air injection (as made evident by the continued detection of methane when the blowers are fully operating)**

- **The forced aeration bioreactor appears to rather quickly revert back to primarily a fermentation system when blowers are shut down**

WILLIAMSON COUNTY SUMMARY

- **Methods of in-situ moisture content measurements are necessary for effective operation relative to concerns over maintaining FAS. Better moisture content monitoring and control should improve system performance and increase the radius of influence of aerobic degradation**

WILLIAMSON COUNTY SUMMARY

- **Review of field data reveals that influence on the bioreactor environment from compressed air injection is evident (i.e., changes in gas composition and ORP); however, the air injection system constructed at Williamson County seems to be somewhat limited in its efficiency (e.g., high backpressures at wells)**

- **Greater success in field applications of forced aeration bioreactor landfills can be better achieved with improvements in the materials of construction (pipe and fittings) and in improved methods in well construction (e.g., auguring or sonic drilling for wells, greater well diameter, angular granular materials used in annular space backfill)**

ADDITIONAL RESEARCH TO BE PERFORMED AT WILLIAMSON COUNTY

During the remainder of 2002 and through 2003, additional research will be carried out as follows:

- **Attempting to better understand the influence of air injection on redox conditions within the bioreactor**
- **Alter injection strategy (pulsed or periodic injection of leachate). Assess the effect based on gas characterization at the wells and temperatures**

ADDITIONAL RESEARCH TO BE PERFORMED AT WILLIAMSON COUNTY

- **Solid waste sample analytical data trends**
- **Continued assessment of air injection influence on degradation process**
- **Continued assessment of leachate quality changes**
- **Flux chamber measurements – Quarterly**

REMAINING RESEARCH TO BE PERFORMED AT WILLIAMSON COUNTY (CONTINUED)

- **Continued documentation of design and operational improvements for aerated bioreactor system**
- **Development of mathematical model (FEMLAB-based) to assist in the assessment of aerated bioreactor feasibility and design. Model development is intended to simulate heterogeneous waste-environment conditions, including mass and heat transport, temperature profiles, air flow and velocity profiles, oxygen utilization, moisture routing, and biodegradation (primarily related to aerated retrofit applications).**