# Exhibit 12

**Sanitary District of Decatur**
501 DIPPER LANE • DECATUR, ILLINOIS 62522 • 217/422-6931 • FAX: 217/423-8171

Exhibit 12

June 29, 2011

Illinois Environmental Protection Agency
Bureau of Water Compliance Assurance Section, MC #19
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Re: NPDES Permit IL0028321
IPCB Order PCB 09-125
Interim Report

Dear Sir or Madam:

Enclosed is the Interim Report regarding compliance with nickel and zinc limits required by Special Condition 18 of the Sanitary District of Decatur's NPDES Permit and the Pollution Control Board Order in PCB 09-125.

Please contact me at 422-6931 ext. 214 or at timk@sdd.dst.il.us if you have any questions regarding this report.

Sincerely,

Timothy R. Kluge, P.E.
Technical Director

cc: Rick Pinneo, IEPA (via email)
Bob Mosher, IEPA (via email)

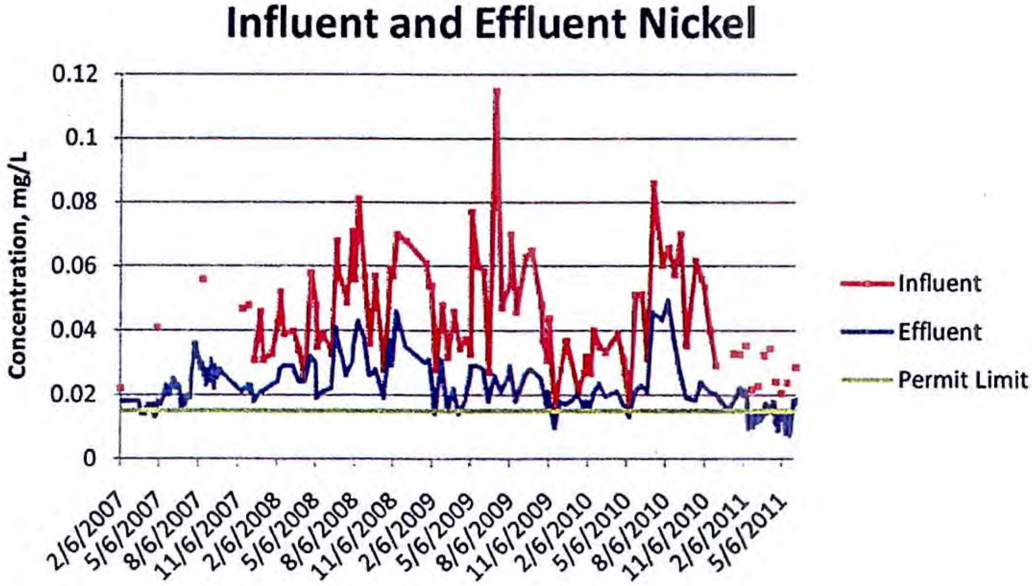
**Sanitary District of Decatur**
**Nickel and Zinc Limits**
**June 2011 Interim Report**

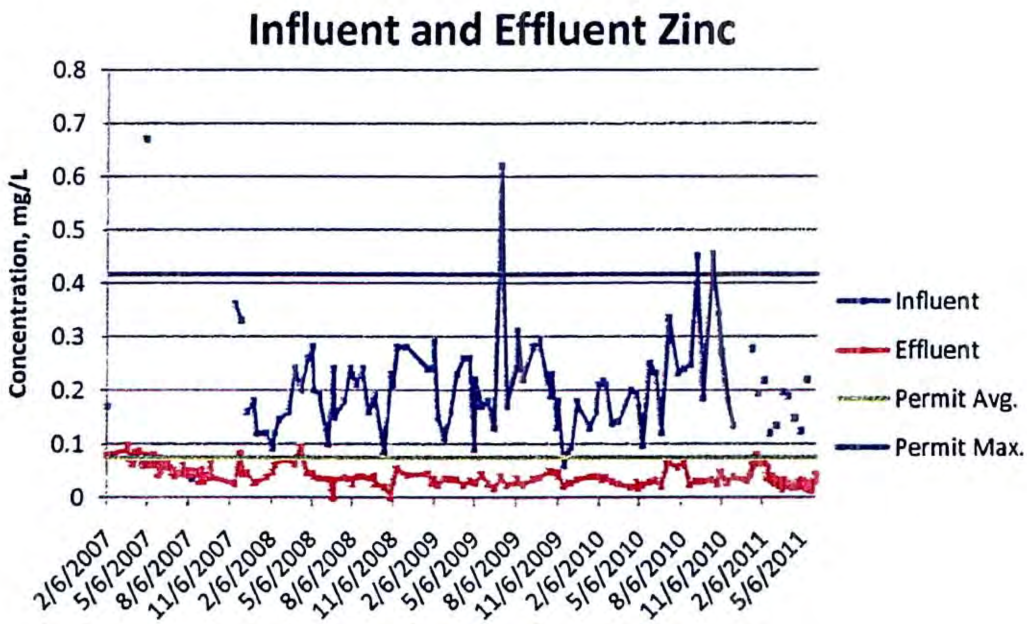
The modified NPDES permit for the Sanitary District of Decatur that became effective July 1, 2009 contains limits for nickel and zinc and a one-year compliance schedule extension for meeting the limits. Special Condition 17 requires that an interim progress report be submitted to Illinois EPA by July 1, 2011.

On January 7, 2010 the Illinois Pollution Control Board granted a variance to the District allowing additional time to comply with final permit limits (PCB 09-125). The final compliance date contained in the Board Order is July 1, 2014. The District's NPDES Permit has not yet been modified to incorporate the variance although Illinois EPA issued a Public Notice and draft modified permit on May 26, 2011. The Board Order also requires that an interim progress report be submitted by July 1, 2011 and lists a number of other activities and investigations that are to be completed. This report is submitted to meet both the permit and variance requirements.

**Plant Influent and Effluent Sampling**

Ongoing influent and effluent sampling for nickel and zinc continues at a frequency of twice monthly. An updated summary of influent and effluent values is shown below. Past data shows that the plant effluent is not able to consistently meet the current nickel permit limit. Influent and effluent nickel concentrations in the first half of 2011 have been lower than in previous years, due to reduced loadings from ADM. According to ADM personnel, variations in product mix or in year-to-year differences in grain may be a factor in the reduction. Zinc concentrations remain below the permit limit.






**Receiving Stream Sampling**

Upstream and downstream sampling continues at a twice monthly frequency to provide a more complete picture of nickel and zinc in the Sangamon River. One upstream and four downstream sampling sites are being monitored. A summary of 2010-2011 river monitoring data is attached. All upstream and downstream zinc results during 2011 have been below the Illinois water quality standard.

**Pretreatment Ordinance Limits**

The District's pretreatment ordinance was amended in October 2009 as noted in previous reports.

**Stream Flow-Based Compliance Options**

The District continues investigation of flow-based permit limits, to take advantage of upstream flow for mixing when it is available. This concept could potentially allow a savings in treatment facility operating costs when the upstream flow is sufficient to meet water quality standards after mixing with treatment plant effluent. A USGS flow gauging station is located about two miles upstream of the District's discharge point, and provides near- real time flow information. We are continuing to develop a proposal that would establish limits based on upstream flow, with a goal of providing an administratively straightforward way to define and evaluate permit compliance. Informal discussions with Illinois EPA personnel have indicated that the concept of flow-based limits could be considered. We expect to have a proposal for presentation to Illinois EPA in the second half of 2011, for consideration during renewal of our NPDES permit in 2012.

**Water Quality Standard Investigations**

The District is continuing to investigate approaches to a water quality standard adjustment including prediction of a water effect ratio using the biotic ligand model (BLM). On December 9, 2010 discussions were initiated with U.S. EPA and Illinois EPA on the reaction to a bioavailability approach. Personnel from U.S. EPA indicated that they would like to review published information on the nickel BLM and also requested information on how variability in discharge parameters would affect the predicted toxicity. Variability information was compiled and reviewed prior to discussion in a follow-up call on June 6. The District anticipates a petition for a site-specific nickel standard will be filed with the Pollution Control Board in the second half of 2011.

We are also following the Pollution Control Board rulemaking currently underway to correct an error found in the existing zinc water quality standard.

**Industrial Source Sampling and Investigations**

Sampling of the major industries (ADM and Tate & Lyle) for metals continues at a frequency of twice monthly and other industries discharging metals are sampled quarterly. Sample results obtained from the major industries within the past year are attached.

The District's operating permit issued to ADM was modified on November 18, 2009 and again on June 17, 2010 to reflect the new limits and provide a compliance schedule for meeting the limits. Final local limits will be effective upon expiration of the District's variance.

Both major industries formerly utilized zinc as part of their cooling tower treatment programs, and both have eliminated or greatly reduced zinc in their towers. At this time, both industries are meeting the zinc pretreatment limit. ADM is continuing to investigate the possible impact of the zinc limit on their planned wasting of solids from their pretreatment system to the District's collection system.

The discharge from ADM is by far the most significant industrial source of nickel. ADM has been very active in seeking treatment technology for nickel removal, involving plant management and research department personnel in addition to environmental compliance and legal staff. District staff met with ADM personnel several times during the first half of 2011, most recently on May 31. The District's pretreatment permit requires semi-annual reports of ADM's investigations, and a report will be provided to Illinois EPA during our meeting scheduled for July 7. Work during the past six months has included pilot testing for several nickel removal technologies, toxicity testing to determine potential impacts of the District's nitrification process, and ongoing research into alternative technologies.

**Additional Pretreatment Limit Investigations**

Pretreatment ordinance limits adopted in 2009 were adopted as total (rather than soluble) limits based on review of soluble/insoluble data. Refinement of pretreatment limits is an ongoing process and will depend on final permit limits as well as treatment technologies that might be employed by industrial users. The required determination of soluble/insoluble vs. total limits will be updated as part of the final compliance plan submitted to the Agency.

**Chronic Toxicity Testing**

Chronic whole effluent toxicity testing was performed on the District's discharge in July, September, and December 2007. The test results were forwarded to Illinois EPA and reviewed in 2008. A number of inconsistencies were found in the test results and in the interpretation of the results by the laboratory. Because of the inconsistencies and to obtain current data, a new round of chronic toxicity testing will be performed in the second half of 2011.

**Compliance Plan**

In summary, the District's proposed compliance plan includes ongoing work as required by the Board Order granting the District's variance. The District will continue to proceed in accordance with the schedule in the Order with efforts in three areas:

1. Continuing to work with ADM to investigate nickel removal technologies, and to determine a sludge wasting plan that will minimize zinc discharges. The Order lists ten technologies that were to be investigated by December 31, 2010, the the investigations were done as required. Additional investigations continue and a summary will be provided to Illinois EPA.

2. Conducting additional discussions with Illinois EPA permit personnel regarding variable permit limits based on the amount of flow available in the Sangamon River. As noted above, Illinois EPA has been receptive to this concept. The District plans to submit a comprehensive proposal to Illinois EPA during the second half of 2011.

3. Conducting additional discussions with Illinois EPA and U.S. EPA standards personnel regarding justification for a site-specific water quality standard for nickel, based on bioavailability. As noted above, development of a petition for the Pollution Control Board is planned in the first half of 2011.

| SDD Major Industrial Nickel and Zinc Results | | | | |
|---|---|---|---|---|
| | | | | |
| | ADM Point A | ADM Point A | ADM Point D | ADM Point D |
| Sample | Nickel, Tot | Zinc, Tot | Nickel, Tot | Zinc, Tot |
| Date | mg/L | mg/L | mg/L | mg/L |
| 6/1/2010 | 0.0813 | 0.488 | 0.12 | 0.441 |
| 6/14/2010 | 0.0826 | 0.453 | 0.104 | 0.345 |
| 7/8/2010 | 0.148 | 0.54 | 0.283 | 1.07 |
| 7/12/2010 | 0.144 | 0.528 | 0.193 | 0.514 |
| 8/2/2010 | 0.125 | 0.457 | 0.172 | 0.446 |
| 8/9/2010 | 0.126 | 0.44 | 0.184 | 0.474 |
| 9/1/2010 | 0.0766 | 0.465 | 0.122 | 0.469 |
| 9/20/2010 | 0.0744 | 0.442 | 0.121 | 0.649 |
| 10/4/2010 | 0.0781 | 0.461 | 0.0938 | 0.369 |
| 10/14/2010 | 0.162 | 1.18 | 0.179 | 1.18 |
| 11/8/2010 | 0.0524 | 0.24 | 0.0646 | 0.208 |
| 11/23/2010 | 0.13 | 0.665 | 0.122 | 0.413 |
| 12/6/2010 | 0.0715 | 0.53 | 0.131 | 0.581 |
| 12/13/2010 | 0.0649 | 0.498 | 0.0774 | 0.219 |
| 1/5/2011 | 0.0629 | 0.53 | 0.0669 | 0.204 |
| 1/10/2011 | 0.0577 | 0.495 | 0.0666 | 0.188 |
| 2/7/2011 | 0.0836 | 0.756 | 0.0892 | 0.329 |
| 2/14/2011 | 0.0589 | 0.472 | 0.0598 | 0.18 |
| 3/7/2011 | 0.0773 | 0.447 | 0.0627 | 0.128 |
| 3/14/2011 | 0.086 | 0.51 | 0.1 | 0.449 |
| 4/4/2011 | 0.07 | 0.428 | 0.0841 | 0.387 |
| 4/20/2011 | 0.0687 | 0.33 | 0.0861 | 0.347 |
| 5/2/2011 | 0.0712 | 0.304 | 0.0809 | 0.302 |
| 5/9/2011 | 0.06 | 0.301 | 0.0712 | 0.3 |
| | | | | |
| SDD Ordinance Limit (Avg.) | 0.0365 | 0.45 | | |
| SDD Ordinance Limit (Max.) | 0.15 | 1.7 | | |

# Sanitary District of Decatur

Nickel and Zinc River Data 2010-2011

| Sample Date | Plant Final Effluent Nickel mg/L | River Up-stream Nickel mg/L | River 100 yds Down stream Nickel mg/L | River 600 yds Down-stream Nickel mg/L | Steven's Creek Nickel mg/L | River Rock Springs Bridge Nickel mg/L | River Wyckle's Road Nickel mg/L | River Lincoln H'stead Nickel mg/L | Plant Final Effluent Zinc mg/L | River Up-stream Zinc mg/L | River 100 yds Down stream Zinc mg/L | River 600 yds Down-stream Zinc mg/L | Steven's Creek Zinc mg/L | River Rock Springs Bridge Zinc mg/L | River Wyckle's Road Zinc mg/L | River Lincoln H'stead Nickel mg/L | Plant Final Effluent Flow mgd | River Up-stream Flow ft$^3$/sec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/14/10 | 0.0202 | <0.00131 | 0.00374 | 0.00407 | <0.00131 | 0.00331 | | 0.00318 | 0.0393 | <0.00660 | 0.0102 | 0.0108 | <0.00660 | 0.00839 | | 0.0112 | 30.29 | 208 |
| 1/28/10 | 0.0160 | 0.00205 | 0.00253 | 0.00240 | <0.00131 | 0.00209 | | 0.00237 | 0.0399 | 0.0129 | 0.0130 | 0.0121 | 0.00773 | 0.0135 | | 0.0138 | 42.87 | 3470 |
| 2/11/10 | 0.0204 | <0.00131 | 0.00462 | 0.00357 | <0.00131 | 0.00277 | | 0.00253 | 0.0344 | <0.00660 | 0.0119 | 0.00980 | 0.00789 | 0.0108 | | 0.00710 | 31.39 | 517 |
| 2/18/10 | 0.0304 | <0.00131 | 0.00527 | 0.00468 | <0.00131 | 0.00398 | | 0.00351 | 0.0377 | 0.00696 | 0.0103 | 0.0103 | 0.00790 | 0.00777 | | 0.00819 | 33.12 | 436 |
| 3/4/10 | 0.0235 | <0.00131 | 0.00376 | 0.00332 | <0.00131 | 0.00242 | | 0.00240 | 0.0304 | 0.00667 | 0.00918 | 0.00851 | <0.00660 | 0.00746 | | 0.00895 | 37.82 | 755 |
| 3/18/10 | 0.0194 | 0.00133 | 0.00232 | 0.00199 | <0.00131 | 0.00165 | | 0.00200 | 0.0260 | 0.00781 | 0.00966 | 0.00953 | 0.00739 | 0.00801 | | 0.0107 | 39.45 | 2160 |
| 4/15/10 | 0.0208 | <0.00131 | 0.00290 | 0.00279 | <0.00131 | 0.00237 | | 0.00281 | 0.0204 | <0.00660 | 0.00758 | 0.00867 | <0.00660 | <0.00660 | | 0.00761 | 35.89 | 482 |
| 4/29/10 | 0.0173 | <0.00131 | 0.00186 | 0.00201 | <0.00131 | 0.00175 | | 0.00222 | 0.0290 | 0.00776 | 0.00676 | 0.00833 | 0.0136 | <0.00660 | | 0.00902 | 31.86 | 728 |
| 5/13/10 | 0.0127 | 0.00137 | 0.00195 | 0.00244 | 0.00176 | 0.00174 | | 0.00229 | 0.0244 | 0.00762 | 0.00767 | 0.00791 | 0.0121 | 0.00821 | | 0.0112 | 38.27 | 1440 |
| 5/27/10 | 0.0211 | <0.00131 | 0.00388 | 0.00284 | 0.00158 | 0.00226 | | 0.00259 | 0.0293 | 0.00765 | 0.00875 | 0.00763 | 0.00872 | 0.00697 | | 0.00982 | 37.01 | 948 |
| 6/10/10 | 0.0229 | 0.00205 | 0.00298 | 0.00241 | 0.00325 | 0.00217 | | 0.00291 | 0.0328 | 0.0108 | 0.0106 | 0.00988 | 0.0183 | 0.0105 | | 0.0145 | 38.57 | 1820 |
| 6/24/10 | 0.0205 | 0.00262 | 0.00620 | 0.00386 | 0.00332 | 0.00311 | | 0.00345 | 0.0212 | 0.0144 | 0.0137 | 0.0125 | 0.0174 | 0.0142 | | 0.0148 | 72.13 | 6120 |
| 7/8/10 | 0.0458 | <0.00131 | 0.00637 | 0.00713 | <0.00131 | 0.00540 | | 0.00571 | 0.0662 | <0.00660 | 0.0148 | 0.0175 | <0.00660 | 0.0155 | | 0.0121 | 34.86 | 348 |
| 7/29/10 | 0.0433 | 0.00190 | 0.00744 | 0.00600 | 0.00151 | 0.00580 | | 0.00600 | 0.0564 | 0.00909 | 0.0132 | 0.0122 | <0.00660 | 0.0123 | | 0.0248 | 38.86 | 285 |
| 8/12/10 | 0.0493 | 0.00157 | 0.0367 | 0.0353 | <0.00131 | 0.0327 | | 0.0338 | 0.0681 | 0.0130 | 0.0578 | 0.0529 | <0.00660 | 0.0480 | | 0.0601 | 31.89 | 24 |
| 8/26/10 | 0.0370 | 0.0025 | 0.0319 | 0.0320 | 0.00177 | 0.0294 | | 0.0211 | 0.0253 | 0.0130 | 0.0255 | 0.0246 | <0.00660 | 0.0221 | | 0.0121 | 30.59 | 4.7 |
| 9/9/10 | 0.0269 | <0.00131 | 0.0203 | 0.0197 | 0.00135 | 0.0166 | | 0.0119 | 0.0314 | <0.00660 | 0.0219 | 0.0209 | 0.0113 | 0.0257 | | 0.0218 | 32.10 | 11 |
| 9/23/10 | 0.0192 | 0.00186 | 0.0136 | 0.0132 | 0.00188 | 0.00915 | | 0.0108 | 0.0309 | 0.0119 | 0.0590 | 0.0249 | 0.0105 | 0.0188 | | 0.0162 | 34.19 | 2.0 |
| 10/14/10 | 0.0182 | 0.00251 | 0.0176 | 0.0182 | 0.00143 | 0.0149 | 0.0152 | | 0.0335 | 0.00827 | 0.0335 | 0.0317 | 0.00893 | 0.0259 | 0.0303 | | 25.66 | 1.9 |
| 10/28/10 | 0.0238 | 0.00135 | 0.0209 | 0.0212 | <0.00131 | 0.0158 | 0.0157 | | 0.0261 | <0.00660 | 0.0316 | 0.0232 | <0.00660 | 0.0179 | 0.0190 | | 28.28 | 1.9 |
| 11/04/10 | 0.0227 | 0.00146 | 0.0222 | 0.0223 | <0.00131 | 0.0193 | 0.0193 | | 0.0474 | <0.00660 | 0.0440 | 0.0421 | <0.00660 | 0.0367 | 0.0354 | | 31.01 | 2.7 |
| 11/18/10 | 0.0207 | 0.00131 | 0.0191 | 0.0189 | <0.00131 | 0.0164 | 0.0170 | | 0.0287 | <0.00660 | 0.0271 | 0.0274 | <0.00660 | 0.0245 | 0.0238 | | 29.94 | 4.5 |
| 12/02/10 | 0.0203 | 0.00180 | 0.00269 | 0.00217 | <0.00131 | 0.00217 | 0.00186 | | 0.0396 | <0.00660 | 0.00702 | 0.00745 | <0.00660 | 0.00779 | <0.00660 | | 33.60 | 1480 |
| 12/16/10 | 0.0199 | <0.00131 | 0.00311 | 0.00210 | <0.00131 | 0.0017 | 0.00156 | | 0.0356 | <0.00660 | 0.00672 | 0.00859 | <0.00660 | <0.00660 | <0.00660 | | 28.51 | 694 |
| 01/13/11 | 0.0181 | <0.00131 | 0.00519 | 0.00495 | <0.00131 | 0.00426 | 0.00504 | | 0.0503 | <0.00660 | 0.0157 | 0.0152 | <0.00660 | 0.0133 | 0.0149 | | 29.48 | 121 |
| 01/27/11 | 0.0218 | <0.00131 | 0.0144 | 0.0138 | <0.00131 | 0.0113 | 0.0102 | | 0.0773 | <0.00660 | 0.0504 | 0.0481 | <0.00660 | 0.0394 | 0.0350 | | 30.71 | 3.9 |
| 02/10/11 | 0.0214 | <0.00131 | 0.0141 | 0.0128 | <0.00131 | 0.0112 | 0.00971 | | 0.0701 | <0.00660 | 0.0460 | 0.0413 | 0.00761 | 0.0364 | 0.0313 | | 27.94 | 5.4 |
| 02/24/11 | 0.0132 | 0.00160 | 0.00242 | 0.00252 | 0.00150 | 0.00214 | 0.00205 | | 0.0406 | 0.00841 | 0.0106 | 0.0108 | 0.0138 | 0.0114 | 0.00992 | | 44.38 | 1970 |
| 3/10/11 | 0.0123 | 0.00169 | 0.00194 | 0.00198 | 0.00153 | 0.00184 | 0.00208 | | 0.0321 | 0.00972 | 0.00978 | 0.00992 | 0.0103 | 0.00974 | 0.0100 | | 47.51 | 2900 |
| 3/24/11 | 0.0132 | <0.00131 | 0.00133 | 0.00133 | <0.00131 | <0.00131 | <0.00131 | | 0.0161 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | | 33.28 | 667 |
| 4/7/11 | 0.0163 | <0.00131 | 0.00343 | 0.00252 | <0.00131 | 0.00241 | 0.00237 | | 0.0246 | <0.00660 | 0.00884 | 0.00689 | <0.00660 | 0.00732 | 0.00691 | | 30.62 | 326 |
| 4/21/11 | 0.0118 | <0.00131 | 0.00236 | 0.00195 | 0.00254 | 0.00157 | 0.00188 | | 0.0215 | 0.00729 | 0.00878 | 0.00822 | 0.0170 | 0.00939 | 0.00934 | | 52.22 | 2540 |
| 5/5/11 | 0.0147 | 0.00177 | 0.00279 | 0.00238 | 0.00137 | 0.00218 | 0.00223 | | 0.0295 | <0.00660 | 0.00932 | 0.00862 | <0.00660 | 0.00760 | 0.00898 | | 41.88 | 1670 |
| 5/19/11 | 0.0125 | <0.00131 | 0.00211 | 0.00186 | <0.00131 | 0.00153 | 0.00150 | | 0.0213 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | 0.00777 | | 32.29 | 1290 |
| 6/9/11 | 0.0187 | <0.00131 | 0.00143 | 0.00194 | 0.00183 | 0.00162 | 0.00177 | | 0.0434 | <0.00660 | <0.00660 | 0.00672 | <0.00660 | <0.00660 | 0.0124 | | | 1540 |

Bridge at Wyckle's Road closed for repair August 2009.

Indicates that effluent or river/creek sample concentration exceeds chronic water quality value

# Exhibit 13

Exhibit 13

# Estimate of BLM Adjustment to Ni Criterion for Decatur Sanitation District

Robert Santore
HydroQual, Inc

# Outline

- *Background on Ni BLM development*
- BLM results with measured water quality
- Predicted toxicity to Daphnia magna
  - Example use as a WER test organism
- *Sensitivity to variation in water chemistry*
- Predicted estimate of WQC
- *Conclusions*

# Water Environment Research Federation (WERF) report 01-ECO-10T

WATER ENVIRONMENT RESEARCH FOUNDATION

Ecosystems

Development of a Biotic Ligand Model For Nickel: Phase I

# Collaborative laboratory study for validation of Ni BLM

Environmental Toxicology and Chemistry, Vol. 23, No. 3, pp. 691–696, 2004

Printed in the USA
0730-7268/04 $12.00 + .00

## ACUTE AND CHRONIC TOXICITY OF NICKEL TO A CLADOCERAN (*CERIODAPHNIA DUBIA*) AND AN AMPHIPOD (*HYALELLA AZTECA*)

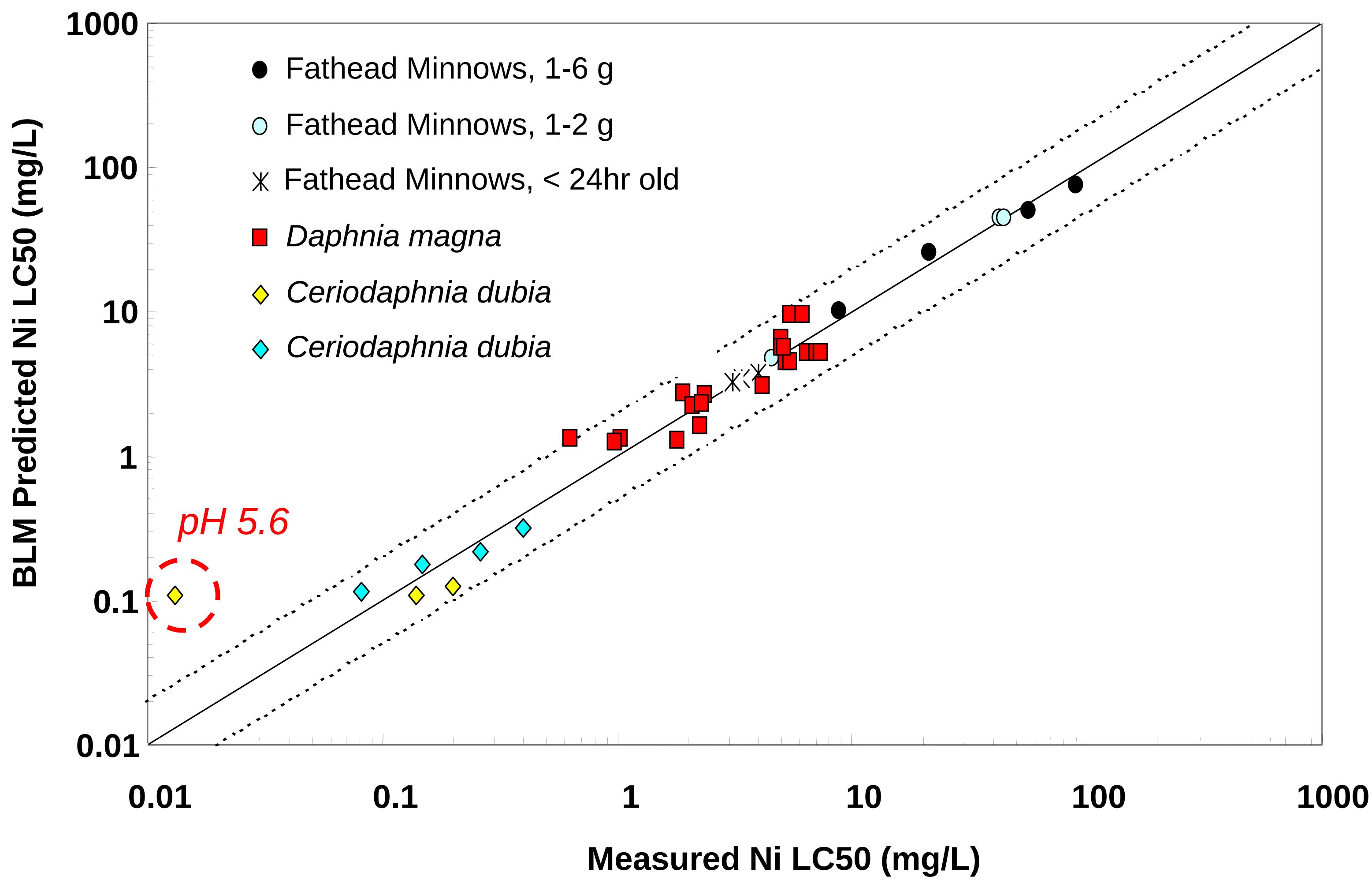
JAMES KEITHLY,*† JOHN A. BROOKER,† DAVID K. DEFOREST,† BENJAMIN K. WU,‡ and KEVIN V. BRIX§
†Parametrix, 5808 Lake Washington Boulevard Northeast, Suite 200, Kirkland, Washington 98033, USA
‡HydroQual, 1200 MacArthur Boulevard, First Floor, Mawah, New Jersey 07430, USA
§EcoTox, 721 Navarre Avenue, Coral Gables, Florida 33134, USA

(*Received* 19 *December* 2002; *Accepted* 24 *July* 2003)

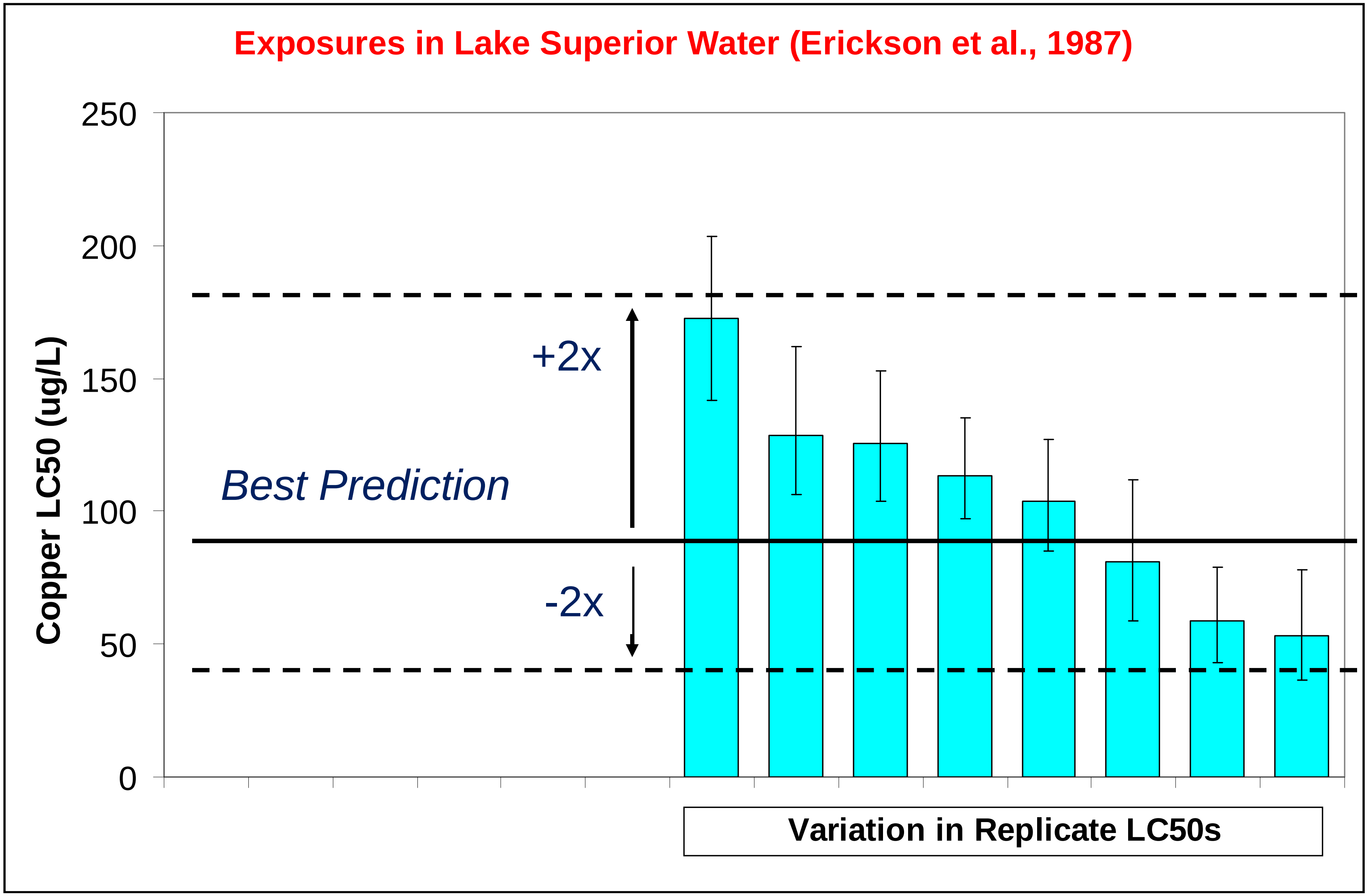
**Abstract**—This study evaluated acute and chronic nickel (Ni) toxicity to *Ceriodaphnia dubia* and *Hyalella azteca* with the objective of generating information for the development of a biotic ligand model for Ni. Testing with *C. dubia* was used to evaluate the effect of ambient hardness on Ni toxicity, whereas the larger *H. azteca* was used to derive lethal body burden information for Ni toxicity. As was expected, acute *C. dubia* median lethal concentrations (LC50s) for Ni increased with increasing water hardness. The 48-h LC50s were 81, 148, 261, and 400 μg/L at hardnesses of 50, 113, 161, and 253 mg/L (as $CaCO_3$), respectively. *Ceriodaphnia dubia* was found to be significantly more sensitive in chronic exposures than other species tested (including other daphnids such as *Daphnia magna*); chronic toxicity was less dependent on hardness than was acute toxicity. Chronic 20% effective concentrations (EC20s) were estimated at <3.8, 4.7, 4.0, and 6.9 μg/L at hardnesses of 50, 113, 161, and 253 mg/L, respectively. Testing with *H. azteca* resulted in a 96-h LC50 of 3,045 μg/L and a 14-d EC20 of 61 μg/L at a hardness of 98 mg/L (as $CaCO_3$). Survival was more sensitive than was growth in the chronic study with *H. azteca*. The 20% lethal accumulation effect level based on measured Ni body burdens was 247 nmol/g wet weight.

**Keywords**—Nickel Daphnids Amphipods Biotic ligand model

# Overall calibration results to fish and invertebrates



# Variability in Measured Cu LC50s

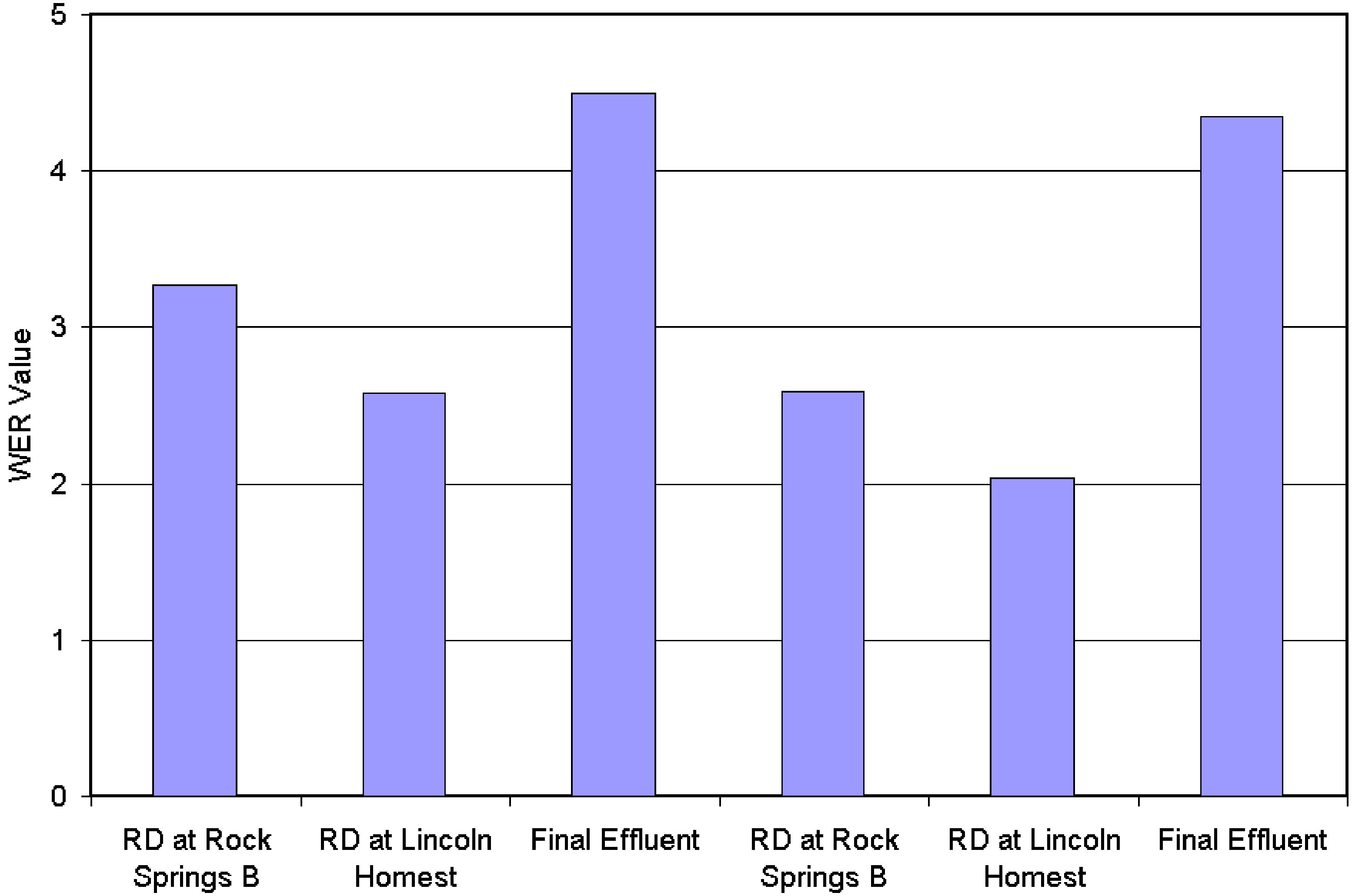


# Method to Calculate WER

- Use the BLM to estimate Ni toxicity to a sensitive aquatic organism suitable for use in a WER study (*Daphnia magna*)
- Site water will be characterized by the provided chemistry
- Reference water will be standard EPA recipe (very hard)
- WER = (Site Water LC50) / (Reference LC50)

# Revised calculated WERs

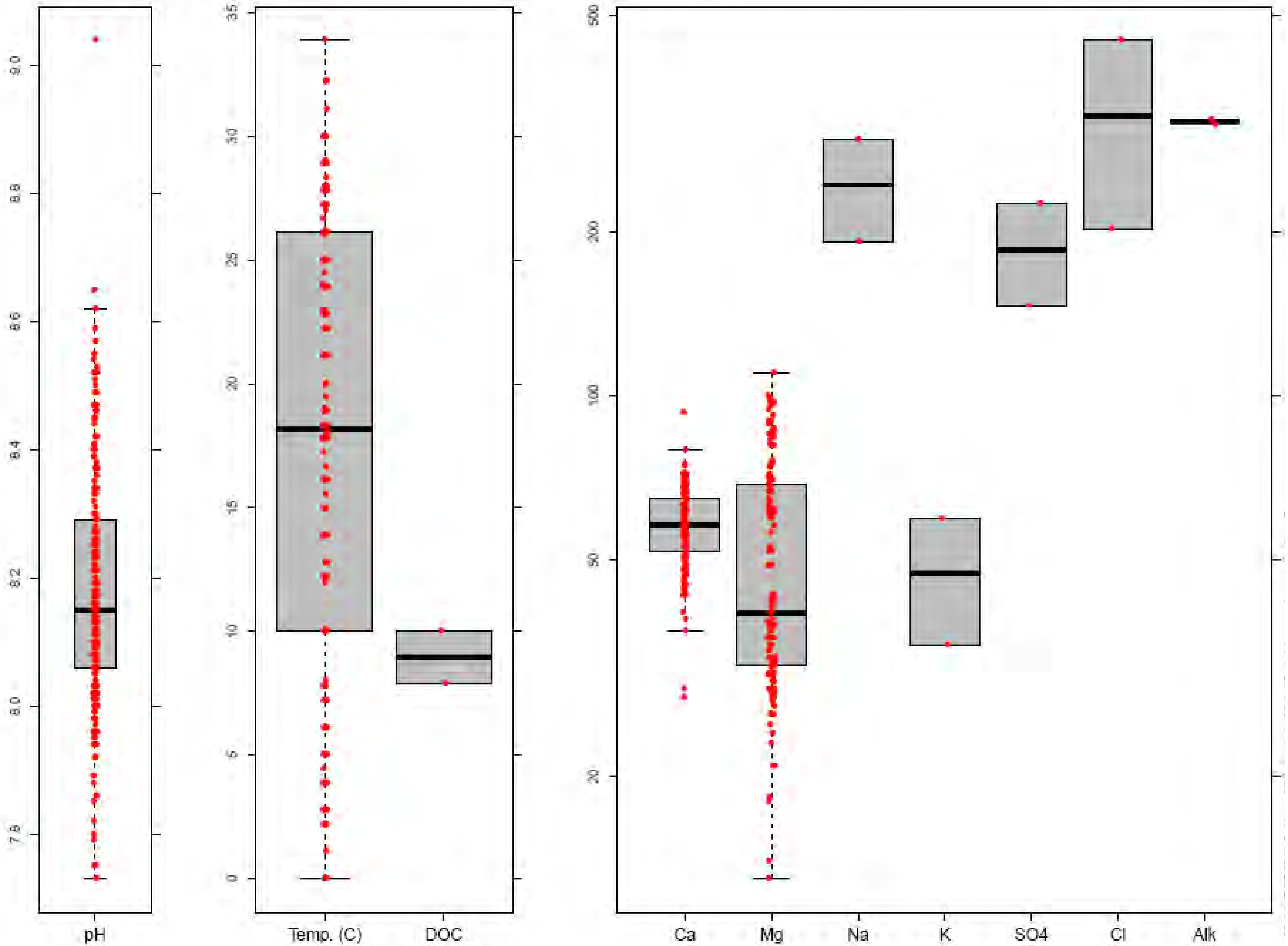
## Range 2.0 to 4.3, Average 3.1, Downstream Avg 2.6



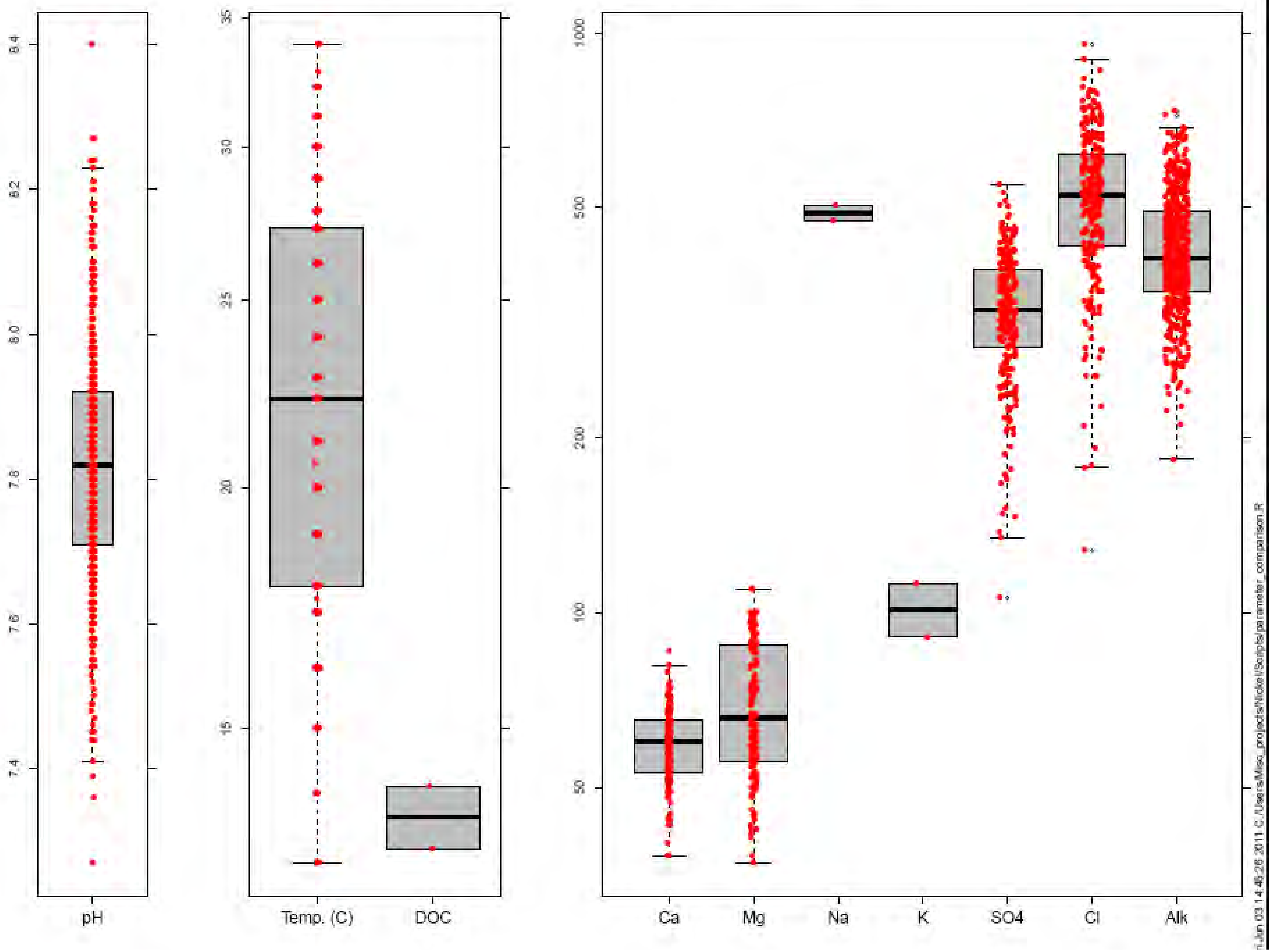
# Water Quality Variability

- Additional monitoring data for all BLM parameters were obtained
- These additional data provide insight in the range and variation of parameter values for BLM inputs
- Data do not necessarily represent coincident measurements in a given sample
- Can be used to estimate effects of chemical variability (due to seasonal or other factors) on model results

River: distribution of BLM input parameters



Effluents: distribution of BLM input parameters

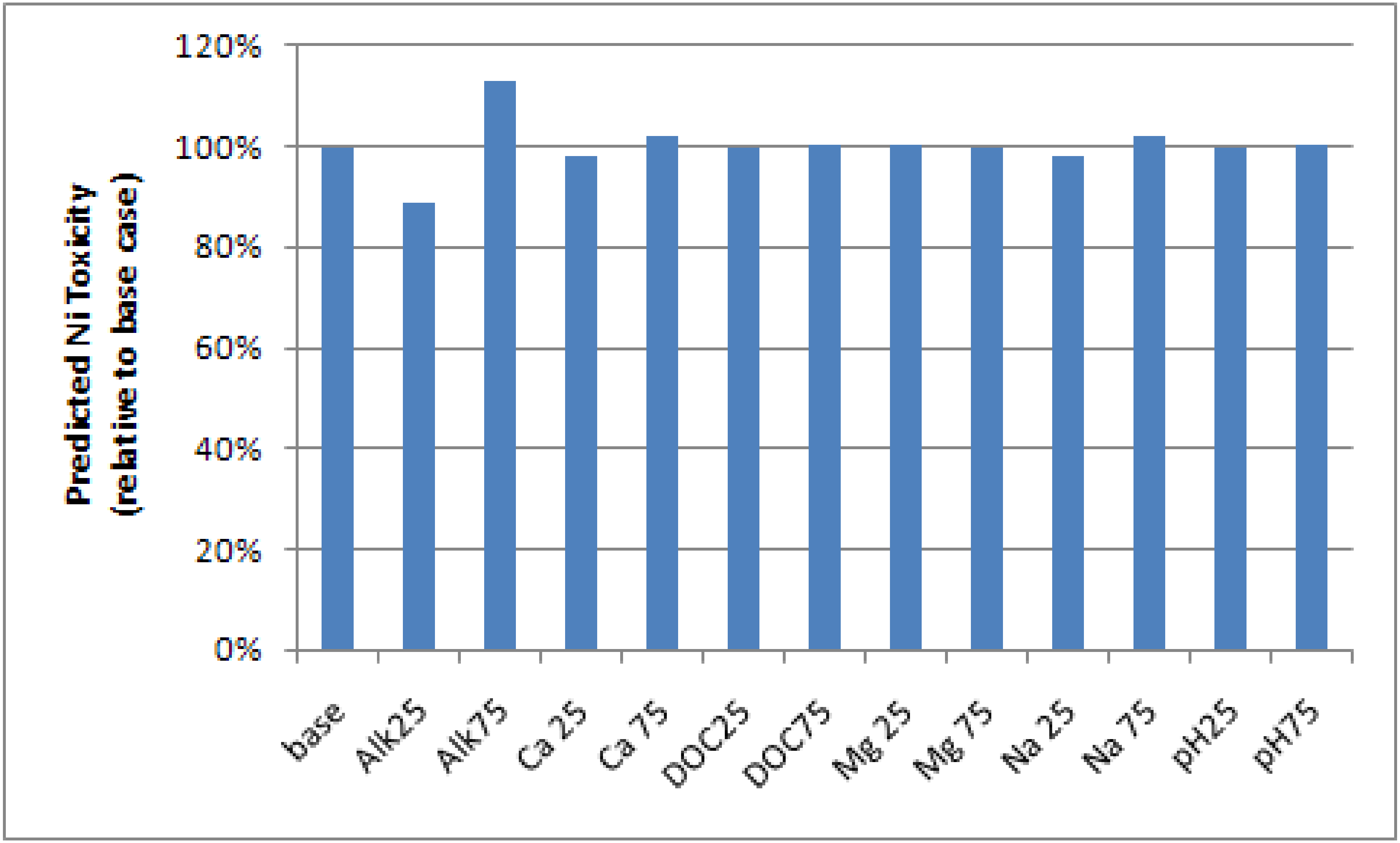


# Sensitivity Analysis: Approach

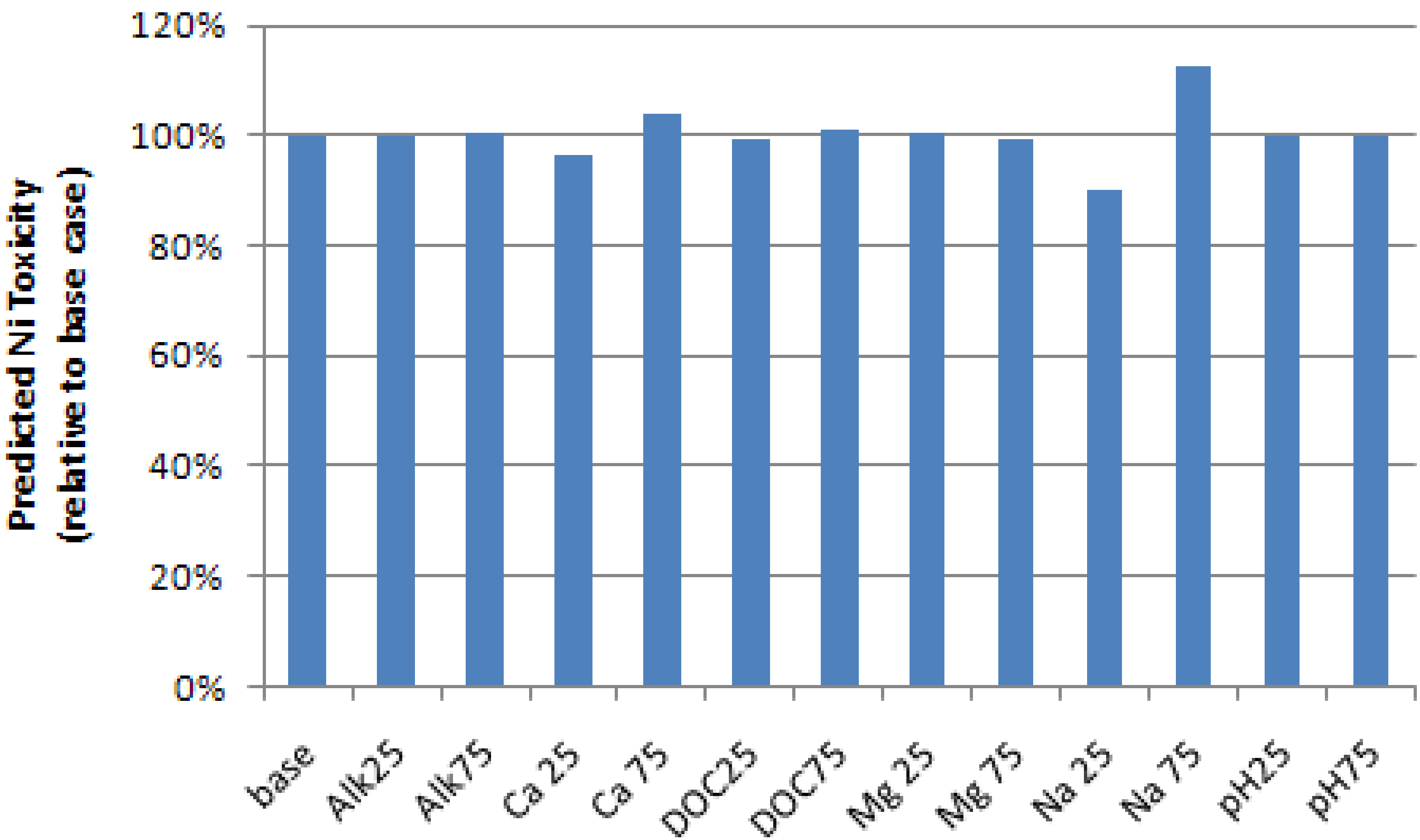
- For each input parameter, “base line” condition was defined as the median value
- For each parameter, a simulation was run using the 25$^{th}$ and 75$^{th}$ percentile value
- The effects of variation in that single parameter on model output was calculated as a simple ratio

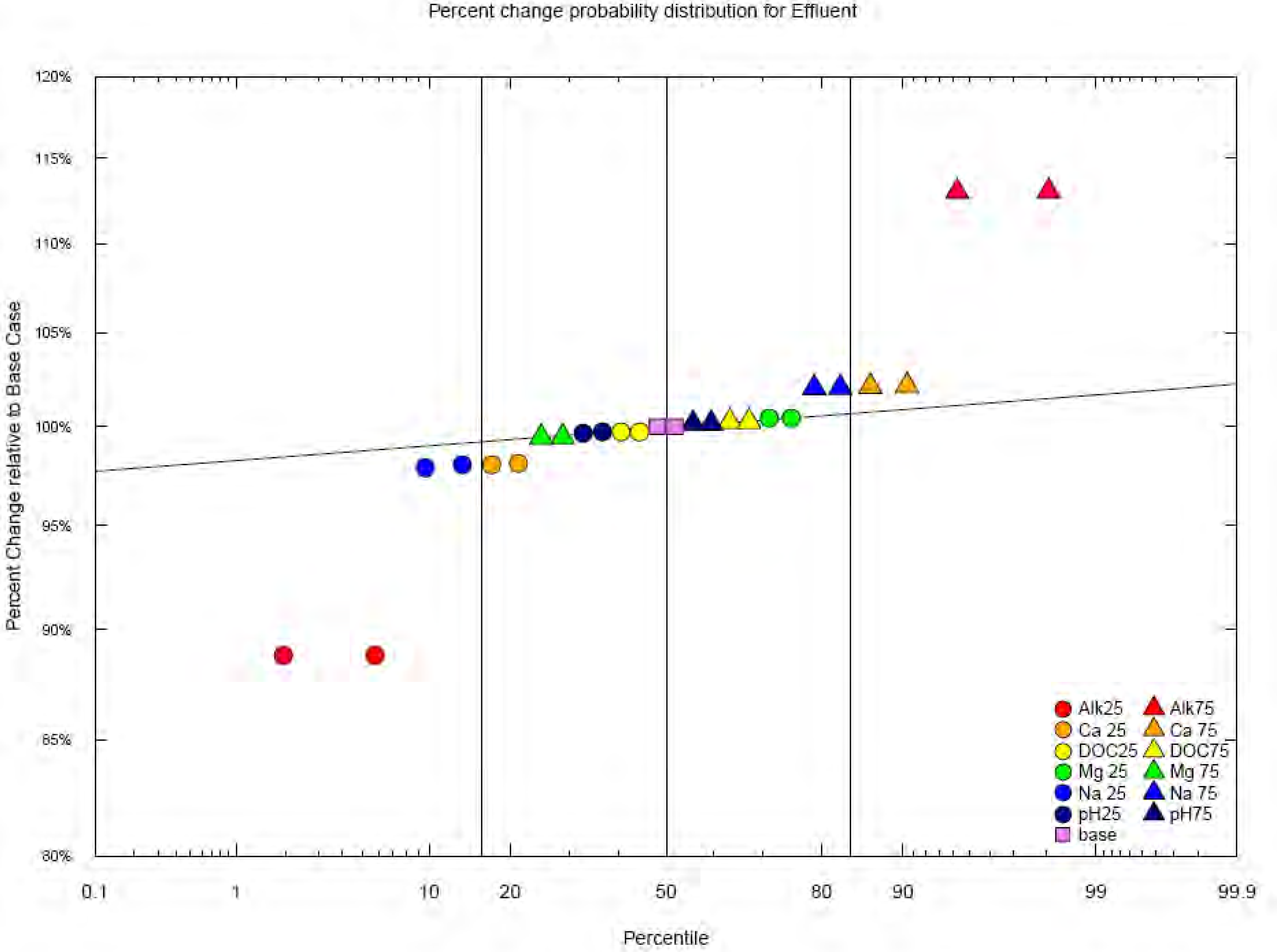
Toxicity (relative to base case) = (LC50(var)/LC50(base))*100

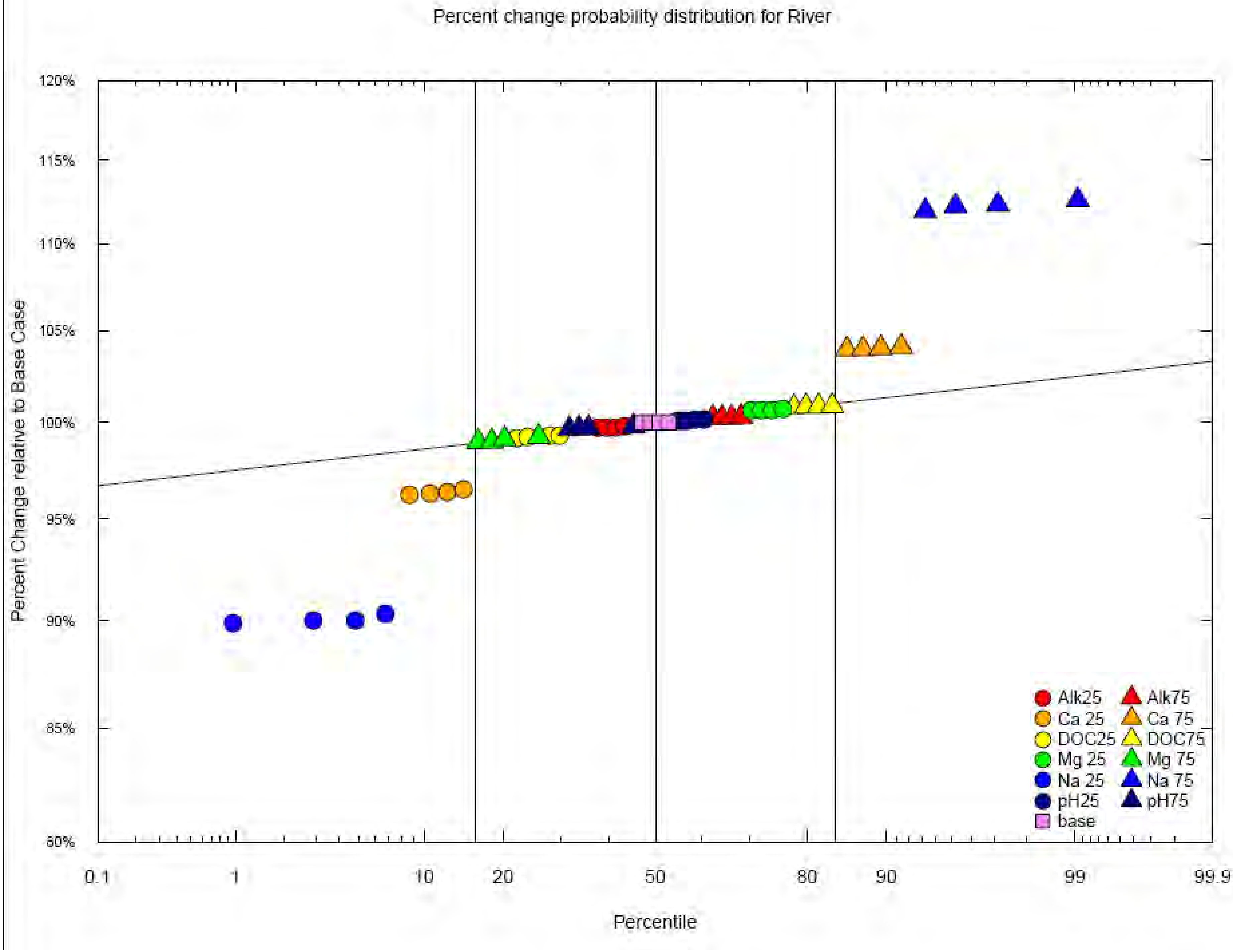
# Sensitivity Analysis: Results Effluent



# Sensitivity Analysis: Results River




Percent change probability distribution for Effluent
Percent Change relative to Base Case
120%
115%
110%
105%
100%
95%
90%
85%
80%
0.1
1
10
20
50
80
90
99
99.9
Percentile
Alk25
Alk75
Ca 25
Ca 75
DOC25
DOC75
Mg 25
Mg 75
Na 25
Na 75
pH25
pH75
base


Percent change probability distribution for River
120%
115%
110%
105%
100%
95%
90%
85%
80%
Percent Change relative to Base Case
0.1
1
10
20
50
80
90
99
99.9
Percentile
Alk25
Alk75
Ca 25
Ca 75
DOC25
DOC75
Mg 25
Mg 75
Na 25
Na 75
pH25
pH75
base

# Parameter variability summary

- Extensive monitoring data used to characterize variability in input parameters
- Base case defined as the median for each parameter
- Comparison of BLM results at 25$^{th}$ and 75$^{th}$ percentiles for each individual parameter relative to base case shows chemical variability may result in ± 15%
- This amount of variability is small, especially when comparison to variability in replicate toxicity tests

# Estimated WER

- The acute standard in IL
  CMC = e(0.8460[ln(hardness)] + 0.5173)
  - At a hardness of 347, CMC = 218.5 µg/L
  - Adjusted by WER, SSCMC = 564 µg/L

- The chronic (geomean) standard in IL
  FCV = e(0.8460[ln(hardness)] – 2.286)
  - At a hardness of 347, FCV = 14.3 µg/L
  - Adjusted by WER, SSFCV = 37 µg/L

# Conclusions

- Measured water chemistry gives comparable results to previous estimates
- BLM Calculated WER ranges from 2.0 to 4.3, and tends to be lower in downstream samples
- A WER adjusted criteria calculated only using downstream BLM predictions is somewhat lower than previously shown, but still considerably higher than the un-adjusted acute and chronic criteria

# Exhibit 14

Exhibit 14

Prepared for Proposed Site Specific Rule for Sanitary District of Decatur
From 35 Ill. Adm. Code Section 302.208(e)

# ESTIMATE OF THE BLM ADJUSTMENT TO THE NICKEL CRITERION FOR THE SANITARY DISTRICT OF DECATUR, ILLINOIS

**Prepared by**

**Robert Santore**

HDR | HydroQual

**January 16, 2014**

## I. INTRODUCTION

This report was prepared in support of the Sanitary District of Decatur's ("District") Petition to the Illinois Pollution Control Board ("Board") seeking a Site Specific Rule to establish an alternative water quality standard ("WQS") for Nickel from the point of its discharge into the Sangamon River from its Main Sewage Treatment Plant ("Main Plant") to the point of the confluence of the Sangamon River with the South Fork of the Sangamon River near Riverton, Illinois. The purpose of this report is to present the calculations, comparisons, and findings acquired from using the federally approved Biotic Ligand Model ("BLM") to adjust the Nickel WQS such that it considers local conditions found in that segment of the Sangamon River.

Adjustment of the WQS for metals in consideration of the local chemical conditions has frequently been shown to be appropriate at sites across the United States, since WQSs are based on water quality criteria ("WQC") that are defined using a traditional methodology that does not consider many of the factors that are known to affect metal toxicity to aquatic organisms. For example, the WQC for several metals (including Silver ("Ag"), Cadmium ("Cd"), Chromium (III) ("Cr(III)"), Lead ("Pb"), Nickel ("Ni"), and Zinc ("Zn"), as well as Copper ("Cu") prior to development of the BLM) are dependent on the hardness of the local water. The term "hardness" refers to the mineral content of the water and is primarily associated with the combined concentration of Calcium ("Ca") and Magnesium ("Mg"). Hardness is one of several key water quality constituents that have been shown to affect metal bioavailability and toxicity. The United States Environmental Protection Agency's ("US EPA") approach for deriving metals WQC as hardness-dependent relationships has considered how variation in toxic response may differ in areas that naturally have either very hard or very soft water.

However, factors other than hardness have been shown to affect metal bioavailability, and in particular variation in pH, Alkalinity ("Alk"), and the presence of natural organic matter ("NOM") have all been shown to be as important, or even more important, than hardness in determining metal toxicity (Erickson, et al., 1996). These factors may increase or decrease the toxicity of metals. The dependence of metal toxicity on local chemical factors is referred to as the "bioavailability" of the metal to aquatic organisms. Since these bioavailability factors are not considered by WQC approaches that only consider hardness, the WQC may be more or less protective than needed for a specific receiving water. This issue has long been recognized by US EPA and, in response, US EPA has developed procedures for derivation of site specific adjustments to WQC (Carlson, et al. 1984; US EPA, 1992, 1994a). In particular, the Water Effect Ratio ("WER") approach is intended to account for local bioavailability factors that can affect metal toxicity (US EPA, 1994b). The site specific adjustment to a WQC provided by a WER is intended to correct for deficiencies in the WQC derivation process and to reduce the degree to which a WQC is over-protective or under-protective for a given location.

## II. BACKGROUND ON NICKEL BLM

Although the WER has been in use for decades, it requires toxicity testing with multiple aquatic organisms in multiple samples. Costs and time required to accommodate WER testing can be significant. As an alternative, the BLM is a computational approach that can simulate the effects of water chemistry on metal toxicity, and on the physiological response of aquatic organisms to metals (Di Toro, et al, 2001; Santore, et al, 2001). The BLM provides information that is similar to the WER, but does so with much less cost and time required. The BLM is a mechanistic approach, not an empirical approach like the hardness equation, and it considers effects from numerous chemical factors such as pH, the presence of NOM, Alkalinity, and major ions (including cations that contribute to hardness). The BLM considers how these factors affect either metal chemistry or organism physiology to determine metal bioavailability (Figure 1).

The BLM has been adopted by US EPA as a replacement for the hardness equation in the most recently updated metals criteria (US EPA, 2007). The use of the BLM provides similar benefits as the WER, and for criteria based on the BLM, the use of the WER is no longer required. For metals (such as Nickel) where US EPA has not adopted a BLM-based procedure for replacement of the hardness equation, the BLM can be used in a manner similar to the WER to modify the hardness equation based WQC. Use of the BLM to derive a site specific WQC provides the same level of protection as intended by US EPA guidelines (Stephan, et al, 1985). To the extent that a BLM derived site specific WQC is different from the national ambient WQC, those differences reflect how local factors which are not considered by the hardness-equation may change metal bioavailability and toxicity.

The BLM can be used to determine modifications to chemistry of receiving water using a procedure that is analogous to the WER. The WER compares the toxicity of Nickel or other toxicant in receiving water to that in reference water. The reference water is intended to represent the conditions comparable to those used to develop the toxicity database in which the acute and chronic WQC were developed. The WER is then simply the ratio of the measured toxic endpoint in the receiving water to that in the reference water. If multiple receiving water and reference water samples are used to generate the WER, the WER is determined for each pair of samples, and then an overall WER is usually determined as the geometric mean. The reference water chemistry must meet WER guidelines (US EPA, 1994b), and US EPA has provided synthetic recipes suitable for generating reference water samples with various hardness concentrations. These recipes can be incorporated into the BLM application to predict toxicity endpoints for suitable reference water that can be used in a WER-type analysis.

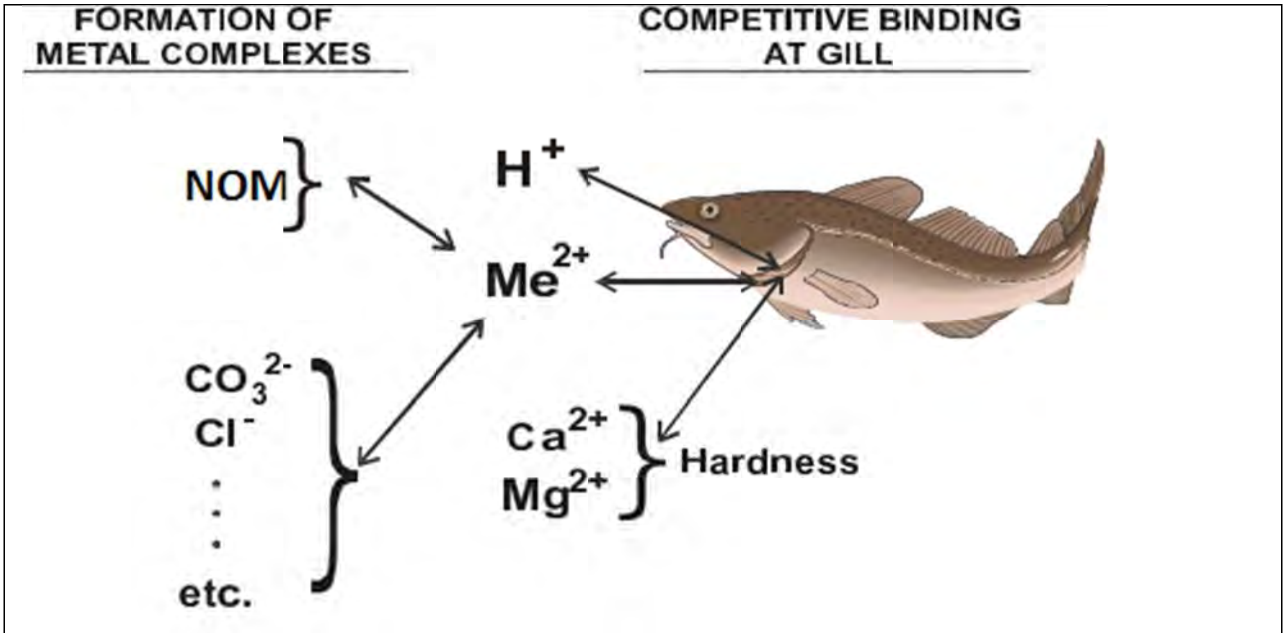



Figure 1. Conceptual model of the chemical and physiological processes represented in the BLM. Water chemistry, including inorganic complexes and binding by NOM, can affect the chemical speciation and reactivity of a metal (i.e., $Me^{2+}$). The accumulation of metal on biological surfaces, such as gill membranes, is related to the chemical reactivity of the metal as well as other factors such as pH and competitive binding of cations. The BLM is a general framework that has been applied to acute and chronic responses of numerous metals including Aluminum ("Al"), Ag, Cd, Cobalt ("Co"), Cu, Ni, Pb, and Zn.

## III. BLM RESULTS WITH MEASURED WATER QUALITY

### A. Overall Calibration Results to Fish and Invertebrates

The BLM is a generalized mechanistic approach that has been applied to a number of different metals including Nickel. Development efforts for Nickel focused on explaining available toxicity data for sensitive aquatic invertebrates and fish in a project sponsored by the Water Environment Research Foundation ("WERF") (WERF, 2003). The project for WERF included a detailed review of the chemical speciation of Nickel in freshwaters, analysis of Nickel accumulation in aquatic organisms, and a summary of important bioavailability factors, including pH, Alkalinity, hardness, and the presence of NOM. The performance of the Nickel BLM was quite good, with excellent agreement between predicted and measured toxicity over a range of several orders of magnitude (Figure 2). Nearly all of the predicted toxicity values are within a factor of two of measured values.

Agreement with a factor of two of a given measured toxicity value has been shown to be about the degree to which replicate measurements agree with a mean value. Replicate toxicity tests used to determine replicate LC50 values for the same organism in the same water frequently does not produce exactly the same result. For example, replicate copper toxicity measurements, expressed as the median lethal concentration to 50% of the population (LC50), made to the same species of fish in water samples from Lake Superior tend to fall in ±2x envelope around a central mean (Figure 3; data are from Erickson et al., 1996). If replicate measurements agree with a central mean value no better than ±2x, then comparison of predicted toxicity values with measured values with a factor of ±2x would be the best that could be expected. Hence, predicted values such as those shown in Figure 2 are often shown within a ±2x envelope around the line of perfect agreement, and predicted values that fall within this envelope show excellent agreement with measured values.

The strength of the predictive ability of the BLM lies in the mechanistic and generalized nature of the model. Although the model simulates a complex set of chemical reactions and biological accumulation processes, these processes are characterized as generalized reactions based on thermodynamics. The model can therefore predict accumulation in aquatic organisms without recalibration of any of the model parameters that describe chemical speciation, or organism accumulation. Application of the same model and same model parameters are used to predict effects to diverse aquatic organisms including fish and invertebrates. The consistency of this approach is evidence of the mechanistic and generally applicable nature of this analysis. The only parameter that varies from one organism to another is the concentration of accumulated metal associated with toxicity (Santore, et al, 2001). The resulting model is capable of simulating Nickel toxicity to a range of organisms in a wide range of chemical conditions (Figure 2).

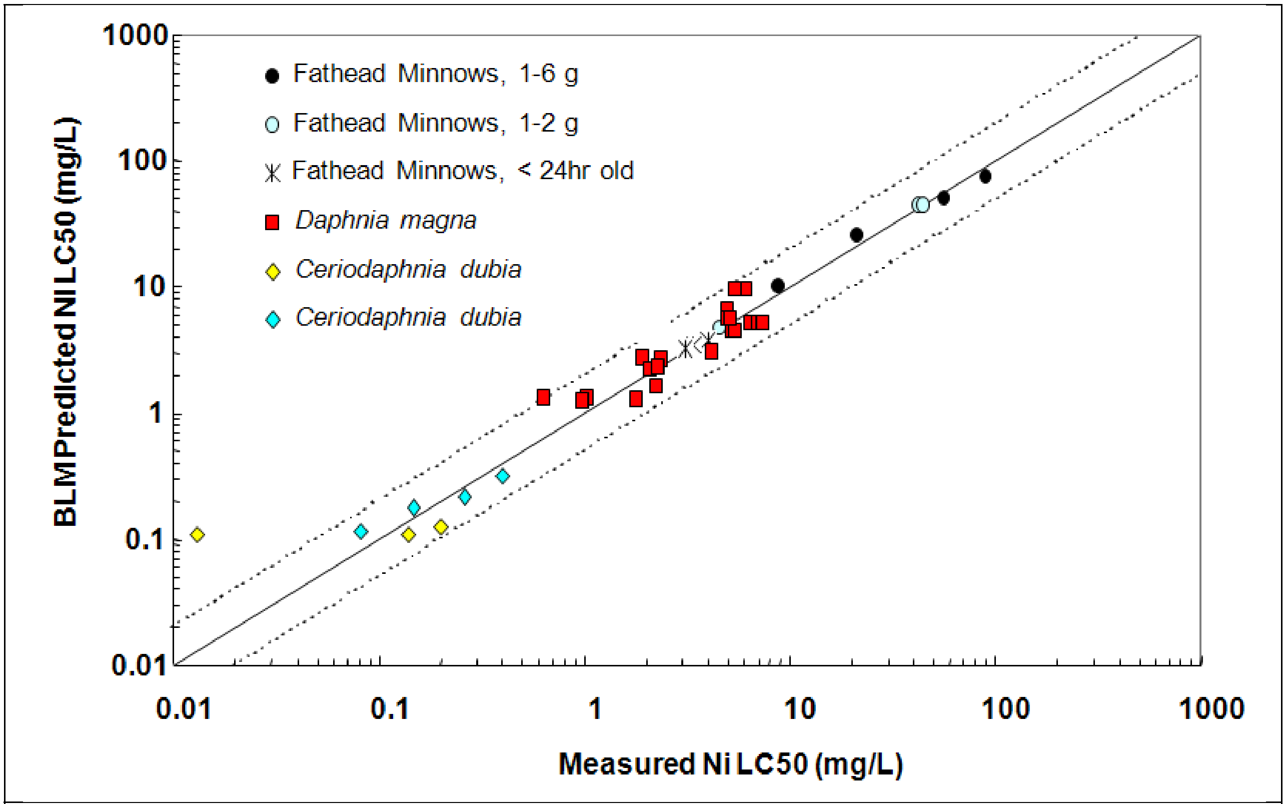



Figure 2. Comparison of the calibrated Nickel BLM to sensitive freshwater aquatic invertebrates and fish. Measured toxicity, as the lethal concentration to 50% of the test organisms, is shown on the horizontal axis. Predicted toxicity is shown on the vertical axis. The diagonal solid black line shows perfect agreement between measured and predicted values, and the dashed black lines show a region of ± factor of 2x from perfect agreement. The ± factor of 2x is intended to show agreement between measured and predicted values that comparable to the expected agreement between replicate measurements.

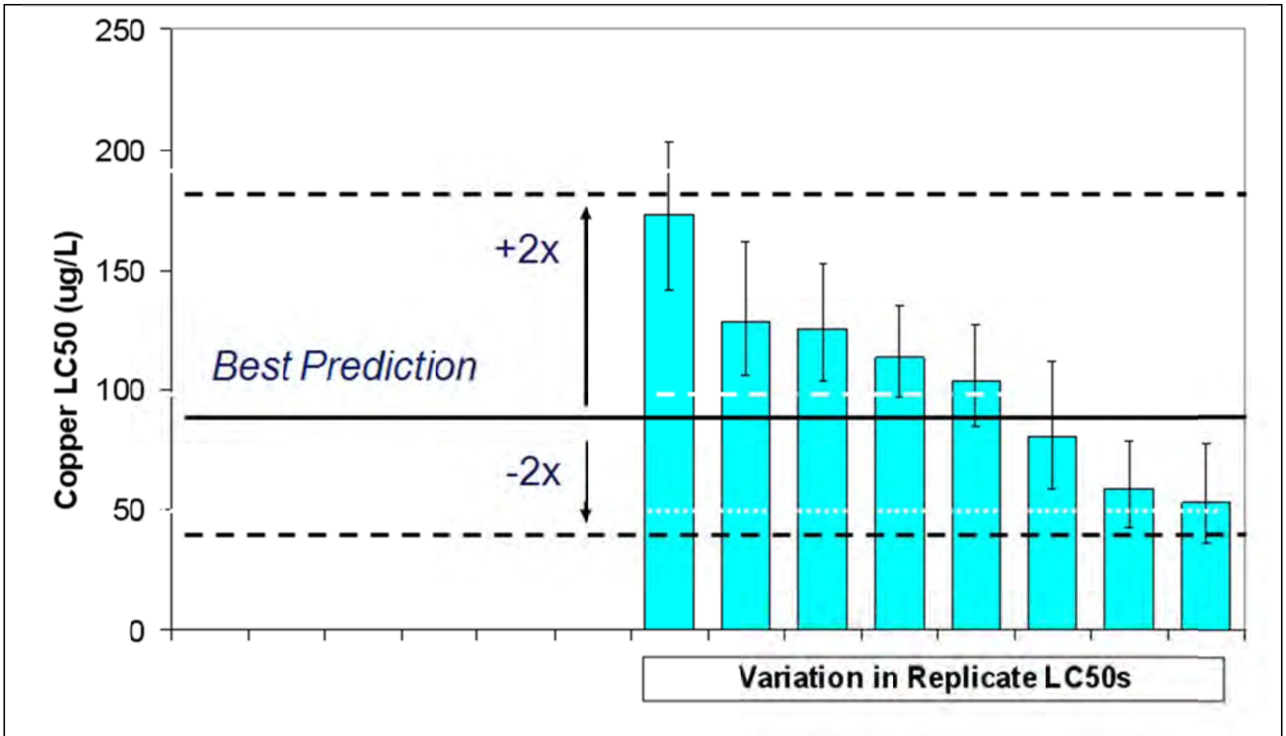



Figure 3. Variation in replicate measurements of LC50 of copper to fathead minnow in Lake Superior water tends to fall in an envelope of plus or minus 2 times the geometric mean value (date from Erickson et al., 1996). The dark solid line labeled "Best Prediction" is shown at the geometric mean of the measured values. The dashed lines correspond to an envelope showing plus or minus a factor of two. Since all of these measured values are from water samples with the same chemistry, the BLM would predict the same LC50 in every case.

## IV. CALCULATED WER WITH PREDICTED TOXICITY TO *DAPHNIA MAGNA*

As discussed in Section II of this report, the BLM for Nickel can be used to calculate a site specific WQC by using the model to calculate a WER for the receiving water downstream of the Main Plant. Samples were collected at two locations downstream of the Main Plant discharge, and chemical analyses for BLM input parameters were measured on these samples. Similar analyses were made on samples taken from the Main Plant effluent, although these were not used in the WER analysis. Measured chemical parameters used as input parameters to the Nickel BLM are shown in Table 1.

The BLM for Nickel was run with these input data to determine Nickel toxicity to *D. magna*, which is a sensitive invertebrate recommended for use in WER testing for Nickel (USEPA, 1994b, Appendix I). For calculation of WER values, the predicted toxicity in these site waters was compared with toxicity in a reference water sample. According to the WER guidance document, suitable reference water must have a hardness concentration close to, but not in excess of, the measured hardness in the site water (US EPA, 1994b). The US EPA's recipe for "very hard" water with a hardness of 317 mg/L as Calcium Carbonate ("CaCO3"), compared with hardness in the site water of 347, would be a suitable choice for use as a reference water for WER testing at the site. Calculated LC50 values for site and reference water are shown in Table 2.

Table 1. Input chemistry used for BLM analyses. For site waters, Sangamon River samples collected at the Rock Springs Trail bridge approximately one-half mile downstream (RD at Rock Springs) and at the South Lincoln Memorial Parkway bridge approximately six miles downstream (RD at Lincoln) were used to characterize the chemistry of the receiving water downstream of the plant. The presence of NOM was characterized by the dissolved organic carbon ("DOC") concentration. For calculation of WER, the US EPA's "very hard" water recipe was used as a reference sample. Variation of an assumed DOC in the reference water sample from 0.5 to 2.0 mg C/L was included in the BLM analysis.

| Sample Description | | Temp | pH | DOC | Ca | Mg | Na | K | SO4 | Cl | Alk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ºC | | mg C/L | | ---------------------- | mg / L | | ---------------------- | | |
| RD at Rock Springs | 8/26/2010 | 23 | 8.00 | 12 | 56 | 53 | 396 | 86 | 298 | 446 | 365 |
| RD at Rock Springs | 9/9/2010 | 21 | 8.09 | 10 | 64 | 48 | 286 | 53 | 214 | 304 | 341 |
| RD at Lincoln | 8/26/2010 | 25 | 8.00 | 10 | 58 | 46 | 296 | 60 | 225 | 450 | 321 |
| RD at Lincoln | 9/9/2010 | 21 | 8.10 | 7.9 | 65 | 43 | 192 | 35 | 146 | 202 | 315 |
| Final Effluent | 8/26/2010 | 30 | 8.09 | 13 | 56 | 62 | 504 | 112 | 374 | 558 | 400 |
| Final Effluent | 9/9/2010 | 28 | 7.90 | 14 | 62 | 62 | 474 | 91 | 328 | 477 | 399 |
| | | | | | | | | | | | |
| US EPA Very Hard | DOC=0.5 | 20 | 8.20 | 0.5 | 47 | 48 | 105 | 8 | 304 | 8 | 229 |
| US EPA Very Hard | DOC=1.0 | 20 | 8.20 | 1 | 47 | 48 | 105 | 8 | 304 | 8 | 229 |
| US EPA Very Hard | DOC=2.0 | 20 | 8.20 | 2 | 47 | 48 | 105 | 8 | 304 | 8 | 229 |

Table 2. Predicted toxicity to *D. magna* by the Nickel BLM in site and reference water samples used in WER analysis. For calculation of WER values, the average LC50 determined in site water was divided by the average LC50 in the reference water. The US EPA's "very hard" recipe for synthetic water was chosen as the reference water due to the good correspondence between the hardness in this recipe and at the site.

| Sample Description | | Ni LC50 mg/L | Average Ni LC50 mg/L | Average WER |
|---|---|---|---|---|
| RD at Rock Springs | 8/26/2010 | 32.38 | 28.89 | 2.92 |
| RD at Rock Springs | 9/9/2010 | 25.61 | | |
| RD at Lincoln | 8/26/2010 | 25.55 | 22.84 | 2.31 |
| RD at Lincoln | 9/9/2010 | 20.13 | | |
| Final Effluent | 8/26/2010 | 44.52 | 43.78 | 4.42 |
| Final Effluent | 9/9/2010 | 43.04 | | |
| | | | | |
| US EPA Very Hard | DOC=0.5 | 9.82 | 9.90 | |
| US EPA Very Hard | DOC=1.0 | 9.88 | | |
| US EPA Very Hard | DOC=2.0 | 10.00 | | |

Site water was characterized by performing two separate sampling events at both Rock Springs B and Lincoln Homestead. The BLM calculated LC50 values to *D. magna* in site-waters downstream of the Main Plant ranged from 22.84 mg/L to 28.89 mg/L (Table 2). For comparison, the calculated LC50 for reference water based on the US EPA's "very hard" water recipe was 9.9 mg/L. The WER values for each sampling location, calculated by dividing site water LC50 by the reference water LC50, correspond to 2.31 and 2.92 for Rock Springs B and Lincoln Homestead. Since these values are similar, an overall WER for the site can be determined by averaging to obtain an overall WER for the site of 2.62.

Predicted toxicity in the Final Effluent and the resulting WER value is also shown for comparison in Table 2, but these values were not averaged into the overall WER for the site. The predicted average LC50 in effluent samples was 43.78 mg/L, which is considerably higher than in downstream receiving water samples. The chemistry for the effluent shown in Table 1 indicates that effluent samples had higher concentrations of cations, such as Ca, Mg, and Sodium ("Na"), as well as a higher concentration of NOM (measured as DOC). All of these factors would tend to further mitigate against Nickel toxicity to aquatic organisms, which is why the predicted LC50 in effluent samples is higher. As a result, Nickel toxicity would be lower in any areas that are poorly mixed downstream of the discharge, and the resulting WER would be protective for these areas as well.

## V. SENSITIVITY TO VARIATION IN WATER CHEMISTRY

Since relatively few samples were used in the BLM analysis summarized in Tables 1 and 2, an additional analysis was conducted to see what effect natural variation in downstream water chemistry would have on the predicted toxicity. Additional monitoring data were used to characterize variation in measured chemistry corresponding to BLM input parameters. Monitoring data describing the variability in downstream chemistry was collected by the District, and combined with monitoring data for the Sangamon River collected by Eastern Illinois University. Samples collected for these monitoring studies were obtained at a number of different stations downstream of the Main Plant, including Lincoln, Rock Springs, and Wyckles Bridge, as well as unnamed stations 100 yards and 600 yards downstream. Variability in measured chemistry in the pooled data from these sampling stations includes both spatial and temporal variation. From these available data, the $10^{th}$, $25^{th}$, $75^{th}$, and $90^{th}$ percentiles were estimated for key water quality parameters that are known to affect Nickel bioavailability, including pH, DOC, Ca, Mg, Na, and Alkalinity (Table 3). A set of base case conditions was established as the median value for all parameters. Variation in Potassium ("K"), Sulfate ("SO4"), and Chlorine ("Cl") was not considered since these parameters are not important in determining the bioavailability of nickel.

Table 3. Variation in water quality parameters that affect Nickel bioavailability was characterized as the $10^{th}$, $25^{th}$, $75^{th}$, and $90^{th}$ percentile estimated from a dataset of pooled measurements are stations downstream of the Decatur Plant. The values for the base case were based on median values from the same dataset.

| Test | Temp. C | pH SU | DOC mg/L | Ca mg/L | Mg mg/L | Na mg/L | K mg/L | SO4 mg/L | Cl mg/L | Alk mg/L |
|---|---|---|---|---|---|---|---|---|---|---|
| *base* | 17.78 | 8.14 | 9.99 | 37.1 | 44.7 | 244.00 | 47.4 | 185.5 | 326.0 | 279.00 |
| *10th* | | 7.96 | 3.7 | 25.4 | 15.8 | 202.4 | | | | 151.2 |
| *25th* | | 8.03 | 6.4 | 30.5 | 20.1 | 218.0 | | | | 223.0 |
| *75th* | | 8.29 | 14.8 | 73.6 | 64.9 | 270.0 | | | | 321.0 |
| *90th* | | 8.47 | 28.2 | 84.3 | 74.3 | 285.6 | | | | 451.2 |

These data correspond to pre-existing monitoring studies and were not specifically collected for BLM analyses. Consequently, not all BLM parameters were measured in every sample. For the purposes of conducting a sensitivity analyses, these data are suitable for showing the expected downstream variation in individual parameters. Available data are plotted in Figure 4 for river samples and Figure 5 for effluent samples.

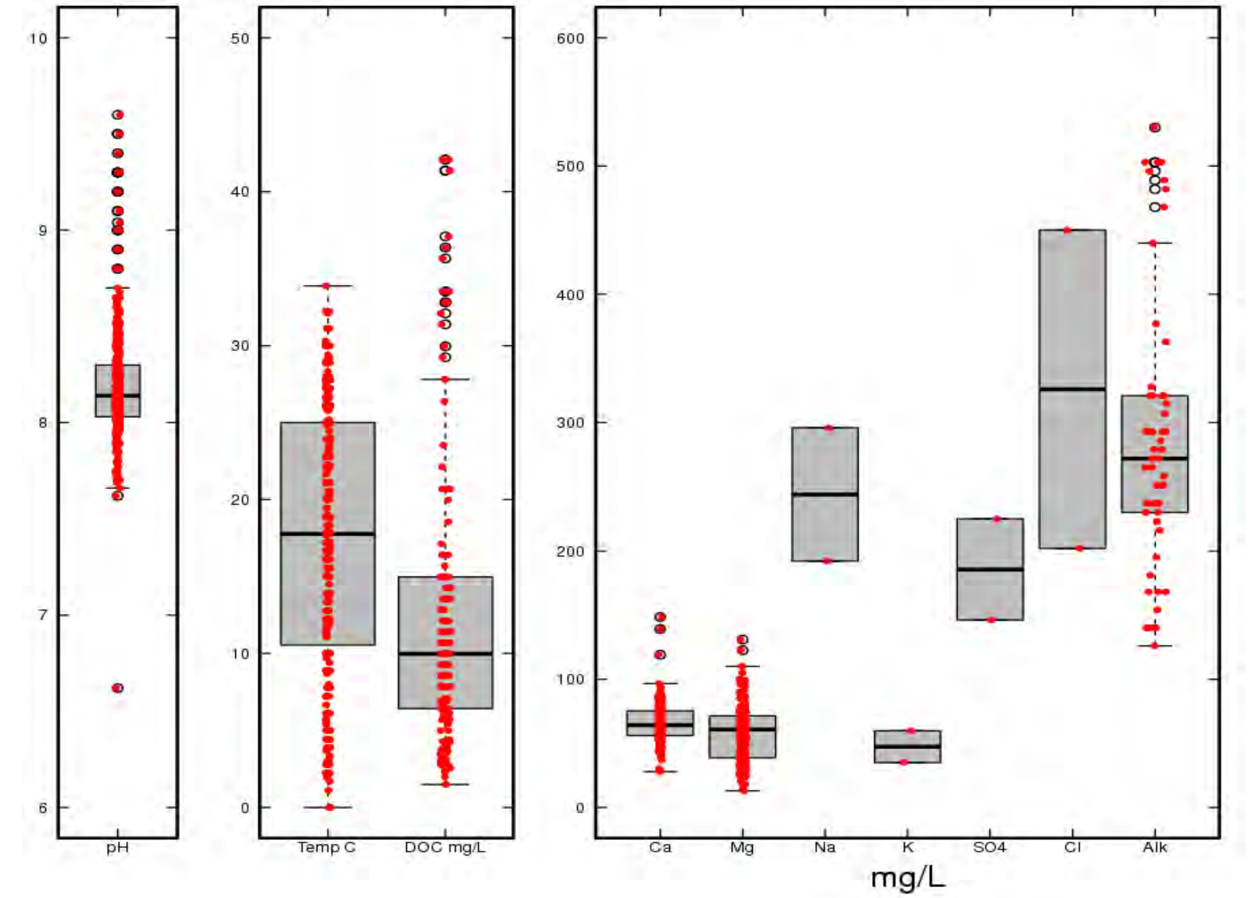



Figure 4. Box and whisker plots showing distributions of measured values for BLM input parameters in river samples. Average values are shown by a black line in the middle of each box and represent mean (pH, Temp, DOC) or geometric mean (Ca, Mg, Na, K, SO4, Cl, Alk) depending on whether parameters are expected to be normally or log-normally distributed. For each box, the lower edge of the box represents the 25$^{th}$ percentile, the upper edge of the box represents the 75$^{th}$ percentile, and whiskers extend to minimum and maximum values exclusive of extreme values. Individual observations are shown as small red circles.

The distribution of values for each parameter are shown as box and whisker diagrams constructed so that the lower edge of the box represents the 25$^{th}$ percentile, the upper edge of the box represents the 75$^{th}$ percentile, and whiskers extend to minimum and maximum values exclusive of extreme values. Median values are shown as the solid black horizontal line in the middle of each box. Individual observations are shown as small red circles. For river samples, there was a large amount of data characterizing pH, Alkalinity, DOC, and hardness cations (Ca and Mg), which are the bioavailability factors that are the most important for determining Nickel toxicity (Figure 4). There were relatively few samples characterizing K, and SO4, but these parameters have little to no effect on Nickel toxicity and do not need to be considered in the uncertainty analysis. There were also relatively few observations for Na, but the estimated variation in Na concentrations is similar to that seen for Ca and Mg and is, therefore, likely to be a reasonable characterization of variation in downstream chemistry. For effluent samples there were many more measurements of anion concentrations (Figure 5), and in comparison with river samples the effluents tended to have lower pH values and higher DOC and ion concentrations. The variation in pH, DOC, and ion concentrations show in these two datasets are consistent with the values seen in detailed sample analyses reported in Table 1.

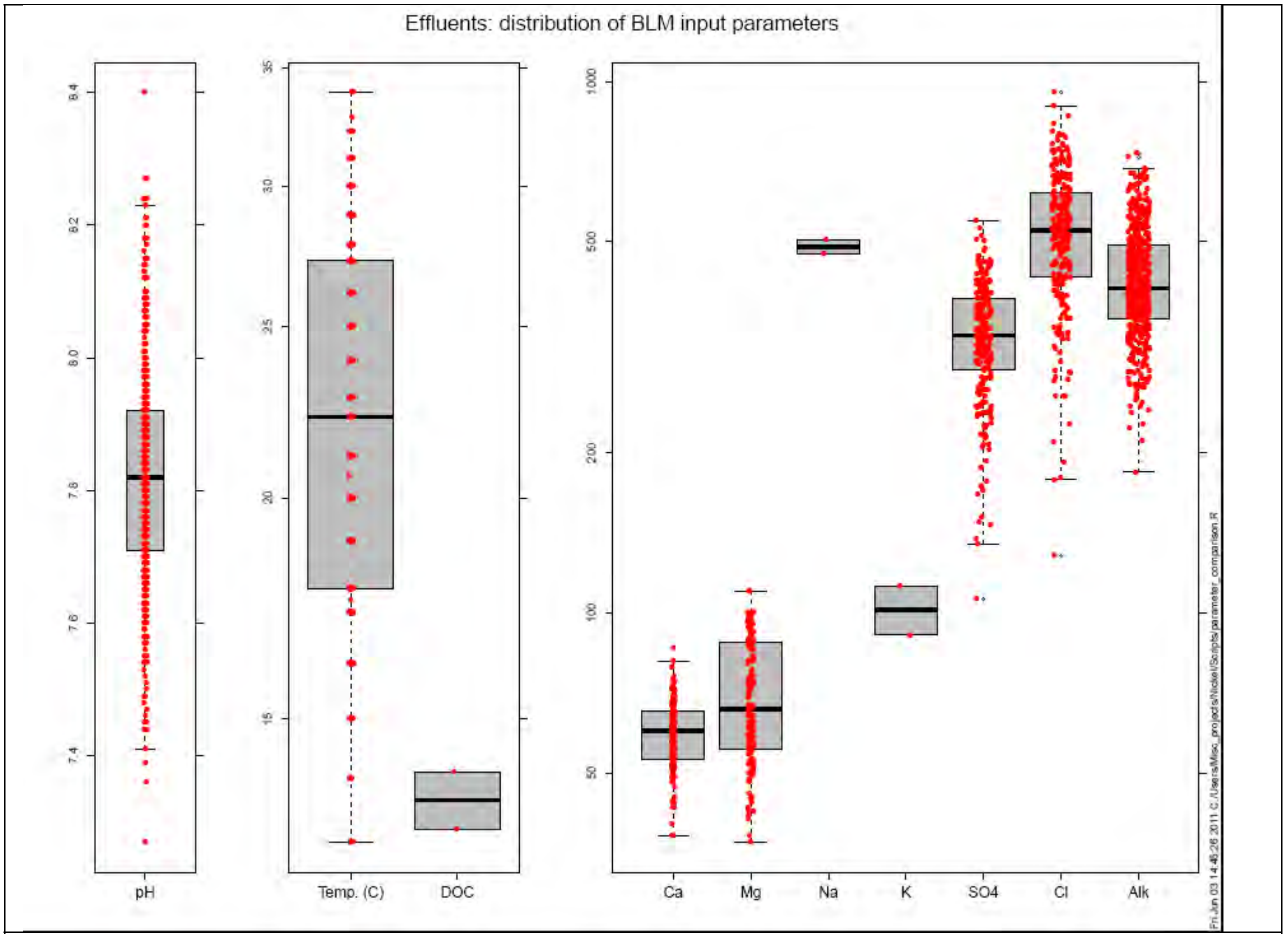



Figure 5. Box and whisker plots showing distributions of measured values for BLM input parameters in effluent samples. Average values are shown by a black line in the middle of each box and represent mean (pH, Temp, DOC) or geometric mean (Ca, Mg, Na, K, SO4, Cl, Alk) depending on whether parameters are expected to be normally or log-normally distributed. For each box, the lower edge of the box represents the 25th percentile, the upper edge of the box represents the 75th percentile, and whiskers extend to minimum and maximum values exclusive of extreme values. Individual observations are shown as small red circles.

Variability in BLM input parameters was used in a sensitivity analysis to determine the degree to which predicted toxicity may be expected to change over time. The model was first run for a base case that used median values for all parameters shown in Figure 4 and Table 3.

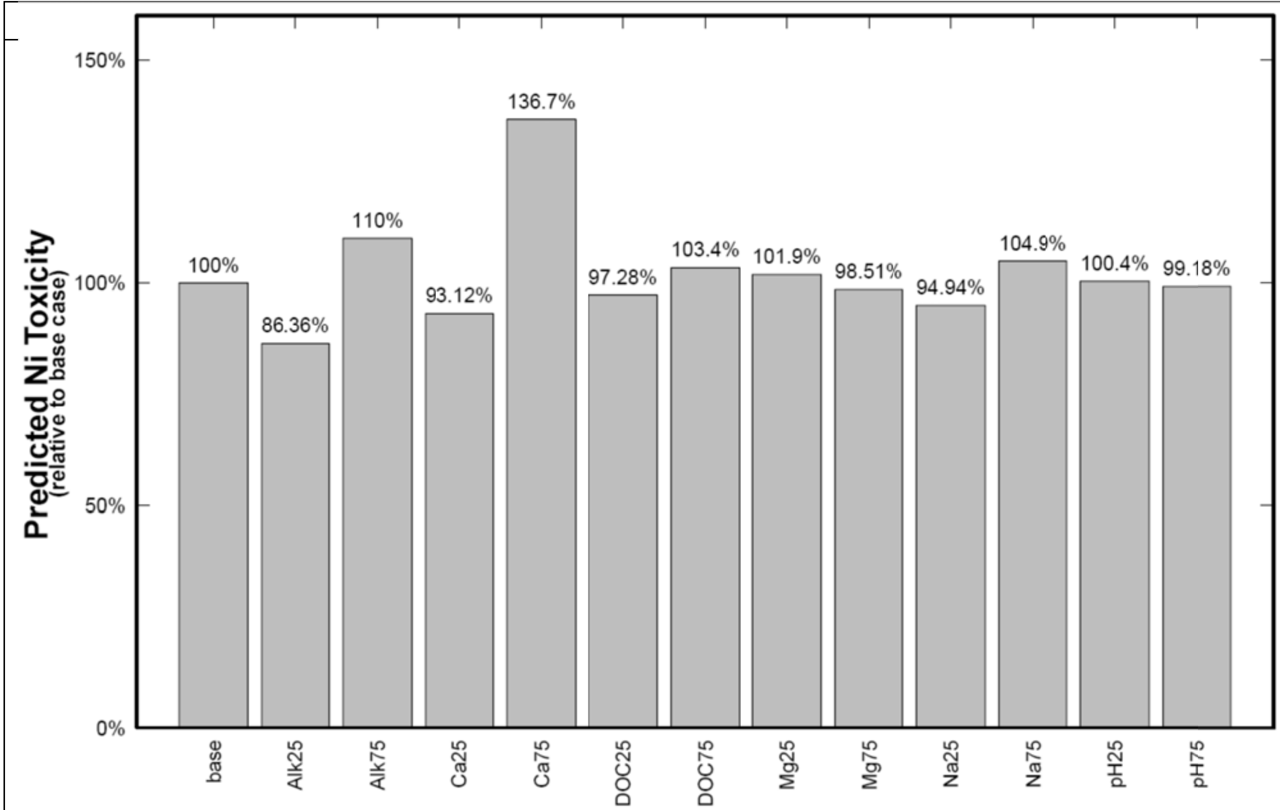



Figure 6. Sensitivity analysis of varying input parameters to the BLM on predicted Nickel toxicity in river samples. For the base case, average values for all parameters shown in Figure 4 were used. A series of additional simulations were then run to see the effect of variation in individual parameter values on the base case. For each additional simulation, the base case was modified with either the 25$^{th}$ or the 75$^{th}$ percentile value of an input variable, while all other parameters were held at the values used for the base case. For example, the result labeled "Alk25" uses the 25$^{th}$ percentile for Alkalinity (shown in Figure 4), and the result "Alk75" uses the 75$^{th}$ percentile for Alkalinity. Sensitivity results for other parameters are labeled with a similar labeling scheme.

For each BLM parameter, two additional runs were then performed by substituting either the 25% or 75% value from the box and whisker plots in Figure 4 for the average value, while keeping all other parameters constant, at their respective average. The resulting sensitivity analyses are shown in Figure 6 for river samples considering variation at the 25$^{th}$ and 75$^{th}$ percentile, and Figure 7 considering variation at the 10$^{th}$ and 90$^{th}$ percentiles.

Variation in input values at the 25th and 75th percentiles for river water samples had relatively little effect on the predicted Nickel toxicity, with the largest effects resulting from changes in Alkalinity and Calcium concentrations. A similar pattern was observed when variation at the 10th and 90th percentiles were considered (Figure 7). Even at these extreme values, the expected variation in predicted Nickel toxicity ranges from about 70 to 150 percent of the base case value. Guidance for derivation of site-specific adjustments to WQC based on the WER procedure allow simple geometric means of individual WER values when the range in values is within a factor of 5. Since the effects of the variation in river water chemistry on Nickel toxicity will be well within those limits, this uncertainty analysis supports the conclusion that average conditions from a relatively small number of samples should provide an acceptable characterization for deriving a site-specific Nickel criterion. As a result of these sensitivity analyses, the calculated WER for the site is not expected to significantly change as a result of variability in water quality within ranges comparable to these existing monitoring datasets.

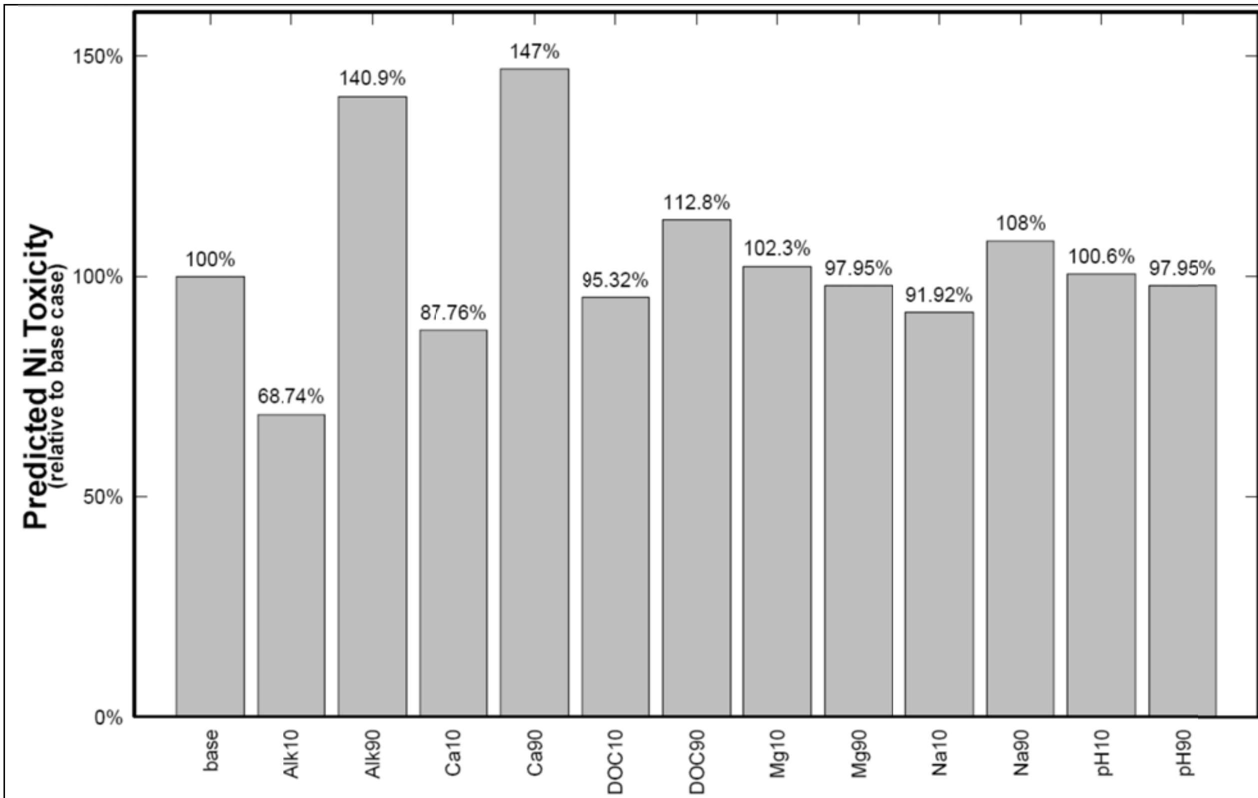



Figure 7. Sensitivity analysis of varying input parameters to the BLM on predicted Nickel toxicity in river samples. For the base case, average values for all parameters shown in Figure 4 were used. A series of additional simulations were then run to see the effect of variation in individual parameter values on the base case. For each additional simulation, the base case was modified with either the $10^{th}$ or the $90^{th}$ percentile value of an input variable, while all other parameters were held at the values used for the base case. For example, the result labeled "Alk10" uses the $10^{th}$ percentile for Alkalinity (shown in Figure 4), and the result "Alk90" uses the $90^{th}$ percentile for Alkalinity. Sensitivity results for other parameters are labeled with a similar labeling scheme.

For effluent samples (Figure 8), variation in Alkalinity had the largest effect on predicted Nickel toxicity. However, the resulting variation in predicted LC50 values was small, corresponding to a little more than 10% change relative to the base case. Variation in effluent characteristics is only presented for comparison to that seen for river water, since it is only the downstream river water that will be used to estimate the site-specific Nickel adjustment.

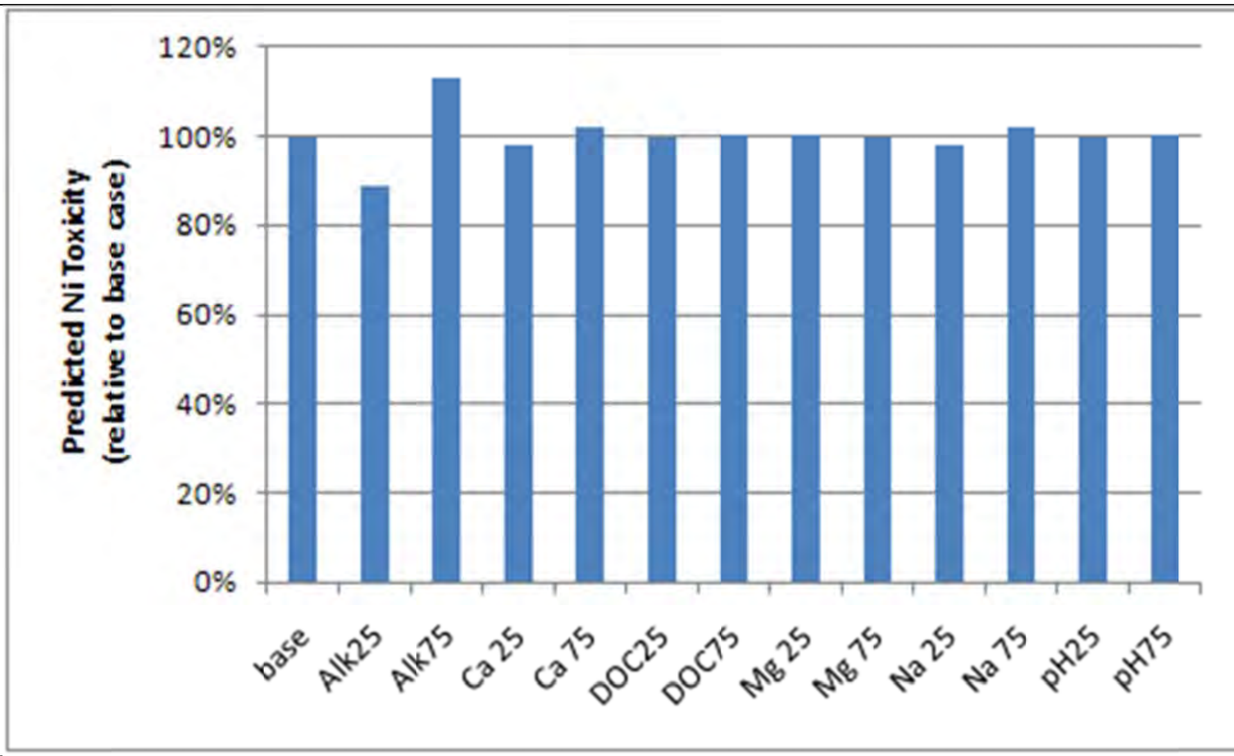



Figure 8. Sensitivity analysis of varying input parameters to the BLM on predicted Nickel toxicity in effluent samples. For the base case, average values for all parameters shown in Figure 5 were used. A series of additional simulations were then run to see the effect of variation in individual parameter values on the base case. For each additional simulation, the base case was modified with either the 25th or the 75th percentile value of an input variable, while all other parameters were held at the values used for the base case. For example, the result labeled "Alk25" uses the 25th percentile for Alkalinity (shown in Figure 5), and the result "Alk75" uses the 75th percentile for Alkalinity. Sensitivity results for other parameters are labeled with a similar labeling scheme.

## VI. PREDICTED ESTIMATE OF WQC

With the WER calculated in Section IV, site specific acute and chronic WQC can be calculated for the site. The site specific criteria are calculated as the state standards times the WER. For the receiving water downstream of the site, the average WER is 2.6, resulting in a site specific acute WQC of 614.1 µg/L and a site specific chronic WQC of 37.2 µg/L (Table 4).

Table 4. Summary of values for corresponding acute [a] and chronic [b] standards, WER, and resulting site specific standards in receiving water samples downstream of the plant. The Illinois acute and chronic standards for Nickel are based on hardness dependent equations. The average for samples collected in this study are based on the average measured hardness in samples collected for the BLM analysis. Also shown are the site-specific values based on a hardness of 359, which was assigned by the State of Illinois for this site.

| Sample Date | Sample Location | Hardness | Nickel Acute[a] Standard | Nickel Chronic[b] Standard | Water Effect Ratio | Site Specific Acute Standard | Site Specific Chronic Standard |
|---|---|---|---|---|---|---|---|
| | | mg/L as $CaCO_3$ | µg/L | µg/L | | µg/L | µg/L |
| 8/26 | RD at Rock Springs | 357 | 241.7 | 14.7 | 2.6 | 628.5 | 38.1 |
| 9/9 | RD at Rock Springs | 360 | 243.5 | 14.8 | | 633.0 | 38.4 |
| 8/26 | RD at Lincoln | 332 | 227.3 | 13.8 | 2.6 | 591.1 | 35.8 |
| 9/9 | RD at Lincoln | 341 | 232.5 | 14.1 | | 604.6 | 36.6 |
| | **Average (this study)** | **347.5** | **236.2** | **14.3** | **2.6** | **614.1** | **37.2** |
| | **Site specific values using Illinois EPA-assigned critical hardness** | **359** | **242.9** | **14.7** | **2.6** | **631.5** | **38.2** |

Notes:

[a:] Nickel Acute Standard = exp[A+B*ln(H)] * 0.998 (where A=0.5173; B=0.846)
[b:] Nickel Chronic Standard = exp[A+B*ln(H)] * 0.997 (where A= -2.286; B=0.846)

## VII. CONCLUSIONS

Water quality factors such as pH, Alkalinity, ion content, and the presence NOM have been shown to affect metal toxicity. However, the WCQ for many metals consider only hardness, making them potentially over-protective or under-protective for many site waters. The BLM is a mechanistic framework suitable for a number of metals, including Nickel, which allows for the consideration of many additional water quality factors. The BLM has been adopted by US EPA in the most recently updated metals criteria (US EPA, 2007). For metals that do not yet have an approved WQC approach, the BLM can be used to calculate a WER adjustment to derive site specific acute and chronic criteria. Application of the Nickel BLM to calculate Nickel toxicity in samples taken from the Sangamon River downstream of the District's Main Plant compared to a reference water results in a calculated average WER of 2.6. This WER results in a site specific acute criterion of 614.1 µg/L and a site specific chronic criterion of 37.2 µg/L at a hardness equal to 347.5 mg/L. Utilizing the Illinois EPA-assigned hardness of 359 mg/L, the WER results in a corresponding acute criterion of 631.5 µg/L and a site specific chronic criterion of 38.2 µg/L.

## VIII. REFERENCES

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# Exhibit 15

**Sanitary District of Decatur**
501 DIPPER LANE • DECATUR, ILLINOIS 62522 • 217/422-6931 • FAX: 217/423-8171

Exhibit 15

December 21, 2011

Illinois Environmental Protection Agency
Bureau of Water Compliance Assurance Section, MC #19
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Re: NPDES Permit IL0028321
IPCB Order PCB 09-125
Interim Report

Dear Sir or Madam:

Enclosed is the Interim Report regarding compliance with nickel and zinc limits required by Special Condition 18 of the Sanitary District of Decatur's NPDES Permit and the Pollution Control Board Order in PCB 09-125.

Please contact me at 422-6931 ext. 214 or at timk@sdd.dst.il.us if you have any questions regarding this report.

Sincerely,

Timothy R. Kluge, P.E.
Technical Director

cc: Rick Pinneo, IEPA (via email)
Bob Mosher, IEPA (via email)
SDD File

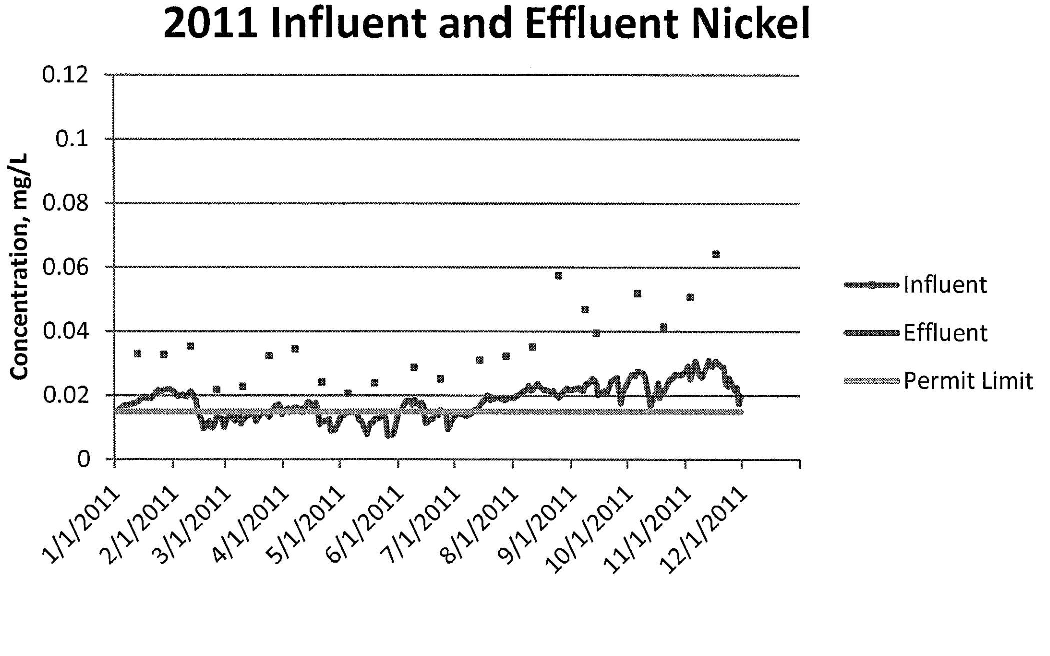
**Sanitary District of Decatur**
**Nickel and Zinc Limits**
**December 2011 Interim Report**

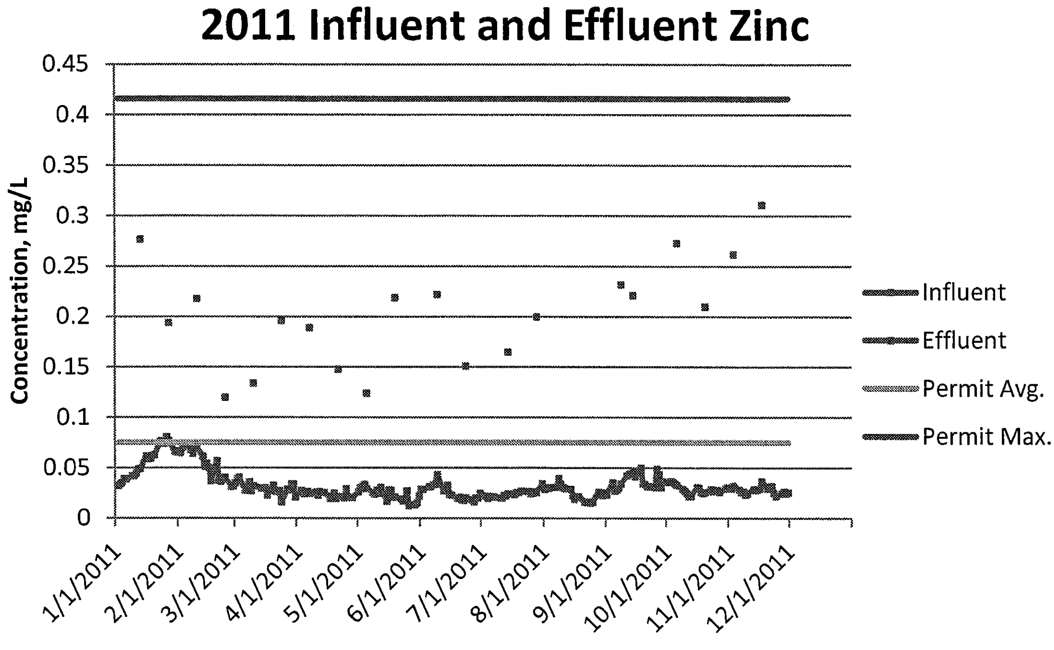
The modified NPDES permit for the Sanitary District of Decatur that became effective July 1, 2009 contains limits for nickel and zinc and a one-year compliance schedule extension for meeting the limits. Special Condition 17 requires that an interim progress report be submitted to Illinois EPA by January 1, 2012.

On January 7, 2010 the Illinois Pollution Control Board granted a variance to the District allowing additional time to comply with final permit limits (PCB 09-125). The final compliance date contained in the Board Order is July 1, 2014. The District's NPDES Permit has not yet been modified to incorporate the variance although Illinois EPA issued a Public Notice and draft modified permit on May 26, 2011. The Board Order also requires that an interim progress report be submitted by January 1, 2012 and lists a number of other activities and investigations that are to be completed. This report is submitted to meet both the permit and variance requirements.

**Plant Influent and Effluent Sampling**

Ongoing influent sampling for nickel and zinc continues at a frequency of twice monthly, and effluent sampling is done five days per week according to NPDES monitoring requirements. A summary of influent and effluent values during 2011 is shown below. Data shows that the plant effluent is not able to consistently meet the current nickel permit limit. Zinc concentrations remain below the permit limit.






**Receiving Stream Sampling**

Upstream and downstream sampling continues at a twice monthly frequency to provide a more complete picture of nickel and zinc in the Sangamon River. One upstream and four downstream sampling sites are being monitored. A summary of 2010-2011 river monitoring data is attached. Downstream nickel results remain high during times of low upstream river flow. All upstream and downstream zinc results during 2011 have been below the Illinois water quality standard.

**Pretreatment Ordinance Limits**

The District's pretreatment ordinance was amended in October 2009 as noted in previous reports.

**Stream Flow-Based Compliance Options**

The District continues investigation of flow-based permit limits, to take advantage of upstream flow for mixing when it is available. This concept could potentially allow a savings in treatment facility operating costs when the upstream flow is sufficient to meet water quality standards after mixing with treatment plant effluent. A USGS flow gauging station is located about two miles upstream of the District's discharge point, and provides near- real time flow information. Informal discussions with Illinois EPA personnel have indicated a preference for flow-based limits to be a part of relief requested from the Pollution Control Board.

**Water Quality Standard Investigations**

The District is continuing to investigate approaches to a water quality standard adjustment including a limit based on a bioavailability approach. SDD staff and personnel from Hydro-Qual have discussed aspects of the proposal with Illinois EPA staff during the past few months. The District is in the final stages of preparing a petition for a site-specific nickel standard, which should be filed with the Pollution Control Board in early 2012.

We are also following the Pollution Control Board rulemaking currently underway to correct an error found in the existing zinc water quality standard.

**Industrial Source Sampling and Investigations**

Sampling at Archer Danield Midland Company for metals continues at a frequency of twice monthly and other industries discharging metals are sampled quarterly. Sample results obtained from ADM within the past year are attached.

The District's operating permit issued to ADM was modified on November 18, 2009 and again on June 17, 2010 to reflect the new limits and provide a compliance schedule for meeting the limits. Final local limits will be effective upon expiration of the District's variance.

Both ADM and Tate & Lyle formerly utilized zinc as part of their cooling tower treatment programs, and both have eliminated or greatly reduced zinc in their towers. At this time, both industries are meeting the zinc pretreatment limit. ADM is continuing to investigate the possible impact of the zinc limit on their planned wasting of solids from their pretreatment system to the District's collection system.

The discharge from ADM is by far the most significant industrial source of nickel. ADM has been very active in seeking treatment technology for nickel removal, involving plant management and research department personnel in addition to environmental compliance and legal staff. District staff met with ADM personnel several times during the second half of 2011, most recently on December 12. The District's pretreatment permit requires semi-annual reports of ADM's investigations, and the most recent report is attached. Work during the past six months has included pilot testing for several nickel removal technologies, toxicity testing to determine potential impacts of the District's nitrification process, and ongoing research into alternative technologies.

**Additional Pretreatment Limit Investigations**

Pretreatment ordinance limits adopted in 2009 were adopted as total (rather than soluble) limits based on review of soluble/insoluble data. Refinement of pretreatment limits is an ongoing process and will depend on final permit limits as well as treatment technologies that might be employed by industrial users. The required determination of soluble/insoluble vs. total limits will be updated as part of the final compliance plan submitted to the Agency.

**Compliance Plan**

In summary, the District's proposed compliance plan includes ongoing work as required by the Board Order granting the District's variance. The District will continue to proceed in accordance with the schedule in the Order with efforts in three areas:

1. Continuing to work with ADM to investigate nickel removal technologies, and to determine a sludge wasting plan that will minimize zinc discharges. The Order lists ten technologies that were to be investigated by December 31, 2010; the investigations were done as required. Additional investigations and pilot studies continue and a summary is attached.

2. Completion and filing a petition for a site-specific water quality standard for nickel, based on bioavailability. Work on the petition is proceeding with a goal of filing early in 2012.

3. Conducting additional discussions with Illinois EPA permit personnel regarding variable permit limits based on the amount of flow available in the Sangamon River. At this time, the District intends to include flow variable limits in its request for a site-specific water quality standard.

**Sanitary District of Decatur**

Nickel and Zinc River Data 2010-2011



| Sample Date | Plant Final Effluent Nickel mg/L | River Up-stream Nickel mg/L | River 100 yds Down stream Nickel mg/L | River 600 yds Down-stream Nickel mg/L | Steven's Creek Nickel mg/L | River Rock Springs Bridge Nickel mg/L | River Wyckle's Road Nickel mg/L | River Lincoln H'stead Nickel mg/L | Plant Final Effluent Zinc mg/L | River Up-stream Zinc mg/L | River 100 yds Down stream Zinc mg/L | River 600 yds Down-stream Zinc mg/L | Steven's Creek Zinc mg/L | River Rock Springs Bridge Zinc mg/L | River Wyckle's Road Zinc mg/L | River Lincoln H'stead Nickel mg/L | Plant Final Effluent Flow mgd | River Up-stream Flow $ft^3/sec$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/14/10 | 0.0202 | <0.00131 | 0.00374 | 0.00407 | <0.00131 | 0.00331 | | 0.00318 | 0.0393 | <0.00660 | 0.0102 | 0.0108 | <0.00660 | 0.00839 | | 0.0112 | 30.29 | 208 |
| 1/28/10 | 0.0160 | 0.00205 | 0.00253 | 0.00240 | <0.00131 | 0.00209 | | 0.00237 | 0.0399 | 0.0129 | 0.0130 | 0.0121 | 0.00773 | 0.0135 | | 0.0138 | 42.87 | 3470 |
| 2/11/10 | 0.0204 | <0.00131 | 0.00462 | 0.00357 | <0.00131 | 0.00277 | | 0.00253 | 0.0344 | <0.00660 | 0.0119 | 0.00980 | 0.00789 | 0.0108 | | 0.00710 | 31.39 | 517 |
| 2/18/10 | 0.0304 | <0.00131 | 0.00527 | 0.00468 | <0.00131 | 0.00398 | | 0.00351 | 0.0377 | 0.00696 | 0.0103 | 0.0103 | 0.00790 | 0.00777 | | 0.00819 | 33.12 | 436 |
| 3/4/10 | 0.0235 | <0.00131 | 0.00376 | 0.00332 | <0.00131 | 0.00242 | | 0.00240 | 0.0304 | 0.00667 | 0.00918 | 0.00851 | <0.00660 | 0.00746 | | 0.00895 | 37.82 | 755 |
| 3/18/10 | 0.0194 | 0.00133 | 0.00232 | 0.00199 | <0.00131 | 0.00165 | | 0.00200 | 0.0260 | 0.00781 | 0.00966 | 0.00953 | 0.00739 | 0.00801 | | 0.0107 | 39.45 | 2160 |
| 4/15/10 | 0.0208 | <0.00131 | 0.00290 | 0.00279 | <0.00131 | 0.00237 | | 0.00281 | 0.0204 | <0.00660 | 0.00758 | 0.00867 | <0.00660 | <0.00660 | | 0.00761 | 35.89 | 482 |
| 4/29/10 | 0.0173 | <0.00131 | 0.00186 | 0.00201 | <0.00131 | 0.00175 | | 0.00222 | 0.0290 | 0.00776 | 0.00676 | 0.00833 | 0.0136 | <0.00660 | | 0.00902 | 31.86 | 728 |
| 5/13/10 | 0.0127 | 0.00137 | 0.00195 | 0.00244 | 0.00176 | 0.00174 | | 0.00229 | 0.0244 | 0.00762 | 0.00767 | 0.00791 | 0.0121 | 0.00821 | | 0.0112 | 38.27 | 1440 |
| 5/27/10 | 0.0211 | <0.00131 | 0.00388 | 0.00284 | 0.00158 | 0.00226 | | 0.00259 | 0.0293 | 0.00765 | 0.00875 | 0.00763 | 0.00872 | 0.00697 | | 0.00982 | 37.01 | 948 |
| 6/10/10 | 0.0229 | 0.00205 | 0.00298 | 0.00241 | 0.00325 | 0.00217 | | 0.00291 | 0.0328 | 0.0108 | 0.0106 | 0.00988 | 0.0183 | 0.0105 | | 0.0145 | 38.57 | 1820 |
| 6/24/10 | 0.0205 | 0.00262 | 0.00620 | 0.00386 | 0.00332 | 0.00311 | | 0.00345 | 0.0212 | 0.0144 | 0.0137 | 0.0125 | 0.0174 | 0.0142 | | 0.0148 | 72.13 | 6120 |
| 7/8/10 | 0.0458 | <0.00131 | 0.00637 | 0.00713 | <0.00131 | 0.00540 | | 0.00571 | 0.0662 | <0.00660 | 0.0148 | 0.0175 | <0.00660 | 0.0155 | | 0.0121 | 34.86 | 348 |
| 7/29/10 | 0.0433 | 0.00190 | 0.00744 | 0.00600 | 0.00151 | 0.00580 | | 0.00600 | 0.0564 | 0.00909 | 0.0132 | 0.0122 | <0.00660 | 0.0123 | | 0.0248 | 38.86 | 285 |
| 8/12/10 | 0.0493 | 0.00157 | 0.0367 | 0.0353 | <0.00131 | 0.0327 | | 0.0338 | 0.0681 | 0.0130 | 0.0578 | 0.0529 | <0.00660 | 0.0480 | | 0.0601 | 31.89 | 24 |
| 8/26/10 | 0.0370 | 0.0025 | 0.0319 | 0.0320 | 0.00177 | 0.0294 | | 0.0211 | 0.0253 | 0.0130 | 0.0255 | 0.0246 | <0.00660 | 0.0221 | | 0.0121 | 30.59 | 4.7 |
| 9/9/10 | 0.0269 | <0.00131 | 0.0203 | 0.0197 | 0.00135 | 0.0166 | | 0.0119 | 0.0314 | <0.00660 | 0.0219 | 0.0209 | 0.0113 | 0.0257 | | 0.0218 | 32.10 | 11 |
| 9/23/10 | 0.0192 | 0.00186 | 0.0136 | 0.0132 | 0.00188 | 0.00915 | | 0.0108 | 0.0309 | 0.0119 | 0.0590 | 0.0249 | 0.0105 | 0.0188 | | 0.0162 | 34.19 | 2.0 |
| 10/14/10 | 0.0182 | 0.00251 | 0.0176 | 0.0182 | 0.00143 | 0.0149 | 0.0152 | | 0.0335 | 0.00827 | 0.0335 | 0.0317 | 0.00893 | 0.0259 | 0.0303 | | 25.66 | 1.9 |
| 10/28/10 | 0.0238 | 0.00135 | 0.0209 | 0.0212 | <0.00131 | 0.0158 | 0.0157 | | 0.0261 | <0.00660 | 0.0316 | 0.0232 | <0.00660 | 0.0179 | 0.0190 | | 28.28 | 1.9 |
| 11/04/10 | 0.0227 | 0.00146 | 0.0222 | 0.0223 | <0.00131 | 0.0193 | 0.0193 | | 0.0474 | <0.00660 | 0.0440 | 0.0421 | <0.00660 | 0.0367 | 0.0354 | | 31.01 | 2.7 |
| 11/18/10 | 0.0207 | 0.00131 | 0.0191 | 0.0189 | <0.00131 | 0.0164 | 0.0170 | | 0.0287 | <0.00660 | 0.0271 | 0.0274 | <0.00660 | 0.0245 | 0.0238 | | 29.94 | 4.5 |
| 12/02/10 | 0.0203 | 0.00180 | 0.00269 | 0.00217 | <0.00131 | 0.00217 | 0.00186 | | 0.0396 | <0.00660 | 0.00702 | 0.00745 | <0.00660 | 0.00779 | <0.00660 | | 33.60 | 1480 |
| 12/16/10 | 0.0199 | <0.00131 | 0.00311 | 0.00210 | <0.00131 | 0.0017 | 0.00156 | | 0.0356 | <0.00660 | 0.00672 | 0.00859 | <0.00660 | <0.00660 | <0.00660 | | 28.51 | 694 |
| 01/13/11 | 0.0181 | <0.00131 | 0.00519 | 0.00495 | <0.00131 | 0.00426 | 0.00504 | | 0.0503 | <0.00660 | 0.0157 | 0.0152 | <0.00660 | 0.0133 | 0.0149 | | 29.48 | 121 |
| 01/27/11 | 0.0218 | <0.00131 | 0.0144 | 0.0138 | <0.00131 | 0.0113 | 0.0102 | | 0.0773 | <0.00660 | 0.0504 | 0.0481 | <0.00660 | 0.0394 | 0.0350 | | 30.71 | 3.9 |
| 02/10/11 | 0.0214 | <0.00131 | 0.0141 | 0.0128 | <0.00131 | 0.0112 | 0.00971 | | 0.0701 | <0.00660 | 0.0460 | 0.0413 | 0.00761 | 0.0364 | 0.0313 | | 27.94 | 5.4 |
| 02/24/11 | 0.0132 | 0.00160 | 0.00242 | 0.00252 | 0.00150 | 0.00214 | 0.00205 | | 0.0406 | 0.00841 | 0.0106 | 0.0108 | 0.0138 | 0.0114 | 0.00992 | | 44.38 | 1970 |
| 3/10/11 | 0.0123 | 0.00169 | 0.00194 | 0.00198 | 0.00153 | 0.00184 | 0.00208 | | 0.0321 | 0.00972 | 0.00978 | 0.00992 | 0.0103 | 0.00974 | 0.0100 | | 47.51 | 2900 |
| 3/24/11 | 0.0132 | <0.00131 | 0.00133 | 0.00133 | <0.00131 | <0.00131 | <0.00131 | | 0.0161 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | | 33.28 | 667 |
| 4/7/11 | 0.0163 | <0.00131 | 0.00343 | 0.00252 | <0.00131 | 0.00241 | 0.00237 | | 0.0246 | <0.00660 | 0.00884 | 0.00689 | <0.00660 | 0.00732 | 0.00691 | | 30.62 | 326 |
| 4/21/11 | 0.0118 | <0.00131 | 0.00236 | 0.00195 | 0.00254 | 0.00157 | 0.00188 | | 0.0215 | 0.00729 | 0.00878 | 0.00822 | 0.0170 | 0.00939 | 0.00934 | | 52.22 | 2540 |
| 5/5/11 | 0.0147 | 0.00177 | 0.00279 | 0.00238 | 0.00137 | 0.00218 | 0.00223 | | 0.0295 | <0.00660 | 0.00932 | 0.00862 | <0.00660 | 0.00760 | 0.00898 | | 41.88 | 1670 |
| 5/19/11 | 0.0125 | <0.00131 | 0.00211 | 0.00186 | <0.00131 | 0.00153 | 0.00150 | | 0.0213 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | 0.00777 | | 32.29 | 1290 |
| 6/9/11 | 0.0187 | <0.00131 | 0.00143 | 0.00194 | 0.00183 | 0.00162 | 0.00177 | | 0.0434 | <0.00660 | <0.00660 | 0.00672 | <0.00660 | <0.00660 | 0.0124 | | 29.12 | 1540 |
| 6/23/11 | 0.0154 | 0.00210 | 0.00335 | 0.00307 | 0.00154 | 0.00280 | 0.00329 | | 0.0203 | 0.0131 | 0.0134 | 0.0138 | 0.0112 | 0.0129 | 0.0155 | | 36.23 | 800 |
| 7/14/11 | 0.0170 | <0.00131 | 0.0118 | 0.0116 | <0.00131 | 0.00886 | 0.00890 | | 0.0242 | 0.00519 | 0.0162 | 0.0171 | <0.00660 | 0.0136 | 0.0130 | | 27.12 | 200 |
| 7/28/11 | 0.0188 | <0.00131 | 0.0187 | 0.0168 | <0.00131 | 0.0158 | 0.0159 | | 0.0255 | <0.00660 | 0.0279 | 0.0219 | <0.00660 | 0.0205 | 0.0207 | | 27.85 | 2.1 |
| 8/11/11 | 0.0218 | 0.00143 | 0.0255 | 0.0212 | <0.00131 | 0.0204 | 0.0199 | | 0.0294 | <0.00660 | 0.0576 | 0.0292 | <0.00660 | 0.0266 | 0.0271 | | 24.82 | 1.6 |
| 8/25/11 | 0.0193 | <0.00131 | 0.0187 | 0.0190 | <0.00131 | 0.0183 | 0.0189 | | 0.0161 | <0.00660 | 0.0153 | 0.0158 | <0.00660 | 0.0142 | 0.0137 | | 24.19 | 1.1 |
| 9/8/11 | 0.0233 | 0.00142 | 0.0208 | 0.0222 | <0.00131 | 0.0207 | 0.0196 | | 0.0341 | <0.00660 | 0.0294 | 0.0303 | <0.00660 | 0.0279 | 0.0254 | | 27.07 | 0.15 |
| 9/14/11 | 0.0237 | 0.00132 | 0.0231 | 0.0235 | <0.00131 | 0.0228 | 0.0231 | | 0.0460 | <0.00660 | 0.0425 | 0.0438 | <0.00660 | 0.0413 | 0.0385 | | 28.62 | 1.9 |
| 10/6/11 | 0.0276 | 0.00140 | 0.0263 | 0.0265 | <0.00131 | 0.0255 | 0.0259 | | 0.0329 | <0.00660 | 0.0318 | 0.0314 | <0.00660 | 0.0296 | 0.0288 | | 23.96 | 0.75 |
| 10/20/11 | 0.0211 | <0.00131 | 0.0189 | 0.0195 | <0.00131 | 0.0159 | 0.0181 | | 0.0260 | 0.0107 | 0.0235 | 0.0238 | <0.00660 | 0.0193 | 0.0199 | | 23.28 | 2.8 |
| 11/3/11 | 0.0250 | 0.00197 | 0.0277 | 0.0304 | 0.00175 | 0.0260 | 0.0275 | | 0.0322 | 0.0115 | 0.0314 | 0.0354 | <0.00660 | 0.0281 | 0.0271 | | 42.99 | 18 |
| 11/17/11 | 0.0307 | <0.00131 | 0.0281 | 0.0283 | 0.00178 | 0.0273 | 0.0277 | | 0.0368 | <0.00660 | 0.0285 | 0.0304 | <0.00660 | 0.0275 | 0.0247 | | 25.80 | 1.1 |
| 12/1/11 | 0.0221 | <0.00131 | 0.0177 | 0.0173 | <0.00131 | 0.0149 | 0.0149 | | 0.0349 | 0.00728 | 0.0245 | 0.0230 | 0.00824 | 0.0207 | 0.0190 | | 27.64 | 2.1 |

Indicates that effluent or river/creek sample concentration exceeds chronic water quality value

| SDD Major Industrial Nickel and Zinc Results | | | | |
|---|---|---|---|---|
| | | | | |
| | ADM Point A | ADM Point A | ADM Point D | ADM Point D |
| Sample | Nickel, Tot | Zinc, Tot | Nickel, Tot | Zinc, Tot |
| Date | mg/L | mg/L | mg/L | mg/L |
| 6/1/2010 | 0.0813 | 0.488 | 0.12 | 0.441 |
| 6/14/2010 | 0.0826 | 0.453 | 0.104 | 0.345 |
| 7/8/2010 | 0.148 | 0.54 | 0.283 | 1.07 |
| 7/12/2010 | 0.144 | 0.528 | 0.193 | 0.514 |
| 8/2/2010 | 0.125 | 0.457 | 0.172 | 0.446 |
| 8/9/2010 | 0.126 | 0.44 | 0.184 | 0.474 |
| 9/1/2010 | 0.0766 | 0.465 | 0.122 | 0.469 |
| 9/20/2010 | 0.0744 | 0.442 | 0.121 | 0.649 |
| 10/4/2010 | 0.0781 | 0.461 | 0.0938 | 0.369 |
| 10/14/2010 | 0.162 | 1.18 | 0.179 | 1.18 |
| 11/8/2010 | 0.0524 | 0.24 | 0.0646 | 0.208 |
| 11/23/2010 | 0.13 | 0.665 | 0.122 | 0.413 |
| 12/6/2010 | 0.0715 | 0.53 | 0.131 | 0.581 |
| 12/13/2010 | 0.0649 | 0.498 | 0.0774 | 0.219 |
| 1/5/2011 | 0.0629 | 0.53 | 0.0669 | 0.204 |
| 1/10/2011 | 0.0577 | 0.495 | 0.0666 | 0.188 |
| 2/7/2011 | 0.0836 | 0.756 | 0.0892 | 0.329 |
| 2/14/2011 | 0.0589 | 0.472 | 0.0598 | 0.18 |
| 3/7/2011 | 0.0773 | 0.447 | 0.0627 | 0.128 |
| 3/14/2011 | 0.086 | 0.51 | 0.1 | 0.449 |
| 4/4/2011 | 0.07 | 0.428 | 0.0841 | 0.387 |
| 4/20/2011 | 0.0687 | 0.33 | 0.0861 | 0.347 |
| 5/2/2011 | 0.0712 | 0.304 | 0.0809 | 0.302 |
| 5/9/2011 | 0.06 | 0.301 | 0.0712 | 0.3 |
| 6/6/2011 | 0.0648 | 0.285 | 0.0786 | 0.276 |
| 6/13/2011 | 0.0692 | 0.293 | 0.0809 | 0.314 |
| 7/11/2011 | 0.0542 | 0.226 | 0.0625 | 0.209 |
| 8/1/2011 | 0.0491 | 0.165 | 0.0621 | 0.172 |
| 8/8/2011 | 0.0567 | 0.215 | 0.074 | 0.242 |
| 9/1/2011 | 0.0662 | 0.285 | 0.0842 | 0.327 |
| 9/7/2011 | 0.0684 | 0.311 | 0.0884 | 0.344 |
| 10/3/2011 | 0.094 | 0.518 | 0.114 | 0.515 |
| 10/10/2011 | 0.0643 | 0.191 | 0.073 | 0.189 |
| | | | | |
| SDD Ordinance Limit (Avg.) | 0.0365 | 0.45 | | |
| SDD Ordinance Limit (Max.) | 0.15 | 1.7 | | |

To: Illinois Environmental Protection Agency
Decatur Sanitary District

From: ADM Decatur WWTP

CC: ADM Corn Processing, ADM Oilseeds Processing, ADM JRRRC

Date: December 12, 2011

Re: Status Report Compliance Strategy for 2011 for Decatur Sanitary District and ADM Decatur WWTP for waste treatment. (Covers updates post July 6, 2011- date)

**Table of Contents**

ADM Research and Decatur Corn Processing have been actively pursuing technologies to remove Nickel (Ni) from its effluent stream released to the SDD treatment plant. Enclosed is a report on the progress ADM has made since the last update issued on July 6, 2011.

## 1 Background

Nickel and Zinc are present in effluent leaving the ADM Decatur Complex Waste Water plant. New effluent limits are proposed which will reduce the discharge limits to 0.0365 ppm for Nickel and 0.35 ppm for Zinc. Of the two metals, nickel is more difficult to remove from the effluent. ADM has conducted 5 plant material balances to understand the sources of Nickel in its internal streams. ADM's Decatur Complex consists of multiple, separate processing plants, which send their wastewater to the on-site wastewater treatment plant ("WWTP") operated by Corn Plant personnel. These processing plants consist of the Corn Wet Mill, BioProducts Plant, Cogeneration Plant, East Soybean Processing Plant, West Soybean Processing Plant, Vitamin E Plant, Corn Germ Processing Plant, Glycols Plant and the Polyols Plant. Each of these unique plants produces multiple products, using both batch and continuous processes, and creates water streams which generally are reused multiple times prior to being discharged to the WWTP. The WWTP treats approximately 11 MGD through a newer anaerobic treatment system followed by aerobic treatment prior to discharge to the District.

The incoming soybeans contain approximately 4.1 parts per million ("ppm") nickel, while incoming corn contains approximately 0.53 ppm nickel. Given that ADM's Decatur Complex processes approximately 600,000 bushels of corn and 200,000 bushels of soybeans per day, our incoming Nickel load is about 49.2 lbs from the Soybeans and 19.1 lbs from the corn. A small portion of the incoming nickel is discharged in the effluent.

The concentration and total quantity coming from the various waste water treatment plant influents from our five plant balances are shown in Table 1 (Total Nickel) and 2 (Soluble Nickel).

**Table 1: Average Total Nickel to HIGH SALT in ppm**

| | Summer 09 balance | Jan-Feb/2010 30 days | Fall 2010 1 day a week for 7 weeks | Jun-Jul/2011 39 days | Fall 2011 5 weeks |
|---|---|---|---|---|---|
| Corn Plt | | 0.104 | 0.088 | 0.09 | 0.13 |
| East Plt | | 0.195 | 0.250 | 0.18 | 0.24 |
| Bio Prod | | 0.028 | 0.028 | 0.037 | 0.242 |
| Glycol | | 0.150 | 0.106 | 0.255 | 0.112 |
| Polyol | | 0.505 | 2.5 | 7.7 | 9.2 |
| Co-gen | | 0.011 | 0.019 | | |
| Truck Wash | | | | | |
| Weighted Average | | 0.121 | 0.139 | 0.140 | 0.154 |
| | | | | | |
| HS EQ Tank | | 0.210 | 0.170 | 0.137 | 0.132 |
| (HS EQ Tank is the combined stream of all plants high salt streams) | | | | | |

**Table 2: Average Soluble Nickel to HIGH SALT in ppm**

| | Summer 09 balance | Jan-Feb/2010 30 days | Fall 2010 1 day a week for 7 weeks | Jun-Jul/2011 39 days | Fall 2011 5 weeks |
|---|---|---|---|---|---|
| Corn Plt | 0.105 | 0.104 | 0.092 | 0.091 | 0.030 |
| East Plt | 0.240 | 0.161 | 0.200 | 0.164 | 0.180 |
| Bio Prod | 0.048 | 0.028 | 0.028 | 0.040 | 0.030 |
| Glycol | | 0.150 | 0.107 | 0.285 | 0.110 |
| Polyol | | 0.476 | 2.6 | 8.1 | 11.1 |
| Co-gen | 0.000 | 0.011 | 0.017 | | |
| Truck Wash | | | | | |
| Weighted Average | 0.142 | 0.107 | 0.125 | 0.135 | 0.110 |
| | | | | | |
| HS EQ Tank (HS EQ Tank is the combined stream of all plants high salt streams) | | 0.170 | 0.140 | 0.090 | 0.151 |

The majority of nickel found in ADM effluent water originates in the corn and soybeans being processed at the facility. During the processing, the metals are released and enter the processing water some of which eventually ends up at the wastewater treatment plant.

ADM has monitored soluble Nickel at the Damon and Front stations continuously (see Figures 3 & 4) and made a number of observations:

1) In the past 9 months there has been a decline in Nickel from about 120 ppb to about 60 ppb. However we have experienced severe spikes in effluent nickel in September-November, 2011 each lasting 2-3 days.
2) There has been a significant reduction in Soluble Nickel using Diatomaceous Earth (~0.2µ) vs. 5µ filtering (see Figure 1). This suggests the insoluble nickel is very small and may not be removed by metal precipitants.
3) ADM sees a large level of carryover from the anaerobic digesters to the aerobic Dissolve Air Floatation units (DAF). (Figure 2)

As discussed below, ADM is investigating other opportunities for processing the Soy Molasses stream from the East Plant. This will reduce the nickel load from the WWTP.

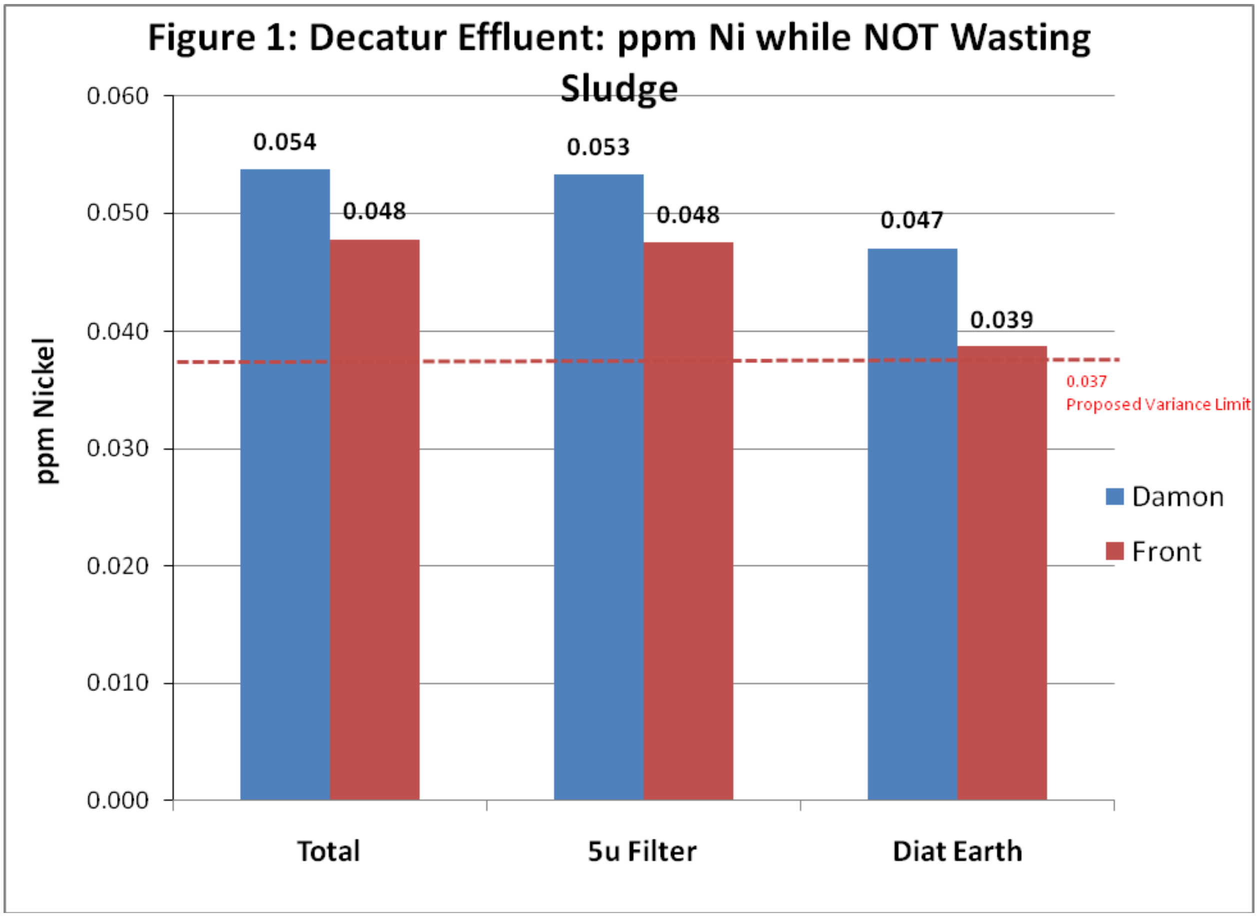
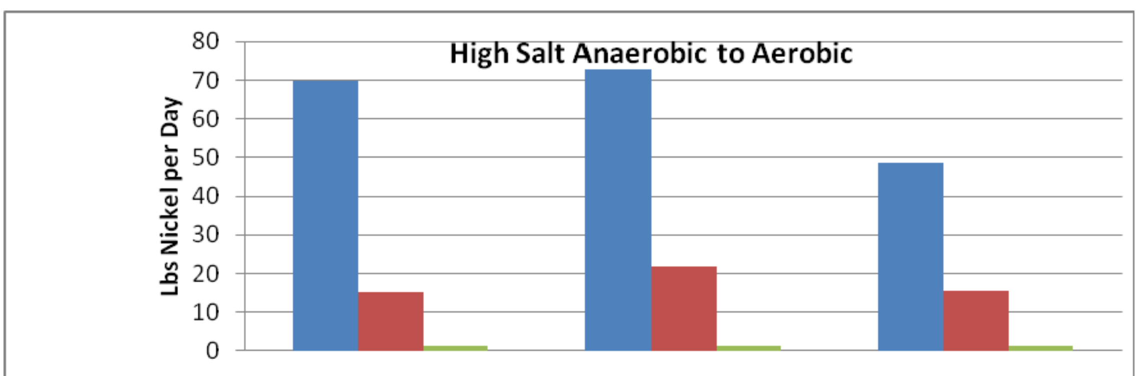



Figure 1: Reduction in DAF Nickel using 0.25 micron DE




| | 9/27/11 | 9/28/11 | 9/29/11 |
|---|---|---|---|
| Total | 70 | 73 | 49 |
| 5u Soluble | 15 | 22 | 16 |
| 0.45u Filtered | 1.4 | 1.5 | 1.4 |

Figure 2: Nickel carryover from Anaerobic digesters

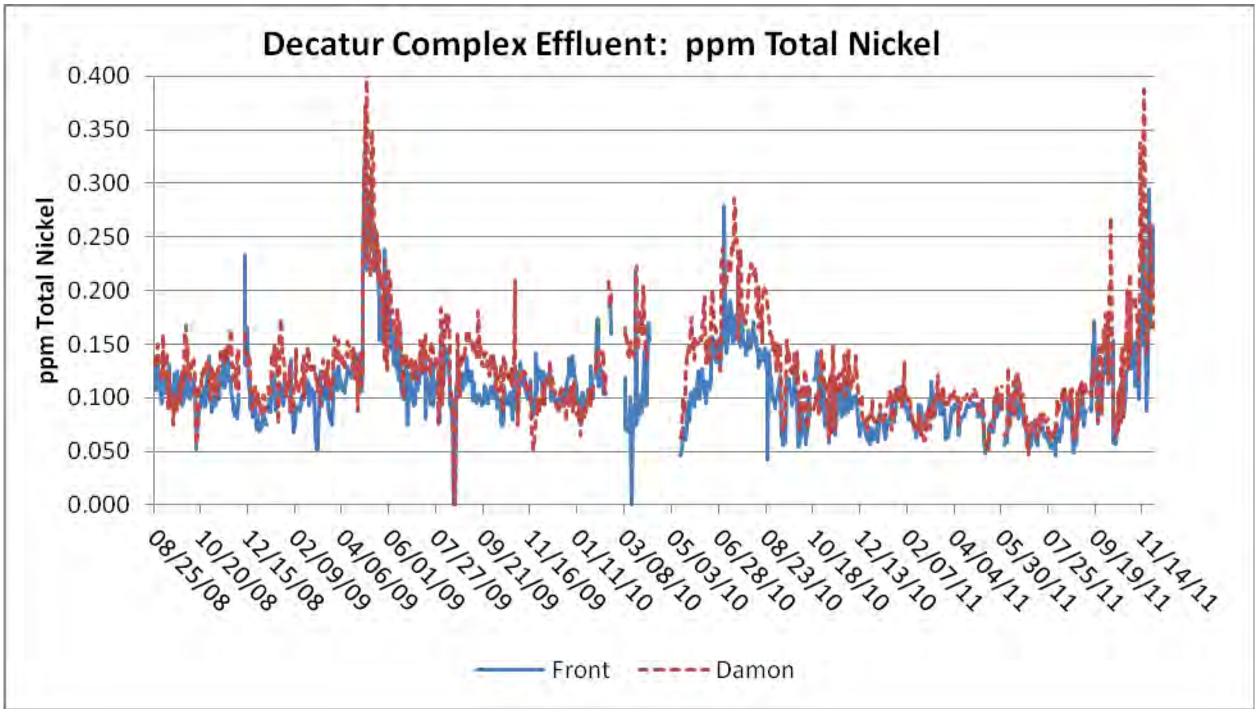



Figure 3: Decatur Complex Effluent- Total Nickel

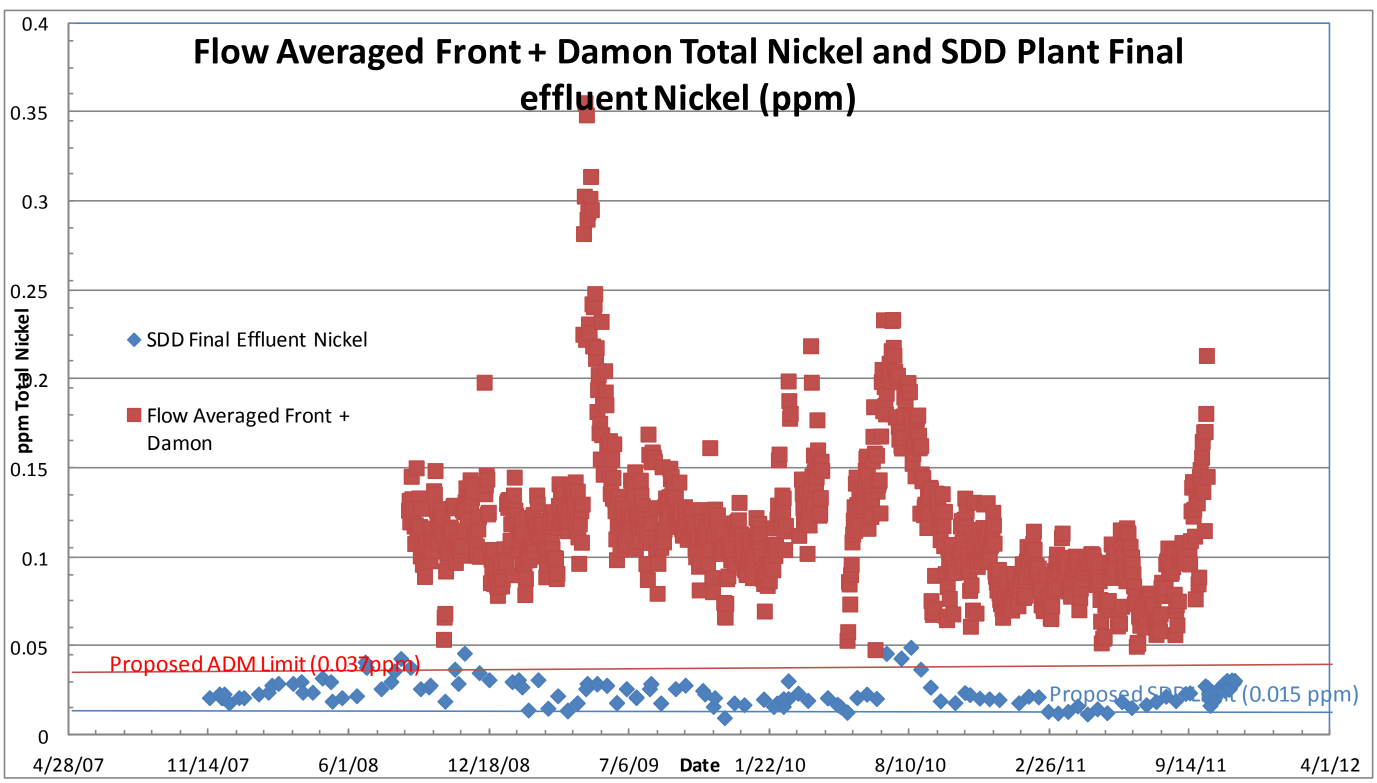



Figure 4: Decatur Complex Effluent- Flow-weighted total Nickel vs. SDD plant effluent total nickel.

As reported in the 2010 and July 2011 updates, ADM has, thus far, investigated 29 technologies that had the potential to control nickel at the Decatur Complex WWTP. (This was in addition to the work ADM has undertaken to reduce nickel within the individual wastewater streams.) As indicated in Table 3, these technologies can be segregated into six broad categories:

1. Nickel Proprietary Precipitation Process;
2. Nickel Chemical Precipitation;
3. Ion Exchange Resin;
4. Filtration;
5. pH Modification
6. Noncommercial, Experimental Technologies.

| Table 3: Summary of Technologies Reviewed by ADM Research (12/1/11) | | | | | |
|---|---|---|---|---|---|
| | Chemistry | Dosage | Nickel Reduction (%) | Current Status | Nitratox / Respirometer Testing* |
| **Nickel Proprietary Precipitation Process** | | | | | |
| 1. Ecovu | Activated Clay | 1%-3% w/w | 40-60% (from 200ppb) | Shelved. Unable to scale up | Not tested |
| 2. EP minerals | Acidic Clay | 4-8% w/w | 40 % (from 90ppb) | Shelved. High dosage | Not tested |
| 3. Crystal Clear Technologies | Chitosan Based | 5% w/w | 90% | Shelved. High dosage | Not tested |
| 4. Siemens / Plymouth Technologies | Proprietary | 2% w/w/ | 82% (from 100ppb) | Shelved. Company went out of business | Not tested |
| 5. GE Water | Metclear | 200 ppm | 64% | Shelved. Strong pH swing (acidification to pH 2, alkalination to 10 and neutralization) | Not tested |
| 6. KML | Not disclosed | Not disclosed | 58% | Shelved. Company not sharing samples. | Not tested |
| **Nickel Chemical Precipitation** | | | | | |
| 1. Chemtreat | Polymeric Di methyl Dithiocarbamate | 100 ppm + 50 ppm CaCl2 | 30% | Piloted. Nickel reduction seen to 60ppb. | Passed |
| 2. Hydrite | Polymeric Di methyl Dithiocarbamate | 20-50ppm | 60% | Piloted. Nickel reduction seen to 54 ppb | Passed |
| 3. Kroff | Polymeric Di methyl Dithiocarbamate | 100ppm | 41% | Piloted. Nickel reduction seen to 32 ppb | Passed |
| 4. Hychem DP4 | Di methyl Dithiocarbamate | 50ppm + pH 6.0 | 24% | Piloted. Nickel reduction seen to 40ppb | Passed |
| 5. Nalmet | Polymeric Di methyl Dithiocarbamate | 300ppm + pH swing | 30% | Shelved. Strong pH swing needed | Not tested |
| 6. Nalmet (Modified) | Polymeric Di methyl Dithiocarbamate | 100ppm | 48% | Piloted. Nickel reduction seen to 20ppb | Passed |
| 7. Hychem Poly DP | Polymeric Di methyl Dithiocarbamate | 200ppm | 52% | Piloted. Nickel reduction seen to 39 ppb | Failed. |

| | | | | | |
|---|---|---|---|---|---|
| 8. GE Betz DTC | Polymeric Di methyl Dithiocarbamate | 100 ppm | 40-60% | Not piloted. GE does not have commercial quantities available | Not tested |
| 9. Nalco DTC | Di methyl Dithiocarbamate | 100ppm | 60% | Piloted. Nickel reduction seen to 24ppb | Passed |
| | | | | | |
| **Ion Exchange Resin** | | | | | |
| 1. Purolite | Styrene Di vinyl benzene | 2% w/w | 20% | Not scaled. High regeneration costs | Not tested |
| 2. Dow | Styrene Di vinyl benzene | 4% w/w | 60% | Not scaled. Very high resin use. Caustic/ ethanol based regeneration. | Not tested |
| 3. Vivenano | Immobilized Ion Exchange beads | 5% | Not significant | Shelved. | Not tested |
| **Filtration** | | | | | |
| 1. Nalco-RO | Phosphate ppt+ Reverse Osmosis | 80% recovery | 95+% reduction | Shelved. Uncertainty about treating RO concentrate stream. Capex [redacted] | Not tested |
| 2. Filtration Energy Solutions | Low pressure Reverse Osmosis | 30% recovery | 95% reduction | Shelved. Uncertainty about treating RO concentrate stream. Capex [redacted] | Not tested |
| 3. Sand filtration (Procorp) | Sand filter | Not disclosed | 20% reduction | Shelved. Insufficient efficacy | Not tested |
| **Other Approaches** | | | | | |
| Captive Deionization | Carbon Aerogels | Not tested | Not tested | Company went out of business. Also technology picks up all ions | Not tested |
| Electrocoagulation | Electrochemical | Not disclosed | Higher Ni seen | Shelved. | Not tested |
| Salt Precipitation | Ferric Chloride | 100ppm | 40% | Unscalable due to higher chloride in our wastewater | Not tested |
| Bioactive Peptides | Protein based | --- | Not significant | Lab scale technique only. | Not tested |
| Advanced Oxidation | Hydrogen Peroxide and Ozone | 5% w/w + pH adjustmen t | 20% | High pH required. Chemical usage significant | Not tested |
| Metallothionein | Protein based | Bench scale | Not tested | Nickel competes for binding with other divalent | Not tested |
| Acidification/ Alkalination based precipitation | pH Swing | Bench Scale | 30% | pH swing to 10 followed by to 2.0 and back to 7 is required. Very high chemical usage | Not tested |
| High pH precitpitation | pH >11.0 | Bench Scale | 100% for Polyol waste | High pH precipitation for inorganic nickel from polyol waste stream. | Not required |

*ADM has been working with Riverbend Laboratories in St. Charles, Missouri, to perform respirometer and nitratox testing on various chemistries using MLSS from the District. Such testing is necessary to determine whether the treated effluent is compatible with the District's treatment processes.

ADM continues to operate its pilot plant for chemical sequestration of nickel as needed. We are also planning to start a new pilot reactor at the High Salt equalization tank (HS EQ Tank) to test polymeric treatment of nickel ahead of the anaerobic digesters. Figures 5&6 are pictures of the pilot plant. There are 4 separate mixing tanks of 100 gallons each, using the Decatur plant DAF effluent as feed, with the respective chemistries at various dosages (10-200ppm) and a combination of residence times (1-4 hrs). HS EQ Tank is running a single 100 gallon reactor with one chemistry. One of the setups was modified to allow for a change in pH and testing of the chemistry at a different pH is scheduled for December 2011. The results from the pilot plant were previously reported on. Since Fall 2011, the chemicals being investigated at the pilot plant have been narrowed to those from Nalco and Hydrite.

**Figure 5: ADM Decatur Nickel Removal pilot plant (5/13/2011). Four 100 gal reactors.**

**Figure 6: High Salt EQ Tank pilot plant. One 100 gallon reactor.**

**Pilot testing protocol:**

- 4 mixing tanks; initially 100 gallons liquid level in each in pilot plant
- 1 mixing tank; 100 gallons liquid level
- Two different products to be tested in each tank (currently, Nalmet, Hydrite) at the pilot plant. One chemistry at the HS EQ Tank.
- Feed flows, chemical dosages and agitation can be optimized independently in each tank.
- Ability to adjust residence time in each tank to 0.5 to 8 hrs, through the adjustment of feed flow and tank liquid level
- Ni Precipitant is added in-line in the influent flow and further mixed/reacted in tank.
- Precipitant dosages planned: 10-200 ppm
- Piloting will continue as needed.
- Treated samples from each tank will be filtered through diatomaceous earth (DE) in the lab and submitted to ADM's lab for ICP analysis.
- We expect to use flocculants and coagulants after treatment with metal precipitant.
- pH is monitored in the feed tank but will not be adjusted initially. One tank has been modified for pH adjustment.
- The toxicity studies (by Riverbend Laboratories) on treated wastewater provided the desired Ni removal at current and peak Influent Ni levels.
- Secondary treatment such as DE/Clarifier/Sand filter will be implemented next month.

As required by the variance, a summary of the various control strategies is presented in Appendix B.

*"By July 1, 2011 the District must complete the following tasks:*

*i. Compile various control strategies based on one or more of the feasible technologies. Develop flow diagrams depicting removal options, pros and cons, capital expenditures, and operating costs.*

*ii. Present findings to ADM division managers"*

- **ADM / SDD Variance, p. 41**.

ADM met with the SDD and IEPA on July 8, 2011 and provided them with a copy of the report detailing the progress and ADM's compliance efforts.

# 2 Deliverables

## 2.1 Nickel- Proprietary Precipitation Process

As reported previously ADM is no longer pursuing the eight technologies we investigated in this area.

## 2.2 Nickel- Chemical Precipitation Process Using Carbamates or Organic Sulfides

### 2.2.1 Chemtreat

A 33% reduction resulted with P8007L from Chemtreat. No any additional work beyond what was reported in July 2011.

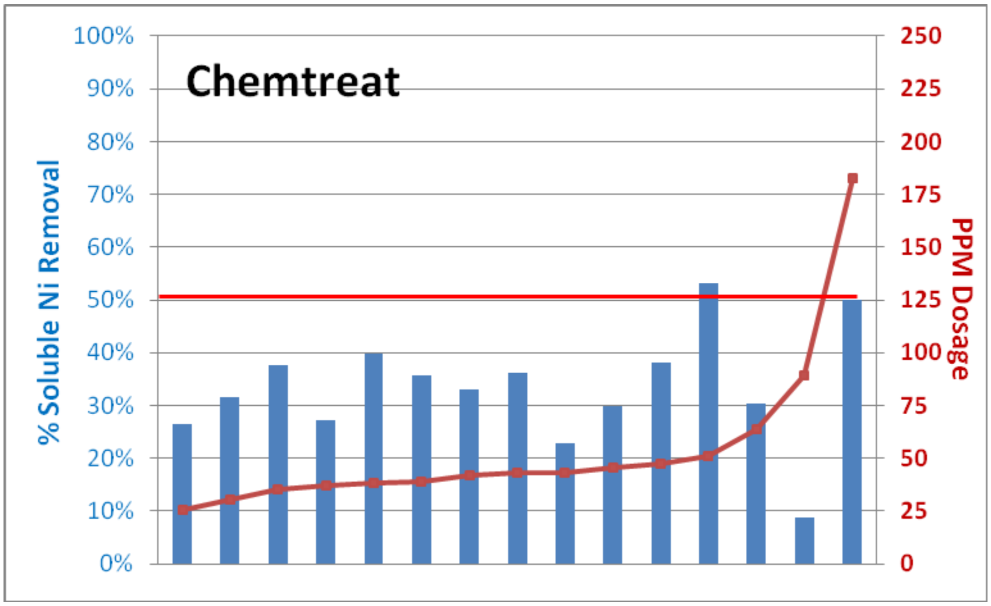



Figure 7: Nickel reduction using Chemtreat P8007L

### *2.2.1.1 Technical Feasibility*

Commercially available product. No problems are expected.

### *2.2.1.2 Capital and Operation Costs*

Chemtreat estimates costs for P8007L at about [redacted]$/lb.

### *2.2.1.3 Reliability*

ADM has reproduced some of Chemtreat's work internally and plan to conduct a pilot trial with their material. To date, Chemtreat P8007L has not been piloted.

## 2.2.2 Hydrite

Hydrite 1740 is currently being tested in the Pilot plant. A 41% average reduction in soluble nickel has been seen using the 1740 as seen in Figures 8 and 9.

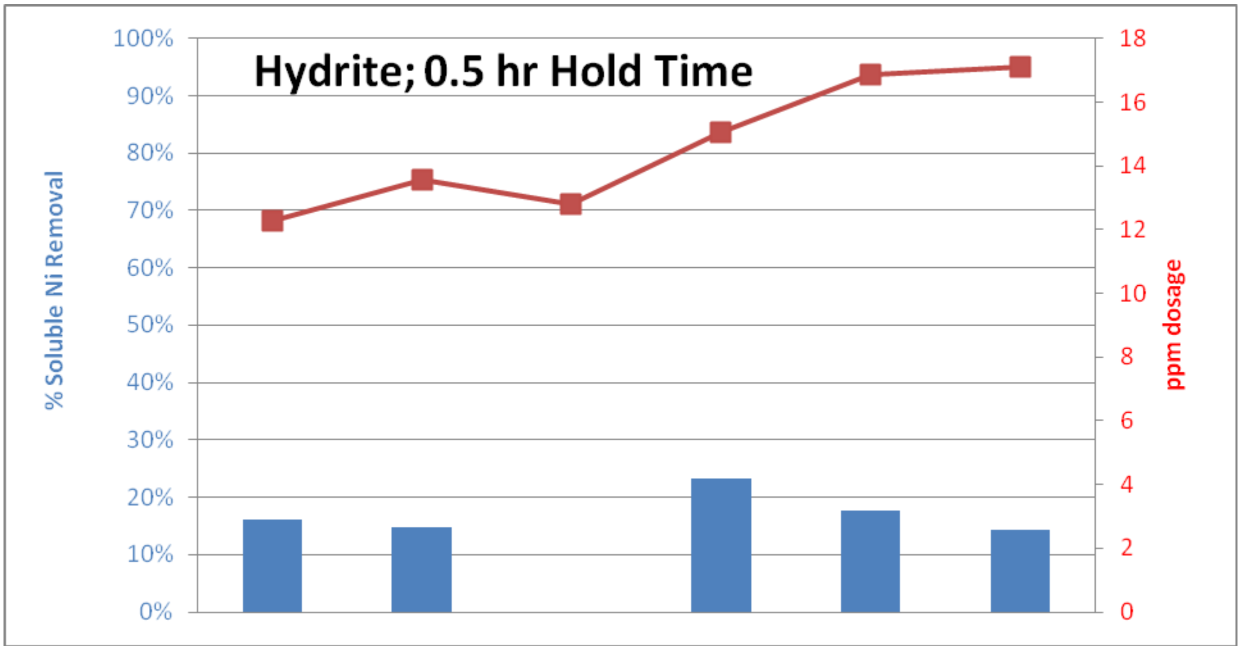



**Figure 8: Nickel reduction with 0.5 hr hold time at DAF Pilot plant using Poly DTC from Hydrite.**

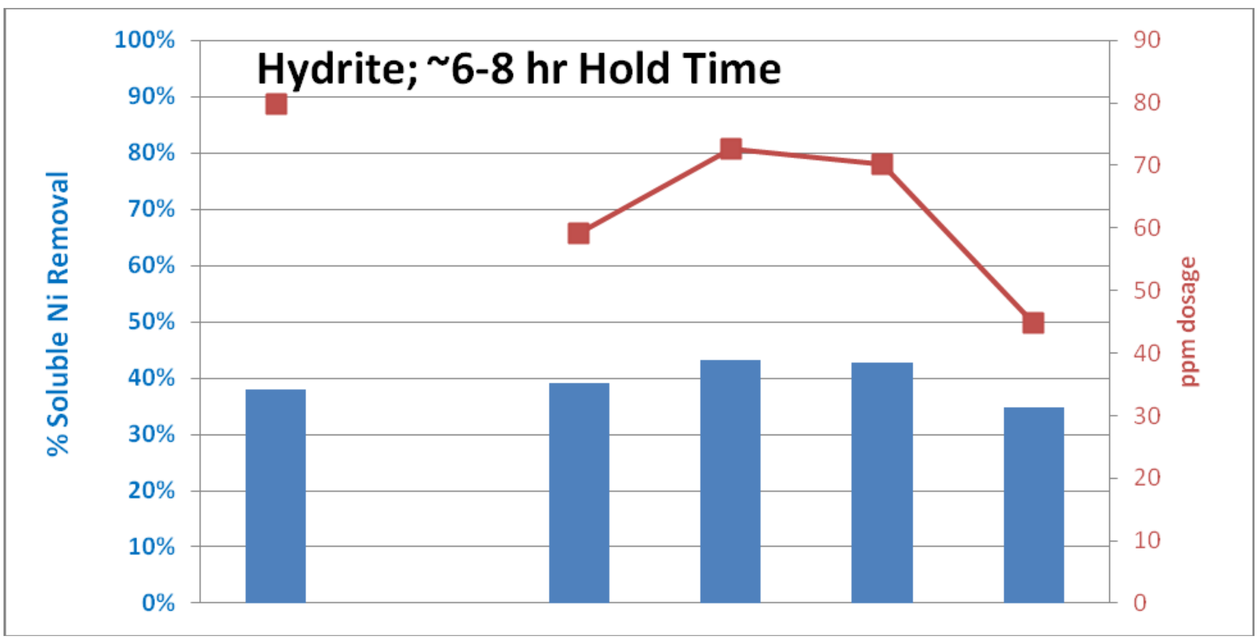



**Figure 9: Nickel reduction with 8 hr hold time at DAF Pilot plant using Poly DTC from Hydrite.**

#### *2.2.2.1 Technical Feasibility*

The product is approved for use in waste water systems. Nitratox and Respirometer testing were performed on the waste water at two different dosages of Hydrite (20ppm and 200ppm) and no adverse effects were seen at either dosage.

#### *2.2.2.2 Capital and Operation Costs*

Hydrite estimates costs at about $[redacted] per lb.

#### *2.2.2.3 Reliability*

Good reproducibility was seen with different feed samples.

### 2.2.3 Kroff 9011

Kroff 9011 is being trialed at the Pilot plant. About a 41% average reduction in soluble nickel was seen using the Kroff 9011 as seen in Figure 10 and 11.

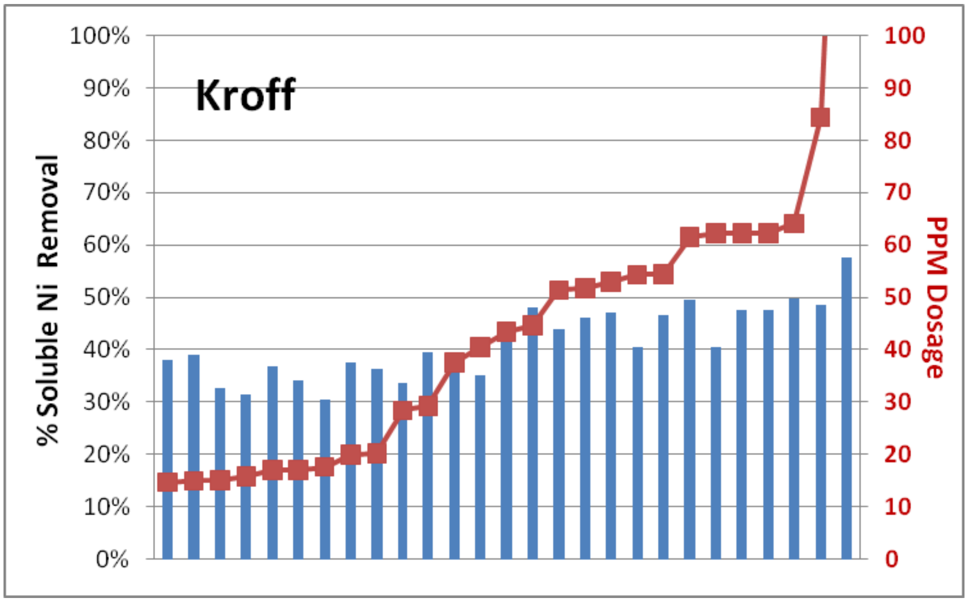



Figure 10: Nickel removal (left scale) and ppm soluble nickel (right scale) with Kroff 9011

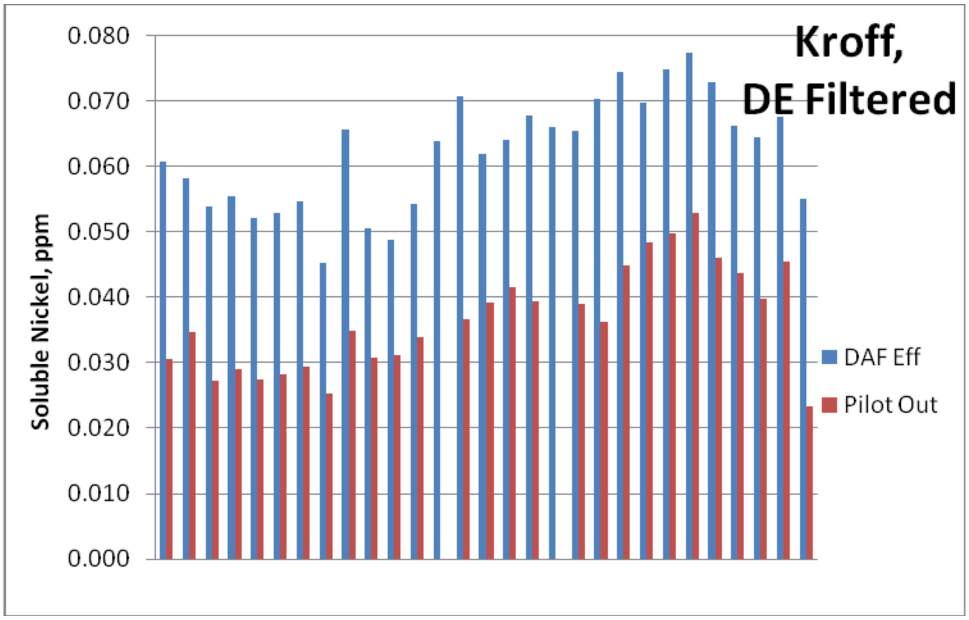



Figure 11: Effect of DE filtration on reduction in soluble nickel after application of 9011

#### *2.2.3.1 Technical Feasibility*
No pH adjustment is required. Product is approved for use in waste water systems.

#### *2.2.3.2 Capital and Operation Costs*
Kroff estimates costs at about $[redacted] per lb.

#### *2.2.3.3 Reliability*
There has been good reproducibility with different feed samples. Nitratox and Respirometer testing were performed on the waste water samples at two different dosages (20ppm and 200ppm) and no adverse effects were seen at either dosage.

### 2.2.4 Hychem Polymeric DP4
Hychem Poly DP4 is a polymeric dimethyl dithiocarbamate and was one the first chemistries found that resulted in a nickel reduction. Hychem DP4 is currently being run in the pilot plant. Since the tests are running at “as-is” pH (~8.0) and about a 38% reduction in soluble nickel is being achieved.

#### *2.2.4.1 Technical Feasibility*
ADM is not further investigating Hychem poly DP4 at present, as the levels of nickel reduction seen were not significant. Also when we performend respirometer and nitratox studies on the Hychem Poly DP4 treated waste water samples using the SDD MLSS , the samples exhibited nitratox toxicity and less reduction in soluble ammonia levels.

#### *2.2.4.2 Capital and Operation Costs*
Hychem poly DP4 is estimated to cost about $[redacted] per lb.

#### *2.2.4.3 Reliability*
There has been good reproducibility with different feed samples, and ADM has tested this chemical in-house the longest. In addition to the “as-is” testing, this chemistry will be tested at pH 6.0 in the pilot trials. Nitratox and Respirometer testing were performed on the treated waste water at two different dosages of DP4 (20ppm and 200ppm) and no adverse effects were seen at either dosage.

### 2.2.5 Nalmet (Nalco)
As reported in December 23, 2010, work has been done with a new chemistry from NALCO. This chemistry has been piloted at the pilot plant and has resulted in a 48% reduction in soluble Nickel as found in Figures 12 and 13. We also tested Alum and Ferric based coagulants from Hychem following addition of the Nalmet polymer to the waste water and binding of nickel to remove the flocs with a 0.2um filter. We found that Alum based flocculants performed better than Ferric based flocculants (Table 4). This approach will be scaled up when we run pilot equipment using the Nalmet chemistry.

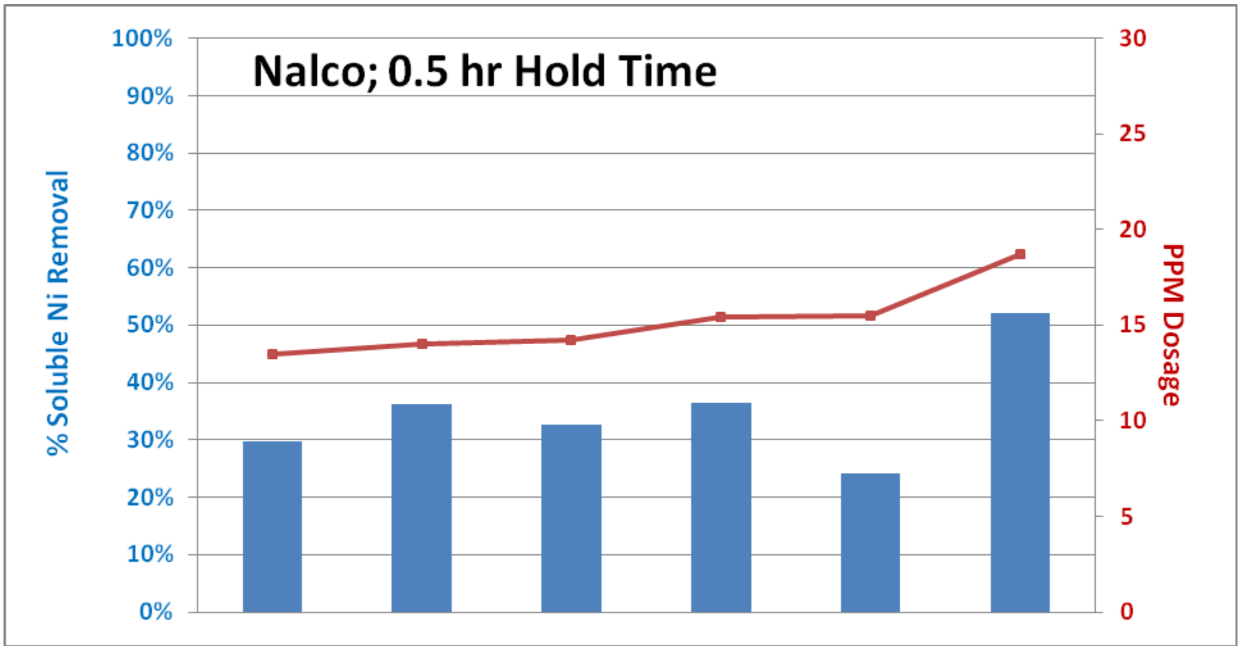



Figure 12: Nickel reduction with 0.5 hr hold time at DAF Pilot plant using Poly DTC from Nalco.

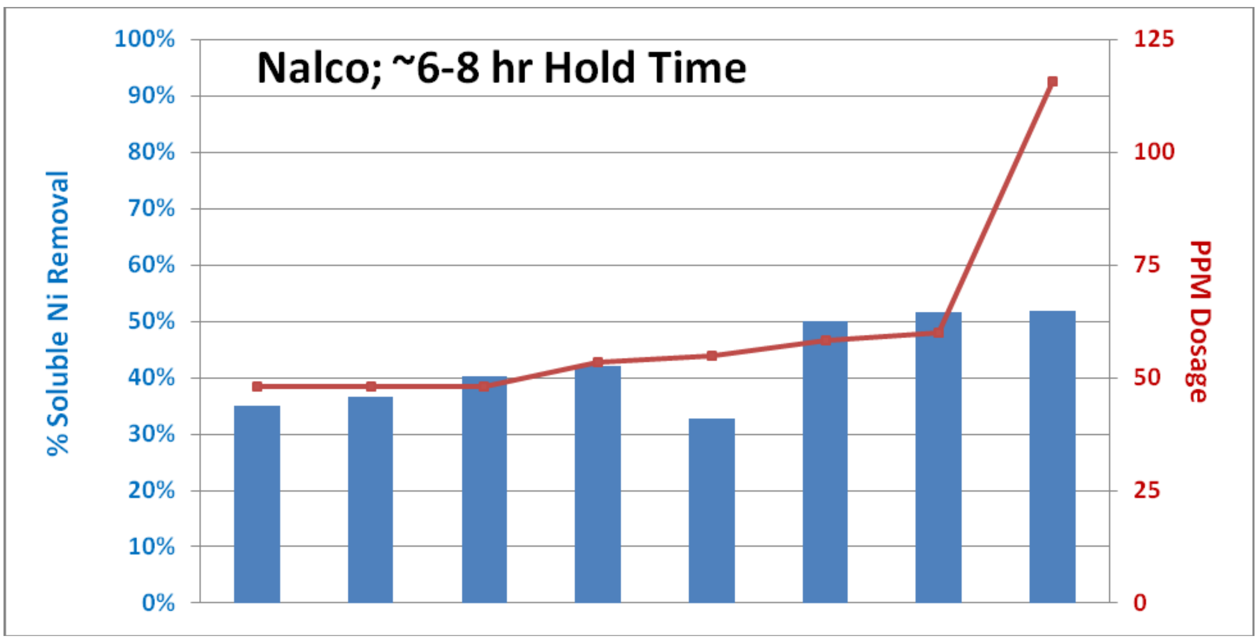



Figure 13: Nickel reduction with 0.5 hr hold time at DAF Pilot plant using Poly DTC from Nalco.

Table 4. Ni removal with Nalmet followed by Hychem 420 Coagulant & 308 Flocculent

| | Total Ni (mg/kg) | Soluble Ni (mg/kg) | Total Ni Reduction (%) |
|---|---|---|---|
| DAF Effluent Feed | 0.083 | 0.071 | - - - |
| Effluent 0.2 micron | 0.051 | 0.051 | 38.6 |
| HN-18 Test | 0.062 | 0.054 | 25.3 |

#### *2.2.5.1 Technical Feasibility*
Nalmet is not a commercial product, and Nalco's plans to manufacture it commercially are uncertain. No pH adjustment is needed and a very short mixing time is possible. The chemistry does produce a very small size floc, and it is expected to be challenging to remove the floc subsequent to nickel binding.

#### *2.2.5.2 Capital and Operation Costs*
Costs are estimated at $[redacted] per lb (N1689/N7768).

#### *2.2.5.3 Reliability*
There has been good reproducibility with different feed samples. Nitratox and Respirometer testing were performed on the treated waste water samples at two different dosages of Nalmet (20ppm and 200ppm) and no adverse affects were seen at either dosages.

## 2.3 Nickel- Ion Exchange Resin

### 2.3.1 Purolite Resin
As reported in the July 2011, ADM is discontinuing further investigation of a brand new resin system for the entire complex. The efforts on ion exchange will focus on small used resin systems located at strategic inorganic nickel sites (such as the Corn Plant or the Polyols plant).

### 2.3.2 Corn Plant Used IX system
As previously disclosed, ADM has been working to install a used ion exchange resin bed system to capture nickel leaching from the sorbitol process catalyst. This system has been running manually for the past 6 weeks. Thus far, about 5 lbs of nickel have been removed from the treated stream and no nickel has been detected in the efluent. This is shown in Figure 14. We are using 105 cu ft of resin and expect a nickel binding capacity of about 3.4 lbs per cubic ft.

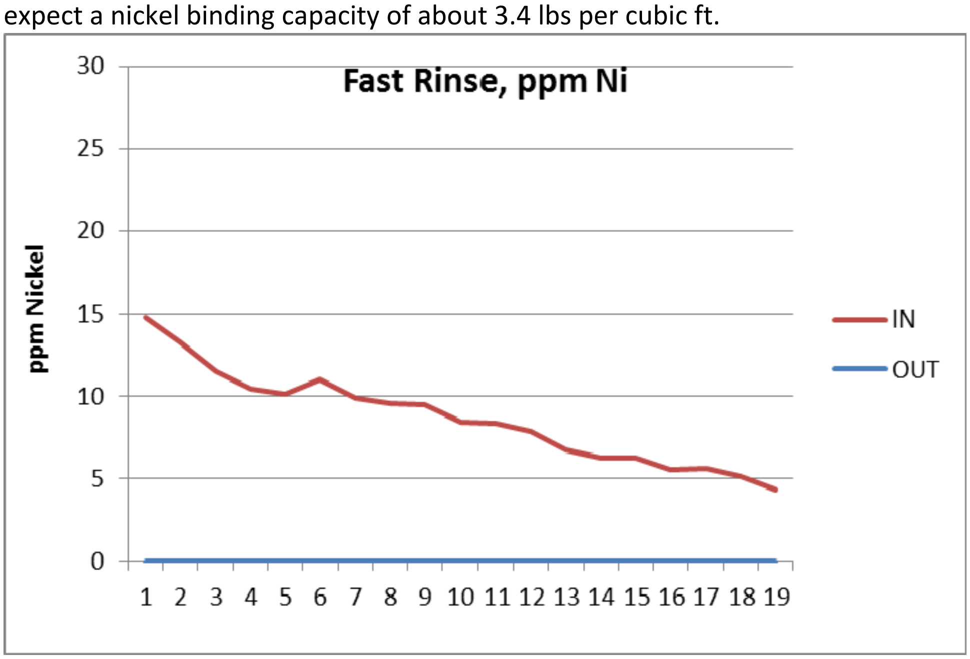



**Figure 14: Used ion exchange resin treating material leaving the sorbitol process**

##### *2.3.2.1 Technical Feasibility*

A full scale system has been installed to capture bulk of the leaching nickel from the sorbitol catalyst.

##### *2.3.2.2 Capital and Operating costs.*

About $[redacted] was spent to install the system and ongoing maintenance and operation costs are expected.

## 2.4 Nickel and Zinc- Soybean Process Stream Alternative.

Alternatives will be continued to be evaluated for this stream. There has been interest in several companies for purchasing this particular stream for a de-nitrfication application in municipal waste treatment plants in the Eastern United States.

## 2.5 Nickel and Zinc- BioProducts Process Stream Alternative

There have no updates from the report of December 23, 2010.

## 2.6 Nickel and Zinc- WWTP Sludge Removal System

This process has been investigated and there are no updates from the report of December 23, 2010.

## 2.7 Nickel and Zinc- Reverse Osmosis

There have been no updates from the report of July 8, 2011.

### 2.7.1 Technical Feasibility

We have seen very poor recovery and do not expect this process to be scaled up.

### 2.7.2 Capital and Operating costs.

The estimated capital for a UF/RO/Thermal evaporation based on a ADM's 6 million gallon per day stream is [redacted]. However, this capital expense was estimated based on 85% recovery in UF and 75% recovery in RO. As discussed here, the best cases of UF recovery achieved are 60-70% and RO only about 30% due to scaling.

## 2.8 Nickel and Zinc- Sludge (WWTP organism cell wall rupture)

There are no updates from the report of December 23, 2010.

### 2.9 Nickel and Zinc- Sludge Sales

There are no updates from the report of December 23, 2010.

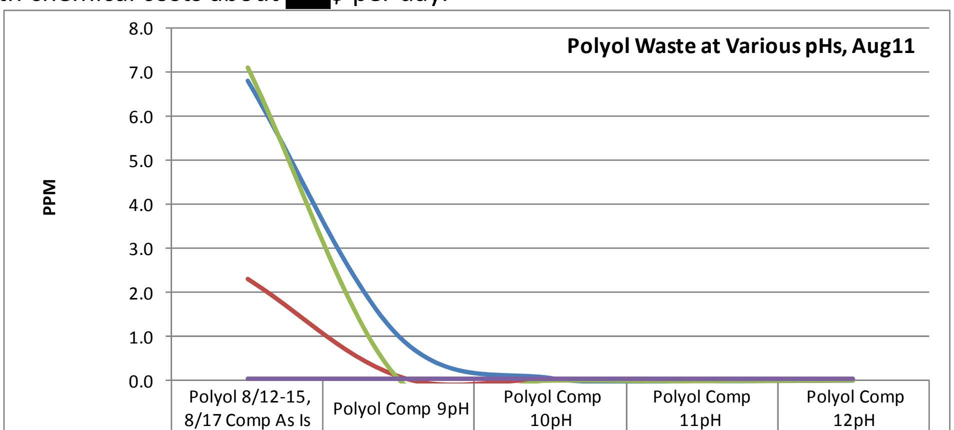
# 3 Review Ceased for Technologies

Since the July 2011 update, we have ceased trials with polymeric DTC from Kroff 9011 and Hychem DP4. We continue to evaluate the options for scale and will be reporting as progress is made on the same.

# 4 Polyol waste stream treatment

We have identified our polyol ix waste stream (between 16-22% of total nickel load) as a significant contributor of inorganic nickel due to corrosion of our distillation columns. Initial work using high pH precipitation has shown almost a complete removal of soluble nickel.

Initial work suggests a pH modification would eliminate all soluble nickel from the IX regen streams with chemical costs about [redacted]$ per day.




| | Polyol 8/12-15, 8/17 Comp As Is | Polyol Comp 9pH | Polyol Comp 10pH | Polyol Comp 11pH | Polyol Comp 12pH |
|---|---|---|---|---|---|
| Nickel | 6.81 | 1.01 | 0.063 | 0.000 | 0.007 |
| Chromium | 2.31 | 0.083 | 0.025 | 0.006 | 0.014 |
| Iron | 7.10 | 0.034 | 0.012 | 0.000 | 0.014 |
| Moly | 0.052 | 0.049 | 0.047 | 0.047 | 0.052 |

Figure 15: Effect of pH on precipitation on Polyol ion exchange regeneration streams.

Table 5: High pH precipitation of Polyol ion exchange regeneration streams

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Adjust to 10pH: | | |
| 2.5 | %NaOH, w/w | Polyol Flows: | lbs / day | | lbs 50% NaOH / day | | $ / day |
| 90 | sample, ml | 8/12/11 | 61,400 | | 3,014 | | [redacted] |
| 10.45 | g NaOH to 9pH | 8/13/11 | 65,400 | | 3,210 | | [redacted] |
| 10.6 | g NaOH to 10pH | 8/14/11 | 60,730 | | 2,981 | | [redacted] |
| 10.8 | g NaOH to 11pH | 8/15/11 | 119,800 | | 5,880 | | [redacted] |
| 16.4 | g NaOH to 12.2pH | 8/17/11 | 27,940 | | 1,371 | | [redacted] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $[redacted] | 50% Caust / lb | | | | | | |
| | | | | | | | |
| **1.6** | **Starting pH** | | | | | | |

The Process Development group at ADM Bioproducts has investigated using gypsum (Table 7) as a filter media and seen nickel reductions over using a 0.1um Filter (Table 6).

| **Table 6: 0.1 micron Buchner Filtration of Polyol IX regeneration stream** | | | |
|---|---|---|---|
| Sample (ppm) | Ni | Zn | P |
| Waste Water Feed | 860.32 | 3.76 | 0.818 |
| Waste water/NaOH solution | 658.897 | 2.90 | 0.856 |
| Treated and filtered waste water | 0.300 | 0.015 | 0.639 |

**Note**: Feed was a composite of the discharge from the acid-in and slow rinse cycle in a proportion that is representative of the volume of water used in each cycle. Precipitate was passed through a Buchner filter with a 0.1um filter.

| **Table 7: Gypsum Filtration of Polyol IX regeneration stream** | | | | |
|---|---|---|---|---|
| Sample Name | Ni | Zn | P | Cr |
| | mg/kg | mg/kg | mg/kg | mg/kg |
| Waste water/NaOH solution | 689.0 | 2.66 | 2.18 | 245.1 |
| Treated and filtered waste water | 81.94 | 0.705 | 18.40 | 23.32 |

**Note**: Feed was a composite of the discharge from the acid-in and slow rinse cycle in a proportion that is representative of the volume of water used in each cycle. Precipitated feed was fed to a Buchner funnel with CaSO4 as filter media.

## 5 Appendix A Pilot Plant Trials Update

ADM is piloting equipment identified in our July 2011 update. A summary of the present status of the trials is included below.

1. **Alar Corp**. – Removal using diatomaceous earth and RVF.
2. **FRC Systems International, LLC** – Removal of Ni precipitate using DAF pilot.
3. **GE Power & Water** – Removal using Entrapped Air Flotation (EAF) Pilot.
4. **Kroff Engineering** – Removal using One Pass Microfiltration.
5. **Krofta Chemical Company, Inc**. – Removal using Dissolved Air Floatation (DAF) and Sandfloat Pilot.
6. **Nalco** – Removal using Lamella Gravity Settler and Dynasand.

In early November 2011, tests were completed at ALAR Engineering (Mokena, IL), to screen use of Rotary Vacuum Filter (RVF) as separation method. During a two-day test, Hychem and the following day, Nalco, separately tested coagulant and flocculent chemistry for removing precipitated Nickel from ADM DAF effluent. Results are presented in Tables 8 & 9 and Figures 16 & 17.

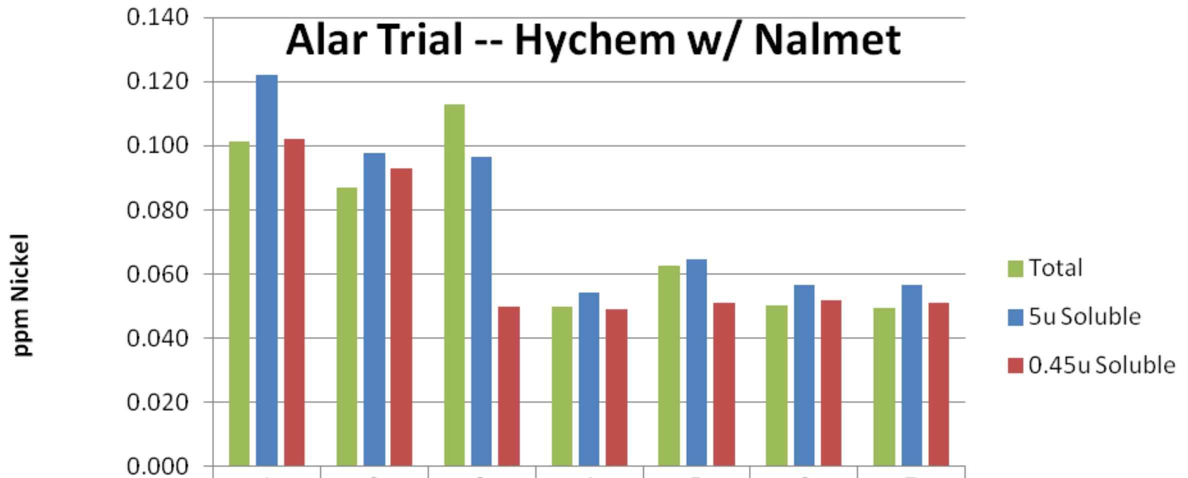
TABLE 8: Test Results of a 100-gallon batch, RVF Filtration at ALAR Engineering. Starting Feed 0.129 ppm Nickel. Metal precipitant: Nalco TX15029SQ, 50ppm, 30 minute residence time.

| | Nickel Reduction (%) | Filtrate Ni (ppm) | Coag (ppm) | Floc1 (ppm) | Floc2 (ppm) | Flux (Gal/Hr/ft2) | D.E. |
|---|---|---|---|---|---|---|---|
| Hychem, Test 1 | 55.0 | .058 | 300 | 0.125 | 0 | 36 | FW-20 |
| Hychem, Test 2 | 55.8 | .057 | 200 | 0.125 | 0 | 43 | FW-20 |
| Nalco, Test 1 | 50.4 | .064 | 0 | 0.5 | 1.0 | 50 | FW-20 |
| Nalco, Test 2 | 51.2 | .063 | 0 | 0.5 | 1.0 | 65 | FW-40 |

| | **Table 9: Bench scale testing of Nalmet with RVF at Alar Engineering using Nalco Flocculants (8133/8131).** | | | |
|---|---|---|---|---|
| | | | | |
| | **Sample Volume : 1L** | | | |
| Sample # | Treatment | DE Filtrate | Ni | |
| | | Turbidity | Soluble | Total |
| | | NTU | mg/kg | mg/kg |
| 0 | | | 0.092 | 0.091 |
| 1 | 50 ppm TX15029SQ (30 min) + 130 ppm Nalco 2 (1 min)+Filtration through 0.9 um (FW20) DE filter | 0.5 | 0.049 | 0.061 |
| 2 | 50 ppm TX15029SQ (30 min) + 120 ppm 8133 (1 min)+Filtration through 0.9 um (FW20) DE filter | 0.3 | 0.042 | 0.052 |
| 3 | 50 ppm TX15029SQ (30 min) + 120 ppm 8131 (1 min)+Filtration through 0.9 um (FW20) DE filter | 0.2 | 0.042 | 0.053 |
| 4 | 50 ppm TX15029SQ (30 min) + 130 ppm Nalco 2 (1 min)+Filtration through 0.5 um (FA 06) DE filter | 0.3 | 0.035 | 0.053 |
| 5 | 50 ppm TX15029SQ (30 min) + 120 ppm 8133 (1 min)+Filtration through 0.5 um (FA 06) DE filter | 0.3 | 0.050 | 0.041 |

| | | | | |
|---|---|---|---|---|
| 1 | 50 ppm TX15029SQ (30 min) + 120 ppm 8131 (1 min)+Filtration through 0.5 um (FA 06) DE filter | 0.3 | 0.040 | 0.046 |
| 7 | 120 ppm 8133 (1 min)+50 ppm TX15029SQ (30 min) + Filtration through 0.5 um (FA 06) DE filter | 0.3 | 0.041 | 0.048 |
| 8 | 120 ppm 8131 (1 min)+50 ppm TX15029SQ (30 min) + Filtration through 0.5 um (FA 06) DE filter | 0.3 | 0.047 | 0.050 |

Nickel reductions with RVF equipment have potential as full-scale option and planned testing at Decatur are scheduled of January 2012.




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Total | 0.102 | 0.087 | 0.113 | 0.050 | 0.063 | 0.050 | 0.050 |
| 5u Soluble | 0.122 | 0.098 | 0.097 | 0.054 | 0.065 | 0.057 | 0.057 |
| 0.45u Soluble | 0.102 | 0.093 | 0.050 | 0.049 | 0.051 | 0.052 | 0.051 |

**Figure 16: Rotary Vacuum Filtration of Polymeric DTC (Nalco) with Flocculant (Hychem)**

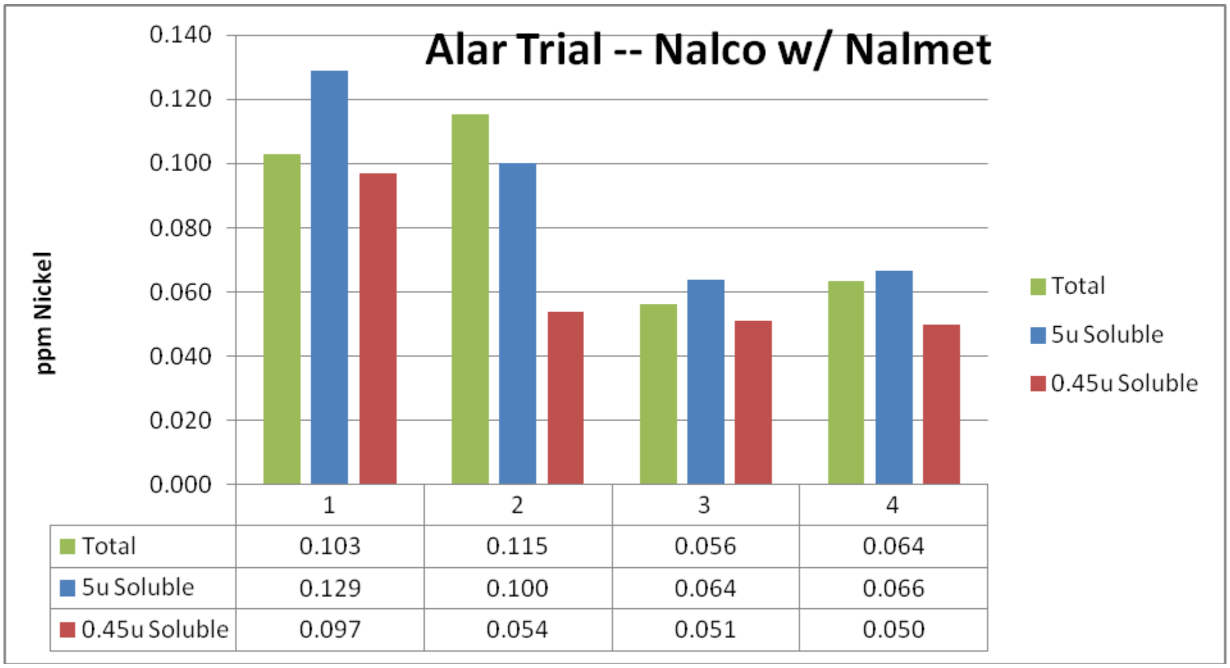



**Figure 17: Rotary Vacuum Filtration of Polymeric DTC (Nalco) with Flocculant (Nalco)**

Equipment currently at ADM Decatur Pilot plant:

1. Krofta/Ecolab DAF and Sandfloat pilot.
2. Kroff one-pass microfiltration.

Krofta/Ecolab equipment is ready to begin testing. We have successfully operated equipment at 25 GPM and everything appears to be functional.

Kroff equipment has been tested and filtration rate dramatically slows, filtration flux estimate: 3.2-3.8 Gal/Hr/ft2. We have been experiencing technical problems with filtration and are working with the vendor to address them.

FRC Systems International, LLC will be shipping unit to Decatur the week of 05-Dec.

**Figure 18: Krofta Sand Filter at ADM pilot plat**

**Figure 19: Kroff One pass MF at ADM Pilot plant**

Figure 20: Alar RVF Filtration with FW40 precoat filteraid

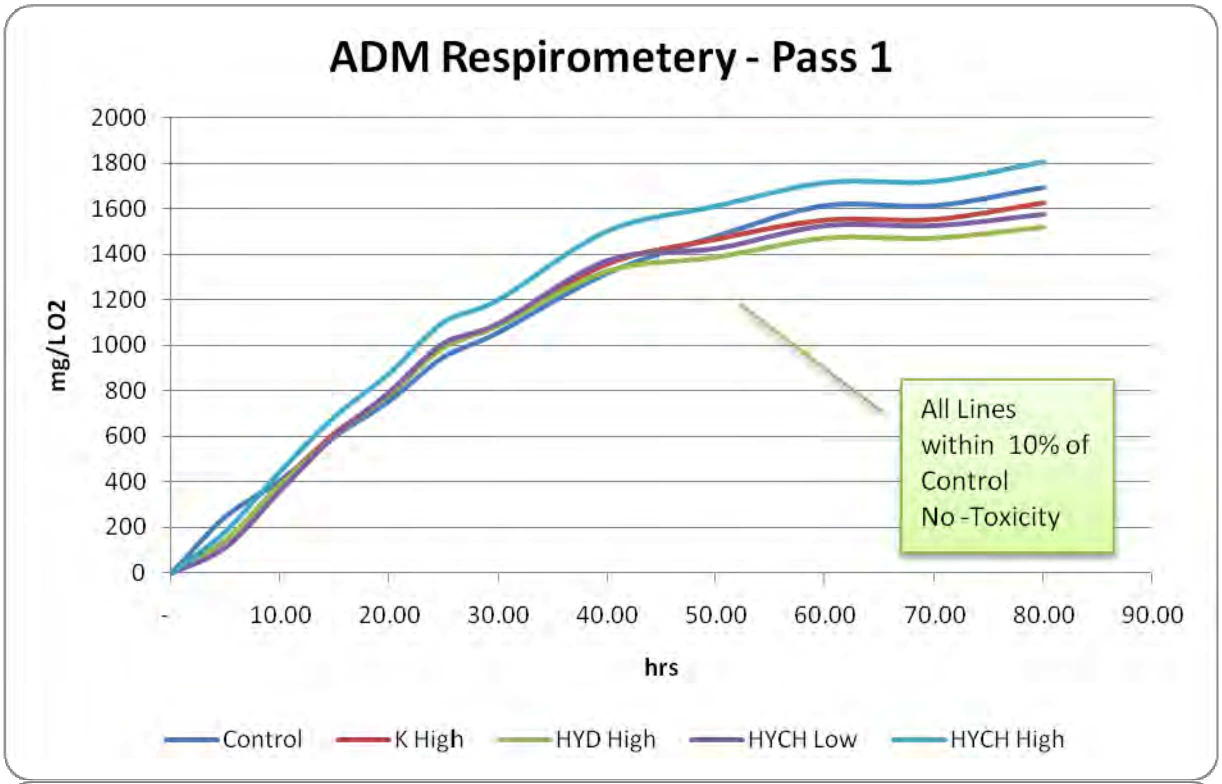
## 6 Appendix B Respirometer and Nitratox Testing

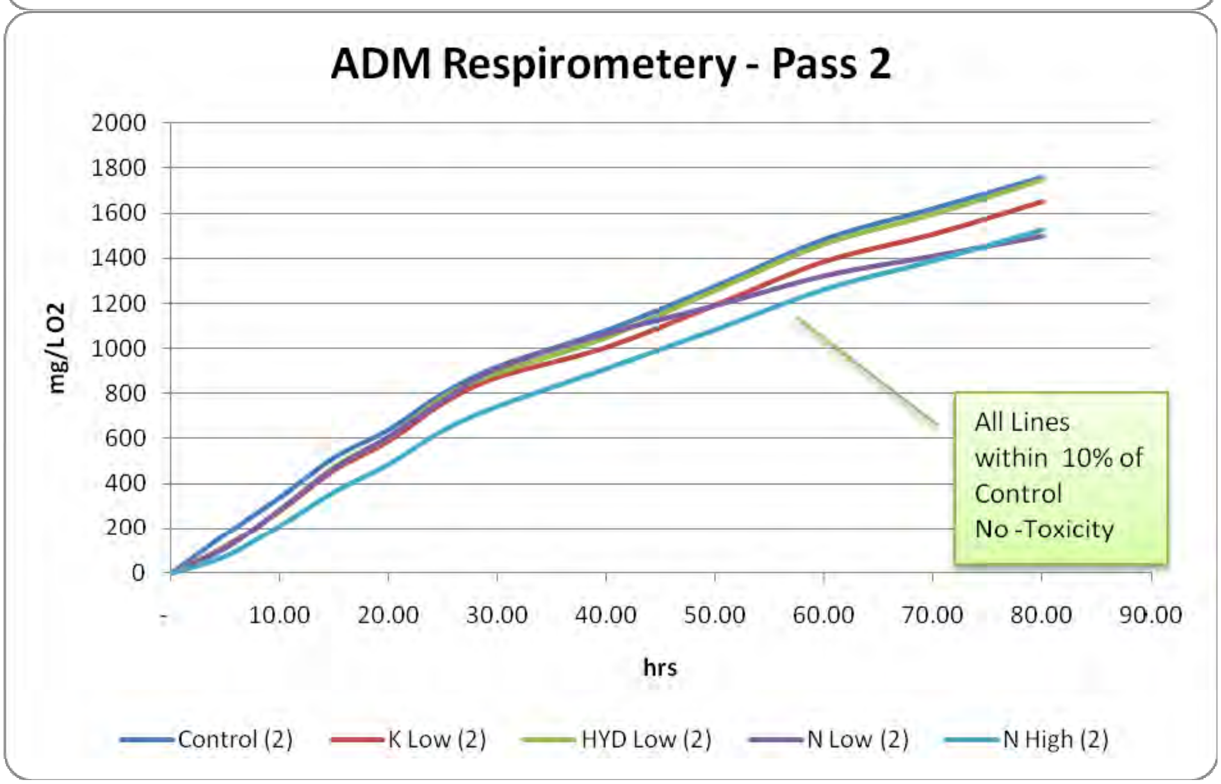
Results from Respirometer and Nitratox testing of Decatur Sanitary Districts MLSS using nickel reduction chemistries piloted at ADM.

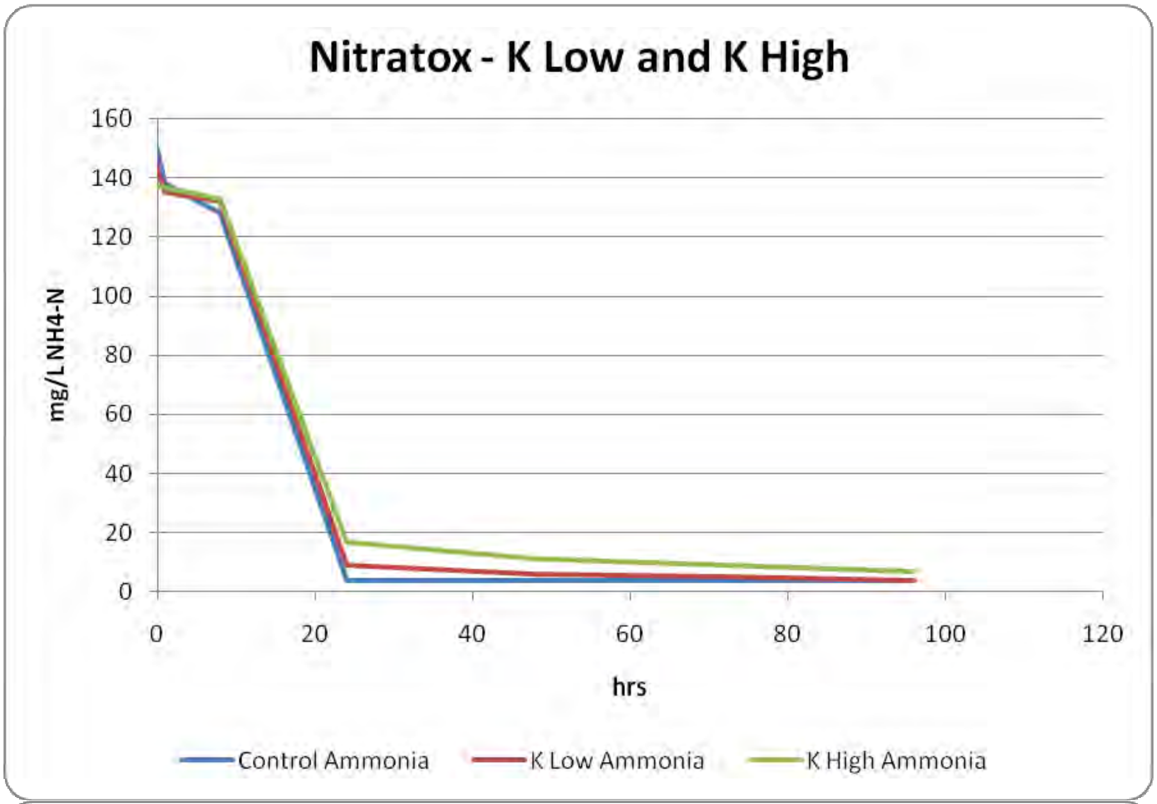
Riverbend Laboratories performed respirometer and Nitratox testing of the four chemistries currently being testing using SDD's MLSS. The chemistries were dosed at ~20ppm and ~200ppm and diluted 50:50 with fresh DAF to simulate a scenario envisioned by the Decatur Sanitary District.

Table 7: Pilot plant results for Samples used for Nitratox and Respirometer testing

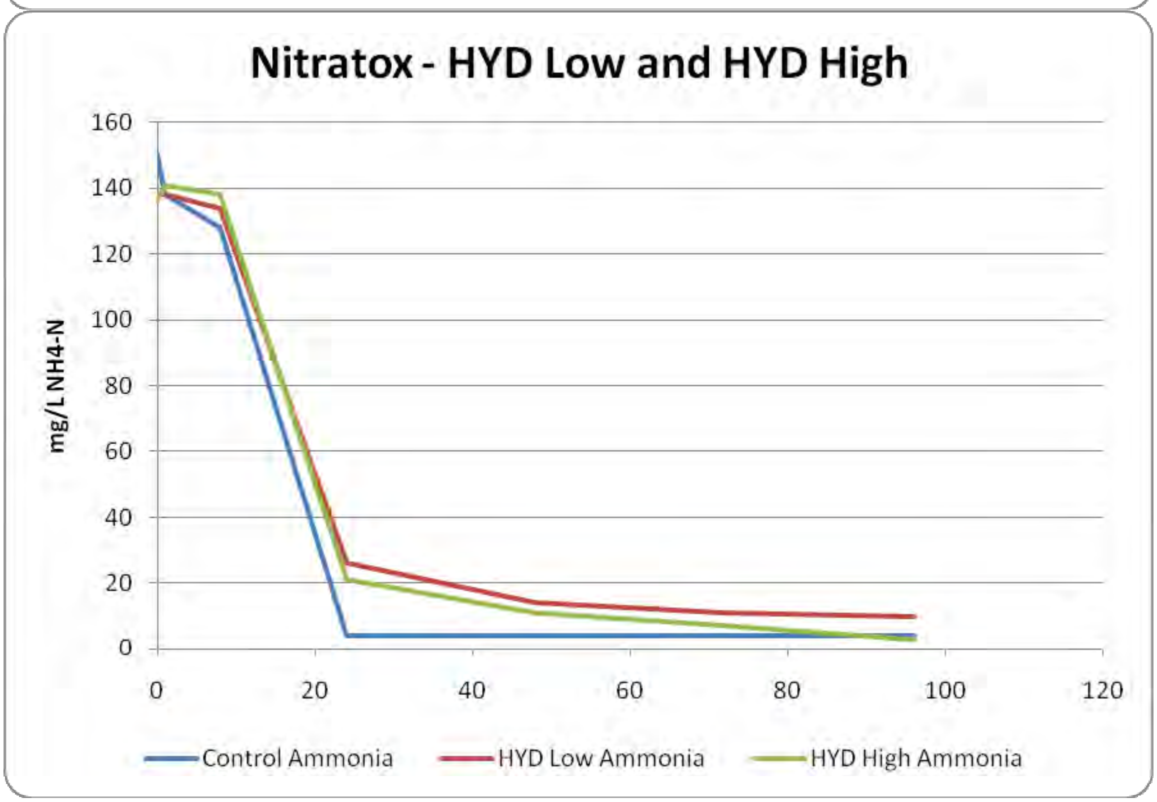
| | ppm Nickel | HOLD Time, Hrs | ppm, by wt | % Reduction |
|---|---|---|---|---|
| LOW SAMPLES TO RIVERBEND | | | added | |
| Feed | 0.07 | | | |
| Kroff | 0.05 | 3.75 | 15.11 | 0.33 |
| Hydrite | 0.04 | 3.87 | 18.41 | 0.34 |
| Hychem | 0.06 | 3.63 | 18.68 | 0.18 |
| Nalmet | 0.04 | 3.87 | 20.39 | 0.47 |
| | | | | |
| | | | | |
| HIGH SAMPLES TO RIVERBEND | | | | |
| 02441 5-10 DAF to Pilot DE | 0.06 | | | |
| Kroff | 0.02 | 3.63 | 190.18 | 0.58 |
| Hydrite | 0.02 | 3.87 | 194.07 | 0.58 |
| Hychem | 0.03 | 3.75 | 207.83 | 0.37 |
| Nalmet | 0.02 | 4.23 | 254.95 | 0.60 |


ADM Respirometery - Pass 1
2000
1800
1600
1400
1200
1000
800
600
400
200
0
mg/L O2
-
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
hrs
All Lines within 10% of Control
No -Toxicity
Control
K High
HYD High
HYCH Low
HYCH High

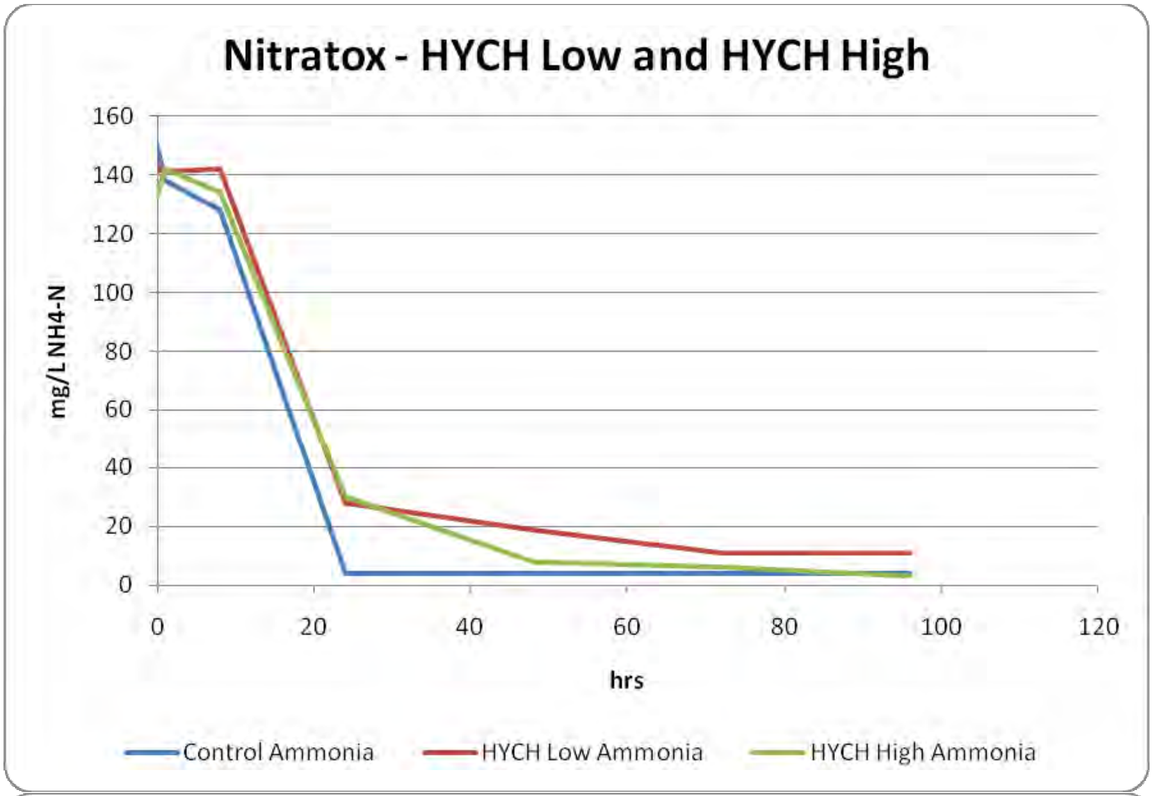

ADM Respirometery - Pass 2
2000
1800
1600
1400
1200
1000
800
600
400
200
0
mg/L O2
-
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
hrs
All Lines within 10% of Control
No -Toxicity
Control (2)
K Low (2)
HYD Low (2)
N Low (2)
N High (2)

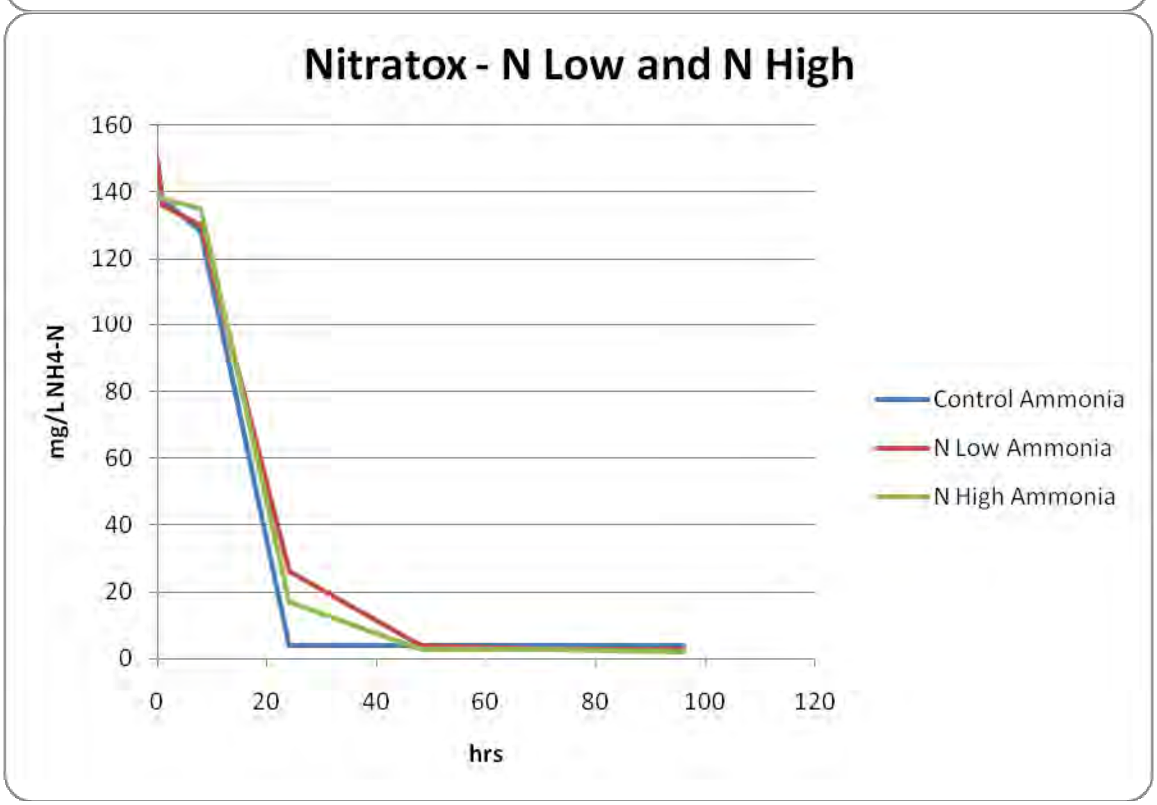


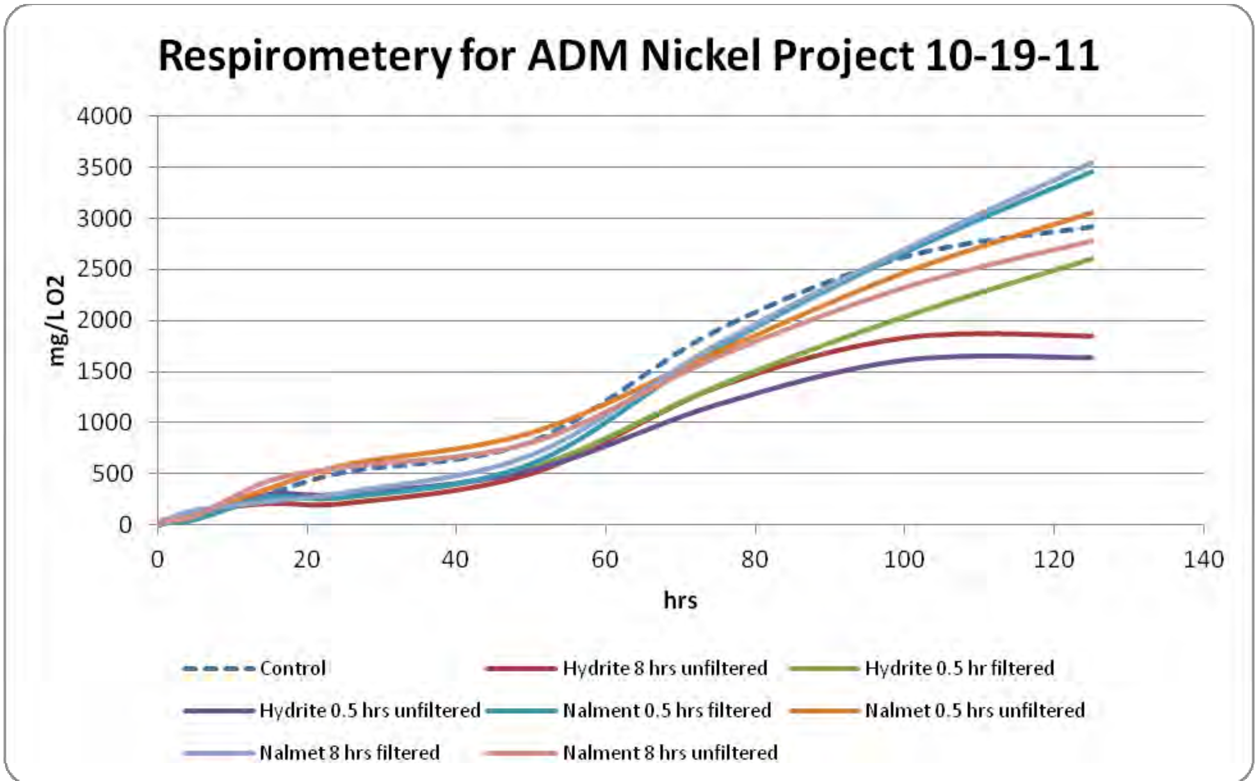
Nitratox - K Low and K High
160
140
120
100
80
60
40
20
0
mg/L NH4-N
0
20
40
60
80
100
120
hrs
Control Ammonia
K Low Ammonia
K High Ammonia

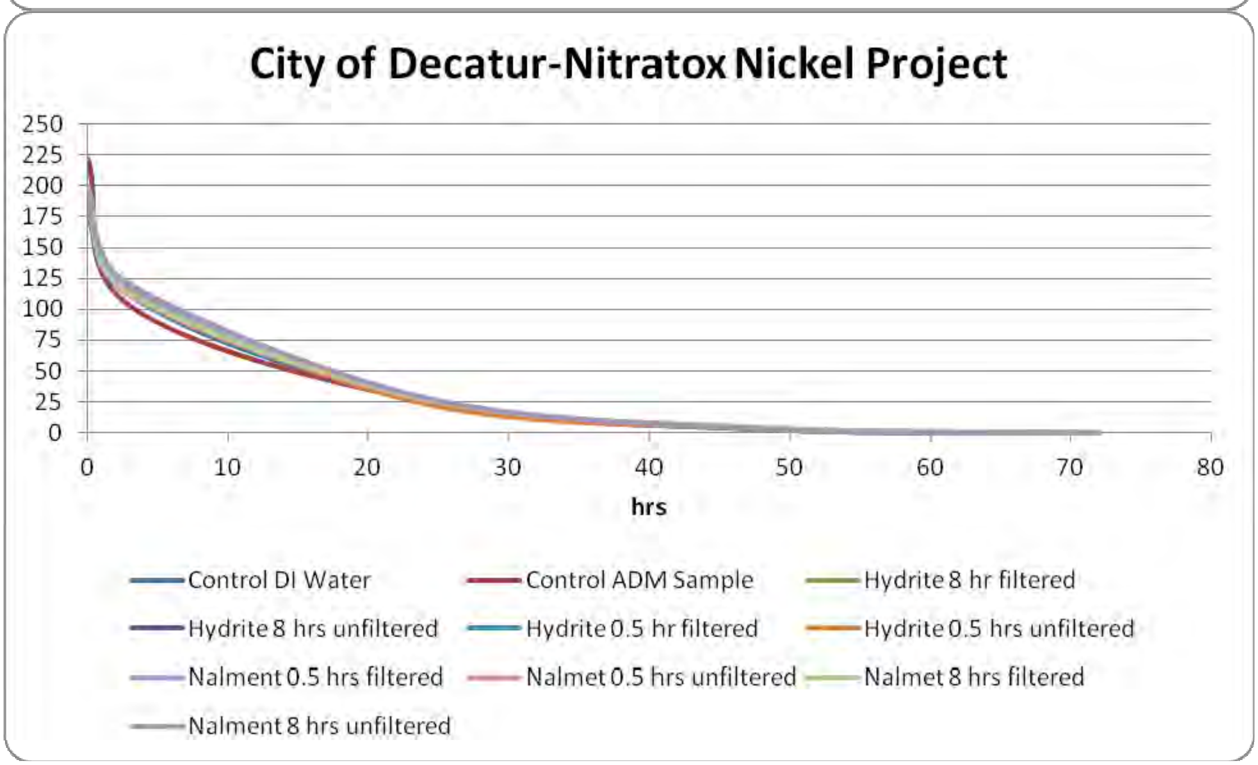



Nitratox - HYD Low and HYD High
160
140
120
100
80
60
40
20
0
mg/L NH4-N
0
20
40
60
80
100
120
Control Ammonia
HYD Low Ammonia
HYD High Ammonia


Nitratox - HYCH Low and HYCH High
mg/L NH4-N
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
hrs
Control Ammonia
HYCH Low Ammonia
HYCH High Ammonia


Nitratox - N Low and N High
mg/L NH4-N
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
hrs
Control Ammonia
N Low Ammonia
N High Ammonia


Respirometery for ADM Nickel Project 10-19-11
mg/L O2
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
hrs
Control
Hydrite 8 hrs unfiltered
Hydrite 0.5 hr filtered
Hydrite 0.5 hrs unfiltered
Nalment 0.5 hrs filtered
Nalmet 0.5 hrs unfiltered
Nalmet 8 hrs filtered
Nalment 8 hrs unfiltered


City of Decatur-Nitratox Nickel Project
250
225
200
175
150
125
100
75
50
25
0
0
10
20
30
40
50
60
70
80
hrs
Control DI Water
Control ADM Sample
Hydrite 8 hr filtered
Hydrite 8 hrs unfiltered
Hydrite 0.5 hr filtered
Hydrite 0.5 hrs unfiltered
Nalment 0.5 hrs filtered
Nalmet 0.5 hrs unfiltered
Nalmet 8 hrs filtered
Nalment 8 hrs unfiltered

ADM

# Exhibit 16

Sanitary District of Decatur
501 DIPPER LANE • DECATUR, ILLINOIS 62522 • 217/422-6931 • FAX: 217/423-8171

Exhibit 16

June 25, 2012

Illinois Environmental Protection Agency
Bureau of Water Compliance Assurance Section, MC #19
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Re: NPDES Permit IL0028321
IPCB Order PCB 09-125
Interim Report

Dear Sir or Madam:

Enclosed is the Interim Report regarding compliance with nickel and zinc limits required by Special Condition 18 of the Sanitary District of Decatur's NPDES Permit and the Pollution Control Board Order in PCB 09-125.

Please contact me at 422-6931 ext. 214 or at timk@sdd.dst.il.us if you have any questions regarding this report.

Sincerely,

Timothy R. Kluge

Timothy R. Kluge, P.E.
Technical Director

cc: Rick Pinneo, IEPA (via email)
Bob Mosher, IEPA (via email)
SDD File

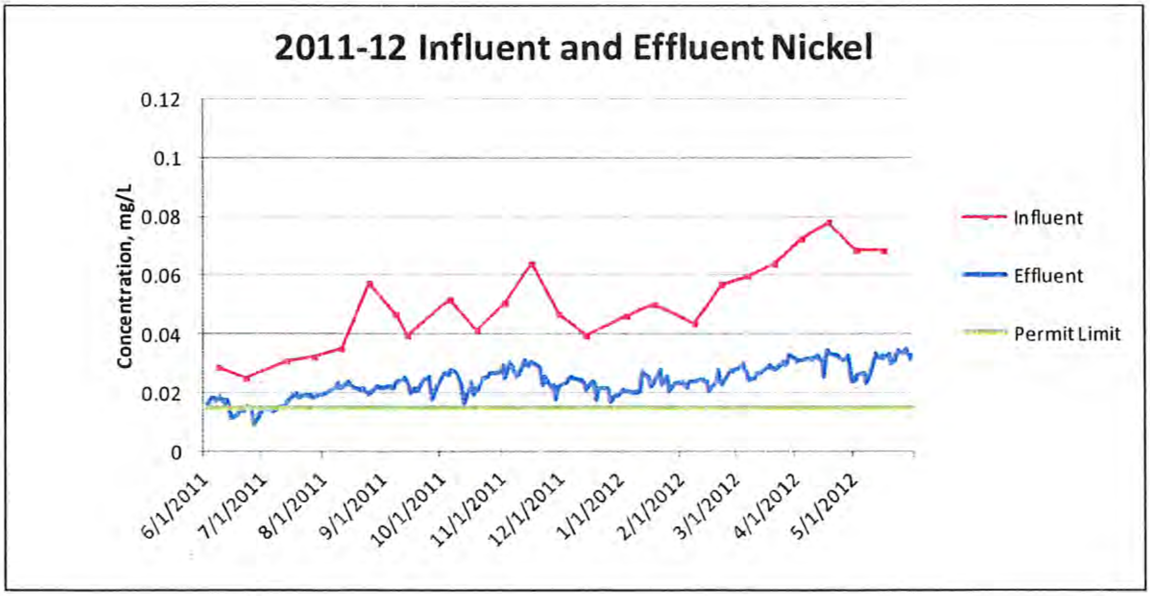
**Sanitary District of Decatur**
**Nickel and Zinc Limits**
**June 2012 Final Compliance Plan**

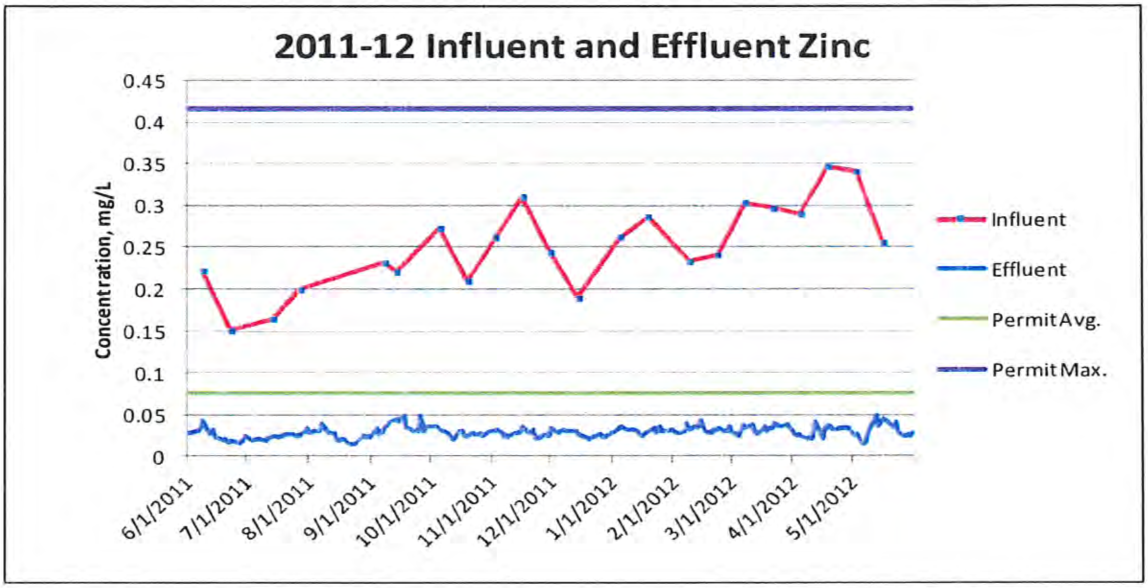
The modified NPDES permit for the Sanitary District of Decatur that became effective July 1, 2009 contains limits for nickel and zinc and a one-year compliance schedule extension for meeting the limits. Special Condition 17 requires the District to achieve compliance with final nickel and zinc effluent limitations by July 1, 2010. This Special Condition also notes that the permit may be modified to include revised compliance dates in Pollution Control Board orders, and that prior to such permit modification, the revised dates in the appropriate orders shall govern the Permittee's compliance.

On January 7, 2010 the Illinois Pollution Control Board granted a variance to the District allowing additional time to comply with final permit limits (PCB 09-125). The final compliance date contained in the Board Order is July 1, 2014. The District's NPDES Permit has not yet been modified to incorporate the variance although Illinois EPA issued a Public Notice and draft modified permit on May 26, 2011. The Board Order also requires that a final compliance plan be submitted to Illinois EPA by July 1, 2012 "containing nickel and zinc controls, treatment technologies, proposed permit modifications, or proposed site-specific water quality standards that will achieve compliance with the District's NPDES permit effluent limits for nickel and zinc." This report is submitted to meet both the permit and variance requirements.

**Plant Influent and Effluent Sampling**

Ongoing influent sampling for nickel and zinc continues at a frequency of twice monthly, and effluent sampling is done five days per week according to NPDES monitoring requirements. A summary of influent and effluent values during the past twelve months is shown below.






Data shows that the plant effluent is not able to consistently meet the current nickel permit limit. Effluent zinc concentrations remain below the permit limit.

**Receiving Stream Sampling**

Upstream and downstream sampling continues at a twice monthly frequency to provide a more complete picture of nickel and zinc in the Sangamon River. One upstream and four downstream sampling sites are being monitored. A summary of 2011-2012 river monitoring data is attached. Downstream nickel results remain high during times of low upstream river flow; low flows have prevailed during most of the past year. All upstream and downstream zinc results during 2011 and 2012 have been below the Illinois water quality standard.

**Pretreatment Ordinance Limits**

The District's pretreatment ordinance was amended in October 2009 as noted in previous interim reports.

**Stream Flow-Based Compliance Options**

The District continues investigation of flow-based permit limits, to take advantage of upstream flow for mixing when it is available. This concept could potentially allow a savings in treatment facility operating costs when the upstream flow is sufficient to meet water quality standards after mixing with treatment plant effluent. A USGS flow gauging station is located about two miles upstream of the District's discharge point, and provides near- real time flow information. A proposal for flow-based limits will be a part of relief requested from the Pollution Control Board.

**Water Quality Standard Investigations**

The District is in the final stages of preparing a petition for a site-specific nickel standard, which we expect to file with the Pollution Control Board in in early July 2012.

We are also following the Pollution Control Board rulemaking currently underway to correct an error found in the existing zinc water quality standard. If the Board adopts the corrected standard, utilizing the corrected number to determine our permit limit should provide further assurance of compliance.

**Industrial Source Sampling and Investigations**

Sampling at Archer Danield Midland Company for metals continues at a frequency of twice monthly and other industries discharging metals are sampled quarterly. Sample results obtained from ADM within the past two years are attached.

The District's operating permit issued to ADM was modified on November 18, 2009 and again on June 17, 2010 to reflect the new limits and provide a compliance schedule for meeting the limits. Final local limits will be determined following Board action on the District's WQS request.

Both ADM and Tate & Lyle formerly utilized zinc as part of their cooling tower treatment programs, and both have eliminated or greatly reduced zinc in their towers. At this time, both industries are meeting the zinc pretreatment limit. ADM is continuing to investigate the possible impact of the zinc limit on their planned wasting of solids from their pretreatment system to the District's collection system.

The discharge from ADM is by far the most significant industrial source of nickel. ADM has been very active in seeking treatment technology for nickel removal, involving plant management and research department personnel in addition to environmental compliance and legal staff. District staff met with ADM personnel several times during the first half of 2012. The District's pretreatment permit requires semi-annual reports of ADM's investigations, and the most recent report is attached. Completed and anticipated modifications made by ADM are listed on pages 3-4 of the report.

**Additional Pretreatment Limit Investigations**

Pretreatment ordinance limits adopted in 2009 were adopted as total (rather than soluble) limits based on review of soluble/insoluble data. Refinement of pretreatment limits is an ongoing process and will depend on final permit limits as well as treatment technologies that might be employed by industrial users.

**Compliance Plan**

District and ADM staff met with Illinois EPA personnel on May 8, 2012 to discuss the District's compliance plan approach. In summary, the District's compliance plan includes the following:

1. Continue to work with ADM to implement nickel discharge reductions and removal technologies. ADM's May 31, 2012 Interim Report describes the completed and planned reductions.

2. Complete and file a petition for a site-specific water quality standard for nickel, based on bioavailability. We anticipate providing a draft of the petition to Illinois EPA before the end of June and filing the petition with the Pollution Control Board in July.

3. The Board petition will contain a request for variable permit limits based on the amount of flow available in the Sangamon River.

**Sanitary District of Decatur**
Nickel and Zinc River Data 2010-2011

| Sample Date | Plant Final Effluent Nickel mg/L | River Up-stream Nickel mg/L | River 100 yds Down stream Nickel mg/L | River 600 yds Down-stream Nickel mg/L | Steven's Creek Nickel mg/L | River Rock Springs Bridge Nickel mg/L | River Wyckle's Road Nickel mg/L | Plant Final Effluent Zinc mg/L | River Up-stream Zinc mg/L | River 100 yds Down stream Zinc mg/L | River 600 yds Down-stream Zinc mg/L | Steven's Creek Zinc mg/L | River Rock Springs Bridge Zinc mg/L | River Wyckle's Road Zinc mg/L | Plant Final Effluent Flow mgd | River Up-stream Flow $ft^3/sec$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01/13/11 | 0.0181 | <0.00131 | 0.00519 | 0.00495 | <0.00131 | 0.00426 | 0.00504 | 0.0503 | <0.00660 | 0.0157 | 0.0152 | <0.00660 | 0.0133 | 0.0149 | 29.48 | 121 |
| 01/27/11 | 0.0218 | <0.00131 | 0.0144 | 0.0138 | <0.00131 | 0.0113 | 0.0102 | 0.0773 | <0.00660 | 0.0504 | 0.0481 | <0.00660 | 0.0394 | 0.0350 | 30.71 | 3.9 |
| 02/10/11 | 0.0214 | <0.00131 | 0.0141 | 0.0128 | <0.00131 | 0.0112 | 0.00971 | 0.0701 | <0.00660 | 0.0460 | 0.0413 | 0.00761 | 0.0364 | 0.0313 | 27.94 | 5.4 |
| 02/24/11 | 0.0132 | 0.00160 | 0.00242 | 0.00252 | 0.00150 | 0.00214 | 0.00205 | 0.0406 | 0.00841 | 0.0106 | 0.0108 | 0.0138 | 0.0114 | 0.00992 | 44.38 | 1970 |
| 3/10/11 | 0.0123 | 0.00169 | 0.00194 | 0.00198 | 0.00153 | 0.00184 | 0.00208 | 0.0321 | 0.00972 | 0.00978 | 0.00992 | 0.0103 | 0.00974 | 0.0100 | 47.51 | 2900 |
| 3/24/11 | 0.0132 | <0.00131 | 0.00133 | 0.00133 | <0.00131 | <0.00131 | <0.00131 | 0.0161 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | 33.28 | 667 |
| 4/7/11 | 0.0163 | <0.00131 | 0.00343 | 0.00252 | <0.00131 | 0.00241 | 0.00237 | 0.0246 | <0.00660 | 0.00884 | 0.00689 | <0.00660 | 0.00732 | 0.00691 | 30.62 | 326 |
| 4/21/11 | 0.0118 | <0.00131 | 0.00236 | 0.00195 | 0.00254 | 0.00157 | 0.00188 | 0.0215 | 0.00729 | 0.00878 | 0.00822 | 0.0170 | 0.00939 | 0.00934 | 52.22 | 2540 |
| 5/5/11 | 0.0147 | 0.00177 | 0.00279 | 0.00238 | 0.00137 | 0.00218 | 0.00223 | 0.0295 | <0.00660 | 0.00932 | 0.00862 | <0.00660 | 0.00760 | 0.00898 | 41.88 | 1670 |
| 5/19/11 | 0.0125 | <0.00131 | 0.00211 | 0.00186 | <0.00131 | 0.00153 | 0.00150 | 0.0213 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | <0.00660 | 0.00777 | 32.29 | 1290 |
| 6/9/11 | 0.0187 | <0.00131 | 0.00143 | 0.00194 | 0.00183 | 0.00162 | 0.00177 | 0.0434 | <0.00660 | <0.00660 | 0.00672 | <0.00660 | <0.00660 | 0.0124 | 29.12 | 1540 |
| 6/23/11 | 0.0154 | 0.00210 | 0.00335 | 0.00307 | 0.00154 | 0.00280 | 0.00329 | 0.0203 | 0.0131 | 0.0134 | 0.0138 | 0.0112 | 0.0129 | 0.0155 | 36.23 | 800 |
| 7/14/11 | 0.0170 | <0.00131 | 0.0118 | 0.0116 | <0.00131 | 0.00886 | 0.00890 | 0.0242 | 0.00519 | 0.0162 | 0.0171 | <0.00660 | 0.0136 | 0.0130 | 27.12 | 200 |
| 7/28/11 | 0.0188 | <0.00131 | 0.0187 | 0.0168 | <0.00131 | 0.0158 | 0.0159 | 0.0255 | <0.00660 | 0.0279 | 0.0219 | <0.00660 | 0.0205 | 0.0207 | 27.85 | 2.1 |
| 8/11/11 | 0.0218 | 0.00143 | 0.0255 | 0.0212 | <0.00131 | 0.0204 | 0.0199 | 0.0294 | <0.00660 | 0.0576 | 0.0292 | <0.00660 | 0.0266 | 0.0271 | 24.82 | 1.6 |
| 8/25/11 | 0.0193 | <0.00131 | 0.0187 | 0.0190 | <0.00131 | 0.0183 | 0.0189 | 0.0161 | <0.00660 | 0.0153 | 0.0158 | <0.00660 | 0.0142 | 0.0137 | 24.19 | 1.1 |
| 9/8/11 | 0.0233 | 0.00142 | 0.0208 | 0.0222 | <0.00131 | 0.0207 | 0.0196 | 0.0341 | <0.00660 | 0.0294 | 0.0303 | <0.00660 | 0.0279 | 0.0254 | 27.07 | 0.15 |
| 9/14/11 | 0.0237 | 0.00132 | 0.0231 | 0.0235 | <0.00131 | 0.0228 | 0.0231 | 0.0460 | <0.00660 | 0.0425 | 0.0438 | <0.00660 | 0.0413 | 0.0385 | 28.62 | 1.9 |
| 10/6/11 | 0.0276 | 0.00140 | 0.0263 | 0.0265 | <0.00131 | 0.0255 | 0.0259 | 0.0329 | <0.00660 | 0.0318 | 0.0314 | <0.00660 | 0.0296 | 0.0288 | 23.96 | 0.75 |
| 10/20/11 | 0.0211 | <0.00131 | 0.0189 | 0.0195 | <0.00131 | 0.0159 | 0.0181 | 0.0260 | 0.0107 | 0.0235 | 0.0238 | <0.00660 | 0.0193 | 0.0199 | 23.28 | 2.8 |
| 11/3/11 | 0.0250 | 0.00197 | 0.0277 | 0.0304 | 0.00175 | 0.0260 | 0.0275 | 0.0322 | 0.0115 | 0.0314 | 0.0354 | <0.00660 | 0.0281 | 0.0271 | 42.99 | 18 |
| 11/17/11 | 0.0307 | <0.00131 | 0.0281 | 0.0283 | 0.00178 | 0.0273 | 0.0277 | 0.0368 | <0.00660 | 0.0285 | 0.0304 | <0.00660 | 0.0275 | 0.0247 | 25.80 | 1.1 |
| 12/1/11 | 0.0221 | <0.00131 | 0.0177 | 0.0173 | <0.00131 | 0.0149 | 0.0149 | 0.0349 | 0.00728 | 0.0245 | 0.0230 | 0.00824 | 0.0207 | 0.0190 | 27.64 | 2.1 |
| 1/5/12 | 0.0207 | <0.00131 | 0.0193 | 0.0206 | <0.00131 | 0.0170 | 0.0174 | 0.0355 | <0.00660 | 0.0328 | 0.0346 | <0.00660 | 0.0298 | 0.0278 | 27.19 | 4.1 |
| 1/19/12 | 0.0245 | 0.00146 | 0.0164 | 0.0166 | 0.00135 | 0.0126 | 0.0127 | 0.0307 | 0.0265 | 0.0229 | 0.0240 | 0.00838 | 0.0203 | 0.0184 | 26.24 | 8.9 |
| 2/9/12 | 0.0241 | <0.00131 | 0.00567 | 0.00496 | <0.00131 | 0.00480 | 0.00421 | 0.0329 | <0.00660 | 0.00944 | 0.00838 | <0.00660 | 0.00788 | 0.00782 | 29.94 | 228 |
| 2/23/12 | 0.0227 | <0.00131 | 0.0135 | 0.0147 | <0.00131 | 0.0118 | 0.0115 | 0.0343 | <0.00660 | 0.0213 | 0.0256 | <0.00660 | 0.0182 | 0.0172 | 28.01 | 50 |
| 3/8/12 | 0.0245 | <0.00131 | 0.0111 | 0.0111 | <0.00131 | 0.00964 | 0.00941 | 0.0338 | <0.00660 | 0.0167 | 0.0161 | <0.00660 | 0.0149 | 0.0150 | 27.78 | 79 |
| 3/22/12 | 0.0277 | <0.00131 | 0.0241 | 0.0211 | <0.00131 | 0.0180 | 0.0185 | 0.0399 | <0.00660 | 0.0501 | 0.0387 | <0.00660 | 0.0245 | 0.0227 | 26.74 | 2.5 |
| 4/5/12 | 0.0313 | <0.00131 | 0.0226 | 0.0226 | <0.00131 | 0.0205 | 0.0207 | 0.0260 | <0.00660 | 0.0214 | 0.0227 | <0.00660 | 0.0185 | 0.0172 | 26.05 | 4.6 |
| 4/19/12 | 0.0334 | <0.00131 | 0.0246 | 0.0238 | 0.00149 | 0.0187 | 0.0199 | 0.0375 | <0.00660 | 0.0331 | 0.0308 | <0.00660 | 0.0240 | 0.0216 | 26.08 | 4.2 |
| 5/3/12 | 0.0262 | 0.00158 | 0.0120 | 0.0105 | <0.00131 | 0.00755 | 0.00770 | 0.0270 | 0.00690 | 0.0231 | 0.0194 | <0.00660 | 0.0148 | 0.0142 | 26.95 | 8.7 |
| 5/17/12 | 0.0317 | 0.00156 | 0.00859 | 0.00888 | 0.00141 | 0.00775 | 0.00806 | 0.0450 | <0.00660 | 0.0160 | 0.0171 | <0.00660 | 0.0139 | 0.0148 | 25.37 | 97 |

Indicates that effluent or river/creek sample concentration exceeds chronic water quality value

| SDD Major Industrial Nickel and Zinc Results | | | | |
|---|---|---|---|---|
| | | | | |
| | ADM Point A | ADM Point A | ADM Point D | ADM Point D |
| Sample | Nickel, Tot | Zinc, Tot | Nickel, Tot | Zinc, Tot |
| Date | mg/L | mg/L | mg/L | mg/L |
| 6/1/2010 | 0.0813 | 0.488 | 0.12 | 0.441 |
| 6/14/2010 | 0.0826 | 0.453 | 0.104 | 0.345 |
| 7/8/2010 | 0.148 | 0.54 | 0.283 | 1.07 |
| 7/12/2010 | 0.144 | 0.528 | 0.193 | 0.514 |
| 8/2/2010 | 0.125 | 0.457 | 0.172 | 0.446 |
| 8/9/2010 | 0.126 | 0.44 | 0.184 | 0.474 |
| 9/1/2010 | 0.0766 | 0.465 | 0.122 | 0.469 |
| 9/20/2010 | 0.0744 | 0.442 | 0.121 | 0.649 |
| 10/4/2010 | 0.0781 | 0.461 | 0.0938 | 0.369 |
| 10/14/2010 | 0.162 | 1.18 | 0.179 | 1.18 |
| 11/8/2010 | 0.0524 | 0.24 | 0.0646 | 0.208 |
| 11/23/2010 | 0.13 | 0.665 | 0.122 | 0.413 |
| 12/6/2010 | 0.0715 | 0.53 | 0.131 | 0.581 |
| 12/13/2010 | 0.0649 | 0.498 | 0.0774 | 0.219 |
| 1/5/2011 | 0.0629 | 0.53 | 0.0669 | 0.204 |
| 1/10/2011 | 0.0577 | 0.495 | 0.0666 | 0.188 |
| 2/7/2011 | 0.0836 | 0.756 | 0.0892 | 0.329 |
| 2/14/2011 | 0.0589 | 0.472 | 0.0598 | 0.18 |
| 3/7/2011 | 0.0773 | 0.447 | 0.0627 | 0.128 |
| 3/14/2011 | 0.086 | 0.51 | 0.1 | 0.449 |
| 4/4/2011 | 0.07 | 0.428 | 0.0841 | 0.387 |
| 4/20/2011 | 0.0687 | 0.33 | 0.0861 | 0.347 |
| 5/2/2011 | 0.0712 | 0.304 | 0.0809 | 0.302 |
| 5/9/2011 | 0.06 | 0.301 | 0.0712 | 0.3 |
| 6/6/2011 | 0.0648 | 0.285 | 0.0786 | 0.276 |
| 6/13/2011 | 0.0692 | 0.293 | 0.0809 | 0.314 |
| 7/11/2011 | 0.0542 | 0.226 | 0.0625 | 0.209 |
| 8/1/2011 | 0.0491 | 0.165 | 0.0621 | 0.172 |
| 8/8/2011 | 0.0567 | 0.215 | 0.074 | 0.242 |
| 9/1/2011 | 0.0662 | 0.285 | 0.0842 | 0.327 |
| 9/7/2011 | 0.0684 | 0.311 | 0.0884 | 0.344 |
| 10/3/2011 | 0.094 | 0.518 | 0.114 | 0.515 |
| 10/10/2011 | 0.0643 | 0.191 | 0.073 | 0.189 |
| 11/7/2011 | 0.0912 | 0.377 | 0.116 | 0.529 |
| 11/22/2011 | 0.221 | 1.28 | 0.136 | 0.623 |
| 12/1/2011 | 0.0917 | 0.416 | 0.11 | 0.492 |
| 12/5/2011 | 0.094 | 0.423 | 0.117 | 0.508 |
| 1/5/2012 | 0.0921 | 0.451 | 0.111 | 0.531 |
| 1/9/2012 | 0.0868 | 0.424 | 0.109 | 0.491 |
| 2/6/2012 | 0.121 | 0.441 | 0.134 | 0.488 |
| 2/13/2012 | 0.127 | 0.49 | 0.159 | 0.601 |
| 3/5/2012 | 0.128 | 0.431 | 0.15 | 0.493 |
| 3/12/2012 | 0.12 | 0.406 | 0.141 | 0.482 |
| 4/12/2012 | 0.169 | 0.621 | 0.191 | 0.705 |
| 4/19/2012 | 0.148 | 0.516 | 0.176 | 0.674 |
| | | | | |
| SDD Ordinance Limit (Avg.) | 0.0365 | 0.45 | | |
| SDD Ordinance Limit (Max.) | 0.15 | 1.7 | | |

ADM



May 31, 2012

CERTIFIED MAIL
7003 3110 0005 2739 4722

Charles Jarvis
Pretreatment Coordinator
Sanitary District of Decatur
501 Dipper Lane
Decatur, Illinois 62522

Re: Interim Nickel and Zinc Report, 2012-1

Dear Charles,

Per Special Condition E.8. of the ADM Industrial Discharge Permit #200, ADM is enclosing the semi-annual report that summarizes ADM's research efforts to reduce nickel and zinc from effluent during the first half of CY2012. In Tables 1 & 2 of the report you will note that we have struck reference to any vendors associated with technology studies. This is in accordance with confidentiality agreements in place with those vendors.

Please contact our Environmental Manager Mark Atkinson if you have any questions or would like to arrange a meeting to discuss.

Regards,

Mark Burau
Plant Manager
ADM Decatur Corn Processing Plant

Ec: Mark Atkinson – ADM Corn Plant Environmental Manager
Dean Frommelt – ADM Corn Division Environmental Manager
EDMS

To: Illinois Environmental Protection Agency

Decatur Sanitary District

From: ADM Decatur WWTP

CC: ADM Corn Processing, ADM Oilseeds Processing, ADM JRRRC

Date: May 31, 2012

Re: Status Report Compliance Strategy for 2012 for Decatur Sanitary District and ADM Decatur WWTP for waste treatment. (Covers updates post December, 2011- date)

ADM

**Table of Contents**

ADM Research and Decatur Corn Processing have been actively pursuing technologies to remove Nickel (Ni) from its effluent stream released to the SDD treatment plant. Enclosed is a report on the progress ADM has made since the last update issued on December 2011.

## 1 Background and Update (post December 2011)

Nickel and Zinc are present in effluent leaving the ADM Decatur Complex Waste Water plant. Of the two metals, nickel is more difficult to remove from the effluent. ADM has conducted 5 plant material balances to understand the sources of Nickel in its internal streams. ADM's Decatur Complex consists of multiple, separate processing plants, which send their wastewater to the on-site wastewater treatment plant ("WWTP") operated by Corn Plant personnel. These processing plants consist of the Corn Wet Mill, BioProducts Plant, Cogeneration Plant, East Soybean Processing Plant, West Soybean Processing Plant, Vitamin E Plant, Corn Germ Processing Plant, Glycols Plant and the Polyols Plant. Each of these unique plants produces multiple products, using both batch and continuous processes, and creates water streams which generally are reused multiple times prior to being discharged to the WWTP. The WWTP treats approximately 11 MGD through a newer anaerobic treatment system followed by aerobic treatment prior to discharge to the District.

The incoming soybeans contain approximately 4.1 parts per million ("ppm") nickels, while incoming corn contains approximately 0.53 ppm nickel. Given that ADM's Decatur Complex processes approximately 600,000 bushels of corn and 200,000 bushels of soybeans per day, our incoming Nickel load are about 49.2 lbs from the Soybeans and 19.1 lbs from the corn. A small portion of the incoming nickel is discharged in the effluent.

In ADM effluent water originates in the corn and soybeans being processed at the facility. During the processing, the metals are released and enter the processing water some of which eventually ends up at the wastewater treatment plant.

ADM has monitored soluble Nickel at the Damon and Front stations continuously (see Figures 1-3) and made a number of modifications in its operations:

1) In the past 9 months there has been a decline in Nickel from about 0.120ppm to about 0.060 ppm. However we have experienced severe spikes in effluent nickel in September-November, 2011 each lasting 2-3 days.

2) Spent catalyst from the West Soybean Processing Plant is collected and sent to a landfill. Spilled catalyst is collected and disposed of as solid waste rather than washed into a sump.
3) Particulate catalyst from the Corn Plant Sorbitol production is captured by filters and physically recovered for recycling or disposal as solid waste. ADM is also installing an ion exchange resin system at the Sorbitol Plant to capture soluble nickel from wastewater.
4) The East Soybean Processing Plant is finalizing its design of a system that will remove the soy molasses stream (containing approximately 2.4 lb/day, approximately 35% of the soluble nickel from the Decatur Complex) from the WWTP. This stream is high in digestible, fermentable sugars but will need to be concentrated for stability. The East Soybean Processing Plant has prepared a cost estimate for this process change. Once the system design is complete and the cost estimate approved, ADM anticipates spending several million dollars to install it.
5) The Polyols Plant accounts for approximately 11% of the soluble nickel from the Decatur Complex. The Polyols Plant has determined that this nickel can be precipitated by pH adjustment. ADM is now determining how to implement this change on its process stream.
6) We have also collected soluble nickel data for the past 8+ yrs. and it shows that our soluble nickel number remain unchanged with the only change in total nickel due to startup of the anaerobic digesters post August 2008.

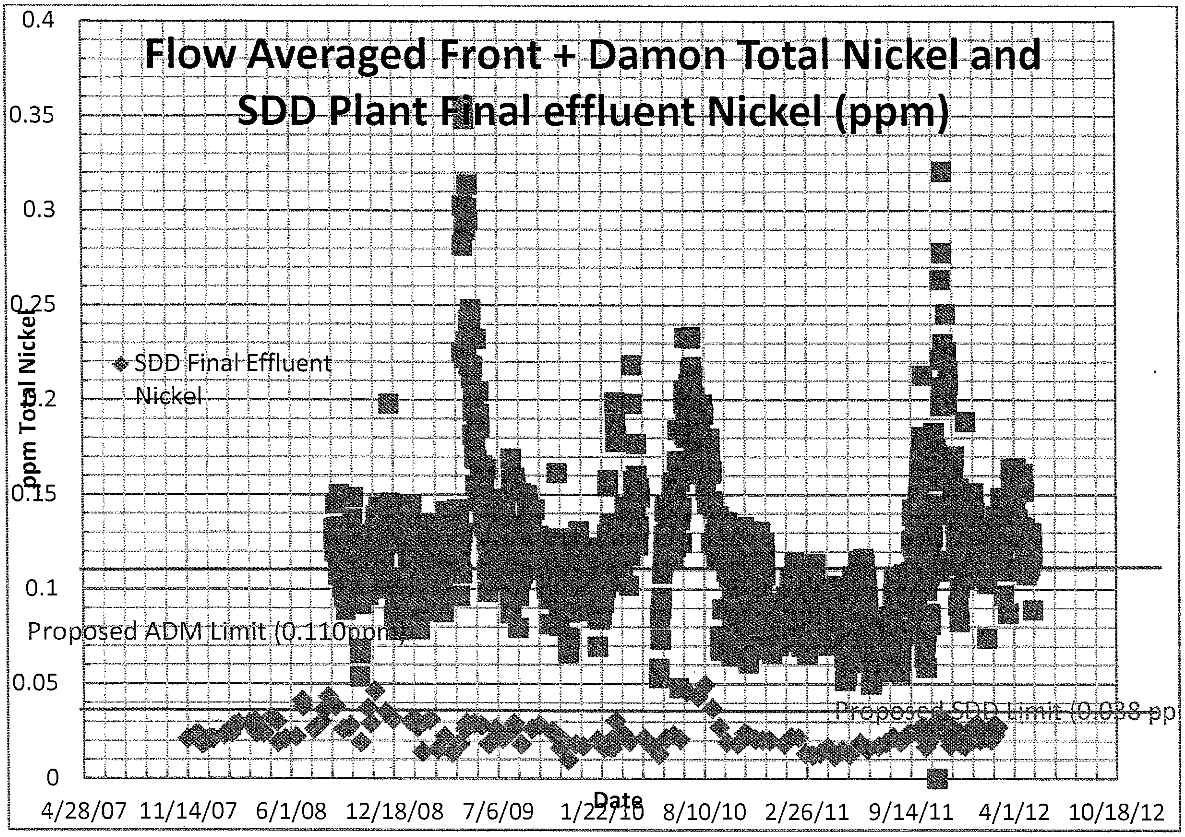



Figure 1 Flow Averaged Front and Damon Nickel

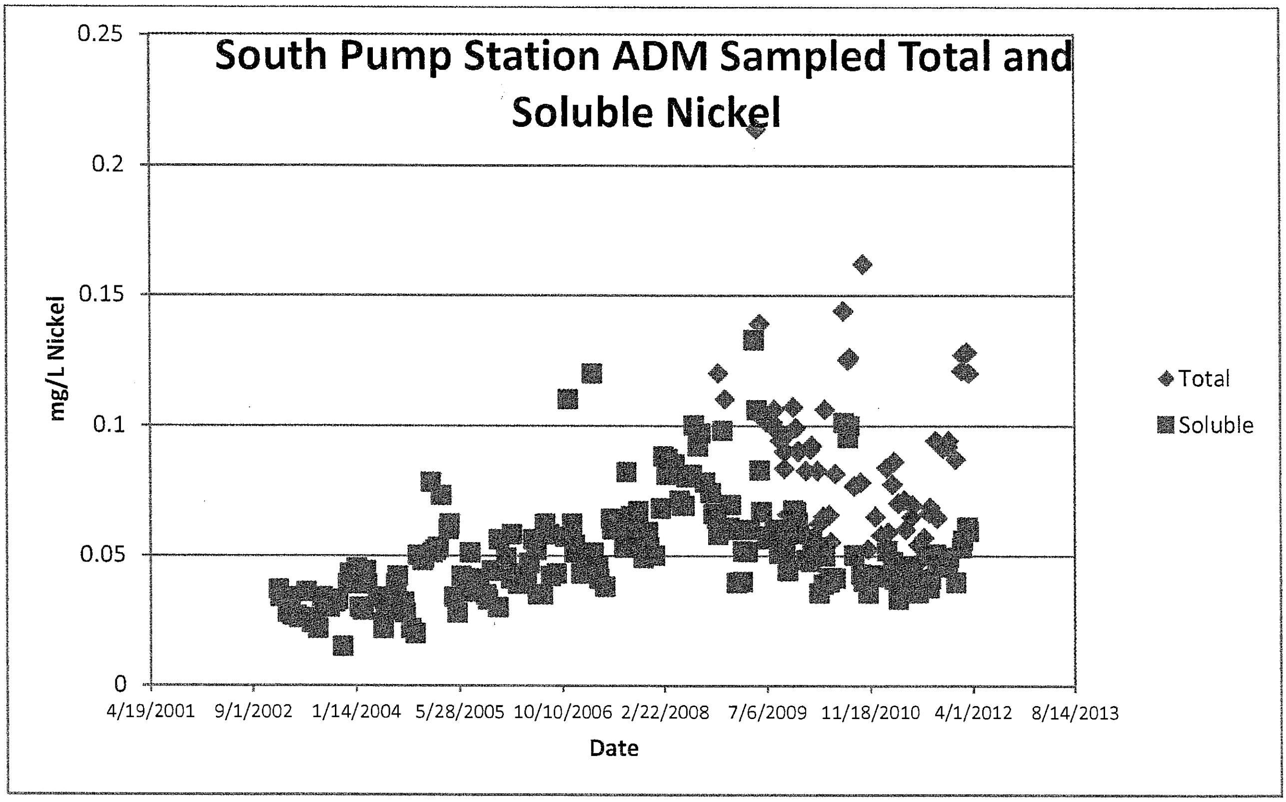



Figure 2 South Pump Station Nickel

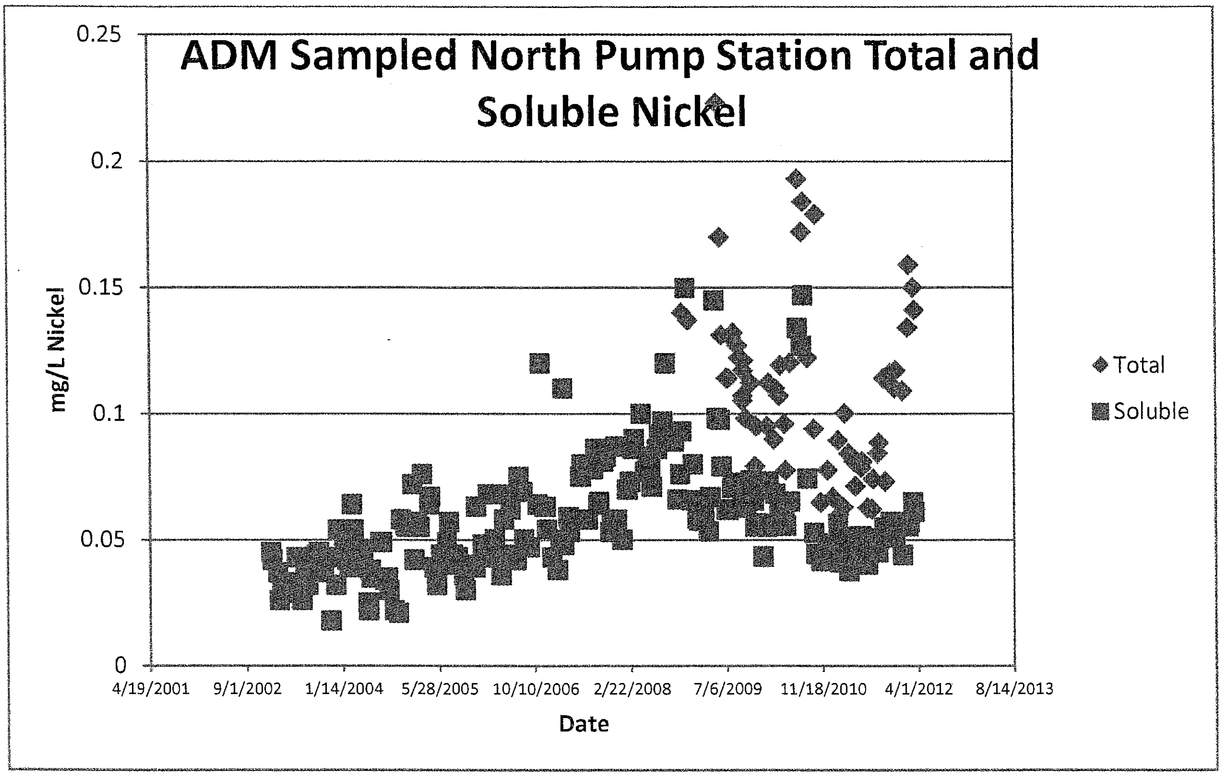



Figure 3 North Pump Station Nickel

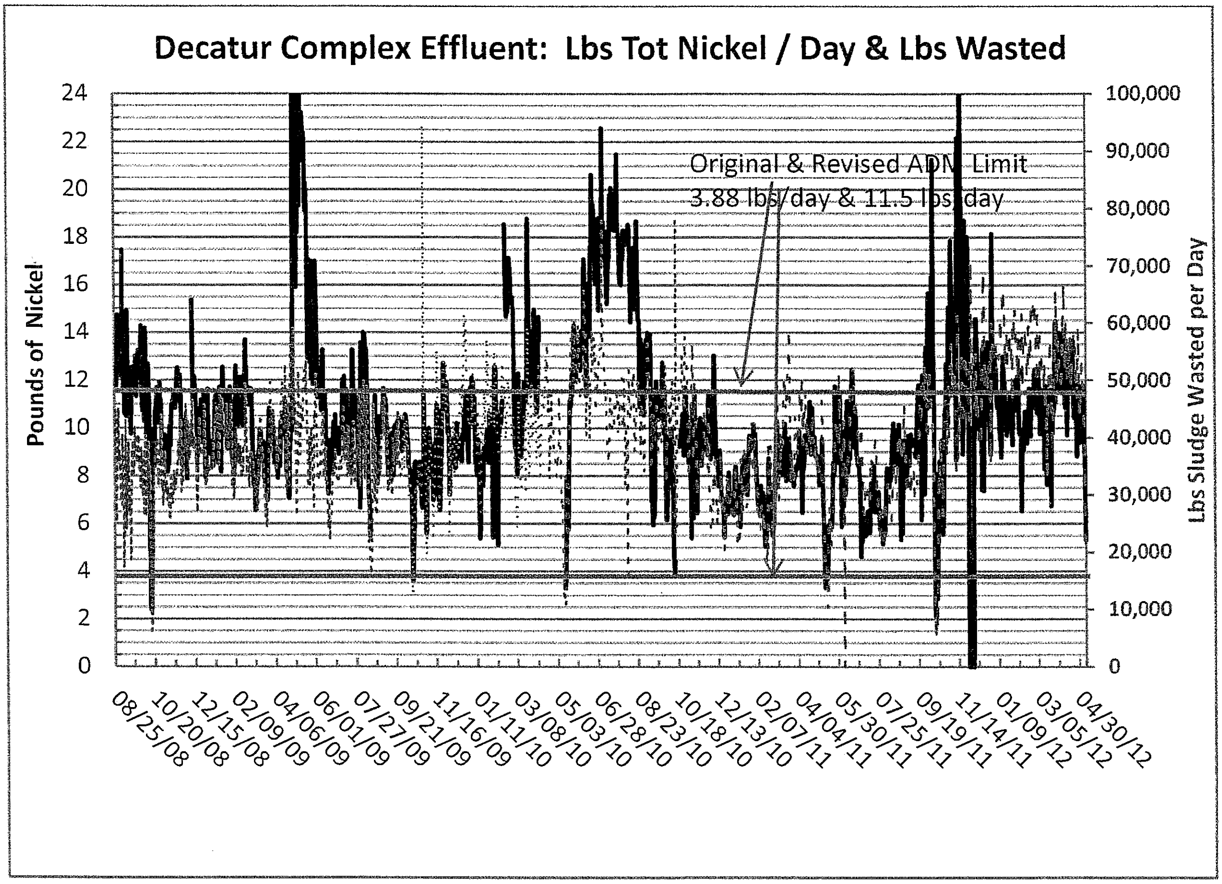



Figure 4 Sludge wasting and Total Nickel ADM WWTP

As reported in the 2010 and 2011 updates, ADM has, thus far, investigated 44 technologies that had the potential to control nickel at the Decatur Complex WWTP. (This was in addition to the work ADM has undertaken to reduce nickel within the individual wastewater streams.) As indicated in Table 1, these technologies can be segregated into six broad categories:

1. Nickel Proprietary Precipitation Process;
2. Nickel Chemical Precipitation;
3. Ion Exchange Resin;
4. Filtration;
5. pH Modification
6. Noncommercial, Experimental Technologies.

Additional details about some of the technologies identified in Table 1 are presented in Table 2, including a general list of reasons why certain of those technologies are not technically feasible and are not currently being pursued.

While most of the technologies evaluated were not found to be technically feasible, ADM identified one technology it had not already actively pursued that it will continue pursuing to reduce nickel at its Polyols Plant. In particular, ADM investigated a technology using pH modification for precipitation of nickel as a hydroxide. During its evaluation, ADM determined that the inorganic nickel present in the effluent leaving the Polyols Plant (which averages about 40,000 gallons per day out of the 11 million gals per day (MGD) Decatur Complex flow) can be precipitated using this technique. However, the majority of nickel present in the bulk of waste streams evaluated appears to be in the form of chelated nickel, which requires a pH swing from 7.0 to 10.0 to 3.0 and back to 7.0. Thus, while pH modification has been determined to be technically feasible to reduce nickel from the Polyols Plant's effluent, the results show that there is still much work to be done to understand and manage the anticipated swings in pH for the entire Decatur Complex. Nevertheless, ADM is committed to determining how to implement this change on the Polyols Plant process stream. It is important to note that, due to the high volume of acid and base that will be required for changing the pH of the waste streams, this approach was not pursued for the dissolved air flotation ("DAF") where the daily volume averages 11.5 MGD effluent, as compared to 0.037 MGD for the Polyols Plant. It is also important to note that, although determined not to be technically feasible, ADM continues to trial polymeric dimethyl dithiocarbamate for use in ADM's final wastewater effluent. This technology would consist of a polymeric dimethyl dithiocarbamate addition to precipitate soluble nickel followed by coagulation and filtration to remove the solid nickel polymer complex. To date, ADM has had reasonable success in some trials with removing 40-60% of the soluble nickel present in DAF effluent water. However, there are still a number of significant technical obstacles to employing this nickel reduction technology, such as scaling, residence time, chemical usage, and nickel reduction percentage and consistency. Further, even if the obstacles inherent in this technology could be overcome, ADM believes that it will continue to be cost prohibitive to employ. Table 3, summarizes the capital, operating and chemical costs for the approaches it is scaling and either installing or continuing to trial.

Thus, of all of the technologies investigated by ADM to date, the only viable option that has not already been fully planned, installed or employed by ADM is the nickel capture process based upon high pH precipitation at the Polyols Plant. Because such technology has been determined to be both technically feasible and economically reasonable for the specific application, ADM will install that system at the Polyols Plant after necessary pilot testing is complete. However, that reduction, even when combined with the other reductions achieved by ADM, will still not reduce nickel to the levels sought by the District under its current permit. Even if ADM could overcome the technical obstacles it faces regarding the use of polymeric dimethyl dithiocarbamate to reduce nickel from the final wastewater effluent, testing indicates that residual soluble nickel concentrations close to 0.050 mg/L will remain irrespective of contact time and incoming nickel levels. ADM's investment to date to identify and implement viable solutions to meet the nickel standard has been approximately $1.02 million in employee costs and $0.45 million in equipment rental and pilot trial costs from 2009 to December 2011. In addition, ADM has spent $0.45 million to install a resin capture system at the Decatur Sorbitol plant. It is also preparing to spend an additional $2.5 million to install a system to allow removal of the soy molasses stream and roughly $0.75 million to install a high pH precipitation and filtration process at the Polyols Plant. ADM has also significantly improved housekeeping in the West Plant to minimize nickel catalyst from entering the wastewater system. Finally, ADM continues to investigate the ability to scale up a potentially viable chemical technology for installation at the Decatur Complex WWTP based on polymeric dimethyl dithiocarbamate to reduce nickel from its effluent. At this point, all reasonably identifiable options have been explored and all technically feasible and economically reasonable solutions are being pursued

Table 1 Summary of Technologies Reviewed by ADM

| | *Chemistry* | *Dosage* | *Nickel Reduction (%)* | *Current Status* | *Nitratox/ Respirometer Testing** | *Technically Feasible (y/n)* | *Economically Reasonable (y/n)* |
|---|---|---|---|---|---|---|---|
| **Category 1 - Nickel Proprietary Precipitation Process** | | | | | | | |
| | | | | | | | |
| [redacted] | Activated Clay | 1%-3% by weight of clay | 40%-60% (from 200ppb influent) | Not Active, High dosages unscalable. | Not tested. | No | No |
| [redacted] | Acidic Clay | 4%-8% w/w | 40% (from 90ppb influent) | Stopped. High dosage. | Not tested. | No | No |
| [redacted] | Chitosan Based | 5% w/w | 90% from 200 ppb influent | Abandoned. High dosage, | Not | No | No |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| [redacted] | | | | Concerns with Chitosan Availability | tested. | | |
| [redacted] | Proprietary | 2% w/w | 82% (from 100ppb) | Abandoned. Company went out of business | Not tested. | No | No |
| [redacted] | Metclear | 200 ppm | 64% (from 120ppb) | Shelved. Strong pH swing (acidification to pH 2, alkalination to 10 and neutralization) | Not tested. | No | No |
| [redacted] | Not disclosed | Not disclosed | 40-60% (from 200ppb) | Shelved. Company not sharing samples. | Not tested. | No | No |
| **Category 2 - Nickel Chemical Precipitation Process Using Carbamates or Organic Sulfides** | | | | | | | |
| [redacted] | Polymeric Dimethyl Dithiocarbamate | 100ppm with 50ppm of CaCl2 | 30% from 150ppb | Piloted. Total Nickel reduction to 60ppb. | Passed | No | No |
| [redacted] | Polymeric Dimethyl Dithiocarbamate | 20-50ppm | 60% from 150ppb | Piloted. Total Nickel reduction to 54 ppb. | Passed | Yes | No |
| [redacted] | Polymeric Dimethyl Dithiocarbamate | 100ppm | 41% from 150ppb | Piloted. Total Nickel reduction to 32ppb | Passed | Yes | No |
| [redacted] | Dimethyl Dithiocarbamate | 50ppm + pH 6.0 | 76% from 150ppb | Piloted. Nickel reduction seen to 40ppb | Passed | Yes | No |
| [redacted] | Polymeric Dimethyl Dithiocarbamate | 300ppm + pH swing | 30% | Not active. Modified chemistry from Nalco being tested | Not tested. | No | No |
| [redacted] | Polymeric Dimethyl Dithiocarbamate | 50ppm | 48% from 100ppb | Piloted. Nickel reduction seen to 20ppb | Passed | Yes | No |
| [redacted] | Polymeric Dimethyl Dithiocarbamate | 200ppm | 52% from 150ppb | Piloted. Nickel reduction seen to 39 ppb | Passed | No | No |
| [redacted] | Polymeric Dimethyl Dithiocarbamate | 100ppm | 40% from 150ppb | Not piloted. GE has not scaled up commercial manufacturing. | Not tested. | No | No |
| [redacted] | Dimethyl Dithiocarbamate | 100ppm | 60% from 150ppb | Piloted. Nickel reduction seen to 24 ppb | Passed | No | No |
| **Category 3 - Non Functional Resins** | | | | | | | |
| [redacted] | Styrene Divinyl Benzene | 2-5% w/w | 20% | Not scaled. High regeneration costs | Not tested | No | No |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| [redacted] | Styrene Divinyl Benzene | 4% w/w | 60% | Not scaled. Very high resin use. Caustic /ethanol based regeneration | Not tested | No | No |
| [redacted] | Immobilized Ion Exchange Beads | 5% | Not significant | Shelved | Not tested | No | No |
| **Category 4 - Reuse of Ion Exchange Resin** | | | | | | | |
| [redacted] | Sulfonic | 0.1-0.5% | Complete removal of Ionic Nickel from the Sorbitol plant waste | Installed at Sorbitol plant | Not required | Yes | Yes |
| | | | | | | | |
| **Category 5 - Filtration** | | | | | | | |
| [redacted] | Phosphate precipitation + Reverse Osmosis | 80% recovery of feed | 95%+ reduction | Shelved. Brine disposal issues. High capex | Not required | No | No |
| [redacted] | Low pressure Reverse Osmosis | 30% recovery of feed | 80% + reduction | Shelved. Brine disposal issues. High capex | Not required | No | No |
| [redacted] | Sand Filter | Not disclosed | 20% reduction | Insufficient efficacy | Not required | No | No |
| **Category 6 - Other Approaches** | | | | | | | |
| [redacted] | Carbon Aerogels | Not tested | Not tested | Company went out of business. CD also binds other ions | Not tested | No | No |
| [redacted] | Electrochemical | Not disclosed | Higher Nickel due to leaching from electrode plates | Shelved after 4 trials. | Not tested | No | No |
| [redacted] | Ferric Chloride | 100ppm | 40% | Unscalable due to chloride limits | Not tested | No | No |
| [redacted] | Protein | not tested | Not tested | Lab scale only | Not tested | No | No |
| [redacted] | Hydrogen Peroxide and Ozone | 5% w/w + pH adjustmen t | 20% from 150ppb | Significant chemical usage | Not tested | No | No |
| [redacted] | Protein based | Not disclosed | Not tested | Other ions compete with nickel. Not scalable. | Not tested | No | No |
| [redacted] | pH Swing | 1-3% w/w | 30% from 150ppb | Very high chemical usage. | Not tested | No | No |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| [redacted] | pH >11.0 | 1-2% w/w | Complete for ionic regeneration waste | Being piloted at polyol plant for waste stream | Not tested | Yes | Yes |

***Table 2: Technical Challenges on Scale Up for Nickel Remediation Chemistries***

| ***Technology / Provider*** | ***cooperative with*** | ***determined not*** | ***Not commercially available*** | ***High Dosages required*** | ***Results not scalable beyond bench scale*** | ***Low recoveries and brine disposal concerns*** | ***Technically Feasible (y/n)*** | ***Comments*** |
|---|---|---|---|---|---|---|---|---|
| [redacted] | X | | X | | | | No | |
| [redacted] | | X | | X | | | No | Would require 5 million pounds of additive per day |
| [redacted] | | | X | X | | | No | |
| [redacted] | X | | | X | | | No | |
| [redacted] | | | | X | | | No | Requires a pH to <2 then to pH 5.5 then to pH 10 |
| [redacted] | X | | | | | | No | |
| [redacted] | | | | | X | | No | Plant pilot trial did not achieve required Nickel reduction. |
| [redacted] | | X | | | X | | No | Plant pilot trial did not achieve required Nickel reduction. |
| [redacted] | | | | | X | | No | Plant pilot trial did not achieve required Nickel reduction. |
| [redacted] | | | X | | | | No | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| [redacted] | | | | | | | No | |
| [redacted] | | | | X | | | No | |
| [redacted] | | | | X | | | No | Decolorization resin needs 3,000 cubic feet of resin at $300/cubic foot. Resin, beds and regeneration equipment estimated at $8 - 10 million and uses Ethanol to regenerate resin. |
| [redacted] | | X | | X | | | No | |
| [redacted] | | | | | | | Yes* | Installed at Sorbitol plant |
| [redacted] | | | | | | X | No | |
| [redacted] | | | | | | X | No | |
| [redacted] | | | | | | X | No | |
| [redacted] | | | X | | | | No | |
| [redacted] | | X | X | | | | No | |
| [redacted] | | X | | | | | No | Requires over 30,000 pounds of ferric salts per day |
| [redacted] | | | X | | | | No | |
| [redacted] | | X | | | | | No | Raise the pH 10 and add ozone and hydrogen |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | peroxide. Large amounts of chemicals required. |
| [redacted] | | | X | | | | No | |
| [redacted] | | | | | | | Yes | Suitable for <~50,000 GPD, non-grain based wastewater with non-chelated, salt-form nickel such as Polyols Plant IX regen waste |
| * The amount of used ion exchange resin is limited and it is most effective on non-chelated nickel. Therefore, it is being used to capture nickel from the sorbitol process. | | | | | | | | |

| **Table 3: Capital and Operating Costs for Nickel Removal at ADM Decatur Complex** | | | |
|---|---|---|---|
| | **Initial Capital Cost** | **Annual Operating & Chemical Costs** | **Status** |
| **Active Projects** | | | |
| 1) Soybean Process Stream Alternative | $2.7 million | $400,000 | Planned |
| 2) Used IX resin system at Sorbitol Plant | $450,000 | $200,000 | Installed |
| 3) High pH precipitation at Polyols Plant | $750,000 | $600,000 | Planned |
| **Further Technical Analysis/Cost Prohibitive** | | | |
| 1) Polymeric DTC addition and nickel removal using different unit operations | | | Being piloted |
| *a) Settling Clarifier and Sand Filter* | $25.58 million | $7.2 million | Being piloted |
| *b) Sand Float Filter* | $23.14 million | $7.2 million | Being piloted |

| | | | |
|---|---|---|---|
| c) *Sand Filter + precipitation* | $24.48 million | $7.2 million | Being piloted |
| d) *DE Filtration + Precipitation* | $14.97 million | $7.2 million | Being piloted |
| e) *DE Filtration* | $ 7.05 million | $7.2 million | Being piloted |
| f) *Sand Filter* | $13.57 million | $7.2 million | Being piloted |

## 2 Reduction in total and soluble nickel between ADM Discharge and SDD effluent

We ran a 5 week trial where in Front and Damon were monitored and compared to corresponding results for SDD Influent and Effluent. While some variability was seen in nickel reduction to SDD influent we are seeing a consistent 80% reduction in total nickel and 59% in soluble nickel to the SDD effluent from the effluent as shown in Table 4.

| | Table 4: Reduction in total and soluble Nickel between ADM and SDD | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Front | Damon | Flow Averaged F+D | SDD Influent | SDD Effluent | Front | Damon | Flow Average F+D | SDD Influent | SDD Effluent | % Reduction in flow averaged Total Nickel | % Reduction in Flow averaged soluble nickel |
| | Total | | | | | Soluble | | | | | | |
| 1/9/2012 | 0.1195 | 0.1240 | 0.1217 | 0.0562 | 0.0270 | 0.0521 | 0.0563 | 0.0542. | 0.0299 | 0.0277 | 78% | 49% |
| 1/11/2012 | 0.1244 | 0.1172 | 0.1132 | 0.0267 | 0.0254 | 0.0563 | 0.0584 | 0.0537 | 0.0250 | 0.0241 | 78% | 55% |
| 1/13/2012 | 0.1250 | 0.0904 | 0.1321 | 0.0343 | 0.0286 | 0.0498 | 0.0541 | 0.0637 | 0.0266 | 0.0285 | 78% | 55% |
| 1/16/2012 | 0.1180 | 0.0933 | 0.1281 | 0.0507 | 0.0255 | 0.0516 | 0.0541 | 0.0641 | 0.0264 | 0.0259 | 80% | 60% |
| 1/18/2012 | 0.1170 | 0.1078 | 0.1286 | 0.0990 | 0.0242 | 0.0530 | 0.0567 | 0.0628 | 0.0237 | 0.0231 | 81% | 63% |
| 1/20/2012 | 0.0960 | 0.0703 | 0.1138 | 0.0653 | 0.0274 | 0.0368 | 0.0563 | 0.0637 | 0.0271 | 0.0273 | 76% | 57% |
| 1/23/2012 | 0.1190 | 0.0930 | 0.1242 | 0.0627 | 0.0285 | 0.0533 | 0.0581 | 0.0652 | 0.0268 | 0.0278 | 77% | 57% |
| 1/27/2012 | 0.1110 | 0.1017 | 0.1200 | 0.0353 | 0.0149 | 0.0421 | 0.0467 | 0.0501 | 0.0108 | 0.0145 | 88% | 71% |
| 1/30/2012 | 0.1190 | 0.1034 | 0.1248 | 0.0455 | 0.0161 | 0.0542 | 0.0501 | 0.0585 | 0.0171 | 0.0164 | 87% | 72% |
| 2/1/2012 | 0.1164 | 0.1413 | 0.1298 | 0.0815 | 0.0216 | 0.0491 | 0.0496 | 0.0497 | 0.0240 | 0.0220 | 83% | 56% |
| 2/3/2012 | 0.1058 | 0.1304 | 0.1197 | 0.2769 | 0.0245 | 0.0500 | 0.0520 | 0.0517 | 0.0404 | 0.0262 | 80% | 49% |
| | | | | | | | | | | Average | 80% | 59% |

ADM continues to operate its pilot plant for chemical sequestration of nickel as needed. Since fall 2011, the chemicals being investigated at the pilot plant have been narrowed to those from Nalco and Hydrite.

*"By July 1, 2012 the District must complete the following tasks:*

*Submit a final compliance plan to [the Agency] containing nickel and zinc controls, treatment technologies, proposed permit modifications, or proposed site-specific water quality standards that will achieve compliance with permit limits.*

- ***ADM / SDD Variance, p. 29.***

ADM met with the SDD and IEPA on May 8, 2012 and provided them with an overview detailing the progress and ADM's compliance efforts. In addition it was agreed that our petition to the PCB would be part of the compliance plan for ADM to meet our July 1, 2012 deadline.

## 3 Corn Plant used IX system

As previously disclosed, ADM has been working to install a used ion exchange resin bed system to capture nickel leaching from the sorbitol process catalyst. This system has been running manually for the past 6 weeks. Thus far, about 5 lbs of nickel have been removed from the treated stream and no nickel has been detected in the effluent. This is shown in Figure 5. We are using 105 cu ft of resin and expect a nickel binding capacity of about 3.4 lbs per cubic ft.

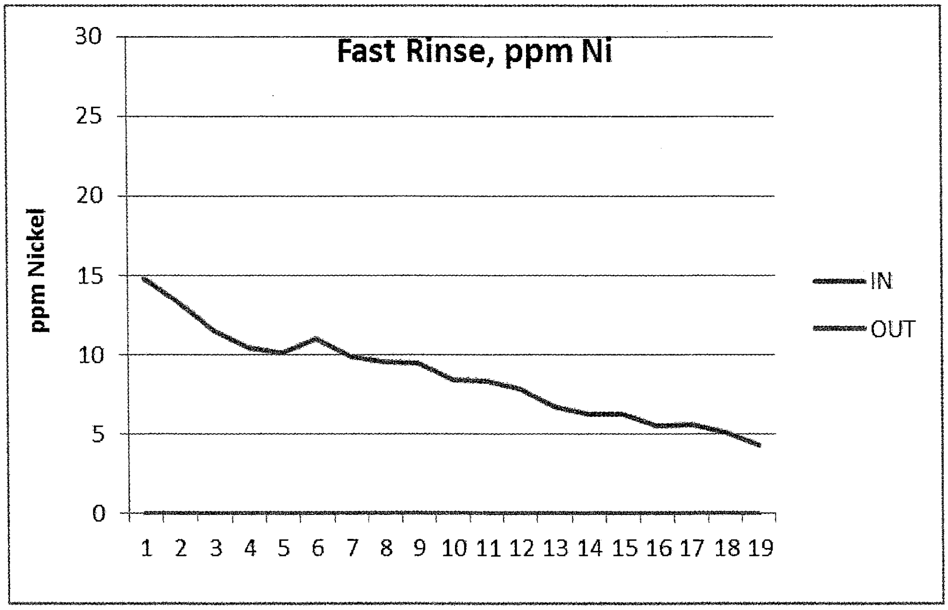



Figure 5: Used ion exchange resin treating material leaving the sorbitol process

In addition we have compiled results for soluble nickel in the refinery waste stream and see a75% reduction in soluble nickel due to better housekeeping and check filters for capturing waste catalyst.

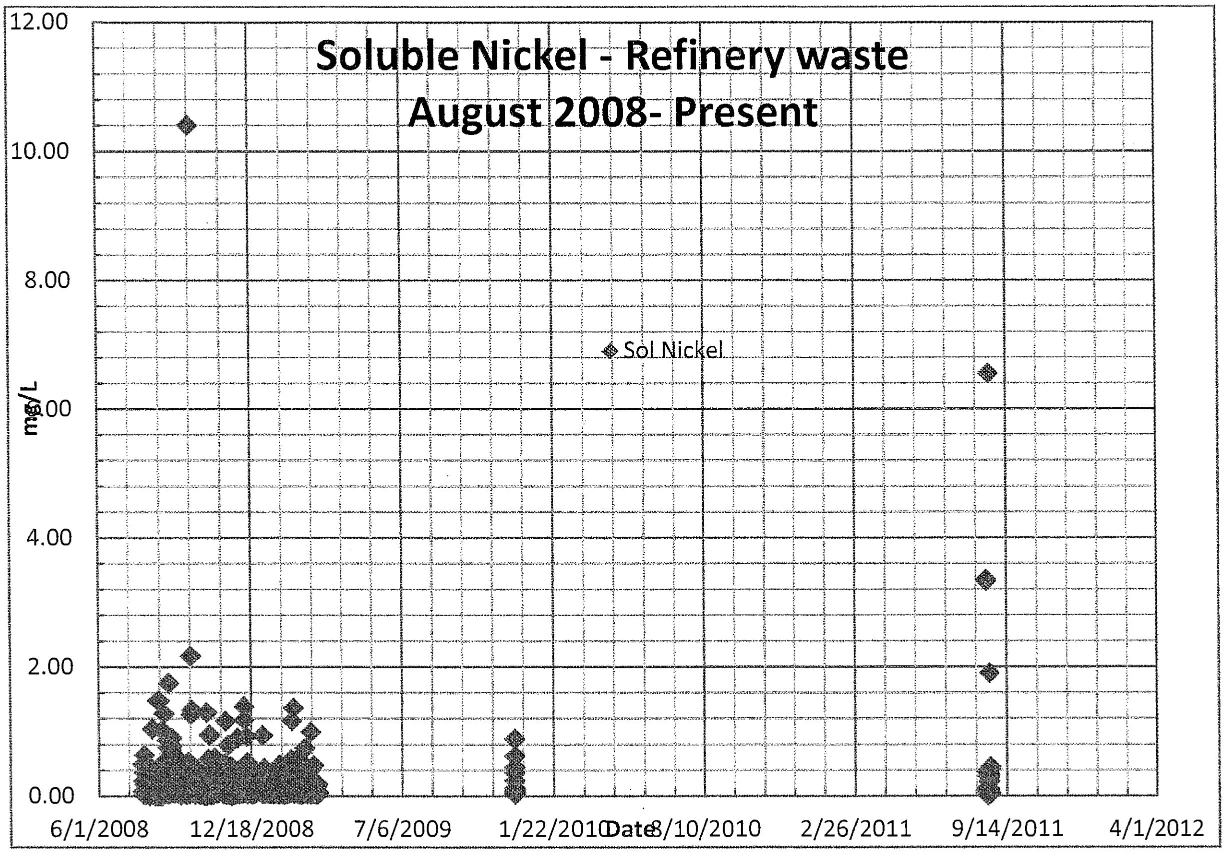



Figure 6 Soluble Nickel reduction on corn plant refinery waste

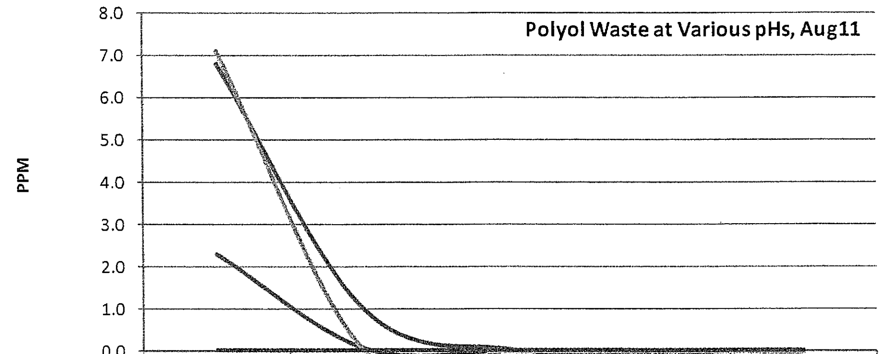
## 4 Review Ceased for Technologies

Since the 2011 update, we have ceased trials with polymeric DTC from Kroff 9011 and Hychem DP4. We continue to evaluate the options for scale and will be reporting as progress is made on the same.

## 5 Polyol waste stream treatment

We have identified our polyol ix waste stream (between 16-22% of total nickel load) as a significant contributor of inorganic nickel due to corrosion of our distillation columns. Initial work using high pH precipitation has shown almost a complete removal of soluble nickel.

Initial work suggests a pH modification would eliminate all soluble nickel from the IX regen streams with chemical costs about $300 per day.




| | Polyol 8/12-15, 8/17 Comp As Is | Polyol Comp 9pH | Polyol Comp 10pH | Polyol Comp 11pH | Polyol Comp 12pH |
|---|---|---|---|---|---|
| Nickel | 6.81 | 1.01 | 0.063 | 0.000 | 0.007 |
| Chromium | 2.31 | 0.083 | 0.025 | 0.006 | 0.014 |
| Iron | 7.10 | 0.034 | 0.012 | 0.000 | 0.014 |
| Moly | 0.052 | 0.049 | 0.047 | 0.047 | 0.052 |

**Figure 7 Effect of pH on precipitation on Polyol ion exchange regeneration streams.**

| Table 5: High pH precipitation of Polyol ion exchange regeneration streams | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | **Adjust to 10pH:** | | |
| 2.5 | %NaOH, w/w | Polyol Flows: | lbs / day | | lbs 50% NaOH / day | | $ / day |
| 90 | sample, ml | 8/12/11 | 61,400 | | 3,014 | | $301 |
| 10.45 | g NaOH to 9pH | 8/13/11 | 65,400 | | 3,210 | | $321 |
| 10.6 | g NaOH to 10pH | 8/14/11 | 60,730 | | 2,981 | | $298 |
| 10.8 | g NaOH to 11pH | 8/15/11 | 119,800 | | 5,880 | | $588 |
| 16.4 | g NaOH to 12.2pH | 8/17/11 | 27,940 | | 1,371 | | $137 |
| $0.10 | 50% Caust / lb | | | | | | |
| | | | | | | | |
| **1.6** | **Starting pH** | | | | | | |

The Process Development group at ADM BioProducts has investigated using gypsum (Table 7) as a filter media and seen nickel reductions over using a 0.1um Filter (Table 6).

| **Table 6: 0.1 micron Buchner Filtration of Polyol IX regeneration stream** | | | |
|---|---|---|---|
| Sample (ppm) | Ni | Zn | |
| Waste Water Feed | 860.32 | 3.76 | |
| Waste water/NaOH solution | 658.897 | 2.90 | |
| Treated and filtered waste water | 0.300 | 0.015 | |

**Note**: Feed was a composite of the discharge from the acid-in and slow rinse cycle in a proportion that is representative of the volume of water used in each cycle. Precipitate was passed through a Buchner filter with a 0.1um filter.

| **Table 7: Gypsum Filtration of Polyol IX regeneration stream** | | | |
|---|---|---|---|
| Sample Name | Ni | Zn | |
| | mg/kg | mg/kg | |
| Waste water/NaOH solution | 689.0 | 2.66 | |
| Treated and filtered waste water | 81.94 | 0.705 | |

**Note**: Feed was a composite of the discharge from the acid-in and slow rinse cycle in a proportion that is representative of the volume of water used in each cycle. Precipitated feed was fed to a Buchner funnel with $CaSO_4$ as filter media.

## 6 Appendix A Respirometer and Nitratox Testing

Results from Respirometer and Nitratox testing of Decatur Sanitary Districts MLSS using nickel reduction chemistries piloted at ADM.

Riverbend Laboratories performed respirometer and Nitratox testing of the four chemistries currently being testing using SDD's MLSS. The chemistries were dosed at ~20ppm and ~200ppm and diluted 50:50 with fresh DAF to simulate a scenario envisioned by the Decatur Sanitary District.

Toxicity Test ADM Decatur / ALAR Effluent (2) May 2012

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**Executive Summary:**
The following are the results for the ADM Decatur ALAR Effluent for Anaerobic Toxicity

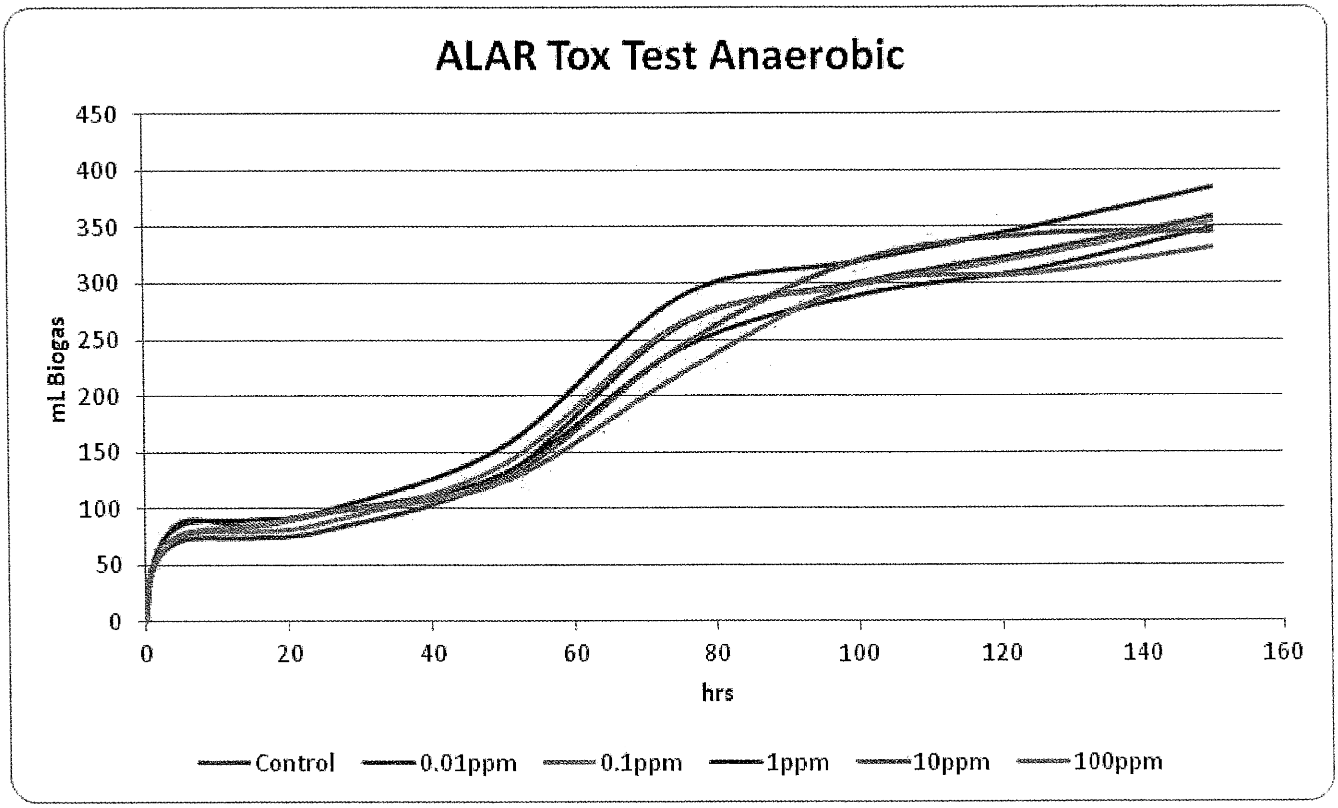
- **The testing showed no definite toxicity at all. There was no trend towards higher concentrations causing more toxicity. This material appears to be safe to use anaerobically.**

**Method:**
Respirometery measures the biogas generation in mL of the samples. Samples were 200 mL sludge. Each influent was adjusted independently then added to the biomass for each variable the bottles were run at 98deg F and biogas production was recorded. Each bottle had various concentrations of ALAR polymer (raw) added to anaerobic influent and an added concentration of MgOH that was then pH adjusted to 7.5.

- Control – Sludge and normal Influent
- 0.01 ppm – 0.01 ppm ALAR & Sludge and normal Influent
- 0.1 ppm – 0.1 ppm ALAR & Sludge and normal Influent
- 1 ppm – 1 ppm ALAR & Sludge and normal Influent
- 10 ppm - 10 ppm ALAR & Sludge and normal Influent
- 100 ppm - 100 ppm ALAR & Sludge and normal Influent

**Results:**

This testing showed that, with equally set up bottles, increasing the concentration of the ALAR chemical had no effect at all. The gas production varied across every concentration, but in general they all followed each other and there was not a statistical difference between the samples, nor a trend as concentrations increased.




ADM & City of Decatur / Respirometry Results (2) / 5/14/12

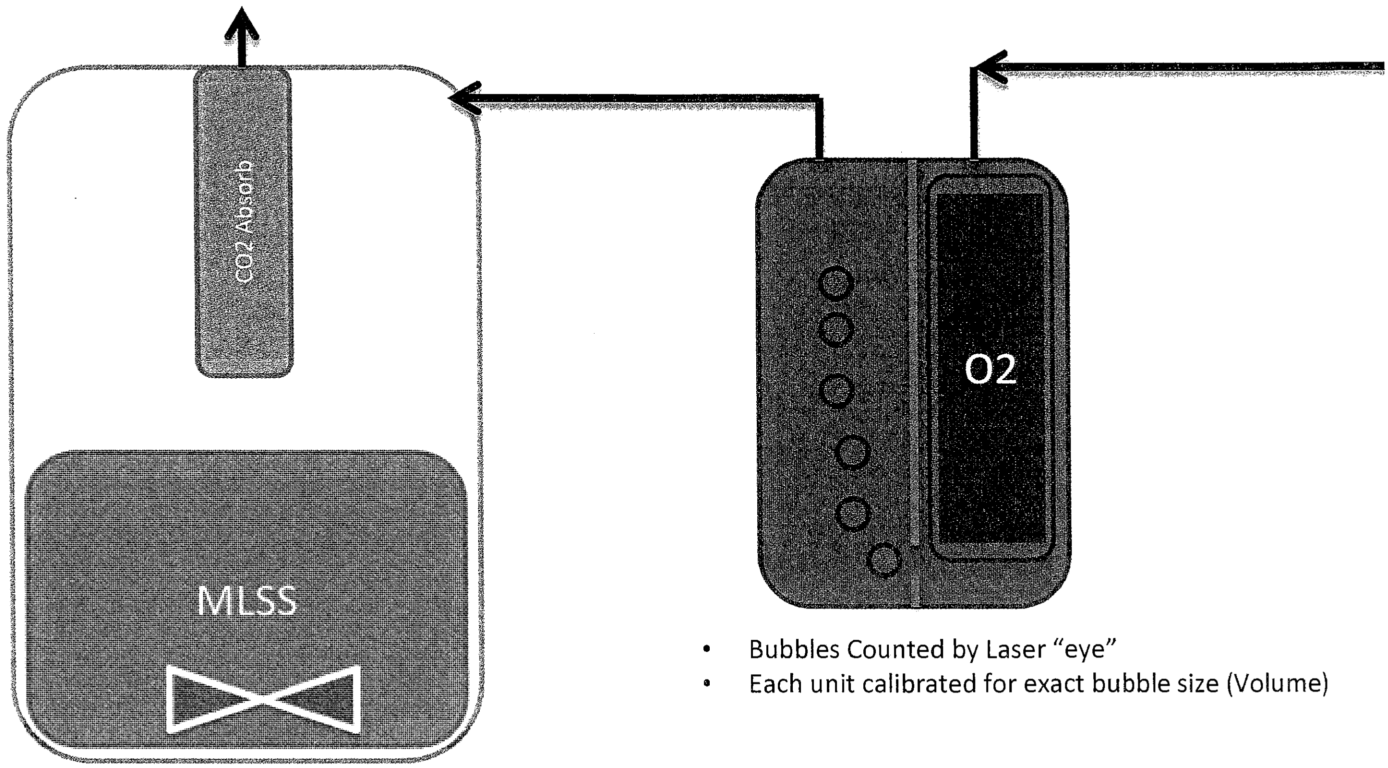
**Executive Summary:**

In all cases the chemistries showed no toxicity or inhibition. The lines were almost exactly the same.

I do not think any toxicity exists for this concentration of ALAR effluent.

**Method:**

The method involves setting up several identical bottles on a Challenge Respirometer in aerobic mode. The Challenge Respirometer accurately measures minute changes in oxygen uptake for the bacteria culture in question. This allows us to look at the total possible toxicity to the aeration bacteria (Aerobic Heterotrophs and Nitrifiers combined). By utilizing a control (normal conditions, we can establish a baseline oxygen uptake and then add various amounts of chemicals or suspect waste stream to be tested to see if there are any toxic (lower oxygen uptake) reactions with the biology. In this case all reactors were held at pH 7.5 (+/-0.2) and a temp of 80F (+/- 5.0)



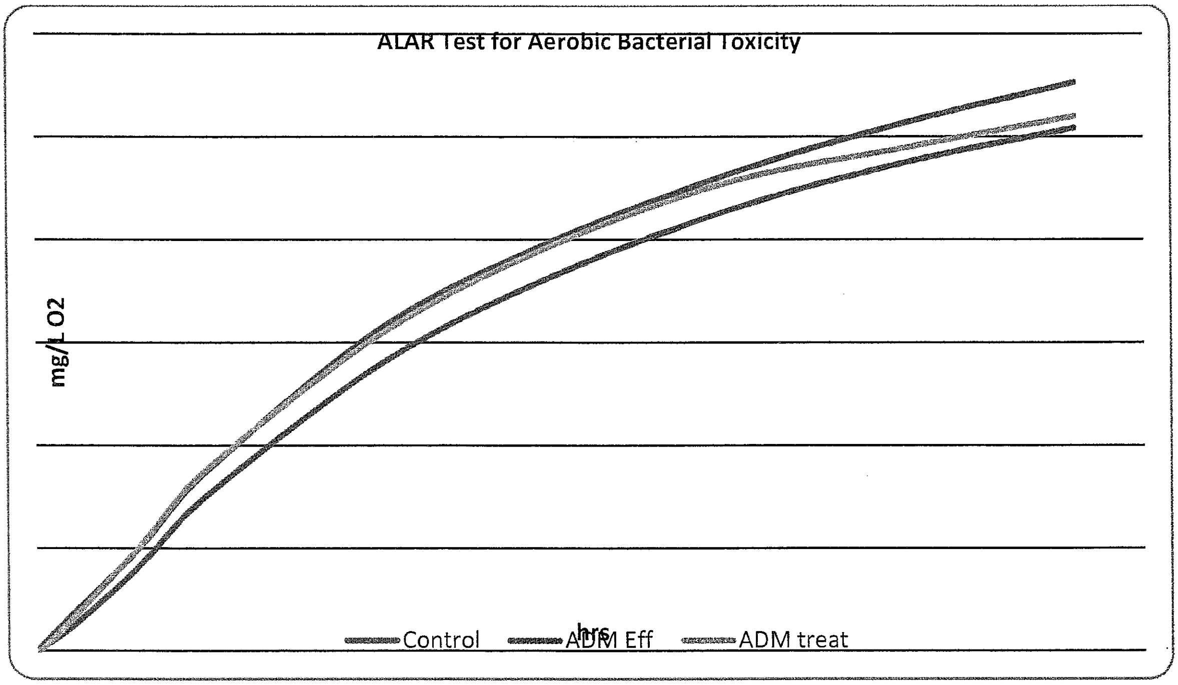

- Bubbles Counted by Laser "eye"
- Each unit calibrated for exact bubble size (Volume)

- Bottle in Bath to hold Temp to Field Conditions
- All Bottles same liquid level
- All Bottles Same rotation Speed

In this test we looked at the following.

- **Control** – 200 mL Mixed Liquor (city), 100mL City Influent
- **ADM** – 200 mL Mixed Liquor (city), 40mL City Influent, 60mL ADM Effluent
- **ADMALAR** – 200 mL Mixed Liquor (city), 40mL City Influent, 60mL ADM Effluent after ALAR treatment.

**Results:**
Every line matched the control almost exactly, or within statistical error. The slopes also correspond with no negative inflections or deviations. This material seems to not be toxic to Heterotrophic bacteria at the City of Decatur.




City Decatur / Nitratox Test Results / 5-10-12

**Executive Summary:**

We saw inhibition again in all samples containing City Influent. I included a graph of the last test as well as a good test from last year for comparison below.

**Method:**

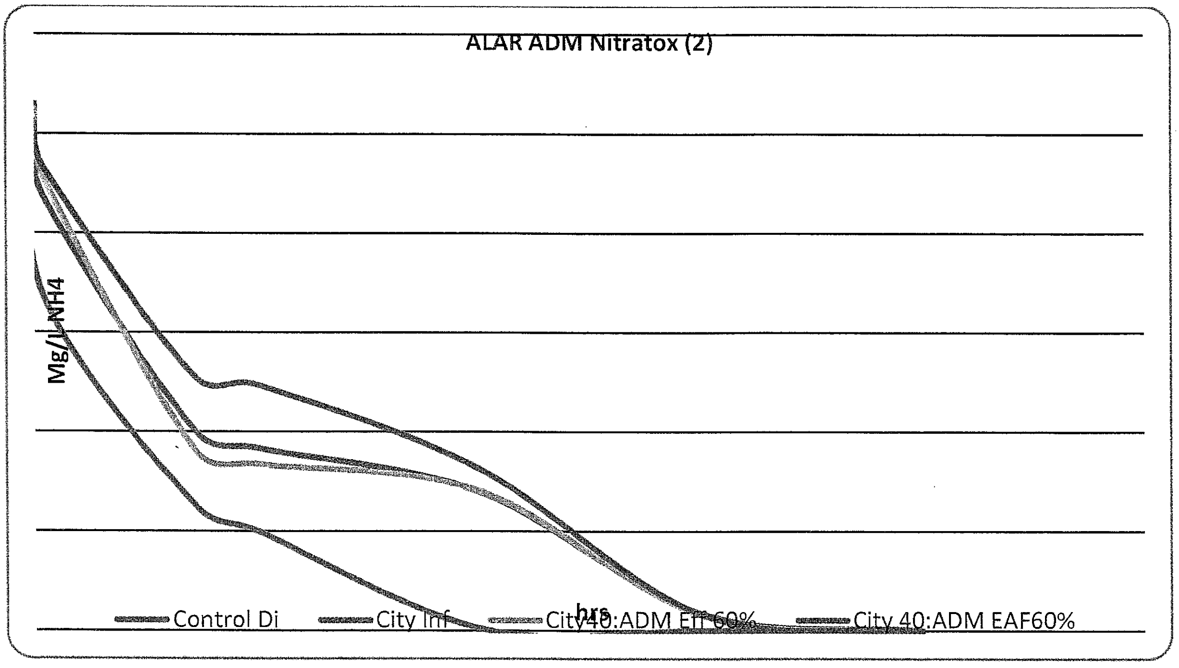
The general method involves setting up each test bottle with a specific volume of pure culture nitrifiers, DI water, and a then a specific concentration of NH4-N (in this case approx. 100 mg/L). Each bottle is aerated with exactly the same air flow through a diffuser. A control is maintained and then various concentrations of a suspect chemical or waste stream are added to each variable bottle. NH4-N is then measured throughout the test (1hr, 8 hrs. 24 hours, 48, hours, 72 hours). All reactors are buffered to 7.5 pH.

In this test we looked at the following.

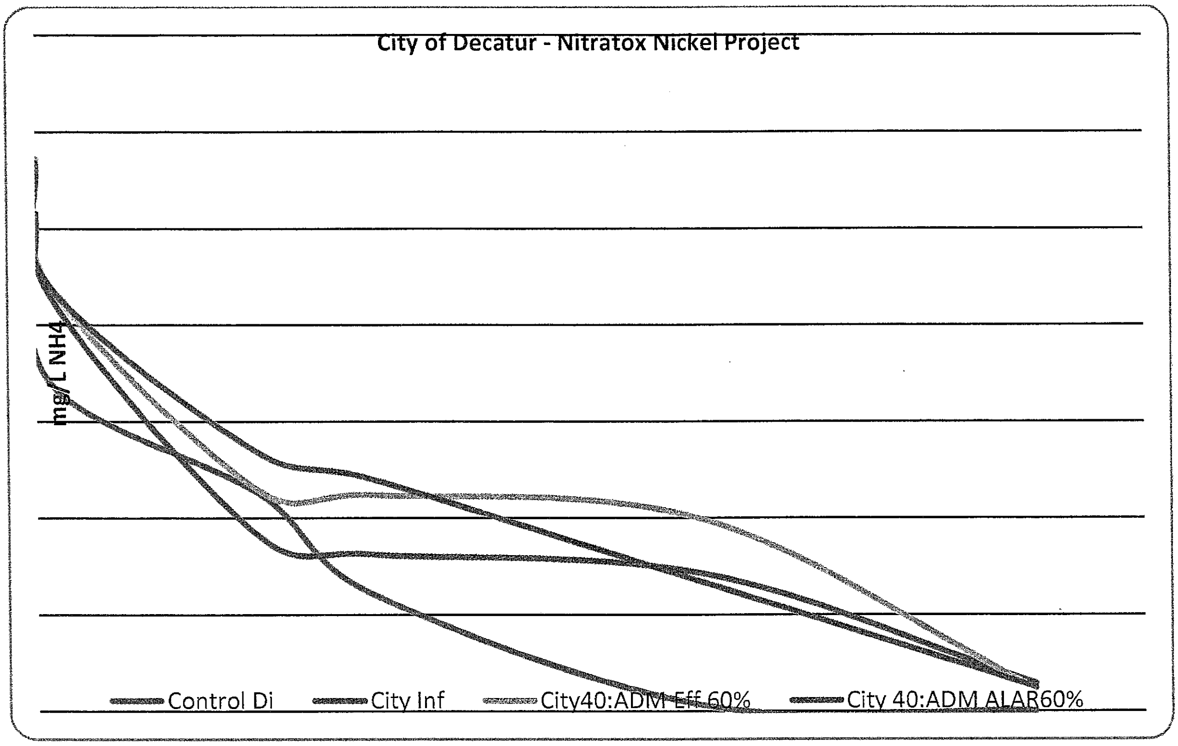
- **Control DI** – DI water, Nitrifiers, Ammonia (110 ppm)
- **City Inf** –Nitrifiers, Ammonia (110 ppm) 100% City Influent
- **City40: ADM Eff 60%** – Nitrifiers, Ammonia (110 ppm) 40% City Influent, 60% ADM Effluent.
- **City 40: ADM ALAR60%** - Nitrifiers, Ammonia (110 ppm) 40% City Influent, 60% ADM Effluent after ALAR treatment.

**Results:**
We saw some nitrification inhibition on all samples, but the DI water control. Again this points to something inhibiting on the city influent to nitrification. I have included 2 more graphs besides the normal one for this testing. The second graph is the testing from before.

Note the similarity in the curves for the last test and this test. It looks like moderate inhibition to the second step of nitrification, Nitrobacteria. Had the DI water sample responded the same I would have thought it a bad batch of our nitrifiers, but they handled the NH4 fine.




Last Test from last month below




Example of good test back on 10-11-11